Environmental Impact Assessment (Draft)

Document Stage: Draft
Project Number: 47341-004
June 2019

IND: South Asia Subregional Economic Cooperation Road Connectivity Investment Program – Tranche 3

Imphal - Moreh Road (Khongkhang-Moreh section)

Prepared by National Highways & Infrastructure Development Corporation Limited (NHIDCL), Government of India for the Asian Development Bank.

CURRENCY EQUIVALENTS
(As of 31 March 2019)

Currency unit	=	Indian rupee/s (Re/Rs)
Re1.00	=	$0.01440
$1.00	=	Rs69.4431

ABBREVIATIONS

AADT	–	Annual Average Daily Traffic
AAQM	–	Ambient air quality monitoring
ADB	–	Asian Development Bank
ASI	–	Archaeological Survey of India
BDL	–	Below detectable limit
BGL	–	Below ground level
BOD	–	Biochemical oxygen demand
BOQ	–	Bill of quantity
CGWA	–	Central Ground Water Authority
CO	–	Carbon monoxide
COD	–	Chemical oxygen demand
CPCB	–	Central Pollution Control Board
CSC	–	Construction Supervision Consultant
DFO	–	Divisional Forest Officer
DG	–	Diesel generating set
DO	–	Dissolved oxygen
DPR	–	Detailed project report
E&S	–	Environment and social
EA	–	Executing agency
EAC	–	Expert Appraisal Committee
EFP	–	Environmental Focal Person
EHS	–	Environment Health and Safety
EIA	–	Environmental impact assessment
EMOP	–	Environmental monitoring plan
EMP	–	Environmental management plan
ESCAP	–	United Nations Economic and Social Commission for Asia and Pacific
GHG	–	Greenhouse gas
GIS	–	Geographical information system
GOI	–	Government of India
GRC	–	Grievance redress committee
GRM	–	Grievance redress mechanism
HFL	–	Highest flood level
IA	–	Implementing Agency
IEE	–	Initial Environmental Examination
IMD	–	Indian Meteorological Department
IRC	–	Indian Road Congress
IUCN	–	International Union for Conservation of Nature
LHS	–	Left hand side
LPG	–	Liquefied petroleum gas
MOEFCC	–	Ministry of Environment, Forests and Climate Change
MORTH	–	Ministry of Road Transport and Highways
NHIDCL	–	National Highways & Infrastructure Development Corporation Limited

N, S, E, W, NE, SW, NW	–	Wind Directions (North, South, East, West or combination of two directions like South West, North West)
NGO	–	Non-governmental organization
NH	–	National Highway
NOC	–	No Objection Certificate
NOx	–	Oxides of nitrogen
PAH	–	Project Affected Household
PAP	–	Project Affected Persons
PAs	–	Protected Areas
PCR	–	Public Community Resources
PCU	–	Passenger Car Units
PD	–	Project Director
PM	–	Particulate Matter
PIU	–	Project Implementation Unit
PPE	–	Personal protective equipment
PPT	–	Parts per trillion
PPTA	–	Project Preparedness Technical Assistance
PUC	–	Pollution Under Control
R & R	–	Rehabilitation and Resettlement
RHS	–	Right hand side
ROB	–	Road Over Bridge
ROW	–	Right-of-way
RSPM	–	Respiratory suspended particulate matter
SAARC	–	South Asian Association for Regional Corporation
SC	–	Scheduled Cast – Name of a community in India
SEIAA	–	State Environmental Impact Assessment Authority
SEMU	–	Social and Environmental Management Unit
SH	–	State highway
SO_2	–	Sulphur Dioxide
SOI	–	Survey of India
SPCB	–	State Pollution Control Board
SPL	–	Sound Pressure Level
SPM	–	Suspended Particulate Matter
SPS	–	ADB Safeguard Policy Statement, 2009
ST	–	Scheduled Tribes
TA	–	Technical assistance
TDS	–	Total dissolved solids
TSS	–	Total Suspended Solids
UNESCO	–	United Nations Educational, Scientific and Cultural Organization
USEPA	–	United States Environmental Protection Agency
UT	–	Union Territories
ZSI	–	Zoological survey of India

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
ha	–	Hectare
km	–	Kilometer
µg	–	Microgram
m	–	Meter
MW (megawatt)	–	Megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10 micron size

NOTE

In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

A. Introduction

1. This report summarizes the findings and results of the Environmental Impact Assessment (EIA) for 29.51 km Khongkhang - Moreh section of Imphal - Moreh Road (non-sample subproject) located in Manipur State of India. This subproject is proposed for financing under Tranche 3 of ADB's SASEC Road Connectivity Investment Program (SCRIP) in India (the Project). The report also describing the Project, existing environmental conditions in the project area, anticipated environmental impacts and corresponding mitigation measures, public consultation process, the environmental management plan (EMP) and its monitoring plan.

2. The Environmental Impact Assessment (EIA) for the proposed subproject has been carried out as part of project preparation and in compliance with Environmental Assessment and Review Framework (EARF[1]) for the Project.

B. Description of the Project

3. The subproject road section proposed for financing under Tranche 3 is part of the 95.4 kms Imphal - Moreh road section called national highway no. 102 (NH-102) and now renamed as Asian Highway 1 (AH1). The subproject road section starts at Khongkhang (km chainage 395+680) and ends at Moreh town (km chainage 425+196) covering a total length of 29.516 kms. The subproject road is proposed for improvement and upgradation to two lane configurations with shoulders and side drains. Table E.1 shows information about the Project Road.

Table E.1: Information of the Project Road

Name of the Project	Subproject No.	Project Length (km)	Districts	State
Improvement and Upgradation of 29.516 kms Khongkhang-Moreh road section of NH-102 in the State of Manipur	Tranche 3 subproject	29.516	Tengnoupal	Manipur

4. The subproject proposes improvement of 29.516 km section of existing Imphal - Moreh road corridor connecting Myanmar Border (at Moreh) to Imphal (Capital of Manipur). The subproject road corridor traverse through the eastern part of Manipur state in India and mostly pass through rural areas. This corridor will be improved to standard two-lane carriageway configuration in hilly terrain from Khongkhang to Moreh (km chainage 395+680 to 425+196). There are bypasses and realignments proposed in this road section of the subproject. The location of project alignment with another project component is shown at Figure 1.

5. The present study section, Khongkhang - Moreh is part of Asian Highway 1 (AH-1) in Manipur state in India. The present subproject is aimed to widen and improve about 29.516 km of existing national highway into 2 lane configuration between Khongkhang and Moreh (NH-102) in the state of Manipur. The road stretch is a critical section of the UNESCAP Asian Highway No. 01 (AH-01), paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

6. The Project Road start near Khongkhang village about 65 km from Imphal. The first approx. 65 km section of the Imphal - Moreh has already been undertaken by NHIDCL for upgrading to 4/2 lane carriageway in package 1&2 under Tranche 2 of SRCIP and it is under Implementation. Therefore; the subproject road's starting point is considered at km 395+680 (end point of

[1] Environmental Assessment and Review Framework for IND: SASEC Road Connectivity Investment Program, ADB, December 2013, and as updated in May 2017.

Package-2 road section). The subproject road corridor starts from Khongkhang village at its Km 395+680 and ends at Moreh (Myanmar Border) at its km 425+196. The road run through hilly/rolling terrain throughout length. The total length of corridor traverses through forest area i.e. 29.516 kilometers length (refer Figure 1– Index Map).

7. The available ROW for the section from 395+680 to Km 425+196 is about 15 m only with hilly/rolling terrain. The major settlements along the project corridor are Khongkhang, Lokchao, Khudhengthabi, Chikim & Moreh. Table 2 present the salient features of the exiting project road.

8. There is no alternatives or bypass/alternative routes are proposed, as the project road section involve the improvement of existing NH-102 road section.

Figure 1: Index Map of the Subproject Road

C. Description of the Environment

1. Physical Environment

9. **Meteorological Conditions.** The climate of subproject area is subtropical temperate. Rainfall is relatively abundant and widespread. The rainy season starts in June with the onset of the southwest monsoon and last up to September. Intermittent rains continue even up to October along with the retreat of the monsoon. The summer months are never oppressive with the average maximum temperature fluctuating from 30°C to 35°C during April-June, the mercury seldom going beyond 37°C. The salient climatic features of the state are as follows:

- Average Annual Rainfall - 1725 mm
- Concentration of precipitation - June to October
- Humidity - 79 to 96%
- Cloudiness - Heavily clouded
- Wind - Generally light except rainy season

• Temperature	-	Summer	32°C to 35°C
	-	Winter	6°C to 4°C

10. **Topography, Geology and Soils.** ***Topography:*** Topographically, the state is divided according to land elevations (lower hills – altitude ranging from 270 to 1,500 meters; mid hills – 1,500 to 2,000 meters; higher hills – 2,000 to 3,000 meters; alpine zone - above 3,900 meters with vegetation and snow bound land – very high without vegetation up to 8,580 meters). The project road is located in lower hills zone with altitude ranging from 500 to 1100m above MSL. It mostly passes through hilly terrain. Geographically the project road lies in the North-Eastern Himalayas between 24°48'8.9" N & 24°14'16.46"N and lies between Longitude of 93°56'18.44"E & 94°18'2.23"E within the state of Manipur.

11. ***Land Use:*** Land use data along the project road were obtained with the help of IRS-P3 LISS-III, 2008 Remote Sensing satellite images. The existing land use along the project road is mostly forest land with thick plantation and patches of rural residential areas. About 21% of the project area is covered by thick plantation and 31.5% by thin plantation followed by agricultural land (23.9%), forest land (10.9%), and settlement areas (8.6%). Water bodies and rivers cover about 4.3% land area in the project road.

12. ***Geology:*** Manipur state belongs to the young folded mountains of the Himalayan system. The rocks in the state vary from upper cretaceous to the present Alluvium. The oldest rocks found in Manipur are mainly confined in the eastern part of the State close to Indo-Myanmar border and the rocks are grouped as cretaceous rocks consisting chromite, serpentine etc. The sandstone, shale of the Disang group found over the eastern half of the Manipur belong to the Eocene period. The rocks consisting of sandstone, shale, clay, etc. of the Barail Group are confined over the rocks of Disang group and extending along the mid-western portion of the state and they belong to the upper Eocene and Oligocene periods. The shales and sandstone of the Tipam and Surma groups cover the western banks of Manipur and they belong to the Miocene period. Rocks of alluvial deposits found in the Manipur valley portion are of recent origin and further they can be grouped as older and younger alluvium. The state is mainly composed of tertiary rocks. The state is also seismically active and characterized by frequent landslides. The proposed project road falls under the Seismic Zone V, which is a susceptible to major earthquake as per the seismic zone map of India (IS 1893 - Part I: 2002).

13. ***Soils:*** The state has been classified into two major types – residual and transported, which cover both the hill and plain of the State. The residual soils are either laterized or non-laterized. The transported soils are of two types – alluvial and organic. The alluvial soils cover 1600 sq. km. in the valley. These soils have general clayey warm texture and grey to pale brown colour. They contain a good proportion of potash and phosphate, a fair quantity of nitrogen and organic matter and are less acidic. The organic soils cover the low-lying areas of the valley.

14. The soil in general is loamy sand to silty clay loam with a depth of 30 cm to 100 cm and in some cases even more than 120 cm. It has less water holding capacity and is dry in nature. Chemically acidic soil abound resulting from the washing down of the salts in rain water and also on account of leaching effect. The pH value varies from 5.98 to 7.14. The soils are characterized by high organic matter (5.5-5.9 percent, in some places even more than 6 percent) with low action exchange capacity and high lime requirement. Notwithstanding the relatively high organic matter content, the nitrogen content in the soil is low.

15. **Water Resources and Hydrology.** The state has vast water resources in the form of lakes, ponds, rivers and streams, some with marshy areas. It has abundant of water potential both ground as well as surface water. Important rivers that flow through the project region are the Lokchao and the Moreh.

16. The surface water body of Lokchow River is close to Project road section. The Lokchow River distance from road varies from 10 to 35 m from the Project road of chainage 404.000 km to

chainage 404.200 km. In addition to this, few numbers of springs (Jhora) are also crossing the Project road.

17. **Water Quality.** In order to represent the true profile of the project area, samples from major surface water source through which the project road runs were collected and analysed as per IS-2488 (Part I-V). Ground water (drinking water) samples were analyses as per IS: 10500-1991.

18. Water quality is monitored at five locations in order to represent the true profile of the project area. Ground water quality was monitored at two locations namely Lokchao village and Moreh. The surface water quality was monitored at three locations namely Lokchao river, Moreh river and a local stream near Lokchao village. Results shows that the pH of the drinking water in the region is well within permissible limits (6.5 – 7.5). The samples collected from bore well at Lokchao show highest value of the total dissolved solids of 336mg/l which is well within the permissible standards. Total hardness as $CaCO_3$ in the ground water sample from Lokchao is found at 102mg/l which is highest in all samples but less than the limit (200mg/l) prescribed for drinking water standard limits. BOD level for all analysed ground water samples is higher than the permissible standards. Other parameters analysed like chloride, sulphate, fluorides are found well within standards. Overall the ground water quality in the project areas in good.

19. **Air Quality.** Ambient air quality in the state is quite pure compared to other neighbouring states. Except for few urban centres like Moreh, the ambient air quality is good. Ambient air quality for particulate matters (PM10 and PM2.5), SO_2, NOx & Pb was monitoring at four locations along the project road.

20. It is found from the results that PM10 concentration at all monitoring locations were well within the permissible limits for residential zone i.e. 100 µg/m^3 prescribed by MOEFCC and World Bank EHS. The highest value of PM 10 is observed at Moreh (70.55 µg/m^3), which is well within permissible limits. Similarly, PM2.5 concentration is highest at Moreh and is 37.8.48 µg/m^3 well within the permissible limit i.e. 60 µg/m^3 prescribed by MoEFCC. Other parameters monitored i.e. NOx, SO_2 were found within the permissible limits for all the locations. Overall the air quality in the project area good.

21. **Noise Levels and Vibrations.** Noise levels were monitored at five locations along the project road. It is found that hourly day equivalent noise level varies from 64.7 dB(A) to 72.8 dB(A), whereas hourly night equivalent noise level ranges from 53.8 dB (A) to 62.4 dB(A). The recorded noise level is higher than the permissible limits for residential area of 55 dB(A) and 45 dB(A) for daytime and nighttime, respectively. This noise is mainly from vehicular traffic and local domestic/commercial activities.

22. Vibration levels were monitored in the terms of peak particle velocity (ppv) at six sensitive locations along the project road alignment. The monitored vibration levels (ppv) at nearby structures are found in the range of 0.127 to 0.435 mm/s. This is well within the cosmetic damage threshold of 3 mm/s as prescribed by Caltrans.

2. Biological Environment

23. **Vegetation and Forests.** In spite of its small size, the state's vegetation is rich and varied in character. This is because of its different climatic conditions found in the state and its peculiar physiography. The forest area of the state falls into four distinct zones viz. i) Burma drainage forests, ii) Urkul pine forests, iii) forests overlooking the valley and iv) Barak drainage forests.

24. About 67% of the geographical area of Manipur is hill tract covered forests. Depending on the altitude of hill ranges, the climatic condition varies from tropical to sub-alpine. The wet forests and the pine forests occur between 900-2700 m above MSL and they together sustain a host of rare and endemic plant and animal life.

25. Vegetation along the subproject road section (Khongkhang to Moreh) is mostly covered by agriculture, thick grass, open forest and dense forests.

26. About 21.066 km length of the subproject road passes through Yangoupokpi Lokchao Wildlife Sanctuary area on one side of road. The first length of 8.450 km transverse through eco-sensitive zone of YLWLS. Starting from Lokchao River Bridge to Khudhengthabi (chainage 404.130 to Chainage 413.230, length 9.100 km) alignment traverses along the border of Core Zone I and Tourism Zone up to Khudhengthabi village. After Khudenthabi village up to Moreh (Chainage 413.230 to 425.196, length 11.966 km) proposed road alignment is in the Buffer Zone.

27. The landuse is mixed of built-up (major settlements Khongkhang, Lokchao, Khudhenthabi, Chikim), agriculture and unclassified forests area of Tengnoupal Forest Division, Tengnoupal. Details of the forest areas/protected areas locations along the subproject road are listed in Table E.2.

Table E.2: Details of Forest Locations along the Project Road section

Sl. No.	Name of Reserve / Protected Forest	District	Chainage		Length (Km)
			From (Km)	To (km)	
1.	Eco-sensitive Zone of Yangoupokpi Lokchao Wildlife Sanctuary	Tengnoupal	395.680	404.130	8.450
2.	Yangoupokpi Lokchao Wildlife Sanctuary (Valley side)		404.130	425.196	21.066
Length (Km) of Project section Road passing through Reserve / Protected Forest			**Total**		**29.516**

Source: Field Survey carried out by the Consultant Team, 2019

28. Local forest department officials were consulted to know the presence of any endangered species of trees within the formation width. It is confirmed by the forest department officials that there are no endangered species which are likely to be affected by current project.

29. Field survey has been carried out to identify the number and type of trees to be affected by the proposed improvement work of subproject road. It is envisaged that about 2013 trees existing within the proposed formation width of the subproject road. Among these trees 1156 are on left side and 857 trees are on right side of the road while travelling towards Moreh.

30. **Wildlife and Protected Areas.** The state's protected area network comprises of five wildlife sanctuaries and two national parks. Recognizing the importance of this region as one of the hot spots, majority of the biodiversity rich areas of the state has been placed inside the protected area network system comprising mainly of the National Park and Sanctuary.

31. About 21.066 km length of the subproject road (Khongkhang –Moreh road) passes through Yangoupokpi Lokchao Wildlife Sanctuary area on one side of road. Starting from Lokchoa River Bridge to Khudhengthabi (chainage 404.130 to Chainage 412.230, length 9.100 km) alignment traverses along the border of Core Zone I and Tourism Zone upto Khudhengthabi village. After Khudenthabi village upto Moreh (Chainage 413.230 to 425.196, length 11.966 km) proposed road alignment is in the Buffer Zone.

3. Socio-economic Environment

32. **Demography**. Manipur is one of the sisters' states in north eastern state a population of 2.38 million with about more than 75 percent of the population living in the rural areas. The human population density is very less (only 107 persons/km^2) compared to 149 persons/km^2 for the north eastern region. Sex ratio is 978 against the 936 in the region. The demographic feature of north eastern states is unique in that there are more than 29 recognized tribes, which inhabit mostly the hill areas and each with distinct culture, ethos, and traditional knowledge systems. The major minority groups in the state namely Aimol, Anal, Angami, Chiru, Chothe, Hmar, Kabui, Kacha Naga, Mizo, Mao, Lusai etc. The majority of the people survive on subsistence economy based

mainly on the agriculture, supplemented with limited horticulture, animal husbandry, crafts/handloom, etc.

33. **Land Resources.** The area available for land utilization in the state is about 2010 thousand hectares out of the total geographical area of 2230 thousand hectare. This means about 90 percent of the area in the state in available under various land uses. Major portion of the land use is under forest cover covering about 78 percent of the land use area. About 11.59 percent area is under gross cropped area. Agriculture is the second major land use in area.

34. Agriculture is the mainstay of the people. It contributes major shares in the state domestic product and provides employment to about 65 percent of total working force in state. Total net sown area is 230,000 hectares. Rice is principal food grain followed by maize and millets.

35. Though the state has no marine fishery, it has vast inland fishery resources like ponds, tanks, naturals lakes, marshy areas, swampy areas, rivers, reservoirs, submerged cropped land, paddy field etc. The largest source of fish is the Loktak Lake. The production of fish in Manipur for the year 2011-12 was estimated to be 22,291 thousand tones.

36. **Infrastructure.** Transportation system is a key factor in the socio-economic development of any state. There is practically no railway network in the state. Two rail heads – one at Dimapur in Nagaland (215 km away from Imphal) and the other at Jiribam (225 km away from Imphal) serves the state. The state has one airport at Imphal, which connects up with the rest of the country. Waterways are also not feasible. Roads, therefore, constitute the only means of transport system in the state for movement of men, materials and services within and outside the state. The total road network stands at around 19252 km, of which 8795 km are unsurfaced roads.

37. The state has endowed with mineral resources. The main mineral reserves in the state includes limestone (14.8 thousand tons), clay (2.5 thousand tons), and chromite (0.1 thousand tons). For exploiting the mineral resources, it is important to provide a good road and rail infrastructure.

38. The north eastern region has the potential to emerge as a strategic base for domestic and foreign investors to tap the potential of the contiguous markets of China, Myanmar, Lao PDR, Nepal, Bhutan and Tibet. This calls for converting the unauthorised trade into authorised trade, at the policy level as well as at the ground level. The BIMST-EC (Bangladesh-India-Myanmar-Sri Lanka-Thailand Economic Cooperation) initiative is creating an enabling environment for rapid economic development through identification and implementation of specific cooperation projects in the sectors of trade, investment and industry, technology, human resource development, tourism, agriculture, energy, infrastructure and transportation.

D. Analysis of Alternatives

39. Although the proposed project is an improvement of the existing road section in hilly terrain, no alternative alignment is proposed. The analysis of alternatives has also been made on the basis of “with and without project scenarios” in terms of potential environmental impacts. On the basis of analysis, we can say that project acquires positive/beneficial impacts “With” project scenario and will greatly improve the environment and enhance social and economic development of the region compared to “Without” project scenario, which will further deteriorate the existing environment and quality of life.

E. Consultation, Disclosure and Grievance Mechanism

40. In accordance with ADB’s Safeguard Policy Statement (SPS) 2009 public consultations were held, as part of the EIA study. Consultation undertaken with project beneficiaries, local/ government officials, community leaders, women groups, NGO’s, stakeholders in corridor of impact and people likely to be affected due to the project on various issues affecting them and

incorporation of various measures pertaining to environmental issues based on the responses from the people.

41. Both formal and informal modes of consultation were used in the public consultation process for the project. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questionnaires. In addition, focused group discussions (FGDs) and personal discussions with officials, on-site discussion with project affected stakeholders, and reconnaissance visits have also been made to the project areas. The attempts were made to encourage participation in the consultation process of the Government officials from different departments that have relevance to the project. Same way, local people from different socio-economic backgrounds in the villages as well as urban areas along the road alignment and at detours, residents near the existing road, women representatives, local commuters, and other concerned were also consulted.

42. In compliance with ADB's SPS requirements consultation will be continued throughout the project process. The consultations were conducted during preparation of the EIA. The official consultation with the key stakeholders was undertaken in the months of February-March 2019 at respective district office and head quarter in Imphal. Various officials consulted include NHIDCL Officials, Forest Officers, Wildlife Officials, Environmental Officers from pollution control board, statistical officer, officials from NGOs active in the project areas etc. Besides interview surveys, focused group discussions (FGDs) were organized at key locations along the project roads. In total five (5) FGDs meetings involving 105 affected people, landowners, and village authorities, were organized. Specific emphasis was given to women participants to ensure that gender concerns are addressed in the project. Out of total participants, 29 participants were from women group. Most of the people interviewed strongly support the project. The people living in the entire project area expect the different project elements to facilitate transport, employment, boost economic development and thereby provide direct, or indirect, benefits to themselves.

43. The project EA will be responsible for the disclosure of this EIA in compliance to ADB's Communication Policy 2011 and ADB SPS 2009. The draft Environmental Impact Assessment Report will be disclosed in the English language in the office of NHIDCL and also in the office of the General Manager (NHIDCL) in Imphal. The report will also be made available to interested parties on request from the office of the NHIDCL. Since this is environment Category A project, this draft EIA report will be disclosed to the public through the ADB website, 120 days before the approval of subproject by ADB Board for financing. This draft EIA report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009.

44. A Grievance Redress Mechanism (GRM) has been proposed to address grievances related to the implementation of the subproject, particularly regarding the environmental management plan and to acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the quarterly environmental monitoring report to ADB. Depending on the nature and significance of the grievances or complaints, the grievance redress mechanism (GRM) will comprise procedures to address grievances i) first at the PIU level and ii) second at the EA level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the EA level will be forwarded to the GRC. The GRC will comprise members from the EA, IA, Authority's Engineer, contractor, local community local forestry and wildlife authorities.

F. **Anticipated Environmental Impacts and Mitigation Measures**

45. The road rehabilitation and upgradation project activities can cause environmental impacts that are short, or long-term, and beneficial, or adverse, in nature. The overall long-term impacts will be largely beneficial in regard to the socio-economic environment and quality-of-life in the region. The key environmental issues associated with various aspects of the proposed subproject

and impacts on various environmental components have been assessed for various stages i.e. (a) the project location, (b) design, (c) construction, and (d) operation.

46. **Environmental Impacts Associated with Project Location, Preliminary Planning and Design.** ***Location issues:*** The environmental impact of subproject road location will not be significant since improvement work will be carried out along the existing road which is passing through wildlife sanctuary. Since about 21.066 km length of the subproject road passes through YLWLS, roadway may form a barrier that blocks the daily and seasonal movement of wildlife during the operational life of the subproject.

47. The detailed design team has proposed measures for the roadway segments those impacts on the movement of wildlife. Specific migratory pathways have been identified and accommodation made for the movements of wildlife in the detailed design. The design consultant has incorporated measures into the design that facilitate these movements. A number of measures such as mild slope conditions, drainage structures, culverts enabling wildlife movement and postage of signboards have been considered during the detailed design.

48. Since the entire length of the subproject road passes through hills and forest area and it require diversion of about 48.29 ha. of forest land, adverse impacts on flora and fauna are anticipated. Also land clearing will involve cutting of about 2013 trees which will problems of soil erosion at some pleased. Loss of trees will be compensated by planting 6039 trees (1:3 ratio) as compensatory afforestation. Adequate measures (including signages, informatory boards, warning signs and strict monitoring) have been included in the EMP to minimize impacts on wildlife in the YLWLS. NHIDCL has obtained Wildlife Clearance from the National Board for Wildlife. Application for forest clearance has been submitted to the Ministry of Environment, Forests and Climate Change, Government of India. Measures will be implemented to minimize tree felling.

49. Minor impacts on land use and local communities are expected due to acquisition of land for widening of road. The project affected people will be compensated as per the provisions of a Resettlement Plan (prepared as separate report). The widening option have been devised so as to cause minimise destruction of structures. There are private structures, few small temples, shrines and educational buildings which are coming adjacent to existing carriageway of the subproject road. Care will be taken to avoid such community structures or cause damage in their relocation. There will also be a requirement to establish construction camps and related contractor's facilities, borrow pits and quarries. These will be located in environmentally sound and socially safe areas. It is expected that construction materials for the road works will be mined only from approved quarries.

50. **Environmental Impacts Due to Construction.** ***Impacts on Topography, Soil and Vegetation:*** During the improvement works of the subproject road section and because of felling of trees, hill cuttings, ground clearing; stone quarrying, and construction of structures etc. the micro-level topography may change.

51. During subproject road improvement works there will be cut and fill activities, cutting of trees, stone quarrying, and construction of structures. Even with reasonable care exercised in the final design, the interaction between proposed road features and existing land features could result in significant land instabilities during construction. Thus, the following mitigating measures should be implemented:

- existing vegetation including shrubs and grasses along the road (except within the strip directly under embankments or cuttings) should be properly maintained and all slopes/soil cutting areas should be revegetated as soon as construction activities are completed,
- excavation and earthworks should be mainly undertaken during the dry season when the risks from erosion and silt run-off are least,

- sites for quarrying, borrowing and disposal of spoils are to be confirmed according to the applicable laws and regulations in the state and the practices followed in recent/ongoing projects of international level,
- controlled and environmentally friendly quarrying techniques should be applied to minimise erosions and landslides,
- cut material should be disposed of in suitable depressions,
- materials that will be used for surface dressing will consist of aggregates and gravel, and must not contain silt, and
- Internationally accepted best practice engineering approaches will be incorporated into contract documents and monitored during construction.

52. ***Impacts on Surface and Groundwater Quality, Drainage and Hydrology:*** Two river and few streams crossed the project road. The improvement of the road may result in disruptions to the natural hydrology and water mismanagement that may lead to further problems of soil erosion. Construction activities could also lead to the temporary pollution of Lokchao and Moreh Rivers from spillage of chemicals and oil at construction sites and waste from construction camps, discharge of sediment-laden water from construction areas and uncontrolled surface water discharge over the road edge creating large–scale erosion on down-slopes. Thus, the following mitigating measures are recommended:

- natural courses of water bodies should, as far as possible be maintained and brought back to their natural course,
- all debris and vegetation, clogging culverts should be regularly cleared and disposal of construction debris in streams and rivers should be avoided,
- river-bank slope stabilities should be monitored, and appropriate remedial measures applied throughout the construction period,
- if possible, construction work at bridge should also be avoided during the rainy season,
- chemicals and oils should be stored in secure, impermeable containers, and disposed of well away from surface waters,
- no vehicle cleaning activity should be allowed within 300 m of water bodies/ drains,
- construction camps should be equipped with sanitary latrines,
- lined drainage structures should be provided,
- side drain waters must be discharged at every available stream crossing.

53. ***Air Quality:*** Prediction of the pollutants (PM2.5, PM10, CO, NOx and SO_2) concentrations has been carried out using AERMOD, a dispersion model based on Gaussian Equation. It has been observed from the model output that when the traffic volume increases, the concentration of air pollutants also increases correspondingly. However, the maximum predicted pollutant concentration over the existing ambient air quality are found to be within the National Ambient Air Quality Standards.

54. During construction, and at the micro-level only, air quality may be degraded by generation of dust (PM) and generation of polluting gases including SO_2, NOx and HC for short periods from vehicular movements, site clearance, earth filling and material loading and unloading. The impacts are expected to be localised, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimised. The following actions should be implemented:

- regular check-up and maintenance of construction equipment,
- mixing plants i.e. asphalt, concrete, and bricks, should be operated within the permissible limits of CPCB and WB EHS, and be located away from settlements,
- the contractor should submit a dust suppression and control programme to the PIU,
- vehicles delivering loose and fine materials should be covered to reduce spills,

- controlled blasting should be carried out and only with the prior approval of the site Engineer and, if required, PIU,
- bitumen emulsion should be used wherever feasible, and
- bitumen heaters should be used and the use of wood for fuel should be discouraged or prohibited.

55. ***Noise and Vibration Quality:*** With the exception of the Moreh town, the ambient noise level along the subproject road section is within standards. During the construction period, noise will be generated from the operation of heavy machinery, blasting works, the haulage of construction materials to the construction yard and the general activities at the yard itself.

56. Noise levels were predicted using Federal Highway Administration's Traffic Noise Model (FHWA TNM) which helps for highway traffic noise prediction and analysis. It is observed that the noise levels (Leq) near the receivers are found to be higher than desired levels for the respective categories. The maximum predicted value 63.9 dB(A) is recorded at the receiver located 10m close to road. The predicted levels show increase in noise levels for future years at all receivers considering increase in traffic volume.

57. Noise and vibration will be unavoidable, but the impact will only be temporary and will only affect people living or working near piling locations. Mitigation measures should include (a) provision of noise barriers at sensitive locations, (b) construction machinery should be located away from settlements (c) careful planning of machinery operation and the scheduling of such operations can reduce noise levels, (d) controlled blasting (if any) should only be carried out with prior approval from the Engineer in charge, and (e) contractors should be required to fit noise shields on construction machinery and to provide earplugs to the operators of heavy machines.

58. ***Flora and Fauna:*** Since about 21.066 km length of the subproject road passes through YLWLS and also subproject road passes through Eco sensitive zone of the YLWLS, it will cause adverse impacts on flora and fauna of the area. Also acquisition of forest land (48.29 hectares) will further add impacts on the presence of flora and fauna in the forest and sanctuary. Removal of the existing vegetative cover and the uprooting of about 2013 trees is an unfortunate activity, which may reduce the ecological balance in the areas. This may also enhance soil erosion problem.

59. To minimise adverse impacts on flora such as trees, contract documents should specify that (a) all wood building material for workers' housing should be brought from outside the project area, (b) workers should be supplied with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract, (c) all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites; (d) during site clearance, care should be taken to ensure that the minimum area of vegetation area is affected and (e) the water sprinkling of trucks used as construction vehicles should be properly and regularly undertaken, so that dust deposition problem on vegetation are minimised. Specific measures such as i) construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest area and YLWLS, ii) employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities, iii) Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the areas of YLWLS, iv) provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents, and v) project staff and work crews should not be allowed to have fire-arms and animal traps etc. There will be strict compliance monitoring by environment specialist of Authority's Engineer and external wildlife monitor throughout the construction work in YLWLS.

60. **Environmental Effects Related to Operation.** ***Noise and Vibration, Air Pollution, Runoff, Spoils of Hazardous Materials:*** The current traffic flows along the project roads is expected to increase because of improved economic activities associated with better access. The larger numbers of vehicles will be an additional source of noise and gaseous emissions. Traffic

volumes will, however, remain low and this should not be a significant impact. Repairs to culverts and new drainage work will eliminate/ reduce the soil erosion problems presently caused by poor cross drainage.

61. ***Flora and Fauna:*** **Flora:** Positive impacts on terrestrial ecology are expected during the project operation stage due to the increase in vegetation and landscaping along the subprojects road. The project will coordinate with the local communities to maintain and enhance the trees planted along the road sections.

62. Post project scenario is expected to reduce the man-animal conflict. However, strict vigil will be required to prevent such conflicts. It is also proposed to collaborate with YLWLS to support conservations programs prioritized in the management plan of YLWLS. Budgetary provision for the same is made in the EMP budget.

63. It is proposed to carry periodic visual check of functionality of proposed mitigation measures taken for the protection of animals. Periodic data pertaining to animal accidents and animal as well human deaths, movement frequency of elephant and other animals, route followed by animals, will be collected from wildlife authorities for at least three years during operation stage. Suitable corrective actions like maintenance of guide rails will be initiated in-case conflict level is found increasing. Relevant expertise under the Authority's Engineer or external wildlife monitor or others may be employed for this.

64. ***Land Use and Settlements:*** The likely impacts on land use and settlement patterns are limited. Improved access will inevitably lead to increase in and out migration, but this is likely to occur gradually and over a prolonged period. There will be time for new residential areas to be established. There may, however, be a need to control ribbon development.

65. **Potential Environmental Enhancement/ Protection Measures.** In order to improve the environment, additional measures were also proposed during construction for the following: (a) sanitation and housekeeping at the labour/ construction camps, (b) provision of water supply, (c) hygiene and provision of toilet facilities, (d) sewerage and waste disposal, (e) first aid, (f) maintenance of buildings and facilities, (g) identification of debris disposal sites and (h) rehabilitation of quarry and borrow pits.

G. Environmental Management Plan

66. A fully budgeted environmental management plan has been prepared for mitigation/management/ avoidance of the potential adverse impacts and enhancement of various environmental components along the subproject road. For each mitigation measures to be carried out its location, timeframe, implementation and overseeing/ supervising responsibilities has been identified. Monitoring plan for construction and operation phase has been framed to ensure effective implementation of EMP.

67. The monitoring program included performance indicators for wildlife, water, air, and noise level monitoring, frequency of monitoring, and institutional arrangements of the subproject in the construction and operation stages, along with the estimated cost. The reporting system included roles and responsibilities of each party involved in the project implementation i.e. PIU, Authority's Engineer, Contractor(s), external monitor, and reporting mechanisms during implementation and operation phases.

68. An environmental management budget of INR 2,89,68,592 (Indian Rupees two crore eighty-nine lakh sixty eight thousand five hundred ninety two only) (USD 0.426 million) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings.

I. INTRODUCTION

A. Project Background and Rational

69. ADB has a regional cooperation program in four South Asian countries: Bangladesh, Bhutan, India and Nepal, called South Asia Subregional Economic Cooperation (SASEC[2]), which has been supporting regional cooperation in the transport sector through SAARC[3] and BIMSTEC[4] over a decade. Major contributions in this regard include assisting the SAARC Regional Multimodal Transport Study (SRMTS)[5] and BIMSTEC Transport Infrastructure and Logistics Study (BTILS).[6] A series of SASEC Trade Facilitation and Transport Working Group meetings have endorsed ADB preparation of a project to improve the most critical corridors connecting regional countries. Furthermore, to initiate connectivity between South Asia and South East Asia and as a follow up activity of the BTILS, strategic roads connecting Bangladesh, India and Myanmar are currently being studied.

70. Manipur being landlocked with no rail connectivity presently has to depend on its road network for its transportation requirements. The present study section, Khongkhang - Moreh is part of Asian Highway (AH-1) in Manipur state in India. AH 1 is the longest route of the Asian Highway Network, running 12,845 miles (20,557 km) from Tokyo, Japan via Korea, China, Southeast Asia, India, Pakistan, Afghanistan and Iran to the border between Turkey and Bulgaria west of Istanbul where it joins end-on with European route E80. In India AH 1 passes through Numaligarh - Golaghat - Garampani - Barpathar - Naojan - Bokajan - Dimapur - Kohima - Tadubi - Senapati - Kangpokpi - Imphal - Thoubal - Tengnoupal - Moreh (Myanmar border).

71. The present subproject aimed to widen and improve about 29.516 km of existing national highway into 2 lane configurations between Khongkhang- Moreh section of NH-102 in the state of Manipur. The road stretch is a critical section of the UNESCAP (United Nations Economic and Social Commission for Asia and Pacific) Asian Highway No. 1 (AH-1), paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

72. **Regional Cooperation:** The Project is a critical section of Asian Highway No. 1 (AH-1), which is also the common section of the Indo-Myanmar-Thailand Trilateral Highway7. In India, the 4-lanning development is ongoing under the National Highway Development Program (NHDP) upto Imphal via Kohima. In Myanmar AH-1 between Yangon and Mandalay is all 4-lane concrete roads with wide median. For the section of AH-1 in Myanmar between Mandalay and Indian Border, it is narrow two lanes, with good condition upto Kalewa, part of the India-Myanmar Friendship Road. The 30-year plan (2011/12-2030/31) of the Myanmar's Ministry of Construction indicated that all international connecting roads will be 4-lane asphalt concrete roads.

73. The Project will integrate two initiatives of subregional economic and social cooperation: SAARC and ASEAN. The Indo-Myanmar connectivity is the key for integration of South and South East Asia. The Project will provide India with new oil and gas opportunities off the coast of Myanmar as well as easier access to Japanese products made in Thailand. Trade between India, Myanmar and Thailand is currently sea-bound, which not only makes exchanges slow but also prohibitively expensive. The Project will whittle down cost stupendously, ushering in economies of scale and commercial prosperity. Industry estimate suggests that seamless connectivity with the Asian Highway Network through trilateral project would ratchet up India's trade with ASEAN to about US$ 100 billion in the next five years.

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[2] South Asia Subregional Economic Cooperation (SASEC) member countries are Bangladesh, Bhutan, India and Nepal

[3] South Asian Association for Regional Cooperation (SAARC). Member countries are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka

[4] Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). Member countries are Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand

[5] SAARC Secretariat. 2007. *Regional Multimodal Transport Study*. Kathmandu.

[6] ADB. 2008. *Final Report of RETA6335: BIMSTEC Transport Infrastructure and Logistics Study*. Manila.

[7] The Indo-Myanmar-Thailand Joint Task Force Meeting on the Trilateral Highway Project held in Delhi on September 2012.

74. Cross-border trades via roads between India and Myanmar, via Moreh/Tamu and Reed, comprises only 1.5% of the total road-based cross-border trades of Myanmar ($1.1 billion), against about 70% with China and 26% with Thailand. Some studies indicate that the informal boarder trade with Myanmar is growing while the official trades have been shrinking. The Project, the biggest official route of border trades, will help to increase the cross-border trade. A substantial increase is expected subject to further improvement of border trade systems, including the development of the integrated check post. Moreh is one of the priority border posts under the GoIs Integrated Check post Program. Govt. of India (GoI) has also been in discussions with the Government of Myanmar on starting of a bus service between Imphal and Mandalay (about 820km).

75. Myanmar receives various supports for infrastructure development from neighboring countries for RCI (Regional Cooperation and Integration) Connectivity. The project will add another RCI Initiative to support Myanmar's opening economy. India supports development of a large new terminal at Sittwe and its access from the Indian border in Mizoram at Hmawngbu (Mobu), i.e. Kaladan Multi-Model Transit Transport Project. China supports development of a deep seaport and a special economic zone (SEZ) at Kyaukphyu on the east side of the Bay of Bengal, which includes 12 crude oil tanks. They have been building new oil and gas pipelines starting from Kyaukphyu with Kunming in China. Thailand supports development of a deep seaport and SEZ at Dawei, together with the support to road development connecting between Thailand and Myanmar, which provides easy access for Thailand and ASEAN countries to Dawei and beyond the Bay of Bengal.

76. **National Economy**: GOI undertakes 4-lanning of the strategic national highway network under NHDP, extending to the India's northeastern region (NER). Currently, it is under development of 4-lanning upto Imphal and Silchar. The Project will complete the 4-lanning for the whole stretch of the national highway to the Myanmar Border (Moreh) via Imphal, or the Indian portion of the Asian Highway No. 1. At a later phase, the road stretch between Imphal and Silchar could be improved into 4-laning, extending the 4-lane East-West Corridor to the Myanmar border, together with the proposed project.

77. The project will also bring new wealth to NER, which have been blighted by local insurgencies and heavy security. The Project road will provide a much shorter route for NER to reach deep seaports in Myanmar, currently under development. The traffic is expected to substantially increase due to the access form other Indian states and also from neighbouring landlocked countries (Bhutan and Nepal) with the result that NER will be transformed into a regional trading hub. The project will also realize the synergy with the 2,000 acre of township development plan of Moreh.

78. Traffic level between 1800 hrs and 0600 hrs were typical 0 and 10% of the daily traffic and the effective road usage hours are less than 12 hours on many roads. In other parts of India traffic levels on road during the night hours are around 30%. Increase to trades and the resultant traffic, the improved road capacity and conditions, will improve the security situation and network utilization.

79. State governments in Assam and Manipur have proposals to provide alternate state roads at state level for improving Myanmar connectivity such as the Leney-Silchar road in Assam and the Jiribhum-Behiang road in Manipur, partly national highways starting from Silchar. These alternate state roads will attract more traffic to the Project road and improve economy of the remote areas in NER.

80. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance (TA) from the Asian Development Bank (ADB) to prepare an ensuing loan for the international trade corridor in Manipur State (the project). The investment program loan will upgrade high priority trade corridors and facilities comprising National Highways (NH) and State Highways (SH) connecting five countries: Bangladesh, Bhutan, India, Myanmar and Nepal in the northeastern part of India. Given the large scale of the program and the need to

carefully study priority corridors particularly in the India - Bangladesh - Myanmar region, a sector loan approach is proposed to finance the project.

81. While approximately seven road corridors have been identified for financing under the program, two sample subprojects were prepared as part of the project processing. The options and design for the remaining roads and facilities are still being studied and yet to be clearly defined. Therefore, the former is selected as sample subprojects and the latter as non-sample subprojects under the program. The list of ongoing and non-sample subprojects are provided below in Table 1.

Table 1: List of Subprojects included in the Project

No.	Name of Road/Facility	Length (km)
I	**Tranche I subprojects**	
1.	AH-2: Panitanki (Nepal border) – Fulbari (Bangladesh border)	37.271
2.	AH-48: Jaigaon (Bhutan border) – Changrabandha (Bangladesh border)	90.56
3.	Imphal-Kanchup-Tamenglong-Tousem-Haflong (Manipur)	103
	Sub-Total A	**230.831**
II	**Tranche II subprojects**	
1.	AH-1: Imphal - Moreh Priority section (Imphal to Khongkhang village (km330.000 to 395.680)) in Manipur	65.68
2.	Mechi bridge (West Bengal)	1.50
3.	Additional financing for Imphal-Kanchup-Tamenglong state highway in Manipur	-
	Sub-Total B	**67.28**
III	**Tranche II subproject**	
1.	AH-1: Imphal - Moreh AB Last mile (Khudengthabi – Moreh, from km 395.680 to 425+196) in Manipur	29.516
	Sub-Total C	**29.516**
	Grand Total	**327.627**

82. This Environmental Impact Assessment (EIA) covers the subproject in the State of Manipur i.e. AH01: Imphal - Moreh last mile (Khongkhang to Moreh road section of Imphal - Moreh road (NH-102). All discussions thereafter focus only on this subproject. The environmental assessment reports for this non-sample subproject is prepared as part of project preparation in compliance with Environmental Assessment and Review Framework (EARF8) for the Project.

B. Subproject Road

83. The subproject road is a section of Imphal - Moreh national highway (part of Asian Highway 1) in Manipur State of India. It passes through the eastern part of Manipur state in India mostly through rural areas. This corridor will improve to standard two lane roadways. No realignment sections are proposed and improvement is limited to existing road geometry. The location of project alignment with another project component is shown at Figure 2.

84. The Imphal - Moreh road start in Imphal city, first 10 km section has already been undertaken by MORTH for upgrading to 4 lane carriageway and 6 km from start is already upgraded and remaining 4 km section has been sanctioned for upgradation to 4-lane and is in advance stage of Implementation. The road section from chainage km 330+000 to km 395.680 already undertaken for improvement in package 1 & 2 under Tranche 2 of the investment program. Hence this subproject road start for package 3 has been considered as km 395+680. The subproject concerns upgrading about 29.516 kilometers of existing old National Highway 102 in the State of Manipur. The subproject road corridor starts from Khongkhang village at its km 395+680 and ends at Moreh (Myanmar Border) at its km 425+196. The road run through hilly

[8] Environmental Assessment and Review Framework for proposed IND: SASEC Road Connectivity Investment Program, ADB, December 2013, and updated May 2017.

terrain (from Khongkhang to Moreh). The total length (29.516) of corridor traverses through forest area but with fair to poor surface condition (refer Figure 1.1 – Index Map).

85. The available ROW for the section from km 395+680 to km 425+196 is 15m only. The terrain is hilly/rolling terrain from start to end of project road corridor. The major settlements along the subproject corridor are Khongkhang, Lokchao, Khudengthabi, Chikim and Moreh. Table 2 present the salient features of the existing subproject road. The improvement work is mainly of existing road alignment and no alternatives alignment are proposed. Hence, no bypass/alternative routes are examined.

Figure 2: Index Map of the Subproject Road

Table 2: Description of Subproject Road Sections

Subproject Road Section	Distance (km)	District	Summary of General Road Condition
Khongkhang-Moreh (National Highway) Subproject	29.516	Tengnoupal	The proposed road section (Khongkhang-Moreh) is a part of Asian Highway 1 (AH1) (New NH-102) in Manipur state in India. The Project Road start in Imphal city, first 10 km section has already been undertaken by MORTH for upgrading to 4 lane carriageway and 6 km from start is already upgraded and remaining 65 km section has been sanctioned for upgradation to 4-lane in tranche 2 of the project and is in advance stage of Implementation. Hence the project start has been considered as km 395+680. The project concerns upgrading about 29.516 kilometers of existing National Highway 102 in the State of Manipur. The project corridor starts from Khongkhang village at its Km 395+680 and ends at Moreh (Myanmar Border) at its km 425+196. The project road length run through hilly/rolling terrain from start to end point. The corridor traverses through forest area for 29.516 kilometers length but with fair to poor surface condition. The available ROW for the road section from km 395+680 to km 425+196 is 15 m only. The terrain is hilly/rolling in entire corridor. The major settlements along the project corridor are Khongkhang, Lokchao, Khudengthabi, Chikim and Moreh.

C. Objective and Scope of the Study

86. The objective of this EIA study is to identify potential environmental impacts of the proposed road improvement work and formulate strategies to avoid / mitigate the same. The scope of work to accomplish the above objective, comprise the following.

- understanding the baseline environmental conditions of the subproject area,
- identifying the potential environmental impacts of the subproject proposal,
- recommending appropriate mitigation measures to avoid / minimise the environmental impacts, and
- preparing an environmental management plan for implementation.

87. The environmental studies have been confined to the situation around the deemed areas of direct influence caused by constructional and operational facilities along the proposed road section. The following sections of the report discusses the methodology adopted by the consultants in conducting the EIA study and presents the results of the same.

D. Methodology Adopted for EIA Study

88. The Environmental Impact Assessment has been carried out, in accordance with the requirements of the ADB's Safeguard Policy Statement (SPS 2009) and Environmental Assessment and Review Framework prepared for the overall SRCIP. The Government of India guidelines for Rail/Road/Highway project; EIA notification 2006 and its amendment of MoEFCC and Highway Sector EIA guidance manual 2010 has also been followed in the process of this environmental assessment. The study methodology has been adopted in such a manner to ensure that environmental concerns are given adequate weightage in the selection of alignment and design of proposed road improvements. The study in this project employs an iterative approach in which potential environmental issues have been examined at successive levels in detail and specificity, at each step in the process.

89. The Environmental assessment is based on the information collected from secondary as well as primary sources on various environmental attributes. Monitoring of air, water, noise and

soil quality was also carried out within the ROW and significant issues were examined during field surveys to determine the magnitude of significant environmental impacts. The major steps in the EIA process for the subproject were as follows:

90. **Collection and Analysis of Data.** Data was collected on various environmental components such as soil, meteorology, geology, hydrology, water quality, flora and fauna, habitat, demography, land use, cultural properties etc, to establish the baseline environmental setup. Secondary data on environment for the project corridor was collected both from published and other relevant sources e.g., the State Department of Forest, Manipur State Pollution Control Board, State Statistical Department etc. The data collection from the field was completed with the help of enumerators / investigators. The interviewers/surveyors were trained for taking the samples and filling up the Questionnaire at site. To ensure the accuracy of the data it was collected under the supervision of the consultant.

91. **Environmental Monitoring and Analysis.** In order to assess the situation in particular sections of the road during the screening and site visit of the area, different locations were identified for monitoring and analysis the noise level, ambient air and water quality. The monitoring and analysis of water quality, soil quality, air quality and noise level has been done by M/s. The Research Institute of Material Sciences, a leading environmental research laboratory based in Dwarka, New Delhi in the month of February-March 2019. Air quality monitoring has been carried out as per MoEFCC notification of November 2009 the revised Air Quality standards and the on-site monitoring results are incorporated in Chapter- 4 of this EIA report.

92. **Vegetation and Wildlife Surveys.** In order to assess presence of flora and fauna along the proposed alignment field surveys have been carried out with the help of field officers of the state forest department and wildlife departments. Specific attention were given to collect the data on presence and movement of wildlife in the YLWLS areas. Findings are incorporated in Chapter-4 of this EIA report.

93. **Analysis of Alternative.** Alternate analysis for the present subproject road alignment has been made on the basis of “with” and “without” project scenario. The parameters considered for the analysis are the environmental as well as social features and their likely impact on the natural ecosystem.

94. **Stakeholder and Public Consultations.** Extensive consultations were held during different stages (reconnaissance, detailed design and design review) with key stakeholders that includes local and beneficiary population, government departments/agencies, wildlife and forestry officials, road users, and project-affected persons. These consultations allowed the interaction between the stakeholders and road designers to identify road features and construction methods that will enhance road upgrading and minimize potential impacts. Information gathered was integrated in the project design and formulating mitigation measures and environmental management plan. Detailed description of public consultation is presented in Chapter-8 of this EIA report.

95. **Assessment of Potential Impacts.** Potential significant impacts were identified on the basis of analytical review of baseline data; review of environmental conditions at site; analytical review of the underlying socio-economic conditions with the project influence area.

96. **Preparation of the Environment Management Plan.** An EMP for the subproject is prepared to specify the steps required to ensure that the necessary measures have been taken and the same will be incorporated during construction and operation stage of the subproject. The EMP includes the monitoring plan giving details of the resources budgeted and the implementation arrangements.

E. Structure of the Report

97. This EIA report has been presented as per requirements of the ADB's Safeguard Policy Statement (SPS) 2009. The report is organised into following ten chapters, a brief of each chapter is described below:

- ***Chapter 1 - Introduction***: This section described the background information about the project and EIA study.
- ***Chapter 2 - Policy, Legal, and Administrative Frameworks***: this section summarizing the national and local legal and institutional frameworks that guided the conduct of the assessment.
- ***Chapter 3 - Project Description***: This section presents the key features and components of the proposed project.
- ***Chapter 4 - Description of the Environment***: This section discussing the relevant physical, biological, and socioeconomic features that may be affected by the proposed project.
- ***Chapter 5 - Anticipated Environmental Impacts and Mitigation Measures***: This section presents the environmental assessment of likely positive and adverse impacts attributed to the proposed project and concomitant mitigation measures.
- ***Chapter 6 - Analysis of Alternatives***: This section covers analysis of various alternatives considered to minimise the overall impacts of proposed development and suggest most appropriate alternatives based of detailed analysis of impact and risk associated with each alternative.
- ***Chapter 7 - Information Disclosure, Consultation, and Participation***: This section describing the consultation process undertaken during the environmental examination and its results, their consideration in the project design, and manner of compliance to the ADB's Publication Policy and related national laws.
- ***Chapter 8 - Grievance Redress Mechanism***: This section describing the formal and informal redress procedures for registering, resolving, and reporting complaints.
- ***Chapter 9 - Environmental Management Plan***: This section discussing the lessons from the impact assessment and translated into action plans to avoid, reduce, mitigate or compensate adverse impacts and reinforces beneficial impacts. This plan is divided into three sub-sections; mitigation, monitoring, and implementation arrangements
- ***Chapter 10 - Conclusion and Recommendation***: This section stating whether there is a need for further environmental assessment and highlights key findings and recommendations to be implemented by the borrower.

98. An Executive Summary is also prepared and presented in the beginning of the report.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORKS

99. India has well defined institutional and legislative framework. The legislation covers all components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. Asian Development Bank has also defined its Environmental and Social Safeguard policies. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards. This section summaries the following:

- National (India) Environmental Legislation and Legal Administrative Framework,
- Social Safeguard Regulatory Requirements,
- ADB safeguard policies and categorisation of the project,
- Summary of international treaties and applicability to the project

A. National (India) Environmental Policy Framework

100. The legal framework of the country consists of several acts, notifications, rules and regulations to protect environment and wildlife. In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. The national legislations are broadly divided under following categories:

- Environmental Protection,
- Forests Conservation, and
- Wildlife Protection.

101. The umbrella legislation under each of above category is highlighted below:

- **The Environment (Protection) Act 1986** was enacted with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. Various rules are framed under this Act for grant of environmental clearance for any developmental project, resources conservation and waste management.
- **The Forest Conservation Act 1980** was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.
- **Wildlife (Protection) Act 1972** amended 2003 was enacted with the objective of effectively protecting the wildlife of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. It defines rules for the protection of wildlife and ecologically important protected areas.

102. State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the part. Other Ministries/ Statutory Bodies/ Departments responsible for ensuring environmental compliance and granting various clearances includes state ministry /dept. of environment, regional offices of MoEFCC and state forests/wildlife departments. Their key roles and responsibilities and interface among them have been concisely depicted through the flow diagram. The administrative framework defines the roles and responsibility of various ministries and government departments at Central Level and State level. The administrative framework for environmental protection, forests conservation and wildlife protection is given at Figure 3.

103. The environmental impact assessment requirement in India is based on the Environment (Protection) Act, 1986, the Environmental Impact Assessment Notification, 2006 (amended 2009), all its related circulars, MOEFCC's Environmental Impact Assessment Guidance Manual for Highways 2010 and IRC Guidelines for Environmental Impacts Assessment (IRC:104-1988) of highway projects. In addition to road widening and rehabilitation including establishment of temporary workshops, construction camps, hotmix plants, and opening of quarries for road construction work require to comply with provisions of The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003): The Wildlife (Protection) Act, 1972 (Amended 1993); The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974; The Air (Prevention and Control of Pollution) Act, 1981 (Amended 1987) and Rules 1982; The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002) and Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009).

104. A review is undertaken for all the environmental rules and regulation which might be applicable to the proposed road corridor improvement activities. These legislations with applicability to this project are summarised below in Table 3 and approval and monitoring framework is depicted in Figure 3. There is no separate state level legislation. However various acts like Water and Air are enforced through state level authority: State Pollution Control Board.

105. Specifically, for the proposed Khongkhang-Moreh subproject in the state of Manipur, the following (Table 3) environmental laws and regulations are applicable:

Table 3: Applicable Environmental National and State Requirements

Sl. No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
Planning Stage: Before start of Civil Works Construction (Responsibility: Executing Agency)						
1.	Implementing Project in Forest Area	Environmental Protection Act of 1986, Forest Conservation Act	Forest Clearance	Conservator of Forest, Government of Manipur	MoRTH	6-12 months
2.	Implementing Project in Protected Area	Wildlife Protection Act	Clearance from National Wildlife Board	Chief Wildlife Warden National Wildlife Board	MoRTH	6-24 months
3.	Borrow areas	EIA Notification 2006	Environmental Clearance	State/District EIAA	The Contractor	4-6 months
Construction Stage (Responsibility: Contractor)						
1	Establishing campsites, stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as amended	Consent-for-establishment	State Pollution Control Board	The Contractor	2-3 months
2	Operating camps, stone crusher, hot mix plant, wet mix plant and	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action	Consent-for-operation	State Pollution Control Board	The Contractor	2-3 months

Sl. No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
	Diesel Generator Sets	of 1986 and as amended				
3	Use and storage of explosive for quarry blasting work	India Explosive Act 1984	Explosive license for use and storage	Chief Controller of Explosives	The Contractor	2-3 months
4.	Storage of fuel oil, lubricants, diesel etc. at construction camp	Manufacture storage and Import of Hazardous Chemical Rules 1989	Permission for storage of hazardous chemical	State Pollution Control Board or Local Authority (DM/DC)	The Contractor	2-3 months
5	Quarry operation	State Minor Mineral Concession Rules, The Mines Act of 1952, Indian Explosive Act of 1984, Air Act of 1981 and Water Act of 1974	Quarry Lease Deed and Quarry License	State Department of Mines and Geology	The Contractor	2-3 months
6	Extraction of ground water	Ground Water Rules of 2002	Permission for extraction of ground water for use in road construction activities	State Ground Water Board	The Contractor	2-3 months
7	Use of surface water for construction	-	Permission for use of water for construction purpose	Irrigation Department	The Contractor	2-3 months
8	Engagement of labour	Labour Act	Labour license	Labour Commissioner	The Contractor	2-3 months

106. In addition to the acts and regulations listed above the Environmental Impact Assessment Guidance Manual for Highways 2010 issued by MOEFCC and the IRC Guidelines for Environmental Impacts Assessment (IRC:104-1988) of highway projects issued by MORTH, were referred in the process of preparing this EIA. The following requirements are particularly important and need special attention in order to avoid any delays for a project:

(i) As per provisions of the EIA Notification 2006 (amended in 2009, 2011 and 2013), all expansion of national highways that are longer than 100km and involve additional right-of-way or land acquisition greater than 40m on existing alignment and 60m on realignment or bypass fall under category A and require environmental clearance from the Ministry of Environment and Forests & Climate Change at the central level. Since the total length of the proposed Imphal - Moreh National Highway (AH1) subproject is less than 100 km (29.516km), it does not fall under

the purview of EIA notification. Therefore Environmental Clearance from MoEFCC is not required for this subproject.

(ii) As per the Forest Conservation Rules (1981, amended 2003) a forestry clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly, timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process. Proposed Khongkhang-Moreh subproject road pass through forest areas and which require diversion of forest land, therefore forest clearance is required as per Government of India requirements.

(iii) As per the Wildlife Protection Act, clearance from National Board for Wildlife (NBWL) is required for proposed Khongkhang-Moreh subproject as about 21.066 km road length part of this subproject is passing through Yangangpokpi Lokchao Wildlife Sanctuary (YLWLS).

(iv) Cutting of trees in non-forest land requires a tree cutting permit from the local forestry department. All trees cut under a project must be compensated by compensatory afforestation as required by the Forest Department.

(v) As per Office Memorandum (OM) issued by MOEFCC on 19 March 2013 the grant of environmental clearance for linear projects including roads has been delinked from the forestry clearance procedure. Hence, after receipt of environmental clearance construction works may commence on sections/parts of a linear project that do not require forestry clearance. Construction works may commence on sections requiring forestry clearance only after receipt of the respective clearance.

(vi) Placement of hot-mix plants, borrow areas, quarrying and crushers, batch mixing plants, discharge of sewage from construction camps requires No Objection Certificate (Consent to Establish and Consent to Operate) from State Pollution Control Board prior to establishment.

(vii) Permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective by them.

107. Before the start of civil works for the any component of the subproject the project proponent (NHIDCL) must obtain necessary clearances / permits from the regional office of the Ministry of Environment and Forests & Climate Change, National Wildlife Board and State Pollution Control Board. Procedures and steps to be followed to obtain various clearances / permits are presented in Figure 3 to Figure 6.

B. Social Regulatory Requirements of India and State

108. There are many rules and regulations framed by the Government of India for the protection of workers. Most of these legislations will be applicable to contractors in charge of construction. EA will ensure compliance to these social legislations through contractual obligation and regular checks & penalties. These legislations include The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996; Child Labour (prohibition and Regulation) Act, 1986; Minimum Wages Act, 1948; Workmen Compensation Act, 1923; Payment of Gratuity Act, 1972; Employee State Insurance Act; Employees P.F. and Miscellaneous Provision Act, 1952; Maternity Benefit Act, 1951; Payment of Wages Act, 1936; Equal Remuneration Act, 1979; Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act, 1979; Equal Remuneration Act, 1979 etc.

C. International Treaties and Relevance to the Project

109. Government of India has signed many international treaties. GOI has also framed various laws, regulations and guidelines to meet country's obligations under these treaties. The projects of this magnitude may contribute in meeting country's obligation directly or indirectly. A screening

was carried out of these treaties regarding its applicability to this project. Outcome of these treaties. The relevant international Treaties are:

- **Kyoto Protocol to the United Nations Framework Convention on Climate Change** (Rectified by India in 1997): The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.
- **Convention Concerning the Protection of the World Cultural and Natural Heritage** (Rectified by India in 1972): The most significant feature of the 1972 World Heritage Convention is that it links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.

D. ADB's Safeguard Policy Statement Requirements

110. The Asian Development Bank has defined its Safeguard requirements under its 'Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB's SPS 2009 classify a project depending on following three categories.

- **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.
- **Category B:** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.
- **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

E. Category of the Project

111. The project has been evaluated considering the outcome of the ADB Rapid Environmental Assessment (REA) checklist and the same is enclosed as Annex-1. All environmentally sensitive areas along the proposed alignment have been critically analyzed to assess the magnitude and extent of likely impacts. The proposed Khongkhang-Moreh subproject passes through Yangangpokpi Lokchao Wildlife Sanctuary (YLWLS) in the State of Manipur. About 12.470 km length of Khongkhang-Moreh (NH Sections) from Lokchao bridge to Khudengthabi (at km 416.6) it is bordering core zone of Yangangpokpi Lokchao Wildlife Sanctuary (YLWLS) and from Khudengthabi to Moreh it is passing through buffer zone of the YLWLS. Approval from the National Wildlife Board for diversion of forest land to non-forest purpose will be required for this subproject for the section passing through the YLWLS and government reserved forests.

112. Certain sections of the subproject road section involve expansion of the existing road to two lane standard road, where there will be substantial land use change and earthworks involved. The road section crosses some of the water bodies and acquisition of land may be involved at a

few stretches. Due to these environmental sensitivities the project falls under environment category A as per ADB Safeguard Policy Statement 2009 hence an environmental impact assessment has been carried out.

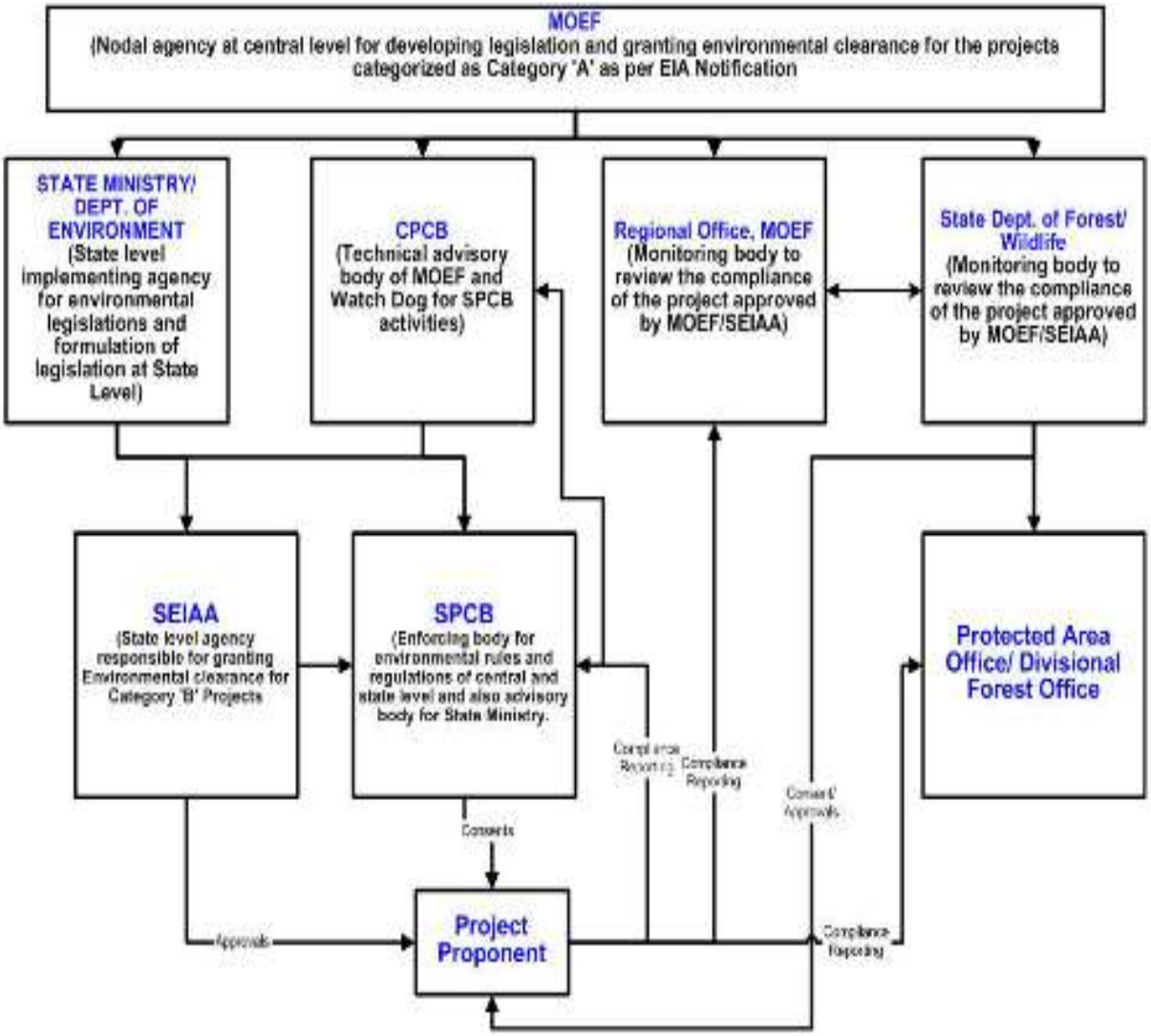


Figure 3: Environmental Legal Administrative Framework in India

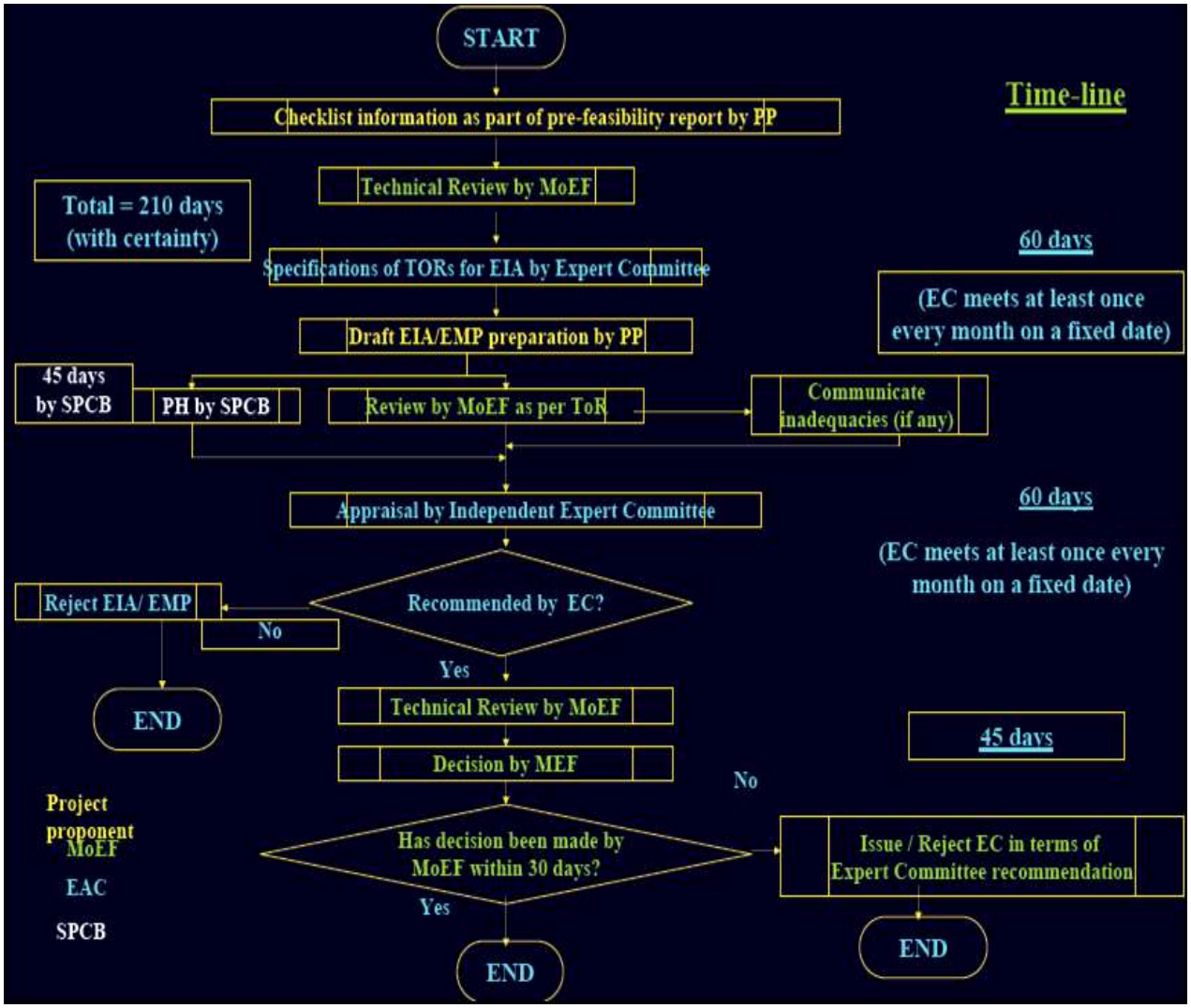


Figure 4: Environmental Clearance Process in India

Key Steps in EC Process:

1. Submission of application along with Form-I, Pre-feasibility report and other necessary documents to Ministry of Environment and Forest & Climate Change (Merck) or State Environmental Appraisal Committee (SEAC)
2. Presentation of Terms of Reference (TOR) to Mecca or SEAC
3. Obtaining TOR from mesc or SEAC
4. Preparation & submission of Draft Environmental Impact Assessment (EIA) / Environmental Management Plan (EMP)
5. Conducting Public Hearing
6. Preparation of revised EIA/EMP (as per comment of Public Hearing)
7. Preparation & submission of Final EIA to MoEFCC or SEAC along with Stage 1 forest clearance.
8. Final presentation to MoEFCC or SEAC.
9. Obtaining Environmental Clearance.

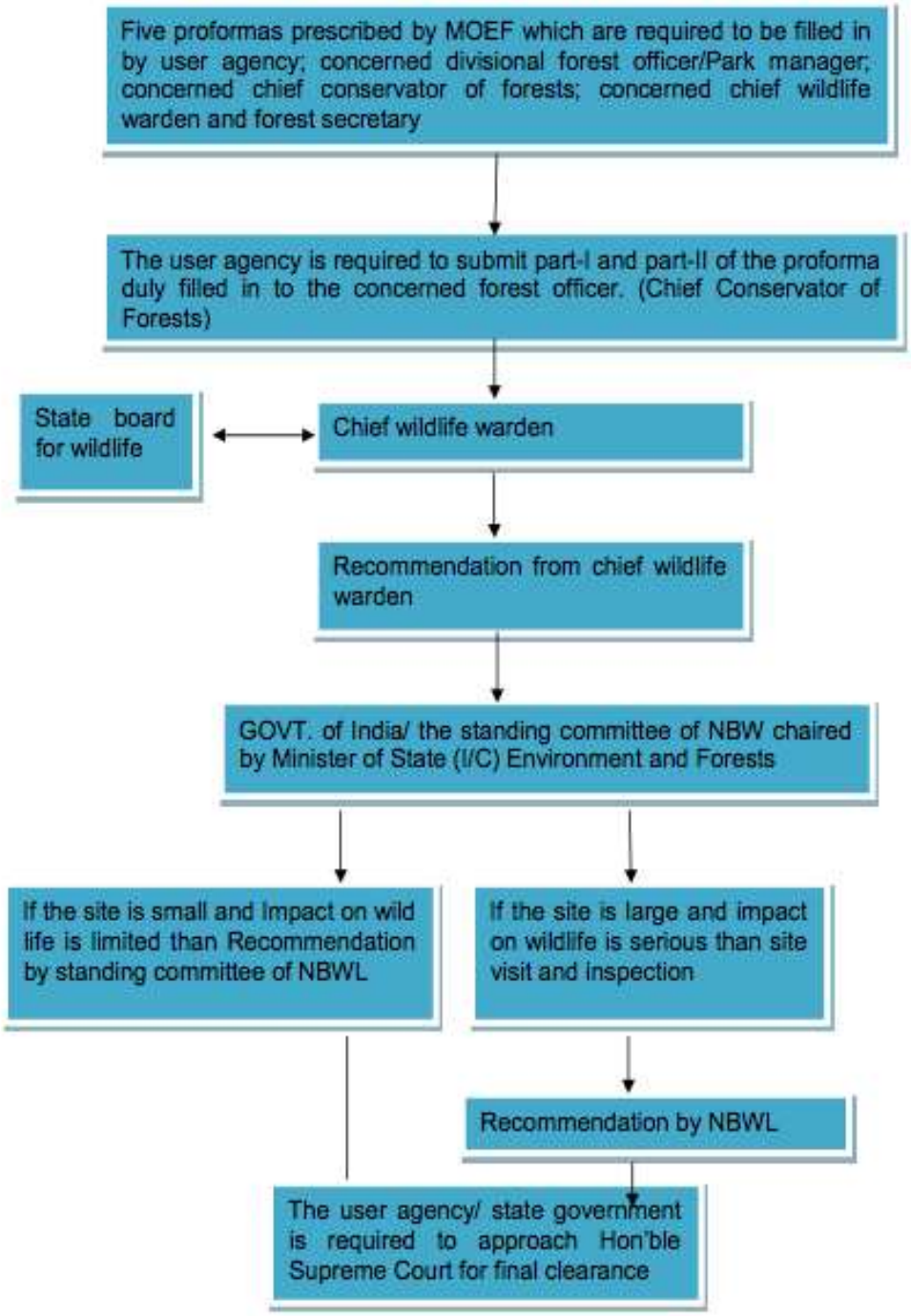


Figure 5: Procedure for Obtaining Wildlife Clearance in India

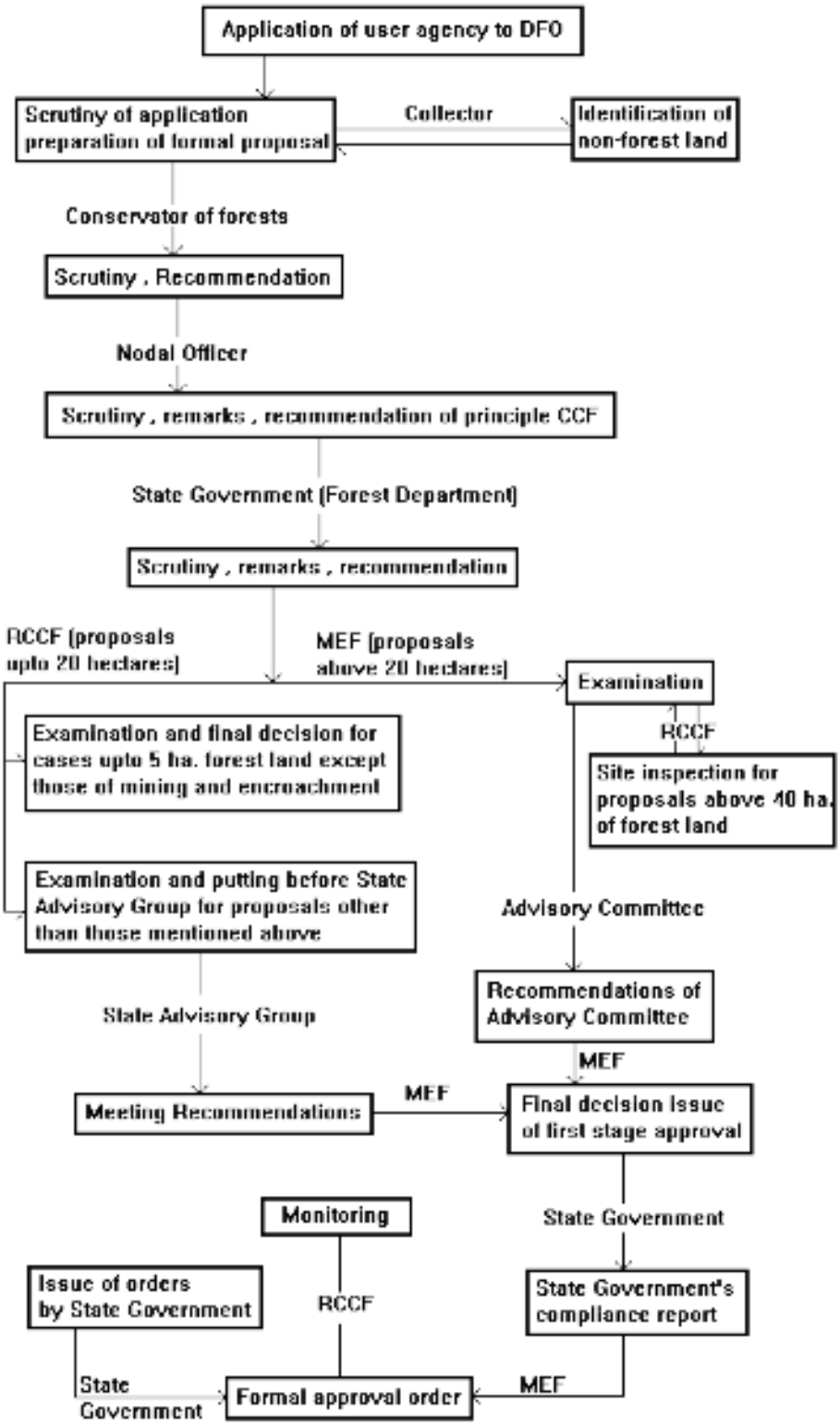


Figure 6: Procedure for Obtaining Forest Clearance

Key Steps in Forest Clearance Process:

Step No.	Activity	No. of Days
1	Preparation of case / application letter that is submitted to Revenue and Forest Department	7
2	Area calculation to identify land diversion requirement with the help of Revenue Department represented	30
3	Joint visit by Executive Engineer, and District Forest Officer (DFO)	
4	Enumeration of trees by the Forest Department after the visit of Forest Guard and Range Officer	7
5	List is forwarded by the Range Officer to DFO for approval	15
6	Preparation of a combined 'case' papers (documents prepared by Revenue Department, list of trees enumerated by Forest Department and actual area calculation for diversion of forest land are enclosed)	7
7	Case submitted to DFO - DFO Office will examine the case and further send to Conservator of Forests	7
8	Conservator of Forests will examine the papers and further forward the case (subject to the fact that no shortcomings/deficiencies are found) to Prin. Chief Conservator of Forests	7
9	Case is further examined by the Prin. Chief Conservator of Forests and forwarded to Additional Secretary (Forests)	4
10	Additional Secretary (Forests) recommends the case for the approval of the Forest Minister.	3
11	Forest Minister approves the case and returns the case file to Additional Secretary (Forests)	8
12	Case file is sent to CF, Shillong (MoEFCC) after the counter signature of Chief Secretary, State Government. (The case file is counter-signed by the Chief Secretary as the case file goes to MoEFCC).	2
13	CF (Shillong) examines the case. May opt for conducting a site inspection or may provide an 'in- principle' clearance without conducting the site visit.	90 (primarily due to workload)
14	If CF, Shillong provides 'in-principle' approval, it is conveyed to DFO. The concerned DFO works out the cost for compensatory afforestation and NPV and the total cost/amount is conveyed to the concerned Executive Engineer.	3
15	Executive Engineer requests PWD for releasing the said amount. The Project Director's Office/PWD directly deposits the specified amount into the bank account of the concerned DFO.	2
16	The DFO communicates the amount deposition to CF, Shillong and requests to provide final/formal approval	2
17	CF, Shillong conveys (in writing) the final/formal approval to the concerned DFO.	30
18	DFO conveys the final/formal sanction to the Executive Engineer	2
19	DFO further directs the concerned Range Officer (Forest Department) to mark (process is formally known as 'hammering') the trees for cutting.	1
20	Range Officer hammers/ marks the trees in presence of Executive Engineer or his field representative	10
21	The Range Officer sends the final list of trees to the concerned DFO for information	1

Step No.	Activity	No. of Days
22	DFO forwards the case to Forest Corporation to call 'tender' for cutting the marked trees	3
23	DM, Forest Corporation calls for bid and fixes date/s to receive the tender documents	30
24	After opening of the tenders and their evaluation, tree cutting work is awarded to the selected contractor	15
25	Contractor mobilizes the required lab our and machinery at site	15
26	Contractor cuts the trees.	30
	Total Number of Days (numbers indicate ideal situations)	**331**

Key Steps in Tree Cutting Permission Process:

Step No.	Activity	No. of Days
1	Preparation of case / application letter to the Revenue and Forest Department for felling of trees falling within the Right-of-way	7
2	Area to be cleared of trees is verified on the ground with the help of Revenue Department	30
3	Joint visit by Executive Engineer, DFO and Revenue Department staff for the verification of the land and trees falling within the ROW	
4	Enumeration of trees by Forest Department after the visit of Forest Guard and Range Officer (both from Forest Department). The details cover number of trees to be cut along with chainage, species and girth information.	7
5	List of trees to be cut is forwarded by the Range Officer to the concerned DFO for approval	15
6	The combined case paper is prepared by enclosing the documents received from Revenue and Forest Department (as prepared in the steps mentioned above).	7
7	Case is submitted to the concerned DFO – the DFO Office examines the case and if there are no observations, sends it to the Conservator of Forests (CF)	7
8	The CF office will examine the case and if there are no observations, will approve the felling proposal.	7
9	The approval from CF office is conveyed to the concerned DFO, who further conveys the final sanction (in writing) to Executive Engineer.	2
10	DFO further directs the concerned Range Officer (Forest Department) to mark (process is formally known as 'hammering') the trees for cutting.	1
11	Range Officer hammers/ marks the trees in presence of Executive Engineer or his field representative.	10
12	The Range Officer sends the final list of trees to the concerned DFO for information.	1
13	DFO forwards the case to Forest Corporation to call 'tender' for cutting the marked trees.	3
14	DM Forest Corporation calls for bids and fixes date/s to receive the tenders.	30
15	After opening of the tenders and their evaluation, tree cutting work is awarded to the selected contractor.	15
16	Contractor mobilizes the required labor and machinery at site.	15

Step No.	Activity	No. of Days
17	Contractor cuts the trees	30
	Total Number of Days (numbers indicate ideal situations)	**187**

III. PROJECT DESCRIPTION

A. Type of Project

113. The present report deals with the Environmental Impact Assessment of Khongkhang-Moreh subproject located in Manipur. This section of the road is included in Tranche 3 of the SASEC Regional Road Connectivity Investment Program (SRCIP) in India. The subproject road is part of the existing national highway no. 102 (NH-102) and now renamed as Asian Highway 1 (AH-1). The Khongkhang-Moreh subproject road starts at Khongkhang village and ends at Moreh (border town of India and Myanmar) covering a total length of 29.516 kms. It is mostly passing through hilly to undulating terrain. The present road section is proposed for improvement and upgradation to two lane configurations with shoulders and side drains. Table 4 shows information about the Project Road.

Table 4: Details of the Project Road

Name of the Project	Subproject No.	Project Length (km)	District	State
Improvement and Upgradation of 29.516 kms Khongkhang-Moreh road section of NH-102 in the State of Manipur	Tranche 3 subproject	29.516	Tengnoupal	Manipur

B. Need for the Project

114. Manipur is one of the eight North Eastern States in India. The geographical area of the state 22.327 sq km constitutes less than 0.70% of the entire country. It lies between latitude of 23°83'N – 25°68'N and longitude of 93°03'E – 94°78'E. the State capital, Imphal is located at an elevation of 790 m above mean sea level. Geographically the state is bounded on all sides by ranges of hills and particularly land blocked.

115. The total population of the state is 27,21,756 as per 2011 census. Of the total area, only 17 % is in valley and balance in hills and hilly/mountain terrain. The state border totals 854 km of which 352 km is international border with Myanmar to the east and south east. The remaining 502 km separate Manipur to rest of India. The road transport infrastructure in the state of Manipur is far below the all India Standards in terms of road length per sq.km. It is imperative to improve the road transport infrastructure in the state.

116. The national highway corridors namely old NH 53, NH 39 and NH 150 are linking the state with the other parts of the country. The NH 39 (recently renamed as NH 102) Imphal Moreh is linking India and Myanmar. Surfaced road in hill districts are mainly limited to National Highways, State Highways and Major District Roads. Majority of the other district roads and village roads are not surfaced. The existing road system suffer from various types of deficiencies such as inadequate crust thickness, inadequate cross drainage works, weak and narrow bridges and pavement failures etc.

117. The present study road section, Imphal - Moreh is part of Asian Highway AH1 in Manipur state in India. AH 1 is the longest route of the Asian Highway Network (see Figure 7 on next page), running 12,845 miles (20,557 km) from Tokyo, Japan via Korea, China, Southeast Asia, India, Pakistan, Afghanistan and Iran to the border between Turkey and Bulgaria west of Istanbul where it joins end-on with European route E80. In India AH 1 passes through Numaligarh - Golaghat - Garampani - Barpathar - Naojan - Bokajan - Dimapur - Kohima - Tadubi - Senapati - Kangpokpi - Imphal - Thoubal - Tengnoupal – Moreh (Myanmar border).

118. The present project is aimed to widen and improve about 29.516 km of existing national highway into 2 lane configuration between Khongkhang village and Moreh (NH-102) in the state of Manipur. The road stretch is a critical section of the UNESCAP Asian Highway No. 01 (AH01),

paving the way for India and other South Asian countries to Myanmar, and further to ASEAN countries.

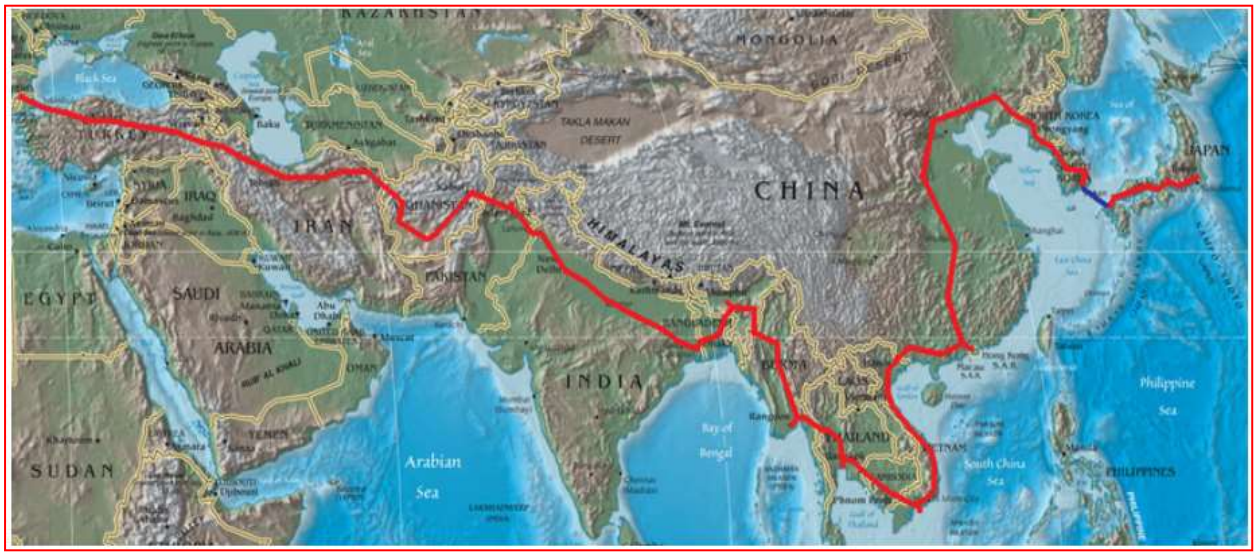


Figure 7: Map showing Asian Highway Network

119. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance (TA) from the Asian Development Bank (ADB) to prepare an ensuing loan for the international trade corridor in Manipur State (the project). The Asian Development Bank (ADB) is supporting the preparation of the Sub regional Road Connectivity Project in the state of Manipur, which is programmed for implementation in 2016 with funding support from ADB. In order to facilitate the implementation of the project, the ADB has engaged consultants to prepare detailed feasibility study and preliminary engineering design to define the project scope for implementation through engineering, procurement and construction (EPC) contract. Besides independent consultants have also been fielded by ADB to prepare the requisite safeguards documents in compliance with ADB and Government of India requirements.

C. Location and Features of the Project Road

120. The subproject road section is located in Tengnoupal district of Manipur state. Figure 8 & 9 shows the location map and alignment plotted on Google earth image and topo sheet respectively.

121. The Imphal - Moreh road start in Imphal city. The first 10 km section has already been undertaken by MORTH for upgrading to 4-lane carriageway upgraded and approx. 65 km section has been sanctioned for upgradation to 4-lane by NHIDCL and is in advance stage of implementation. Hence; this subproject start has been considered as km 395+680. The subproject concerns upgrading about 29.516 kilometers of existing National Highway 102 in the State of Manipur. The project corridor starts from Khongkhang village at its Km 395+680 and ends at Moreh (Myanmar Border) at its km 425+196. The road section under subproject run through hilly/rolling terrain from Khongkhang to Moreh). The corridor traverses throughout forest area with fair to poor surface condition.

122. The project road running north to south east between Longitudes 24°48'8.9"N & 24°14'16.46" N and lies between Longitude of 93°56'18.44"E & 94°18'2.23"E within the state of Manipur.

123. The landuse along the alignment from Khongkhang to outskirt of Moreh, is mix of open/barren land with thin vegetation and patches of agricultural activities on hillocks. These hills are mostly owned by village communities. The vegetation on hilly terrain is mostly mixed bushes and thin forests owned by communities.

Figure 8: Map showing Project Alignment

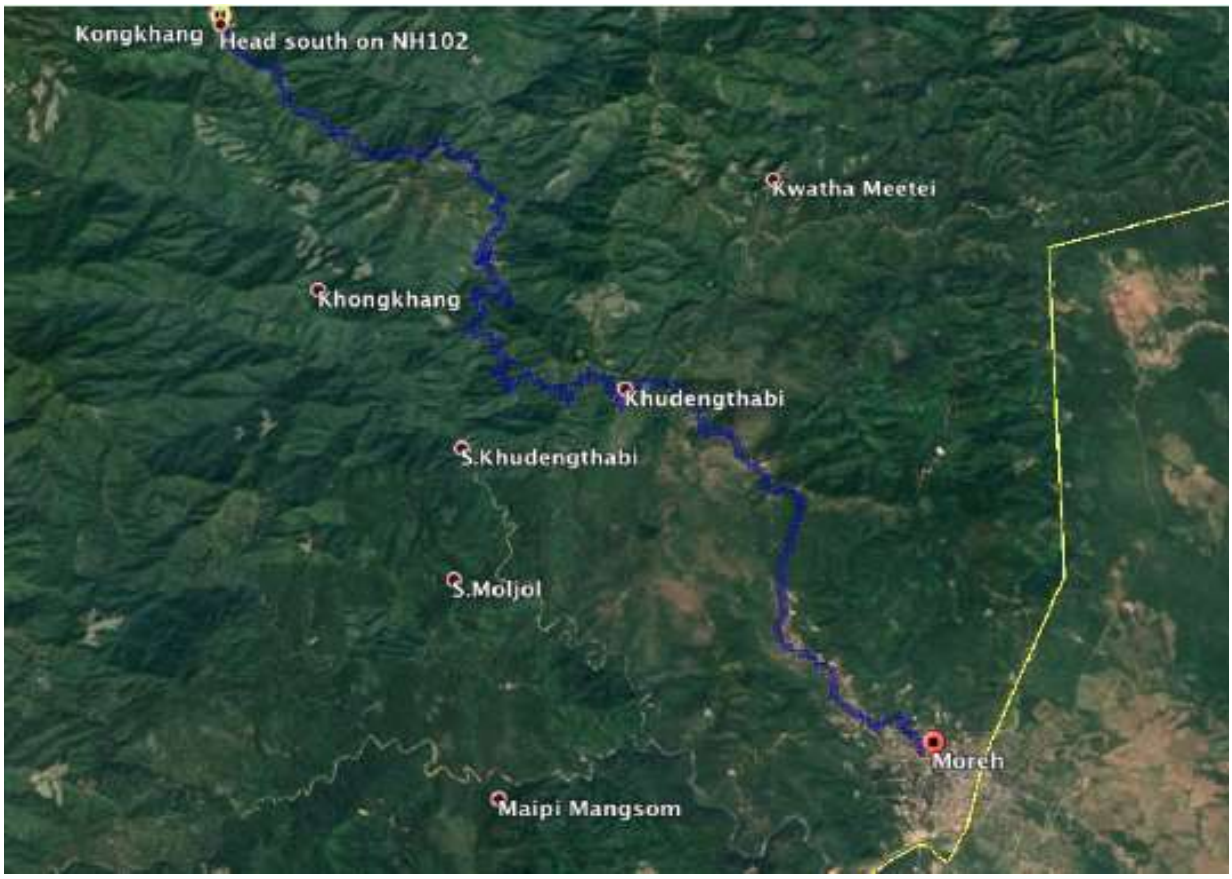


Figure 9: Project Alignment on Google Earth Image

124. The project corridor also passes through some habitation areas, the ROW is available for widening or even minimum improvement of road geometry.

	
Khudhengthabi Village	Moreh Town

D. **Chainage Reference System**

125. Since Kilometer stones are available along the project road, the same is followed from km 395+680 to km 425+196.

E. **Corridor Sections**

126. Considering the nature of traffic, geometric features as observed during the preliminary visits, a segmental approach is appropriate to describe the project road features. Accordingly, the corridor can be divided into two broad sections as given below in Table 5.

Table 5: Subproject Project Road Section as per traffic

Subproject	Segment No.	Sections / Segments	Length (km)
Khongkhang-Moreh NH Section	1.	Khongkhang – Khudengthabi (From Km 395+680 to Km 412+600)	16.92
	2.	Khudengthabi – Moreh (From Km 412+600 to Km 425+196)	12.596
		Total Length	**29.516**

127. **Segment 1: Khongkhang to Khudengthabi (From Km 395+680 to Km 412+600).** This segment from Pallel runs towards south east through the hilly terrain where the formation width is 10 m only and passes through Thamlapokpi, Bongyang, Sinam and Tengnoupal villages. Two army check post are at present located near start of ghat section and at highest altitude point near Tengnoupal village where all the vehicles are being checked. Majority of passenger/commercial traffic terminates near Pallel town. In hilly terrain isolate slipouts were noticed where the formation widening have been taken up by the department, and the protection works in the form of breast walls will be included in the improvement proposals, in many of the locations of old formation breast walls have been constructed for majority of it length in hill side. There are 3 minor bridges existing in this segment. Pavement condition varies from fair to good. The segment passes on the ridges of the hills for majority of its length. The ROW is 15 m only.

128. There is a steel minor bridge existing at km 404+500 on a sharp curve over Lokchao River. Detailed Engineering Design Project Report (DPR) has already been prepared by PWD for improvement of this bridge and approaches. The construction of the bridge is already started and is in advance stage for its implementation. Geometrics improvements proposed in the PWD DPR

will be considered for the present study. This segment ends near Khudengthabi village junction with PMGSY road.

129. Two villages along this segment are Khongkhang and Lokchao village at km 396+400 and km 404+600 respectively.

130. **Segment 2: Khudengthabi - Moreh (From Km 412+600 to Km 425+196).** This segment starts from Khudengthabi village and end before international border in Moreh town. The section passes through hilly/rolling terrain for its total length and the carriageway widths varies from 7.0 m to 8.0 m. Formation width of 10 m is observed and available right-of-way is 15 m only. Pavement is mostly in fair condition. This segment passes through the Moreh town for about 4 km length. There is a LCS (Land Customs office) located near km 424. The length of urban section observed is around 2.3 kilometers. The last section of the road in Moreh urban area is not included in any widening proposal due to developed are on both of road; here only re-surfacing work is proposed. As a bypass for Moreh Town already taken up as separate assignment by NHIDCL. Moreh town is shown in Google earth image below in Figure-10.

131. There are 2 minor bridges existing in this segment out of which one bridge is located on the border at which is a Bailey steel bridge and only half-length maintained by India. The design scope for this bridge is not considered in the present study because 50% of length (shown yellow in color) maintained by Myanmar government.

Figure 10: Google image showing Road section in Moreh Town

F. Project Network

132. The corridor identified for development is situated in southeastern part of Manipur state and offers excellent potential to become a major traffic corridor connecting international traffic from Myanmar. At present the traffic from Myanmar is low due to regulations not permitting vehicle travel between the countries. Goods are transported from Myanmar to Moreh (India) through porters and further loaded in mini trucks for further transportation to various places in India and same thing is in practice in Myanmar also. Once the regulations for free travel are implemented and international trade corridor opens, then the project corridor will become an important trade corridor with large potential for traffic and will provide the Manipur state and the region opportunities for trade development and also access to import from south east Asian countries.

G. Design Standards for the Project Road

133. The IRC design standards have been followed in consultation with ToR, while formulating the road design standards. As the project road sections pass mainly through hilly terrain, the ruling design speeds considered for the formulation of design standards are 100 km/hr. for plain sections

and 50 km/hr. for hilly sections. The purpose of formulation of design standards is to avoid any inconsistency in design during the road construction and operation.

H. Proposed Improvement Works

134. The project road corridor has been divided into four homogenous sections based on the traffic flow characteristics. The defined homogeneous sections have been referenced with the existing chainages from km 395+680 to km 425+196. The salient proposals for upgradation and improvement of the existing road sections are classified into the following engineering aspects.

Table 6: Details of Improvement Proposal for Various Sections

Sl.No	Homogenous Section Details	Recommendation on Capacity Augmentation
1	HS 1: Khongkhang to Khudangthabi (395+680 to km 412+600)	2 Lane with Paved shoulder
2	HS 2: Khudangthabi to Moreh (km 412+600 to km 425+196)	2 Lane with Paved shoulder

I. Engineering Surveys and Investigations

135. Following surveys and investigations had been carried out on the Project roads for collection of data for incorporation in the DPR and evolve the design for improvement and upgradation.

- topographic surveys;
- traffic surveys;
- road and pavement condition survey and inventory;
- culverts and bridges condition survey and inventories;
- material surveys;
- hydrology studies for new bridge structures;
- Geotechnical investigations & subsoil exploration for structures; and
- existing utilities surveys.

136. These surveys had been carried out in accordance with the guidelines in IRC:SP:19 to fulfill requirement in the TOR.

J. Traffic Surveys

137. Traffic surveys were carried out with main objectives to assess:

- The volumes of traffic flows and their characteristics.
- The trip distribution and travel characteristics.
- The through traffic characteristics.
- The commodities distributions.

138. In order to understand the traffic characteristics and the volume of traffic using the project road, primary surveys were carried out to know the existing travel pattern. A detailed reconnaissance survey had earlier been conducted to identify the appropriate locations for the mid-block traffic volume count survey. The traffic on the project corridor is a mixture of through and local types because, the land use along the route is both rural and residential. To achieve the stated objectives, the traffic following locations were selected for the traffic surveys and the details are given in Table 7.

139. Midblock classified traffic volume count surveys were carried out at 2 locations for seven consecutive days each from morning 6:00 AM to 6:00 PM due to security issues and traffic beyond 6:00 PM is almost negligible. Origin and Destination survey carried out at one location near Kakching village for 12 hours during daytime.

140. Table 7 show details of the various surveys carried out.

Table 7: Details of Traffic Surveys

Sl. No	Description of Location	Dates of Survey
Traffic Volume Count Survey		
1	TVC- 1 Near Khudengthabi village (km 412+000) for 7 days.	05.10.2013 to 11.10.2013
2	TVC- 2 Near Moreh Central Bazaar (km 424+500) for 7 days.	05.10.2013 to 11.10.2013
Origin & Destination Survey		
1	OD at Kakching village (Km 362+000) for 12 hours	19.10.2013

141. **Annual Average Daily Traffic (AADT):** The traffic plying on any road generally varies over the different periods of the year depending on the cycle of different socio-economic activities in the regions through which it passes. Therefore, in order to have more realistic picture of the traffic on the project road, it is required to assess seasonal variation in traffic to estimate Annual Average Daily Traffic (AADT). In the absence of any reliable data on seasonal variation, no correction was carried out. The traffic survey was carried out for 12 hours from 6 AM to 6 PM and for the remaining time traffic is negligible. In order to account for the daily traffic the ADT observed for 12 hours is increased by 5% to arrive at the AADT.

Table 8: Annual Average Daily Traffic (AADT)-Normal Traffic

S. No	Vehicle Type	TVC 1	TVC 2
		HS 1	HS 2
1	Car/Jeep/Van	1141	1199
2	Taxi	0	0
3	2-Wheeler	16	1584
4	3-Wheeler	0	1698
5	Minibus	1	1
6	Std Bus	2	3
7	Ambulance, Firetender, Funeral vans	1	2
8	Trucks	19	30
9	Cycle	0	88
10	CRK	0	1
11	AC	0	0
12	HC	0	0
13	Others	0	0
14	3-Tyre	14	16
15	Mini LCV (Ace)	4	4
16	4-Tyre	65	67
17	6-Tyre	33	45
18	2-Axle	23	26
19	3-Axle	7	7
20	MAV	0	0
21	7 Axle or more Axle/HCM/EME	0	0
22	Trailers	0	0
23	Tractor	0	0
Total Fast Vehicles		1326	4682
Total Fast PCU's		0	0

S. No	Vehicle Type	TVC 1	TVC 2
		HS 1	HS 2
Total Slow vehicles		0	89
Total Slow PCU's		0	46
Grand Total Vehicles		1326	4771
Grand Total PCU's		1470	4125

Source: Traffic Survey carried out for May 2013

142. **Traffic Projections / Growth Rates**: Traffic growth rates established for the study are based on historic traffic data, vehicle registration data, GDP growth and taking into consideration the likelihood of diverted and generated traffic. Based on available evidence and data, the base traffic growth rates as per TA are reasonably in order and adopted are Passenger – 8.6% and Freight – 6.4%. Table 9 present summary of growth rates for the project road section.

Table 9: Summary of Recommended Growth Rates for Project Road

Vehicle Type	2013-18	2018-23	2023-28	2028-33	2033-38
Car/Van/Jeep	7.2	6.4	5.8	5.0	4.0
2-Wheeler	9.0	8.0	6.5	5.6	4.0
3-Wheeler	6.5	5.8	5.2	4.5	3.6
Bus	5.0	4.3	4.0	3.4	3.4
All Trucks	5.5	5.0	4.5	4.0	3.5
LCV	6.1	5.5	5.0	4.4	3.9

Table 10: Projected Traffic along the Additional Alignment in Opening Year

Vehicle Category	Traffic estimated to realize in the opening year (2018)
Car/Jeep/Van	572
2-Wheeler	181
3-Wheeler	42
Bus	25
LCV	48
Trucks	17

143. **Traffic Forecast**: Traffic growth rates adopted over the design life and preconstruction activities are given as under:

Year 2006-2008 : 7.5%.
Year 2009-2011 : 7.5
Year 2012-2031 : Passenger – 8.6%
: Freight – 6.4%

144. Traffic projections for all the homogenous sections were computed with the growth rates given in Table 11 and the traffic from chapter 4 (AADT) of DPR of the project. The yearly projections summary for 30 years from year 2013 for Vehicles and PCU and for each homogenous section of Project Road is given in Table 11.

Table 11: Year wise AADT Projections for Project Road Sections (VEH & PCU)

Year	HS 1		HS 2	
	Veh's	PCU	Veh's	PCU
2018	2505	2928	7995	7182
2019	2863	3312	8722	7830

Year	HS 1		HS 2	
	Veh's	PCU	Veh's	PCU
2020	3442	4134	9739	9061
2021	3665	4403	10385	9632
2022	4476	5676	11735	11483
2023	4773	6061	12519	12213
2024	5066	6446	13253	12917
2025	5377	6857	14032	13663
2026	5706	7293	14857	14454
2027	6059	7762	15732	15294
2028	6432	8259	16660	16186
2029	6682	8633	17205	16770
2030	6943	9026	17771	17381
2031	7219	9445	18360	18023
2032	7509	9889	18972	18696
2033	7779	10286	19573	19327
2034	8008	10648	20034	19860
2035	8246	11027	20508	20413
2036	8494	11424	20997	20987
2037	8751	11838	21499	21582
2038	9019	12273	22018	22202
2039	9297	12727	22552	22844
2040	9588	13204	23104	23514
2041	9889	13702	23672	24209
2042	10203	14224	24257	24931

145. **Capacity** Analysis and Level of Service: The projected traffic is compared with the Design Service Volume (DSV) at Level of Service (LOS) -B (for rural roads, IRC: 64- 1990) to examine whether the facility would be able to carry the anticipated traffic or capacity augmentation would be needed. The design service volumes and capacities based on IRC 64-1990 are shown in Table 12.

Table 12: Design Service Volume (PCU/day)

Terrain	Lane Configuration	Design Service Volume (LOS B)	Design Service Volume (LOS C)
As per IRC: SP48-1998 (Hill Road Manual)			
Hilly Terrain with Low Curvature	2 Lane with earthen shoulder	7,000	10,500
	2 Lane with 1.5m paved shoulder	8,050	12,075

146. Based on the above design service volume for LOS B and LOS C the capacity augmentation till 2045 is established and the summary is given in Table 13.

Table 13: Level of Service

Homogenous Section	Two Lane with Earthen shoulder		Two Lane with Paved Shoulder		Four Lane with Paved Shoulder	
	LOS B	LOS C	LOS B	LOS C	LOS B	LOS C
HS 1 (Based on Hill roads manual)	2026	2034	2028	2038	NA	NA
HS 2	2027	2039	2030	NA	NA	NA

147. The level of service assessment indicates that HS1 & HS2 will cross its LOS B by 2028 to 2036 with a two-lane paved shoulder configuration which is within the design period of 20 years from opening year of 2018. Considering difficulty in developing a four-lane road on hilly/mountainous terrain through which HS 1 and part of HS 2 is passing through, it is considered that the NH 102 is providing sufficient capacity for HS 1. On NH 102, the road sections upto Pallel well exceeds capacity of even 4-lane by 2028, it is being undertaken to be developed to four lane facility to ease the pressure of development all along the length up to Pallel town (foot of the hill). The summary of recommendation for all the four homogeneous sections is given below in Table 14.

Table 14: Summary of Homogenous Sections

Homogenous Section Details	Lane Configuration
HS 1: Pallel Junction to Khudengthabi Village	Two-Lane paved shoulder
HS 2: Khudengthabi Village to Moreh Junction End	Two-Lane paved shoulder

K. The Design

148. The improvement proposal involving design for the Project road specifies widening and strengthening of existing road. The design of the Project road incorporates the following design components:

- analysis of present traffic and future projections,
- analysis of present pavement structure and its strength and design requirements for the new pavement and overlay over the design period for widening and strengthening,
- determination of adequacy of the hydraulic capacity and structural parameters of the existing structures, determination of adequacy of the road's geometry (horizontal as well as vertical); and
- ensuring road safety aspects are addressed.

L. Design Standards

149. Although the project road is composed of National Highway and State Highway warranty the corresponding set of design standards recommended by IRC, the nature of land use abutting the corridor has made introduction of location specific deviation essential from the point of view of safety and socio-economic contribution. The design considerations and the standards adopted to formulate the typical cross sections and for preliminary design are discussed in the following sections.

150. The following IRC codes, inter alia, were used as reference:

IRC: 3-1983	:	Dimensions and Weights of Road Design Vehicles
IRC: 37-2001	:	Guidelines for the Design of Flexible Pavements
IRC: 48-1988	:	Hill Roads Manual
IRC: 58-2002	:	Rigid Pavements for Highways
IRC: 64-1990	:	Guidelines for Capacity of Roads in Rural Areas
IRC: 70-1977	:	Guidelines on Regulation and Control of Mixed Traffic in Urban Areas
IRC: 73-1990	:	Geometric Design Standards for Rural (Non Urban)
IRC: 86-1983	:	Geometric Design Standards for Urban Roads in plains
IRC SP-73-2007	:	2 Lane manual for PPP project

IRC SP-84-2010	:	4 Lane manual for PPP project
IRC: 81:1997	:	Flexible Road Pavements Using Benkelman Beam Deflection Technique
IRC-SP 13:2004	:	Guidelines for the Design of Small Bridges and Culverts

151. AASHTO and the TRL guidelines for pavement and geometric design were also appropriately referred to.

M. Geometric Design Standards

152. The salient parameters for the geometric design of roads suggested are given in Table 15 to 18.

Table 15: Design Speed

Type of Section	Ruling		Absolute Minimum
	Desirable	Minimum	
Rural	100 km/h	80 km/h	60km/h
Urban/Builtup Section	60 km/h	50 km/h	30 km/h*
Hill Roads	Ruling	Minimum	-
National and State Highways	50 km/h	40 km/h	-
Major District Roads	40 km/h	30 km/h	-

* From the point of view of safety only.

153. Safe stopping sight distances confirm to an object height of 0.15 m and driver's eye level of 1.05 m above road.

Table 16: Sight Distance Standards

Palin/Rolling Terrain				Hilly Terrain		
Design Speed (km/h)	Sight Distance (m)			Design Speed	Stopping Sight Distance	Intermediate Sight Distance
	SSD	ISD	OSD			
100	180	360	640	25	25	50
80	130	240	470	30	30	60
60	80	160	300	35	40	80
50	60	120	235	40	45	90
30	30	60	110	50	60	120

154. On hill roads stopping sight distance is absolute minimum from safety angle and must be ensured regarding of any other considerations. Radii for the plain terrain and hilly terrain are given in Table 17 and 18 respectively.

Table 17: Geometric Standards for Horizontal Alignment

Particulars	Design Speed(km/h)				
	100	80	60	50	30
Minimum radius of horizontal curve(m)*	400	255	130	90	35
Maximum super elevation 'e'	5%	5%	5%	5%	5%

* Minimum radius of the curve calculated based on maximum super elevation value of 5% and friction coefficient of 15%.

Table 18: Minimum Radii of Horizontal Curves

Classification	Mountainous Terrain	
	Areas not affected with Snow	
	Ruling Min (m)	Absolute Min (m)
National Highways and State Highways	80	50
Major District Roads	50	30

155. The super-elevation should be attained gradually over the full length of the transition curve so that the design super-elevation is available at the starting point of the circular portion. In case where transition curve cannot be provided for some reason, 2/3 of the super elevation may be attained on the straight section before start of the circular curve and the balance 1/3 on the curve.

156. In developing the required super-elevation, it should be ensured that the longitudinal slope of the pavement edge compared to the centre-line (i.e., the rate of change of super-elevation) is not steeper than 1 in 150 for roads in plain and rolling terrain.

157. Methods of attaining Super elevation in Hill Roads: The normal cambered section of the road section is changed into super elevation section in two stages. First stage is the removal of adverse camber in outer half of the pavement. In the second stage, super elevation is gradually built up over the full width of the carriageway so that required super elevation is available at the beginning of the circular curve. There are three different methods for attaining super elevation;

(i) Revolving pavement about the Centre line;
(ii) Revolving pavement about the inner edge and;
(iii) Revolving pavement about the outer edge

158. When culverts fall on a horizontal curve, the top surface of the wearing course of culverts should have the same profile as the approaches. The super-elevation may be given to the abutments keeping the deck slab thickness uniform as per design. The level of the top of the slab of the culverts should be the same as the top level of the approaches so that undue jerk while driving on the finished road is avoided.

159. On Indian highways, the proportion of slow-moving vehicles and heavily laden commercial vehicles in the traffic stream is substantial. Consequently, it has been observed, 70% to 80% of the vehicles travel at two-third of the design speeds. Also, speed restrictions are often imposed on curves because of line-of-sight limitations. Therefore, vehicles travelling at speeds less than the design speed, particularly the SMVs such as tractor-trailers find it difficult to negotiate superelevationhigherthan5%. Slow traffic on the outer lane (s) on a curve tend to drift toward the center of the curvature (i.e. toward the fast lane) posing hazard to themselves and all other road users. The other issue is the roll-over factor, which affects slow-moving vehicles, against travelling on the outer lane of curve. The camber break between the carriageway lane and the paved shoulder, i.e. the roll-over, has to be restricted to 8% else vehicles like tractor-trailers would overturn. Assuming that the paved shoulder camber cannot be less than 2.5%, the super-elevation shall be limited 5% so that the roll-over (2.5% + 5%) remains within 8%. However, this required a flatter radius than what is proposed in the Table 19.

Table 19: Longitudinal Gradients in Rural Stretches (Plain/Rolling Terrain)

Particulars	Design Speed (km/h)			
	100	**80**	**60**	**50**
Gradient				
• Ruling maximum	3.3%	3.3%	3.3%	4%
• Absolute maximum	3.3%	4%	4%	4%
Min. 'K' Value (for safe stopping sight distances)				
• Summit curves				
SSD	74	33	14.5	8.2
ISD	135	60	27	15
OSD	427	230	94	58
• Sag curves	43	26	15	10
Grade difference not requiring vertical curve	0.5%	0.6%	0.8%	1.0%

Note: Length of curve = K × grade difference in percent

160. Hilly Terrain: broken back grade lines, i.e. two vertical curves in the same direction separated by a short tangent, should be avoided due to poor appearance, and preferably replaced by a single curve. Decks of small cross drainage structures (i.e. culverts and minor bridges) should follow the same profile as the flanking road section, with no break in the grade lines;

161. The proportion of slow-moving vehicles and heavily laden commercial vehicles in the traffic stream is substantial. Consequently, it has been observed, 70 to 80% of the vehicles travel at two-break in the grade line. Recommended gradients for different terrain conditions, except at hair-pin bends are given in Table 20 below:

Table 20: Recommended Gradients for Different Terrain Conditions

Classification of Gradient	Mountainous Terrain and steep terrain more than 200 m above MSL	Mountainous Terrain up to 3000 m height above MSL
Ruling Gradient	5% (1 in 20.0)	6% (1 in 16.7)
Limiting Gradient	6% (1 in 16.7)	7% (1 in 14.3)
Exceptional	7% (1 in 14.3)	8% (1 in 12.5)

Note: Gradients up to the ruling gradients may be used as a matter of course in design.

Table 21: Cross-Sectional Elements

Element Characteristics	Design Values	
	Ruling	**Minimum**
Widths		
Lane	3.5 m*	-
Paved shoulder	2.0 m/1.5m	1.5 m
Earthen shoulder	2.0 m	1.0 m
Slow/parking lane	2.5 m	1.5 m
Median	1.50m with RCC crash barrier. If standard wide median of 4.5m is provided, no crash barrier would be required.	
Footpath	2.5 m	1.5 m
Cross-Fall		
Carriageway	2.5%	0.5%***
Paved shoulder	2.5%	0.5%
Hard /gravel shoulder	4.0%	1.0%
Earthen shoulder	4.0%	1.0%

Element Characteristics	Design Values	
	Ruling	Minimum
Footpath	3.0%	1.0%
Median top	4.0%	-
Embankment Side Slope (Vertical: horizontal)		
Fill	1(V):2(H) (min)	1(V):1.5(H)
Cut	2(V):1(H)	

* Add 0.25m on each kerb side to account for kerb shyness.
** Wide paved shoulder where necessary (ref: Para 7.4.5).
*** At junctions only, where camber may reduce to zero for level matching with crossroads

N. Widening Options

162. Capacity augmentation requirement necessitate widening of pavement throughout the section in the form of adding paved shoulder, service road, additional lanes etc. Dual carriage way is proposed where 4 lane sections is required. The dual carriageway ensures improvement of road safety by physically separating the traffic in each direction.

163. Options of eccentric and concentric widening to be chosen judicially as this will impact land acquisition, cost and also traffic movement during construction. The proposed widening options are shown in Table 22.

164. Considering the pros and cons of widening options, by default, eccentric widening is considered for this study. However, concentric widening in semi-urban/urban stretches is preferred to avoid unnecessary R&R and drainage problems.

165. Furthermore, it is not advisable to shift side of widening so frequently as it will lead to serious traffic management issue and also need additional curves to be introduced to transit from one scheme to another. As in the case of addition of paved shoulders, some of the bridges may not be widened if the existing width is more than the requirement given in MORTH circulars on widening of existing structures. In this case concentric widening to be considered invariably. Hence, wherever such constrains like bridge or built up locations exist at very closer interval concentric widening will be preferred. The widening scheme proposed for this project is given in Table 22 below:

Table 22: Proposed widening scheme

S.No	Design Chainage(m)		Length(m)	TCS Type	Type of Widening
	From	To			
1	395680	418000	22320	6	Eccentric (Hill Side)
2	418000	423200	5200	6	Eccentric (Hill Side)
3	423200	425196	1996	8	Concentric

O. Median

166. As per IRC recommendations 4.5 m median with raised kerb is provided in a dual carriageway road (4 lane section) to segregate horizontally opposite directional traffic. Its primary objective is to eliminate the possibility of head-on collision.

P. Paved Shoulders

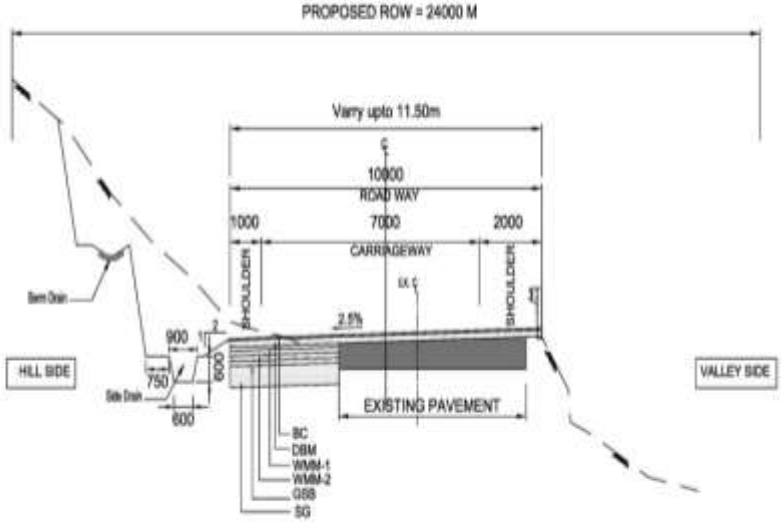
167. 2.0 m wide paved shoulders have been adopted as an improvement option strategy for many upgrading cases. IRC recommends 1.5m wide paved shoulder on either side of carriageway of 2-lane width or more. The usefulness of a paved (or even hard) shoulder is beyond dispute. One of the most important uses of a shoulder is to provide space for movement of slow-moving vehicles and for routine and emergency parking of vehicles.

Q. Typical Cross-sections

168. Based on the standards and the discussions mentioned earlier typical cross-sections for application in different common situations and for assessment of preliminary costs have been developed after considerable deliberations. The types and situations attracting these cross-sections are briefly described as under:

169. Figure 11 show some of the typical cross-sections considered as strategies in this study. Various cross sections proposed are:

- Type 6: Hill side Widening in Hill Areas- 2 lane carriageway.
- Type 7: Both Hill & Valley side Widening in Hill Areas- 2 lane carriageway
- Type 8: Concentric Widening in Urban Areas- 2 lane carriageway
- Type 9: Concentric Widening in Rural Areas- 2 lane carriageway
- Type 10: Typical Cross section for VUP Approach with Service Road



TCS - 6

HILL SIDE WIDENING IN HILL AREAS - TWO LANE CARRIAGEWAY

*Note :- Extra Widening as per Cuvature

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

NO	DATE	DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
0	03.01.14	Draft Detail Project Report	DP	BSH	MRS	BSD

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

JOB No. : SAI 0448

TITLE : TYPICAL CROSS SECTION

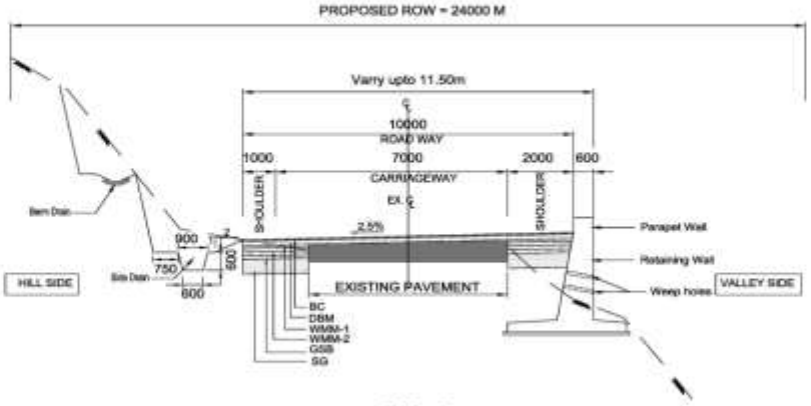
DRAWING NO : ADB-8116-DPR-TCS

SCALE : NOT TO SCALE

SHEET SIZE : A2

IMPHAL

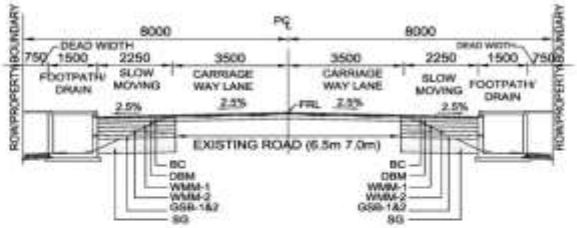
MOREH



TCS - 7

BOTH HILL & VALLEY SIDE WIDENING IN HILL AREAS - TWO LANE CARRIAGEWAY

*Note :- Extra Widening as per Cuvature



TCS - 8

CONCENTRIC WIDENING IN URBAN AREAS - TWO LANE CARRIAGEWAY

DRAFT FOR APPROVAL

NOTES:
1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

JOB No. : SAI 0448

TITLE : TYPICAL CROSS SECTION

DRAWING NO : ADB - 8116 - DPR - TCS

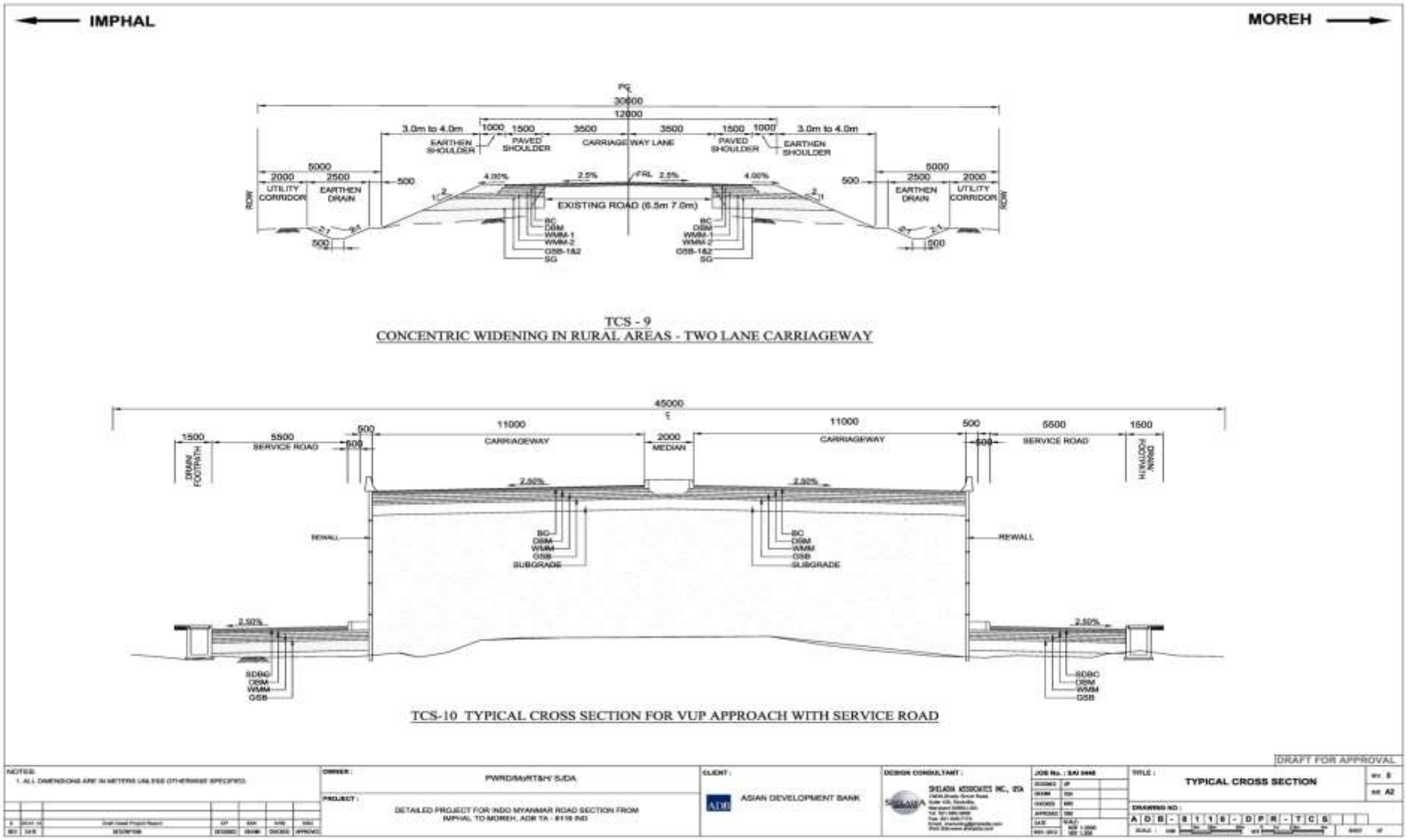


Figure 11: Typical Cross-section proposed for road widening

170. Application of the different typical road cross-sections will depend on the capacity augmentation requirement, the availability of Right-of-way, land use pattern etc. Use of retaining walls or geo-textile in slopes at restricted ROW locations is also recommended. Details of widening proposals and adopted typical cross section type are given in Table 23.

Table 23: Details of proposed cross section

Sl. No	Design Chainage(m)		Length(m)	TCS Type	Type of Widening	Homogenous Section
	From	To				
1	395680	418000	22320	6	Eccentric (Hill Side)	1
2	418000	423200	5200	6	Eccentric (Hill Side)	2
3	423200	425196	1996	8	Concentric	

R. Embankment Height

171. From the inventory analysis, it is observed that the subproject road section in the hilly terrain and has embankment height above HFL during monsoon season. Hence, raising of the embankment is not proposed for this road section in Hilly Area in between Khongkhang to Moreh.

S. Pavement Design

172. The general design procedure is based on the prevalent practices in the country. The design of pavement structure has been carried out as per IRC Guidelines and TOR. The detailed design of new pavement and overlays on existing pavement shall be based primarily on IRC-37:2012 and IRC-81: 1997 for flexible pavement and IRC-58: 2011 for rigid pavement.

173. Design CBR will be based on the results of borrow area sample testing as the borrow area sampling is not carried out a minimum CBR of 10% for from Pallel to Moreh recommended.

174. Minimum design traffic of 20 CMSA for Khongkhang to Moreh recommended respectively. Based on the pavement condition and keeping the embankment heights and overtopping situation the total project road section from km 395+680 to km 425+196 has recommended for reconstruction.

Table 24: New/Widening Pavement Thickness

Design MSA	Road Sections with 20-year Design Life	CBR	BC	DBM	WMM	GSB
20	Khongkhang to Khudengthabi	10	40	75	250	200
20	Khudengthabi to Moreh	10	40	75	250	200

T. Junction Improvement

175. The upgrading of the project roads would involve improvement of junctions, with other roads, in order to carry through the standard features of the project roads. As a policy, improvement of the crossroads over a suitable length from the junction has been proposed. The existing junctions requiring improvement have been classified into two categories, major and minor.

176. **Major Junction:** Intersection of the project road with another highway or a major district road is treated as a major junction. (refer Volume III: Drawings) show the typical improved layout of major 4-legged and ‘T’ junction respectively. There are no major junctions and underpasses are proposed in the subproject road section.

177. **Minor Junction**: Intersection of the subproject road with a minor road such as ODR or village road has been termed as a minor junction. The minor road approaches, however, are proposed to be widened to facilitate easy movement of turning traffic.

U. Road Furniture and Markings

178. The road furniture proposed to be provided include routine and special road signs; hectometer, kilometer and 200 m stones, guard posts on high embankment stretches (3m and above) e.g. bridge approaches and also at sharp curves. The existing furniture, which are in a reasonably good state of repair, are proposed to be recycled to the extent possible. Road markings would be generally standard centerline and yellow edge markings using thermoplastic paints. Lane markings, kerb/object markings, etc. as required under different options and stretches have been considered. Street illumination for urban road sections has been considered and included in design as appropriate.

V. Safety Features

179. The typical provisions that have been considered in design to prevent or minimize accidents are:

- Reflective studs (cats' eyes) on road markings.
- Double Beam Crash barriers in high embankment greater than 3 m and on approaches of bridges and also on valley side.
- Pedestrian crossings with road markings and reflective studs.
- Pedestrian guardrails (in Palin built-up area)

W. Truck Terminal, Truck Lay bays and Rest Area

180. Based on the inventory data collected it is observed that way side amenities like truck lay bays and rest area is not available along the project. Since the project road improvement envisages induced truck traffic into the project, adequate number of truck lay byes to be provided. The exact location of the truck lay byes is given in DPR. Appropriately designed rest areas are not available on the project alignment.

181. No major industrial corridor which requires a truck terminal kind of facility is existing on the project road.

X. Bus Bays / Way side Bus Stops

182. Considering the overall safety of traffic and minimum hindrance to through traffic, bus bays with pick-up bus stops have been proposed at following major town and villages along the project road.

183. Bus stop locations will be finalized such that,

- It shall not be located at horizontal curves.
- It shall not be located on top of summit vertical curves.
- it shall be located away from intersection as specified in IRC: 80-1981
- It shall be located preferably at straight road at flat gradient with good visibility.
- The location should not be prone to land slide for the safety of passengers.

184. The shelter shed for passenger shall be structurally safe and aesthetically pleasing in appearance, while also being functional so as to protect the waiting passenger adequately from the sun, wind, and rain. Bus-lay byes shall also be designed with proper drainage (Cross and Longitudinal) along with proper signage and markings. There are 2 bus shelters are observed along the subproject corridor and the following villages are recommended for providing bus shelters.

Table 25: Details Village Required for Bus Shelters

Sl. No	Name of Village require bus shelters
1.	Chikim Village
2.	Moreh Village

Y. Toll Plaza

185. Based on the finding of chapter 6 of DPR, toll plaza is proposed at the following location. However, the requirement toll plaza reviewed in consultation with the PIU based on the tolling policy of the execution agency. The exact location of the Toll plaza has been identified based on the availability of land and the suitability at the DPR stage.

Z. Retaining Wall

186. Upgrading options involving widening of the roadway in hilly terrain on valley side up to 9 m heights.

AA. Roadside Drain and Footpath

187. In rural sections of the road, unlined toe drains are invariably proposed unless, the embankment height exceeds 1 m. The toe drain literally starts from the embankment toe with a generally acceptable slope of 1:1. The depth of this drain would have to be sufficient to allow at least the drainage layer in the pavement to be exposed to daylight. As a rule, the minimum depth should be 60 cm.

188. In urban and semi-urban areas, to facilitate proper drainage of surface run-off, roadside drains have been proposed. The three common types of drains envisaged are:

(i) Lined rectangle open drain in semi-urban area
(ii) Lined trapezoidal type open drain in semi-urban areas
(iii) PCC box-type covered drain with footpath in urban areas
(iv) RCC pipe drain under footpath/shoulder in urban areas
(v) Chute drains in high embankment would also be required.

AB. Paver Blocks in Urban Area

189. **In** Service Roads: The service roads in urban areas where the right-of-way is a constraint to have exclusive utility corridor (refer typical cross-sections), are proposed to be constructed with vibrio-pressed interlocking concrete paver blocks. Laid on a sand-bed of 50 mm over granular base and sub-base courses, these paver blocks function very well in urban situations because these:

a. are not affected by poor drainage conditions
b. can be easily removed and re-laid in connection with maintenance of utility services housed below.
c. present a clear distinction between the main carriageway and the slow-lane.

190. In footpath: Paver blocks have also been proposed in footpath albeit of lower thickness 50 mm. Paver block construction would generally conform to IRC 63-2004.

191. **Median Opening:** In dual carriageway roads, median opening at important junctions, and at regular interval of 2 km in straight stretches have to be provided.

AC. Drainage Design Standards

192. The design of drainage structures is carried out in accordance with the following codes:

- IRC: SP: 13 - 2004, “Guidelines for the design of small bridges and Culverts”.
- IRC: 5 – 1998 “Standard specifications and code of practice for Road bridges”.
- IRC: SP: 84 - 2009, “Manual of Specifications & Standards for Four laning of Highways through Public Private Partnership”.
- IRC: SP: 42 – 1994, “Guidelines on Road Drainage”.
- IRC: SP: 50 – 1999/IRC: SP: 50 – 2013, “Guidelines on Urban Drainage”.
- IRC: SP: 48– 1998, “Hill Road Manual”.

AD. Recommendation for Bridges

193. As a safety consideration, width of the bridges was proposed to match with the width of the road at approaches. That is 14.8m in urban and 12.9m in rural for the 2 lane road improvement.

194. **Major bridge.** No major bridge would be covered in this road section of study.

195. **Minor bridges**. Minor bridges at chainage 409+000 and 412+230 are solid slab bridges which fall in this subproject road section 2 lane improvement with paved shoulder. These bridges are structurally sound so they are widened to 12.9m concentrically.

196. Bridge at chainage 404+450 is stone abutment with foundation on rock with bailey super structure; Separate DPR had been submitted to the bridge. Hence not in the scope of the present study.

197. Bridge at 423+150 is RCC girder bridge is structurally sound and comes in 2 lane improvement of the project and as it is meeting the 2 lane carriage way width, hence it is retained. Bridge at chainage 430+400 is across menar river with RCC abutment with bailey type super structure is on the international border hence not in the scope of the project.

198. **VUP/ PUP.** There is no PUP or VUP are proposed along the project road.

199. **Viaduct.** Due to steeper slope, it is difficult for the vehicle to mount the road. Hence viaduct has been provided at Km-397+960 on NH-102 for easier mounting of vehicle.

Table 26: Details of New Viaduct Existing Road

Sl. No.	Design Chainage	Proposed span (m)	Type of structure	Road Crossing	Structure Type
1	397+960	9x33.0	PSC	2 lane	Viaduct

200. **Culverts.** Referring to the standards highlighted in the previous sections, improvement proposal for culverts are prepared. Annexure 7.2 of DPR gives the improvement proposal for pipe culverts of the project road. Improvement proposal for Box/Slab and culvert is given in Annexure 7.3 of DPR. Summary of improvement proposal for pipe and box culverts along the project road are given in Table 27 and Table 28.

Table 27: Summary of Pipe Culvert improvement proposal

Item Description	Numbers
No. of Pipe Culverts	117
Retained	0
Reconstruction	117

Table 28: Summary of SLAB/BOX/ARCH culvert improvement proposal

Item Description	Numbers
No. of Culverts	29
Retained	0
Reconstruction	29

AE. Shifting of Utilities

201. Utilities like telephone cable, electrical lines along with water supply lines may be required to shift during widening. A proper scheme of relocating these shall be worked out once the widening schemes are approved. Details of the utilities along the project road are given in the

inventory. Strip plan showing existing utilities and relocation plan for the affected utilities due to the widening shall be submitted separately.

AF. Road Construction Materials

202. Material Survey for road construction materials for the Project roads, i.e. earth, aggregates, water, bitumen etc. has been carried out in the Project corridor and the indicative lead charts have been prepared.

203. Besides, the field in-situ investigations were conducted. The materials samples collected were tested in the laboratory and results data compiled in Material Report of the DPR.

204. The lead involved for the project roads and the investigations are quite representative, but more extensive investigation shall need to be conducted by the contractors at the time of construction, for earth and aggregates available from such sources.

AG. Project Cost

205. The cost of civil works including maintenance amounts to Rs. 523.49 crore (US$ 76.24 million) for package 3 of Imphal - Moreh NH section. These costs are based on 2013 rates as per analytical rates. The cost has been indexed for escalation till mid-2013 @ 5% per annum. The maintenance component in Part D of the Cost Estimate is based on an average 3% of total cost of Civil Works for 5 years. This component shall not be undertaken as part of contract for Civil Works, but to be undertaken separately subsequent to the construction.

AH. Construction Packaging and Implementation Schedule

206. It is proposed to carry out construction of the subproject road sections under one package with a time period of 36 months under the contract. The Project is proposed to be undertaken through International Competitive Bidding (ICB). Currently the project is at bidding stage and scheduled to award contract in the third quarter of 2019. The project is expected to complete in second quarter of 2020.

207. The following key factors in Construction Contract Packaging are considered in making the recommendation on Contract Packaging,

- Logical sections for construction, worksite access and earthwork balance
- Administrative jurisdiction and administrative efficiency
- Size of contract to attract medium and large size contractors with the required equipment and capability
- Time to completion
- Environmental requirements and constraints to specific segments

208. The proposed Contract Package is of 29.516 km in length of section from Km 395+680 to km 425+196 included in the subproject. The mode of contract is indicated as EPC model. The contract packaging and mode of contracting and implementation arrangements are as EPC Model.

AI. Project Benefits

209. The implementation of various project items is envisaged to have the following direct benefits:

- improved quality of life for the rural population in the project influence: this as a result of better access to markets, health, education and other facilities; and the derived stimulus for local economic activity;
- a more efficient and safe road transport system: through reduced travel times, reduced road accidents, reduced vehicle operating and maintenance costs and reduced transportation costs for goods;

- the facilitation of tourism; and
- Interstate connectivity to Imphal and Thoubal, Tengnoupal and Chandel Districts.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

210. The collection of current baseline information on biophysical, social, and economic aspects of the project area provides an important reference for conducting an EIA. The description of environmental settings includes the characteristic of area in which the project activities would occur and likely to be affected by project related impacts. Compiled existing baseline conditions include primary data on air quality, water quality, noise, vibration, soil, ecology and biodiversity, and socio-economic aspects. Secondary data were also collected from published source and various government agencies.

211. The data on water, soil, air, noise, vibrations were collected through field monitoring. The environmental monitoring was carried out by NABL accredited laboratory "Research Institute of Material Science Pvt. Ltd.", Delhi in the month of February-March 2019 for baseline air, noise, vibration, water and soil parameters. Climatological data was collected from India Meteorological Department. Efforts have been made to compile the available data from literature, books, maps and reports. The methodology adopted for data collection is highlighted wherever necessary. Environmental attributes and frequency of baseline surveys are presented in Table 29(a) and environment parameters monitoring locations are presented in Table 29(b) and shown in Figure-12(a). The baseline parameters are selected as specified by regulatory agencies in India and number and locations of the sampling are selected with due consideration to environmental sensitivity along the project line alignment and as agreed upon with the client.

Table 29 (a): Environmental Attributes and Frequency of Monitoring

S. No	Attribute	Parameter	No. of Samples	Source
LAND ENVIRONMENT				
1	Geology	Geological Status	---	Literature review
2	Seismology	Seismic Hazard	---	Literature review
WATER ENVIRONMENT				
3	Ground Water	Physical, Chemical and Biological parameters	Two	Sampling/ Monitoring locations
4	Surface Water	Physical, Chemical and Biological parameters	Three	Sampling/ Monitoring locations
AIR, NOISE, VIBRATIONS AND METEOROLOGY				
5	Ambient Air Quality	PM 2.5, PM10, SO_2, NO_x, CO, HC, NMHC	Four	Sampling/ Monitoring locations
6	Noise	Noise levels in dB (A)	Five	Sampling/ Monitoring locations
		Leq, Lmax, Lmin, L_{10}, L_{50}, L_{90}		
7	Soil Quality	Physico-chemical parameters	Three	Sampling/ Monitoring locations
8	Vibration	Peak particle velocity (ppv) in mm/s	Six	Sampling/ Monitoring locations
SOCIO-ECONOMIC				
9	Socio-economic aspects	Socio-economic profile	Once	Field Studies, Literature review.

Table 29 (b): Environmental Attributes and Frequency of Monitoring

S. No	Monitoring Requirement	No of samples/ Locations	Location
1	AAQ Monitoring – PM10, PM2.5, SO2, NOx, CO, HC, NMHC	4	1. AQ1 – Khongkhang
			2. AQ2 – Lokchao
			3. AQ3 – Khudengthabi Check Point
			4. AQ4 – Moreh
2	Ground Water Sampling for Analysis – General Chemical & biological Parameters	2	1. GW1 – Lokchao
			2. GW2 – Moreh
3	Surface Water Sampling for Analysis - Physico-chemical and biological parameters of water	3	1. SW1 – Lokchao River
			2. SW2 – Local Stream
			3. SW3 – Moreh River
4	Noise Level Monitoring – 24 Hourly	5	1. N1 – Khongkhang
			2. N2 – Lokchao
			3. N3 – Near Local Stream
			4. N4 – Khudengthabi
			5. N5 – Moreh
5	Vibration level monitoring	6	1. V1 – Khongkhang
			2. V2 – Lokchao
			3. V3 – Khudengthabi Army Check Post 4. V4 – Khudengthabi Village 5. V5 – Ima Ima Kondong Lairembi (Temple) 6. V6 - Moreh College
6	Soil Sampling for Analysis – General Physical, Chemical, Heavy Metal Parameters	3	1. SO1 – Khongkhang
			2. SO2 – Khudengthabi
			3. SO3 – Chikim (Moreh)

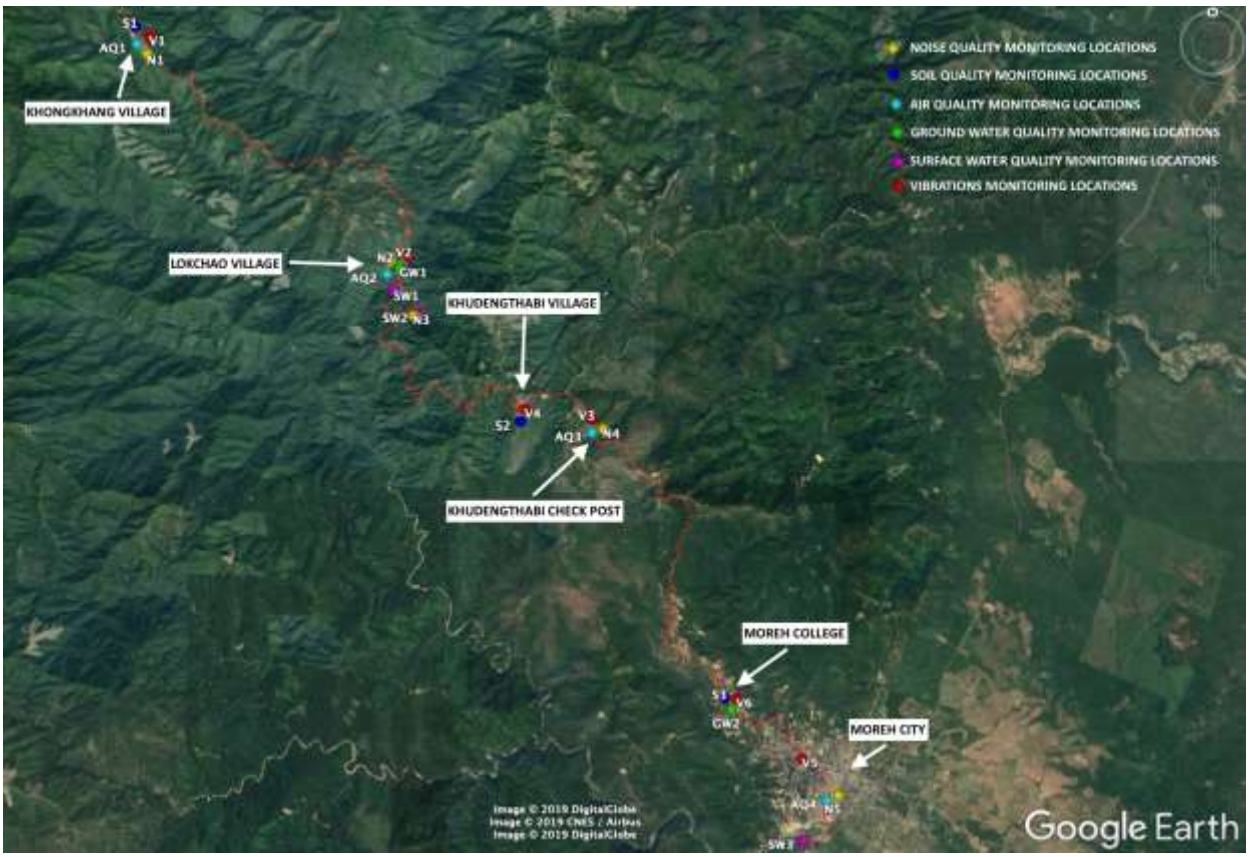


Figure 12 (a): Ambient Air and Noise, Vibration, Water and Soil Sampling Locations

B. Physical Environment

212. Information of various physical parameters was collected from the Guwahati Centre of Indian Meteorological Department, Statistical Department, Gazetteer of Manipur, Forest Department, Department of Environment and other concern Government Departments and discussions with the officials from these agencies.

213. **Meteorological Conditions.** The state has a subtropical monsoon to temperate climate depending on elevation. Rainfall is relatively abundant and widespread. The rainy season starts in June with the onset of the south-west monsoon and last upto September. Intermittent rains continue even upto October along with the retreat of the monsoon. During the rainy season the rainwater in the hills quickly flow down to the valley and all the rivers and small streams rises to the full brim, frequently flooding its embankments. The cold season last from the month of December to February. During the winter months light rainfall occurs under the influence of the north-east monsoon, March and October are by far the most pleasant months in the year. April and May are not hot season followed by occasional thunderstorms.

214. The annual rainfall of Manipur in 2017 was 2439.4 mm, against the highest rainfall of 2000mm. The state has a salubrious climate. The summer months are never oppressive with the average maximum temperature fluctuating from 30°C to 35°C during April-June, the mercury seldom going beyond 37°C. In December-February with the start of the cold winter months the average minimum temperature fall to 6°C to 4°C.

215. The salient climatic features of the state are as follows:

- Average Annual Rainfall - 1725 mm
- Concentration of precipitation - June to October
- Humidity - 79 to 96%
- Cloudiness - Heavily clouded

- Wind - Generally light except rainy season
- Temperature - Summer 30°C to 35°C
  - Winter 6°C to 4°C

216. Based on temperature, rainfall attributes and wind directions, three main seasons are clearly be recognised, these are: (i) winter extending from November to February, (ii) summer from March to May and (iii) rainy season from May to October.

217. The climatic conditions of the project area, Tengnoupal district is summarised in subsequent paragraphs.

218. **Tengnuopal District:** Tengnuopal district come in existence and separated from Chandel district. In Tengnoupal, the climate is warm and temperate. Throughout the year, there is virtually no rainfall. According to Köppen and Geiger climate is classified as Cwb. The average annual temperature in district is 20.6°C. About 1877 mm of precipitation falls annually. The driest month is December with 8 mm rainfall. Most precipitation falls in June, with an average of 432 mm. The warmest month of the year is May with an average temperature of 23.8°C. In January, the average temperature is 14.4°C. It is the lowest average temperature of the whole year. The difference in precipitation between the driest month and the wettest month is 424 mm. The average temperatures vary during the year by 9.4°C.

219. **Rainfall**. The climate of Manipur State is sub-tropical monsoon type. The rainy season of the area is quite long starting sometimes in the early part of May and continues up to the middle of October. The annual rainfall varies from 895 mm to 2135 mm in the valley and up to 3148 mm in the hilly area.

220. The average rainfall in the state is around 1725 mm (Figure 12 (b)). Monsoon confers upon Manipur a very good rain as seen below.

- Southwest monsoon (June-Sept.) - 825 mm
- Post monsoon period (Oct. to Dec.) - 151 mm
- Winter monsoon (Jan. to Feb.) - 52 mm
- Pre monsoon (March – May) - 407 mm

Total - 1725 mm

Figure 12 (b): Average Monthly Rainfall in Manipur

221. Table 29 (c) and Figure 13 present the month-wise normal rainfall data in Manipur.

Table 29 (c): Monthly Normal Rainfall in Manipur as a whole and Project Districts

Month	Monthly Rainfall (mm)	
	Manipur	Tengnoupal
January	6.9	13.0
February	0.3	27.0
March	128.1	58.0
April	229.5	73.0
May	193.7	150.0
June	238.4	432.0
July	296.1	334.0
August	103.6	336.0
September	262.3	225.0
October	195.0	196.0
November	12.6	15.0
December	59.2	8.0
Annual	**1725.7**	1867.0

Source: i) Economic Survey Manipur 2010-11, ii) www.en.climate-data.org

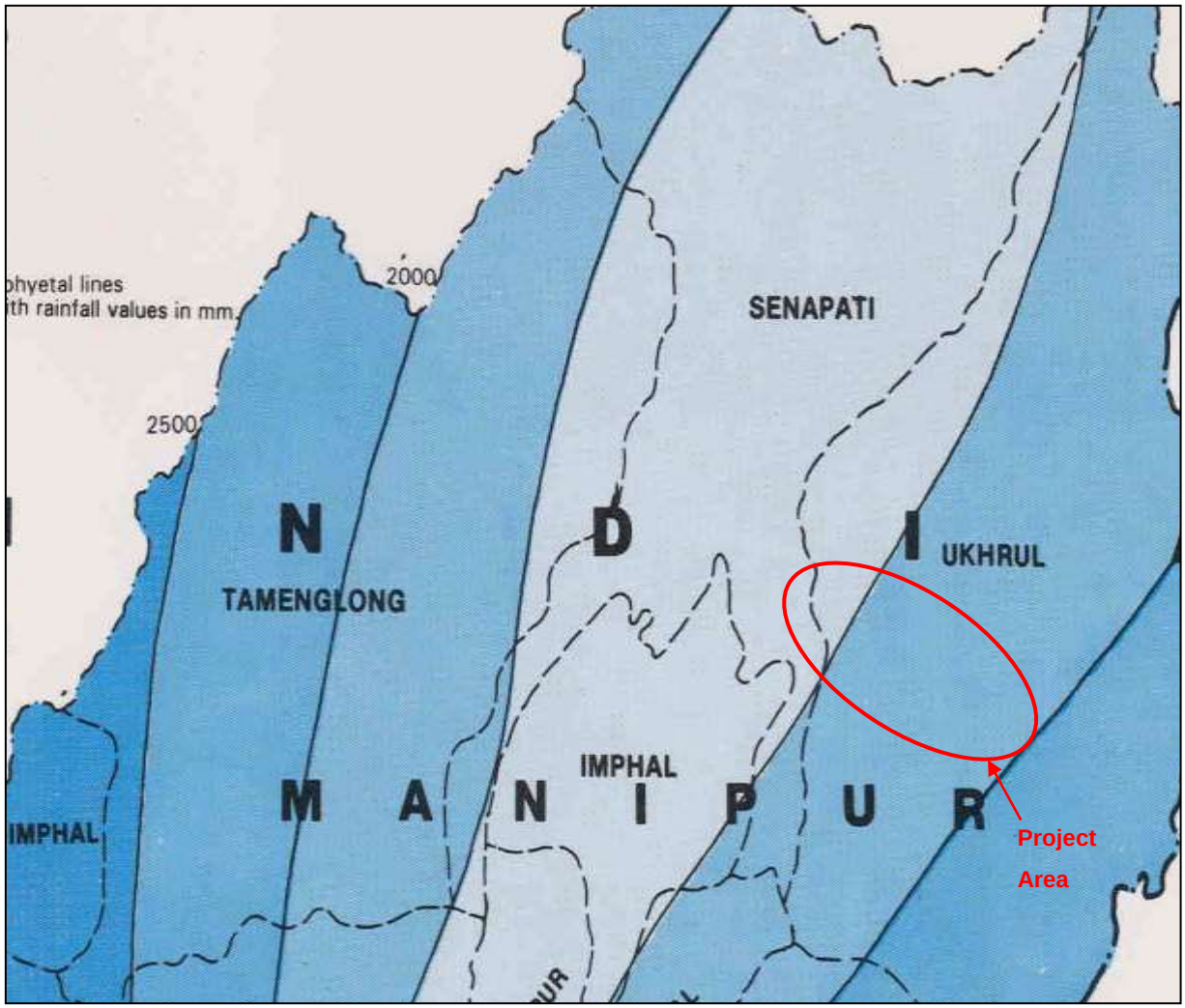


Figure 13: Average Annual Rainfall Map of Project Area

222. **Temperature**. The mean annual temperature of the state ranges from 15.4^{0}C to 25.3^{0}C. The mean monthly temperature rises abruptly with the onset of southwest monsoon in May (23.1^{0}C) from April (20.8^{0}C), and it continues high upto October (24.0^{0}C), until the southwest monsoons have started to retreat. December (17.10C) and January (15.40C) are the coldest months. August temperature (25.00C) is the hottest in a year.

223. The average minimum temperature of the coldest month of January is 4.30C; and the average maximum temperature is 26.40C with the mean temperature 15.40C. The minimum temperature of the hottest month August is 19.80C and the maximum temperature is 30.70C with the mean temperature of 25.30C. The annual average mean maximum temperature of the state is 36.60C and minimum mean temperature is 4.20C with mean temperature of 20.40C.

224. Relative Humidity. The relative humidity curve of the state has little downwards from January (74 %) to March (71 %). It rises abruptly with the increasing atmospheric moisture from April (77 %) to October (84 %) during the monsoon season and it becomes a downward from November (78 %) to December (77 %) with the onset of dry winter season, due to increasing atmospheric moisture. The drier months, November to march have great range between the morning and evening relative humidity than that of the wet months (April-October).

225. Table 30 shows the project road area monthly mean temperature and monthly mean daily relative humidity in Manipur and project district.

Table 30: Monthly Mean Temperature and Relative Humidity of State and District

Month	District / Mean Monthly Temperature (°C) and Relative Humidity (%)					
	Manipur			Tengnoupal (Chandel)		
	Max	Min	RH	Max	Min	RH
January	25.1	9.9	-	20.8	8.0	-
February	27.6	11.6	-	22.9	9.5	-
March	31.3	14.9	-	26.8	12.8	-
April	33.2	19.1	-	29.1	16.2	-
May	33.9	22.2	-	29.0	18.6	-
June	31.8	24.1	-	27.5	20.2	-
July	30.8	24.3	-	27.0	20.5	-
August	31.0	24.3	-	26.9	20.4	-
September	31.4	23.6	-	26.9	19.8	-
October	31.6	21.8	-	26.3	17.8	-
November	28.4	16.7	-	23.6	13.5	-
December	25.6	11.4	-	21.2	9.4	-

Source: i) Economic Survey Manipur 2017-18, ii) www.en.climate-data.org

226. **Wind Speed.** The average annual wind speed in project area is 5.55 km/hrs. The mean monthly wind speed varies from as low as 5.55 km/hrs from July to September to high of 7.4 km/day in the month of April. Table 31 and Figure 14 present the monthly mean wind speed in Manipur.

Table 31: Monthly Mean Wind Speed in Manipur as a whole

Month	Wind Speed (km/hrs)
January	5.55
February	7.41
March	7.41
April	7.41
May	7.41
June	7.41
July	7.41
August	7.41
September	5.55
October	5.55
November	7.41
December	5.55

Source: www.windfinder.com

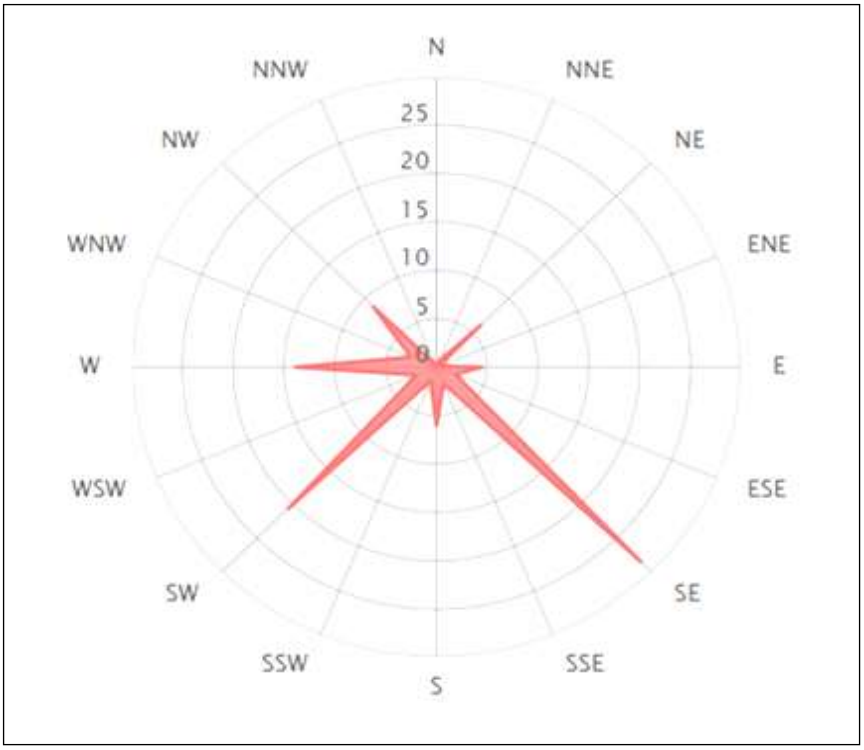


Figure 14: Annual Wind Direction and Distribution in (%) in Manipur

227. **Topography, Land Use, Geology and Soils.** ***Physiography***. Manipur, one of the eight sisters of the north eastern region in India, is an isolated hill-grit state located between $90^0$03'E and $94^0$42'E longitude and $23^0$50' and $25^0$42'N latitude. The state IS encircled by nine hill ranges on all sides with a small oval valley at the centre. The state has 352 km long international border with Myanmar to the south-east and 502 km border with the adjacent states of Nagaland on the north, Cachar district of Assam in the on the west and Mizoram on the south and the south west. The altitude of the state above the mean seal level varies from 790 meters to 2020 meters.

228. The state has a total geographical area of about 22327 sq km. which constitutes 0.7 percent of the total land surface of the country. Ninety percent of the total area of state is covered by hills; remaining area is a small valley. About 78 percent of the area is recorded as under forest. The population of the state stood at 2.72 million in 2011 of which 71 percent is rural.

229. The topography of the project area is hilly/rolling type. Land use is mainly forest followed by residential and agriculture type. Image 1 and Image 2 shows the typical terrain along the project road, whereas Figure 15 shows that topography and land use along the project road marked on the Google-earth image.

Table 32: Details of the Existing Road Section

Sl. No.	Road	Length (km)	Terrain	Land Use	Average Elevation above MSL (m)
1.	Khongkhang - Moreh	29.516	Hilly	Forest/ Agricultural	1060 - 1225

Figure 15: Google earth image showing terrain and land use along the Project road

Image 1: Typical Terrain along the Khongkhang-Moreh road Section

Image 2: Typical Terrain along the Road Section near Moreh

230. The project road running north to south east between Longitudes 24°48'8.9"N & 24°14'16.46"N and lies between Longitude of 93°56'18.44"E & 94°18'2.23"E within the state of Manipur. The Indo-Myanmar road project in Manipur state transverses through hilly terrain of Tengnoupal district.

231. Map showing physical features of the state is presented in Figure 16 and Figure 17 show the altitudinal zone in the project areas. It can be seen from the map that physiographically the subproject road section i.e. Khongkhang to Moreh are laying mostly on the low and high hill slopes along with piedmont.

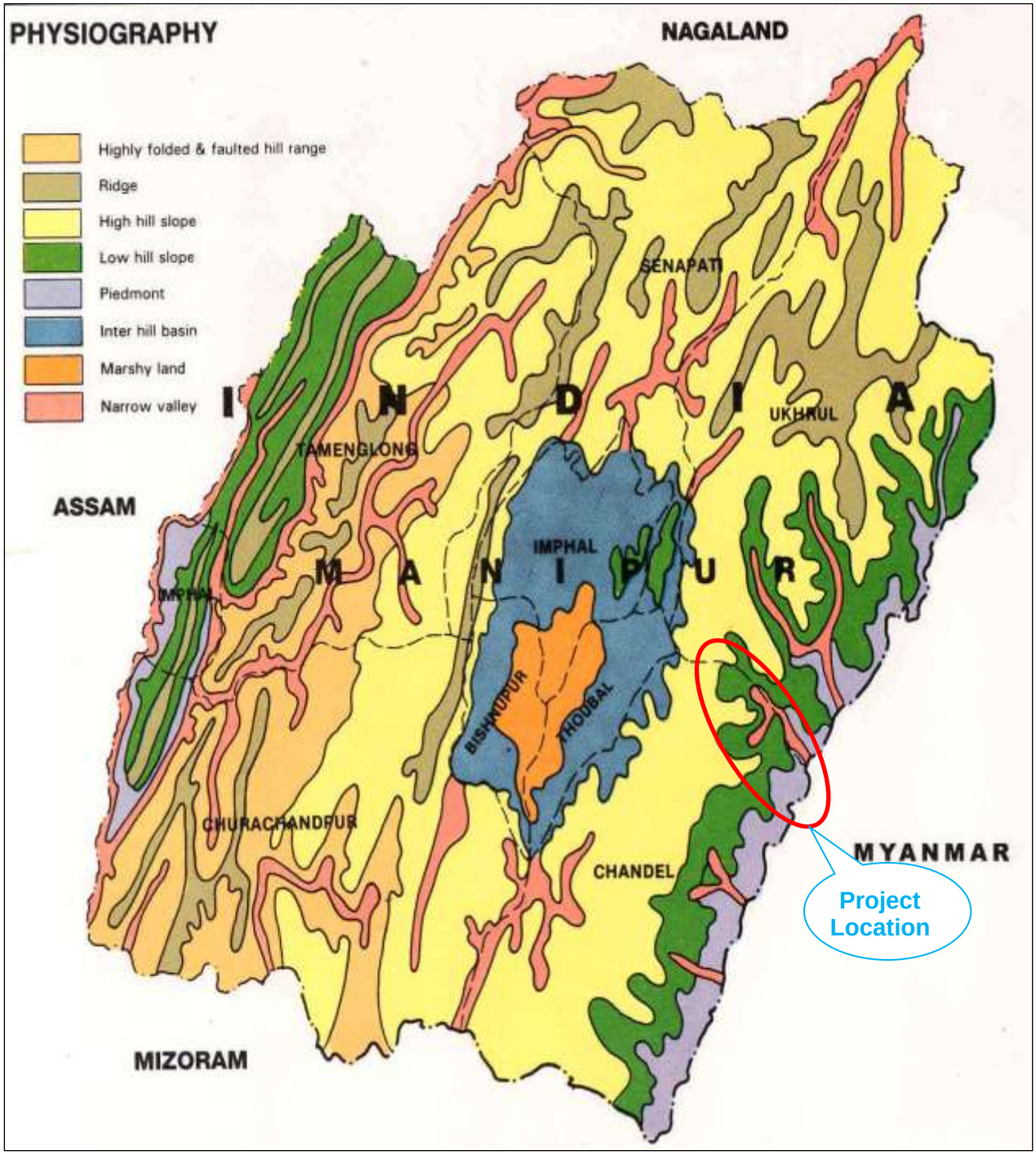


Figure 16: Physiological map showing in the Project Area
Source: Manipur Science & Technology Council (MASTEC), Imphal

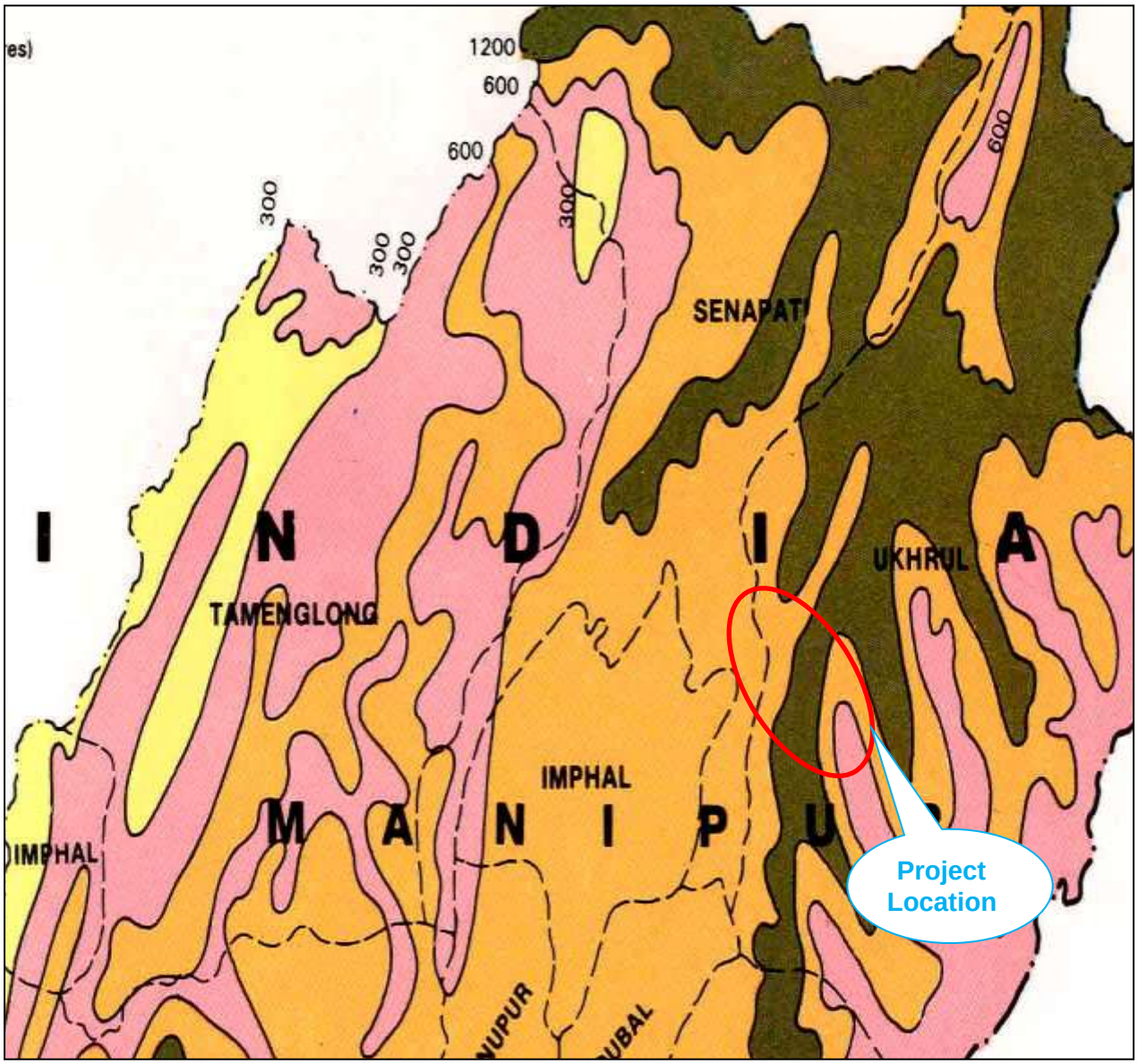


Figure 17: Altitudinal Zone Map of Manipur and Project Area

232. **Land Use.** The existing land use along the project road is mostly vegetative and forested on hilly terrain. Land use in Khongkhang-Moreh section dominated by forests and vegetative. About 29.516 km length of this section from Khonkhang Village to Moreh is classified as protected area as part of Yangoupokpi Lokchao Wildlife Sanctuary. Patches of agricultural activities are also noticed on hills in this section.

233. Data obtained from IRS-P6 LISS-IV 2011 satellite image of the project area shows that about 21% of the project area is covered by thick plantation and 31.5% by thin plantation followed by agricultural land (23.9%), forest land (10.9%), and settlement areas (8.6%). Water bodies and rivers cover about 4.3% land area in the project road.

234. Figure 4.7 and Table 4.5 show the detailed of the land use distribution along the project road section.

235. Detailed landuse map with the help of IRS-P6 LISS-IV, 2011 Remote Sensing satellite data has been prepared for within 10 km radius on either side of the project road and the breakup of land use is given in Table 33 and shown in Figure 18. This shows that vegetation cover, forest land, and agrable land are the major land use followed by habitation and water bodies.

236. False Colour Composite (FCC) scenes generated from IRS-P6 LISS-IV 2011 for 10 km radius of proposed alignment is shown in Figure 19.

Table 33: Land Use Pattern along the Project Road

Land Use Type	%
Thick Vegetation	20.9
Thin Vegetation	31.5
Degraded Forest/ Scrub	10.9
Agrable Land	23.8
Human Settlements	8.6
River/ Water bodies	4.3
Total	**100**

Source: Data obtained with the help of IRS-P3 LISS-III, 2008 remote sensing satellite

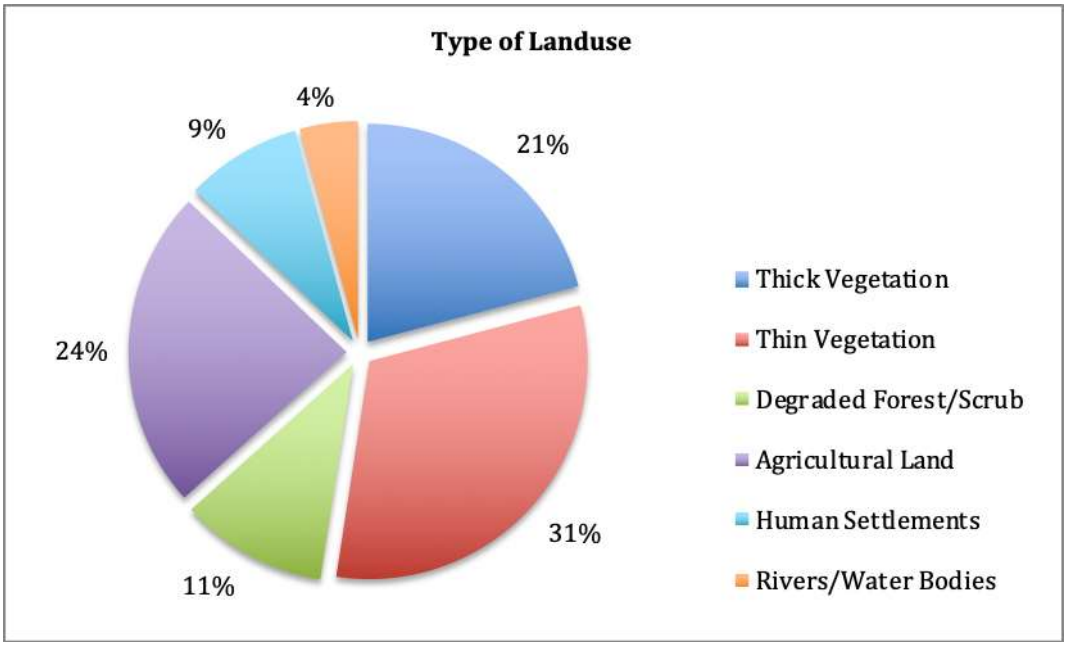


Figure 18: Land Use Distribution along the Project Road

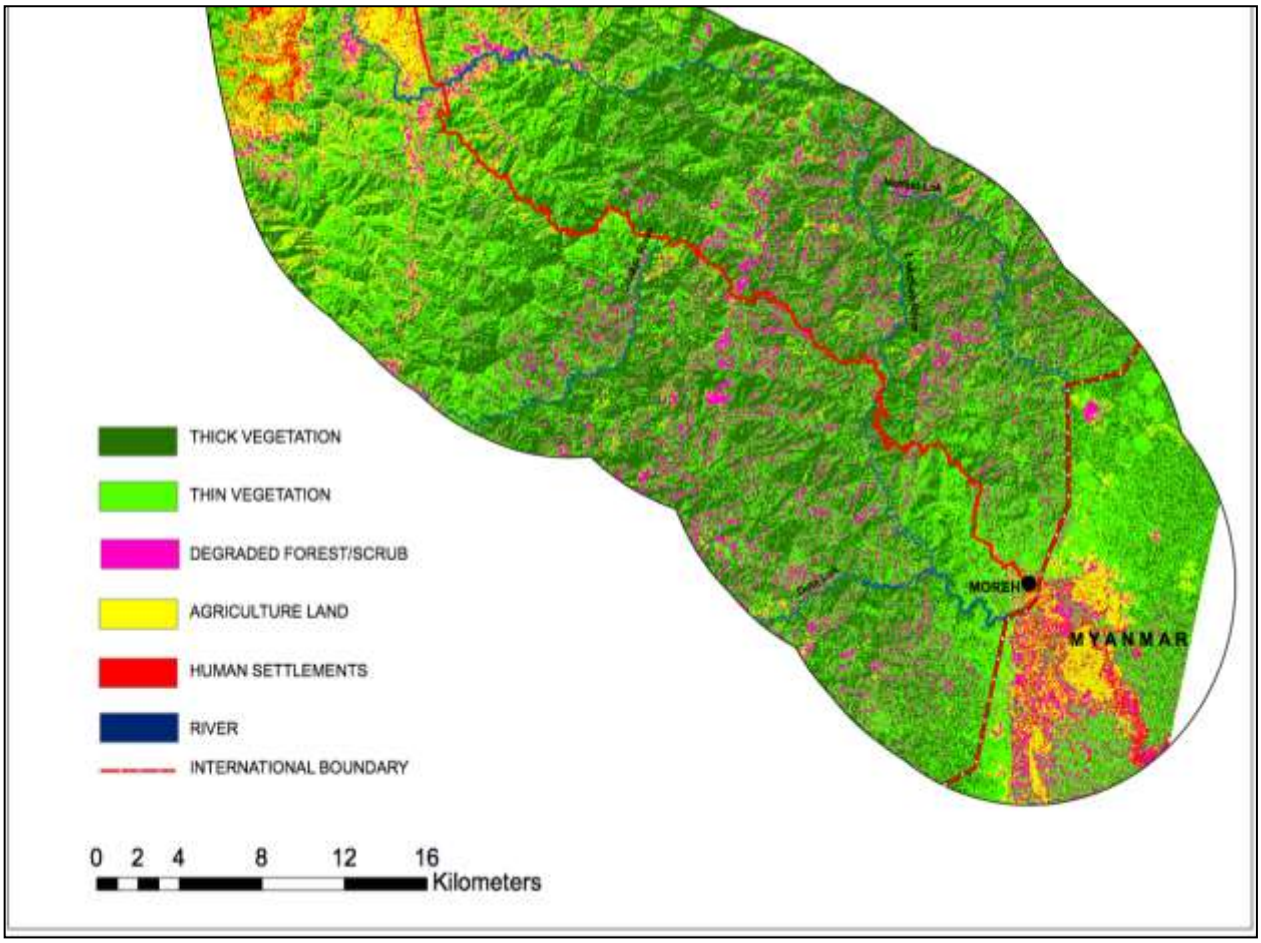


Figure 19: Land use Cover of the Project Area

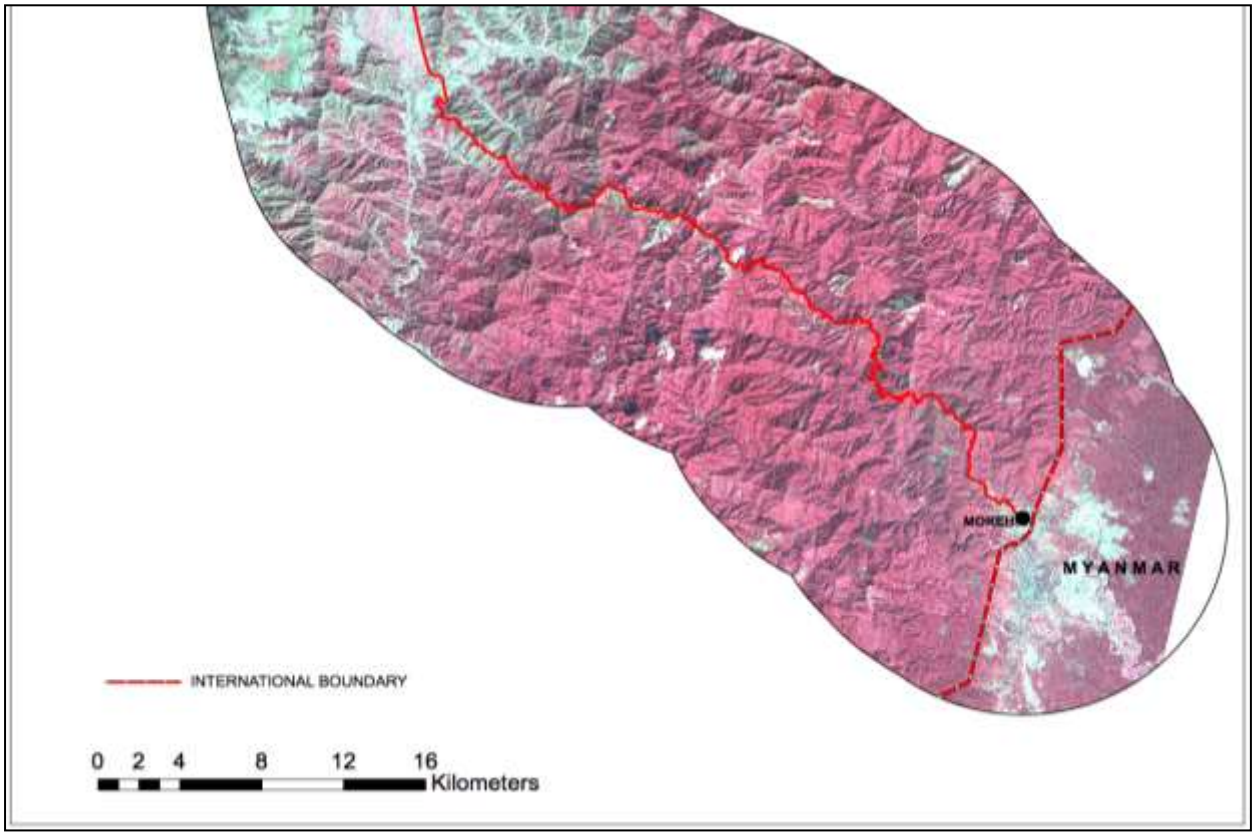


Figure 19a: FCC Scene Generated from Satellite Image for Subproject Area

237. **Geology**. Geologically, Manipur state belongs to the young folded mountains of the Himalayan system. The rocks in the state vary from upper cretaceous to the present Alluvium. The oldest rocks found in Manipur are mainly confined in the eastern part of the State close to Indo-Myanmar border and the rocks are grouped as cretaceous rocks consisting chromite, serpentine etc. availability of Asbestos, Chromite, Copper ore, Coal, Big iron, Lignite, Lime stone, Nickel ore and petroleum is reported in some parts of the state.

238. The limestone deposits found in the Ukhrul district belong to the upper creataceous period. The sandstone, shale of the Disang group found over the eastern half of the Manipur belong to the Eocene period. The rocks consisting of sandstone, shale, clay, etc. of the Barail Group are confined over the rocks of Disang group and extending along the mid-western portion of the state and they belong to the upper Eocene and Oligocene periods. The shales and sandstone of the Tipam and Surma groups cover the western banks of Manipur and they belong to the Miocene period. Rocks of alluvial deposits found in the Manipur valley portion are of recent origin and further they can be grouped as older and younger alluvium. The state is mainly composed of tertiary rocks. In the Ukhrul area there are igneous rocks which contain quartz, sandstone, limestone, etc. Figure 20 present the map showing geology and stratigraphy of the Project area.

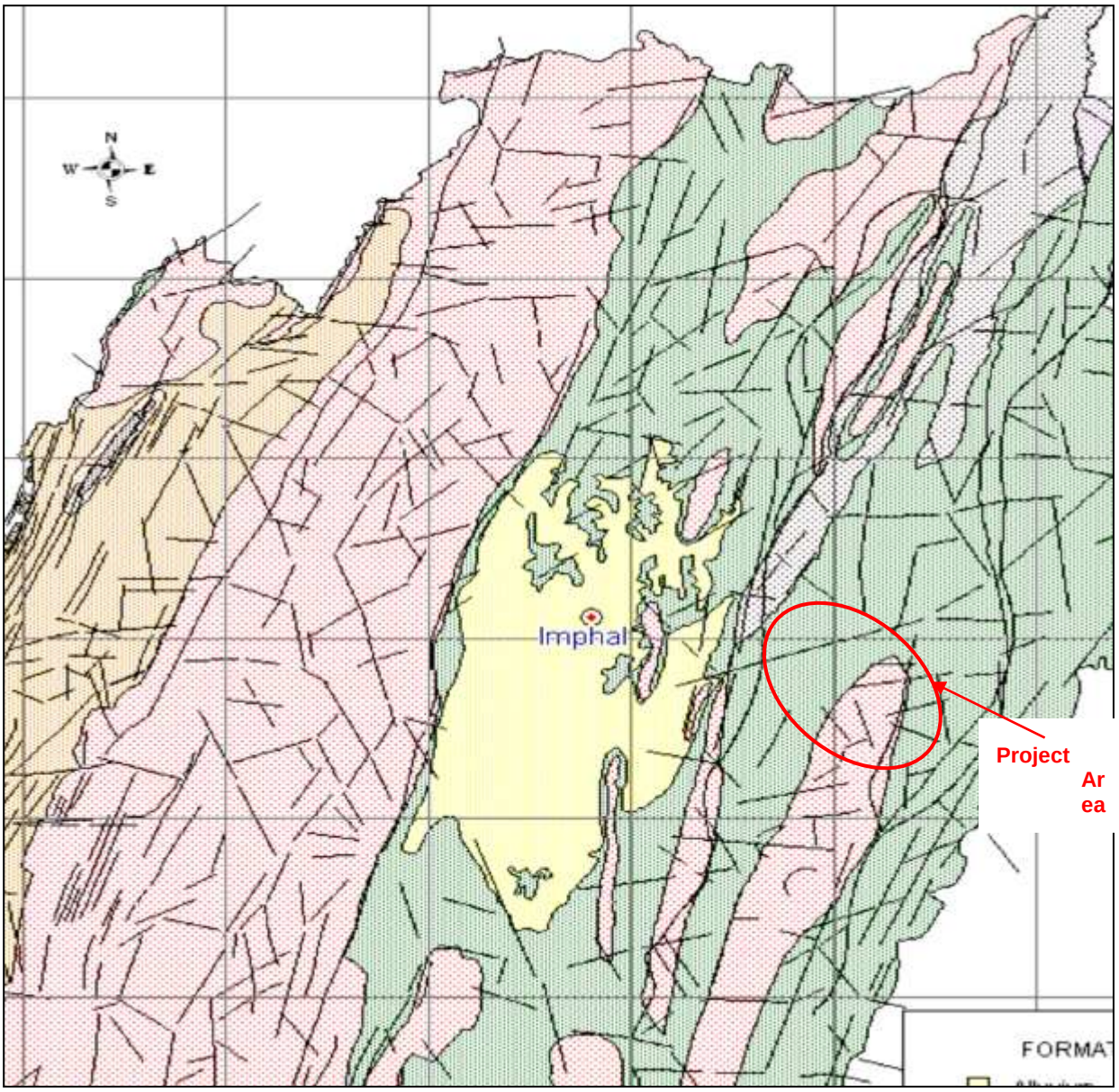


Figure 20: Geology and Stratigraphy of the Project area
Source: SOE Report, Government of Manipur

239. **Seismicity**. The proposed project road falls under the Seismic Zone V, which is susceptible to major earthquakes as per the seismic zone map of India (IS 1893 - Part I: 2002), shown below in Figure 21.

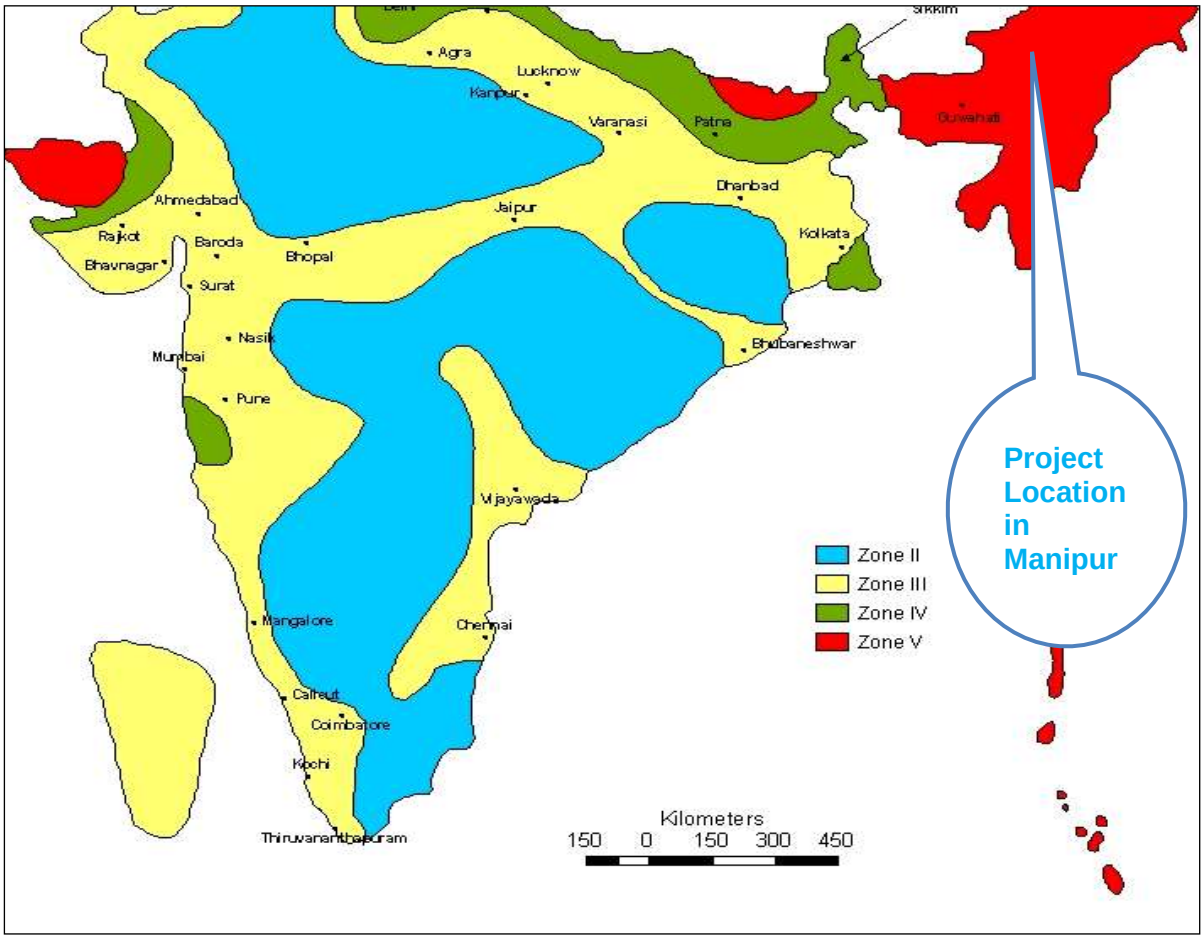


Figure 21: Seismic Zoning Map of India showing Project Location
Source: Envis, Government of Manipur

240. Earthquakes of low to moderate intensity are recorded here regularly. The state of Manipur, has weathered dozens of large earthquakes the biggest in recent times being the 1988 M7.2 earthquake. Most earthquakes in western Manipur are shallow. But some, especially those recorded in the eastern parts and along and across the Myanmar border have greater depths. Areas in central Manipur are especially vulnerable to damage during earthquakes as they lie in the Imphal Valley, the lowest point of which lies the Loktak Lake. Much of the valley floor provides for strong shaking from even far off quakes as its soft soil amplifies the wave motions.

241. Tectonically, the project area lies on the tertiary sediments on the western side. Figure 22 show the seismotectonic map of Manipur and Project location.

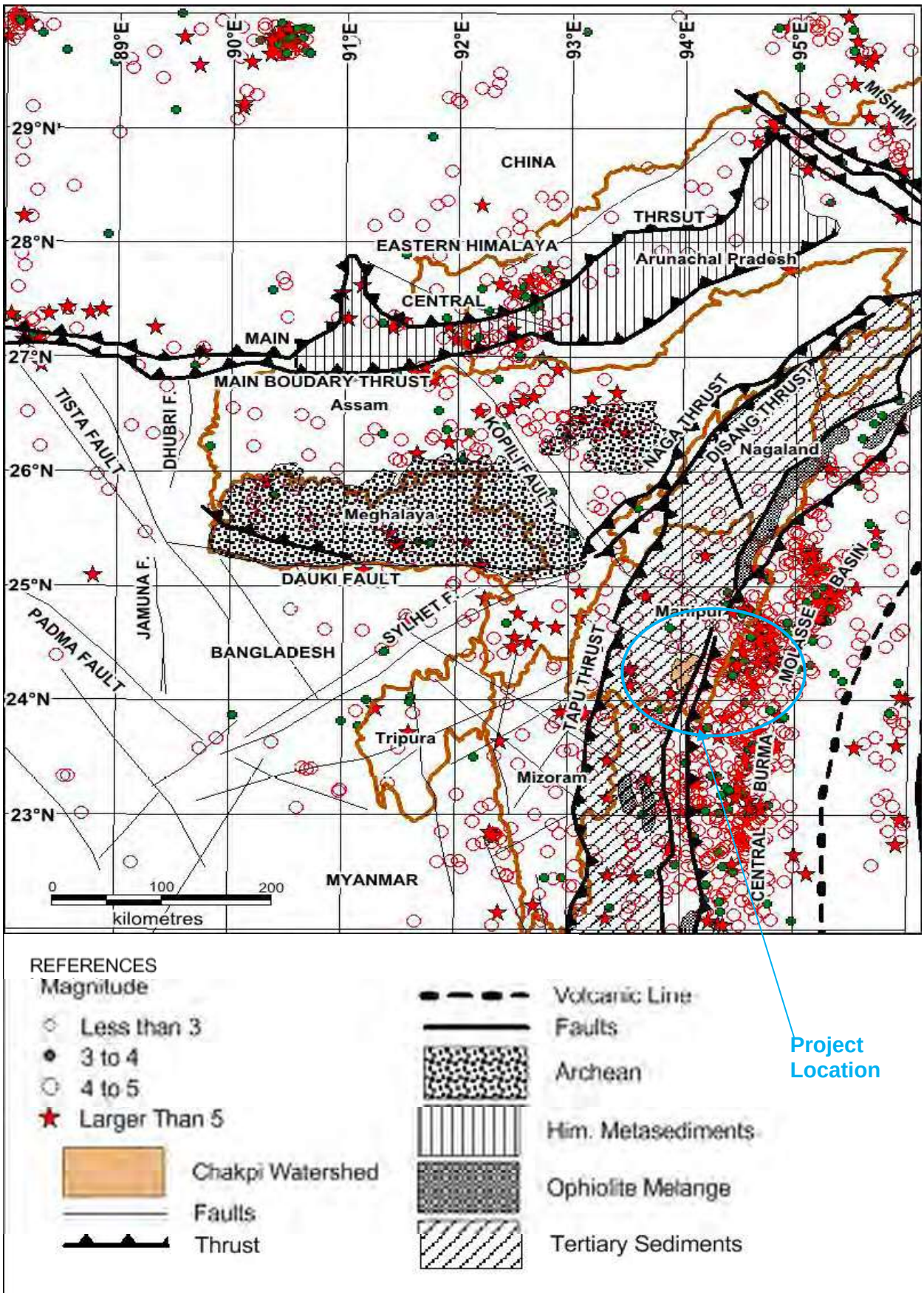


Figure 22: Seismotectonic Map of Manipur showing Project Location
Source: Manipur State Disaster Management Plan, Volume 1, Government of Manipur

242. **Soils**. The soil in the project area is mostly clay to sandy loam. Near Myanmar border the soil is sandy loam. The soil of the state is of two major types – residual and transported, which

cover both the hill and plain of the State. The residual soils are either laterized or non-laterized. The laterized red soils covering an area of 2,500 sq. km. in the Barak drainage on the Western slope of Manipur. It contains rich portion of nitrogen and phosphate, a medium acidity and lesser amount of Potash. The old alluvial is brought down by river Barak basin and Jiri river and their tributaries from their lateritic water ship hills. The compact and less permeable soils contain higher quantity of potash, fair amount of nitrogen and phosphorus with medium acidity.

243. The transported soils are of two types – alluvial and organic. The alluvial soils cover 1600 sq. km. in the valley. These soils have general clayey warm texture and grey to pale brown colour. They contain a good proportion of potash and phosphate, a fair quantity of nitrogen and organic matter and are less acidic. The organic soils cover the low lying areas of the valley. With dark grey colour and clayey loam texture, these peaty soils have high acidity, abundance of organic matter, a good amount of nitrogen and phosphorus but are poor in potash. The hill soils are more or less rich in organic carbon (1 to 3%) in the top soil, but poor in available phosphorus and potash. They are acidic in nature.

244. The soil of Manipur belongs to 4 orders, 8 suborders, 13 greatgroups and 23 subgroups. It is observed that the Inceptisols are the dominant soils followed by Ultisols, Entisols and Alfisols and occupy 38.4%, 36.4%, 23.1% of the total geographical area of the State, respectively. Lakes and marshy lands occupy 1.9 percent. The area- wise distribution of soil at order and suborder levels of Taxonomy are given below.

245. Hill soils being acidic are not suitable for much plant growth and traditional shifting cultivation together with indiscriminate cutting and burning of forest (jhum) over the years have seriously affected the ecological balance leaving the soil barren. In the valley region the deep soils are poorly drained and low in available phosphorus content. They are also susceptible to flood hazards.

246. The characteristics of soil of the project area (Khongkhang-Moreh Road corridor) vary from place to place due to topographical variations. The soil in general is loamy sand to silty clay loam with a depth of 30 cm to 100 cm and in some cases even more than 120 cm. It has less water holding capacity and is dry in nature. Chemically acidic soil abound resulting from the washing down of the salts in rainwater and also on account of leaching effect. The pH value varies from 5.98 to 7.14. The soils are characterized by high organic matter (5.5-5.9 percent, in some places even more than 6 percent) with low action exchange capacity and high lime requirement. Notwithstanding the relatively high organic matter content, the nitrogen content in the soil is low.

247. Some of the plant nutrient like phosphate gets fixed in soils due to the high acidity and thus does not become available to the growing plants even on application. As such there is remarkable deficiency of micronutrients viz. zinc, boron, copper, calcium, magnesium, manganese etc. in the soils. Figure 23 shows the soil map of the project area.

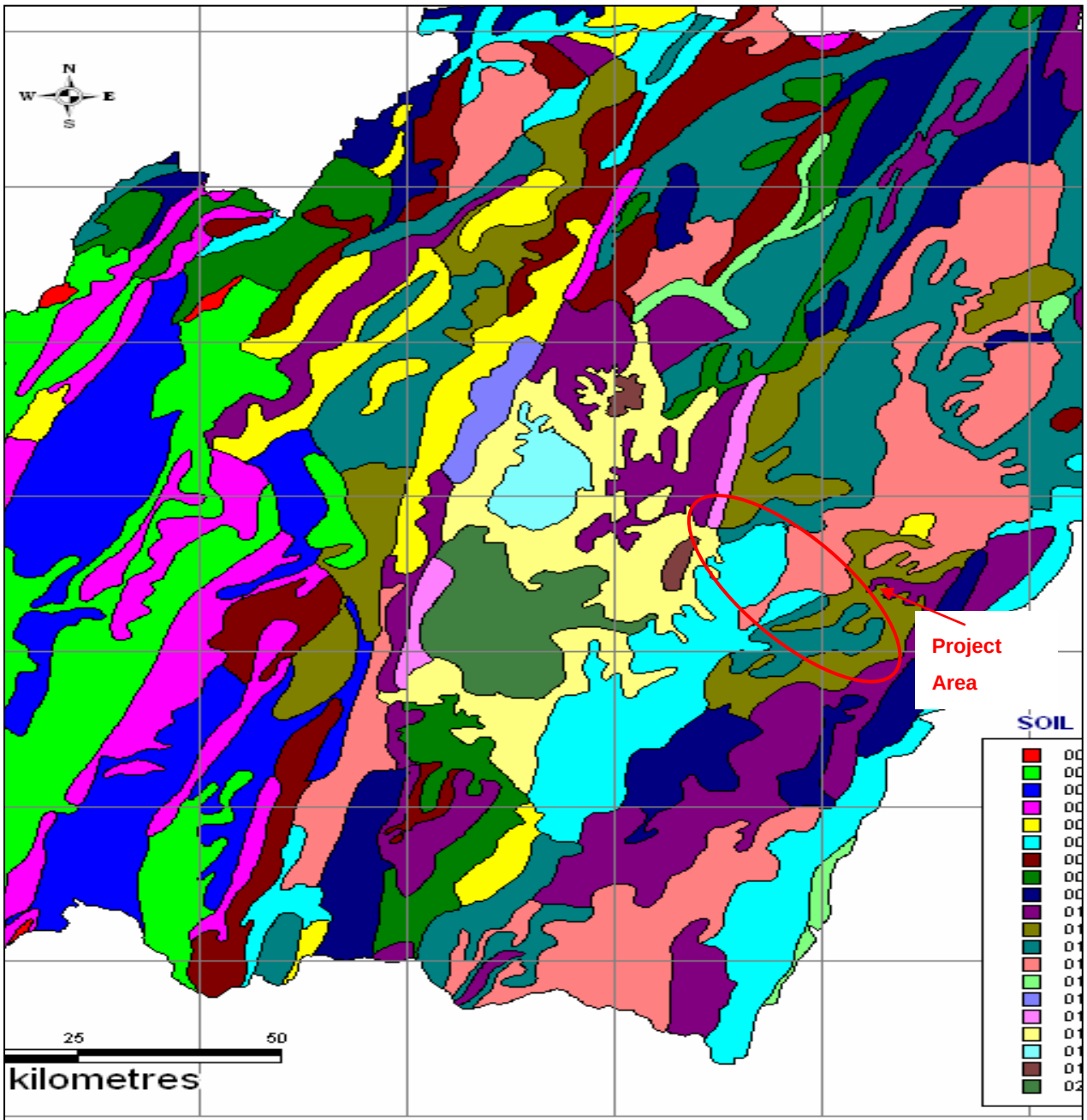
248. Chemical tests were carried out on soil at selected locations along the project road and the test results are given Table 34.

Table 34: Soil Quality along the subproject Khongkhang-Moreh road

S. No.	Parameter(S)	Unit	Test Result		
			Khongkhang	Khudengthabi	Chikim (Moreh)
1	Soil Texture	-	Clay Soil	Clay Soil	Clay Soil
2	Particle size distribution	-	-	-	-
a	Sand	% by mass	18.9	20.1	21.1
b	Silt	% by mass	22.4	23.8	24.2
c	Clay	% by mass	58.7	56.1	54.7
3	Soil Colour		Light Brown	Light Brown	Light Brown
4	pH Value at 25°C	-	6.12	7.14	5.98
5	Conductivity at 25°C	µS/cm	984	1008	841
6	Moisture	% by mass	4.8	5.6	5.2

S. No.	Parameter(S)	Unit	Test Result		
			Khongkhang	Khudengthabi	Chikim (Moreh)
7	Bulk Density	gm/cc	1.28	1.31	1.28
8	Water Holding Capacity	Inches/foot	1.18	1.24	1.21
9	Nitrogen as N	mg/Kg	14.2	15.2	14.1
10	Phosphorus	mg/Kg	2.14	2.54	2.32
11	Potassium (as K)	mg/Kg	11.4	12.4	11.2
12	Calcium as Ca	mg/Kg	4.2	3.2	3.1
13	Nitrate as NO3	mg/Kg	7.4	8.5	7.8
14	Sulphate as SO4	mg/Kg	10.2	11.4	10.2
15	Chloride	mg/Kg	4.2	5.3	5.6
16	Organic Carbon	% by mass	3.9	4.6	4.7
17	Organic Matter	% by mass	5.5	5.6	5.9
18	Total Soluble Solids	mg/Kg	18.2	24.2	18.7

Source: Soil Testing Carried Out by EIA Team, March 2019



Source : Department of Earth Sciences, Manipur University, Canchipur

ochrepts	8.	Typic Haplumbreplts	15.	Raptic Ultic Dystochrepts
chrepts	9.	Typic Dystochrepts	16.	Umbric Dystochrepts

Figure 23: Map showing Soils and Surface Texture Class in the Project Area

Source: SOE Report, Government of Manipur

249. **Water Resources and Hydrology.** The state has vast water resources in the form of lakes, ponds, rivers and streams, some with marshy areas. It has abundant of water potential both ground as well as surface water. Important rivers that flows through the project region are the Lokchao (Image 3) and Moreh River. During the dry seasons these rivers are lean and thin but, during the rainy monsoon periods these rivers are very wild and frequent flood. Other local streams of these rivers in the region drain rainy season storm water in these rivers. Table 35 list out the major rivers which cross the project road. Besides these rivers there are several small streams and small ponds exist along the project road.

Image 3: Project road at Lokchao River Bridge in hill section

Table 35: Major Rivers crossing the project road

Sl. No.	River Name	Chainage (Km)	Width of the River Crossings (m)
1.	Lokchao River (Bridge)	404+130	Major
2.	Moreh River	422+200	Minor

250. The ground water aquifers in the region occur in sediments and fractured rocks. Springs are either seasonal or perennial and are often used for irrigation and drinking purposes. There are number of hot springs in the region which are being used by the local communities for domestic and agricultural purposes and also being used by the visiting tourists.

251. The surface water quality in the region is reported to be well within the permissible limits and also found by visual identifications. There are no reports of any water born decease in the region. People are using this water for drinking purpose without any treatment. In case of ground water quality, it is generally good in entire north east region. People use ground water for domestic purposes without any treatment. Overall ground water quality is acceptable.

252. The surface water such as Lokchao River and Moreh River are close to Project road. The Lokchao River distance from road varies from 10 to 35 m from the Project road of chainage 403.500 km to chainage 407.400 km. In addition to this, large numbers of springs (Jhora) are crossing the Project road.

253. Water Quality. In order to establish baseline conditions, surface and groundwater samples were collected. The sampling locations were selected after the field reconnaissance and a review of all the water bodies/ resources in the project influence area. Samples were collected as per IS- 2488 (Part I-V).

254. In order to represent the true profile of the project area, samples of ground and surface water of the area through which the project road runs were collected and analysed. Ground water (drinking water) samples were analyses as per IS: 10500-1991. Grab sample were collected from water source and were analysed for various parameters as per the procedures laid down in the APHA and BIS. Atomic Absorption Spectrophotometer and UV/VIS Spectrophotometer were used for analysis of water samples according to the necessity.

255. The results of the analysed of these samples are presented in Table 36. The results were compared with standards for drinking water quality (Annex 2).

256. It can be seen from Table 36 that, the pH of the drinking water in the region is well within permissible limits (6.5 – 7.5). The samples collected from bore well at Lokchao show highest value of the total dissolved solids of 336mg/l which is well within the permissible standards. Total hardness as CaCO3 in the water sample from Lokchao is found at 102mg/l which is highest in all samples but less than the limit (300mg/l) prescribed for drinking water standard limits. Other parameters analysed like chloride, sulphate, fluorides are found well within standards. Overall the ground water quality in the project areas in good.

Table 36: Ground (Drinking) & Surface water Characteristics in the project area

Sl. No.	Parameter	Prescribed Limit as per IS:10500 & IS:2296	Monitored Value				
			Ground water		Surface water		
			Lokchao	Moreh	Lokchao River	Local stream	Moreh River
1	Colour, Hazen units	5 Max	<1	<1	< 1	< 1	< 1
2	Odour		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Turbidity, NTU	1 Max	<1	<1	<1	<1	<1
4	Electrical Conductivity at 25°C	-	518	376	298	358	288
5	pH Value at 25°C	6.5 - 8.5	7.51	7.16	7.58	7.62	7.34
6	Total Dissolve Solids, mg/l	500 Max	336	244	194	233	187
7	Total Alkalinity (as $CaCO_3$), mg/l	200 Max	64	67	45	68	51
8	Total Hardness (as $HCaCO_3$), mg/l	200 Max	102	80	38	59	62
9	Calcium (as Ca), mg/l	75 Max	24.8	16.8	14.2	24.1	20.2
10	Magnesium (as Mg), mg/l	30 Max	9.7	9.2	6.5	12.4	11.4
11	Chloride (as Cl), mg/l	250 Max	64.6	37.6	22.4	34.5	29.4
12	Sulphate (as SO_4), mg/l	200 Max	42	41.0	26.8	31.2	28.6
13	Nitrate (as NO_3), mg/l	45 Max	8	5.4	5.4	6.2	4.5
14	Sodium (as Na), mg/l	-	43	42	26	32	31
15	Potassium (as K), mg/l	-	17	16	14	18	13

Sl. No.	Parameter	Prescribed Limit as per IS:10500 & IS:2296	Monitored Value				
			Ground water		Surface water		
			Lokchao	Moreh	Lokchao River	Local stream	Moreh River
16	Bicarbonate (as HCO_3), mg/l	200 Max	76	74	51	76	59
17	Fluoride (as F), mg/l	1 Max	0.09	0.08	0.06	0.08	0.07
18	Phenolic Compound (as C_6H_5OH), mg/l	0.001 Max	BDL	BDL	BDL	BDL	BDL
19	Cyanide, mg/l	0..05	BDL	BDL	BDL	BDL	BDL
20	Aluminum, mg/l	0.03	BDL	BDL	BDL	BDL	BDL
21	Arsenic, mg/l	0.05	BDL	BDL	BDL	BDL	BDL
22	Cadmium (as Cd), mg/l	0.003 Max	BDL	BDL	BDL	BDL	BDL
23	Chromium as Cr, mg/l	0.05	BDL	BDL	BDL	BDL	BDL
24	Iron (as Fe), mg/l	0.3 Max	0.08	0.08	0.08	0.08	0.05
25	Copper (as Cu), mg/l	0.05 Max	BDL	BDL	BDL	BDL	BDL
26	Lead (as Pb), mg/l	0.01 Max	BDL	BDL	BDL	BDL	BDL
27	Manganese (as Mn), mg/l	0.1 Max	BDL	BDL	BDL	BDL	BDL
28	Zinc (as Zn), mg/l	5 Max	BDL	BDL	BDL	BDL	BDL
29	Mercury as Hg, mg/l	0.001	BDL	BDL	BDL	BDL	BDL
30	Dissolve Oxygen, mg/l	-	-	-	6.2	5.8	5.4
31	Biochemical Oxygen Demand, mg/l	-	-	-	4	5	4
32	Chemical Oxygen Demand, mg/l	-	-	-	18	23	21
33	Oil &Grease, mg/l	-	-	-	BDL	BDL	BDL

Source: Water Quality Monitoring Carried out by EIA Team, March 2019

257. **Air Quality.** Ambient air quality in the state is quite pure compared to other neighboring states. Except for few urban centres like Moreh, the ambient air quality at all the monitoring locations is good. There are no major industrial activities in the State. Dust arising from unpaved surfaces, forest fire, smoke charcoal production and domestic heating, and vehicular pollution are sources of pollution in the region. Firewood burning is the major contributor in the ambient pollution load.

Air quality monitoring station at Khudhengthabi

258. Vehicular pollution is a secondary source of pollution in the state as the traffic density is low. Pollution from vehicles is mainly due to use of low-grade fuel, and poor maintenance of vehicles. The level of pollution in rural areas is much lower than that of the urban areas due to lower volume of traffic. The traffic density in the state is very low. There is sudden increase in the number of vehicles in the town area during the last one decade producing a lot of smoke. The use of a large number of second-hand diesel jeeps as transport is another cause of air pollution.

259. Secondary information is not available on ambient air quality of the project road area. The major transport on the project section is the traffic flowing on National highway connecting Imphal to rest of the country as well as traffic flow towards Moreh from Imphal and from Assam. This might also add to the air pollution load on the project section.

260. The base-line status of the ambient air-quality was assessed using a scientifically designed ambient air-quality monitoring network. The design of this network was based on the following:

- meteorological conditions;
- the assumed regional influences on background air quality;
- the areas where impact would most likely be greatest;
- present land use along the proposed alignment; and
- traffic congestion points.

261. To establish the baseline ambient air quality, Ambient Air Quality Monitoring (AAQM) stations were set up at five locations as indicated in Table 37.

Table 37: Details of Ambient Air Quality Monitoring Locations

Sl. No.	Location Code	Name of the Location	Source
1.	AQ1	Khognkhang Village: Chainage Km 396.900 i.e. near starting point of project road on RHS of Road	Rural/Sensitive
2.	AQ2	Lokchao Village: Chainage Km 405.200: Right hand side of the road	Rural/Sensitive
3.	AQ3	Khudhengthabi Check Point: Chainage Km 418.700: Right hand side of the road	Market/Commercial
4.	AQ4	Moreh: Market area Chainage Km 425.100 Left hand side of the road	Urban/Sensitive

262. At each of the five locations monitoring was undertaken as per new notification issued by MoEFCC on 16th November 2009, in the first quarter of 2019. Data for the following parameters was collected.

- Suspended Particulate Matter (SPM)
- PM 10
- PM 2.5
- Sulphur Dioxide (SO_2)
- Oxides of Nitrogen (NO_x)
- Carbon monoxide (CO)

- Hydrocarbons (HC); and
- Lead (Pb)

263. The sampling of SPM, PM10, PM2.5, SO_2, NOx & Pb was undertaken on a 24-hourly basis while 8- hourly samples were collected for CO and HC. SPM, RPM, SO_2, NOx, & Pb were monitored using M/s Envirotech Instruments Private Ltd; make Respirable Dust Sampler (APM 460) (Figure 24) along with gaseous attachment (Model APM 415 & 411). Whatman GF/A filter papers were used for SPM, whereas, Whatman EPM 2000 filter papers were used for monitoring Pb. Carbon monoxide (CO) & Hydrocarbon samples were monitored by using M/s Endee Engineers Pvt. Ltd. make gas detector model No. CO96 & GP - 200P respectively.

264. Methodology adopted for sampling and analysis and instrument used for analysis in laboratory are presented in Table 38.

Table 38: Techniques Used for Ambient Air Quality Monitoring

Sl. No.	Parameter	Technique	Instrument Used	Minimum Detectable Limit ($\mu g/m^3$)
1.	Suspended Particulate Matter	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
2.	PM 10 and PM2.5	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
3.	Sulphur Dioxide	Improved West & Gaeke Method	Colorimeter	5.0
4.	Nitrogen Oxide	Jacob & Hochheiser modified (Na-Arsenite) Method	Colorimeter	5.0
5.	Carbon Monoxide	Gas Chromatograph		0.01
6.	Hydrocarbons	Gas Chromatograph		0.01
7.	Lead	AAS Method after sampling using EPM 2000 filter paper	Atomic Absorption Spectrophotometer	0.01

265. A summary of results for each location is presented in Table 39. Figure 24 shows the graphically presentation of the existing air quality along the project road at five monitored locations. These results are compared with the new National Ambient Air Quality Standards prescribed by the MoEFCC for respective zones.

Table 39: Summary of AAQM Results (Average Values)

Location	Parameter and Values ($\mu g/m^3$)						
	PM10	PM2.5	NOx	SO_2	Pb	CO	HC
Standard for Sensitive	100	60	80	80	1.0	4000	1000
Standard for Residential	100	60	80	80	1.0	4000	2000
AQ-1 Khognkhang Village	63	30	11.8	9.15	BDL	BDL	BDL*
AQ-2 Lokchao Village	64.5	31.5	13.3	8.41	BDL	BDL	BDL
AQ-3 Khudhengthabi Check Point	64	32.5	13.3	7.76	BDL	BDL	BDL
AQ-4 Moreh: Market area	70.55	37.6	13.8	6.59	BDL	BDL	BDL

Note: BDL-Below Detectable Limit
Source: Ambient Air Quality Monitoring Carried out by EIA Team, 2019

266. It can be seen from the Table 39 that concentration of all parameters monitored were well within the prescribed limits of CPCB as well as World Bank EHS standards at all the locations. Thus, the air quality of project area is reasonably good. The National Ambient Air Quality Standards (NAAQS) prescribed by MOEFCC are given in Annex 3.

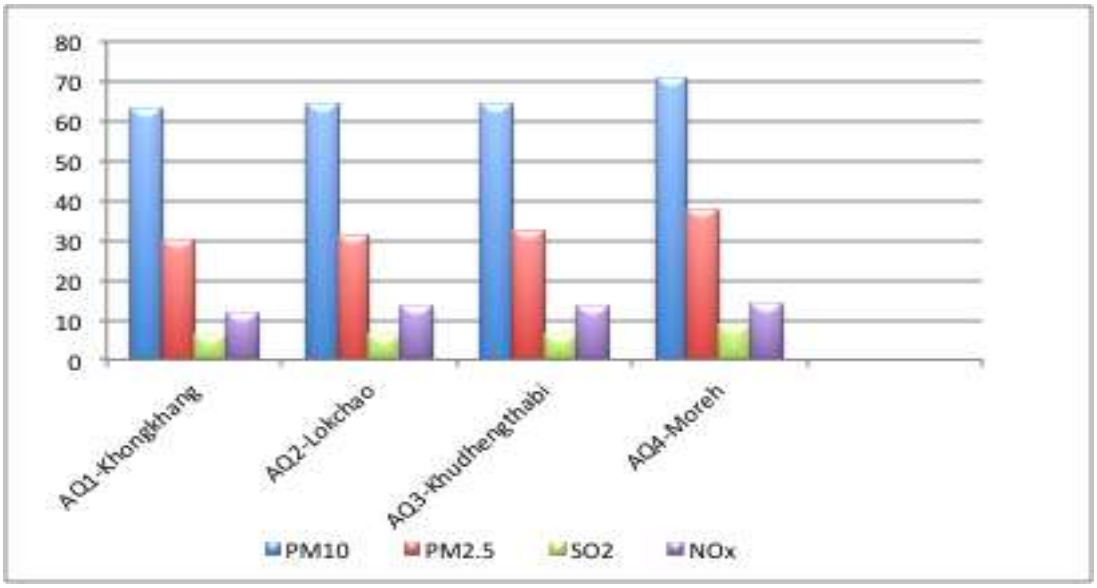


Figure 24: Air Pollutant Concentration in Ambient Air along the Project Area

267. **Noise Quality.** Noise pollution is not a current problem in the region except in commercial location in urban areas where major settlements are along the road, and high traffic flow. However, few commercial locations in Moreh will experience increase in noise levels but still the ambient noise quality is expected to be higher than the permissible limits.

268. During construction period, temporary increase in the noise levels are expected from the movement of construction machineries and construction activities. Suitable barriers and timely scheduling of construction activities will minimize these impacts.

269. No secondary information was available on noise level in the project area. In order to establish the baseline noise quality in the project area, a reconnaissance survey was therefore undertaken to identify noise generating sources and sensitive receptor such as school, hospitals, temples, built-up areas. Five locations listed in Table 40 were selected for monitoring the noise level.

Table 40: Details of Noise Level Monitoring Locations

Sl. No.	Location Code	Name of the Location	Landuse
1.	NL1	Khognkhang Village: Chainage Km 396.900 i.e. near starting point of project road on RHS of Road	Residential/Village
2.	NL2	Lokchao Village: Chainage Km 405.200: Right hand side of the road	Residential/Village
3.	NL3	Local Stream: At crossing the road alignment: Right Hand Side of the road	Forest area
4.	NL4	Khudhengthabi Check Point: Chainage Km 418.700: Right hand side of the road	Commercial/Residential
5.	NL5	Moreh: Market area Chainage Km 425.100 Left hand side of the road	Built-up Area

270. **Methodology:** At each of the five locations, Sound Pressure Level (SPL) measurements were taken at an interval of 1 minute using a sound level meter of Lutron make Digital Sound Level Meter. At all these locations, daytime noise levels were monitored during the period 6 am to 9 pm and night-time noise levels during the period 9 pm to 10 pm. Noise readings, with setting at 'A' response - slow mode, were recorded. The readings were tabulated and a frequency distribution table prepared from which 24 hourly, hourly, and Average L_{eq} noise levels were calculated.

271. **Presentation of Results:** Table 41 show the noise level at the monitored locations. It can be seen from the table that at locations (NL1, 2, 3, 4 & 5) along main alignment, the average day

time noise level varies from 64.7 dB(A) to 72.8 dB(A), whereas average night time noise level ranges from 53.8 dB(A) to 62.4 dB(A).

272. It is found that the recorded noise level is higher than the permissible limits for residential area prescribed by CPCB and also by World Bank EHS standards of 55 dB(A) and 45 dB(A) for daytime and nighttime respectively. Nighttime noise level readings were taken upto 10 pm only as after 10 pm no traffic movements were observed. This noise is mainly from vehicular traffic and local domestic/commercial activities.

Table 41: Ambient Noise Level in decibel (A) along the Project Road

Location	Date of Sampling	Noise Level dB (A)						CPCB / World Bank Standard dB(A)
		Daytime			Nighttime			
		L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}	
NL1	11.03.2019 to 11.03.2019	49.2	69.7	63.25	42.0	50.3	45.68	55 for daytime and 45 for nighttime
NL2	12.03.2019 to 13.03.2019	48.9	73.3	67.26	43.1	51.2	46.83	
NL3	12.03.2019 to 13.03.2019	47.1	70.8	67.23	39.0	49.5	43.82	
NL4	13.03.2019 to 14.03.2019	51.5	75.9	70.58	39.6	49.1	46.64	
NL5	13.03.2019 to 14.03.2019	44.9	71.6	63.98	39.5	43.2	41.82	

Source: Noise Monitoring Carried out by EIA Team, 2019

273. **Vibration Level.** The vibration monitoring is carried out to know the impact of ground borne vibration due to operation of construction equipment during construction phase and due to road traffic during operation phase, on existing structures along the alignment. Vibration levels were monitored in the terms of peak particle velocity (ppv) at six sensitive locations along the project road alignment. The locations were selected to represent building/structures sensitive to vibrations. Table 41a show the locations of the vibration monitoring.

Table 41a: Details of Vibration Monitoring Locations

Monitoring Code	Location	Latitude	Longitude
V1	Khongkhang	24°21'29.06"	94°11'31.18"
V2	Lokchao	24°19'2.42"	94°13'59.64"
V3	Khudengthabi Army Check Post	24°18'0.60"	94°15'57.97"
V4	Khudengthabi Village	24°18'6.30"	94°15'15.78"
V5	Ima Ima Kondong Lairembi (Temple)	24°15'1.74"	94°18'1.87"
V6	Moreh College	24°15'24.84"	94°17'26.45"

274. **Methodology:** The monitoring is carried out using the PCE-VM 3D Vibration Analyzer. The instrument is compliant in accordance with ISO 2954 and GB13823.3 standards, which can measure the radial, transverse and vertical vibration of ground borne vibration. The monitoring has been conducted during the busy traffic hours for 15 minutes intervals at each location and peak particle velocity observed in mm/s is presented in Table 41b.

275. **Presentation of Results:** Table 41b show the results of the vibration monitoring at selected locations. It can be seen from the table that the monitored vibration levels (ppv) at nearby structures are found in the range of 0.127 to 0.435 mm/s. This is well within the cosmetic damage threshold of 3 mm/s as prescribed by Caltrans.

Table 41b: Ambient Noise Level in decibel (A) along the Project Road

Coordinate Axis	Peak Particle Velocity, mm/s					
	V1	V2	V3	V4	V5	V6
X	0.006	0.007	0.004	0.015	0.020	0.010
Y	0.037	0.017	0.028	0.044	0.049	0.010
Z	0.121	0.146	0.390	0.213	0.432	0.328
Resultant Vibration	0.127	0.147	0.391	0.217	0.435	0.328
Cosmetic Damage Threshold ppv, mm/s Source: Caltrans	3	3	3	3	3	3

C. Biological Environment

276. **Forests and Vegetation.** In spite of its small size, the state's vegetation is rich and varied in character. This is because of its different climatic conditions found in the state and its peculiar physiography. The forest area of the state falls into four distinct zones viz. i) Burma drainage forests, ii) Urkul pine forests, iii) forests overlooking the valley and iv) Barak drainage forests.

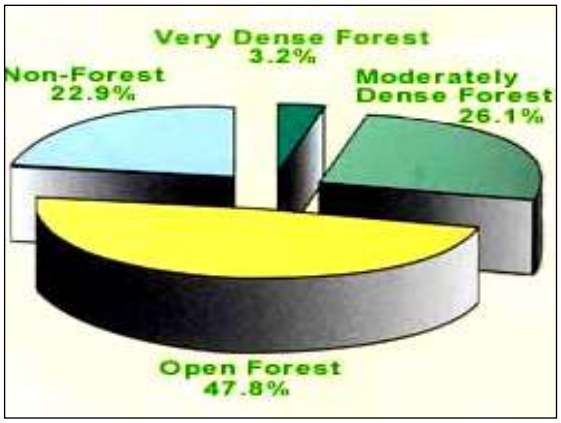


Figure 25: Distribution of Forests in the State

277. According to State of Forest report 2013, by Forest Survey of India, the forest cover of Manipur is 17,418 sq.km which is 78.01% of the total geographical area of the State. Out of the total forest area in the State, the area under Reserved Forests including Wildlife Protected Area Network is 1,467 sq. km. i.e. 8.4 % of the total forest area. An area of 4,171 sq. kms. or 24 % of the total forest area is recorded as Protected Forests and the rest 11,780 sq. kms.(67.6%) belong to the category of Unclassed forests. During the year 2010-11 there is no reservation and de-reservation of forest areas within RF. Table 42 and Figure 26 shows area under legal type of forest in the state of Manipur. Figure 25 show the distribution of forest area of Manipur.

Table 42: Area under Forest type in the State of Manipur

S. No.	Forest Type	Area (Sq.km.)	% to Total Forest Area
1	Reserved Forest	1,467	8.40
2	Protected Forest	4,171	24.00
3	Other Forest	11,780	67.60
4	Total	17,418	100.00

Source: State of Forest report, 2013

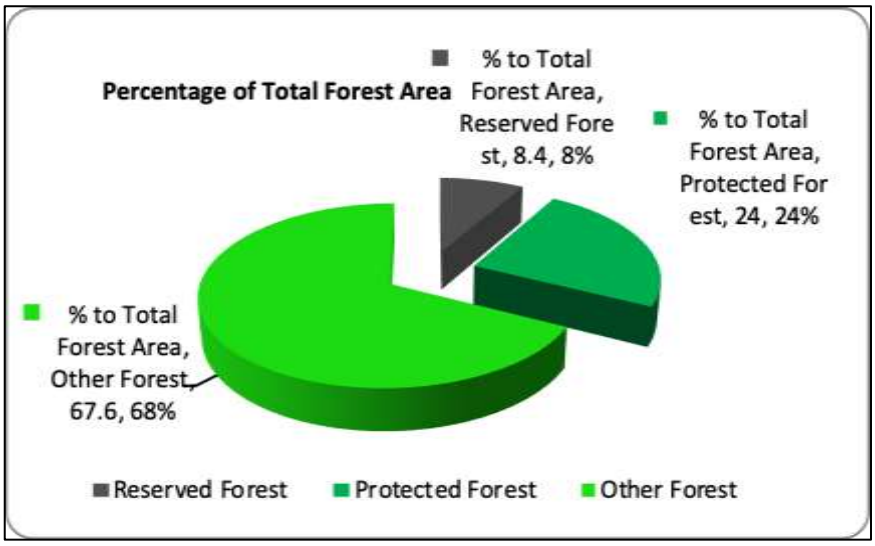


Figure 26: Recorded Forest Land of State

Source: Forest Department, Manipur, Annual Administrative Report, 2013-14

278. Blessed with an amazing variety of flora and fauna, 67% of the geographical area of Manipur is hill tract covered forests. Depending on the altitude of hill ranges, the climatic condition varies from tropical to sub-alpine. The wet forests and the pine forests occur between 900-2700 m above MSL and they together sustain a host of rare and endemic plant and animal life. Coveted the world over as some of the most beautiful and precious blooms, orchids have an aura of exotic, mysteries about them.

279. In Manipur, they are abound in their natural habitat growing in soil or on trees and shrubs speaking their beauty and colour, stunning the eye that is not used to seeing them in such profusion. There are 500 varieties of orchids which grow in Manipur of which 472 have been identified.

280. The major species of vegetation available in the state include Teak, Uninthou, Khasi-pine, Dipterecarpes species, Michelia, Champa, Terminalia, species, Cedrela Toona, Schima Wallichii etc.

281. Classification of forests with the dominant and associated plant species in each zone was given by Deb (1960). According to him the state was divided into four climatic Zones, Tropical climate (valley and hill upto 900m), Mountain subtropical climate (area lying between 900-1800m). Mountain temperate climate (area ranging from 1800-2400m), Sub-alpine (hills ranges above 2400m). Forest Types in Manipur Eastern Himalaya are presented in Table 43.

Table 43: Details of Forest Types in Manipur Eastern Himalaya, India, adapted from Champion and Seth (1968)

Sl. No.	Characteristic species	Altitude Range (m)	Classification code	Forest Types adapted from Champion and Seth (1968)
1.	*Laurus-Melia- Bauhinia association and Michelia champaca, Schima wallichi, Gmelina arborea, Podocarpus nerifolium, Dillenia spp.*	300–900	2B/C2	Tropical Semi-evergreen forests
2.	*Tectona grandis, Dipterocarpus turbinatus, Melanorrhoea usitata, Dillenia, Xylia, Lagerstroemia, Terminalia, Gmelina, Bombax spp*	300–900		Moist deciduous forests

Sl. No.	Characteristic species	Altitude Range (m)	Classification code	Forest Types adapted from Champion and Seth (1968)
3.	*Quercus-Magnolia-Acer and conifers association*	1700-2700	11B/C1	East Himalayan Wet temperate forests
4.	*Prunus, Pyrus, Ligustrum, Taxus, Bucklandia populnea, Acer campbelli, Magnolia campbelli, Castanopsis tribuloides*	Above 2700	-	Sub-Alpine Forests
5.	*Sub-climax state of grassland due to heavy biotic*	-	-	Grassy blanks
6.	*Bambusa manipureana and Dendrocalamus manipureanus*	1,700–2,800	12/DS1	Bamboo brakes
7.	*Calamus tenius, C. leptospadix, C. floribundus and C. erectus*	-	-	Cane brakes

Source: Forest Department, Manipur, Annual Administrative Report, 2010-11

282. Vegetation along the project road section from Khongkhang to Moreh, are mostly covered by the think grass and secondary Moist Deciduous Forest as shown in the Vegetation map and Forest map of the Manipur state in Figure 27 and Figure 28, respectively.

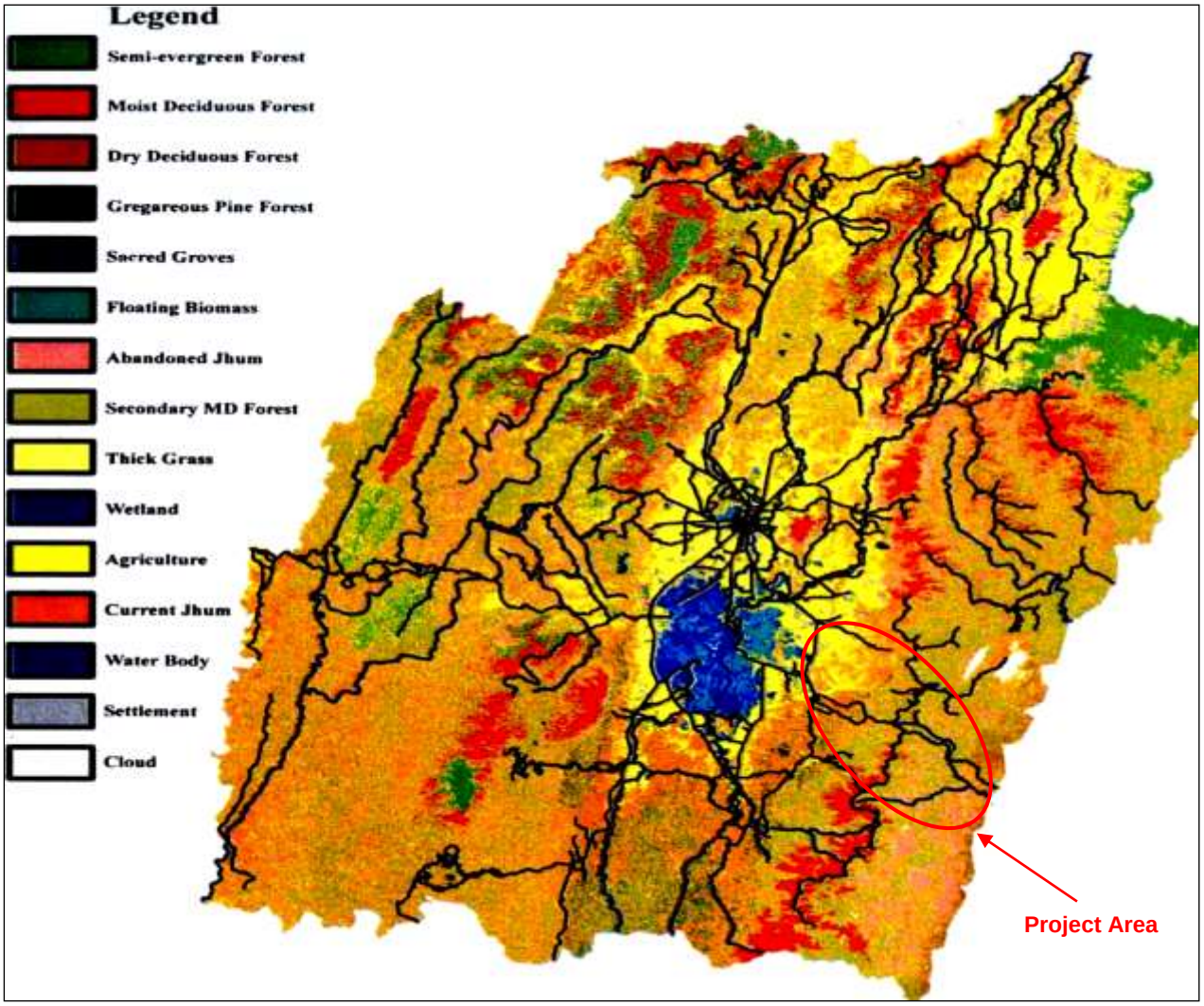


Figure 27: Vegetation Map of Manipur State
Source: MRSAC, Imphal

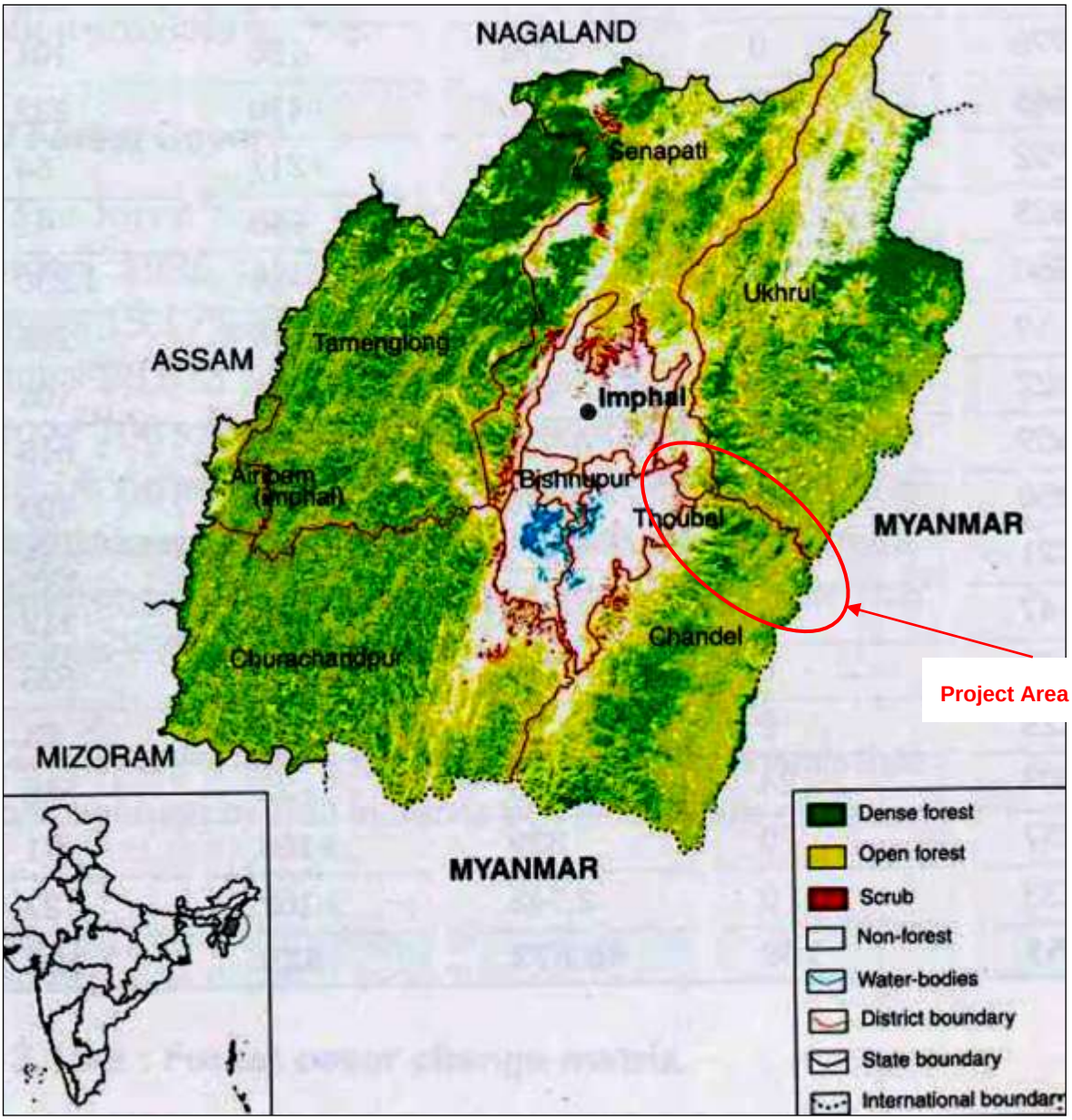


Figure 28: Forest Map of Manipur State
Source: State of Environment Report, Manipur

283. Forests along the project road sections from Khonkhang to Moreh in Hilly terrain are mix of agriculture, open forest and dense forests as shown in the map (Figure 28).

284. A length of 8.450 km of alignment from start point of the road section i.e. from chainage Km 395+680 to Km 404.130 is in the ESZ of Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS). About 9.100 km length of the proposed project road i.e. main alignment (Indo-Myanmar road) passes through Yangoupokpi Lokchao Wildlife Sanctuary area on one side of road. Starting from Lokchoa River Bridge to Khudenthabi village (chainage 404.130 to Chainage 413.23, length 9.100 km) alignment transverse along the border of Core Zone I and Tourism Zone. After Khudenthabi village upto Moreh (Chainage 413.23 to 425.196, length 11.966 km) proposed road alignment is in the Buffer Zone. Details of the forest locations along the project road sections are listed in Table 44.

Table 44: Details of Forest Locations along the Project Road section

Sl. No.	Name of Reserve / Protected Forest	District	Chainage	
			From (Km)	To (km)
1.	Yangoupokpi Lokchao Wildlife Sanctuary (Valley side)	Tengnoupal	395.680	425.196
Length (Km) of Project section Road passing through Reserve / Protected Forest			**29.516 Km**	

Source: Field Survey carried out by the Consultant Team, 2019

285. Field survey has been carried out to identify the number and type of trees to be affected by the proposed improvement work of main alignment. It is envisaged that about 2013 trees existing within the proposed formation width of the project road. Among these trees 1156 are on left side and 857 trees are on right side of the road while travelling towards Moreh. These trees are likely to cut for widening of the road. Table 45 show details of the trees to be cut.

Table 45: Detail of trees within formation width of the Main alignment (Indo-Myanmar)

Section	Chainage (km)		Left Hand Side (LHS)	Right Hand Side (RHS)	Type of Trees[9] (local name)
	From	To			
Khongkhang to Lokchow Bridge	395.680	404.130	297	314	Nasik, Boroi, Jam, Baraphi, Heibong, Tairm, Mango, Heikha, Neem, Sorokhi, Tumitla, Khongnang, Heinou, Konbla, Uyumg, Pungton, Jamun, Yongchak, Theibong, Heirik, Ouchan, Teak, Sayee, Kaygay, Kwa, Tera, Thibong, Qurei, Hawaizar Mana Panbi, Lairik Heibi, Kongong Thopki, Bhushlei
Lokchow Bridge to Khundhanthabi	404.130	413.230	443	204	
Khundhanthabi to Moreh	413.230	425.196	416	339	
Total trees to be cut (Nos)			**1156**	**857**	
			2013 Trees		

Source: Field Survey carried out by the Consultant Team, 2019

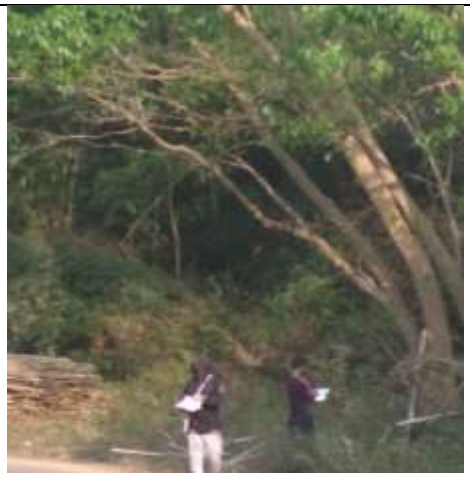
286. **Forests and Vegetation along the Project Road.** In order to establish baseline data on the presence of important floral habitats in the project area, a vegetation assessment study has been carried using field surveys (sampling of flora species and consultations with local forestry officials and communities). The main findings of the vegetation study are summarised herewith.

287. The main objectives of the vegetation study was to focus on valuable forest resources and other significant vegetative features along the proposed alignment of the road project. The study has been carried out in the months of February-March 2019. Efforts were made to collect data/information on the type of flora and vegetation along the alignment. The vegetation study for sloppy areas was also taken within the vicinity of the proposed alignment. The assessment was limited to a corridor of 60m along the proposed alignment and specifically areas within the proposed right-of-way (ROW) of the road or on the both sides along the proposed alignment. The existing diversity of floral / vegetation species, type of forests were determined along the proposed alignment from management plan of YLWLS.

288. The land use for this section of the project road is classified as Wildlife Sanctuary forest, however it is being used by local communities for agriculture purpose with patches of removal of shrubs & trees in between.

[9] None of these specific are recorded in the IUCN red data list of endangered / protected species. Local forest department were consulted and they also confirmed that none of these species are classified as rare or endangered.

Measuring DBH of tree on existing Khongkhang – Moreh road



Inventory of tree in the corridor of impact along existing Khongkhang –Moreh road

Floral species identification and data recording with forest officer along the road alignment

289. Key findings of the vegetation study are presented category wise herewith as i) vegetation and flora of the study area in holistic views, ii) types of forests, iii) specific observations, and iv) sensitive habitats.

290. **Vegetation and Flora of the Project Area.** Secondary information was used to understand the vegetation and flora of YLWLS forest areas along the alignment in Tengnoupal district. Table 46 present the floral species found in the project area (mostly in protected area of YLWLS) with their family and its IUCN status.

Table 46: Floral Species Recorded in the Project Area

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Pinus kesiya Royle	*Uchan*	Pinaceae	Not Assessed
Gnetum montanum		Gnetaceae	Not Assessed
Persea villosa (Roxb) Koster		Lauraceae	Not Assessed
Fragaria dattondama S. Gay		Rosaceae	Not Assessed
Potentilla griftihii Hookf		Rosaceae	Not Assessed
Prunus persica (Linn) Stokes		Rosaceae	Not Assessed
Roja multiflora Thunb		Rosaceae	Not Assessed
Rubus calycinus Wall		Rosaceae	Not Assessed
Rubus niveus Thanb		Rosaceae	Not Assessed
Chailleta gelonioides Hool f.		Chailletiaceae	Not Assessed
Bauhinia variegate L.		Caesalpiniaceae	Not Assessed
Cassia fistula Linn.	*Chaohui*	Caesalpiniaceae	Not Assessed
C. leschenaultainae DC		Caesalpiniaceae	Not Assessed
C. mimosoides Linn		Caesalpiniaceae	Not Assessed
C. sophera Linn		Caesalpiniaceae	Not Assessed
Acacia pennata (Linn) Willd		Caesalpiniaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Acacia myriophylla Benth		Caesalpiniaceae	Not Assessed
Phaneria glabifolia Benth		Mimosordeae	Not Assessed
Calliandra grithhii Benth		Mimosordeae	Not Assessed
Mimosa pudica Linn		Mimosordeae	Least Concern
Butea minor Ham		Mimosordeae	Not Assessed
Crotolaria juncea Linn		Papilionaceae	Not Assessed
Crotolaria pallid Ait		Papilionaceae	Not Assessed
Crotolaria sessiliflora Linn		Papilionaceae	Not Assessed
Dalbergia sissoo Roxb		Papilionaceae	Not Assessed
Desmodilum confertum DC		Papilionaceae	Not Assessed
Desmodium diocium DC		Papilionaceae	Not Assessed
D. laxiflorum DC		Papilionaceae	Not Assessed
D. parvifloum DC		Papilionaceae	Not Assessed
D. sequax Wall		Papilionaceae	Not Assessed
D. triquetrum (Line) DC		Papilionaceae	Not Assessed
Indigofera atropurpurea		Papilionaceae	Not Assessed
I. cassioides Ronl		Papilionaceae	Not Assessed
I. wightii Graen		Papilionaceae	Not Assessed
Smithia sensitive Ail		Papilionaceae	Not Assessed
Spatholobus roxburghi Benth		Papilionaceae	Not Assessed
Dipterocarpus turbinatus Gaerin		Dipterocarpaceae	Not Assessed
Dillenia pentagyna		Dilleniaceae	Not Assessed
Juglans regia Linn		Jaglandaceae	Not Assessed
Cannabis sativa Linn		Cannabaceae	Not Assessed
Ficus benghalensis Linn	*Khonang*	Moraceae	Not Assessed
F. elastica Roxb.	*Rubberpambi*	Moraceae	Not Assessed
F. geniculata Kurj	*Ksiherbong*	Moraceae	Not Assessed
F. racemosa Linn	*Heibong*	Moraceae	Not Assessed
F. religiosa Linn	*Kanakhsangnang*	Moraceae	Not Assessed
F. semicordata Buch-Hem		Moraceae	Not Assessed
F. squamosa		Moraceae	Not Assessed
Morus australis Poir		Moraceae	Not Assessed
Strobilanthus zeylanicus Kerr		Moraceae	Not Assessed
Diplolyclos palmatus C. Jeffery		Cucurbtaceae	Not Assessed
Epiphylum, phyllanthus (Linn) Hew		Cactaceae	Not Assessed
Opuntia vulgaris Mill		Cactaceae	Not Assessed
Boehmeria platyphylla D. Don		Urticaceae	Not Assessed
Broussonetia papyrifera		Urticaceae	Not Assessed
Poikilospermum suaveolens BI		Urticaceae	Not Assessed
Bixa orellana		Bisaceae	Not Assessed
Capparis multiflora Hook F		Capparaceae	Not Assessed
Crateva religiosa Forst F		Capparaceae	Not Assessed
Begonia roxbunghii A DC		Begomaceae	Not Assessed
Hibiscus cannabinus Linn		Malvaceae	Not Assessed
H. surattensis Linn		Malvaceae	Not Assessed
Grewia microcos Linn	*Heitup*	Tiliaceae	Not Assessed
Triumfetta pilosa Boj		Tiliaceae	Not Assessed
Byttneria pilosa Roxb.		Sterculiaceae	Not Assessed
Sterculia indicca Merr.		Sterculiaceae	Not Assessed
Bombax ceiba Linn		Bombacaceae	Not Assessed
Bombax insigne Wall		Bombacaceae	Not Assessed
Actephila excels (Dalz.) Muel		Euphorbiaceae	Not Assessed
Baliospermum calycinum Muell		Euphorbiaceae	Not Assessed
Breynia retusa (Dennst) Alston		Euphorbiaceae	Not Assessed
Bridelia pubescens Kurz		Euphorbiaceae	Not Assessed
Croto roxburghii Balakrishnan		Euphorbiaceae	Not Assessed
Euphorbia hypervifolia Linn.		Euphorbiaceae	Not Assessed
Homonoia riparia Lour.		Euphorbiaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Phyllanthus emblica Linn		Euphorbiaceae	Not Assessed
P. virgatus G. Furst		Euphorbiaceae	Not Assessed
Ricinus communis Linn	*Kege*	Euphorbiaceae	Not Assessed
Securinega virosa (Roxb & Willd) Bail		Euphorbiaceae	Not Assessed
Garcina cowa Roxb	*Heibung*	Guttiferae	Not Assessed
Combretem ovalofoium Roxb		Combretaceae	Not Assessed
Vaccinium graiffithianum Wight		Vacciniaceae	Not Assessed
Callistemon linearis DC		Myrtaceae	Not Assessed
Osbeckia nutans Wall		Melastomaceae	Not Assessed
Sonerila stricta Hook		Melastomaceae	Not Assessed
Daubanga grandiflora (Roxb. ex DC) Walp		Lythraceae	Not Assessed
Celastrus stylosus		Calastraceae	Not Assessed
Rhamnus nepalensis (Wall) Lawson		Rhamineceae	Not Assessed
Cissus javanica DC		Vitaceae	Not Assessed
Tetrastigma bracteolatum (Wall) Plench		Vitaceae	Not Assessed
Vitis vinifera Linn.		Vitaceae	Not Assessed
Leea edgeworthii Santapou		Leeaceae	Not Assessed
Boenninghausenia albiflora (Hook) Reichneb		Rutaceae	Not Assessed
Citrus maxima (Burm) Merr	*Nowab*	Rutaceae	Not Assessed
C. media Linn.	*Heizang*	Rutaceae	Not Assessed
Paramigynna armata oliv		Rutaceae	Not Assessed
Zanthoxylum acanthospodium DC		Rutaceae	Not Assessed
Z. armatum DC		Rutaceae	Not Assessed
Rhus semilata Murrey		Anacardiaceae	Not Assessed
Spondias pinnata (L.f.) Kruz		Anacardiaceae	Not Assessed
Catharanthus roseus (Linn.) G. Don		Apocynaceae	Not Assessed
Nerium indicum Mill		Apocynaceae	Not Assessed
Thevetia peruviana (Pers) K Schum		Apocynaceae	Not Assessed
Calotropis giganties (Wild). Aitf		Ascelecediaceae	Not Assessed
Agrostemma sarmentosum Wall		Rubiaceae	Not Assessed
Coffea Arabica Linn.		Rubiaceae	Not Assessed
Gardenia jasminoides Ellis.		Rubiaceae	Not Assessed
Hedyotis biflora (Linn.)		Rubiaceae	Not Assessed
Hedyotis lineate Roxb		Rubiaceae	Not Assessed
Meyna spinosa Roxb	*Heibi*	Rubiaceae	Not Assessed
Mussaenda incana Wall.		Rubiaceae	Not Assessed
Ophiorrhiza mungos Linn.		Rubiaceae	Not Assessed
Paveta brunmsis Linn.		Rubiaceae	Not Assessed
Pavetta subapitata Hook		Rubiaceae	Not Assessed
Spirendiclis cylindrical Wall.		Rubiaceae	Not Assessed
Wendlandia glabra DC		Rubiaceae	Not Assessed
Holmskioidea sanguine Retz		Verbenaceae	Not Assessed
Lantana camara Linn		Verbenaceae	Not Assessed
Premna coriacea (B. Clarke)		Verbenaceae	Not Assessed
Pygmaeopremna berbaceae (Roxb) Moldenka		Verbenaceae	Not Assessed
Stachytarpheta jamaicensis (Linn.) Vahl		Verbenaceae	Not Assessed
Tectona grandis Linn.		Verbenaceae	Not Assessed
Clematis gouriana Roxb		Ranuculaceae	Not Assessed
Stephania japonica (Thunb.) Meir		Menispermeae	Not Assessed
Papaver orientale Linn.		Papaveraceae	Not Assessed
Capsella bursa pastoris (Linn) Medikus		Brassicaceae	Not Assessed
Cardamine hirsute Linn		Brassicaceae	Not Assessed
Rorippa indica (L.) Hochreut		Brassicaceae	Not Assessed
Stellaria aquatica (Linn.) Scop		Caryophyllaceae	Not Assessed
Fagopyrum eslentum Moench		Polygonaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Muchlenbeckia platyclades (Muell) Meissn		Polygonaceae	Not Assessed
Polygonum capitatum Auch Hum.		Polygonaceae	Not Assessed
Polygonum chinense Linn.		Polygonaceae	Not Assessed
P. orientale Linn		Polygonaceae	Not Assessed
P. tubulosum Boiss		Polygonaceae	Not Assessed
Rumex nepalensis Spreng		Polygonaceae	Not Assessed
Chenopodium album Linn.		Chenopodiaceae	Not Assessed
Altenenthera sessilis (Linn) R. Br.		Chenopodiaceae	Not Assessed
Amaranthus viridis Linn.		Amaranthaceae	Not Assessed
Celosia argentea Linn.		Amaranthaceae	Not Assessed
C. polygonoides Reitz.		Amaranthaceae	Not Assessed
Cyathula capitata DC		Amaranthaceae	Not Assessed
Gompherena globosa Linn.		Amaranthaceae	Not Assessed
Ludwigia adscendens (Linn.) Hore		Onagraceae	Not Assessed
Plantago erosa Wall.		Plantaginaceae	Not Assessed
Eryngium foetidum Linn.		Apiaceae	Not Assessed
Hydrocotyle himalaica P.K. Mukherjee		Apiaceae	Not Assessed
H. sibthorpiodes Lam		Apiaceae	Not Assessed
Peucedenum dhana Wall		Apiaceae	Not Assessed
Agerratum coyzoides Linn.		Asteraceae	Not Assessed
Ambrosia artemsifolia Linn.		Asteraceae	Not Assessed
Artemisia indica Willd.		Asteraceae	Not Assessed
Bidens pilosa Linn.		Asteraceae	Not Assessed
Blumea aromatic DC		Asteraceae	Not Assessed
B. balsamifera (Linn) DC		Asteraceae	Not Assessed
Blepharis boerhaaviaefolia Pers.		Acanthaceae	Not Assessed
Eranthemum pulchellum Andrews		Acanthaceae	Not Assessed
Gymnostachyum glabrum T. Anders		Acanthaceae	Not Assessed
Justicia diffusa Wild		Acanthaceae	Not Assessed
Nelsonia canescens Datz.		Acanthaceae	Not Assessed
Thunbergia alata Bujer		Acanthaceae	Not Assessed
T. grandiflora (Roxb ex. Rottl) Roxb.		Acanthaceae	Not Assessed
Impatiens balsamifera Linn.		Balsaminaceae	Not Assessed
I. Tomentosa Heyne		Balsaminaceae	Not Assessed
Heliotropium indicum Linn.		Boraginaceae	Not Assessed
Rhabdia lycioides Mart		Boraginaceae	Not Assessed
Clinopodium umbrosum (M. Bieb) C. Kah		Labiatae	Not Assessed
Eusterelis cruciata (Benth) Panigrahi		Labiatae	Not Assessed
Epimeedi indicus (Linn) Rotham		Labiatae	Not Assessed
Gomphostema niveum Hook f.		Labiatae	Not Assessed
G. wallichi Prain		Labiatae	Not Assessed
Leonurus japonicas Houtt.		Labiatae	Not Assessed
Nepeta leucophylla Benth.		Labiatae	Not Assessed
Rhabdosia scrophularioides (Wall ex. Benth)		Labiatae	Not Assessed
Salvia plebeja R. Br.		Labiatae	Not Assessed
S. saxicola Wall.		Labiatae	Not Assessed
Scutellaria assamica Mukherjee		Labiatae	Not Assessed
S. rivularis Wall		Labiatae	Not Assessed
Cyanotis vaga(Lour) J.A. & J.H Schultes		Commelinaceae	Not Assessed
Hedychium marginatum Clarke		Zingiberaceae	Not Assessed
Hedychium coronarium koeing		Zingiberaceae	Not Assessed
H. thyrsiforme Buch		Zingiberaceae	Not Assessed
Zingber officinale Losc		Zingiberaceae	Not Assessed
Alpinia calcarata Rose		Zingiberaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
A. nigra (Gaertn) B.L. Burtt		Zingiberaceae	Not Assessed
Curcuma angustifolia Roxb		Zingiberaceae	Not Assessed
C. caesa Roxb		Zingiberaceae	Not Assessed
B. fistulosa (Roxb) Kurz		Asteraceae	Not Assessed
B. hieraciifolia (D. Don) DC		Asteraceae	Not Assessed
B. lacera (Burmt.) Mar		Asteraceae	Not Assessed
Carthamus tinctorius Linn.		Asteraceae	Not Assessed
Cetipeda minima (Linn) A. Br. and Aschers		Asteraceae	Not Assessed
Chrysanthemum indicum Linn.		Asteraceae	Not Assessed
Conyza angustifolia Roxb.		Asteraceae	Not Assessed
C. striata Willd		Asteraceae	Not Assessed
Cyathocline purpurea (Buch-Ham ex. D. Don)		Asteraceae	Not Assessed
Dicrocephala integrifolia (L.f.) O. Kuntze		Asteraceae	Not Assessed
Emilia sonchifolia DC Var. Scabra Hooker		Asteraceae	Not Assessed
Eupatorium adenophorum Spreng		Asteraceae	Not Assessed
E. odoratum Linn.		Asteraceae	Not Assessed
Gallinsoga parviflora Cav.		Asteraceae	Not Assessed
Inula barbata Wall. Ex. DC		Asteraceae	Not Assessed
I. eupatoriodes DC		Asteraceae	Not Assessed
Lactuca sativa		Asteraceae	Not Assessed
Laggera alata (D. Don)		Asteraceae	Not Assessed
Sclerocarpus africanus Jacq		Asteraceae	Not Assessed
Senecio scendens Buch Ham.		Asteraceae	Not Assessed
Sieges beckia orientalis Linn		Asteraceae	Not Assessed
Sochus oleraceus Linn.		Asteraceae	Not Assessed
Synedrella nodiflora (Linn) Gaertn.		Asteraceae	Not Assessed
Tagetes patuna Linn.		Asteraceae	Not Assessed
Veronia aspera Buch-Ham		Asteraceae	Not Assessed
V. cinerea (Linn.) Less		Asteraceae	Not Assessed
Zinnia elegans Jacq		Asteraceae	Not Assessed
Nicotiana tobacum Linn.		Solanaceae	Not Assessed
Physalis minima Linn		Solanaceae	Not Assessed
Solanum nigrum Linn.		Solanaceae	Not Assessed
Lindernia allioni		Scrophulariaceae	Not Assessed
Stemodia viscose Roxb.		Scrophulariaceae	Not Assessed
Acanthus leucostachys Wall. ex. Nees		Acanthaceae	Not Assessed
C. domestica Valeton		Zingiberaceae	Not Assessed
C. reclinata Roxb		Zingiberaceae	Not Assessed
C. flaccid Sal.		Cannaceae	Not Assessed
C. indica Linn		Cannaceae	Not Assessed
Dianelia nemorosa Lamk		Liliaceae	Not Assessed
Streptopus simplex		Liliaceae	Not Assessed
Smilax roxburghiana Wall		Smilacaceae	Not Assessed
Colocasia esculenta (Linn) Schott		Araeae	Not Assessed
Lasia spinosa (Linn) Thw		Araeae	Not Assessed
Pothos cathcartii Schott		Araeae	Not Assessed
Dioscorea kamoonesis Kunth		Dioscoreaceae	Not Assessed
Areca catechu Linn.		Palmae	Not Assessed
Caryota sp.		Palmae	Not Assessed
Phoenix sylvestris (Linn)		Palmae	Not Assessed
Pandanus furcatus Roxb		Pandanaceae	Not Assessed
Dendrobium chrysotoxum Lindl.		Orchidaceae	Not Assessed
D. densiflorum Lindl.		Orchidaceae	Not Assessed
Habenaria prainii Hook f.		Orchidaceae	Not Assessed
H. suaveolens Dalz		Orchidaceae	Not Assessed

Botanical Name	Local Name (Common Name)	Family	IUCN Status
Carex indica Linn.		Cyperaceae	Not Assessed
Cyperus diffuses Vahl		Cyperaceae	Not Assessed
Fimbrostyllus diphylla (Retz) Vahl		Cyperaceae	Not Assessed
Bambusa balcooa Roxb		Poaceae	Not Assessed
B. burmanica Gamble		Poaceae	Not Assessed
B. pallid Roxb		Poaceae	Not Assessed
Cynodon dactylon (L) Pers		Poaceae	Not Assessed
Dinochloa compactiflora (Kurz) McClore		Poaceae	Not Assessed
Pogonatherum crinitum (Thunb.) Kunth.		Poaceae	Not Assessed
Thysanolaema maxima (Roxb) Kuntze		Poaceae	Not Assessed

291. The YLWLS is well endowed with good forest cover. Broadly, there are 4 (four) distinct vegetal types. They can be classified as (1) Teak forest along the foothills, (2) Dipterocarpus spp. forest in the mid-range, (3) The mixed broad leaf upper forest and (4) The riverine bamboo forest.

292. ***Teak Forest:*** The foothills bordering the International Boundary is covered with teak. The associates are Terminallia chebula, Melanorrhoea usitata, Oroxylum indicum, etc.

293. ***Dipterocarpus Forest:*** Upper to the teak belt, a distinct belt of Dipterocarpus spp. are found in abundance. D. turbinatus being a shade bearer, it grows in deep nalahs and northern aspects and D. tuberculatus grows in open areas exposed to sunlight. Associates are Strychnos nux-vomica, Melanorrhoea usitata, Emblica officinalis, Cedrella serrata, etc.

294. ***Mixed broad leaf forest:*** The highest reaches of the Sanctuary is covered with mixed broad leaf spp. They are Cedrella toona, Cedrella serrata, Quercus spp., Castanopsis spp., Mango, Terminalia chebula, Duabanga spp., Bauhinia spp., etc.

295. ***Riverine bamboo forest:*** Along the banks of the rivers and streams, a thick forest of bamboos is found. Some important spp. are Melaconna, Bamboosa, etc. It is to mention that the bamboo brakes are found abundantly along the sides of Lokchao river. However, when the above 4 (four) types of forests are destroyed due to fire or shifting cultivation, the forest which comes thereafter is scrub forest that is composed of Sacchurum munja, Cymbopogon spp., Mikania, Ageratum, etc.

296. **Endangered and Protected Flora.** Some of the important rare and endangered floral species in the protected areas[10] along the project road are *Tectona grandis, Dipterocarpus turbinatus, Dipterocarpus tuberculaus, Melonarrhoea usitata, Duabanga Sonnoroedes, Dillenia pentagyna, Terminallia tomentosa, Gmelina arborea, Bauhinia spps*., some species of bamboos, orchids, etc.

297. Local forest department were consulted to know the presence of any endangered and protected species of flora within the formation width. It is confirmed by the forest department officials that there are no endangered species which are likely to be affected by current project.

298. Joint inspection is being carried out with field officials from the local forest department to prepare the detailed inventory and marking of the trees to be cut. During the joint inspection, if any endangered and or protected species of flora found within the formation width of the project road section, necessary mitigation measures will be adapted to protect such species.

299. Also based on the joint inspection, a suitable compensatory afforestation plan will be prepared to mitigate loss of vegetative cover due to the project activities.

D. Wildlife and Protected Area Network

[10] Source: Management Plan of the Yangoupokpi Lokchao Wildlife Sanctuary prepared by Wildlife Division of Manipur.

300. The State has rich wildlife and has long network of protected area. In order to protect the rich flora and fauna of Manipur from the poacher, the Government has established parks and sanctuaries. The state's protected area network comprises of five wildlife sanctuaries and two national parks. Recognizing the importance of this region as one of the hot spots, majority of the biodiversity rich areas of the state has been placed inside the protected area network system comprising mainly of the National Park and Sanctuary.

301. In the State, conservation of wildlife is carried out in two categories as ex-situ conservation and in-situ conservation.

302. **Ex-Situ Conservation**: The wildlife is located/ transported from their natural habitat to an area well protected from outside elements and preserved there. An example of this category is the Manipur Zoological Garden at Iroishemba, Orchid Preservation Centre at Khonghampat, Arboretum etc.

303. **In-Situ Conservation**: Areas having adequate natural flora and fauna are declared as National Parks and Wildlife Sanctuaries. They are known as the Protected Areas Networks (PAN). The entry of human and cattle inside the area is strictly under control. No dead, dying or diseased plants can be removed from such areas. The examples of this category are the Keibul Lamjao National Park and Yangoupokpi Lokchao Wildlife Sanctuary.

304. The details of sites are given in Table 47. Figure 29 show the protected area map of the Manipur. The total area under the protected area network is 1 percent of total geographical area of state and that of under national parks is 0.2 percent.

Table 47: Protected Area Network in the State of Manipur

Sl.	Protected Area	Location (District)	Area in sq.km
A.	**In-situ Conservation Sites**		
1	Keibul Lamjao National Park	Keibul Lamjao (Bishnupur Dist.)	40.00
2	Yangoupokpi Lokchao Wildlife Sanctuary	Lokchao (Chandel Dist.)	184.80
3	Shiroi Hill National Park	Ukhrul (Ukhrul Dist.)	41.00
4	Kailam Wildlife Sanctuary	Churachandpur Dist.	187.50
5	Jiri-Makru Wildlife Sanctuary	Tamenglong Dist.	198.00
6.	Bunning Wildlife Sanctuary	Tamenglong Dist.	115.80
7.	Zeliad Wildlife Sanctuary	Tamenglong	21.00
B.	**Ex-site Conservation Sites**		
1	Manipur Zoological Garden	Iroisemba, Imphal West	0.08
2	2nd Home SANGAI	Iroisemba, Imphal West	0.60
3	Orchid Preservation Centre	Khonghampat, Imphal West	0.50

Source: Statistical Booklet of Manipur Forest (2010-2011), Wildlife Wing, Forest Department, Gov't of Manipur

305. In the state, in spite of its rich vegetation, due to the absence of any forest worth the name within the district wild animals are not found abundantly, Deer and Jungle fowl are some of the varieties found at present occasionally along the slope of eastern hills adjoining the district. But the lakes support a variety of wild birds such as partridge, snipe, duck, geese, etc. particularly in winter months. These birds are mostly migratory in character. Some of them are seen coming from far off Siberia. With the gradual conversation of the lakes into agricultural lands these migratory birds are seen in increasingly fewer members in recent times.

306. It can be seen from the map (Figure 29 and 30) that the project road from Lokchao bridge to Moreh town is passing through protected area of Yangoupokpi Lokchao Wildlife Sanctuary. It can be seen from the zonation map (Figure 31) of the YLWLS that total 29.516 km length of the proposed project road passes through Yangoupokpi Lokchao Wildlife Sanctuary area on one side of road. Starting from Khogkhang village to Lokchao River Bridge (km 395+680 to km 404+130) length of 8.450 km alignment is in ESZ of YLWLS. From to Lokchao River Bridge Khudenthabi village (chainage 404.130 to Chainage 413.230, length 9.100km) alignment traverses along the border of Core Zone I and Tourism Zone. After Khudenthabi village upto Moreh (Chainage 413.23

to 425.196, length 11.966 km) proposed road alignment is in the Buffer Zone of Yangoupokpi Lokchao Wildlife Sanctuary.

307. According to the ADB SPS (page 35, footnote 5) a legally protected area is one of the criteria for defining an area as critical habitat. Since 21.066 km section of the project road passes through the YLWS comprising of forests and river systems, this section falls inside critical habitat. Figure 32 shows the habitat map of YLWLS.

308. The Yangoupokpi Lokchao Wildlife Sanctuary has a diverse assemblage of wildlife harbouring many species of mammals, birds, reptiles & amphibian, fishes and insects. The main Carnivores are Leopard, Jungle cat, Jackal, Mongoose, Civet cat, Fox, etc. The main Herbivores are Sambar, Deer, Wild boar, Monkey, etc. Among the small Mammals, Langur, Porcupine, Pangolins are to be mentioned. Hoolock gibbon and Serrow are rare and endangered ones. The Reptilian fauna is represented by Cobra, Krait, Tree-boa, Python, Lizards, Water monitor lizards, Tortoise, Tokke gekko, etc. Avian fauna is represented by Burmese peafowl, Moorhen, Blyth‟s tragopan, Mrs. Hume‟s bar-backed pheasant, Red Jungle fowl and 3 species of Hornbills viz. Great Indian Hornbill, Rufous-necked hornbill, Wreathed hornbill, etc. The stamp-tailed Macaques are also found. Many seasonal colorful birds also visit the sanctuary. And there is the seasonal migration of elephants from Myanmar plains to the sanctuary during paddy harvesting season i.e. August to September every year. Many of the above species of wildlife are becoming rarer and rarer due to substantial increase in human and domestic cattle population, large scale de-forestation, shifting cultivation and poaching including illegal trading of wildlife parts. It has been observed that various factors like vegetation, terrain, water and biotic pressure, etc. greatly influence the habitat preference of wild animals inhabiting in the Protected Area of YLWLS.

309. The habitat quality is reflected by the abundance of the prey species. The prey base is the most crucial requirement for the survival of a thriving population of predators. Habitat use in the YLWLS is presented in Table 48.

Table 48: Habitat use in the YLWLS

S. No.	Kind of animal	Shelter	Loafing ground	Travel lane
1	Sambar	Dense wet deciduous riverine forests on hill slopes	Denser patches close to water	Mixed deciduous areas along upper hill slopes
2	Leopard	Wet and mixed deciduous forest areas	As above	Hilly slopes of open scrub forests
3	Fox	Open deciduous Scrub forest	Bushy areas	Barren scrub areas
4	Jackal	-do-	Bushy areas and waterholes	Flat tracts and open scrubs
5	Jungle Cat	Wet deciduous and mixed forest	Flat area and water holes	Scrubby, grassy trails
6	Wild Boar	Wet deciduous scrub and teak forest	Flat and gentle undulating areas	Deciduous forest areas
7	Monkey	Deciduous forest mixed forests	Deciduous forests	Upper & middle storey trees
8	Porcupine	Rocky lower hill sides	Deciduous forest areas	Uses rough roads & trails
9	Pangolin	Open deciduous scrubs over grazed areas	Areas with ant hills	In dry nalahas & scrubby open forest

Source: YLWLS Management Plan (2012-13 to 2021-22)

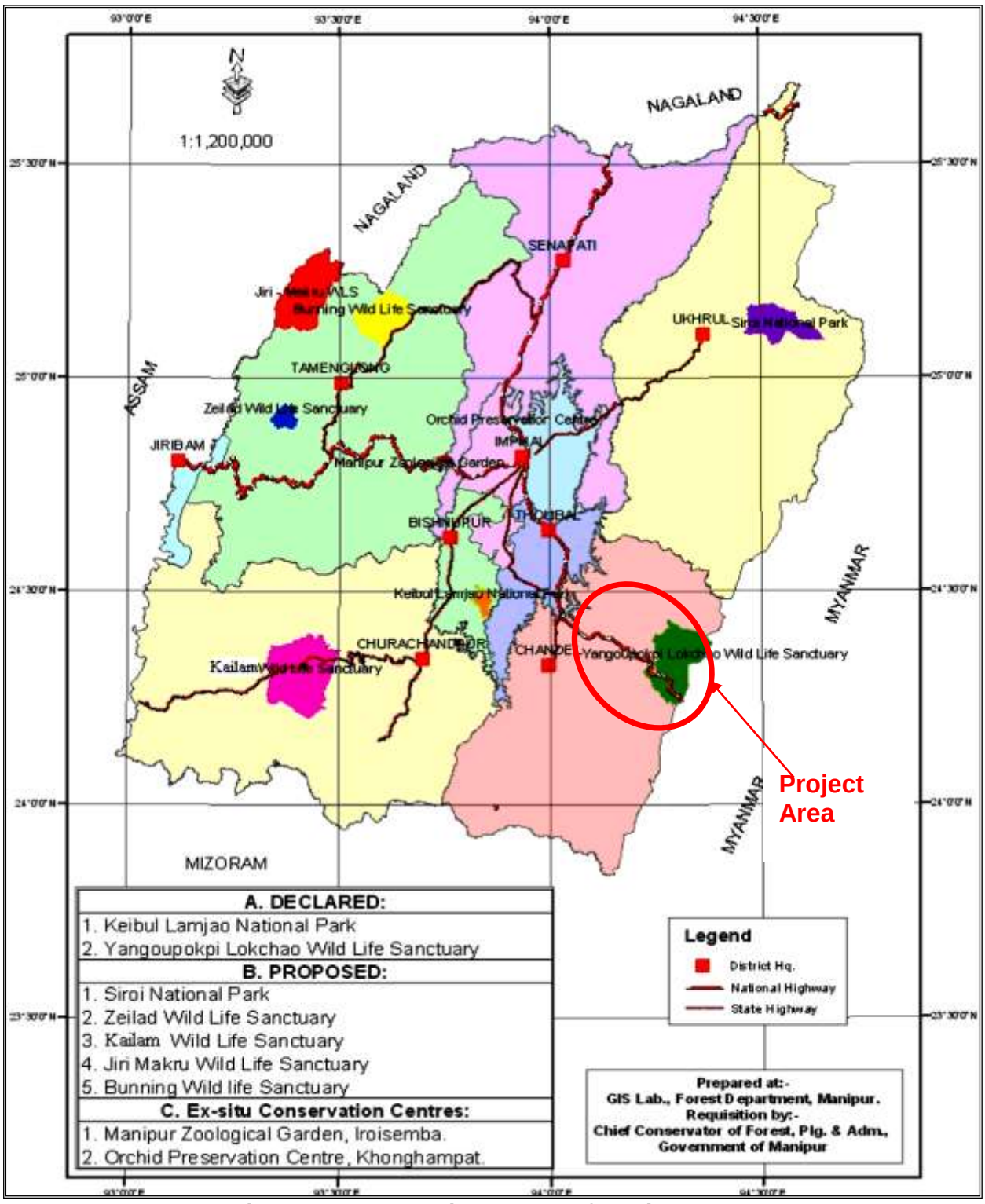


Figure 29: Protected Area Map of Manipur State

Source: Wildlife Wing, Forest Department, Government of Manipur

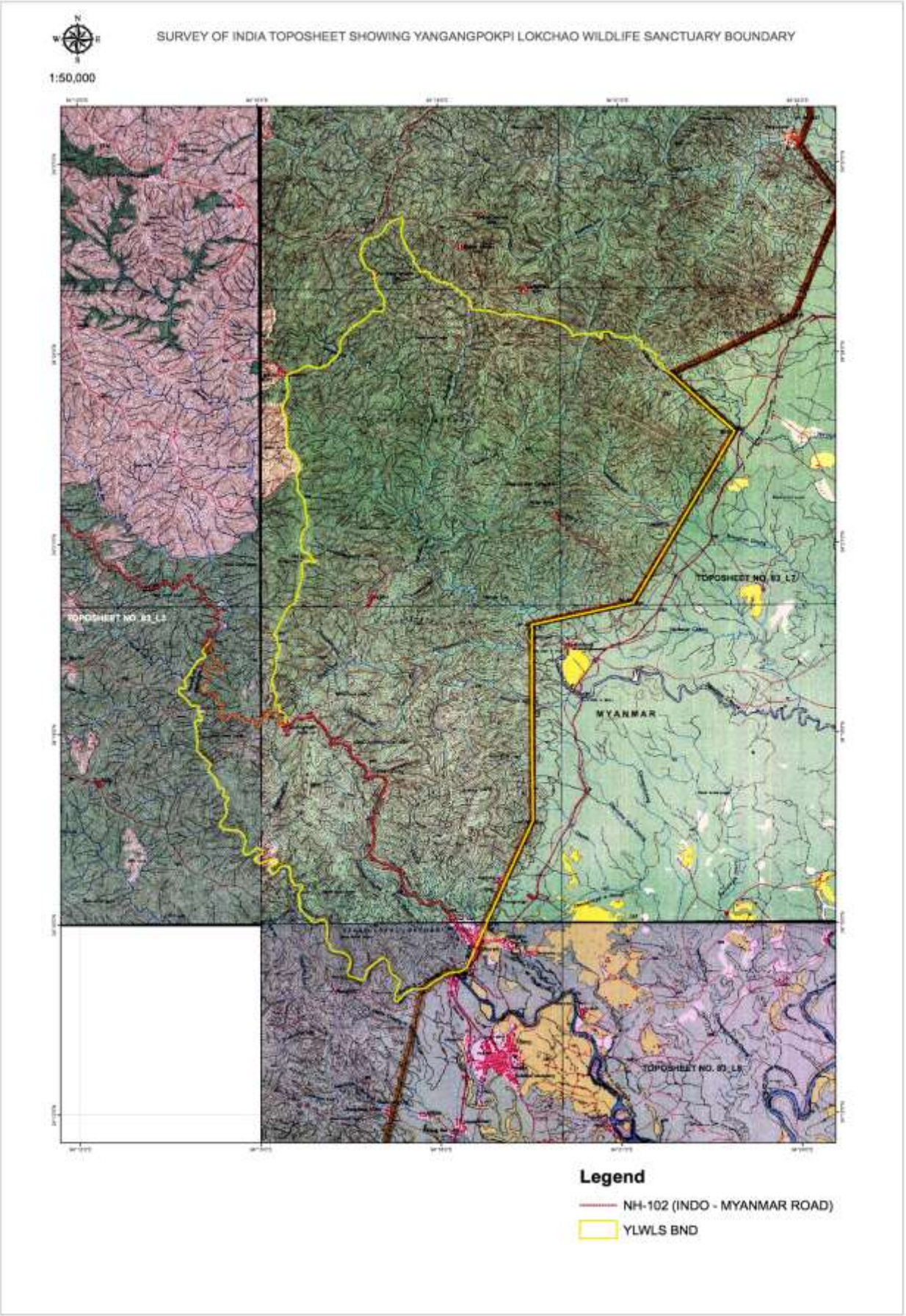


Figure 30: Project Road alignment on toposheet showing YLWLS boundaries

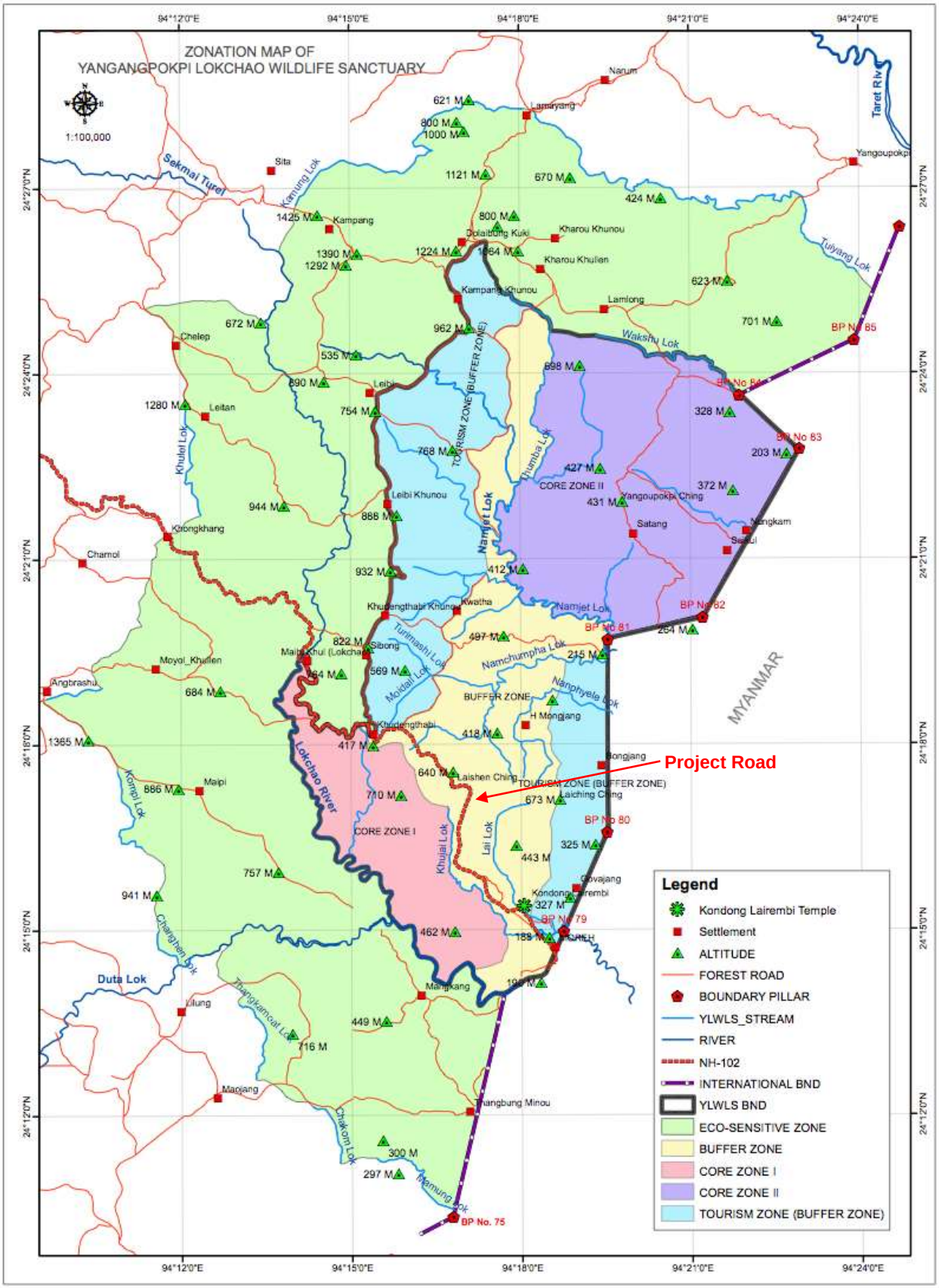


Figure 31: Zonation map of YLWLS showing project alignment

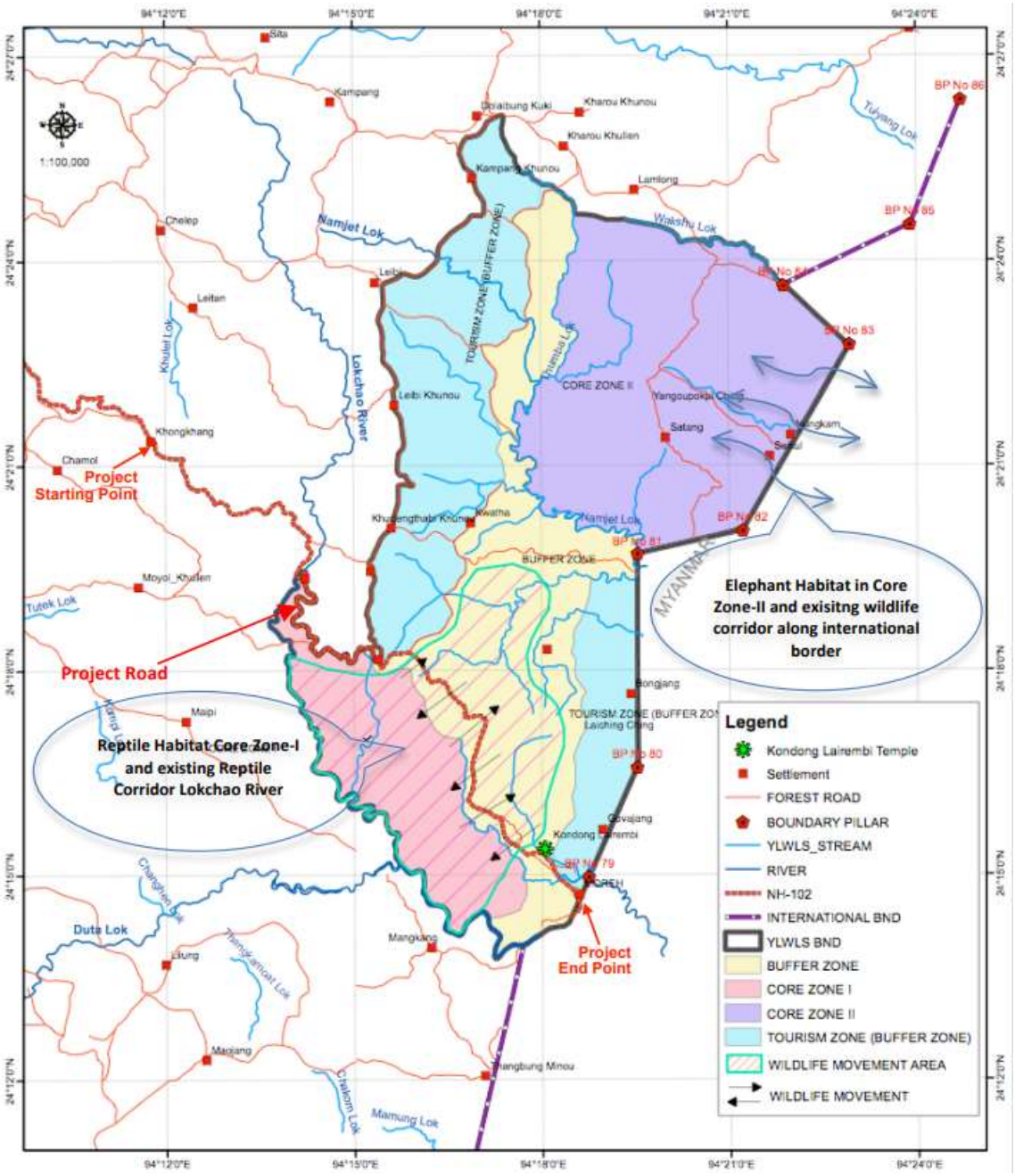


Figure 32: Habitat Map of project road along YLWLS

310. **Assessment of Wildlife along the Subproject Road.** In order to establish baseline data on the presence of important wildlife and faunal habitats in the project area, a Wildlife Assessment Study has been carried using field surveys (walkover transect surveys and consultations with local forestry and wildlife officials and local communities). The main findings of this Wildlife Study are summarized herewith.

311. **Objectives and Methodology.** The main objectives of the wildlife study was to assess and document wildlife and faunal habitats in the project area and along the proposed alignment in particular. The study has been carried out in the months of February-March 2019. The methods including literature review, direct field sightings by transact walk, discussions with local communities, consultations with local (field level) forest officials etc. were used to collect data on presence of wildlife in the project area. Altogether 6 random line transects of varying lengths were set up in and along the project road alignment in order to document any direct wildlife observations encountered.

312. **Key Findings.** Based on secondary sources, this sanctuary is the abode of 42 species of mammalia, 74 species of aves, 29 species of reptiles, 6 species of amphibia and 86 species of fishes. The habitat quality is reflected by the abundance of the prey species.

313. A transact walk field survey on mammals was conducted along the proposed project road alignment particularly on the 21.066 km section of the project road within YLWLS with critical wildlife habitat area during the field surveys in the first quarter of 2019. Information and evidences on mammals were collected. Also, data from wildlife census conducted by Forest Department in YLWLS were used to assess the status of wildlife habitat in the project area.

314. Informal interviews were held with the local villagers, livestock herders to gather information on the status of wildlife and their habitats. Information on cattle depredation, crop damage by wild animals, incidences of road accidents involving wild animals were also collected during informal interviews.

315. Officials from Wildlife division including Chief Wildlife Warder, Chief Conservator of Forests and Field officers of YLWLS were also consulted in the process. As mentioned, management plan of YLWLS, the Core Zone-I is habitat (Lokchao river) for reptiles and amphibians. The Core Zone-II is the main habitat and activity area for all mammals listed in the YLWLS management plan.

316. As a result of surveys and consultations, it was found that the project area has faunal species of shaji (deer), fox, jackle, jungle cat, wild pig, monkey (langur), porcupine & pangolin.

317. Besides these species, it is reported that the protected area of YLWLS (core zone) has rare and endangered faunal species which include Mammals: Hoolock gibbon, Malayan Sun Bears, Serow, Pangolins, and Macaques; Birds: Hornbills, Mrs Hume's bar-backed pheasant, Blyth's tragopan, Burmese peafowl; Reptiles & Amphibians: King cobra, Monocle cobra, krait, Rock pythons, Monitor lizards, Tokke gokko, Leaf Turtle, a number of frogs which includes species of genus Cylemys Polypedates, Fajerverya and Hoplobatrachus,etc.

318. Office of the Wildlife Warden (Manipur) informed that there is no specific information available about wildlife movement corridors and wildlife migratory routes along national highway section (project road section). Wildlife movement is mostly limited to the core zone of the sanctuary and along the rivers/streams within sanctuary. The sanctuary has an existing natural wildlife corridor between eastern part of sanctuary and adjoining Myanmar border (Figure 32 show the wildlife corridor). Seasonal migration of wildlife including Asian Elephant were reported through this corridor. However, there is no record of wildlife movement across project road. It can be seen from the Figure 32 that the elephant migratory corridors are limited to eastern part of sanctuary and adjoining Myanmar border, which are outside of the project area of influence. Local communities also informed that they rarely noticed movement of animals across the national highway. Some of the people consulted indicated that they occasionally (once in a week or less) spot small animals such as langur crossing the national highway. Also, there is no history of road accident involving wild animals on national highway section.

319. Table 49 present the faunal species in the protected areas of YLWLS and its IUCN status. It is found that none of the endangered or rare specific of wildlife will be impacted from the proposed project activities since movement of endangered species are mostly limited to core zones of the sanctuary.

Table 49: Faunal Species Recorded in the Project Area

Scientific Name	*Local Name (Common Name)*	IUCN Status
FISHES		
Acantopsis choirorhynchus (Blecker)	*Chingngakrichou*	Not assessed
Catla catla (Ham.)	*Catla*	Not assessed
Silurus morehensis	*Ching-Ngaten*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Tetraodon cucutla. (Ham)	*Hnagoi-nga*	Not assessed
Anguilla bengalensis bengalensis Gr. & Harol	*Ngaril leina*	Not assessed
Amblycep mangois Ham	*Ngaril leina*	Not assessed
Chanda nama Ham.	*Ngamhai*	Not assessed
Aorichthys aor (Ham)	*Ngachou*	Not assessed
A. scenghala (Syke)	*Ngachou*	Not assessed
Mystus bleckeri (Day)	*Ngasep*	Not assessed
M. menoda (Ham.)	*Ngasep*	Not assessed
M. microphthalmus (Day)	*Nganan*	Not assessed
Rita rita (Ham.)	*Nganan*	Not assessed
Xenontodon cancilla (Ham.)	*Ngacheklaobi*	Not assessed
Colisa fasciatus (Schn.)	*Ngapemma*	Not assessed
Channa marulius Bloch & Schn	*Ngamu gojar (Snake head)*	Not assessed
Aspidoparia morar (Ham)	*Ngarang*	Not assessed
Barilius dogarsinghi (Hora)	*Ngawa*	Not assessed
B. barnoides Vinciguerra	*Ngawa*	Least Concern
Chela laubuca (Ham)	*Ngasang*	Not assessed
Cirrhinus reba (Ham)	*Ngaton*	Not assessed
Chagunius nicholsi (Myers)	*Ngawameingbi*	Not assessed
Danio naganensis (Chandhuri)	*Ngasang*	Not assessed
D. yunsis	*Ngasang*	Not assessed
Exomus danricus (Ham)	*Ngasengum*	Not assessed
Garra gavelvi (Annandelei)	*Ngasengum*	Not assessed
G. gotyla gotyla (Gray)	*Ngasengum (Pattar Chat)*	Not assessed
Labeo calbarasu (Ham)	*Ngathi*	Not assessed
L. pangusia (Ham.)	*Ngathi*	Not assessed
Neollissochilus hexagonolepsis (Mecl.)	*Ngara*	Not assessed
Oxteobrama Cotio cunma (Day)	*Ngaseksa*	Not assessed
Poro sarana Orphoides (Ham.)	*Ngahou*	Not assessed
P. meinganbi	*Ngakhameingabi*	Not assessed
P. yuensie	*Ngakhahangampal*	Not assessed
Parluciosoma daniconius (Ham.)	*Ngasanpokchaobi*	Not assessed
Tor putitora (Ham.)	*Nunga (Golden Mahsheer)*	Not assessed
T. tor (Ham.)	*Nunga*	Not assessed
Glossogobius giuris (Ham.)	*Nailon-ngamu*	Not assessed
Aeanthocabitis botia (Ham.)	*Ngatup*	Not assessed
Schistura manipurensis Chandhuri	*Ngatup*	Not assessed
S. praschadi Hora	*Ngatup*	Not assessed
S. vinciguerrae Hora	*Ngatup*	Not assessed
Mastacembelus armatus Lacepede	*Ngaril*	Not assessed
M. alboguttatus Boulenger	*Ngaril*	Not assessed
Macrognathus pancalus Ham.	*Ngaril macha*	Not assessed
M. moreehensis	*Ngamoitup*	Not assessed
Badis badis (Ham.)	*Nga-Sakthibi*	Least Concern
Psilorphynhus manipurensis Vishwanath	*Nga-Sakthibi*	Not assessed
Bagarius bagarius (Ham.)	*Ngarel*	Not assessed
Gagata cenia. Cenia (Ham.)	*Ngarang*	Not assessed
Gluptothorax cavia Ham.	*Ngapang*	Not assessed
G. pectinopterus (Mccl.)	*Ngapang*	Not assessed
G. sinense Regan	*Ngapang*	Not assessed
G. trilineatus Blyth	*Ngapang*	Not assessed
Channa orientalis (Ham.)	*Meitei-ngamu*	Not assessed
Amblypharyngodon mola (Ham.)	*Muka-nga*	Not assessed
Cirrhinus mrigala. (Ham.)	*Mrigal*	Not assessed
Cyprinion semplotum (Mccl.)	*Maku-nga*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Labeo bata (Ham.)	*Khabak*	Not assessed
Labeo rohita (Ham.)	*Rou*	Not assessed
Botia berdmorei (Blyth)	*Sarengkhoibi*	Not assessed
B. histronica (Blyth)	*Sarengkhoibi*	Not assessed
Wallago attu (Schneider)	*Sareng*	Not assessed
Osteobrama belangeri (Val.)	*Pengba*	Not assessed
Poro sophore (Ham.)	*Phabounga*	Not assessed
AMPHIBIANS		
Polypedates leucomystax Gavenhorst	*Hangoi tangsang*	Not assessed
Bufo melasnotictus Schneider	*Hangoi borbi*	Not assessed
Hyla annectan Jerdon	*Laphu-hanoi*	Not assessed
R. breviceps Schneider	*Labuk-hangoi*	Not assessed
Rana tigerina Daudin	*Moreh-hangoi*	Not assessed
Rana limnocharis Boie	*Narak-hangoi*	Not assessed
REPTILES		
Rhabdop bicolar Schiegel	*Ching-Kharou*	Not assessed
Hemidactylus bowringi Gray	*Chum*	Not assessed
Varanus bengalensis Daudin	*Hang-kok*	Not assessed
V. Salvator Laurenti	*Hang-kok*	Not assessed
Ophiophagus hannah	*Ishing-kharou*	Not assessed
Naja naja Kauthia Linnaeus	*Kharou (Monocled Cobra)*	Least Concern
Amphiesma stolata Linn	*Linha*	Not assessed
Natrix himalayana Gunther	*Linha*	Not assessed
N. Punetulata Gunther	*Linha*	Not assessed
Oligodon albocinctus Cantor	*Linkhak*	Not assessed
Xenochrophis piscator Schineider	*Lilabob*	Not assessed
Bungarus fasciatus Schineider	*Linkhak*	Not assessed
Python molurus bivittatus Schlegel	*Lairen (Indian Python)*	Lower Risk/Near threatened
P. reticulates Schneider	*Lairen (Oriental Rat snake)*	Not Assessed
Ophisaurus gracilis Boulenger	*Lin-makhongpanbi*	Not assessed
Boiga ochracea Walli Smith	*Naril-asangba*	Not assessed
Opheodrys doriae Boulenger	*Naril*	Not assessed
Calotes versicolor Daudin	*Numit yungbi (Changeable Lizard)*	Not assessed
C. jerdoni Gray	*Numit yungbi*	Not assessed
C. microlepsis Boulenger	*Numit yungbi*	Not assessed
C. mystaceus Dumeril & Bibon	*Numit yungbi*	Not assessed
Mabuya novemcarinata (Anderson)	*Sharit*	Not assessed
M. multifasciata (Schneider)	*Sharit*	Not assessed
Ptyas korros Schlegel	*Tanlei (Oriental Rat snake)*	Not assessed
Trionyx hurum. Gray (Lokchao river)	*Thengu-arangbi*	Not assessed
Typhlos braminus Cuv.	*Timul-napun*	Not assessed
AVES		
Acridotheres tristis tristis (Lin.)	*Chong-nga*	Not assessed
A. albocinctus Godwin A. & Walden	*Chong-nga*	Not assessed
A. focus (Wagler)	*Chong-nga*	Not assessed
Sturnus centra Superciliaris (Blyth)	*Chonga-thijabi*	Not assessed
S. malabaricus (Gmelin)	*Chonga-thijabi*	Not assessed
Dicrurus adsmiles albrictus (Hodgson)	*Charoi*	Not assessed
Upupa epops longirostris Jerdon	*Chongaraba*	Least Concern
Aecipitter badius (Gmelin)	*Khunukharang*	Not assessed
Pandion hallactus hallactus (Linnaeus)	*Khunukharang*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Treron phoenicaptera (Lathani)	*Khunu asangba*	Not assessed
Corvus macrorhynchus levaillantii Lesson	*Kwak*	Least Concern
Eudynamis scolopaceus (Linnaeus)	*Kokil*	Not assessed
Motacilla alba (Lin)	*Khambrangehak*	Least Concern
M. caspica (Gmelin)	*Khambrangehak*	Least Concern
Pcynonotus jocosus monticola (Mccl)	*Khoining*	Not assessed
P. cafer cafer (Lin.)	*Khoining*	Not assessed
Francolinus pintadaenus phayrei	*Kabo-urenbi*	Not assessed
Streptopelia chinensis (Scopoli)	*Lam-Khunu*	Least Concern
S. tranquebarica (Hermann)	*Lam-Khunu*	Not assessed
S. decaoto (Frivaldszky)	*Lam-Khunu*	Not assessed
S. senegalensis (Linnaeus)	*Lam-Khunu*	Not assessed
Treron pompadora phayarei (Blyth)	*Lam-Khunu*	Not assessed
T. bicineta (Jerdon)	*Lam-Khunu*	Not assessed
Gallus gallus spadiceus (Bonnaterre)	*Lam-Khunu*	Least Concern
Polypectron bicalcaratum bakeri Lowe	*Lamyel*	Least Concern
Otus bakkamoena maniprensis Roonwal & Nath	*Layel*	Least Concern
Tyto capensis longimembris (Jerdon)	*Maku*	Not assessed
Corcacias benghalensis (Linnaeus)	*Maku*	Not assessed
Prinia socialis Sykes	*Mayang kwak*	Not assessed
Lonchura malacca (Linnaeus)	*Mongtit*	Not assessed
L. maiabarica (Linnaeus)	*Mongba*	Not assessed
L. punetulata (Linnaeus)	*Mongba*	Not assessed
L. striata (Linnaeus)	*Mongba*	Not assessed
Centropus sinesis intermedius (Hume)	*Nong-guo-bi*	Not assessed
Halcyon smyronnsis perpul chra Madarasz	*Ngarakpi*	Not assessed
Ceryle rudis leucomclanura Reichenbach	*Orit achouba (Pied Kingfisher)*	Least Concern
Turdoides caudatus (Dumont)	*Orit achouba*	Not assessed
T. strintus (Dumont)	*Orit achouba*	Not assessed
Pellorneum ruficeps Swnisson	*Orit achouba*	Not assessed
Monticola solitarius (Linnaeus)	*Orit achouba*	Least Concern
Picoides cathpharius pyrrothorax (Hume)	*O-tubi*	Not assessed
Jynx torquilla Linnaeus	*Oophak-ohabi*	Not assessed
Buho nipalensis nipalensis Holgsin	*Oorak-maku*	Not assessed
Zosterops palpebrosa (Temminek)	*Oorit Mtlaobi*	Not assessed
Lanius excubiator (Linneaus)	*Oori Mitlaobi*	Not assessed
Saxicoloides fulicata (Linneaus)	*Robin*	Not assessed
Copsychus saularis (Linneaus)	*Robin achouba (Oriental Magpie Robin)*	Least Concern
Aegithina tiphia (Linneaus)	*Shoubeega*	Not assessed
Hirundo dauria (Lin)	*Sembrang*	Not assessed
H. concolar sykes	*Sembrang*	Not assessed
Apus affinis (J.E. Gray)	*Sembrang (House Swift)*	Least Concern
Coturnix coturnix (Lin)	*Sorbol*	Not assessed
Passer montanus (Lin)	*Sendrang*	Not assessed
Alausda gulgula (Franklin)	*Tinkhaklen*	Not assessed
Psittacula eupatria avensis (Kloss)	*Tenawa*	Not assessed
P. krameri borealis (Neumann)	*Tenawa*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
P.K. manillensis (Bechstein)	*Tenawa*	Not assessed
Emcurus schistaceus (Hodgson)	*Uchinao*	Not assessed
Francolinus francolinus (Lin)	*Urel*	Not assessed
Amaurornis phoenicurus phoenicurus(Penant)	*Uren-konthou*	Not assessed
Milvus migrans govinda . Sykes	*Umaibi*	Not assessed
Spilornis chela chela (Latham)	*Umaibi-limphabi (Crested Serpent Eagle)*	Least Concern
Saxicola caprata. (Linneaus)	*Warak Sendrang*	Not assessed
Bambusicola fytechii hopkinsonii Godwon-Austen	*Wakhrek*	Not assessed
Lophura leucomelana lathami (J.E Gray)	*Waba (Kalij Pheasant)*	Least Concern
Pavo muticus specife Shaw & Nodder	*Wahong asangba*	Not assessed
MAMMALS		
Paradoxurus hermaphrodites (Pallas)	*Chahelo manam nimbi (Common Palm Civet)*	Lower Risk
Vulpes bengalensis (Shaw)	*Keishal (Bengal Fox)*	Lower Risk
Felis bengalensis. Kerr	*Keijenlang (Leopard Cat)*	Lower Risk
Felis marmorata charl toni Gray	*Keijeng (Marbled Cat)*	Vulnerable (VU)
F. temmineki Vigros & Horsefield	*Keimu*	Not assessed
Funambulus pennati (Wroughton)	*Kheiroi-achouba*	Not assessed
Petaurista petaurista (Paslas)	*Kheiroi-apaibi*	Not assessed
Bos gaurs H. Smith	*Lamsan (Gaur)*	Vulnerable (VU)
Canis aureus Lin.	*Lamhui*	Not assessed
Felis chaus Guldenstaedt	*Lamhoudong (Jungle Cat)*	Lower Risk
Arctictis binturong (Raffles)	*Lam-ok-macha*	Not assessed
Sus scorfa Lin	*Lam-ok (Wild Pig)*	Lower Risk
Prionodon perdicolor Hodgson	*Linsang*	Not assessed
Arctictis binturong (Raffles)	*Linsang*	Not assessed
Petaurista alborufus candidulus wroughton	*Kheiroi-apaibi*	Not assessed
Panthera pardus Linn.	*Kabokei (Leopard)*	Lower Risk
Hylopetes alboniger alboniger (Hodgson)	*Kheiroi-apaibi*	Not assessed
Manis crassicaudata Gray	*Kakchenchabi (Pangolin)*	Endangered
Viverricula indica. (Desmarest)	*Moirang Sathibi macha (Small Indian Civet)*	Vulnerable (VU)
Paguma larvata (Ham & Smith)	*Moirang Sathibi (Gem-faced Civet)*	Least Concern (LC)
Arctonyx collaris Cuvier	*Nung-ok (Hog Badger)*	Near Threatened (NT)
Neofelis nebulosa macrosceloides Hodgson	*Oothak-Keijeng*	Not assessed
Golunda ellioti. Gray	*Oochi (Indian Bush Rat)*	Least Concern (LC)
Mus booduga. Gray	*Oochi*	Not assessed
Rattus manipulus kekrimus Roonwal	*Oochi*	Not assessed
Capricornis sumatraensis (Bechstein)	*Sabeng (Himalayan Serow)*	Vulnerable (VU)
Cervus unicolor equines. Guvier	*Shajal*	Not assessed
Manis pentadactyla aurita (Hodgson)	*Shaphu*	Not assessed

Scientific Name	*Local Name (Common Name)*	IUCN Status
Herpestes urva. (Hodgson)	*Sandung*	Not assessed
Marte-flavigula. (Boddaert)	*Shaji-kurangyai*	Not assessed
Ursus malayanus Raffles	*Sawom*	Not assessed
U. thibetanus Guvier	*Sawom*	Not assessed
Pteropus giganticus (Brunnich)	*Sekpi-achouba*	Not assessed
Pipistrellus coromandra. (Gray)	*Sekpi-macha*	Not assessed
P. paterculus Thomas	*Sekpi-macha*	Not assessed
Eptesicus serotinus. (Schreber)	*Sekpi-macha*	Not assessed
Elephas maximums. Linn.	*Shamu (Asian Elephant)*	Endangered
Muntiocus muntijak (Zimmermann)	*Shaji*	Not assessed
Macaca mulata (Zim.)	*Yong*	Not assessed
Hylobates hoolock (Harlan)	*Yong mu*	Not assessed

320. **Results of Field Surveys.** ***Avifauna (Birds species):*** Altogether 9 species of birds were observed during the wildlife survey in forest areas along the project road alignment. Black-headed bulbul (Pycnonotus atriceps), Black-headed yellow bulbul (Pycnonotus melanicterus), Purple wood pigeon (Columba punicea) and Batek were most commonly observed avifauna in the forest areas. The species of Blue-eared kingfisher (Alcedo meninting) were seen in forest areas adjoining to Lokchao river. Besides these birds, Purple wood pigeon (Columba punicea), Forest eagle owl (Bubo nipalensis), Tawny eagle (Aquila vindhiana), Indian golden-backed three-toed woodpecker (Dinopium javanense) were also observed.

Table 50: Birds species observed in forest area along the road section

S. No.	Common Name	Scientific Name	Location/Chainage	Remarks
1	Black-headed bulbul	*Pycnonotus atriceps*	*From Km 398+500 to Km 404+100 & from Km 407+000 to Km 410+000*	*Mostly found in forest area near agriculture fields*
2	Black-headed yellow bulbul	*Pycnonotus melanicterus*		
3	Purple wood pigeon	*Columba punicea*	*From km 404+500 to 412+000*	*Found in mixed/dense forest area*
4	Forest eagle owl	*Bubo nipalensis*	*From Km 398+500 to Km 404+100 & from Km 407+000 to Km 410+000*	Found in open forest area
5	Tawny eagle	*Aquila vindhiana*		
6	Indian golden-backed three-toed woodpecker	*Dinopium javanense*	*Near Lokchao River i.e. 400+000 to 404+100*	*Found in mixed/dense forest area*
7	Blue-eared kingfisher	*Alcedo meninting*	*Near Lokchao River i.e. 400+000 to 404+100*	Near Water bodies
8	Batek	-	*From km 404+500 to 412+000*	*Found in mixed/dense forest area*
9	Charoi	*Dicrurus adsmiles albrictus (Hodgson)*		

Source: Wildlife Field survey along proposed existing road section (Khongkhang to Moreh)

321. ***Wild animals:*** The transects no. 1, 2, 3, 4 & 5 were laid along the proposed alignment in YLWLS Forest area to survey the signs of wild animals' movement. In this area signs of animal (footprints & fresh droppings) at transect line no. 2 & 3) of barking deer/shaji (Muntiocus muntijak) and droppings of wild pig (Sus scorfa) at transect line no. 4 were observed. There no animal sign (footprints & droppings) were found in transect line no. 1 & 5, which was near to human settlement on existing road alignment after village Khongkhang & Kudhengthabi, respectively. The transect no. 2, 3 & 4 were laid down in the Core zone -1, while transect no. 1 & 5 were studied in the buffer zone of YLWLS. The details of wild animals observed are presented in Figure 33 and Table 51.

Deer Footmark in Transect No. 2 along Lokchao River

Fruit bearing tree food for wild animal near Lokchao River

Animal (deer) footmark in Transect No. 2 along Lokchao River

Animal footmark in Transect No. 3 local stream of Lokchao River

Animal (wild pig) footmark in Transect No. 4

Bamboo forest habitat of wild pig in Transect No. 4

Figure 33: Animal signs recorded in Transect survey in the YLWLS area along the proposed alignment

Table 51: Details of wild animals observed during survey

S. No.	Common Name *(Local Name)*	Scientific Name	Family	Identification	Location
1	Barking Deer *(Saji)*	*Munitacus muntjak*	Cervidae	F & P	TL-2 & 3
2	Wild Pig *(Wild Boar)*	*Sus scrofa*	Suidae	F & D	TL-4

Note: Identification: V=Direct Sighting, P=Pellet, F=Footprint, S=Scat, Sc=Scent, D=Digging
Source: Wildlife Field survey along proposed existing road section (Khongkhang to Moreh)

322. ***Animal movement tracks:*** In between chainage km 405+400 to 405+900 of proposed alignment there was possible movement of wild animals (barking deer, cat & wild pig) across proposed alignment as animals track from hill towards local stream (water source) was found with less slope area of the forest. In this region is buffer zone and Core Zone-I of YLWLS protected forest area with minimum human movement due to no track in this region.

323. As per local community and forest officer observations there was movement of barking deer and wild pig in between chainage km 408+500 to km 408+600.

324. In YLWLS protected forest area at km 404+000 to 404+200 of proposed alignment there was possible movement track across the road section mainly for reptile and amphibains. This region has Lokchao River to serve as water source for wild animal.

325. In Kudhengthabi village boundary under Core Zone-1 forest area of YLWLS possible route of wild animal movement from hills to fields across alignment at chainage km 413+000 to km 413+300. As per local community from Kudhengthabi settlement there was a movement track for wild animals in this area but with human settlement and security check point, wild animals movement route does not exist anymore.

326. Locations of the animal tracks and different wildlife habitats are shown on map in Figure 34.

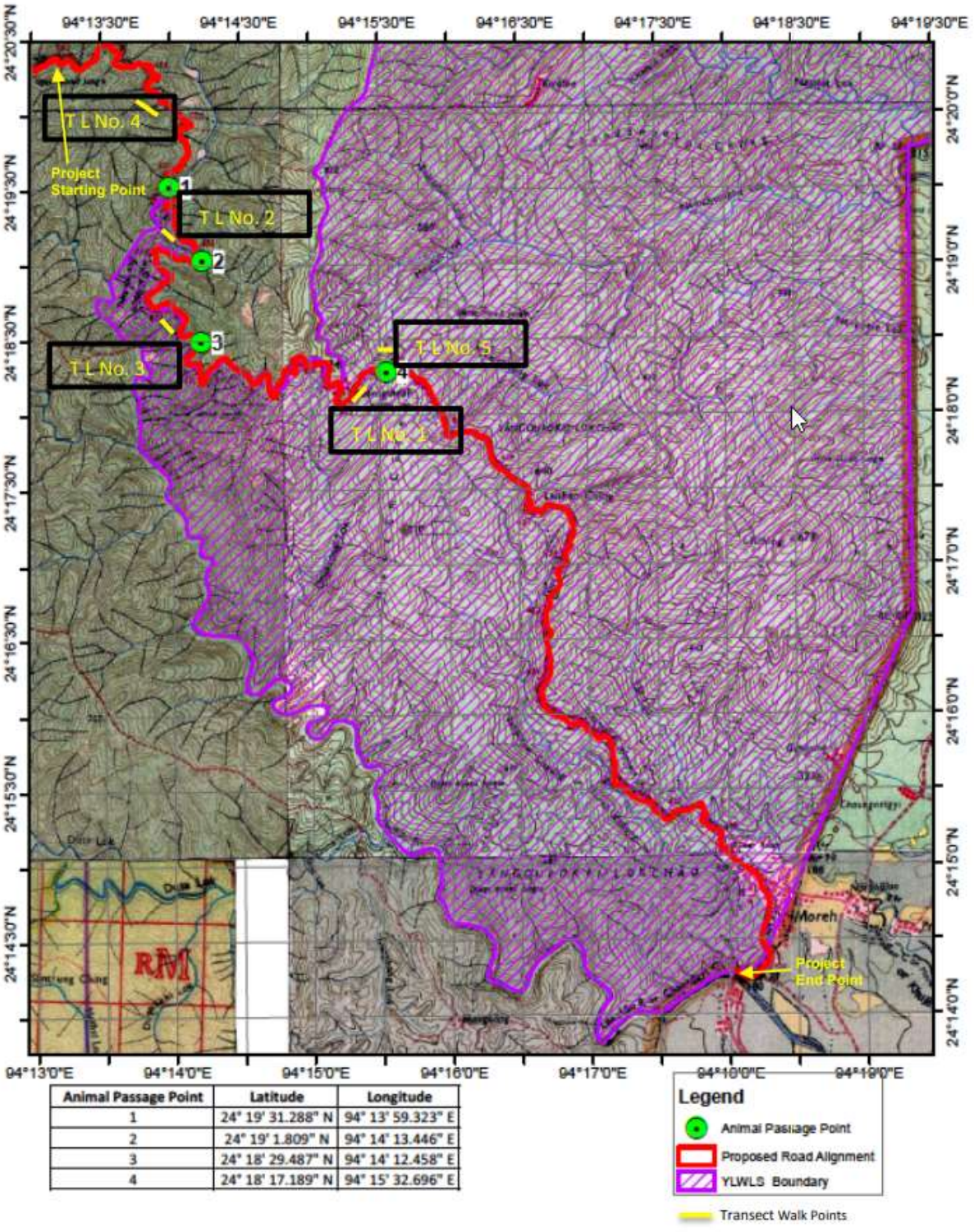
Table 52: Locations of possible animal movement tracks crossing proposed alignment

Animal tracks from km 404+000 to 404+200 (Lokchao River) possibly for reptiles & amphibians

Possible animal track (deer & wild cats) during rainy season across alignment at km 405+700 to 405+900

Route movement for between chainage at Km 408+500 to km 407+600

Possible movement route for wild boar (pig) from hill to agriculture fields between chainage km 413+000 to km 413+300



Animal Passage Point	Latitude	Longitude
1	24° 19' 31.288" N	94° 13' 59.323" E
2	24° 19' 1.809" N	94° 14' 13.446" E
3	24° 18' 29.487" N	94° 14' 12.458" E
4	24° 18' 17.189" N	94° 15' 32.696" E

Figure 34: Animal movement Tracks and Locations of transact walk points along the proposed road alignment

327. **Threatened and Endangered Wild Animals**. The working plan of YLWLS recorded that the area along proposed alignment provides shelter to 13 species of wild animals listed in Schedule of Wildlife Protection (Act) 1972 of India. Of these the Pangolin (Manis crassicaudata Gray) and Shamu (Elephas maximums. Linn.) is endangered, Hog Badger (Arctonyx collaris Cuvier), Python (Python molurus bivittatus) are threatened. Sabeng (Himalayan Serow), Small Indian Civet (Viverricula indica), Gaur (Bos gaurs), Marbled Cat (Felis marmorata charl toni Gray) are considered vulnerable. Least concerns animals list includes Barking deer (Muntiacus muntjak) and Wild pig (Sus scrofa). Table 53 present the list of wild animals reported in the project affected forest area that are listed in IUCN red list and in the Schedule of the Wildlife Protection (Act) 1972 (GoI).

Table 53: List of Wild Animals reported in the Project affected Forest Area listed in IUCN

Scientific Name	***Local Name (Common Name)***	**Category**	
FISHES		**Schedule list of Act 1972**	**IUCN Status**
B. barnoides Vinciguerra	*Ngawa*	-	Least Concern
Badis badis (Ham.)	*Nga-Sakthibi*	-	Least Concern
REPTILES			
Naja naja Kauthia Linnaeus	*Kharou (Monocled Cobra)*	II	Least Concern
Python molurus bivittatus Schlegel	*Lairen (Indian Python)*	II	Lower Risk/Near threatened
AVES			
Upupa epops longirostris Jerdon	*Chongaraba*	-	Least Concern
Corvus macrorhynchus levaillantii Lesson	*Kwak*	-	Least Concern
Motacilla alba (Lin)	*Khambrangehak*	-	Least Concern
M. caspica (Gmelin)	*Khambrangehak*	-	Least Concern
Streptopelia chinensis (Scopoli)	*Lam-Khunu*	-	Least Concern
Gallus gallus spadiceus (Bonnaterre)	*Lam-Khunu*	-	Least Concern
Polypectron bicalcaratum bakeri Lowe	*Lamyel*	-	Least Concern
Otus bakkamoena maniprensis Roonwal & Nath	*Layel*	-	Least Concern
Ceryle rudis leucomclanura Reichenbach	*Orit achouba (Pied Kingfisher)*	IV	Least Concern
Monticola solitarius (Linnaeus)	*Orit achouba*	-	Least Concern
Copsychus saularis (Linneaus)	*Robin achouba (Oriental Magpie Robin)*	-	Least Concern
Spilornis chela chela (Latham)	*Umaibi-limphabi (Crested Serpent Eagle)*	-	Least Concern
Lophura leucomelana lathami (J.E Gray)	*Waba (Kalij Pheasant)*	-	Least Concern
MAMMALS			
Paradoxurus hermaphrodites (Pallas)	*Chahelo manam nimbi (Common Palm Civet)*	I	Lower Risk
Vulpes bengalensis (Shaw)	*Keishal (Bengal Fox)*	-	Lower Risk
Felis bengalensis. Kerr	*Keijenlang (Leopard Cat)*	I	Lower Risk
Felis marmorata charl toni Gray	*Keijeng (Marbled Cat)*	I	Vulnerable (VU)

Scientific Name	*Local Name (Common Name)*	Category	
FISHES		**Schedule list of Act 1972**	**IUCN Status**
Bos gaurs H. Smith	*Lamsan (Gaur)*	I	Vulnerable (VU)
Felis chaus Guldenstaedt	*Lamhoudong (Jungle Cat)*	-	Lower Risk
Sus scorfa Lin	*Lam-ok (Wild Pig)*	III	Lower Risk
Panthera pardus Linn.	*Kabokei (Leopard)*	I	Lower Risk
Manis crassicaudata Gray	*Kakchenchabi (Pangolin)*	I	Endangered
Viverricula indica. (Desmarest)	*Moirang Sathibi macha (Small Indian Civet)*	-	Vulnerable (VU)
Paguma larvata (Ham & Smith)	*Moirang Sathibi (Gem-faced Civet)*	-	Least Concern (LC)
Arctonyx collaris Cuvier	*Nung-ok (Hog Badger)*	I	Near Threatened (NT)
Golunda ellioti. Gray	*Oochi (Indian Bush Rat)*	-	Least Concern (LC)
Capricornis sumatraensis (Bechstein)	*Sabeng (Himalayan Serow)*	I	Vulnerable (VU)
Elephas maximums. Linn.	*Shamu (Asian Elephant)*	I	Endangered

Source: Working plan for YLWLS and Wildlife Protection act, 1972 (Schedule list)

328. Of these species of wild animals Jungle Cat, Barking deer (Muntiacus muntjak) and Wild pig (Sus scrofa) are recorded during site survey in the forest areas.

329. **Community Discussion**. Discussions with local community chiefs and local peoples were carried out to know about sighting of wildlife in the forest around their settlements. The wildlife listed in the categories of IUCN and schedules of Wildlife Protection (Act), 1972 were specifically targeted in discussion and information was collected about location of sighting, possible movement tracks, habitats and season of sighting. Barking deer, jungle cat, wild pig and langur are animals frequently sighted in the forest. Community informed that the frequency of sighting of animals (Leopard Cat, Golden Cat, Monitor lizard, Porcupine and Pangolin) is decreasing in the region.

E. Socio-economic Environment

330. **Demography**. Manipur is one of the sisters' states in north eastern state a population of 2.38 million with about more than 75 percent of the population living in the rural areas. The human population density is very less (only 107 persons/km2) compared to 149 persons/km2 for the north eastern region. Sex ratio is 978 against the 936 in the region. The demographic feature of north eastern states is unique in that there are more than 29 recognized tribes, which inhabit mostly the hill areas and each with distinct culture, ethos, and traditional knowledge systems. The major minority groups in the state namely Aimol, Anal, Angami, Chiru, Chothe, Hmar, Kabui, Kacha Naga, Mizo, Mao, Lusai etc. The majority of the people survive on subsistence economy based mainly on the agriculture, supplemented with limited horticulture, animal husbandry, crafts/handloom, etc. Table 54 presents the demographic features of the state and the North eastern region.

Table 54: Demographic Features of Manipur and North Eastern Region as per 2011 census

State	Area (sq.km)	Population			Density	Sex Ratio
		Rural	Urban	Total		
Manipur	22327	1818224	570410	2388634	107	978
NE Region	262179	33008703	5809395	39041167	149	936
All India	3287263	741660293	285354954	1027015247	312	933

Source: 1) Census of India, 2001 (Provisional), 2) Statistical Abstract of State Governments, Directorate of Economics and Statistics, 3) Where do we stand in 2003, Meghalaya & North East and India & The World, Directorate of Economics & Statistics, Government of Meghalaya

331. The Net State Domestic Product in the year 2017-18 was Rs.231670 million, with annual growth of around 10.21 percent from year 2011-12 to year 2017-18. Per capita income at constant prices in 2017-18 was Rs.58501 (against Rs.79882 for the country as a whole). Agriculture continues to be a major contributor for the economy.

332. The progress on industrial front has been constrained by many factors particularly the lack of appropriate infrastructure, lack of raw materials and trained manpower.

333. **Land Resources.** The area available for land utilization in the state is about 2010 thousand ha. out of the total geographical area of 2230 thousand ha. This means about 90 percent of the area in the state in available under various land uses. Major portion of the land use is under forest cover covering about 86 percent of the land use area. About 11.59 percent area is under gross cropped area. Agriculture is the second major land use in area. The area under various land uses in the region is presented in the Table 55.

Table 55: Land use pattern in North East Region (Figure in thousand hectare)

State	Reporting area for land utilization	Forest area	Not available for cultivation	Other uncultivated land excluding fallow land	Fallow land	Gross cropped area	Net area sown	Area sown more than once	Total
Manipur	2010	1742	27	8	0	0	233	0	2230
NE Region	23214	11589	3277	1357	870	3226	1178	2048	26216.6

Source: www.neportal.org (Directorate of Economics and Statistics, NE states and NEC, Shillong).
Statistical Abstract (2015), Sikkim, Directorate of Economics and Statistics, NE States.

334. **Agriculture and Forestry.** Agriculture is the mainstay of the people. It contributes major shares in the state domestic product and provides employment to about 65 percent of total working force in state. Total net sown area is 230,000 hectares. Rice is principal food grain followed by maize and millets. An annual production of 591,000 tons of rice was registered in 2011-12. Sugarcane is another cash crop.

335. The socio-economic life of people centres on the forests. As mentioned earlier they cover about 70 per cent of the total geographic area of the state. Wide varieties of bamboos, orchids, aromatic and medicinal plants are found in the State.

336. **Fisheries**. Though the state has no marine fishery, it has vast inland fishery resources like ponds, tanks, naturals lakes, marshy areas, swampy areas, rivers, reservoirs, submerged cropped land, paddy field etc. The largest source of fish is the Loktak Lake. The production of fish in Manipur for the year 2011-12 was estimated to be 22,291 thousand tones.

337. The important fishes commonly found in the region's plain and river basins are *Catla catla, Labeo rohita, Labeio calbase, Cirrihinus mirigale, Clarius, batrachus, Rita rita, Heteropneuptus fonilis, Notopterus nontopterus, N. Chitala, Macrobrachum rosenbergii, M. malconsoni, M. Chapral, Channa punetatus C. gaehua, C. striatus.*

338. **Transportation**. Transportation system is a key factor in the socio-economic development of any state. There is practically no railway network in the state, the construction work for the railway section from Jiribam –Tupul-Imphal is being implemented. Two rail heads – one at Dimapur in Nagaland (215 km away from Imphal) and the other at Jiribam (225 km away from Imphal) serves the state. The state has one airport at Imphal, which connects up with the rest of the country. Waterways are also not feasible. Roads, therefore, constitute the only means of transport system in the state for movement of men, materials and services within and outside the state. The total road network stands at around 19252 km, of which 8795 km are unsurfaced roads.

339. **Mineral Resources.** The state has endowed with mineral resources. The main mineral reserves in the state includes limestone (14.8 thousand tons), clay (2.5 thousand tons), and

chromite (0.1 thousand tons). For exploiting the mineral resources, it is important to provide a good road and rail infrastructure. Mineral resources of the Manipur are shown in Figure 35.

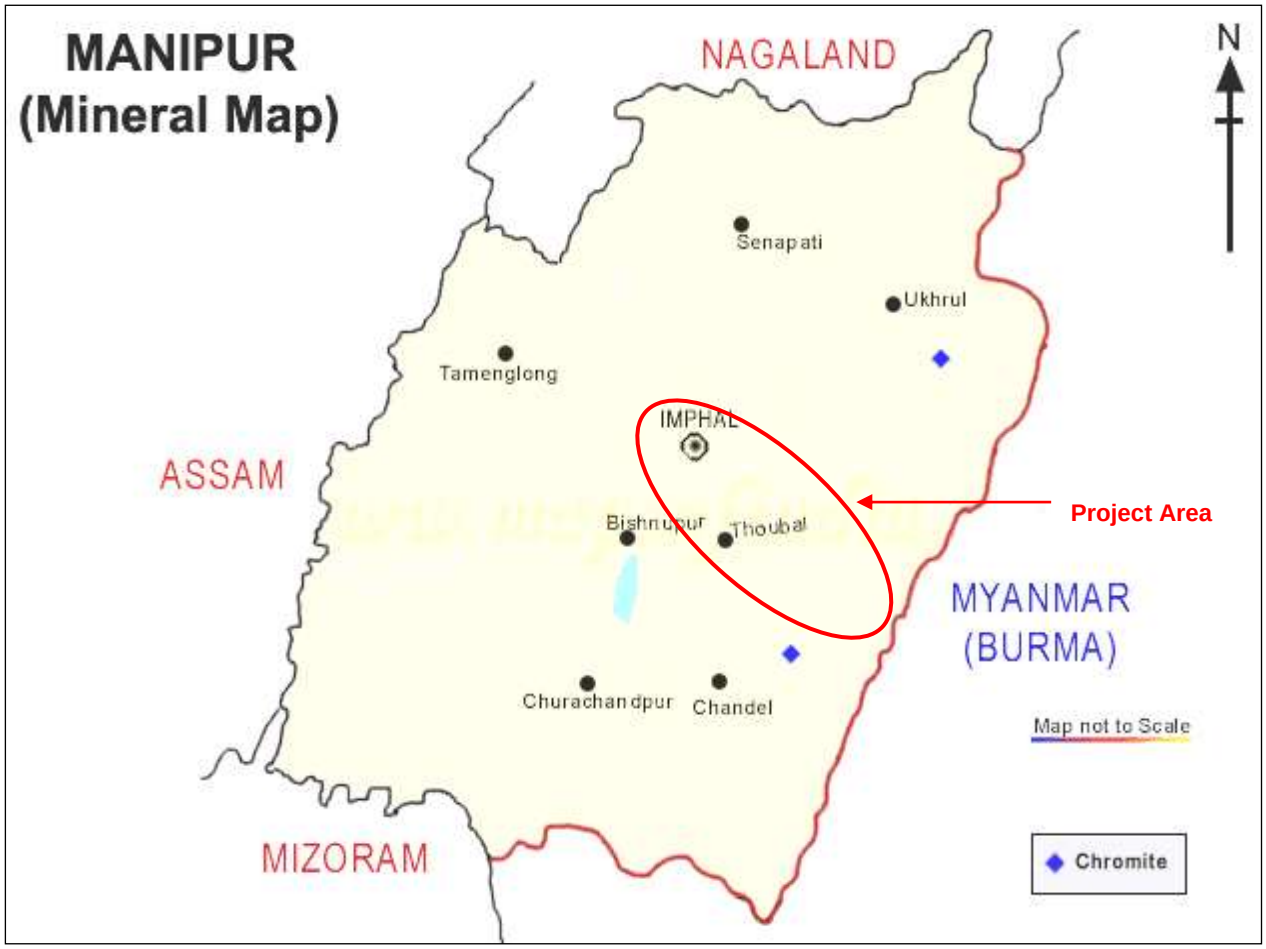


Figure 35: Mineral Map of Manipur State

340. **Industrial Situation.** The State is industrially backward compared to the rest of the country. There is no large-scale industry. It has 1 industrial estate, 12 medium scale and 12071 small scale units (2011) giving employment to about 3 lacs people. Lack of roads, power and transport are the major constraints impeding the industrial growth.

341. **Aesthetic and Tourism.** The state has immense scope for promotion of tourism. It has a salubrious climate, exotic greenery and rich flora and fauna besides the rich culture. Keibul Lamjo National Park, the only habitat of Brow Antlered Deer, on the bank of Loktak Lake (the biggest freshwater lake in north eastern India), Khongjom War Memorial are few major tourist spots in the region. During the year 2011-12, 749 foreign tourists and 134541 thousand of domestic tourists came to the state. The state offers unique opportunity for eco-tourism development.

342. **Cultural Resources.** The state has great cultural value. Festivals and cultural activities are being celebrated throughout the year in the state. The department of arts and cultural has taken various activities like promotion of art and culture, preservation of old and historical monuments. The state has great cultural value for Buddhism. To promote and preserve the rich cultural heritage of the state, the department has been organising a number of programmes annually.

343. **Energy and Electric Power Potential.** The state has an installed capacity of 200 MW of power including the power from central sector. It is just able to meet the current demand. With increase in socio-economic development, more power will be required. It is, therefore, necessary to increase power availability in the state.

344. **International Trade & Commerce.** The north eastern region has the potential to emerge as a strategic base for domestic and foreign investors to tap the potential of the contiguous markets of China, Myanmar, Lao PDR, Nepal, Bhutan and Tibet. This calls for converting the unauthorised trade into authorised trade, at the policy level as well as at the ground level. The BIMST-EC (Bangladesh-India-Myanmar-Sri Lanka-Thailand Economic Cooperation) initiative is creating an enabling environment for rapid economic development through identification and implementation of specific cooperation projects in the sectors of trade, investment and industry, technology, human resource development, tourism, agriculture, energy, infrastructure and transportation.

345. The various physical features along the project road are described in Table 56.

Table 56: Physical /Sensitive Features along the project road

Location / Chainage (Km)	Features
395+680 -396+000	Starting point, Khongkhang settlement, Bus Shed, hilly terrain.
396+000-404+400	Hilly terrain and forest mixed with agriculture fields
404+400-404+500	Lokchao River
404+500 – 404+700	Lokchao settlement, hilly terrain
404+700 – 405+700	Hilly terrain (village boundary of Lokchao) and mixed type of forest mainly bamboo and patches of agriculture fields
405+700-412+300	Hilly terrain (village boundary of Kudhengthabi) and mixed type of forest mainly bamboo and patches of agriculture fields
412+300-413+00	Kudhengthabi settlement, waiting shed, public toilet, community hall, aganwadi center, church and hilly terrain
413+00- 414+400	Hilly terrain (village boundary of Kudhengthabi) and forest area mixed with agriculture fields
414+400-414+700	Check point and Market area Kudhengthabi village
414+700-415+300	Hilly terrain (village boundary of Kudhengthabi) and forest area mixed with agriculture fields
415+300 -415+800	T.M. Zomunnuam settlement, waiting shed, Community hall, Primary School and hilly terrain with agriculture field and thin settlement
415+800-418+000	Hilly terrain (village boundary of T.M. Zomunnuam) and forest area mixed with agriculture fields
418+000-419+300	Hilly Terrain (village boundary of T.M. Zomunnuam) with Army area
419+300-425+500	Project road passes through Moreh town with hill/rolling terrain with pockets of forests on hillocks with residential, institutional and commercial structures on both sides.

V. ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

A. Introduction

346. This chapter presents key environmental issues associated with various aspects of the proposed project. The environmental impacts caused due to the development of the project road sections can be categorised as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are induced directly by the project whereas the secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. Interaction of the project activities with environmental attributes is presented as Activity-Impact matrix in Table 57.

Table 57: Activity-Impact Identification Matrix

Sl. No.	Activities	Type of Impact								
		Air	**Water**	**Noise**	**Flora**	**Fauna**	**Drainage**	**Soil**	**Topography**	**Social**
1.	Labour camp activities		- ve/t							- ve/t
2.	Quarrying	-ve/t		- ve/t	- ve/t		- ve/t		- ve/p	
3.	Material transport and storage	- ve/t		- ve/t						- ve/t
4.	Drilling, blasting and hill cutting	- ve/t		- ve/t	- ve/t	- ve/t		- ve/t	- ve/t	
5.	Earthwork						- ve/p	- ve/t	- ve/t	
6.	Pavement works	- ve/t	- ve/t	- ve/t	- ve/t			- ve/t	- ve/p	
7.	Use of construction equipments	- ve/t	- ve/t	- ve/t		- ve/t				- ve/t
8.	Plantation	- ve/p		- ve/p	- ve/p					
9.	Drainage work						- ve/p			- ve/t
10.	Culvert and bridge construction		- ve/t	- ve/t			- ve/p			- ve/t
11.	Stripping of top soil							- ve/p		- ve/t
12.	Debris generation						- ve/t	- ve/t		- ve/t
13.	Oil and grease							- ve/t		- ve/t
14.	Construction in forest and sensitive areas	- ve/t	- ve/t	- ve/t	- ve/t	- ve/t	- ve/p	- ve/p	- ve/p	
15.	Vegetation clearing and removal of trees	- ve/t			- ve/t	- ve/t			- ve/t	- ve/t

Notes: t – temporary, p – permanent. Impact indicated in bold letters indicates significant impacts.

347. Identification and assessment of the potential environmental impacts are based on secondary information supplemented by field visits. Impacts on various environmental components have been assessed at four different stages, namely:

- the project location;
- design and pre-construction;
- construction; and
- operation stages.

348. A few short-term and long-term adverse effects, mainly at the construction and operation stages, are, nonetheless, anticipated. These can be kept in check through proper planning and

adopting environment friendly road construction methods and the appropriate regulatory measures.

B. Identification and Assessment of Impacts

349. **Positive Environmental Impacts due to improvement of subproject road sections**. The positive impacts expected from the improvement of the Khongkhang-Moreh (AH1) road section includes:

- education in travel time and lower vehicle operating cost will reduce fuel consumption and emissions of pollutants,
- enhance the trade and commerce between India and Myanmar and other ASEAN regional countries, and
- provide better access to other parts of the state and Myanmar by connecting National Highway 102 (Asian Highway 1) which is major routes connecting these districts with other parts of State and also international border to Myanmar at Moreh.

350. **Adverse Environmental Impacts due to improvement of subproject road sections.** The adverse environmental impacts anticipated from the improvement of the project road section are:

- cutting of road site trees that falls within formation width i.e. 10-30 m may reduce the ecological balance of the area and also increase soil erosion problem.
- road may become a barrier to the natural movements of wildlife particularly in 9.100 km length of project road bordering through core zone of Yangoupokpoi Lokchao Wildlife Sanctuary and forest areas.
- noise, air and water pollution and disposal of construction waste, during construction, will adversely impact both local residents and wildlife. These latter effects should, however, only be temporary/reversible.
- a number of quarries and other sources will be established which will change the landscape. However, the operation of quarries is an independent and already regulated activity. Adverse impacts on water quality of river (Lokchao) in the form of silt deposition and runoff during construction are expected. However, this is short term and will be taken care of by controlled construction activities.
- improvement on existing road and construction of bridges, although limited, may enhance soil erosion, landslips and reduce the micro-level ecological balance of the area. Construction may also disturb the habitation of fauna living in this area. These should, however, be only temporary/reversible effects. The improvement will also require the cutting of about 2013 trees.
- Minor impacts of noise and air quality for those now living and workings close to the project road (mainly at Khongkhang, Lokchao, Khudengthabi and Moreh) will deteriorate during the construction period and afterwards during operation.

C. Impacts Related to Project Location, Preliminary Planning and Design

351. **Forest Clearing and Tree Felling.** The project road section (except Moreh town) passes though hilly terrain with forest areas and patches of agriculture fields. About 29.516 km length of subproject road passes through YLWLS. Since, improvement work will be kept limited to the available ROW, minimal adverse impacts due to diversion of forest land. Nonetheless, land clearing will involve cutting of about 2013 trees. Problem of soil erosion is expected in some locations. To minimize loss of trees, the following mitigation measures have been /will be adopted during the detailed design and construction stage of the project:

- widening proposal considered option with minimal tree cutting.
- Widening is restricted to minimum width in the length passing through YLWLS. Widening is proposed on the other side of the YLWLS.

- Adequate measures are included in the design to minimize impacts on wildlife.
- Land stabilization measures were included in identified areas prone to erosion.
- strictly enforce the environmental conditions put as part of the environmental clearance by the MoEFCC and SPCB.
- adopting Environmental Friendly Road Construction (EFRC) methods.

352. The improvement of the proposed road is largely confined on the existing alignment. At some locations, improvements to the geometry may involve cutting, filling, and the need to cut vegetation along most of the project road length. This will have more significant impact and this matter is discussed in the sections which follow.

353. In forest areas (about 29.516 km on AH road section), it is particularly important that the road improvement works should minimise environmental impacts from inadequate drainage and/or slope failures and should assist in maintaining, or repairing, forest cover. Wildlife should be protected, and hunting will be restricted. Table 58 list out the locations of the forest area along the project road.

Table 58: Sections of Subproject Road Passing through Reserve /Protected Forest

Sl. No.	Name of Reserve / Protected Forest	District	Chainage	
			From (Km)	To (km)
1.	Yangoupokpi Lokchao Wildlife Sanctuary (Valley side)	Tengnoupal	395.680	425.196

354. Based on the tree inventory carried out during the field surveys in 2019, the total number of trees to be cleared along AH1 (Khongkhang-Moreh) section is 2013. Table 59 present details of the trees to be cut due to proposed road improvement. As per compensatory afforestation requirement, the tree plantation will be done three times of tree cutting (1:3 of tree cutting). At sensitive locations such as schools, colleges and hospitals along the project road noise barrier shall need to be provided.

Table 59: Detail of trees within formation width of the AH1 Khongkhang-Moreh

Section	Chainage (km)		Left Hand Side (LHS)	Right hand Side (RHS)	Type of Trees[11] (local name)
	From	To			
Khongkhang to Lokchow Bridge	395.680	404.130	297	314	Nasik, Boroi, Jam, Baraphi, Heibong, Tairm, Mango, Heikha, Neem, Sorokhi, Tumitla, Khongnang, Heinou, Konbla, Uyumg, Pungton, Jamun, Yongchak, Theibong, Heirik, Ouchan, Teak, Sayee, Kaygay, Kwa, Tera, Thibong, Qurei, Hawaizar Mana Panbi, Lairik Heibi, Kongong Thopki, Bhushlei
Lokchow Bridge to Kundhanthabi	404.130	413.230	443	204	
Kundhanthabi to Moreh	413.230	425.196	416	339	
Total trees to be cut (Nos)			**1156**	**857**	
			2013 Trees		

Note**:** The exact number of trees to be cut might vary from these figures. Joint inspection with forest range officers shall be carried out to estimate the number and type of trees to be cut by improvement proposals. In case of any change, numbers will be updated, and accordingly compensatory plan be updated.
Source: Field Survey carried out by the Consultant Team, 2019

[11] None of these specific are recorded in the IUCN red data list of endangered / protected species. Local forest department were consulted and they also confirmed that none of these species are classified as rare or endangered.

355. The compensatory plan is being developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done three times of tree cutting (1:3 of tree cutting) as detailed in Table 60.

Table 60: Details of Trees to be Cut and Planted

Sub-project	Road Section (From / To)	Length (km)	Tree to be cut in the project road	Proposed tree to be planted in the project area in consultation with Forest Dept. (1:3 of tree cutting)
AH 1 (Main Alignment)	Khongkhang to Moreh road section along Asian Highway 1	29.516	2013	6039

356. **Borrow Pits and Quarries Operation.** There is a need to establish construction camps and related facilities, such as borrow pits and quarries. These must be located in environmentally sound and socially safe areas. It is expected that construction materials for the road works will be mined mostly from approved quarries. The following criteria is applied for locating the borrow areas:

- borrow areas should obtain necessary clearances including environmental clearance as required under EIA Notification 2006 and other GOI regulations;
- borrow areas are not established in ecologically sensitive areas;
- villagers are consulted in regard to the design and location of all borrow areas – these should ensure the safety of local communities and, if possible, should incorporate beneficial post construction features for the villages;
- located away from the road and hill slopes as well as settlements facing the road, so as to minimise visual impacts;
- In case of protected areas/ reserve forest areas, construction facilities such as temporary workers camp, hot mix plants, and concrete batching plant and stone crushers should not be established in stretches that passes through reserve / protected forests. Local forest department / village forest management committees should be consulted before locating these temporary project facilities;
- construction camps for labourers should be located at a suitable distance away from settlements in accordance with relevant national or state regulations such as the State Pollution Control Board and in a manner to avoid stressing local resources (water, electricity etc.) and 1 km away from forest/protected areas;
- living accommodation and ancillary facilities should be erected and maintained to standards and scales approved by the Engineer-in-Charge; and
- toilets and urinals should be provided in accessible places away from the asphalt plant and mixing yard.

357. **Cultural Heritage**. There are no adverse impacts anticipated on historical places/monuments. However, there are few small shrines along the road. Care must be taken to avoid any damage to these structures. Earthworks, as associated with the road construction/improvement works, or deriving from secondary sites such as quarries or borrow pits, may reveal sites or artifacts of cultural/archaeological significance. In the event of such discovery, the concerned authorities should be informed and the requirement to take such action should be incorporated in contract documents.

358. **Other Impacts deriving from the Project Planning and Design Process.** During preliminary planning and design of this project, the Consultant has taken into account the need for:

- optimum siting and control of quarries;
- reduced incidence of slope failures due to inadequate drainage;
- providing adequate culverts/drains;

- providing side-drainage structures;
- mechanised construction methods and thereby, for example, reduced use of firewood for heating bitumen;
- maximising safety and thereby reducing traffic accidents;
- reducing travel times and, thereby, fuel consumption and emissions;
- adequate signages for wildlife protections,
- increased accessibility for residents to education and health facilities, markets etc., and for others who might come for tourist or other purposes; and
- improving the socio-economic conditions of residents in the project areas of influence.

359. As part of the engineering works for this work, the following guiding principles have been used in determining the alignments:

Environmental Issue	Measures taken
Alignment	Final alignment has been determined so as to minimise land take, air pollution and the impact on people and animals and to avoid unfavourable geological condition and cultural relics.
Balancing cut and fill	The design attempted to equalise cut and fill. The centreline has been aligned so that on all slopes below 60 degrees, half cut and half fill is achieved.
Soil erosion	Temporary and permanent drainage systems have been designed to minimise the soil erosion.
Dust and air pollution	Borrow sites, waste disposal sites and asphalt mixing sites have been identified – keeping in mind environmental issues such as dust.
Cultural heritage	Any archaeological sites identified along the alignment should be excavated prior to construction.
Wildlife Habitat	Care has been taken in preservation of wildlife and construction workers should be educated on wildlife protection.

D. Environmental Impacts - Construction Stage

360. **Permits and Clearances.** As a requirement of Environmental Impact Assessment (EIA) Notification, 2006, by Government of India, any development activities should not be taken in any part of the Country unless it has granted environmental clearance by the Ministry of Environment and Forests, Government of India.

361. Highways are classified as one of the projects, listed in said notification, which require prior clearance. However, an amendment to this notification clarifies, that the highway improvement projects are excluded from purview of this notification. Some of the relevant applicable sections are:

(i) As per provisions of the EIA Notification 2006 (amended in 2009, 2011 and 2013), all national highway expansion projects that are longer than 100km and involve additional right-of-way or land acquisition greater than 40m on existing alignment and 60m on realignment or bypass fall under category A and require environmental clearance from the MOEFCC at the central level. Since the total length of the Khongkhang-Moreh Road Section of National Highway-102 (AH1) is less then 100 km (29.516km), it does not fall under the purview of EIA notification. Therefore Environmental Clearance from MoEFCC is not required for this subproject.

(ii) Further, under the same notification, it is stated that any category B project will be treated as category A if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972; (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time; (iii) Notified Eco-sensitive areas; and (iv) interstate boundaries and international boundaries. Although the subproject is located in a protected area,

the road is a national highway and is less than 100km in length hence it doesn't trigger the requirements of the EIA Notification of 2006 A categorization.

(iii) As per the Forest Conservation Rules (1981, amended 2003) a forestry clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly, timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process. Both the subprojects pass through forest areas and may require diversion of forest land, therefore forest clearance is required as per Government of India requirements.

(iv) As per the Wildlife Protection Act, Clearance from National Board for Wildlife (NBWL) is required for this subproject as the road section is passing through Yangangpokpi Lokchao Wildlife Sanctuary (YLWLS). About 29.516 km road length on NH section passing through YLWLS.

(v) Cutting of trees in non-forest land require a tree cutting permit from the local forestry department. All trees cut under a project must be compensated by compensatory afforestation as required by the Forest Department.

(vi) As per Office Memorandum (OM) issued by MOEFCC on 19 March 2013 the grant of environmental clearance for linear projects including roads has been delinked from the forestry clearance procedure. Hence, after receipt of environmental clearance construction works may commence on sections/parts of a linear project that do not require forestry clearance. Construction works may commence on sections requiring forestry clearance only after receipt of the respective clearance.

(vii) Placement of construction camp sites, hot-mix plants, quarrying and crushers, batch mixing plants, discharge of sewage from construction camps requires No Objection Certificate (Consent to Establish and Consent to Operate) from State Pollution Control Board prior to establishment.

(viii) Permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective by them.

362. Before the start of civil works for of subproject road section the project proponent (NHIDCL) must obtain necessary clearances / permits from the regional office of the Ministry of Environment and Forest & Climate Change and State Pollution Control Board. Table 61 outlines the applicable clearances and permits and the authorised bodies that issue them along with the procedures involved. The status of the permits / clearances has also been presented in this table.

Table 61: Clearances and Permits Required for the Subprojects

Sl. No.	Clearance/ Permit	Authorised body	Procedures involved	Time involved	Responsibility	Status (as on March 2019)
1.	Forest Clearance	Regional Office of MoEFCC, Shillong	Detailed proposal in appendix specified in Forest (Conservation) Act, 1980 along with project report and necessary details of tree felling. Local division office will forward after joint verification of site and preliminary scrutiny of proposal to PCCF office for approval. Joint verification and enumeration of trees to be cut shall be done by division office and after	Approx. 6 months or more	NHIDCL	At advance stage (regional office of MoEFCC)

Sl. No.	Clearance/ Permit	Authorised body	Procedures involved	Time involved	Responsibility	Status (as on March 2019)
			approval shall be allowed to cut.			
2.	Clearance for National Wildlife Board	Chief Wildlife Warden/ National Wildlife Board	Detailed project proposal along with details of the protected areas along the project road.	Approx. 6 months or more	NHIDCL	Obtained.
3	Clearance for quarry sites and borrow areas	Department of Geology and Mines, Govt. of Manipur, Imphal / Local office of the MoEFCC for borrow area EC	Submission of application for quarry site to mining department. Department of mines and geology after scrutiny of application and consultation with forest department and revenue department together with site verifications will give approval with specific conditions.	Takes between 3 months and six months.	Contractors	To be initiated.
4	Clearance for blasting	State Mining Department, Imphal	Detailed application with blasting locations and amount of blasting shall be submitted to DoM. Mining department may issue the conditional approval.	2 to 6 months	Contractors	To be initiated.

363. Any felling of trees requires forestry clearance and appropriate permits. The procedures necessary to obtain such permits will require liaison with local territorial forestry offices and their head office in Imphal. Joint verification and making of trees to be cut is being carried out jointly with divisional forest departments of districts involved. The clearance is required for the use of surface sand and stone from the river banks from district authorities and forest office. It is imperative that all necessary clearances and permits be obtained before commencement of work.

364. **Physical Environment.** ***Topography, Geology and Soil.*** During the improvement works for the road section, the cutting of hill slope, filling, the cutting of trees, stone quarrying, and construction of structures, the micro-level topography may change. With proper planning, these topographical impacts can be kept within acceptable limits and sometimes even used to enhance local aesthetics. Any negative impacts on topography (existing or new), particularly soil erosion due to a lack of drainage facilities, will be minimised with the provision of proper drainage facilities such as culverts, causeways etc. The overall impact on topography is, therefore, anticipated to be insignificant.

365. The terrain and geological conditions of area are such that, even with reasonable care exercised during final design, during construction the interaction between proposed road features and existing land features may reveal/result in significant land instabilities.

366. During the construction phase following restrictions should be imposed:

- existing vegetation including shrubs and grasses along the road (except within the strip directly under embankments or cuttings) should be properly maintained;
- sites for quarrying, borrowing and disposal of spoils are to be confirmed according to the applicable laws and regulations in the state and the practices followed in recent/ongoing internationally funded road projects should be continued;
- controlled and environmentally friendly quarrying techniques should be applied to minimise erosions and landslides;
- blasting should not be carried out during busy periods;

- use ‘controlled blasting’ to minimize damage to the topography, geology and soil; and
- cut material should be disposed of in suitable depressions.

367. It is also important to:

- maintain adequate vegetative cover above and below the road;
- maintain the natural course of water bodies (that is as far as possible) and avoid throwing debris into stream courses;
- construct proper drainage structures to avoid erosion; and
- minimise the construction of hair-pin bends that are close to each other: as this often adds to instability.

368. Given the existence of high slope and high rainfall in almost entire project area and weak geology in some areas, it is inevitable that some sites will face problems of erosion, mostly debris slides.

369. ***Erosion, Silt Run-Off and Landslides***. Construction work in Khongkhang to Moreh section of the road section will be virtually through mountainous terrain with steep and unstable slopes. Much of areas in this section is geologically young, resulting in soft/fragile substrates. Another complicating factor is the high monsoon rainfall throughout most parts of the project road. These factors mean that project area conditions are amongst the most difficult in the region for road construction. Landslides frequently caused by inappropriate construction techniques, slope instability, and inadequate drainage are major problems and are associated with all types of road construction. It should be noted that a significant number of landslides that occur in the vicinity of road are caused by factors/features only indirectly linked to the road itself – frequently, irrigation channels, logging, quarrying and cultivation practices. To control these, following measures are suggested by local environmental authorities:

- logging immediately above road should be restricted to reduce erosion/landslide potential;
- quarrying along road ROW should be restricted;
- excavated material should be properly disposed of and not simply dumped downhill;
- adequate reclamation (e.g. fertilisation and reseeding) along denuded ROW should be implemented;
- particular care should be given to providing adequate drainage;
- careful supervision/training of blasting technicians is required; and
- to the largest extent possible, care should be taken to avoid sacred and religious sites i.e. km 412+450 (church), Ima Ima Kondong Lairembi village (temple).

370. Previous studies by the Border Road Organisation and CRRI indicate the need to incorporate the following measures:

- balance cut and fill: with a prohibition on the dumping of spoil over the road edge – thus minimising erosion;
- more frequent use of retaining walls - to control landslips;
- improved drainage - again so that erosion is minimised;
- controlled blasting in rock-cut areas - to minimise erosion; and
- use of bioengineering technique for slope protection: use of native species of plants and shrubs for slope stabilisation.

371. Unstable, uncompacted road embankment materials and exposed material can result to soil erosion, clogging of side drains and the spill-over of rainwater runoff onto the road surface and down slopes. These cause landslides and hinder traffic movement. These problems can be mitigated by maintaining the batter gradients as specified in the MoRTH guidelines. The existing vegetation on slopes outside the immediate area of construction must remain undisturbed during construction and/or upgrading. Bioengineering techniques will be used to prevent barren slopes and to stop soil erosion and to protect the animals from grazing animals. Support structures will be installed where slope failures are anticipated or may have occurred previously. Slope failures should be monitored, and remedial actions initiated at the earliest possible time.

Figure 36: Landslide Prone Location along Imphal - Moreh subproject Road

372. Construction involving rock/soil cutting of hillsides may render hill slopes unstable and increase vulnerability to landslides. Blasting of rocks may also result in landslides.

373. All hill/soil cutting areas should be revegetated as soon as construction activities are completed. At more vulnerable locations, selected bioengineering techniques should be adopted - a combination of bioengineering techniques and engineering solutions such as rock bolting and the provision of bank drains may be required. Solutions will, however, need to be individually tailored by the geo-technical/ environmental experts of the Supervision Consultant. Figure 36 below shows the typical landslide zone along the project road.

374. Excavation and earthworks should be undertaken during the dry season when the risks from erosion and silt run-off are least. The materials used for surface dressing will consist of aggregates and gravel which do not contain silt. Internationally accepted best practice engineering approaches to minimise landslide and erosion risks and silt run-off will be incorporated into contract documents and monitored during construction.

375. In order to minimise erosion, silt run off and landslides, it will also be important to:

- ensure all embankment grades are not too steep and prone to erosion;
- waste material is not thrown into nearby river (Lokchao) and cross cutting water bodies;
- temporary retention ponds, interception drains, and silt traps are installed to prevent silt laden water from entering adjacent water bodies;
- topsoil of borrow areas is preserved and used for re-vegetation;
- borrow areas are provided with gentle side slope that are re-vegetated and connected to the nearest drainage channel to avoid the formation of cess pools during the rainy season; and
- control the disposal and ensure the vegetative stabilisation of spoil.

376. ***Surface and Ground Water, Drainage and Hydrology.*** Given the presence of rivers and streams and subproject road running parallel to some of the stream and crossing the project road, improvement of road may result in disruptions to the natural hydrology and water mismanagement and lead to further problems of soil erosion.

377. The natural courses of rivers/streams will be maintained. Appropriate temporary diversions of streams will be made and brought back to their natural course as soon works are completed in that section. No disposal of construction debris in streams and rivers is allowed.

378. Minor impacts on water resources are expected during the construction phase. The rehabilitation of existing bridges may also cause soil erosion and turbidity in downstream water bodies. To mitigate this, river-bank slope stabilities will be monitored and, if necessary, appropriate remedial measures applied throughout the construction period. Construction work at bridges during rainy season will be minimized to avoid erosion and sedimentation.

379. The likely impacts of surface water movements are changes in the natural drainage systems, downstream scour, and erosion due to constriction in flows. If suspended solid concentrations in the water are affected, this could also affect aquatic river ecology.

380. To mitigate these impacts the following measures should be implemented:

- chemicals and oils are stored in secure, impermeable containers, and disposed of well away from surface waters;
- no vehicle cleaning activity is allowed within 300 m of water bodies/ drains;
- construction camps are equipped with sanitary latrines that do not pollute surface waters;
- the work on bridges and culverts is limited to dry seasons, when many of the smaller streams will have low water - water diversion works can be minimised and the original course restored immediately after the work has been completed;
- drivers are made aware of diversions and other works at bridge construction site to avoid accidents;
- drainage structures are properly designed to accommodate forecast discharges;
- side drain waters must be discharged at every available stream crossing to minimize volume and prevent erosion at discharge point;
- provide lined drainage structures;
- where an increased discharge of surface water endangers the stability of the water outlet, erosion protection measures such as bioengineering measures, ripraps, and check dams are incorporated;
- in areas with high water tables, seepage may occur and side drains and up-slope catch drains must always been lined to avoid percolation; and
- all debris and vegetation, clogging culverts are regularly cleared.

381. Ground water pollution is not envisaged in this subproject.

382. ***Air Quality.*** During construction air quality may be degraded for short periods due to (i) the exhaust emissions from the operation of construction machinery; (ii) fugitive emissions from brick, concrete, and asphalt plants; (iii) the dust generated from the haulage of materials, exposed soils and material stockpiles; (iv) cutting and filling of hill slope; (v) cleaning of the road; (vi) material loading; (vii) unloading; and (viii) blasting activities. The impact is expected to be localised, temporary and confined to construction areas.

383. Adverse air quality impacts during construction are likely to result from three main sources; (i) emissions from construction equipment, including delivery trucks; (ii) fugitive dust from earth-moving operations and demolition; and (iii) localised increased traffic congestion in construction areas.

384. The adverse impacts on air quality during construction stage were classified and presented in Table 62. There are two types of pollution i.e. dust pollution and pollution from harmful gases.

Table 62: Impact on Air Quality during Construction Stage

Sl. No.	Impact	Source
1.	Generation of Dust (SPM)	• Cutting of slopes towards hillsides • Transportation and tipping of cut material - while the former will occur over the entire stretch between the cutting location and disposal site, the latter is more location specific and more intense;

Sl. No.	Impact	Source
		• Blasting operations; • Activation of landslides and rock falls etc.; • Transportation of raw materials from quarries and borrow sites; • Stone crushing, handling and storage of aggregates in asphalt plants; • Site levelling, clearing of trees, laying of asphalt, construction of bridges; • Concrete batching plants; • Asphalt mix plants – due to the mixing of aggregates with bitumen; and • Construction of structures and allied activities
2.	Generation of polluting gases including SO_2, NOx and HC	• Hot mix plants; • Large construction equipment, trucks and asphalt producing and paving equipment; • The movement of heavy machinery, oil tankers etc. on steep slopes will cause much higher emissions of gases; • Toxic gases released through the heating process during bitumen production; and • Inadequate vehicle maintenance and the use of adulterated fuel in vehicles.

385. On the Khongkhang-Moreh road section, it is expected that air quality will be affected to some minor extent by dust and particulate matters generated by construction, vehicular movements, site clearance, earth filling and material loading and unloading. The impacts are expected to be localised, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimised.

386. **Air Quality Modelling and Prediction of Impacts**. To assess the likely concentrations at the various locations along the project road corridor, the prediction of the pollutant concentrations has been carried out using AERMOD, a dispersion model based on Gaussian Equation. Detailed analysis is presented in Annex 5. The input parameters for the prediction are detailed in subsequent paragraphs.

387. The AERMOD atmospheric dispersion modeling system is an integrated system that includes three modules: (a) A steady-state dispersion model designed for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources. (b) A meteorological data preprocessor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux. (c) A terrain preprocessor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behavior of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills. AERMOD also includes PRIME (Plume Rise Model Enhancements) which is an algorithm for modeling the effects of downwash created by the pollution plume flowing over nearby buildings.

388. Various input parameters for the prediction of pollutant concentrations are discussed below:

- ***Traffic Volume:*** The fleet wise traffic volumes for the present study have been taken from the detailed feasibility report of the project. The annual average daily traffic (AADT) data is available for the proposed road through traffic survey. AERMOD model needs hourly average traffic volume. The total traffic hour volume is further categorized in to two wheeler, four wheeler, Light commercial vehicles (LCVs), Bus and high commercial vehicles (HCVs), based on the traffic survey at different road stretched along the highway. The annual average daily motorized traffic data are given in Table 63 at five locations along with future traffic growth.

Table 63: Annual average daily motorized traffic data

Year	2w	4w	LCV	HCV	Buses
2020	42	2962	304	127	8
2025	65	4627	474	199	12
2030	84	5974	613	257	15
2035	99	7096	728	305	18
2040	116	8250	846	354	21

- ***Emission Factors:*** Emission factor is one of the important input parameter in AERMOD model. In the present study, the emission factors specified by the Automotive Research Association of India (ARAI, 2007) have been used for calculation of weighted emission factors. These emission factors have been expressed in terms of type of vehicles and type of fuel used (for petrol and diesel driven passenger cars). The emission factor used in the present study for different vehicles type are given in Table 64.

Table 64: Emission factors for different types of Vehicle (ARAI, 2007)

Emission factors, g/km (ARAI, 2007)						
	2w	**3w**	**4w**	**lcv**	**bus**	**truck**
CO	1.04	1.25	1.28	1.56	8.03	6
Nox	0.31	0.6	0.32	1.46	9.01	9.3
PM	0.02	0.22	0.04	0.28	0.55	1.24
SO2	0.01	0.01	0.03	0.06	0.13	0.13

- ***Meteorological Conditions:*** The meteorological parameters such as wind speed, wind direction, temperature, rainfall, cloud cover, pressure, and humidity were used in model. Due to limited availability of good data, the data has been taken from nearest World Meteorological Observation Station, Imphal airport for this study.
- ***Receptors****:* A set of link receptors were taken at various receptor locations within each section at a distance of 5 m, 10 m, 20 m, 50 m, 100 m and 200 m both sides from centre line of the carriageway to know the dispersion of pollutant from the road.
- ***Background Concentration:*** The background pollutant concentrations were taken from environmental monitoring data. Air quality monitoring was carried out in the month of March 2019 at four locations throughout the alignment on two alternate days. The following background pollutant concentrations were taken for model predictions:

Table 65: Average background concentration of pollutants along the alignment

Average Background concentration, microgram/m^3	
CO	**0**
NOx	**13.0**
$PM_{2.5}$	**31.3**
PM_{10}	**63.8**
SO_2	**6.6**

389. ***Predicted Pollution Levels.*** The model has been setup and run to predict hourly average CO, PM2.5, PM10, NOx and SO2 concentrations for year 2020, 2025, 2030, 2035 and 2040 using forecasted traffic data on proposed highway. The predicted hourly average concentration of CO, PM2.5, PM10, Sox and NOx during peak traffic are shown in Tables 66, 67, 68, 69, 70 for proposed highway project.

Table 66: CO predicted concentrations (ppm) along the proposed road

Year	CO Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
	-200	**-150**	**-100**	**-50**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**50**	**100**	**150**	**200**
2020	2.8	3.5	4.4	5.6	12.4	19.9	28.2		9.6	7.8	5.4	1.3	0.6	0.4	0.4
2025	4.4	5.5	6.9	8.8	19.3	31.2	44.2		15.1	12.1	8.4	2	0.9	0.6	0.6
2030	5.5	7	8.8	11.2	24.6	39.7	56.2		20.5	15.5	10.8	2.5	1.1	0.8	0.8
2035	6.7	8.5	10.7	13.5	29.6	47.9	67.8		23.9	18.6	13	3	1.3	0.9	1
2040	7.9	10	12.5	15.8	34.7	56.1	79.4		27.4	27.7	15.1	3.5	1.5	1.1	1.1
WB EHS Guidelines limits	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-GOI limits	4000	4000	4000	4000	4000	4000	4000		4000	4000	4000	4000	4000	4000	4000

Table 67: PM2.5 predicted concentrations (µg/m3) along the proposed road

Year	PM2.5 Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
	-200	**-150**	**-100**	**-50**	**-20**	**-10**	**-5**		5	10	20	50	100	150	200
2020	31.3	31.3	31.3	31.4	31.4	31.5	31.6		31.6	31.5	31.4	31.3	31.3	31.3	31.3
2025	31.3	31.3	31.4	31.4	31.5	31.7	31.8		31.8	31.6	31.5	31.3	31.3	31.3	31.3
2030	31.3	31.4	31.4	31.4	31.6	31.8	32		32	31.7	31.5	31.3	31.3	31.3	31.3
2035	31.4	31.4	31.4	31.5	31.7	31.9	32.1		32	31.8	31.6	31.4	31.3	31.3	31.3
2040	31.4	31.4	31.4	31.5	31.7	32	32.2		32.2	31.9	31.6	31.4	31.3	31.3	31.3
WB EHS Guidelines limits	25	25	25	25	25	25	25		25	25	25	25	25	25	25
GOI limits	60	60	60	60	60	60	60		60	60	60	60	60	60	60

Table 68: PM10 predicted concentrations (µg/m3) along the proposed road

	PM10 Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	63.8	63.8	63.8	63.9	63.9	64	64.1		64.1	64	63.9	63.8	63.8	63.8	63.8
2025	63.8	63.8	63.9	63.9	64	64.2	64.3		64.3	64.1	64	63.8	63.8	63.8	63.8
2030	63.8	63.9	63.9	63.9	64.1	64.3	64.5		64.4	64.2	64	63.8	63.8	63.8	63.8
2035	63.9	63.9	63.9	64	64.2	64.4	64.6		64.5	64.3	64.1	63.9	63.8	63.8	63.8
2040	63.9	63.9	63.9	64	64.2	64.5	64.7		64.7	64.4	64.1	63.9	63.8	63.8	63.8
WB EHG Guidelines limits	50	50	50	50	50	50	50		50	50	50	50	50	50	50
GOI limits	100	100	100	100	100	100	100		100	100	100	100	100	100	100

Table 69: NOx predicted concentrations (µg/m3) along the proposed road

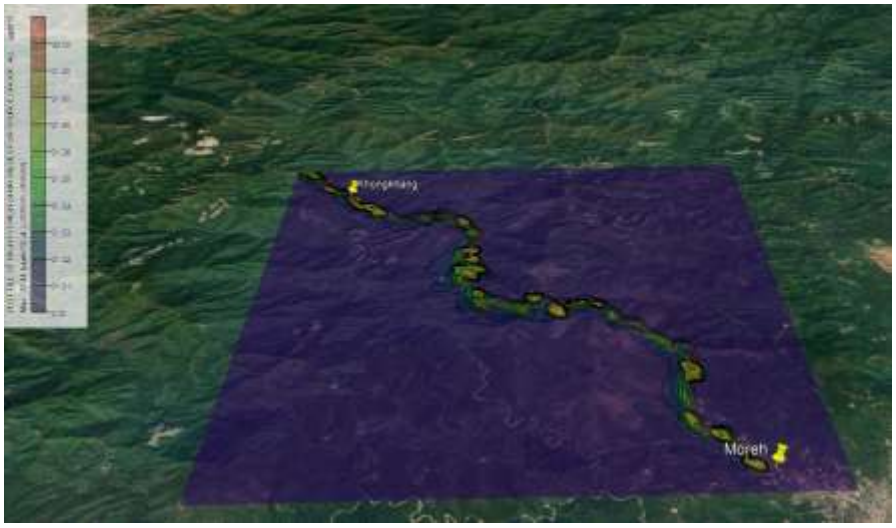
	NOx Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	13.3	13.3	13.4	13.6	14.2	14.8	15.5		15.3	14.5	13.9	13.4	13.2	13.1	13.1
2025	13.3	13.4	13.6	13.8	14.8	15.8	16.8		16.6	15.4	14.4	13.3	13.2	13.2	13.2
2030	13.4	13.5	13.7	14	15.2	16.5	17.8		17.5	16	14.7	13.4	13.2	13.2	13.2
2035	13.5	13.6	13.8	14.2	15.6	17.2	18.7		18.3	16.5	15	13.5	13.3	13.2	13.2
2040	13.5	13.7	13.9	14.4	16.1	17.9	19.7		19.1	17	15.3	13.5	13.3	13.2	13.2

	NOx Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
WB EHG Guidelines limits	40	40	40	40	40	40	40		40	40	40	40	40	40	40
GOI limits	80	80	80	80	80	80	80		80	80	80	80	80	80	80

Table 70: SOx predicted concentrations (µg/m3) along the proposed road

	SOx Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	6.6	6.6	6.6	6.6	6.7	6.7	6.7		6.7	6.7	6.6	6.6	6.6	6.6	6.6
2040	6.6	6.6	6.6	6.7	6.7	6.8	6.9		6.9	6.8	6.7	6.6	6.6	6.6	6.6
WB EHG Guidelines limits	20	20	20	20	20	20	20		20	20	20	20	20	20	20
GOI limits	80	80	80	80	80	80	80		80	80	80	80	80	80	80

390. In addition, the spatial distribution of hourly average predicted PM2.5 and PM10 concentrations have been plotted in Figures 37 and 38 respectively which shows that pollutant concentrations is decreasing when goes away from the kerb side.



Spatial Distribution of $PM_{2.5}$ for year 2020

Spatial Distribution of $PM_{2.5}$ for year 2025

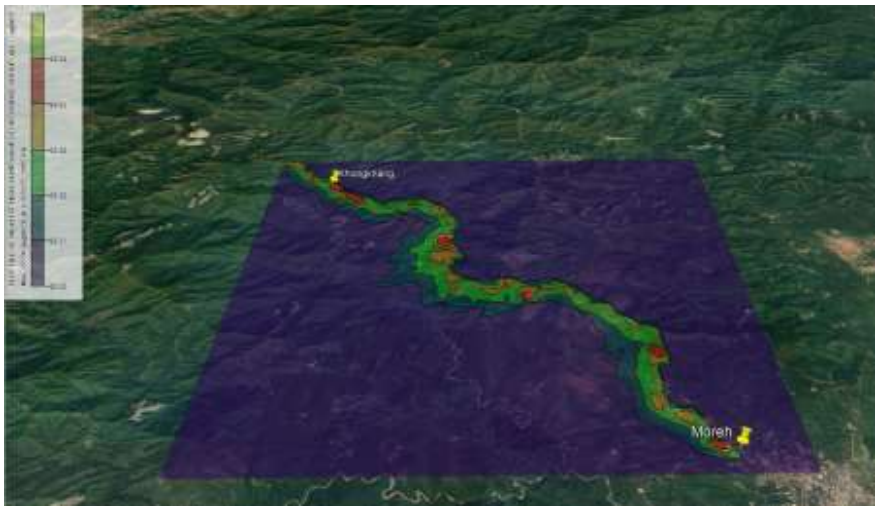
Spatial Distribution of $PM_{2.5}$ for year 2030

Spatial Distribution of $PM_{2.5}$ for year 2035

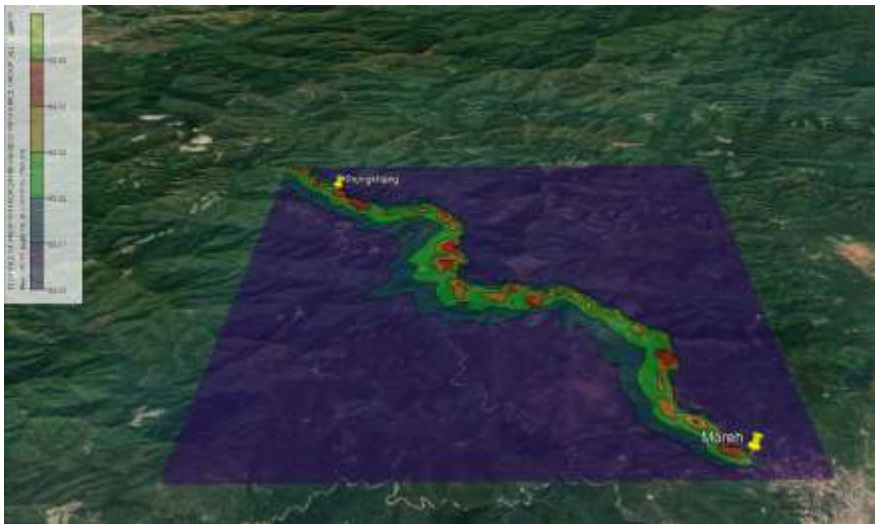
Spatial Distribution of $PM_{2.5}$ for year 2040

Figure 37: Spatial Distribution of $PM_{2.5}$ (2020-2040)

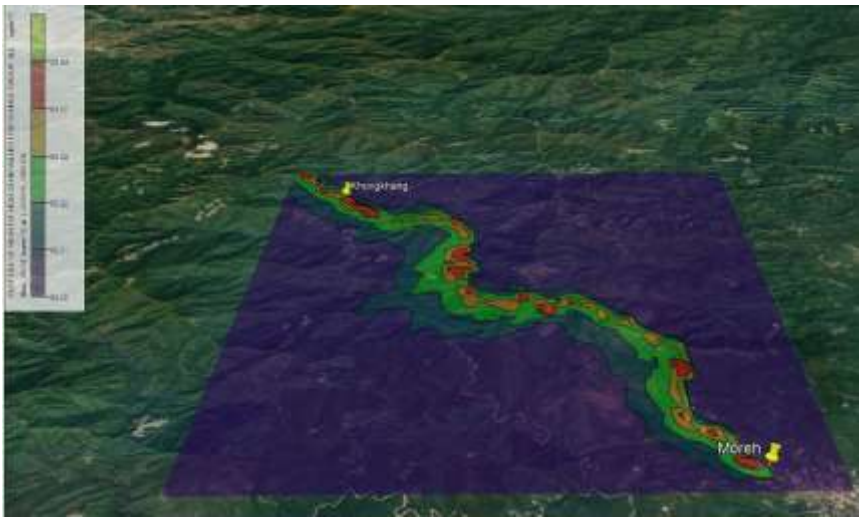
Spatial Distribution of PM_{10} for year 2020



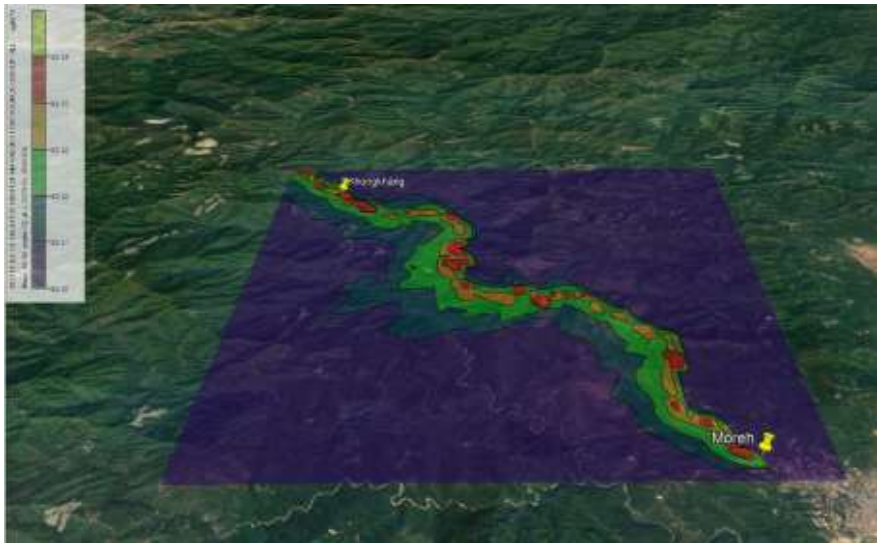
Spatial Distribution of PM_{10} for year 2025



Spatial Distribution of PM_{10} for year 2030



Spatial Distribution of PM_{10} for year 2035



Spatial Distribution of PM_{10} for year 2040

Figure 38: Spatial Distribution of PM_{10} (2020-2040)

391. ***Observations***. It has been observed from the model output that when the traffic volume increases, the concentration of air pollutants also increases correspondingly. However, the maximum predicted pollutant concentrations of PM2.5, PM10, CO, SO2 and NOx over the existing ambient air quality are found to be within the National Ambient Air Quality Standards of CPCB and well as World Bank EHS standards for all the parameters monitored.

392. As it is expected that suspended particulate matter (PM10) levels will increase during construction, certain mitigation measures are suggested in order to keep these levels within the permissible standards. The following actions should be implemented:

- all operation areas will be water sprinkled to control dust levels;
- regular check-up and maintenance of construction equipment and long idling of engines are discouraged;
- mixing plants i.e. asphalt, concrete, and bricks, should be operated within the permissible limits of CPCB and WB EHS, and located away from settlements;
- the contractor will submit a dust suppression and control programme to the PIU prior to construction – this plan details actions to be taken to minimise dust generation and identify equipment to be used;
- vehicles delivering loose and fine materials should be covered to reduce spills;

- controlled blasting should be carried out and such only with the prior approval of the site Engineer and, if required, PIU;
- bitumen emulsion should be used wherever feasible, and
- bitumen heaters should be used and the use of wood for fuel prohibited.

393. **Noise Levels**. With the exception of the urban centres such as Moreh, the ambient noise level along the road sections is within standards. During the construction period, noise will be generated from the operation of heavy machinery, blasting works, the haulage of construction materials to the construction yard and the general activities at the yard itself. Concrete mixing and material movements will be the primary noise generating activities and will be uniformly distributed over the entire construction period. These construction activities are expected to produce noise levels in the range of 80-95 dB(A) at a distance of about 5 m from the source.

394. Construction noise is not normally regulated, though still may cause concern among local villagers. The range of typical noise levels in relation to distance from a construction site is shown in Table 70.

Table 71: Construction Noise / Distance Relationship

Distance from construction site (m)	Range of Typical Noise Level dB(A)
8	82 – 102
15	75 – 95
30	69 – 89
61	63 – 83
91	59 – 79
122	57 – 77
152	55 – 75
305	49 - 69

Source: Department of Transportation, State of Wisconsin (USA)

395. Piling, if necessary, will also cause vibration. In this subproject piling will be required only at bridge locations i.e. Lokchao bridge at chainage km 404+130. There are no settlement/communities around this location. Noise and vibration from piling will be unavoidable, but the impact will only be temporary and affect people living or working near piling locations. In construction sites within 500 metres of a settlement, noisy operations should cease between 22:00 and 06:00 hrs. Regular maintenance of construction vehicles and machinery must also be undertaken to reduce noise. The impact and sources of noise and vibration are summarised in Table 71.

Table 72: Likely Impact on Noise Quality in the Vicinity of Project Area

Impact	Source
Increased noise levels causing discomfort to local residents, workers and local fauna	• Mobilisation of heavy construction machinery; • Accelerations/ decelerations/ gear changes – though the extent of impact will depend on the level of congestion and smoothness of the road surface; • Use of blasting to cut into hill sides; • Excavation work for foundations and grading; • Construction of structures and other facilities; • Crushing plants, asphalt production plants; and loading, transportation and unloading of construction materials.

396. Typical noise levels associated with various construction activities and equipment are presented in Table 72.

Table 73: Typical noise levels of principal construction equipments (Noise Level in db (A) at 50 Feet)

Clearing		Structure Construction	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation and Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading and Compaction		Landscaping and clean-up	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
Paving		Front and end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94

Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. 300.1. December 31, 1971

397. The noise levels indicated for various construction activities/equipment, while far exceeding permissible standards of CPCB and WB EHS for residential areas, it will occur only intermittently. Still, these extremely high sound levels present real risk to the health of workers on- site. Timely scheduling of construction activities, proper maintenance of construction machineries, use of personnel protective equipments etc. will minimize these impacts.

398. Residences, schools, health clinics, and other noise sensitive areas within 100 m the roadways will be affected temporarily during construction. The number of persons potentially affected and the duration of these effects cannot be estimated based on available information.

399. During construction, varying degree of noise impacts are likely to be felt by the communities of main settlements i.e. Khudengthabi, and Moreh and other small settlements along the project road. Although temporary in nature, the construction noise will affect the most communities living close to the construction zone.

400. Noise impacts are an unavoidable consequence of construction that should be mitigated by limiting the times of construction to daylight hours (8am-5pm) in the vicinity of sensitive receptors.

Further to minimize noise impacts near sensitive receptors (particularly schools), operation of excavator and other heavy machineries will be carried out mostly during off-hours (7 am to 9 am) and 3.30 pm to 7 pm) and on holidays (Saturday and Sundays). Baseline noise will be established for all sensitive areas prior to construction and follow up noise monitoring will be carried out during the construction.

401. ***Noise Level Modeling and Predictions.*** Federal Highway Administration's Traffic Noise Model (FHWA TNM) helps for highway traffic noise prediction and analysis. Detailed analysis is presented in Annex- 6. TNM helps for highway traffic noise prediction and analysis. TNM computes highway traffic noise at nearby receivers. As sources of noise, it includes noise emission levels for the following vehicle types:

- Automobiles: all vehicles with two axles and four tires -- primarily designed to carry nine or fewer people (passenger cars, vans) or cargo (vans, light trucks) -- generally with gross vehicle weight less than 4,500 kg (9,900 lb);
- Medium trucks: all cargo vehicles with two axles and six tires -- generally with gross vehicle weight between 4,500 kg (9,900 lb) and 12,000 kg (26,400 lb);
- Heavy trucks: all cargo vehicles with three or more axles -- generally with gross vehicle weight more than 12,000 kg (26,400 lb);
- Buses: all vehicles designed to carry more than nine passengers; and
- Motorcycles: all vehicles with two or three tires and an open-air driver / passenger compartment.

402. The procedure for prediction of noise levels involves the following steps:

(i) Identification of various receivers,
(ii) Determination of land uses and activities which may be affected by the noise generated,
(iii) Assemble input parameters, and
(iv) Application of the model.

403. The description of the components to predict noise level are as follows:

a. *Receivers*: TNM calculates the sound levels at the input receivers.
b. *Land Uses*: Land use along the road is obtained from the topographic drawings. This information provides the range of shielding and absorption factors to be applied at the various receivers.
c. *Input Parameters*: Traffic volume for the projected period is obtained from the traffic projections. The total number of vehicles passing per hour by type - light, medium and heavy along with their average speed is used for predictions.
d. *Average Noise Level*: All vehicles produce noise, which is taken as the base, and the cumulative noise at the receiver distance due to the whole traffic is estimated. The average noise level varies depending on the type of vehicle.
e. *Application of Model*: Equivalent noise levels due to traffic at the receivers are estimated using Federal Highway Noise model. Equivalent Sound Level (TEQ, denoted by the symbol, LAeqT): Ten times the base-10 logarithm of the square of the ratio of time-average, mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T (where T=t2-t1), and the reference mean-square sound pressure of 20: Pa, the threshold of human hearing, e.g., 1HEQ, denoted by the symbol, LAeq1H, represents the hourly equivalent sound level. LAeqT is related to LAE by the following equation:

$$L_{AeqT} = L_{AE} - 10*\log10(t_2-t_1)$$

where LAE = Sound exposure level in dB

404. Sound Exposure Level (SEL, denoted by the symbol, L_{AE}): Over a stated time interval, T (where $T=t_2-t_1$), ten times the base-10 logarithm of the ratio of a given time integral of squared

instantaneous A-weighted sound pressure, and the product of the reference sound pressure of 20:Pa, the threshold of human hearing, and the reference duration of 1 sec. The time interval, T, must be long enough to include a majority of the sound source's acoustic energy. As a minimum, this interval should encompass the 10 dB down points.

Table 74: Annual average daily motorized traffic data

Year	2w	4w	LCV	HCV	Buses
2020	42	2962	304	127	8
2025	65	4627	474	199	12
2030	84	5974	613	257	15
2035	99	7096	728	305	18
2040	116	8250	846	354	21

Table 75: Equivalent Background Noise levels

Location / Noise Zone		Khongkhang/ Residential	Khudenthabi/ Residential	Lokchao/ Rural	Khudenthabi Army Checkpost / Residential	Moreh College / Sensitive
Night	Leq(dB)	45	43	46	46	42
Day	Leq(dB)	63	67	67	70	64

Table 76: Predicted Noise Levels along the subproject road sections

Year	Distance from the edge of the road, m. (Left side)						Distance from the edge of the road, m. (Left side)				
	200	100	50	20	10		10	20	50	100	200
2020	38.4	45.7	53.1	57.8	59.8		59.8	57.7	52.9	44.6	38.5
2025	39.6	46.9	54.4	59.1	61.1		61.1	59	54.2	45.8	39.7
2030	40.6	47.9	55.4	60.1	62.1		62.1	60	55.2	46.8	40.6
2035	41.5	48.8	56.3	61	63		63	60.9	56.1	47.7	41.5
2040	42.4	49.7	57.2	61.9	63.9		63.9	61.8	57	48.6	42.5

405. ***Observations***. It can be seen from the Table 75 that noise levels (Leq) near the receivers are found to be higher than desired levels for the respective categories when compared with prescribed standards of CPCB (Government of India) as well as IFC (World Bank EHS Guidelines). The maximum predicted value 63.9 dB(A) is recorded at the receiver located close to 10m. The predicted levels show increase in noise levels for future years at all receivers considering increase in traffic volume. It is found (Table 76) that an incremental noise level due to current traffic and project traffic is in the range of 3 dB(A). The current spot measurement level at few sensitive receptors shows much lower value compared to the traffic-based assessment indicating noise is being attenuated by various existing barriers like trees, buildings etc. Installations of physical noise barriers are proposed sensitive locations to keep the projected noise levels at these locations within CPCB/WB EHS standards i.e. 55 dB(A).

406. The noise levels were predicted at sensitive receptors along the alignment and presented in annexure 6. Baseline noise levels (Leq) near the sensitive receivers are found to be marginally

higher than desired levels for the respective categories. However the increase in noise level due to project are within permissible limits at all the sensitive receptors. The predicted levels show increase in noise levels for future years at all receivers considering increase in traffic volume. The noise levels at sensitive receptors is presented in Table 76a and detailed assessment is provided in annexure 6. It can be seen from this table that the maximum increase in noise levels due to project is predicted at 3.0 dB(A) in the year 2040. Therefore project is not expected to cause any significant noise impacts.

Table 76a: Predicted Noise levels at sensitive receptors along the project corridor (Year 2040)

Receptor	LHS/ RHS	Chainage Km		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Extent of Impact
Community Hall, Khudengthabi	LHS	412+400	412+500	5	67	66.5	69.8	2.8	Insignificant
Angawadi Centre	LHS	412+500	412+600	5	67	66.5	69.8	2.8	Insignificant
Church	LHS	412+600	412+700	5	67	66.5	69.8	2.8	Insignificant
Market Area	LHS	414+400	414+700	5	70	66.5	71.6	1.6	Insignificant
Army Camp	RHS	414+400	414+800	10	70	63.9	71.0	1.0	Insignificant
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	60.8	65.7	1.7	Insignificant
Community Hall	LHS	415+400	415+500	10	64	63.9	67.0	3.0	Insignificant
Church	RHS	419+300	419+400	8	64	62.9	66.5	2.5	Insignificant
Moreh college	LHS	421+500	421+700	50	64	57	64.8	0.8	Minimal

407. ***Noise dispersion.*** A small road corridor has been selected to develop noise contour for base year as well as future years also. The contour lines are generated by plotting a contour zone within 30 m distance from edge of the road on both side of the road. Due to model limitation, it is not possible to select the whole road corridor in the modelling domain. Therefore, spatial dispersion of noise has been shown with a small stretch of road. Figure 1 to 5 shows noise level contour around a small road corridor for year 2020, 2025, 2030, 2035 and 2040 respectively. The selected road stretch is small part of section -I, i.e., Khongkhang-Moreh road stretch. These predicted results are for peak traffic hours. During non-peak traffic hours, the noise levels are very less compared to noise level for peak traffic hours.

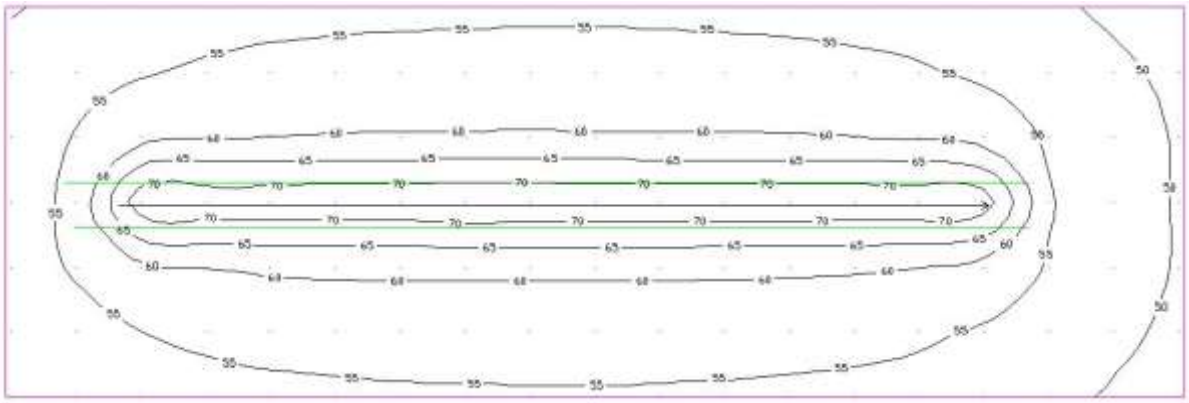


Figure 1: Noise contour for year 2020

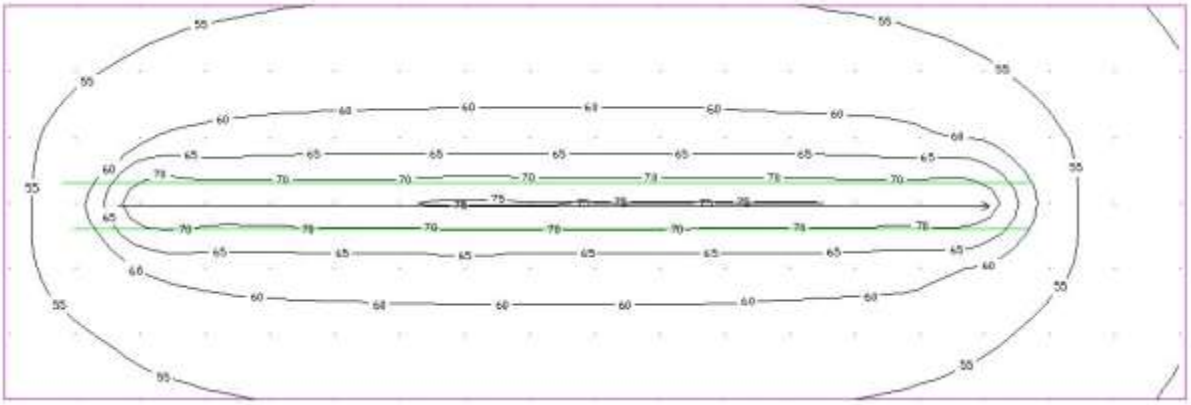


Figure 2: Noise contour for year 2025

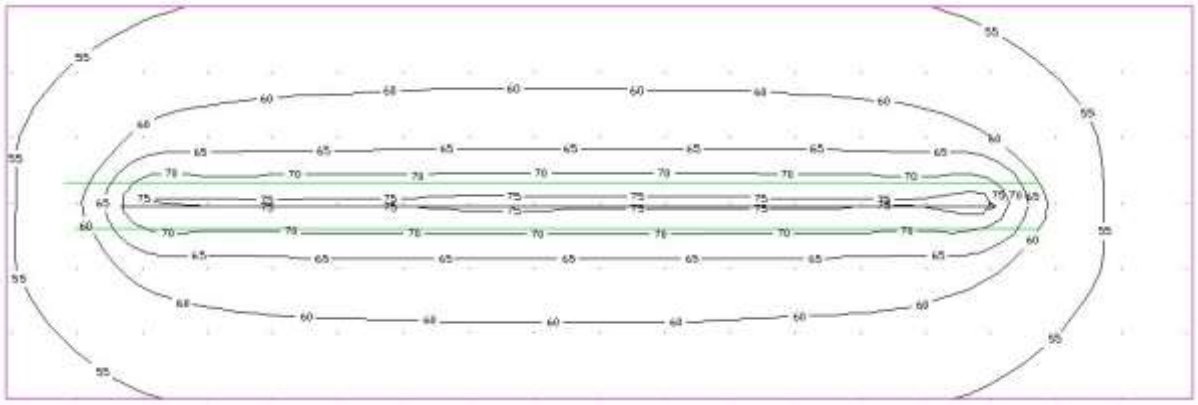


Figure 3: Noise contour for year 2030

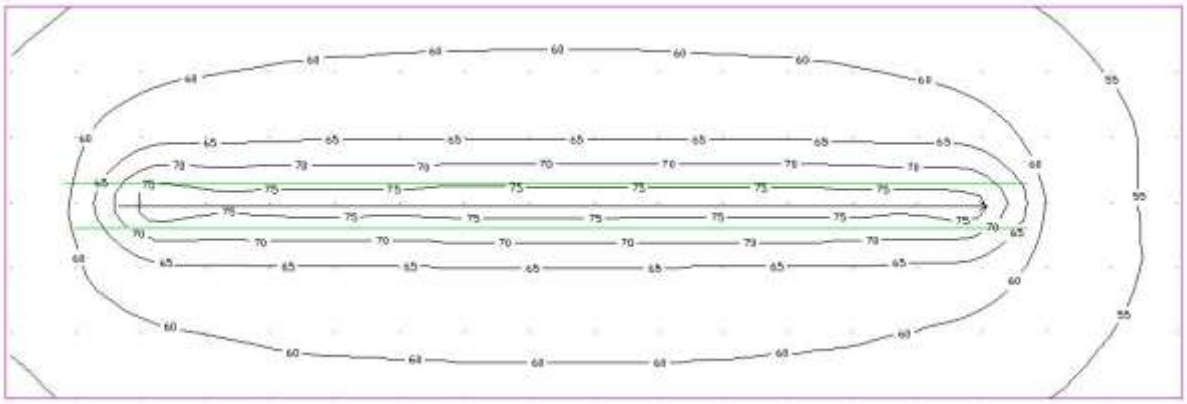


Figure 4: Noise contour for year 2035

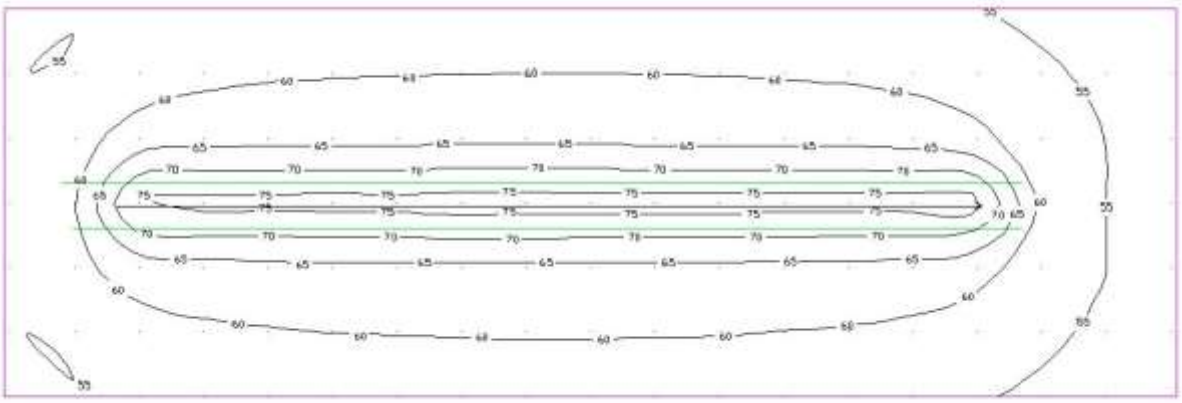


Figure 5: Noise contour for year 2040

408. Although estimated noise over the project duration shows higher noise levels at various receptor locations; implementation of suitable mitigation measures will reduce the construction noise to acceptable limits. Mitigation measures should include:

- Installations of noise barriers;
- construction machinery should be located away from settlements;
- careful planning of machinery operation and the scheduling of such operations;
- controlled blasting should only be carried out with prior approval from the Engineer in charge;
- contractors should be required to fit noise shields on construction machinery and to provide earplugs to the operators of heavy machines;
- blasting should be conducted only during day-light hours; and
- only controlled blasting should be conducted.

409. Trees will be planted along the road to act as natural barrier to noise. Further, physical noise barriers have been provided in the subproject design. These physical noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. To effectively reduce sound transmission through the barrier, the material chosen must be rigid and sufficiently dense (at least 20 kilograms/square meter). To effectively reduce the noise coming around its ends, a barrier should be at least eight times as long as the distance from the home or receiver to the barrier.

410. ***Topography and Appearance.*** Construction activities of the project road will bring permanent changes in the local-level topography and appearance of the project site. There will be loss in aesthetic beauty of the project area mainly due to the earthwork. Table 77 elaborates potential effects on the topography and appearance and appropriate mitigation measures.

Table 77: Potential Effects on Topography by the Proposed Road Section Upgrading

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
1.	Clearing of vegetation and cutting of hillside for widening of the road	Scarring of landscape from cutting and potential landslides (short term and long term) may be caused. There may be minor permanent changes in the landscape.	Cut material should be used to widen the road or disposed off at proper disposal sites. Cut slopes should be re-vegetated immediately after widening activities.
2.	Stone quarrying	Scarring of landscape and potential landslides (rock slides/falls). There may be permanent changes in the landscape.	Stone quarrying should only be undertaken in legally approved areas. Controlled and environmental friendly quarrying should be carried out to minimise landslides and erosion.

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
3.	Earthwork from borrow areas	Scarring of landscape due to unearthing activities. Minor but permanent changes in landscape.	Borrow areas should be in legally approved locations. As soon as construction activities are complete, they should be re-vegetated and brought back as far as possible to their previous appearance.
4	Waste disposal	Disposal of cut soils and debris at improper locations such as hillside below the road will make the area look untidy and unattractive.	Cut off material should be used to widen the road or disposed of at proper disposal sites.
5	Establishment of labour camps	Disposal of waste and litter at improper locations and deforestation for fire-wood will make the area look dirty and unattractive.	Provision and allocation of proper waste disposal bins and sites are required. A supply of cooking gas should be provided by the contractor to eliminate the use of fire wood.

411. **Vibration Levels.** When the ground is subject to vibratory excitation from a vibratory source, a disturbance propagates away from the vibration source. The ground vibration waves created are similar to those that propagate in water when a stone is dropped into the water.

412. The duration and amplitude of vibration generated by construction equipments varies widely depending on the type of equipment and the purpose for which it is being used. The vibration from blasting has a high amplitude and short duration, whereas vibration from grading is lower in amplitude but longer in duration. In assessing vibration from construction equipments, it is useful to categorize the equipment by the nature of the vibration generated.

413. Review of available literature indicates that there is limited information available on vibration source levels from general construction equipment. The most comprehensive list of vibration source amplitudes is provided in the document entitled Transit Noise and Vibration Impact Assessment (Federal Transit Administration 2006)[12].

Table 78: Vibration generated from different construction equipments

Equipment	Reference PPV at 25 ft. (in/sec)
Vibratory Roller	0.21
Large Bulldozer	0.089
Caisson Drilling	0.089
Loaded Trucks	0.076
Jackhammer	0.035
Small Bulldozer	0.003

Sources: Federal Transit Administration 2006 (except Hanson 2001[13] for vibratory rollers)

[12] Hanson, C. E., Towers, D. A., & Meister, L. D. (2006). Transit noise and vibration impact assessment (No. FTA-VA-90-1003-06).

[13] Peck R B, Hanson W E and Thornburn T H (1974). Foundation Engineering. John Wiley and Sons, New York.

414. Using these source vibration levels, vibration from these equipment can be estimated by the following formula:

$$PPV_{Equipment} = PPV_{Ref} (25/D)^n \text{ (in/sec)} \quad \text{……..(1)}$$

Where: PPV_{Ref} = reference PPV at 25 ft.

D = distance from equipment to the receiver in ft.

n = 1.1, attenuation rate ([14])

415. **Vibration Impact Criteria.** International Guidelines and Standards present criteria for vibration related building damage in the form of threshold levels of vibration (peak particle velocity), as either a value or range of values. Key factors in determine these levels are as follows:

- the nature of the building including its construction, its condition, and whether is of historic importance;
- the likely extent of damage i.e. cosmetic, minor structural or major structural; and
- whether the source of vibration is continuous or a single event and the dominant frequency (Hz).

Table 79: Building Vibration Damage Assessment Criteria

Building Vibration Damage Risk Level	Building Description	Cosmetic Damage Threshold ppv (mm/s)	Source Reference for Criteria	Assumed Building Coupling Loss
	Extremely fragile historic buildings, ruins, ancient monuments	2	Caltrans/BART	n/a
High Risk A	Fragile buildings of clay construction with shallow (<1m) rubble footings	3	Caltrans	1
High Risk B	Fragile buildings of clay construction with concrete foundations/footings	3	Caltrans	0.5
Medium Risk	Residential brick built on concrete foundations/footings and light commercial	10	BS 7385/DIN 4150	0.5
Low Risk	Heavy commercial, industrial and framed buildings	25	BS 7385/DIN 4150	0.5

Table 80: BS 5228 Vibration Assessment Criteria for Human Perception

Vibration Level ppv (mms-1)	Description of Effect	Description of Impact
<0.3	Vibration unlikely to be perceptible	Negligible
0.3 to 1.0	Increasing likelihood of perceptible vibration in residential	Minor

[14] WOODS, R.D. and JEDELE, L.P., 1985. Energy-attenuation relationships from construction vibrations. American Society of Civil Engineers, Proceedings of ASCE Symposium on Vibration Problems in Geotechnical Engineering, Detroit, Michigan, G. Gazetas and E.T. Selig, Editors, pp. 229-246.

Vibration Level ppv (mms-1)	Description of Effect	Description of Impact
1.0 to 10	Increasing likelihood of perceptible vibration in residential environments but can be tolerated at the lower end of the scale if prior warning and explanation has been given to residents	Moderate
>10	Vibration is likely to be intolerable for any more than a brief exposure to a level of 10mms-1	Major

416. ***Assessment of Vibration levels.*** The vibration levels in this study have been calculated using the empirical formula given by FTA (equation 1), and the results are presented in Table 81 below:

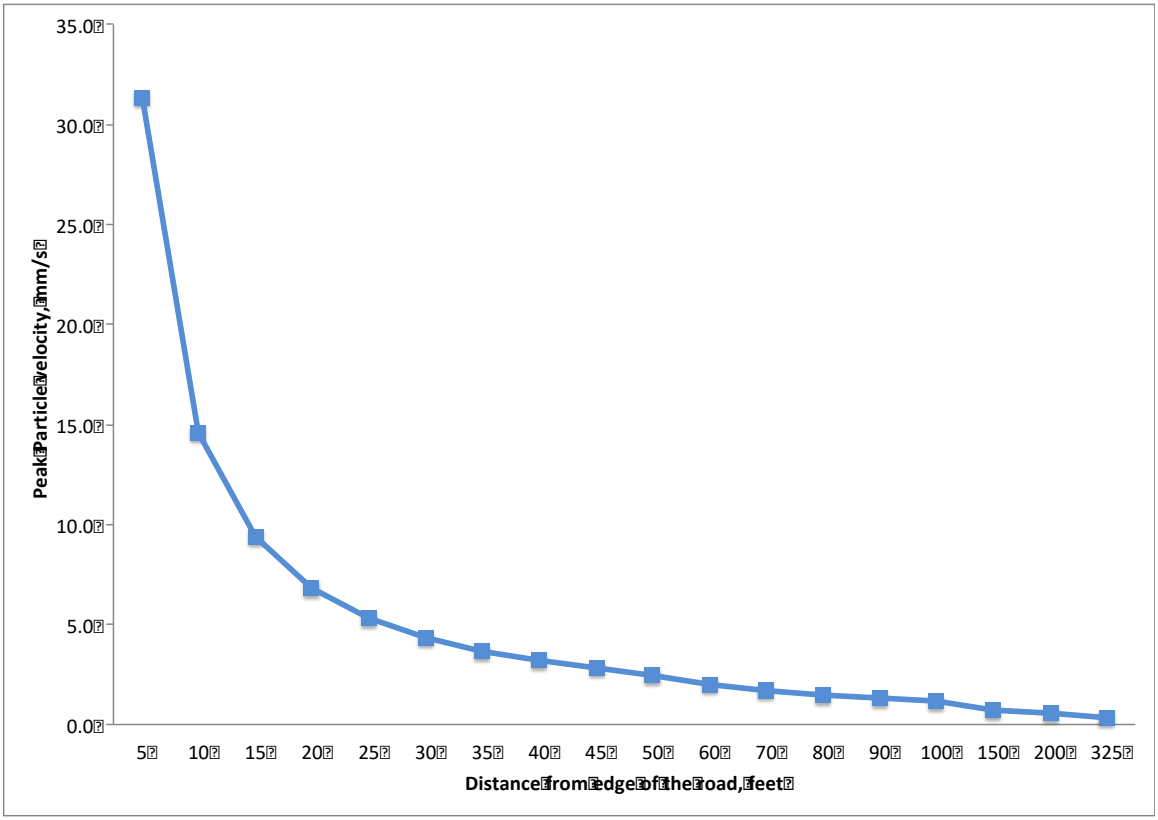


Figure 39: Vibration levels due to vibratory roller from edge of the road

417. From the above graph it is clear that buildings/structures within 4.5m from edge of the road will have major impact of vibrations due to vibratory roller, as per BS 7385/DIN 4150 standards.

418. ***Vibration assessment at sensitive receptors.*** Vibration monitoring was carried out at the sensitive receptors along the alignment and monitoring results are presented in below Table 81 and details of study are given in Annex 14:

Table 81: Vibration impact assessment at sensitive receptors

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Vibration velocity, mm/s	Vibration due to vibratory roller, mm/s	Resultant Vibration velocity, mm/s	Increase in vibration level, mm/s	Type of Impact	Building Vibration Damage Risk Level
Community Hall,Khudengthabi	LHS	412+400	412+500	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Angawadi Centre	LHS	412+500	412+600	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Church	LHS	412+600	412+700	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Market Area	LHS	414+400	414+700	5	0.1	8.9	8.9	8.8	Moderate	Medium Risk
Army Camp	RHS	414+400	414+800	10	0.1	7.8	7.8	7.7	Moderate	Medium Risk
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	0.4	3.4	3.4	3.0	Moderate	Medium Risk
Community Hall	LHS	415+400	415+500	10	0.2	7.8	7.8	7.6	Moderate	Medium Risk
Church	RHS	419+300	419+400	8	0.4	8.4	8.4	8.0	Moderate	Medium Risk
Moreh college	LHS	421+500	421+700	50	0.3	0.6	0.7	0.4	Minor	Low Risk

419. ***Vibration Produced during Operation***. Because vehicles traveling on highway are supported on flexible suspension systems and pneumatic tires, these vehicles are not an efficient source of ground vibration. They can, however, impart vibration into the ground when they roll over pavement that is not smooth. Continuous traffic traveling on a smooth highway creates a fairly continuous but relatively low level of vibration. Where discontinuities exist in the pavement, heavy truck passages can be the primary source of localized, intermittent vibration peaks. These peaks typically last no more than a few seconds and often for only a fraction of a second. Because vibration drops off rapidly with distance, there is rarely a cumulative increase in ground vibration from the presence of multiple trucks. In general, more trucks result in more vibration peaks, though not necessarily higher peaks. Automobile traffic normally generates vibration amplitudes that are one-fifth to one-tenth the amplitude of truck vibration amplitudes. Accordingly, ground vibration generated by automobile traffic is usually overshadowed by vibration from heavy trucks.

420. ***Mitigation Measures***. Because vibration from vehicle operations is almost always the result of pavement discontinuities, the solution is to smooth the pavement to eliminate the discontinuities. This step will eliminate perceptible vibration from vehicle operations in virtually all cases.

- A wave barrier is typically a trench, or a thin wall made of sheet piles or similar structural members. The purpose of a barrier is to reflect or absorb wave energy, thereby reducing the propagation of energy between a source and a receiver. The depth and width of a wave barrier must be proportioned to the wavelength of the wave intended for screening.
- Adverse human response to construction vibration can be mitigated by good communication between the contractor and local residents. If occupiers of dwellings are informed of their nature, duration and potential vibration effects prior to the works, then adverse response will be less. Generally, the main concern relating to construction vibration is of damage to property and if this is not likely to occur, then this point should be made clear to residents.

421. ***Observations***. The principal source of vibration is the operation of vibratory rollers during ground preparation. Buildings of the types found alongside the road have been classified, according to their sensitivity to vibration damage, with the categories including low, medium and high-risk buildings.

422. From the study it is found that buildings/structures within 4.5m from edge of the road will have major impact of vibrations due to vibratory roller, as per BS 7385/DIN 4150 standards. The sensitive receptors will encounter moderate impact of vibrations due to construction equipment. The impact of vibrations due to road traffic will be negligible given the highway pavement is maintained at good condition. For the structures within 4.5 m from road edge, suitable mitigation measures should be adopted to minimize the vibration levels.

423. **Ecological Resources. *Wildlife*.** Construction activities are likely to cause some disturbance to the wildlife population particularly areas along 29.516 km length of project road which passes through buffer/tourism zones of YLWLS.

424. Officials from YLWLS including the Chief Wildlife Warden, the Chief Conservator of Forests (Wildlife), Field Staff of YLYWLS, NGOs (IBCN/WWF), representative of local communities and villagers, were consultant to identify possible impacts of proposed road improvement project on wildlife of sanctuary.

425. Office of the Wildlife Warden (Manipur) informed that there is no specific information available about wildlife movement corridors and wildlife migratory routes along national highway section (project road). Wildlife movement is mostly limited to the core zone –II of the sanctuary and along the rivers/streams within sanctuary. The sanctuary has an existing natural wildlife corridor between eastern part of sanctuary and adjoining Myanmar border. Seasonal migration of wildlife including Asian Elephant were reported through this corridor. However there is no

record of wildlife movement across project road. Local communities also informed that they rarely noticed movement of animals across the national highway. Some of the people consulted indicated that they occasionally (once in a week or less) spot small animals such as langur crossing the national highway. Also there is no history of road accident involving wild animals on national highway section.

426. The road construction through critical wildlife habitat in 21.066 km (from Lokchao river towards Moreh) will require new hill cutting and steep slopes. Although improvement work will be taken up eccentrically (on one side of existing road –not towards boundary of the sanctuary), it will affect the habitats of the area. The critical wildlife habitat tests using the biodiversity decision framework tool of IFC, World Bank as shown in Table 82; indicates that there will no major or severe impacts on the critical habitat and its endangered species such as Hoolock gibbon, Slow lorries, Malayan Sun Bear, Serrow, Pangolin, Leopard, Golden cat, Hornbills. The main predicted impact is the damage and disruption of wildlife movement routes (although no specific route exist); and loss of food sources and the nesting sites for birds.

Table 82: Critical Wildlife Habitat Tests using biodiversity Decision Framework Tool as required by SPS

Sl. No.	Question	Answer
1.	Is the site legally protected or proposed for protection?	Yes. About 21.066 km length of the project road bordering core zone of the Yangoupokpoi Lokchao Wildlife Sanctuary, which is a protected area declared by Government of India.
2.	Are the project activities consistent with the protected area management plan?	Yes. The project is an improvement of existing road, which is allowed as per management plan of the sanctuary.
3.	Have the protected area sponsors and managers, local communities and other key stakeholders been consulted and their views taken into account?	Yes. The officials from Yangoupokpoi Lokchao Wildlife Sanctuary including Chief Wildlife Warden, Chief Conservator of Forests (Wildlife), Field Staff of Sanctuary, NGOs (IBCN/WWF), representative of local communities and villagers, were consultant in the process of environmental impact assessment and their views were incorporated in the design of the Project.
4.	Have appropriate additional programs been implemented to promote and enhance the conservation aims of the protected area?	Yes; the project will support conservation programs as prioritized by wildlife authorities in the management plan of YLWLS such as biodiversity assessment study across existing biodiversity corridor across Indo-Myanmar border (eastern part of the sanctuary), community based education and wildlife conservation programmes.
5.	Will the project reduce populations of any recognized critically endangered or endangered species?	No; since the critical habitat of YLWLS area is small part of the overall habitat available for Hoolock gibbon, Slow lorries, Malayan Sun Bear, Serrow, Pangolin, Leopard, Golden cat, Hornbills.
6.	Will there be measurable adverse impacts, or likelihood of such, on the habitat's ability to support its high value species and functions?	No; since project will avoid the damage of critical habitat area of YLWLS; will restrict felling of tall, matured and fruiting trees; provide temporary migratory passage during construction; and restore or build permanent crossing points for wildlife. Further, safety feature such as wildlife movement signage and speed limit will be erected to minimize the wildlife- vehicle collisions.
7.	Will there be a loss in habitat which will compromise the persistence of a viable and representative host ecosystem?	No; since the road formation cutting will be restricted to 7.0m wherever feasible and important wildlife sites are avoided altogether.
		Any remaining impacts will be mitigated by implementing suitable mitigation measures recommended by the EIA report and under the EMP.

427. Steep road cuts will form a barrier to wildlife movements and disrupt the wildlife migration. Based on field surveys, consultation with wildlife officials and data analysis, it is generally known that wildlife generally migrates seasonally. In the project areas there are four animal/wildlife crossing points mostly in the core zone of the sanctuary as shown in Figures 32 and 34. The movement of wildlife in these locations is mostly observed during rainy season. The project design has included adequate cross drainage structures in the project design which can also serve as underpass for the wildlife/animal crossings. In total there are two bridges (chainage km 405.540 and km 408.465) and 118 culverts are provided in 21.066 km length of the alignment passes/bordering through YLWLS. The locations of the two bridges and two culverts are also among the four animal/wildlife crossing points identified along the alignment. Road construction works will be allowed only during dry season following winter timing from 8.00am till 4.00pm to minimize the disturbance to wildlife. Total controlled blasting will be implemented if rock blasting is unavoidable. Blasting will be carried out during daytime (from 8.00am till 4.00pm) only. Gentle side slope will be maintained at all wildlife crossings/movement points. Spoil will be disposed to the pre-identified dumpsites. Wildlife crossing and speed limit signages will be posted on both sides of road in YLWLS area to caution travelers of possible dangers of collision with elephants. Exact location of signage posting will be determined by Wildlife Specialist along with Environmental Specialist in consultation with the Wildlife conservator. Further as long-term mitigation measures, the habitat enrichment activities such as planting of native bamboos, fruiting and fodders trees will be carried out. The Wildlife Specialist in collaboration with Wildlife Conservator will determine the suitable plant species for wildlife habitat enrichment. There will be strict compliance monitoring by the Wildlife Specialist along with the Environmental Specialist while constructing road through YLWLS. Considering the above measures the project road meets the requirements of para 28 (page 35) of the SPS – no measurable adverse impacts, no reduction in population of endangered species etc. Hence, the project works will be in compliance with the SPS.

428. Construction workers may hunt, fish or carry out other activities that will negatively impact wildlife. No construction or labour camps, batching plants, stone crushing plants, and quarrying activities will be allowed within or 1 km radius YLWLS area and biological Corridor. The contractor will clearly brief the construction workers on strict forestry rules on illegal harvesting of forest products, poaching of wildlife and illegal fishing. Contractor will ensure supply of all necessary food items, cooking fuel and proper housing is provided to prevent illegal hunting and tree felling.

429. The operation of various construction equipment is likely to generate significant noise. Noise disturbance may cause migration of the animals to other areas which may increase the probability of human-animal conflicts. Setting of construction camp near forests or protected area may generally disturb surrounding fauna.

430. Limited indirect ecological degradation may also occur from wildlife poaching, by construction workers and outsiders due to greater accessibility and as a result of increased local demand for food. In order to avoid such impacts, the contract document should include the following:

- Improvement proposals are restricted to minimum width in the length passing through YLWLS. Eccentric widening (one side) is proposed to minimize impacts from encroachment of forest areas from YLWLS.
- Adequate measures are included in the design to minimize impacts on wildlife.
- Signage for no-noise zones, wildlife conservation boards should be installed at the required project sites.
- Noise generating equipment like DG set, compressors will have acoustic enclosures. These will not be installed at least in one km area of YLWLS or Reserved forests. Noise generating activities should not be permitted during night.
- Drivers should be warned to move slowly in the wildlife movement areas.
- If any wild animal come within the vicinity of 100m from the construction site, construction works must immediately stop and resume only after the wild animals have moved away

- Provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents
- project staff and work crews should not be allowed to have firearms and animal traps etc. in the work zone within YLWLS;
- construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest stretches.
- employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities.
- Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the areas of YLWLS.

431. It is reported in the Management Plan of YLWLS that the construction of Border Fencing and the upcoming Border road at the International Boundary with Myanmar along the eastern part of the YLWLS causes fragmentation of wildlife habitat thereby obstructing the existing wildlife corridor between the YLWLS and adjoining Myanmar. The wildlife sanctuary management is currently working on a suitable and alternative scientific methodology to restore the habitat fragmentation and wildlife corridor.

432. The YLWLS also faces many problems and issues including hunting, poaching, etc.; and additionally, the illegal trade on wildlife parts and articles at the International Cross Border (with Myanmar) after passing through NH-102 and then to the Moreh town. The Wildlife Specialist and Environment Specialist of CSC will coordinate with YLWLS authorities to support its programmes on regular checking and monitoring of illegal contraband wildlife, their parts and other wildlife articles.

433. ***Vegetation***. Part of the subproject road passes though forest areas of YLWLS. The density of vegetation in forest is 0.4 to 0.5. Removal of the existing vegetative cover and the uprooting of 2013 trees is an unfortunate activity, which will reduce the ecological balance in the areas. This will also affect the wildlife habitat and enhance soil erosion. About 147,580 sq m (5 m strip for entire length 29.516 km) of scrub forests and vegetation will probably be removed for improvement of road section of AH1 between Khongkhang and Moreh. The loss of vegetative cover will mostly be permanent and only some might be revived through mitigation efforts. Another impact from road construction activities and deriving from the cutting of hillsides, quarrying, preparation and transfer of stone chips and other earthwork; is the accumulation of dust on the surrounding vegetation. This leads to deterioration of the vegetative health, which in turn will affect the ecology as well as the aesthetic beauty of the area. Induced impacts may result from the following:

- increased forest harvesting for fire-wood, construction timber, forage, medicinal plants and other products;
- increased earth and rock extraction;
- construction crew demands for wood as a fuel and for building materials;
- construction crew demands for food and recreational hunting and fishing;

434. To minimise negative impacts on the vegetative cover the contract documents should specify that:

- all wood building material for workers' housing should be brought from outside the project area;
- workers should be supplied with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract;
- all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites;
- during site clearance, care should be taken to ensure that the minimum area of vegetation area is affected; and

- water sprinkling of trucks used as construction vehicles should be properly and regularly undertaken, so that dust deposition problem on vegetation are minimised.

435. **Human Use Values.** Field reconnaissance surveys of the project road were conducted to assess the environmental and social conditions. It was noted that the relocation of structures will be required at congested locations along the subproject road mainly Khongkhang, Lokchao Khudengthabi, and Moreh. The widening options have been devised to minimise impacts of structures.

436. The survey also found that there are about 180-200 temporary structure and two shrines likely to be affected due to widening of road section. A resettlement plan is prepared to address this issue. The affected people will be compensated and rehabilitated as per the provisions of the Resettlement Plan.

437. There will be negligible land acquisition as the proposed widening will be accommodated within existing ROW i.e. 54 ft either side of the road.

438. At certain locations on the road, particularly at bridge /culver sites, traffic will be temporarily diverted from the existing carriageway while construction is in progress and temporary traffic diversions will be managed within the ROW. In other instances, traffic may have to be diverted across adjacent private land, in which case compensation will be paid for any loss of crops or the replacement of damaged structures. In other situations, most frequently not at bridge sites, for example when bitumen surfacing is in progress, it may be required to close the road temporarily. In these circumstances, adequate radio and press releases should be made beforehand and a date/time given for the re-opening.

439. Most construction will be undertaken during the dry season when few crops are planted. Losses should be minimised during construction.

440. **Sensitive Location Such as School, College and Hospital along the Project Road.** The sensitive location such as school, college and hospital along subproject road within 100 meter from the edge of the existing road has been identified as given Table 56 above. These structures are kept unaffected by the proposed improvement proposal. Short term impacts during the construction stage are expected. Measures such as timely scheduling of construction activities in these areas, provision of sign boards, appropriate barriers such as planting trees and / or raised boundary walls are adopted to minimize impacts.

441. **Health, Safety and Hygiene for Construction Workers**. Construction of the road will result in the generation of waste. In isolated places, the amount of waste generated may be greater than normal because of substandard subsoil materials, which will need to the replaced.

442. The Contractor will be required to control the construction site, keep it clean and provide facilities such as dust bins and collectors for the temporary storage of all waste. This waste should be adequately stored to avoid pollution of water supplies and water sources and to avoid dust formation. The Contractor will be responsible for the safe removal and/or storage of all waste in order to prevent environmental pollution of any type that may be harmful to people or animals.

443. All necessary safeguards should be taken to ensure the safety, welfare and good health of all persons entitled to be on the sites and to ensure that works are carried out in a safe and efficient manner. All personnel working at vulnerable site locations will wear safety helmets and strong footwear. It should be ensured that all workmen and staff employed on site use proper safety equipment – for example, eye protectors, ear plugs, safety helmets, the designated safety equipment when working over water – and that proper rescue equipment is available. Fire extinguishers and first-aid equipment will be kept at all sites.

444. The construction camps are anticipated to house up to 200 people for about two years. With this concentration of people, the potential for the transmission of diseases and illnesses will increase. The main health and safety risks during construction will arise from:

- inadequate sanitation facilities in worker camps;
- introduction of sexually transmitted, and other diseases, by immigrant workers; and
- outbreaks of malaria, typhoid, cholera etc. amongst the labour force.

445. The following actions will be undertaken at construction camps and stipulated in construction contracts:

- submit and obtain approval for a health and safety plan prior to the commencement of work;
- provision of adequate health care facilities; and
- workers will be required to undergo pre-employment medical screening and treatment (if required) and periodic health checks thereafter.

446. The project will support a public health education programme for workers and villagers covering road safety, malaria, hygiene, and sexually transmitted diseases. The district health departments will also be invited to participate in monitoring and educating communities and workers affected by the project.

447. **Nuisance to Nearby Properties**. Nuisance to nearby properties is likely to result from:

- noise and vibration from mechanical devices and construction plant;
- dust during quarrying, construction and the trafficking of new surfaces prior to sealing;
- gaseous emissions from heavy equipment; and
- fumes from asphalt boiling sites.

448. The project road length Khongkhang - Moreh section pass through forest areas and presently air/dust pollution is not a major issue. Nonetheless, there will be regular watering of the road surfaces or the application of emulsion coats near villages, where dust is a nuisance. Noise generating equipment such as power generators and concrete mixers will be kept away from populated/commercial areas. Provisions will be incorporated into the contractor's contract to require the use of dust suppression measures.

449. **Interference with Utilities and Traffic.** On the project road, utilities interfere with the ROW at few locations that will have to be shifted / removed prior to construction. This should not be a major problem.

450. Traffic may experience minor delays when diverted around active construction areas, but will be more severely hampered at the locations where temporary road closures are necessary. Such hazard points will have proper signs indicating the nature of the problem envisaged.

451. Contractor will ensure that information on the timing of construction works and notifications of road closure (if any) is provided via the local media (radio, TV, newspaper etc.) or through the local community heads.

452. **Community Impacts**. Community impacts are mostly due to the resettlement of people due to widening of the project road to 2 lanes.

453. Construction camps may put stress on local resources and the infrastructure in nearby communities resulting to people raising grievances. This sometimes leads to conflict between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as health care clinics, places of worship, and occasional

entertainment. The use of local labourers during the construction will be promoted to minimise these problems.

454. **Quality of Life**. The impact of the improvements of the project road is expected to benefit the socio-economic conditions of communities in and around the project area. Improved access and reduced travel time and cost will be major stimuli to economic growth, particularly in rural areas. Better access of agricultural goods to market will be important and a major contributor to poverty reduction.

455. Increased labour mobility will occur. This has both positive and negative impacts. Increased access is a two-way phenomenon, and the corollary to increased access to the project areas is increased access for the residents of these areas to more urban life-styles. Out-migration may result. There is also the likelihood of the relocation of homes and businesses to new road-side locations.

456. During construction, benefits to local people can be maximised if the contractor recruits construction workers locally regardless of gender. Where possible, he/she should also not discriminate in the employment of women.

457. **Construction Materials**. The use of proper sources for stone and aggregates has become a major issue in most of the northeastern states. Historically, stone has been collected from the roadside or from shallow surface workings. Small quarries on steep slopes are often enlarged by blasting or excavation at the base. This is dangerous and can cause slope failures. Roadside stone collection continues in some districts despite its proven negative impacts on road safety and stability. Sand and gravel are often obtained from river deposits. Jurisdiction over stone and aggregates is shared between the Geological Survey of India and the State Forest Department. The Geological Survey of India issues licences for major mineral developments while the Forest Department issues permits for stone quarrying and for sand and gravel extraction. This is largely because these are mostly found on forest lands. Roadside quarrying is officially discouraged, but unofficially continues, invariably by petty contractors.

458. Adequate earth material is available from barren land in the vicinity. Estimated quantity is 5,5000 cum Aggregates (120000 MT) will be mostly sourced from licensed quarries available locally. Tentatively it is proposed that the aggregates and boulders will be sources from Bongmol quarry located in Chandel district located about 120 km from the project road. Sand 80,000 cum will be taken from quarries or river beds after prior permission from competent authority. Tentatively it is proposed that the sand will be sources from Nongpok Sekmei quarry located in Thoubal district at a distance of about 69 km from project road.

459. Construction water requirement (avg. 200KLD and peak 300 KLD) will be met through Imphal and Lokchao Rivers and other local streams. Domestic water requirement (40 KLD) for workers will also be met mainly through local streams. If needed, groundwater may also be abstracted.

460. The engineering team as part of material survey has identified and recommended sources of the construction materials. Details are these sources are provided in Volume 1 (Material survey chapter) of Detailed Project Report. As a prior requirement of project, every new quarry and borrow area should also be subjected to a site specific environmental investigation work according to an approved plan; and should be left in a safe condition or restored to a productive land use. Subject to these conditions, obtaining construction materials for projects will not cause unacceptable impacts.

461. Quarry and borrow pits may be filled with rejected construction waste and afterwards should be given a vegetative cover. If this is not possible, then the excavated slopes will be filled in such a way that they resemble an original ground surface.

462. Mitigation for Quarries

- aggregates will be first sourced from licensed quarry sites (which are in operation) that comply with environmental and other applicable regulations;
- occupational safety procedures/practices for the work force will be adhered to in all quarries;
- quarry and crushing units will be provided with adequate dust suppression measures; and
- regular monitoring of the quarries by concerned authorities to ensure compliance with environmental management and monitoring measures.

463. Mitigation of Borrow Areas

- prior approval will be obtained from concerned authorities and all local environmental regulations be complied with;
- within all identified borrow areas, the actual extent of area to be excavated will be demarcated with signs and access to the operational area controlled;
- borrow pit plant and machinery will conform to CPCB and World Bank EHS noise emission regulations;
- protective gear will be provided to the workforce exposed to noise levels beyond threshold limits and there should be proper rotation of such personnel; and
- all operation areas will be water sprinkled to control dust levels to national ambient air quality standards.

464. The project will require large amounts of bitumen or bitumen emulsion usually stored in drums. These empty bitumen drums are generally recycled as steel sheeting, or used in road construction as parapets or for riverbank stabilization. When supplied and used in this manner, bitumen is not regarded as a significant environmental hazard.

465. The project will require the import, transport and use of fuel and oils. Minor diesel spills are common in region, especially around fuel stations. To mitigate these impacts following measures will be applied.

- Secondary containment around fuel tanks and at fueling stations will be built;
- Oil and fuel spills, and other runoff from contaminated areas will be controlled; and
- Equipment and fuel depots will be placed in safe zones away from drinking water sources and along riverbanks.

466. The project provides an opportunity to assist the PIU and contractors in improving fuel handling practices so as to minimise future fuel spillage.

E. **Environmental Impacts - Operation Phase**

467. **Noise Vibration, Air Pollution, Runoff, Spoils of Hazardous Materials.** The current low traffic flows along the project road is expected to increase because of improved economic activities associated with better access. The larger numbers of vehicles will be an additional source of noise and gaseous emissions.

468. The predication of future noise levels due to increase in traffic has been carried out using FWHA noise model. The detail results are provided discussed in Table 75. It is found that an incremental increase of about 3 dB(A) noise level is expected due to increased traffic over the designed life of the project i.e. 20 years. Most of these increase in noise level will be attenuated by natural means i.e. distance form source, obstacles from nearby and surrounding building and structures, difference in levels of vehicle and receptor as well as installation of recommended mitigation measures such as installation of noise barriers at sensitive location, planning of trees etc.

469. Repairs to culverts and new drainage work will eliminate/reduce the soil erosion problems presently caused by poor cross drainage. Also, the situation will remain good because this road

pass through area that are largely forested and trees and plants have the capacity to absorb gaseous as well as noise pollutants. Bioengineering techniques may also help to absorb pollution.

470. The project road is part of Asian Highway network which will carry a variety of goods and materials across ASEAN countries. With the road improvements including safety measures, it is envisaged that overall road safety will improve resulting to reduced risk of accidental spillages.

471. **Flora and Fauna.** ***Terrestrial Flora:*** Positive impacts on terrestrial ecology are expected during the project operation stage due to the increase in vegetation and landscaping along the subproject road. The project will coordinate with the local forest office and communities to maintain and enhance the trees planted along the road section. No adverse impact is anticipated during operation stage except accidental damages or absence of proper tree management.

472. To conserve the critical flora habitats of the YLWLS, the project will support plantation of rare and endangered indigenous tree, shrubs, herbs, grass species, etc. as prioritized in the wildlife management plan of YLWLS. The species which could be planted include *Tectona grandis, Dipterocarpus turbinatus, Dipterocarpus tuberculaus, Melonarrhoea usitata, Duabanga Sonnoroedes, Dillenia pentagyna, Terminallia tomentosa, Gmelina arborea, Bauhinia spps., some species of bamboos, orchids,* etc.

473. To mitigate possible impacts, arrangement will be made to ensure survivability of the tree plantation. Budgetary provision is made for tree plantation and maintenance of newly planted sampling for next three years. Respective agency village panchayat or forest department as the case be accountable to ensure minimum survivability rate of 70%. Forest department as well as village panchayat will also be advised to submit compensatory tree plantation plan in advance which can be audited for performance tracking. The tree survivability audit will also be conducted at least once in a year to assess the effectiveness of the programme. Audit will be carried out with the help of experts either through supervision consultant or external monitor.

474. **Terrestrial Fauna:** Post project scenario is expected to reduce the man-animal conflict. However, strict vigil will be required to prevent such conflicts. It is also proposed to follow conservation programs as prioritized in the wildlife management plan of YLWLS and terms and conditions given in Wildlife Clearance from MoEFCC for this road section. This will be done in consultation with wildlife and forests department. Budgetary provision for the same is made in the EMP budget.

475. Although the project is directly not affecting the rare or endangered specialist of wildlife, the project will collaborate with YLWLS officials in its conservation programmes for key rare and endangered species of faunal habitats particularly *Hoolock gibbon, Slow lorries, Malayan Sun Bear, Serrow, Pangolin, Leopard, Golden cat, Hornbills* etc.

476. To mitigate operational impacts it is proposed to carry periodic visual check of functionality of underpasses and other measures taken for the protection of animals. Periodic data pertaining to animals accidents and animal as well human deaths, movement frequency of wild animals, route followed by wild animals will be collected from wildlife sanctuary authorities for at least three years during operation stage. Suitable corrective actions like maintenance of guide rails will be initiated in-case conflict level is found increasing. Relevant expertise under the CSC (wildlife expert, environmental expert) or external monitor or others may be employed for this.

477. **Aquatic Ecology**: No impact is envisaged during operation phase of the project and hence no mitigation proposed. However, periodic surveillance will be conducted to check erosion and siltation in major water bodies.

478. **Land Use and Settlements.** The likely impacts on land use and settlement patterns are limited. Improved access will lead to increased migration, but this will occur gradually and over a prolonged period. There will be time for new residential areas to be established. There will be a need to control ribbon development.

479. **Social Impacts.** Specific benefits to local people will include:

- easier communication;
- easier access to markets (both internally and regionally) with savings in travel times and costs;
- enhanced market efficiency through better distribution and accelerated deliveries etc.;
- improved access to health, education and other social services;
- employment generation;
- improved technical skills; and
- enhanced economic activity.

480. Likely adverse social impacts will include:

- increased chances of exposure to communicable diseases, particularly during construction;
- influxes of new settlers leading to increased pressure on natural resources causing hardship to local communities relying on local/forest resources; and
- rural-to-urban migration causing labour shortages in the depleted rural areas and other negative impacts in the urban areas.

481. **Induced and Cumulative Environmental Impacts.** According to the ADB Environment Safeguards Sourcebook[15] Cumulative Impacts is described as: “The combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that cannot be expected in the case of a stand-alone project.” The sourcebook also describes Induced Impacts as: “Adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location.

482. **Cumulative Impacts.** The existing projects with significant environmental implications in the project areas are cross border trade through Asian Highways, quarry development in Tengnoupal district, and new township development at Moreh.

483. The establishment of civilian government in Myanmar and the intensification of engagement with other countries and relaxation of trade sanctions is opening up trade opportunities with Myanmar. India is engaged in Myanmar with several projects and is actively taking steps to upgrade border trade infrastructure and other trade facilitation measures. All these are expected to significantly increase the border trade. The India-ASEAN FTA in goods has seen increasing India’s trade with ASEAN has seen large increase reaching USD 81.3 billion last year (2018). With the opening up of Myanmar and the large potential in India-ASEAN trade growth, there is vast scope for generating traffic from adjacent country Myanmar for the various tradable goods. The trade potential at the Indo-Myanmar border through Moreh was estimated based on available assessments from various sources[16,17] and volume of trade estimated through Moreh Integrated Check post within 5 years of its operationalization. It is expected that a large portion of North East India’s needs will come through these border points in future. Based on the details collected from the Manipur PWD, the estimated goods vehicle traffic are given below for each type of tradable item:

- Pulses, beans and lentils: 150 truckloads daily @ 10 tons capacity (Background of the forecast: Estimated at two-third of the North East India pulses Consumption @ 58.1gm/capita/daily currently brought from rest of India).

[15] Environment Safeguards, A Good Practice Sourcebook, Draft Working Document, December 2012

[16] Kimura, F., T. Kudo and S. Umezaki (2011), ‘ASEAN-India Connectivity: A Regional Framework and Key Infrastructure Projects’ in Kimura, F. and S. Umezaki (eds.), ASEAN-India Connectivity: The Comprehensive Asia Development Plan, Phase II, ERIA Research Project Report 2010-7, Jakarta: ERIA, pp.1-56.

[17] Augmenting Bilateral Trade Between India &Myanmar, Country Report, Indian Chamber of Commerce, 2012

- Timber and timber products (teak, hardwood & C class) – for use in 'Timber Park' at Moreh and for domestic demands: 50-60 truck loads daily (Background of the forecast: Estimated volume 200,000 cubic meters, (100,000 cum from Myanmar and 100,000 cum import from ASEAN Countries)).
- Minerals (coal, limestone, granite, iron ore, gypsum, silica sand, dolomite, rock phosphate etc.)= 75 to 200 truck loads daily. (Background of the forecast: Estimated at the installed manufacturing capacity of the factories in North East and local market).
- [India is importing about 5 million tons of rock phosphate for manufacture of fertilizer; of this about 2 million tons are imported from Kunming China. In return China imports 1.5 to 2 million tons of iron ore from India. Kunming to Kolkata via Moreh-Manipur route is less than 2000 Kms. There are huge coal mines in Myanmar, coal is cheaper and better. Other minerals command the same advantage from commercial points of view.
- Items of general trade & commerce: 40 to 60 truck loads daily. Items: Industrial goods & FMCG products, steel bars, cement, hardwares, petroleum products, tyres, automobile parts, machinery, equipments, fabric, yarn, essential commodity products, tea, marine fish, crafts & handlooms products, minor forest products etc.

484. Assuming about one-third of the export-import through land routes and Moreh being the main gateway from Myanmar, the potential of trade through Moreh is of the order of UD$ 600 million and this in terms of truck traffic based on broad assumptions is equivalent to about 750 trucks per day. With an annual growth of 14% in trade between India and Myanmar and the potential for trade with other ASEAN countries also through this corridor, it is safe to assume the potential will realize in the next 10 years and the potential for truck traffic is of the order of 1000 trucks per day along this corridor including empty trucks by 2022. This is also in line with the above estimate of about 400 trucks for import alone from Myanmar (almost 600 trucks including empty trucks).

485. The road upgrading will also improve the travel speed and travel condition along the Imphal - Moreh corridor and is expected to generate a road user cost saving of over 20% and this will result in additional traffic generation along the corridor which is taken at 10% of the traffic

486. In addition, there is potential for large scale quarry development along project corridor (mainly Khudhengthabi area) this corridor with abundant quantity of good quality aggregate availability. Based on consultation with state PWD and others involved in the construction industry, it is estimated that about 200 trucks per day will be generated by developing the quarries. This is expected to happen within 5 years of opening of the road. Besides vehicular emission, other impacts associated with operation of quarries are soil erosion, noise and dust.

487. Development of proposed new township[18] at Moreh is also expected to contribute to traffic. The township is planned for next ten years. It is expected that about 80-100 vehicles will be added to the project road due to this proposed township. The environmental issues associated with township would be vehicle pollution, waste management etc.

488. Currently there is no other information on future development projects along the project road. Hence, it is difficult to assess cumulative impacts from other projects which may get implemented in the project area.

489. **Induced Impacts.** An assessment is made of likely induced impacts due to improved project activities. The trade level between border countries is on rise since a very long period. The damaged road condition has little deterrent on trade in the past through, it has posed substantial inconvenience to people and trading community. The region to which the road traverse is already developed in terms of industry and trade aspects for supply of commodities required by neighbouring countries. The improved road is expected to increase transport through

[18] Master Plan for new township at Moreh, Manipur (2013-2032) prepared by Town and Country Planning Organization, MoUD, Government of India.

this region but is unlikely to trigger exponential development in this region. Setting up few new industries and increase in trade volume though cannot be ruled out. As such no significant induced environmental impact is anticipated due to proposed project activity. Few of the probable positive and negative induced impact are indicated below:

Positive Induced Impacts

- Increased Trade Opportunities among ASEAN countries
- Increase in Per Capita Income in Manipur and country as a whole
- Easy access to cross country education and employment opportunities
- Increased competition requiring better products at least costs, forcing entrepreneur adoption of technologically advanced systems and process resulting in efficient resource utilisation,
- Link infrastructural development.

Negative Induced Impacts

- May stress the available limited resources
- May lead to conversion of more and more agricultural areas to non- agricultural uses
- May have cultural changes due to movement of people from different caste and culture
- May lead to faster growth of urban population putting larger pressure on municipal infrastructure.
- May result in deterioration of air, water and soil quality due to inappropriate disposal of municipal waste and increase of vehicle population in satellite township areas,
- Illegal felling of trees or sourcing other natural resources and poaching,
- Cross-border trade of wild animals
- Increase in road safety risks and vehicle wildlife collisions due to increased traffic.

490. For addressing the impacts of air pollution, noise and safety, measures on regular maintenance of the road including the road furniture, monitoring of vehicle emissions and enforcement of BIS-IV standards, construction of noise barriers and others have been included in the EMP during operation stage.

491. The improved road will improve access to the forested area between Lokchao and Moreh. The local forestry officials have expressed that the improved road will bring better accessibility for patrolling the forest area for illegal activities especially from across the border to India. Currently, they patrol the area by travelling on foot and hence are limited in the area that they can cover as well as the frequency of patrolling. However, it is also likely that there will be better accessibility for carrying out illegal activities on the other hand. To mitigate these impacts the local Forestry officials will conduct stringent monitoring and patrolling. It is also likely for vehicle wildlife collisions to occur. To address this concern the road design has included features such as gentle slopes, speed breakers, sign boards and underpass bridge at Lokchao river. The Wildlife Specialist under the Construction Supervision Consultant's team will continue monitoring the effectiveness of these measures during the early stages of the project operation period and provide recommendations for improvement if necessary.

492. **Potential Environmental Enhancement/ Protection Measures**. Annex -7 to Annex -11 of this EIA Report presents good environmental management practices and guide documents in the following aspects of road construction:

- Plant Management – Annex 7.
- Camp Site Management – Annex 8.
- Debris Disposal Management – Annex 9.

- Borrow Area Management – Annex 10.
- Quarry Area Management – Annex 11.

VI. ANALYSIS OF ALTERNATIVES

A. Introduction

1. This chapter presents the symmetrically compared feasible alternatives to the proposed project with respect to site, design, technology etc. Since, the proposed project is an improvement of the existing road, no alternative alignments were considered for alternate route. Hence, an evaluation has been carried out for the 'with' and 'without' project situation-in terms of the potential environmental impacts for the justification of the project. This chapter discusses how environmental parameters were assigned due importance and were carefully considered in the analysis of alternatives.

B. 'With Project' and 'Without Project' Scenario

2. **'With Project' Scenario**. The 'with project' scenario includes the widening of road sections to two lane carriageway configurations of the existing road sections of Khongkhang-Moreh (Asian Highway 1) in Manipur. The 'with project' scenario has been assessed to be economically viable and will alleviate the existing conditions. It would thereby, contribute to the development goals envisaged by the Government of India, and enhance the growth potential of the state as well as SASEC Region as well as region.

3. To avoid the large-scale acquisition of land and properties, the project envisages the widening of road to intermediate lane and mostly along the existing alignment to minimize the loss of properties and livelihood of the PAPs.

4. '**Without Project' Scenario**. In the case of 'without project' scenario the existing road with narrow carriageway width will be considered as it is. Considering the present traffic volume and potential for growth in near future, the capacity of the present road is insufficient for handling expected traffic volume and calls in for immediate improvements.

5. The existing road section has poor riding condition with landslide zones, poor drainage conditions and poor geometry. Poor drainage is seriously impacting and deteriorating the road surface. This is further compounded by the landslides and disrupting the traffic for long hours particularly in monsoon season. The poor road conditions, population growth, increase in traffic volumes and the economic development along the project corridor would continue to occur and will exacerbate the already critical situation. The existing unsafe conditions and the adverse environmental consequences, in terms of the environmental quality along the roads, would continue to worsen in the absence of the proposed improvements.

6. Therefore, the no-action alternative is neither a reasonable nor a prudent course of action for the proposed project, as it would amount to failure to initiate any further improvements and impede economic development. Keeping in view the site conditions and the scope of development of the area, the 'With' and 'Without' project scenarios have been compared as shown in Table 83. By looking at the table it can be concluded that "With" project scenario with positive/beneficial impacts will vastly improve the environment and enhance social and economic development of the region compared to the "Without" project scenario, which will further deteriorate the present environmental setup and quality of life. Hence the "With" project scenario with minor reversible impacts is an acceptable option than the "Without" project scenario. The implementation of the project therefore will be definitely advantageous to achieve the all – round development of the economy and progress of the State.

Table 83: Comparison of Positive and Negative Impacts of 'With' and 'Without' Project Scenario

With Project		Without Project	
Impacts		**Impacts**	
+ve	**-ve**	**+ve**	**-ve**
• With the improvement of road surface and slope protection measures, the traffic congestion due to obstructed movement of vehicles will be minimized and thus wastage of fuel emissions from the vehicles will be reduced. • Tourism will flourish. • Better access to other part of the region as the project road is a lifeline of the region. • Providing better level of service in terms of improved riding quality and smooth traffic flow. • Will reduce accident rate.	• Minor change in topography is expected due to construction of embankments. • Minor changes in land use pattern. • Loss to properties and livelihood.	Nil	• Increase in travel time. • Increase case of landslide and soil erosion. • Increase in fuel consumptions. • Increase in dust pollution and vehicular emission. • Increase in accident rate. • Overall economy of the State will be affected.
• All weather access reliability.	• Removal of vegetative cover along the road at selected locations and loss of trees. • Impacts of flora and fauna. • Diversion of small area of forest land.	Nil	• Increase in accidents.
• Reduced transportation costs.	• Increase in air pollution due to vehicular traffic. • Short term increase in dust due to earth work during construction at micro-level.	Nil	• Project road will further deteriorate.
• Increased access to markets.	• Increase in noise pollution due to vehicular traffic during construction work.	Nil	• Increased vehicle operation cost.
• Access to new employment centers.	Nil	Nil	• Reduced employment/ economic opportunities.
• Employment to local workers during the execution of the project.	Nil	Nil	• Arrest of possible significant enhancement and economic development of the region.

With Project		Without Project	
Impacts		**Impacts**	
+ve	**-ve**	**+ve**	**-ve**
• Better access to health care centres and other social services. • Improved quality of life.	Nil	Nil	• Land degradation, dust pollution and damage to pastureland, contamination in water bodies due to vehicles travelling along multiple tracks on the open ground. • Deep impact to human health in case of emergency.
• Strengthening of local economies.	Nil	Nil	• In absence of the project, it is extremely difficult to generate funds for such a massive improvement of the road infrastructure from its own resources.
• Reduction in travel time and development of the important places of in the district of Tengnoupal of Manipur State.	Increase in speed may lead to accidents in congested areas.	Nil	• Affect the development of the area.
• Reduction in erosion and landslides from multi tracking and stone pitching of elevated embankments.	Nil	Nil	• Increase in dust pollution and creation of sedimentation problems in water bodies.
• The widened and paved road will reduce impacts due to multiple tracking on soil and vegetation along the road.	Nil	Nil	• Increased adverse impacts on soil and vegetation.

C. Location and Alignment Alternatives

7. The proposed road section is a strategic road under ASEAN Highway and GOI has planned to implement this road from regional cooperation, economy and trade perspective. Therefore, no alternate location were considered for this project.

8. The selection of a particular alignment is a difficult process that is seldom clear or straight forward. In this section the principal differences among the feasible alternatives for road segment are considered in regard to potential environmental impacts alongside length, cost and communities provided access.

9. No alternative alignments were assessed as part of the Khongkhang-Moreh section of NH-102.

10. The improvement of existing national highway section to be the best possible alignment. This alignment has following advantages over any other alternate alignment option:

- It follows existing alignment for entire section.
- Land take from forest and private parties is less compared to new alignment, if proposed.
- Length of road passing through wildlife sanctuary is less,
- NH section is geologically more stable,
- Cost of construction is lower for 2 lane configuration road.

D. Alignment Modifications due to Environmental Considerations

11. The selection of the alignment / widening options along various sections has been worked out based on continuous interaction between the engineering design team and environmental study teams. Various alignment improvement alternatives (left/right) for the project road have been analyzed along entire project road considering rural sections, alignment in forest areas and junction improvements. The factors considered for evaluation of alternatives are:

- Flora and fauna likely to be impacted;
- Productive agricultural land likely to be impacted;
- Impact on water resources and surface water bodies;
- Environmental quality.
- Land availability;
- Land uses along the alignment;
- Residential / Commercial structures Impacted;
- Utilities likely to be impacted;
- Common property resources likely to be impacted; and
- Religious structures affected.

E. Engineering / Technological Alternatives

12. The formulation and analysis of engineering alternatives have been undertaken in terms of alternative cross-sections of road, highway-design principles (such as embankments for soil erosion and slope protections, hill cuttings, minimum width of road ride drainage, adequacy of roadway width at cross drainage structures, minimum gradient, etc.), comparison between flexible and rigid pavements (cement-concrete built rigid pavement as being environmentally superior then traditional flexible pavement), and selection of environmental friendly road construction methods.

13. The final alignment considered after detailed survey and design is about 29.516km in length, which is last section of about 3.700 km length in Moreh Town is proposed for re-surfacing only. As bypass to Moreh Town already being taken up by NHIDCL as separate project.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

14. In accordance with ADB's Safeguard Policy Statement (SPS) 2009 and Environment Impact Assessment Notification of GoI (2006), public consultations were held, as part of environment assessment study. The consultation undertaken with project beneficiaries, local/ government officials, community leaders, non-government organizations (NGO's), stakeholders in the corridor of impact and people likely to be effected due to the project on various issues affecting them and incorporation of various measures pertaining to environmental issues based on the responses from the people.

A. Objectives of Consultations

15. The process of public participation/ consultations was taken up as an integral part of the project in accordance with environmental assessment requirements. The objectives of these consultations are:

- To inform and educate the general public, specially potentially impacted communities/ individuals and stakeholders about the proposed project activities;
- To familiarize the people with technical, environmental, social and economic issues of the project for better understanding;
- To solicit the opinion of the affected communities/ individuals on environmental issues and assess the significance of impacts due to the proposed development;
- To foster co-operation among officers of NHIDCL, the communities and the stakeholders to achieve a cordial working relationship for smooth implementation of the project;
- To identify the environmental issues relating to the road improvement work;
- Assess the views of the beneficiary communities and their willingness to participate in the project in a bottom up planning and decision-making process;
- To secure people's inputs in respect of project planning, selection of mitigation measures and monitoring strategies;
- To ensure lessening of public resistance to change by providing them a platform in the decision-making process;
- To inculcate the sense of belongingness among the public about the project.

B. Methodology used for Consultations

16. Both formal and informal modes of consultation were used in the public consultation process for the project. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questionnaires. In addition, focused ground discussions (FGDs) and personal discussions with officials, on-site discussion with project affected stakeholders, and reconnaissance visits have also been made to the project area. The attempts were made to encourage participation in the consultation process of the government officials from different departments that have relevance to the project. Same way, local people from different socio-economic backgrounds in the villages as well as urban areas along the road alignment and at detours, women, residents near the existing road, local commuters, and other concerned were also consulted.

C. Identification of Stakeholders

17. Stakeholders were identified to ensure as wide coverage as possible of the project area as follows:

- Households in the project area including potential Project Affected Persons,
- Women groups,
- Local, regional and international voluntary organisations / non-government organizations (NGOs),
- Government agencies, and

- Community leaders.

18. Questionnaire survey/ discussions were designed to obtain background information and details of general environmental issues that concern people in the project area. In addition, environmental issues were discussed with relevant organizations, government officials, beneficiaries, community leaders, women groups and experts.

19. In compliance with ADB's SPS requirements consultations will be continued throughout the project planning, design and implementation phase. The consultation process initiated during preparation of the EIA. The official consultation with the key stakeholders was undertaken in the months of February to March 2019 at respective district office and head quarter in Imphal. Various officials consulted include NHIDCL Officials, Forest Officers, Wildlife Officials, Environmental Officers from pollution control board, statistical officer, officials from NGOs active in the project areas etc. Various issues discussed are:

- Statistics of forests cover in the State and its legal status i.e. Reserved, Protected, Unclassed;
- Protected area network of Manipur,
- Applicability of various laws and regulations to the present road development project;
- Requirements of Forest Department to carryout project activities within forest /protected areas;
- Flora and Fauna and endangered species in the State and project area in particular;
- Scope of the proposed road development, EIA and likely impacts on flora & fauna;
- Major threats to flora & fauna in the state;
- Procedure to get clearance from forest department and NOC from pollution control board;
- Environmental quality parameters i.e. air, water, noise quality in the State and major sources of pollution;
- Institutional capacity of state authorities in pollution control and environmental management;
- Socio-economic conditions and likely impacts on due to proposed road improvement;

20. The list of officials/ people contacted along with the venue, issues raised, date of consultation is presented on Table 84.

Table 84: List of Officials Consulted & Issues Discussed During Field Visit

Sl. No.	Name of Official Consulted	Department	Issue discussed
1.	Mr. Sunil Kumar Singh	General Manager, NHIDCL Manipur, Imphal	Existing conditions of NH road, Major problems of national highway roads, clearances /permits requirements, Treatment to landslides
2.	Mr. Sanjoy Kumar	Manager, NHIDCL Manipur, Imphal	Existing conditions of road, alignment details and design, clearances /permits requirements, muck disposal areas etc.
3.	Mr. Soma Prakash Mitra	Manager-Environment, NHIDCL Manipur, Imphal	Forest and wildlife clearance proposal for the section, terms & conditions of Wildlife clearance for the project road section, muck generation & disposal sites etc.
4.	Shri P.N. Prasad	PCCF, Forest Department, Govt. of Manipur, Imphal	Scope of EIA, Impacts on wildlife and forest, Wildlife status in state, flora & fauna species, environmental aspects of hilly roads, regulatory

Sl. No.	Name of Official Consulted	Department	Issue discussed
			requirements of Manipur and GOI for the implementation of the Project.
5.	Mr. Anurag Bajpai, IFS	CCF (Forest and Wild Life) and Env. & Biodiversity, Forest Department, Govt. of Manipur, Imphal	Scope of EIA, Impacts on wildlife and forest, Wildlife status in state, flora & fauna species, environmental aspects of hilly roads, regulatory requirements of Manipur and GOI for the implementation of the Project.
6.	Mr. L. Joukumar Singh, IFS	Dy. Conservator of Forests (Wildlife), National Parks and Sancturies Division, Forest Department, Government of Manipur, Imphal	Scope of EIA, Impacts on Wildlife and forest, Wildlife status in state, flora & fauna species, Environmental aspects of hilly roads Scope of EIA, Impacts on Wildlife and forest, Wildlife status in state, flora & fauna species, Environmental aspects of hilly roads.
7.	Mr. Dhananjay, IFS	Chief Conservator of Forests, Forest Department, Manipur, Imphal	Details of Flora & Fauna, Forest Resources, Scope of EIA, potential impacts due to proposed project
8.	Mr. Mahendra Pratap, IFS	Chief Conservator of Forests, Forest Department, Manipur, Imphal	Details of Flora & Fauna, Forest Resources, Scope of EIA, potential impacts due to proposed project
9.	Mr. R.S. Arun, IFS	Dy. Conservator of Forests (Wildlife), National Parks and Sancturies Division, Forest Department, Government of Manipur, Imphal	Scope of EIA, Impacts on Wildlife and forest, Wildlife status in state, flora & fauna species, Environmental aspects of hilly roads
10.	Ms. Waikhom Romabai	DFO, Wildlife (YLWLS), Moreh	Details of wildlife in the Core Zone of YLWLS, Forest Resources, Management Plan, census study data of fauna along the road, scope of EIA, potential impacts due to proposed project.
11.	Mr. T. Mangi Singh	Member Secretary, Manipur Pollution Control Board (MPCB), Lamphalpat, Imphal	Applicability of MPCB requirements for the currently road development project. Ambient air quality monitoring network in Manipur and existing environmental quality in Manipur.
12.	Mr. Heiribo Tomba Singh	Scientist C, MPCB, Lamphalpat, Imphal	Environmental quality monitoring for along project road section. Existing environmental quality in Manipur.
13.	Dr. Raju Themba Singh	Associate Professor, Deptt. Of Environment Science, Manipur University, Imphal	Environmental quality and issues in the project areas. Research projects on biodiversity.
14.	Mr. RajKumar Birjit Singh	State coordinator, Indian Bird Conservation Network (IBCN), Ningthoukhong, Bishnupur, Manipur	IBCN activities in Manipur, biodiversity issued in Manipur, bird conservations programs in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of birds and wildlife in Yangoupokpoi Lokchao Wildlife Sanctuary.
15.	Mr.Wahengbam Rajesh Singh	Nodal Person, Indian Bird Area (IBA) Program for Yangoupokpoi Lokchao	Bird conservations programs in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of

Sl. No.	Name of Official Consulted	Department	Issue discussed
		Wildlife Sanctuary, IBCN, Imphal, Manipur	birds and wildlife in Yangoupokpoi Lokchao Wildlife Sanctuary.
16.	Ms. Archita B. Bhattacharyya	Program Officer, WWF India (Assam & Arunachal Pradesh State Office), Uzan Bazar, Guwahati	WWF activities in Manipur and northeastern region, biodiversity issued in Manipur, conservations programs in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of flora and fauna in Manipur and in Yangoupokpoi Lokchao Wildlife Sanctuary.
17.	Mr. Sharat Kumar	Range Officer, Wildlife Department, Imphal Manipur	Wildlife animals in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of birds and wildlife in Yangoupokpoi Lokchao Wildlife Sanctuary

21. In order to document likely impacts on affected persons, an interview survey has been carried out. A sample of PAPs was selected and interviewed through a designed questionnaire. Precaution has been exercised during the survey to ensure that the sample interviewed is truly representative of the affected groups and the questions are worded so as not to generate a bias response. Figure 40 below shows one such interview survey. The consultation is focused on:

- General awareness in local communities about environmental quality in terms of quality of water in rivers, ponds, lakes, ground water, ambient air and noise quality and its sources.
- Presence of archaeological / historical sites, monuments in the project region and likely impacts.
- Presence of endangered /rare species of flora and fauna and its locations in the project region.
- Frequency of natural calamities / disasters in the region.
- Seek views of people on the project.
- Cultural places along the project roads and likely impacts of proposed road development, etc.

Consultation with Lokchao community head

Consultation with Khudhengthabi community head

Consultation with local community at Lokchao

Consultation with local community at Khongkhang

Consultation with local community at Moreh

Consultation with local community at Moreh

Figure 40: View of Consultation

22. Besides interview surveys, focused group discussions (FGDs) were organized at key locations along the project roads. In total there are 10 communities (villages) along the project road and all the communities have been consulted as part of environmental and social safeguards assessment. Details are given in Table 84.

Table 84: List of Villages and Community Consulted along the Alignment

Sl. No	Name of Village	Chainage	Covered under FGDs	Date of FGDs
1	Khongkhang	396+100-396+200	Yes	23.02.2016 (IEE) 11.01.2016 (SIA)
2	Lokchao (Tuipi)	404+600-404+700	Yes	23.02.2016 (IEE) 08.01.2016 (SIA)
3	Khudengthabi	412+100-412+300	Yes	23.02.2016 (IEE) 09.01.2016 (SIA)
4	K. Zalenmol	415+800-415+900	Yes	07.01.2016 (SIA)
5	Zomunnum (Chahnou)	415+800-415+900	Yes	25.02.2016 (IEE) 07.01.2016 (SIA)
6	H.Mongjang	415+900-417+100	Yes	07.01.2016 (SIA)
7	L.Phiamol	416+360-416+630	Yes	08.01.2016 (SIA)
8	Jangnouphai	416+360-418+260	-	

Sl. No	Name of Village	Chainage	Covered under FGDs	Date of FGDs
9	New Mongjang	419+500-419+600	Yes	08.01.2016 (SIA)
10	Moreh / Chikkim	420+600-420+700	Yes	25.02.2016 (IEE) 09.01.2016 (SIA)

23. As part of environmental assessment process five (5) FGDs meetings involving 105 affected people, landowners, and village authorities, were organized. Specific emphasis was given to women participants to ensure that gender concerns are addressed in the project. Out of total participants, 29 participants were from women group. Besides these five FGDs, local communities have also been consulted through nine (9) FGDs conducted as part of social impact assessment. In total 178 persons (57 female and 121 male) participated in nine (9) FGDs. Both environmental and social safeguards issues have been discussed during these FGDs.

24. Summary of public consultations through focused ground discussion (FGD) meetings organized is presented in Table 85.

Table 85: Summary of Public Consultations Conducted during IEE Preparation

Date	Venue / Place	Participants	Remarks
Khongkhan-Moreh NH Section			
23 February 2019	Village: Khongkhang	12 Participants (9 man and 3 women) from village community including village head, housewife, business owners, labours, farmers and students	All participants supported the project.
	Village: Lokchao	17 Participants (12 man and 5 women) from village community including village head, housewife, business owners, labours, and farmers.	All participants supported the project.
	Village: Khudhengthabi	28 Participants (19 man and 9 women) from village community including villages head, housewife, business owners, labours, farmers and students	All participants supported the project.
25 February 2019	Village: Jangnouphai	17 Participants (14 man and 3 women) from village community including village heads, housewife, business owners, labours, farmers and students	All participants supported the project.
	Village:Moreh	31 Participants (22 man and 9 women) from village community including government servants, housewife, business owners, labours, farmers and students	All participants supported the project.
	Total	**105 (man - 76, women - 29)**	

D. Results of Consultations

25. Most of the people interviewed strongly support the project. The people living in the entire project area expect the different project elements to facilitate transport, employment, boost economic development and thereby provide direct, or indirect, benefits to themselves.

26. Construction camps may, however, put stress on local resources and the infrastructure in nearby communities. In addition, local people raised construction-process related grievances with

the workers. This sometimes leads to aggression between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as proper housing, health care clinics, proper drinking water and timely payment. The use of local labourers during the construction will, of course, increase benefits to local peoples and minimise these problems. Wherever possible, such people should be employed.

27. In order to access the existing environment and likely impacts on PAPs, an interview survey has been carried out. A sample of PAPs has been interviewed through a designed questionnaire. Precaution has been exercised during the survey to ensure that the sample interviewed is truly representative of the affected groups and the questions are worded so as not to generate a bias response.

28. It is envisaged from the interview survey that there is increased environmental awareness among the people. It can also be seen from the table that more than 70% of the persons believes the existing environmental conditions of the area is good. Over 90% of the people agreed that the quality of air, water and noise in the area is good; whereas, about 6% respondent feel that the environmental quality is being deteriorated. Poor road condition and vehicular emissions are the major sources they feel responsible for this. In case of presence of archaeological / historical the responses are very few. The area has great cultural significance as 80% people say that there are places of cultural significance in the region. The area experiences natural disasters i.e. floods, earthquake etc. as it also envisaged that 73% of respondent reported history of natural disaster. About 63% people indicated that there are rare and endangered species of fauna in the forests of the region. Overall, the general environmental conditions in the region are good and people have increased environmental awareness. Table 86 shows the result of public opinion survey carried out in the region.

Table 86: Peoples' Perception about Environment Degradation

Sl. No.	Question asked about	No. of people interviewed	Positive response (%)	Negative response (%)	No response (%)
1.	Water quality of rivers, ponds, wells, and canals	39	94	6	0
2.	Noise quality of the area		87	13	0
3.	Air quality of the area		94	6	0
4.	Archaeological sites		82	6	12
5.	Natural disaster		73	27	0
6.	Rare species of animals and birds		63	37	0
7.	Cultural sites i.e. market, melas		88	6	6

Note: Positive response shows that the overall environmental scenario in the area is good and wise versa.

29. During FGDs, local people extended their support to the project as they expect better connectivity and improved livelihood opportunities from the development of proposed road sections. Details of issues discussed during FGDs conducted as part of IEE and mitigation measures incorporated in the project design are presented in Annex-12 whereas detailed of nine FGDs conducted as part of social impact assessment are included in the Resettlement Plan.

E. Interaction with Local/National and International NGOs

30. In order to get independent views on the likely impacts of the projects, non-government organizations at local as well as international level were consulted during the EIA process. This includes Indian Bird Conservation Network (IBCN); World Wide Fund (WWF) for Nature Assam Office; and local self-help groups. The IBCN is active in Yangoupokpoi Lokchao Wildlife Sanctuary whereas the WWF do not have direct activities along the project road. Local NGOs consulted included i) Social Education and Economic Development Society (SEEDS)- Wangjing;

ii) Social and Health Development Organization-Moreh; and iii) Socio-Economic Development Association (SEDA)- Thoubal.

31. Aspects such as conservation activities, presence of flora and fauna, likely project impacts and possible mitigation measures were discussed and views and suggestions from these NGO's were incorporated in the EMP. IBCN informed that YLWLS is one of the nine important bird areas (IBA) identified in Manipur. It was informed that the area is rich in endemic bird species such as of the *genus Sphenocichla* (Babblers), Peafowl etc. At present there are no ongoing programs on conservation of birds in the sanctuary but IBCN is willing to support project with conservation measures. WWF informed that they do not have any ongoing programs in the project region. Local NGOs are willing to support project in implementing wildlife conservation activities.

32. Consultation will continue with these NGO's during finalization of EIA, and project implementation and operation.

F. Public Disclosure

33. The project EA will be responsible for the disclosure of this EIA in compliance to ADB's Communication Policy 2011 and ADB SPS 2009. The draft Environmental Impact Assessment Report will be disclosed in the English language in the office of NHIDCL. The report will also be made available to interested parties on request from the office of the NHIDCL. Since this is Category A subproject, this draft EIA report will be disclosed to the public through the ADB website, 120 days before the approval of the respective tranche for ADB financing. This draft EIA report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009.

VIII. GRIEVANCE REDRESS MECHANISM

34. Grievances related to the implementation of the project, particularly regarding the environmental management plan will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the semi-annual environmental monitoring report to ADB.

35. Depending on the nature and significance of the grievances or complaints, the grievance redress mechanism (GRM) will comprise procedures to address grievances i) first at the PIU level and ii) second at the EA level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the EA level will be forwarded to the GRC. The GRC will comprise members from the EA, IA, CSC, contractor, local community, women groups and local forestry authority.

36. All the parties involved in project implementation i.e. contractor, engineer, and employer will maintain complaint registers at their following respective offices:

- Contactor's main site offices i.e. office of the Project Manager,
- Supervision Consultants' main site office i.e. office of the Engineer's Representative; and
- NHIDCL's Branch Office i.e. Employer's field office.

37. Environment complaints will be received through the Grievance Focal Point (GFP), these will be designated personnel from within the community and appointed by the community, who will be responsible for receiving the Environmental complaints. The Contractor will record the complaint in the onsite Environmental Complaints Register (ECR) in the presence of the GFP.

38. All public complaints regarding environmental issues received by GFP will be entered into the register with specific details such as name and address of the person or representative of the community registering a complaint, the details of complaint, and time. The Executive Engineer and Engineer's Representative will immediately communicate the details of the complaint to the Contractor. The Environment and Safety Officer (ESO) of the contractor will promptly investigate and review the environmental complaint and implement appropriate corrective actions to mitigate the cause of the complaints. The Engineer's Representative will decide on the exact time frame within which the action will be taken on case-to-case basis depending on the nature and sensitivity of the same. However, in all the cases, it will be responsibility of the contractor to take action immediately upon receiving any complaint. The contractor will report to Engineer's Representative about the action taken on the complaint, within 48 hours of receiving the complaint, for his further intimating to PIU and the Executive Engineer. The person making a complaint would be intimated by the complaint receiving person or his representative, about the action taken, within 48 hours, along with his/her feedback. Figure 41 shows that Grievance Redress Mechanism.

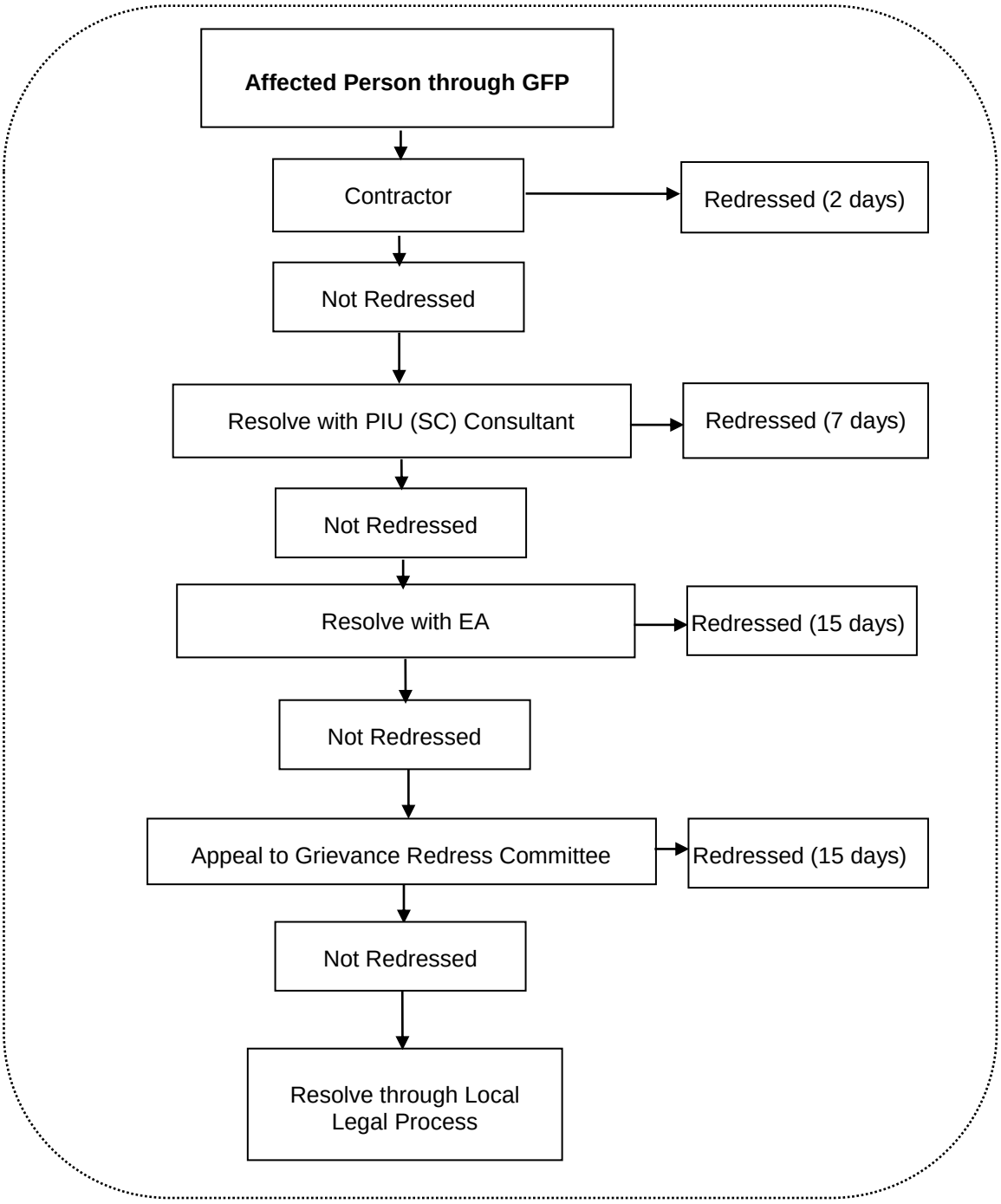


Figure 41: Grievance Redress Mechanism

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

39. The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a timeframe with specific responsibility assigned and follow-up actions defined. It contains all the information for the proponent, the contractor and the regulatory agencies to implement the project within a specified timeframe.

40. This EMP consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the Environmental Management Plan are:

- Mitigation of potentially adverse impacts;
- monitoring of EMP implementation during project implementation and operation; and
- Institutional arrangements to implement the EMP.

B. Objectives of Environmental Management Plan

41. The main objectives of this EMP are:

- To ensure compliance with Asian Development Bank's applicable safeguard policies, and regulatory requirements of Manipur and the Government of India;
- To formulate avoidance, mitigation and compensation measures for anticipated adverse environmental impacts during construction and operation, and ensure that environmentally sound, sustainable and good practices are adopted;
- To stipulate monitoring and institutional requirements for ensuring safeguard compliance; and
- The project road should be environmentally sustainable.

C. Impacts and Mitigation Measures

42. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision and monitoring have been provided in a matrix format in Table 88. However, anticipated potential impacts and suggested mitigation measures specific to this project are summarised in following paragraphs. These mitigation measures will be implemented as part of this project.

43. **Impacts**. Following are anticipated potential adverse environmental impacts:

- Impacts on surrounding area due to tree cutting (2013) for the proposed widening;
- Impacts due to conversion of about 48.29 hectare of forest land for non-forest purpose;
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
- Impact on biophysical environment due to quarry operation;
- Impacts on roadside flora and fauna particularly on sections of road passing through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS);
- Impact on air quality, water quality, drainage, road users due to construction activities of project road;
- Impact on land and water environment due to disposal of waste materials; and
- Impact on occupational health and safety due to all onsite and offsite construction works.

44. **Mitigation Measures.** ***Compensatory Tree Plantation***. The compensatory plan is being developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done three times of tree cutting (1:3 of tree cutting) as detailed in Table 87.

Table 87: Details of Trees to be Cut and Planted

Sub-project	Road Section (From / To)	Length (km)	Tree to be cut in the project road	Proposed tree to be planted in the project area in consultation with Forest Dept. (1:3 of tree cutting)
AH 1 (Main Alignment)	Khongkhang to Moreh road section along Asian Highway 1	29.516	2013	6039

45. ***Wildlife Protection.*** To minimize the likely impacts on the wildlife and other animals in YLWLS, following measures were incorporated in the project design as well as proposed for implementation during construction and operation phase of the Project.

- Improvement proposals are restricted to minimum width in the length passing through YLWLS. Eccentric widening (one side) is proposed to mibimize impacts from encroachment of forest areas from YLWLS.
- Adequate measure are included in the design to minimize impacts on wildlife.
- Signage for no-noise zones, wildlife conservation boards should be installed at the required project sites.
- Noise generating equipment like DG set, compressors will have acoustic enclosures. These will not be installed at least in one km area of YLWLS or Reserved forests. Noise generating activities should not be permitted during night.
- Drivers should be warned to move slowly in the wildlife movement areas.
- If any wildlife come within the vicinity of 100m from the construction site construction works must immediately stop and resume only after the wild animal have moved away
- Provisions of signage as a precautionary measure to provide awareness about animal movement will be made to avoid accidents
- project staff and work crews should not be allowed to have fire-arms and animal traps etc.;
- construction facilities such as workers camp, construction camp, hot mix plant, batching plant should be located at least 1 km away from the forest stretches.
- employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities.
- Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the areas of YLWLS.

46. ***Slope Protection and Bio-engineering Measures***. The bio-engineering measures are suitable for slope protection in hill roads. The following items have been suggested as bio-engineering measures for slope protection in hill roads.

- Turning of slopes through rough grassing; and
- Tree plantation along the hill section (slopes) of the project road to control the soil erosion.

47. The above items as bio-engineering measures have been incorporated in EMP budget.

48. ***Excavated Roadside Debris and its Disposal***. The provision has been made in cost estimate to use the roadway excavated materials as necessary for the construction of road, which are as follows.

- For all types of soil, such as ordinary rock, hard rock and
- Excavation from drain and foundation of other structures.

49. As per above description, the Contractor will use the excavated road side material for construction of road. The rest unsuitable material will be disposed suitably. The lead and lift has been considered in cost estimates. The Contractor will not dispose the excavated unsuitable material generated from hill section to other side (valley side) of the project road. Proper disposal plan will be prepared by the Contractor to dispose the unsuitable material generated from hill cutting/ road excavation.

50. ***Protection of Water Bodies***. The surface water bodies in the project road require protection during construction phase of the project road. The Contractor shall not disturb/ pollute the surface water due to construction activities of the project road. The Contractor will be responsible to protect the surface water and extra payment for the same will not be given.

51. ***Re-development of Borrow Area***. The items for redevelopment of borrow area such as preservation of top soil and re-application of stored top soil has been considered in proposed EMP cost. The Contractor will re-develop the borrow areas before closing of same. The estimated quantities for preservation and re-application of the top soil has been considered for redevelopment of borrow area.

D. Environmental Monitoring and Reporting Program

52. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. To ensure the effective implementation of mitigation measures and environmental management plan during construction and operation phase of the up gradation of subproject road, it is essential that an effective Environmental Monitoring Plan be designed and followed.

53. Environmental monitoring program has the underlying objective to ensure that the intended environmental mitigations are realized and these results in desired benefits to the target population causing minimal deterioration to the environmental parameters. Such program targets proper implementation of the EMP. The broad objectives are:

- To evaluate the performance of mitigation measures proposed in the EMP.
- To evaluate the adequacy of environmental assessment.
- To suggest ongoing improvements in management plan based on the monitoring and to devise fresh monitoring on the basis of the improved EMP.
- To enhance environmental quality through proper implementation of suggested mitigation measures.
- To meet the requirements of the existing environmental regulatory framework and community obligations.

54. **Performance Indicators**. The significant physical, biological and social components affecting the environment at critical locations serve as wider/overall Performance Indicators. However, the following specific environmental parameters can be quantitatively measured and compared over a period of time and are, therefore, selected as specific Performance Indicators (PIs) for monitoring because of their regulatory importance and the availability of standardized procedures and relevant expertise.

- Air Quality with respect to PM2.5, PM10, CO, NOx and SO_2 at selected location.
- Water Quality with reference to DO, BOD, Oil and grease, COD, Suspended Solids and Turbidity, Alkalinity at crossing points on rivers/streams at selected points.
- Noise levels at sensitive receptors (schools, hospitals, community/religious places).
- Survival rates of trees planted as compensatory plantation to compensate for lost forestlands and compensatory plantation raised for removal of roadside trees.

55. ***Ambient Air Quality (AAQ) Monitoring***. Ambient air quality parameters recommended for monitoring road development projects are PM2.5, PM10, Carbon Monoxide (CO), Oxides of Nitrogen (NOx) and Sulphur Dioxide (SO2). These are to be monitored, right from the commencement of construction activity at selected locations of plants and machinery, crushers on sites, excavation works etc. Data should be generated once in a season excluding monsoon at the monitoring locations in accordance with the revised National Ambient Air Quality Standards formulated by MoEFCC in 2009 (Annex 3).

56. ***Water Quality Monitoring.*** The physical and chemical parameters recommended for analysis of water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, Chloride, Lead, Zinc and Cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are given in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at locations identified along the project road during construction and operation phase. The Indian Standard Specifications – IS10500: 1991 is given in Annex 2.

57. ***Noise Level Monitoring.*** The measurements for monitoring noise levels would be carried out at sensitive receptors and construction sites along the project road. The Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989 or the standards by State Pollution Control Board of Manipur if such standards are stringent than those of the CPCB are to be complied. The CPCB standards are given in Annex 4. Sound pressure levels would be monitored on a 24-hour basis. Noise should be recorded at “A” weighted frequency using a “slow time response mode” of the measuring instrument.

58. ***Success of Re-vegetation.*** The project involves widening and up-gradation including construction of cross drainage structures hence these will require felling of trees. Such lost vegetation will be required to be replaced by compensatory plantation. As per policy of the State Government 03 trees have to be planted for each tree removed. These compensatory plantations will have to be monitored by the implementing agency with the help of the Forest Department. Such monitoring will be conducted through random samples. Such sampling should cover at least 5% of the area planted up.

59. ***Environmental Reporting System.*** The monitoring plan covering various performance indicators, frequency and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in Table 89.

60. The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the CSC, who in turn shall report to the PIU. All reporting by the contractor and CSC shall be on a quarterly basis. The PIU shall be responsible for preparing targets for each of the identified EMP activities.

61. The compliance monitoring and the progress reports on environmental components may be clubbed together and submitted to the PIU quarterly during the implementation period. The operation stage monitoring reports may be annual or biannual provided the Project Environmental Completion Report shows that the implementation was satisfactory. Otherwise, the operation stage monitoring reports will have to be prepared as specified in the said Project Environmental Completion Report.

62. Responsibilities for overseeing will rest with the CSC’s staff reporting to the PIU. Capacity to quantitatively monitor relevant ecological parameters would be an advantage but monitoring will primarily involve ensuring that actions taken are in accordance with contract and specification clauses, and specified mitigation measures as per the EMP.

63. During the implementation period, a compliance report may include description of the items of EMP, which were not complied with by any of the responsible agencies. It would also report to the management about actions taken to enforce compliance. It may however, be noted that certain items of the EMP might not be possibly complied with for a variety of reasons. The intention of the compliance report is not to suppress these issues but to bring out the

circumstances and reasons for which compliance was not possible (such as jurisdictional issues). This would help in reinforcing the implementation of the EMP.

64. Photographic records will also be established to provide useful environmental monitoring tools. A full record will be kept as part of normal contract monitoring. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed to ensure timely and effective implementation of the EMP.

65. The reporting system has been prepared for each of the stage of road construction namely:

- Preconstruction stage
- Construction Stage
- Operation Stage

66. This reporting shall be done through:

- Reporting by the Contractor to the CSC
- Reporting by CSC to PIU.

67. The stage-wise reporting system is detailed out in the following Table 88.

Table 88: Stage-wise Reporting System of PIU

Format* No.	Item	Contractor	Construction Supervision Consultant (CSC)		Project Implementation Unit (PIU)	
		Implementation and Reporting to CSC	Supervision	Reporting to PIU	Oversee / Field Compliance Monitoring	Reporting to Environment Officer of PIU
C1	Monitoring of construction site and construction camp	Before start of work	-	Quarterly	-	Quarterly
C2	Target sheet for Pollution Monitoring	-	As required	After Monitoring	-	After Monitoring
C3	Target sheet for roadside plantation	-	Monthly	Quarterly	Quarterly	Bi-annual
C4	Target sheet for monitoring of cleaning water bodies	-	Monthly	Quarterly	Quarterly	Bi-annual
O1	Target sheet for Pollution Monitoring	-	-	-	As per monitoring plan	After Monitoring
O2	Target sheet for survival reporting of roadside plantation	-	-	-	Quarterly	After Monitoring
O3	Target sheet for monitoring of cleaning water bodies	-	-	-	Quarterly	After Monitoring

*Formats will be developed and provided by supervision consultant to the contractor.

Table 89: Environmental Management Plan

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
PRE-CONSTRUCTION PHASE							
1.	Tree cutting	Cutting of about 2013 nos. trees during site clearance	• Restricting tree cutting within construction limit. • Avoiding tree cutting at ancillary sites. • Providing and maintaining compensatory tree plantation of 6039 numbers i.e. three times of cutting.	No. of trees to be cut	Observations	Forest Dept. / PIU	PIU
2.	Removal of utilities	Work site clearance	• Necessary planning and coordination with concerned authority and local body. • Prior notice to and consultation with concerned authority, local body and public to be affected so as to ensure that work does not get affected and impact on public is minimum.	Utility shifting plan	Observations	Concerned utility agencies / PIU	CSC/ PIU
3.	Religious places	Work site	• Suitable mitigation measures have been incorporated in Social report.	Resettlement Plan	Observations	PIU	CSC/PIU
CONSTRUCTION PHASE							
1.	Air Pollution	Construction plants, equipment and vehicles	Refer Annex 7 and Annex 8	PM10, vehicle maintenance record	PM10 Measurement	Contractor	CSC/PIU
		Temporary diversion	• Maintaining diversion and detour for road traffic in good shape and traffic regulated. • Regular sprinkling of water, as necessary.	Complaints from local residents	Observations	Contractor	CSC/PIU
		Dust during earth works or from spoil dumps	• Maintaining adequate moisture at surface of any earthwork layer completed or non-completed unless and until base course is applied, to avoid dust emission. • Stockpiling spoil at designated areas and at least 5 m away from traffic lane. • Refer Annex -9.	Dust pollution, Complaints from local residents	Observations, public discussions	Contractor	CSC/PIU
		Borrow pits and haul road	Refer Annex -10.	PM10, Dust pollution, Complaints	Measurement Observations	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
				from local residents	, public discussions		
		Storage of construction materials	• Sprinkling of water as necessary.	Dust pollution, Complaints from local residents	Observations , public discussions	Contractor	CSC/PIU
2.	Water Pollution	Construction of Bridges or Culverts – Earthwork and marginal spillage of construction materials causing temporary turbidity and suspended solids	• Constructing and maintaining diversion channel, sedimentation basin, dykes, etc. as may be required to temporarily channelize water flow of streams / river. • Storage of construction material and excavated soil above high flood level.	Placement and no. of slabs, hume pipe/ bridge height, Total solids and turbidity level	Review of design document, turbidity level check	Contractor	CSC/PIU
		Construction vehicles	• Strictly avoiding cleaning / washing of construction vehicle in any water body.	Equipment/ vehicle maintenance record	Review records, site visit and observations	Contractor	CSC/PIU
		Soil erosion from construction site	• Proper planning of site clearing and grubbing so as not to keep the cleared site before working for long duration. • Providing temporary side drains, catch water bank or drains, sedimentation basin, as necessary to avoid or minimize erosion and prevent sedimentation to receiving water bodies.	Soil erosion planning and cases	Review of design document, turbidity level check	Contractor	CSC/PIU
		Seepage from Construction Debris	Refer Annex -9.	Planning for seepage and spoil disposal, number of cases	Review of planning and practices for seepage and spoil disposal,	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
					control, site visits		
		Construction camp and workers' camp	Refer Annex -8.	Planning for waste management	Review of planning and practices for waste management, site visit, observations	Contractor	CSC/PIU
3.	Ground water Pollution	Wastewater logging	• All wastewater will be diverted to a ditch that will be managed for the period of construction and after construction such ditches will be filled and restored to original condition.	Planning for water diversion	Review of plans, field observations	Contractor	CSC/PIU
		Borrow pit excavation	• Excavation of borrow pit should not touch the aquifer.	Planning for borrow pit excavation	Review of plans, field observations	Contractor	CSC/PIU
		Human wastes and wastewater at construction camp	• Providing septic tanks for treating sewage from toilets before discharging through soak pits. • Locating soak pits at least 50m from any ground water sources. • Decanting and or controlled disposal of oil and grease as collected at collection tanks of maintenance yard and chemical storage areas. Refer Annex -8.	Planning for waste management	Review of planning and practices for waste management, site visit, observations	Contractor	CSC/PIU
4.	Noise Pollution and Vibration	Vehicles and Construction machinery	• Site Controls: Stationary equipment will be placed along un-inhabited stretches as per distance requirements computed above as far as practicable to minimize objectionable noise impacts. • Scheduling of Project Activities: Operations will be scheduled to coincide with period when people would least likely to be affected. Construction activities will be	Noise level, complaints from local residents, vehicle maintenance record, awareness	Noise level measurement, field observations, discuss with local residents	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			avoided between 9 P.M. and 6 A.M. near residential areas. • Protection devices (ear plugs or earmuffs) will be provided to the workers operating in the vicinity of high noise generating machines. • Construction equipment and machinery should be fitted with silencers and maintained properly. • Source-control through proper maintenance of all equipment. • Use of properly designed engine enclosures and intake silencers. • Noise measurements should be carried out along the road to ensure the effectiveness of mitigation measures. • Vehicles and equipment used should confirm to the prescribed noise pollution norms. • Constructing noise barriers as proposed for schools and hospitals prior to taking up road construction activities at those sections. • Movements of heavy construction vehicles and equipment near public properties will be restricted. • Comply with siting criteria for stone crushers, Hot Mix Plant/s (HMP) and concrete batching plant/s (CBP), and installations and maintenance of pollution control devices as mentioned in Annex -7. • Refer Annex-11 for identification, and operation of quarry areas and adopting controlled blasting.	programs implemented			

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
5.	Land Pollution	Spillage from plant and equipment at construction camp	• Providing impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform. • Collection oil and lubes drips in container during repairing construction equipment vehicles. • Providing impervious platform and collection tank for spillage of liquid fuel and lubes at storage area. • Providing bulk bituminous storage tank instead of drums for storage of bitumen and bitumen emulsion. • Providing impervious base at bitumen and emulsion storage area and regular clearing of any bitumen spillage for controlled disposal. • Reusing bitumen spillage. • Disposing non-usable bitumen spills in a deep trench providing clay lining at the bottom and filled with soil at the top (for at least 0.5 m). Refer Annex -7 and Annex-11.	Vehicle maintenance record, review plans for waste management and oil handling practices	Check equipment maintenance records, field visits, observations	Contractor	CSC/PIU
		Domestic solid waste and wastewater generated at camp	• Collecting kitchen waste at separate bins and disposing of in a pit at designated area/s. • Collecting plastics in separate bins and disposing in deep trench at designated area/s covering with soil. • Collecting cottons, clothes etc. at separate bins and burning in a pit (with sand bed).	Planning for waste management	Review of planning and practices for waste management , site visit, observations	Contractor	CSC/PIU
		Borrow pits	• Controlled operation and redevelopment of borrow pits to avoid water logging and land contamination.	Plan for borrow pit management	Review plans, observations	Contractor	CSC/PIU
6.	Loss of topsoil	All construction sites	• The topsoil from all areas of cutting and all areas to be permanently covered shall be stripped to a specified depth of 150 mm and stored in stockpiles. At least 10% of the	Planning for top soil conservation	Review plan, field visits and observations	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			temporarily acquired area shall be earmarked for storing topsoil. • The stockpile shall be designed such that the slope does not exceed 1:2 (vertical to horizontal), and the height of the pile be restricted to 2m. To retain soil and to allow percolation of water, the edges of the pile shall be protected by silt fencing. • Stockpiles will not be surcharged or otherwise loaded and multiple handling will be kept to a minimum to ensure that no compaction will occur. The stockpiles shall be covered with gunny bags or tarpaulin. • It shall 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 returned to cover the disturbed area and cut slopes. Residual topsoil will be distributed on adjoining/proximate barren/rocky areas as identified by the CSC in a layer of thickness of 75mm – 150mm. Top soil shall also be utilized for redevelopment of borrow areas, landscaping along slopes and incidental spaces.				
7.	Compaction of soil	All construction sites	• Construction vehicle, machinery and equipment shall move or be stationed in the designated area (ROW or CoI, as applicable) only. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, topsoil from agricultural land will be preserved as mentioned above.	Planning for top soil management, traffic diversion plan	Review plans, field visits and observations	Contractor	CSC/PIU
8.	Ecology	Site clearance	• Restricting tree cutting within corridor of impact.	No. of tree to be cut	Review clearance	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
					papers, field observations		
		Ancillary sites	• Minimizing tree cutting and vegetation clearance during site selection. • Preservation of trees within ancillary sites and avoiding impact on forest resources by providing buffer area from boundary of PF, RF, national park and wildlife sanctuary of 1km for locating construction plants, construction camp, and quarry and 500 m for borrow areas. • Preservation of trees of ecological, socio-cultural importance • Providing cooking gas at camp for discouraging and prohibiting use of fire-wood i.e. cutting of trees by the workers.	No. of tree to be cut	Review clearance papers, field observations	Contractor	CSC/PIU
9.	Occupational health and safety of workers	Construction camp	• Water supply, sanitation, drainage and medical health facilities at campsite. • Providing and using PPEs. • Using working reverse horn for all construction equipment and vehicles. • Providing earth link circuit breaker (ELCB) for all electrical connections. • Maintaining first aid at construction sites. • Maintaining emergency response system. Refer Annex -8.	Planning for health and safety, practices being implemented	Review records, field check, observations,	Contractor	CSC/PIU
10.	Accidents and safety	Construction sites	• Providing and maintaining traffic management comprising diversion; warning, guiding and regulatory signage; channelisers and delineators; lighting, flagmen; dust control system etc. as specified in the contract. • Providing adequate light at construction zone if working during night time is permitted by the Engineer.	Planning for Traffic management, training plans	Check records, field observations	Contractor	CSC/PIU

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
			• Conducting induction and periodic training for all workers and supervisors.				
		Construction camp	• Conducting periodic mock drilling on critical accident prone activities. • Conducting periodic training for all personnel working at plant site.	Planning for health and safety	Check record, observations, discussion with workers	Contractor	CSC/PIU
OPERATION							
1.	Air Pollution	Vehicular gaseous emission	• Periodicals monitoring of air pollutants and if values exceed the standard limits, suitable mitigation measures to be taken.	PM10 level, gaseous emissions	PM10 monitoring, vehicle maintenance record check	PIU	SPCB and Traffic Police
2.	Noise Pollution	Vehicular	• Periodical monitoring of noise level will be carried out. If values exceed the standard limits, suitable measures will be taken. • Providing and maintaining signage on noise regulation at silence zones.	Noise level	Noise level measurements, field observations	PIU	SPCB
3.	Road Safety	Traffic and Vehicles Slow moving traffic	• Maintenance as per Standard Highway Safety Signage and Traffic Management.	Traffic movement	No. of accidents	PIU	PIU and Traffic Police
		Lighting	• Maintenance of road / flyover lighting.	Traffic movement	No. of accidents	PIU	PIU/Traffic police
4.	Tree plantation	-	• Roadside tree plantation three times of cutting.	Survival rate of trees	Field observations	Forest Dept. / PIU	PIU
5.	Contamination of Soil and Water Resources from Spills due to	Vehicular Traffic	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals. • Spill of oil, fuel and automobile servicing units without adequate preventive systems in place to be discouraged.	Incidences of spills, accidents	Review of records, field consultations	PIU	

Sl.	Environmental Issue	Location/ Sources	Mitigation Measures	Monitoring Indicators	Monitoring Methods	Implementing Agency	Supervising & Monitoring Agency
	traffic & accidents						
6.	Soil Erosion and Sedimentation	-	• Maintaining the slope protection measures provided at stretches of high embankment and protection measures for bed scouring at cross drainage locations as per maintenance manual to be prepared before operation.	Cases of landslides	Maintenance Records	PIU	
7.	Maintenance of drainage system	-	• The drains will be periodically cleared to maintain storm water flow. • Road drains will be cleared of debris before onset of every monsoon.	Maintenance plans	Maintenance Records	PIU	

Note: PIU – Project Implementation Unit of NHIDCL, CSC-Construction Supervision Consultant or Authority Engineer

Table 90: Environmental Monitoring Plan

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Air Quality and Noise Levels							
Construction Stage	• $PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC (Standards given in Annex-3) • Leq - Noise levels on dB (A) scale (Standards given in Annex-4)	• Wherever the contractor decides to locate the Hot mix plant • Along the project road at different zone as suggested by CSC for regular monitoring • At hot mix plant and equipments yards	Once in a season excluding monsoon for 2 years	Continuous 24 hours/ or for 1 full working day	Check and modify control devices like bag filter/cyclones of hot mix plant Provide additional noise barriers	Contractor Through approved monitoring agency	Supervision Consultant, PIU

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Operations Stage	• $PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC (Standards given in Annex-3) • Leq - Noise levels on dB (A) scale (Standards given in Annex - 4)	Along the project road at different zone as suggested by CSC for regular monitoring	Once in a season excluding monsoon for 2 years	Continuous 24 hours/ or for 1 full working day	-	Contractor Through approved monitoring agency	Supervision Consultant, PIU
Water Quality							
Construction Stage	pH, Temperature, DO, Oil & Grease, Conductivity, TSS, TDS, Alkalinity, Total Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, COD, BOD, Iron, Total Coliform, Faecal Coliform, Salinity (Surface Quality Standards by CPCB as given in Annex-2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Supervision Consultant, PIU
	pH, Temperature, Conductivity, TSS, TDS, Alkalinity, Total, Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, Iron. (Ground Quality Standards by CPCB as given in Annex-2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Supervision Consultant, PIU
Operation Stage	pH, Temperature, DO, Oil & Grease, Conductivity, TSS, TDS, Alkalinity, Total Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, COD, BOD, Iron, Total Coliform, Faecal Coliform, Salinity (Surface Quality Standards by CPCB as given in Annex - 2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Supervision Consultant, PIU

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
	pH, Temperature, Conductivity, TSS, TDS, Alkalinity, Total, Hardness, Calcium, Magnesium Chloride, Phosphate, Sulphate, Nitrate, Iron. (Ground Quality Standards by CPCB as given in Annex 2)	At identified locations	Once in a season Excluding monsoon for 2 years	-	Check and modify petrol interceptors, Silt fencing devices.	Contractor Through approved monitoring agency	Supervision Consultant, PIU
Soil Quality							
Construction	Chemical properties including oil and grease	At identified locations	Once in a season excluding for 2 years	-	Check oil and chemical spillage	Contractor Through approved monitoring agency	Supervision Consultant, PIU
Operation	Chemical properties including oil and grease	At identified locations	Once in a season excluding for 2 years	-	Check oil and chemical spillage	Contractor Through approved monitoring agency	Supervision Consultant, PIU
Accidental and Health and Safety							
Construction	No. of accidents or near miss involving workers.	All along the road	Once in 3 months	-	Corrective measures	Contractor	Supervision Consultant, PIU
Operation	No. of accidents or near miss involving workers.	All along the road	Once in 3 months excluding for 2 years	-	Corrective measures	Contractor / PIU	PIU
Tree Plantation							
Operation	Survival rate of plants	All along the project corridor	1 samples (quadrants) for each km	Once every year after monsoon for 3 years	Corrective measures	Contractor /PIU	PIU, Forest department

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
Wildlife							
Construction	No if wildlife accidents Cases of poaching	Forest area and YLWLS area	Once every quarter	-	Corrective measures in coordination with wildlife authorities	Contractor	Supervision Consultant, YLWLS authorities
Operation	No if wildlife accidents	Forest area and YLWLS area	One every six month for first 2 years	-	Corrective measures in coordination with wildlife	Contractor /PIU	PIU, YLWLS authorities

Note: PIU – Project Implementation Unit (NHIDCL), CSC-Construction Supervision Consultant or Authority's Engineer

E. Institutional Requirements

68. The Ministry of Road Transport and Highways (MoRTH) will be the executing agency (EA) for the project and the Implementing Agency (IA) will be the National Highways and Infrastructure Development Corporation Limited (NHIDCL). A Project Implementation Unit (PIU) will be established by NHIDCL to implement the subproject. EA together with IA will be responsible for the implementation of the Project. The Project Director of PIU will be overall responsible for EMP implementation. The following key players are involved in EMP implementation during construction stage:

- MoRTH as Project EA
- NHIDCL as subproject PIU and its environmental unit;
- Authority's Engineer i.e. Engineer (also called Construction Supervision Consultant) and his representatives;
- Contractors; and
- External monitor.

69. The PIU will have an Environmental and Social Management Unit (EMSU). It is recommended that two senior officers of PIU could be designated as an Environment Officer and as a Social Officer for monitoring implementation of proposed environmental and social safeguard measures respectively. EMSU will be headed by the Project Director but coordinating and supervising implementation of safeguard measures will be undertaken by the designated Environmental and Social Officers. Field level environmental staff will also be recruited by PIU to ensure the contractor is following EMP. There is a need for capacity building of environmental unit through various trainings. Environment Expert of Authority's Engineer will work as field level environmental staff.

70. The Project Director of PIU with the assistance of designated Environmental and Social Officer will be overall responsible for ensuring compliance of safeguard measures and will be reporting to the regulatory bodies and ADB certifying that relevant environmental safeguard measures have been complied with during project implementation. At the field level, the Executive Engineer with his Assistant Engineer/s will supervise implementation of safeguard measures for this subproject and submit monthly reports to PIU.

71. PIU may engage independent agencies for carrying out environmental quality monitoring activities. The Supervision Consultant shall be interacting with these agencies and facilitate them in carrying out such activities.

72. The Construction Supervision Consultant (CSC) will have an Wildlife Expert and an Environmental Safeguards Specialist in its team and it will liaise with PIU environment unit to ensure that Contractor complies with the requirements of various wildlife and environmental safeguard measures through supervision, monitoring and reporting on the same. Efforts must be made by SC to ensure that environmental mitigation and good-construction-practices are not only considered but actually implemented as integral component of each civil activity. It should be considered as day-to-day activity. Implementation of wildlife and environmental safeguard measures needs team effort and as such the Team Leader of CSC will delegate the responsibilities to each member of the supervision team with respect to their core responsibilities. The project should have a provision of Environmental Specialist within CSC to supervise implementation of safeguard measures. His role would be more on advisory. He will assist the Team Leader of CSC on the following:

- Advise PIU on preparing reports to ADB and other statutory bodies;
- Preparing procedures for implementing EMP;
- review Contractor's EMP, traffic management plan and safety plan and recommend for its approval / improvements, to the Team Leader;

- provide training to PIU, CSC and Contractors' staff on implementing environmental safeguard measures;
- advise on obtaining various statutory environmental clearances on time;
- conduct periodic field visits to examine environmental compliances and suggest corrective actions; and
- any other issues as will be required to ensure environmental compliance.

73. The Wildlife Expert within CSC will be responsible for monitoring of wildlife related activities including implementation of wildlife management plan and associated monitoring activities.

74. Besides, the Team Leader of CSC will nominate a senior engineer from the site office for being directly responsible for day-to-day supervision of implementation of stipulated safeguard measures, to ensure accountability. He will provide guidance to the field staff of SC and Contractor for implementing each of the activities as per the EMP. He will be responsible for record keeping, providing instructions through the Engineer for corrective actions, ensuring compliance of various statutory and legislative requirements and assist Engineer for submitting reports to PIU. He will maintain a close co-ordination with the Contractor and PIU for successful implementation of the environmental safeguard measures.

75. Since this subproject is an environment category A project, an external monitoring agency will be engaged to conduct third party monitoring on implementation of environment safeguards and wildlife protection. External monitor will have one international environment specialist and one national wildlife expert.

76. Responsibilities of various agencies involved in the project implementation are described in following paragraphs.

77. **Executing Agencies (EAs) Responsibilities**. The EA's responsibilities will mainly be focused on addressing national or state level environment safeguard issues and decisions concerning the subprojects. Specific responsibilities on environment safeguards at the EA level are:

- Ensure that all environment safeguard requirements as given in ADB SPS 2009, and applicable laws and rules under MOEF are being complied with during all stages of respective subprojects under the loan.
- Reviewing and approving all environment safeguards related documents such as EIA, monitoring reports etc. prepared for subprojects under the investment program with recommendations and clarifications from the IA where necessary.
- Timely endorsement and signing of key documents and forwarding to the respective agency such as those required for processing of environmental clearance, forestry clearance etc. and disclosure on ADB website.
- Taking proactive and timely measures to address any environment safeguards related challenges at the national or state level such as delays in processing of clearances (during pre-construction stage), significant grievances (during construction stage)
- Recruiting an external monitor to conduct third party environmental monitoring for the subproject.

78. Implementing Agencies (IAs) Responsibilities. The IA's responsibilities will mainly be focused on implementing environment safeguard requirements in accordance with the EIA or IEE and EMP at the subproject and site level. Specific responsibilities on environment safeguards at the IA level are:

- Hire an environmental consultant to prepare IEE or EIA report including EMP as may be required.
- Ensure that the consultant follows all procedures for conducting the environmental assessment as given in ADB's SPS.

- Review the budgetary needs for complying with the Government's and ADB's requirements on environment safeguards and ensure the proposed budget is in line with project requirements.
- Prepare forms, reports and all documents etc. for processing of environmental, forestry and related clearances in a timely manner and submit them for further review and signing to the authorized officer in the respective EA office.
- If any problems or long delays are encountered when processing the clearance documents, immediately alert the authorized officer at the EA level and seek ways resolve the problem at the soonest.
- Provide necessary support to the consultants preparing the environmental assessment reports to facilitate smooth and efficient preparation of documents, conduction of meetings, conduction of public hearings etc. required by ADB, MOEFCC, SPCB, Forestry Department, Wildlife Board etc.
- Review the EIA or IEE reports including EMP and EMOP prepared by the consultant and provide comments if necessary.
- After receipt of satisfactory EIA or IEE report including EMP and EMOP forward the respective reports to the respective EA for further endorsement and forwarding to ADB for disclosure on the ADB website.
- Ensure that all necessary regulatory clearances are obtained prior to commencing any civil work of the respective contract package or road section.
- Ensure that for Engineering Procurement and Construction (EPC) based contracts updating of the EMP and EMOP based on detailed design and implementation of the EMP is included under the contractor's responsibilities.
- Ensure that the EMP which include required mitigation measures and monitoring requirements with defined Bill of Quantity (BOQ), forms part of bidding document for the case of item rate based contracts.
- Ensure that contractors have access to the EIA or IEE report including EMP and EMOP of the subprojects.
- Ensure that contractors understand their responsibilities to mitigate environmental problems associated with their construction activities.
- Ensure and Monitor that all required permits, no objection certificates etc. are obtained by the contractor for establishment and operation of equipments and facilities as detailed in EIA/IEE.
- With the support of the EFP of the contractors and ISC ensure that the contractor implements the EMP including EMOP as given in the respective EIA or IEE report.
- In case of unanticipated environmental impacts during project implementation stage, with the support of ISC prepare and implement an updated EMP to account for such impacts after seeking concurrence from ADB. The updating shall be carried out after due consultation with the stake holders and concerned government agencies.
- In case during project implementation a subproject needs to be realigned, review the environmental classification and revise accordingly, and identify whether supplementary IEE or EIA study is required. If it is required, prepare the TOR for undertaking supplementary IEE or EIA and hire an environment consultant to carry out the study.
- Ensure that construction workers work under safe and healthy working environment.
- Ensure effective implementation of Grievance Redress Mechanism to address affected people's concerns and complaints.
- Submit semi-annual reports for category A subprojects and annual reports for category B subprojects on the implementation of all environment safeguard requirements including the EMP and EMOP under the respective subproject to ADB and make these reports available for public disclosure.

79. **Responsibilities of the External Monitor.** The External Monitor will conduct third party monitoring of environment safeguard and wildlife protection activities. The following are the responsibilities of the External Monitor:

- Review the EIA and EMP to understand the background environmental and biodiversity issues of the subproject.
- Conduct third party monitoring of the implementation of the EMP and EMOP by the contractor and supervisory activities of the AE/CSC through periodic site visits and review of environment safeguard and wildlife protection related documents maintained by the contractor, AE/CSC and PIU.
- Advise the PIU on the need for corrective actions if any.
- Implementation of additional environmental enhancement and wildlife protection activities as recommended in the EIA report.
- Based on the observations from the site visits and review of documents and monitoring reports prepared by the contractor and AE/CSC prepare semi-annual reports for submission to the PIU and onward to ADB for disclosure on the ADB website.

80. **ADB's Responsibilities.** ADB is responsible for the following:

- Review REA checklist and endorse or modify the tranche classification proposed by the EA
- Review EIA or IEE reports and disclose the draft and final reports on the ADB website as required;
- Issue subproject's approval based on EIA or IEE reports;
- Monitor implementation of the EMP through due diligence missions;
- Provide assistance to the EA and IA of subprojects, if required, in carrying out its responsibilities and for building capacity for safeguard compliance;
- Monitor overall compliance of the subprojects to this EARF; and
- If necessary, provide further guidance to the IA on the format, content, and scope of the EIA or IEE reports and annual and/or semi-annual monitoring reports for submission to ADB.

81. For ensuring that EMP is properly implemented, Contractor shall appoint a full time qualified and experienced Environmental and Safety Officer (ESO) from the commencement to completion of the project. The qualification and responsibilities of ESO as stipulated below should be considered. The qualification of ESO will be as given below:

- Diploma or Graduate in Civil Engineering with post graduate specialization in Environmental Engineering or Environmental Science or equivalent;
- 5 to 10 years of total professional experience; and
- About 3 to 5 years of experience in similar projects i.e. management of environmental issues in design and construction of road / highway / flyover / bridge projects.

82. The responsibilities of ESO of Contractor will include the following:

- Directly reporting to the Project Manager of the Contractor;
- Discussing various environmental issues and environmental mitigation, enhancement and monitoring actions with all concerned directly or indirectly;
- Prepare Contractor's EMP, traffic management plan and safety plan as part of their Work Program;
- Ensure contractor's compliance with the EMP stipulations and conditions of statutory bodies;
- Assisting his project manager to ensure environmentally sound and safe construction practices;

- Assisting his project manager to ensure the timely procurement of materials that are included in the Bill of Quantities relating to environmental mitigation and enhancement measures;
- Conducting periodic environmental and safety training for contractor's engineers, supervisors and workers;
- Preparing a register for material sources, labour, pollution monitoring results, public complaint and as may be directed by the Engineer;
- Assisting the PIU on various environmental monitoring and control activities including pollution monitoring; and
- Preparing and submitting monthly reports to SC on status of implementation safeguard measures.

83. As mentioned above, there will need for capacity building of PIU on various environmental and social aspects of the project through various environmental training. Recently, there has been change of statutory requirements for similar projects based on new EIA Notification. This has changed the landscape of legal and administrative framework for implementing the projects. Thus, there is a need for the PIU staff to updating the information and keeping abreast with the changing legal and administrative requirement. The requirements of various statutory permits and clearances are mentioned in Table 3 (Chapter 2). For successful implementation of EMP, it is essential to orient engineers of PIU, CSC and Contractor who would be mobilized for this project. One day environmental orientation workshop will be conducted at Imphal by ADB supported consultant, once most of the staff has been mobilized. The training program is included in Annex 13.

F. Environmental Management Budget

84. An environmental management budget of INR 2,89,68,592 (Indian Rupees two crore eighty nine lakh sixty eight thousand five hundred ninety two only) (USD 0.426 million) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings. A detail of environmental management budget is given in Table 90.

Table 91: Environmental Management Cost Estimate *

SL. No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE (Rs.)	AMOUNT (Rs.)	RESPONSIBILITY
A.	**Forest Clearance and Compensatory Afforestation**					
A.1	Payment of Forest Compensation for diversion 48.29 ha of forest land					PIU through Forest Department
A.1.4	Crop Compensation				1,911,143	
A.1.5	Compensatory Afforestation				1,095,914	
A.1.6	Net Present Value (NPV)				1,776,535	
Total (Rupees) Amount to be Deposited by NHIDCL					**4,783,592**	
B.	**Environmental Monitoring**					
B.1	Ambient air quality monitoring during construction and operations phases	36	No.	8,000	288,000	PIU through Approved Monitoring Agency
B.2	Ambient noise level monitoring during construction and operations phases	36	No.	2000	72,000	
B.3	Water quality monitoring of surface water during construction and operations phases	24	No.	5000	120,000	
B.4	Water quality monitoring of drinking water during construction and operations phases	18	No.	5000	90,000	
B.5	Soil quality monitoring during construction and operations phases	18	No.	10,000	180,000	
B.6	Monitoring survival rate of plantation	3	No.	20,000	60,000	
C.	**Noise Barrier at sensitive location**					
C.1	Provide the Noise barrier at sensitive areas like schools and hospitals. The noise barriers of hollow brick wall/reinforced concrete panels with height of 3.5m. The design of the noise barrier shall be approved by the engineer in charge**.**	120	Rm	4,000	480,000	Contractor through BOQ
D.	**Enhancement of common property resources as per directed by the engineer including the following items**					
D.1	Provision and erection of cement concrete, standard sitting benches including clearing of the area around the benches.	30	No.	1,000	30,000	
D.2	Boundary fencing with barbed wire fencing of approved make and specification including provision and erection of struts	300	Rm.	550	165,000	
E.	**Wildlife Conservation Activities**					

SL. No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE (Rs.)	AMOUNT (Rs.)	RESPONSIBILITY
E.1	Supporting wildlife conservation programmes as prioritized in the management plan of the YLWLS	1	Lump Sum	50,00,000	50,00,000	PIU through Supervision Consultant
F.	**External Monitor**					
F.1	External Environment and Wildlife monitoring services	1	Lump Sum	1,75,00000	1,75,00000	PIU through Supervision Consultant
G.	**Environmental Training**					
G.1	Training at site as per Annex-13 **of EIA.**	1	Lump Sum	2,00,000	2,00,000	PIU through Supervision Consultant
				Grand Total (Rupees)	**2,89,68,592**	

* Cost estimate is preliminary based on the current unit rates. Therefore this estimate is tentative only.

X. CONCLUSIONS AND RECOMMENDATIONS

85. The subproject road (Khongkhang-Moreh Road Section) proposed for improvement is classified as environment Category A project as per ADB SPS requirements. This is mainly as the subproject road passes through Yangoupokpi Lokchao Wildlife Sanctuary. As per Government of India regulations EC is not required for this subproject however clearance from National Board for Wildlife and Forest Clearance for Central/State Government is required. The categorization has been done based on environmental screening and assessment of likely impacts while the environmental impact assessment ascertains that it is unlikely to cause any significant environmental impacts. Few impacts were identified attributable to the proposed project, all of which are localized and temporary in nature and easy to mitigate.

86. About 29.516 km length of subproject roads passes through buffer /tourism zone of the Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS). There are no other ecologically sensitive areas along the subproject road neither there are any archaeological/protected monument located in the project vicinity. The land use pattern around the proposed alignment is predominantly mix of forest and agriculture land.

87. The significant adverse impacts of the road section upgrading are:

- Impacts on surrounding area due to tree cutting (2013) for the proposed widening;
- Impacts due to conversion of about 48.29 hectare of forest land for non-forest purpose;
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
- Impact on biophysical environment due to quarry operation;
- Impacts on roadside flora and fauna particularly on sections of road passing through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS);
- Impact on air quality, water quality, drainage, road users due to construction activities of project road;
- Impact on land and water environment due to disposal of waste materials; and
- Impact on occupational health and safety due to all on-site and off-site construction works.

88. Measures such as use of EFRC slope protection measures are proposed to minimize the impacts of slope instability, use of bioengineering technique, compensatory afforestation, measures to minimize impacts on wildlife movement, engineering alternatives to limit impacts on forest areas etc. are proposed to minimize the potential impacts.

89. Besides, series of mitigation measures have been proposed that are described in the EIA Report and addressed comprehensively in the environmental management plan. These include provision of bioengineering applications for stabilizing slopes, use of spoil disposal areas to minimize destruction of forests down-slope of the alignment, proper sizing of hydraulic structures to assure adequate capacity and prevent destruction of adjacent land, provision of sign boards along migratory paths of animals and other precious ecological zones, provision of bridges and culverts designed especially for facilitating the movement of animals, identification of vulnerable community infrastructure that must be preserved or replaced under construction contracts, limits on location and access of workers and other provisions regarding construction to assure minimum impact, and other basic provisions found in the EMP. All the above observations and mitigation measures will be included in the tender documents for contract works.

90. Application of these measures in parallel with MoRTH environmentally friendly road construction practices will reduce significantly any potential environmental impact. Impacts remaining on the physical environment (air and water pollution) are temporary and often occur away from the presence of people. The biological environment will reconstitute itself following any residual or remaining impacts on it.

91. Potential adverse effects during operations of the roadways have been minimized by aligning the road in optimal locations in relation to roadway safety and community impact, through provision of designs and budgets for superior roadway drainage structures.

92. A systematic approach for surveillance and monitoring is provided by means of a management framework, and monitoring and reporting protocol. In general, the project received good support from local people. The local people appreciated that besides providing an all-weather efficient connectivity to large rural populations and improving the traffic scenario in the region, it will bear out several other socio-economic positive benefits. Follow-up public consultation is intended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons. The social component of the project has identified the numbers of affected persons and households, the amount and locations requiring total and partial land acquisition, and the amount of damage costs. The EMP is a living document and the same will be revised if necessary during project implementation or if there is any change in the project design and with approval of ADB during the construction period. The environmental mitigation measures are itemized in the EMP and the Executing Agency (NHIDCL) shall ensure that EMP and EMoP are included in Bill of Quantity (BOQ) and forms part of bid document and civil works contract.

Annex 1: RAPID ENVIRONMENTAL ASSESSMENT (REA) CHECKLIST

Country/Project Title: INDIA/ SASEC Road Connectivity Sector Project

Sector / Division: South Asia Transport and Communication Division (SATC)

Road Section: Khongkhang-Moreh Road Section in the State of Manipur (Tranche 3 Subproject)

Screening questions	Yes	No	Remarks
A. Project siting ▪ Is the project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site		X	
▪ Protected area		X	The total 29.516 km length of the project road section passes through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS) including Eco-sensitive zone and buffer zone. Mitigation measures are included in the EMP to avoid impacts on flora and fauna in the forest areas. EA will obtain wildlife and forest clearance from statutory authority at State and Central Level.
▪ Wetland		X	
▪ Mangrove		X	
▪ Estuarine		X	
▪ Buffer zone of protected area	X		Total 21.066 kms of alignment transverse through buffer zone of YLWLS. Out of this length about 9.1 km length of alignment is passing along the boundary of Core Zone-1 and Buffer zone.
▪ Special area for protecting biodiversity	X		
B. Potential environmental impacts ▪ Will the project cause…			
▪ Encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?	X		The topography of project road section from Khongkhang to Moreh is hilly and this section is mostly following existing road alignment. Hilly sections are vulnerable to landslide. Impacts of landscape by road embankments, cuts and fills are anticipated. Proper management plan for will be required during construction to sustain the quarries.
▪ Encroachment on precious ecology (e.g. Sensitive or protected areas)?		X	
▪ Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?	X		Khongkhang - Moreh section of the project road hilly areas and is high rainfall zone prone to flood. Also rivers crosses the this section of the project road. Controlled construction activities will ensure sediment discharge into streams.

Screening questions	Yes	No	Remarks
▪ Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?		X	During construction period suitable mitigation measures will be required to control the silt runoff. Adequate Sanitary facilities and drainage in the workers camps will help to avoid this possibility. As the construction activity in this project will not contain any harmful ingredients, no impact on surface water quality is anticipated.
▪ Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?	X		With appropriate mitigation measures and use of most modern environment friendly equipments/machineries air pollution shall be reduced to permissible levels.
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?	X		Possible. With appropriate mitigation measures such risks would be minimized.
▪ Noise and vibration due to blasting and other civil works?	X		Short term minor impact may occur during construction period, Suitable mitigation measures will be required to minimize the adverse effects
▪ Dislocation or involuntary resettlement of people	X		Likely. A Resettlement Plan will be prepared and compensation shall be paid as per approved entitlement matrix.
▪ dislocation and compulsory resettlement of people living in right-of-way?	X		Likely. A Resettlement Plan will be prepared and compensation shall be paid as per approved entitlement matrix.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	Possible. Gender Action Plan and Indigenous People Development Plan shall be prepared as part of the Project.
▪ Other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress?	X		Imposing of appropriate mitigation measures in contract agreement to keep the air pollution within permissible levels will keep a check on this problem.
▪ Hazardous driving conditions where construction interferes with pre-existing roads?		X	To minimized the impact suitable traffic management plan will be required
▪ Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases from workers to local populations?	X		Proper provisions for sanitation, health care and solid waste disposal facilities will be available in the contract documents to avoid such possibility. Workers will be made aware about communicable diseases
▪ Creation of temporary breeding habitats for mosquito vectors of disease?		X	
▪ Accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials and loss of life?	X		Adoption of suitable traffic signage system at sensitive places will reduce such possibility.
▪ Increased noise and air pollution resulting from traffic volume?	X		Due to improvement in Riding Quality & Comfort in driving due to unidirectional traffic such pollution will be reduced. Mitigation measures along with monitoring plan will be required

Annex 1

Screening questions	Yes	No	Remarks
▪ Increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?	X		Controlled construction activities and proper drainage system will reduce this possibility.
▪ social conflicts if workers from other regions or countries are hired?		X	Not anticipated. Local labors would be hired to the extent possible.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?	X		Possible.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?	X		Possible. EMP shall be followed to minimize this risk.
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.		X	Not anticipated.

Climate Change and Disaster Risk Questions The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.	**Yes**	**No**	**REMARKS**
• Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes (see Appendix I)	X		Project is vulnerable to rainfall and landslides.
▪ Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (e.g., increased erosion or landslides could increase maintenance costs, permafrost melting or increased soil moisture content could affect sub0-grade).	X		Likely. Increase in rainfall will reduce lifespan of the project as this is a landslide prone area.
▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (eg., high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?		X	
▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., by encouraging settlement in areas that will be more affected by floods in the future, or encouraging settlement in earthquake zones)?		X	

Annex 2. INDIAN STANDARD DRINKING WATER SPECIFICATION: IS 10500:1991

Sl. No.	Substance/ Characteristic	Desirable Limit	Permissible limit	Remarks
1	Colour, Hazen units, Max	5	25	Extended to 25 if toxic substance are not suspected in absence of alternate sources
2	Odour	Unobjectionable		a) Test cold and when heated
				b) Test at several dilution
3	Taste	Agreeable		Test to be conducted only after safety has been established
4	Turbidity NTU, Max	5	10	
5	pH value	6.5 to 8.5	No relaxation	
6	Total Hardness (as $CaCO_3$ mg/lit)	600	600	
7	Iron (as Fe mg/lit, Max	0.3	1.0	
8	Chlorides (as Cl mg/lit Max	250	1000	
9	Residual Free Chlorine, mg/lit Max	0.2		To be applicable only when water is chlorinated. Treated at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/lit
10	Dissolved Solids mg/l, Max	500	2000	
11	Calcium (as Ca) mg/l, Max	75	200	
12	Copper (as Cu) mg/l, Max	0.05	1.5	
13	Manganese (Mn) mg/l Max	0.1	0.3	
14	Sulphate (As SO_4), Max	200	400	May be extended up to 400 provided (as Mg) does not exceed 30
15	Nitrate (as NO_3) mg/l, Max	45	100	
16	Fluoride (as F) mg/l, Max	1.0	1.5	
17	Phenolic Compounds (as C_6H_6OH) mg/l Max	0.001	0.002	
18	Arsenic (as As mg/l	0.05	No relaxation	To be tested when pollution is suspected
19	Lead (as Pb) mg/l	0.05	No relaxation	
20	Anionic Detergents (as MBAS) mg/l	0.2	1.0	
21	Chromium (as Cr) mg/l	0.05	1.0	To be tested when pollution is suspected
22	Mineral Oil mg/l	0.01	0.03	
23	Alkalinity mg/l	200	600	
24	Total Coliform	95% of the sample should not contain coliform in 100 ml. 10 coliform /100 ml		

Annex 3: NATIONAL AMBIENT AIR QUALITY STANDARDS (MOEFCC, 2009)

Pollutant	Time Weighted Average	Concentration in Ambient air (μg/m^3)	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Areas
Sulphur Dioxide (SO2)	Annual Average*	50	20
	24 hr**	80	80
Oxides of Nitrogen (as NO2)	Annual Average *	40	30
	24 hr**	80	80
Particulate Matter: PM10 (<10 μm)	Annual Average *	60	60
	24 hr**	100	100
Particulate Matter: PM2.5 (<2.5 μm)	Annual Average *	40	40
	24 hr**	60	60
Lead	Annual Average *	0.5	0.5
	24 hr**	1.0	1.0
Carbon monoxide mg/m3	8 hr	2.0	2.0
	1 hr	4.0	4.0

* Annual Arithmetic mean of minimum 104 measurement in a year taken for a week 24 hourly at uniform interval.

** 24 hourly or 8 hourly or 1 hourly monitored values should meet 98 percent of the time in a year

Source: MoEF notification Central Pollution Control Board (1997) National Ambient Air Quality Monitoring Series, NAQMS/a/1996-97.

Annex 4. NATIONAL AMBIENT NOISE LEVEL STANDARDS

Area Code	Category	Limits in Decibels (dB A)	
		Day Time	Night Time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zones	50	40

Note: (1) Daytime: 6 AM to 9 P.M., Night-time 9 PM to 6 AM;
(2) Silence zone is an area up to 100 m around premises as hospitals, educational institutions and courts.
Source: Central Pollution Control Board, New Delhi

Annex 5: AIR QUALITY IMPACT PREDICTION

A. Introduction

1. The major impact on the air quality during the operation stage will be due to plying of vehicles on the proposed corridor. The impact on air quality depends upon traffic volume, traffic fleet including fuel type and prevailing atmospheric conditions. An unstable atmospheric condition disperses pollutants more and results to low pollutant concentrations while stable atmospheric conditions buildup the pollution level. To assess the likely impacts on the ambient air quality due to the proposed highway project, the prediction of the carbon monoxide (CO) and particulate matter (PM), Nitrogen Dioxide (NOx) and Sulphur Dioxide (SO2) concentrations have been carried out using line source dispersion modelling approach, based on Gaussian equation. CO is an indicator pollutant for vehicular pollution. So, prediction of CO concentration is representative of the impacts of air pollution due to traffic movement. The modeling for this project has been carried out using AERMOD-9, a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain, developed by the "The American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC)".

2. It has been setup and run by using emission factors prevalent for Indian vehicles (ARAI, 2007) and hourly traffic volumes as predicted for the project. The study is conducted to predict 1-houly increment in CO concentrations for the years 2020, 2025, 2030, 2035 and 2040.

B. Model descriptions

3. The AERMOD atmospheric dispersion modeling system is an integrated system that includes three modules: (a) A steady-state dispersion model designed for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources. (b) A meteorological data preprocessor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux. (c) A terrain preprocessor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behavior of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills. AERMOD also includes PRIME (Plume Rise Model Enhancements) [4] which is an algorithm for modeling the effects of downwash created by the pollution plume flowing over nearby buildings.

C. Source information

4. Traffic data. The fleet wise traffic volumes for the present study have been taken from the detailed feasibility report of the project. The annual average daily traffic (AADT) data is available for the proposed road through traffic survey. AERMOD model needs hourly average traffic volume. The total traffic hour volume is further categorized in to two-wheeler, four wheeler, Light commercial vehicles (LCVs), Bus and high commercial vehicles (HCVs), based on the traffic survey at different road stretched along the highway (Figure 1).

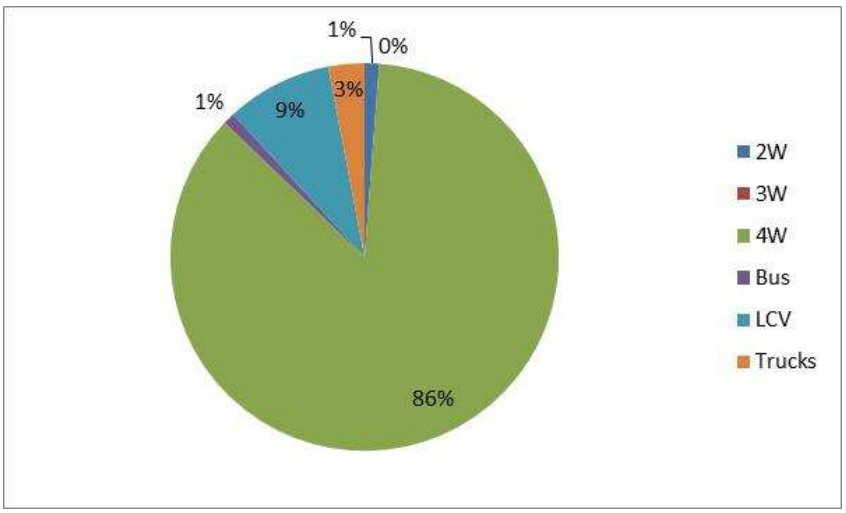


Figure 1: Traffic Fleet on the highway

5. The annual average daily motorized traffic data are given in Table 1 at five locations along with future traffic growth.

Table 1: Annual average daily motorized traffic data

Year	2w	4w	LCV	HCV	Buses
2020	42	2962	304	127	8
2025	65	4627	474	199	12
2030	84	5974	613	257	15
2035	99	7096	728	305	18
2040	116	8250	846	354	21

6. **Emission factors**. Emission factor is one of the important input parameter in AERMOD model. In the present study, the emission factors specified by the Automotive Research Association of India (ARAI, 2007) have been used for calculation of weighted emission factors. These emission factors have been expressed in terms of type of vehicles and type of fuel used (for petrol and diesel driven passenger cars).

7. The emission factor used in the present study for different vehicles type are given in Table 2.

Table 2 Emission factors for different types of Vehicle (ARAI, 2007)

Emission factors, g/km (ARAI, 2007)						
	2w	3w	4w	lcv	bus	truck
CO	1.04	1.25	1.28	1.56	8.03	6
Nox	0.31	0.6	0.32	1.46	9.01	9.3
PM	0.02	0.22	0.04	0.28	0.55	1.24
SO2	0.01	0.01	0.03	0.06	0.13	0.13

8. **Meteorological data.** The meteorological parameters such as wind speed, wind direction, temperature, rainfall, cloud cover, pressure, and humidity were used in model. Due to limited availability of good data, the data has been taken from nearest World Meteorological Observation Station, Imphal airport for this study.

9. **Receptor**. A set of link receptors were taken at various receptor locations within each section at a distance of 5 m, 10 m, 20 m, 50 m, 100 m and 200 m both sides from centre line of the carriageway to know the dispersion of pollutant from the road.

10. **Background Concentration**. The background pollutant concentrations were taken from environmental monitoring data. Air quality monitoring was carried out in the month of March 2019 at four locations throughout the alignment on two alternate days. The following background pollutant concentrations were taken for model predictions:

Table 3: Average background concentration of pollutants along the alignment

Average Background concentration, microgram/m^3	
CO	**0**
NOx	**13.0**
$PM_{2.5}$	**31.3**
PM_{10}	**63.8**
SO_2	**6.6**

11. **Results**. The model has been setup and run to predict hourly average CO, PM2.5, PM10, NOx and SO2 concentrations for year 2020, 2025, 2030, 2035 and 2040 using forecasted traffic data on proposed highway. The predicted hourly average concentration of CO, PM2.5, PM10, Sox and NOx during peak traffic are shown in Tables 4, 5, 6, 7, 8 for proposed highway project. The graphical representation of hourly average pollutant concentrations on both side of the road sections shown in figures 2, 3, 4, 5 and 6 at different locations.

Table 4: CO predicted concentrations (ppm) along the proposed road

	CO Concentration (µg/m3)													
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)					
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	2.8	3.5	4.4	5.6	12.4	19.9	28.2		9.6	7.8	5.4	1.3	0.6	0.4	0.4
2025	4.4	5.5	6.9	8.8	19.3	31.2	44.2		15.1	12.1	8.4	2	0.9	0.6	0.6
2030	5.5	7	8.8	11.2	24.6	39.7	56.2		20.5	15.5	10.8	2.5	1.1	0.8	0.8
2035	6.7	8.5	10.7	13.5	29.6	47.9	67.8		23.9	18.6	13	3	1.3	0.9	1
2040	7.9	10	12.5	15.8	34.7	56.1	79.4		27.4	27.7	15.1	3.5	1.5	1.1	1.1

Table 5: PM2.5 predicted concentrations (µg/m3) along the proposed road

	PM2.5 Concentration (µg/m3)													
	Distance from the centre line of the road, m. (Left side)							Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	31.3	31.3	31.3	31.4	31.4	31.5	31.6		31.6	31.5	31.4	31.3	31.3	31.3	31.3
2025	31.3	31.3	31.4	31.4	31.5	31.7	31.8		31.8	31.6	31.5	31.3	31.3	31.3	31.3
2030	31.3	31.4	31.4	31.4	31.6	31.8	32		32	31.7	31.5	31.3	31.3	31.3	31.3
2035	31.4	31.4	31.4	31.5	31.7	31.9	32.1		32	31.8	31.6	31.4	31.3	31.3	31.3
2040	31.4	31.4	31.4	31.5	31.7	32	32.2		32.2	31.9	31.6	31.4	31.3	31.3	31.3

Annex 5

Table 6: PM10 predicted concentrations (µg/m3) along the proposed road

	PM10 Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	63.8	63.8	63.8	63.9	63.9	64	64.1		64.1	64	63.9	63.8	63.8	63.8	63.8
2025	63.8	63.8	63.9	63.9	64	64.2	64.3		64.3	64.1	64	63.8	63.8	63.8	63.8
2030	63.8	63.9	63.9	63.9	64.1	64.3	64.5		64.4	64.2	64	63.8	63.8	63.8	63.8
2035	63.9	63.9	63.9	64	64.2	64.4	64.6		64.5	64.3	64.1	63.9	63.8	63.8	63.8
2040	63.9	63.9	63.9	64	64.2	64.5	64.7		64.7	64.4	64.1	63.9	63.8	63.8	63.8

Table 7: NOx predicted concentrations (µg/m3) along the proposed road

	NOx Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	13.3	13.3	13.4	13.6	14.2	14.8	15.5		15.3	14.5	13.9	13.4	13.2	13.1	13.1
2025	13.3	13.4	13.6	13.8	14.8	15.8	16.8		16.6	15.4	14.4	13.3	13.2	13.2	13.2
2030	13.4	13.5	13.7	14	15.2	16.5	17.8		17.5	16	14.7	13.4	13.2	13.2	13.2
2035	13.5	13.6	13.8	14.2	15.6	17.2	18.7		18.3	16.5	15	13.5	13.3	13.2	13.2
2040	13.5	13.7	13.9	14.4	16.1	17.9	19.7		19.1	17	15.3	13.5	13.3	13.2	13.2

Table 8: SOx predicted concentrations (µg/m3) along the proposed road

	SOx Concentration (µg/m3)														
	Distance from the centre line of the road, m. (Left side)								Distance from the centre line of the road, m. (Right side)						
Year	-200	-150	-100	-50	-20	-10	-5		5	10	20	50	100	150	200
2020	6.6	6.6	6.6	6.6	6.7	6.7	6.7		6.7	6.7	6.6	6.6	6.6	6.6	6.6
2040	6.6	6.6	6.6	6.7	6.7	6.8	6.9		6.9	6.8	6.7	6.6	6.6	6.6	6.6

Annex 5

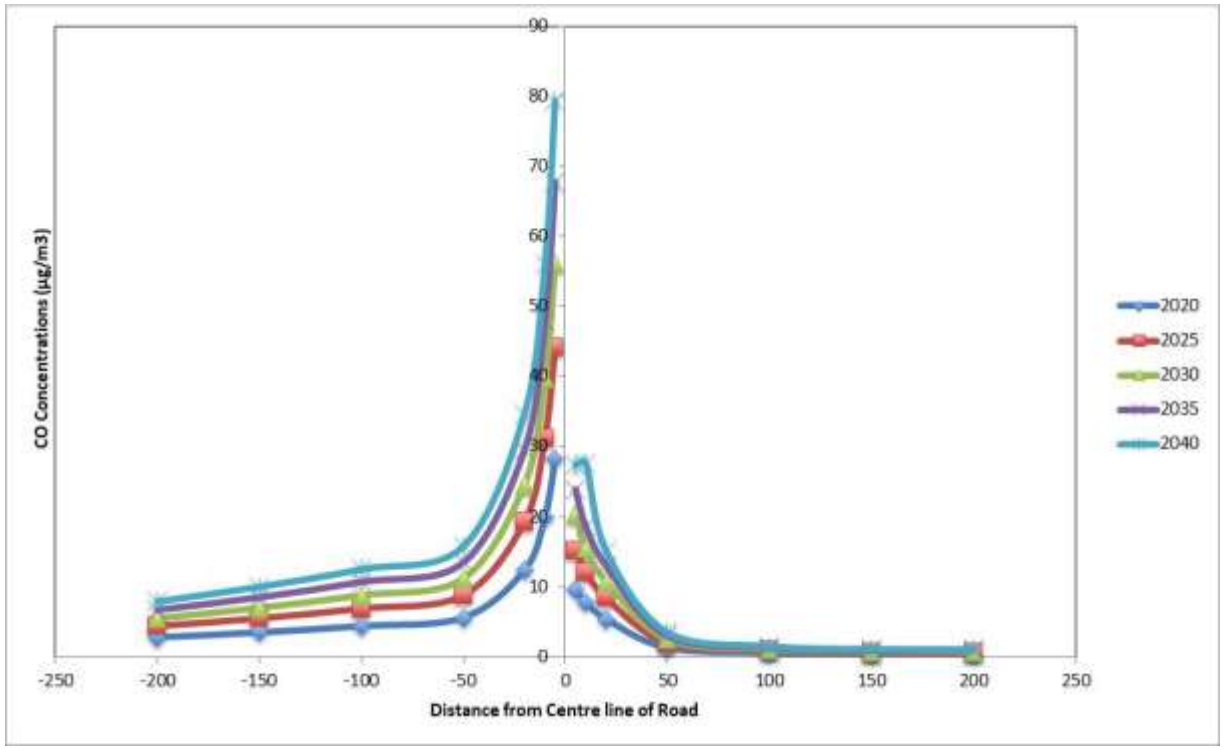


Figure 2: CO distribution from Centre line of the road

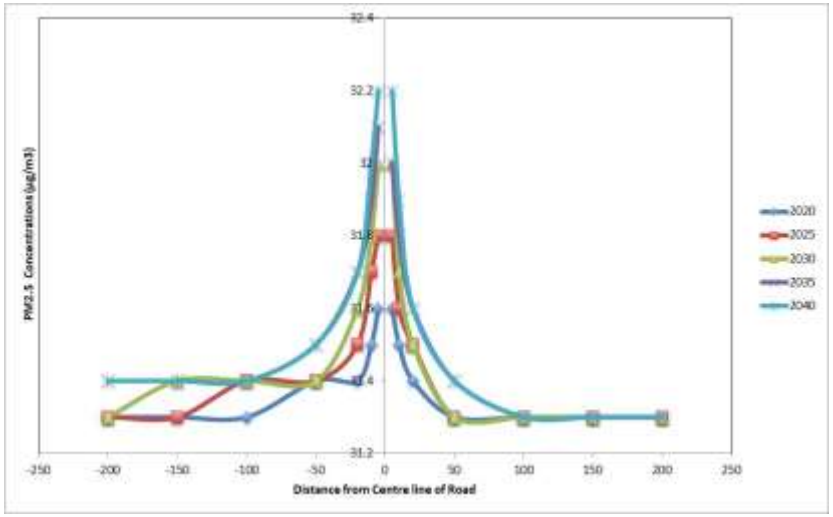


Figure 3: PM2.5 distribution from Centre line of the road

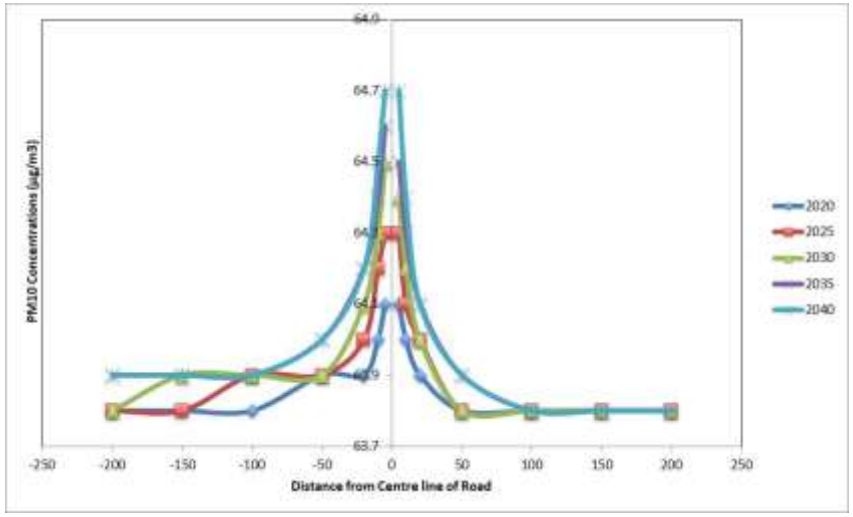


Figure 4: PM10 distribution from Centre line of the road

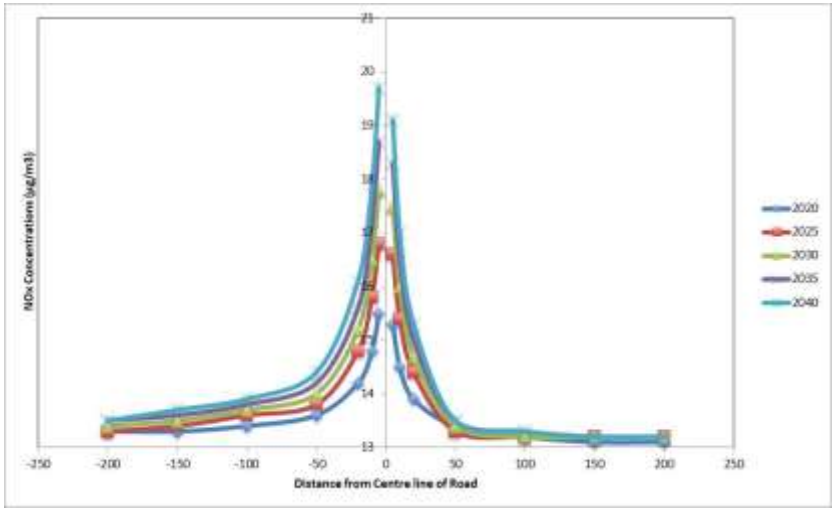


Figure 5: NOx distribution from Centre line of the road

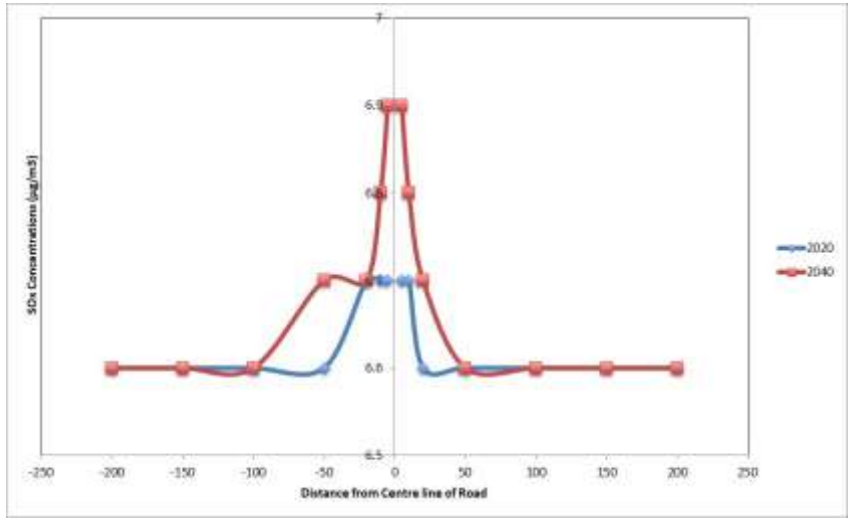
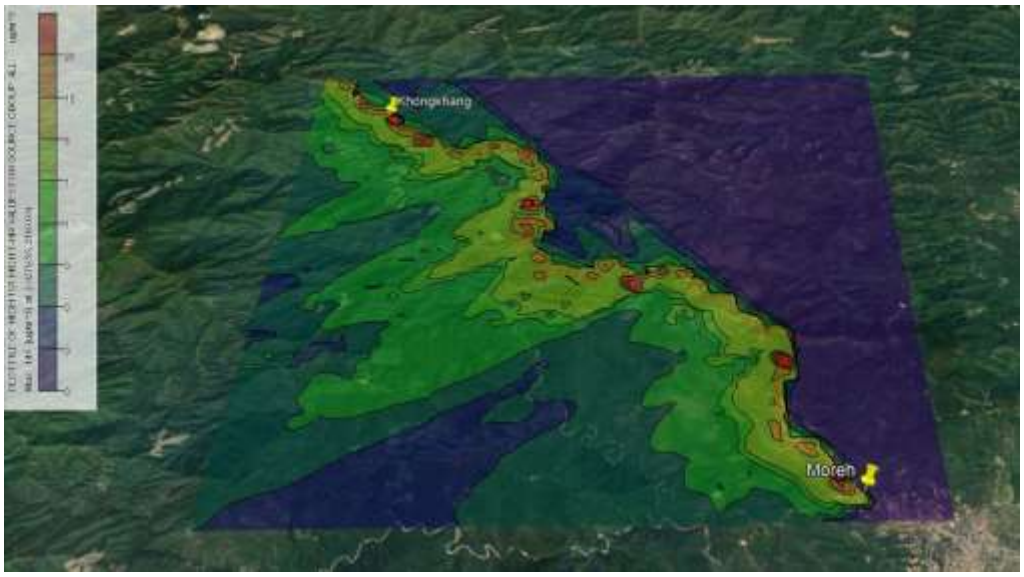
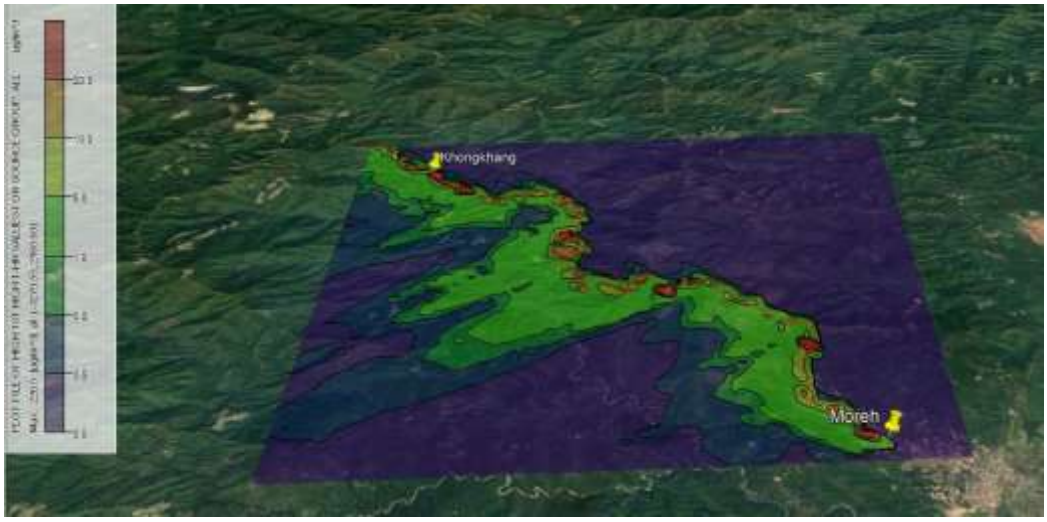


Figure 6: SOx distribution from Centre line of the road

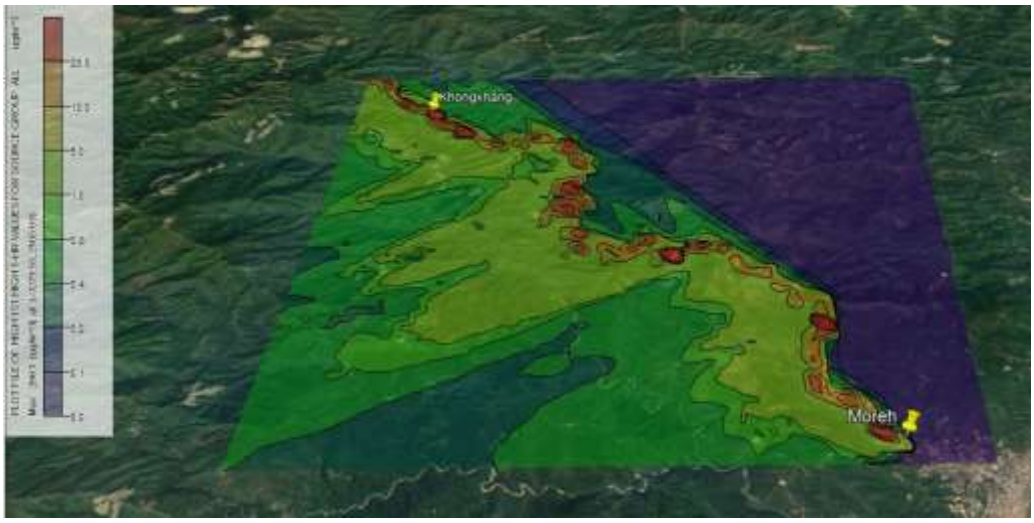
12. In addition, the spatial distribution of hourly average predicted CO, PM2.5 and PM10 concentrations have been plotted in Figures 8, 9, 10, 11 and 12 respectively which shows that pollutant concentrations is decreasing when goes away from the kerb side.



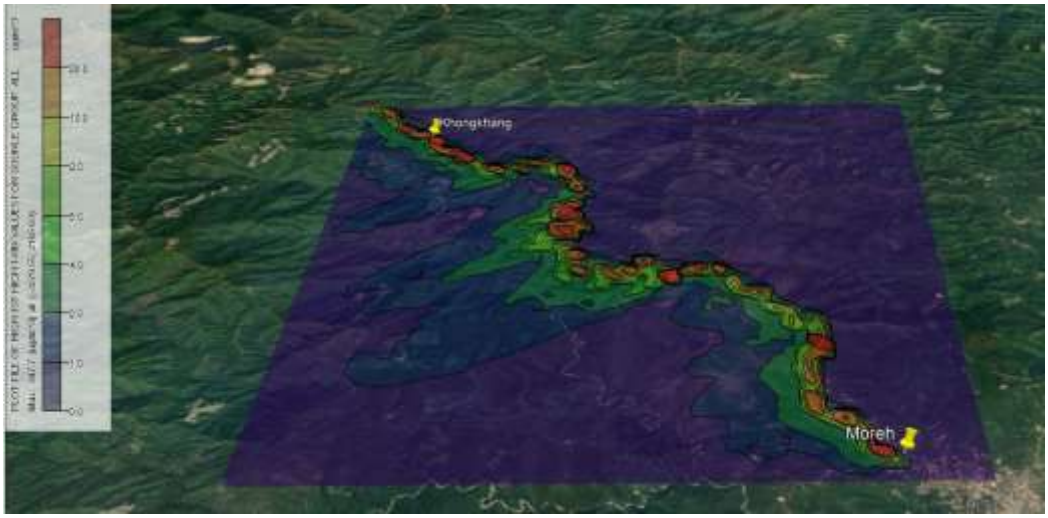
Spatial Distribution of CO for year 2020



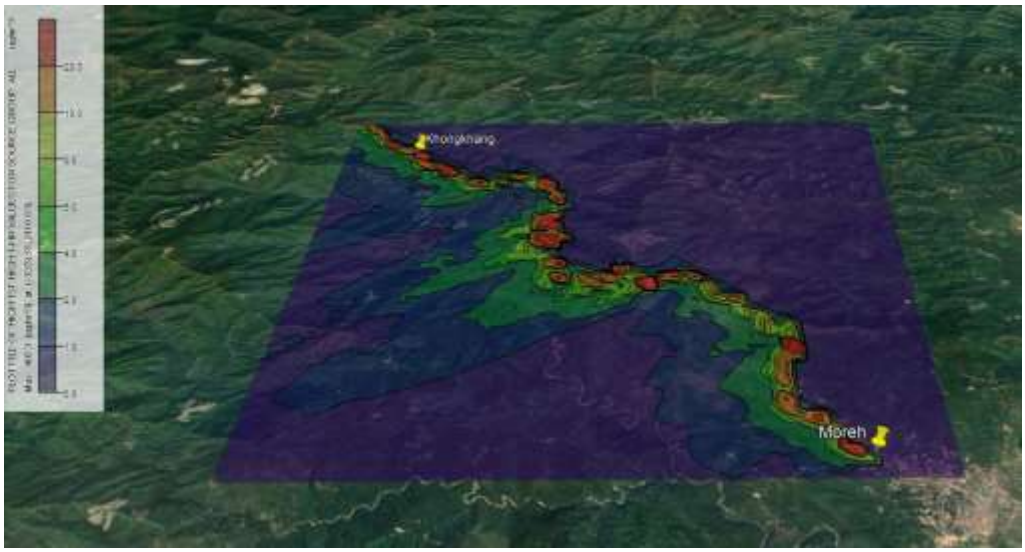
Spatial Distribution of CO for year 2025



Spatial Distribution of CO for year 2030

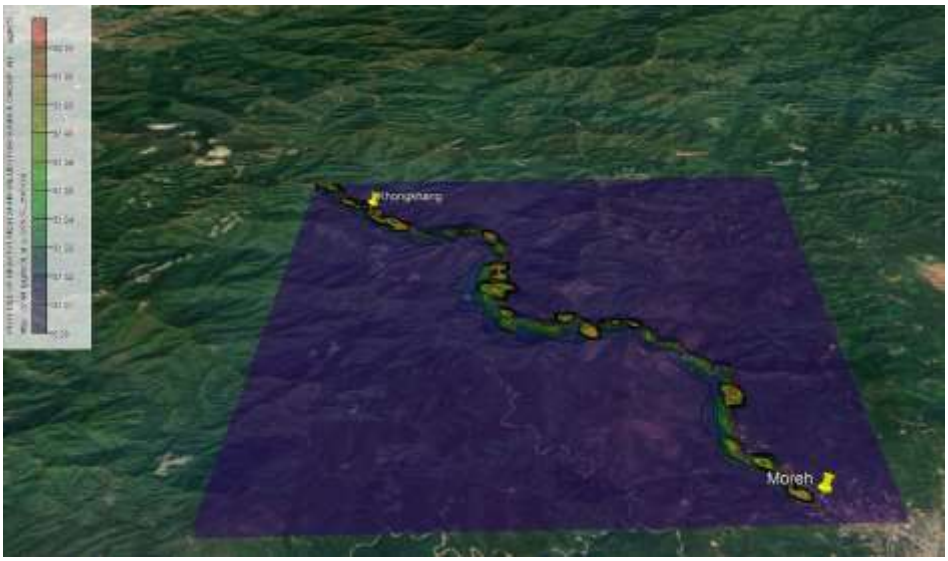


Spatial Distribution of CO for year 2035



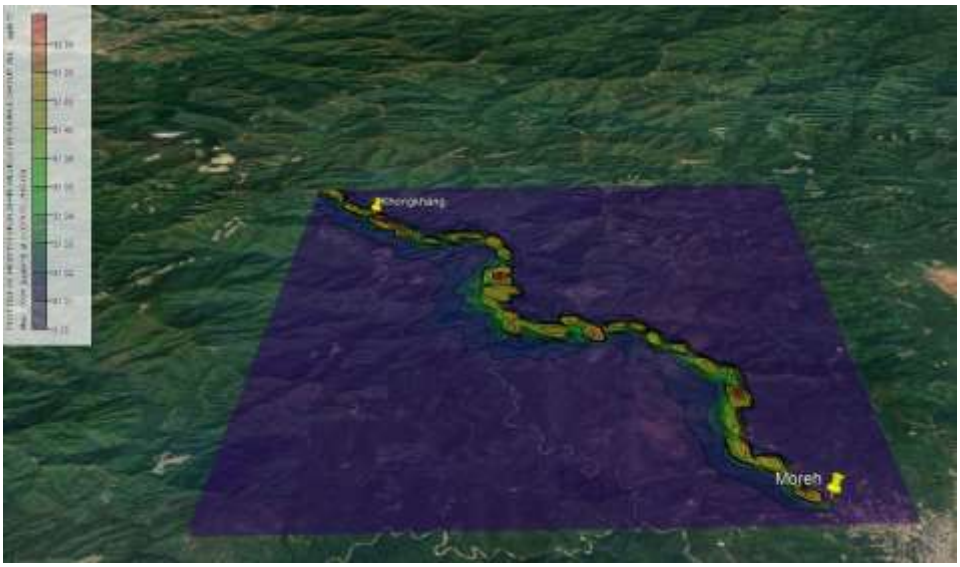
Spatial Distribution of CO for year 2040

Figure 8: Spatial Distribution of CO (2020-2040)



Spatial Distribution of $PM_{2.5}$ for year 2020

Spatial Distribution of $PM_{2.5}$ for year 2025

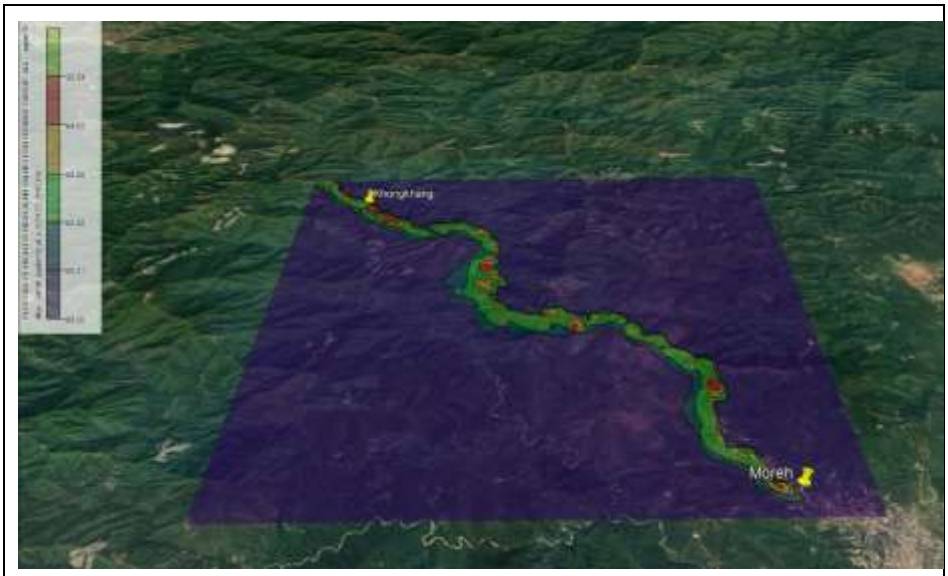


Spatial Distribution of $PM_{2.5}$ for year 2030

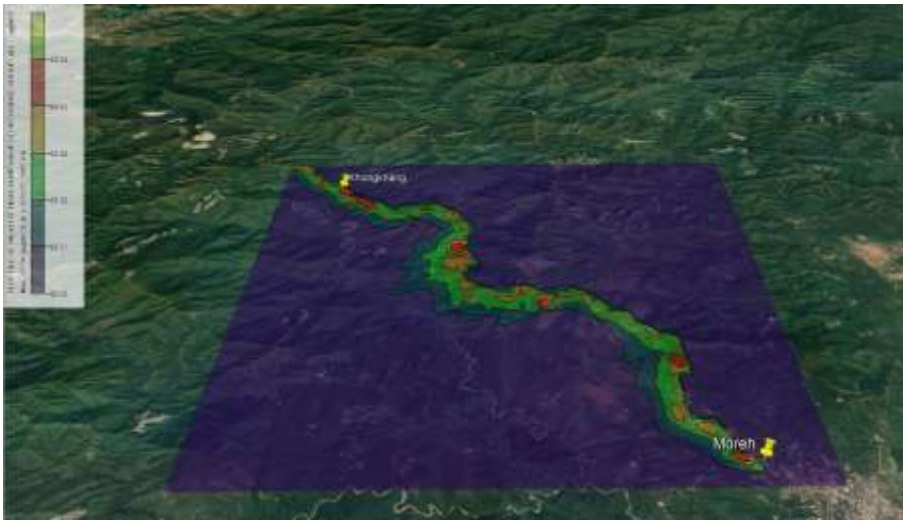
Spatial Distribution of $PM_{2.5}$ for year 2035

Spatial Distribution of $PM_{2.5}$ for year 2040

Figure 9: Spatial Distribution of $PM_{2.5}$ (2020-2040)

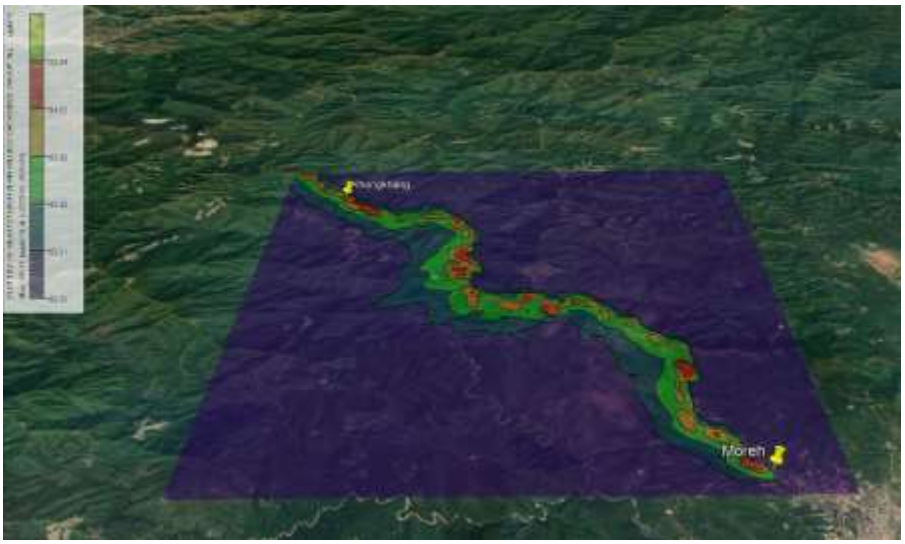


Spatial Distribution of PM_{10} for year 2020

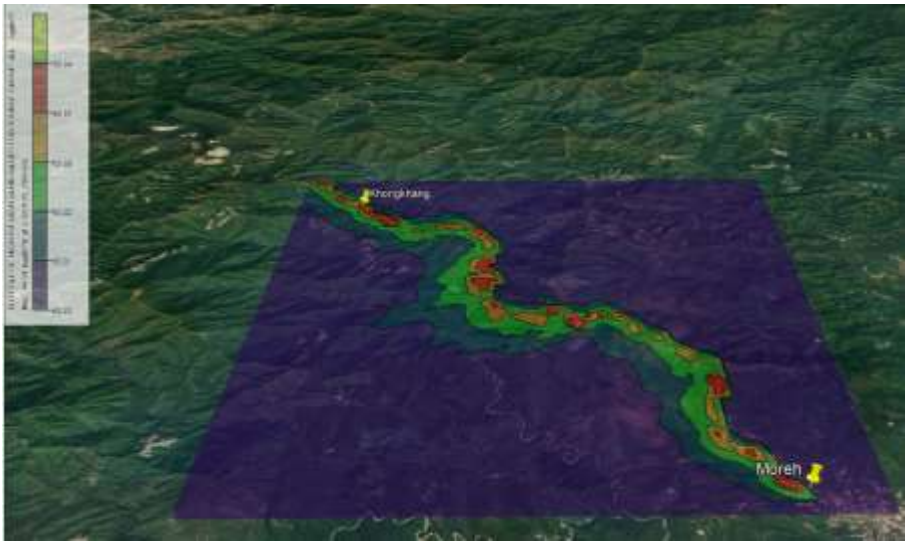


Spatial Distribution of PM_{10} for year 2025

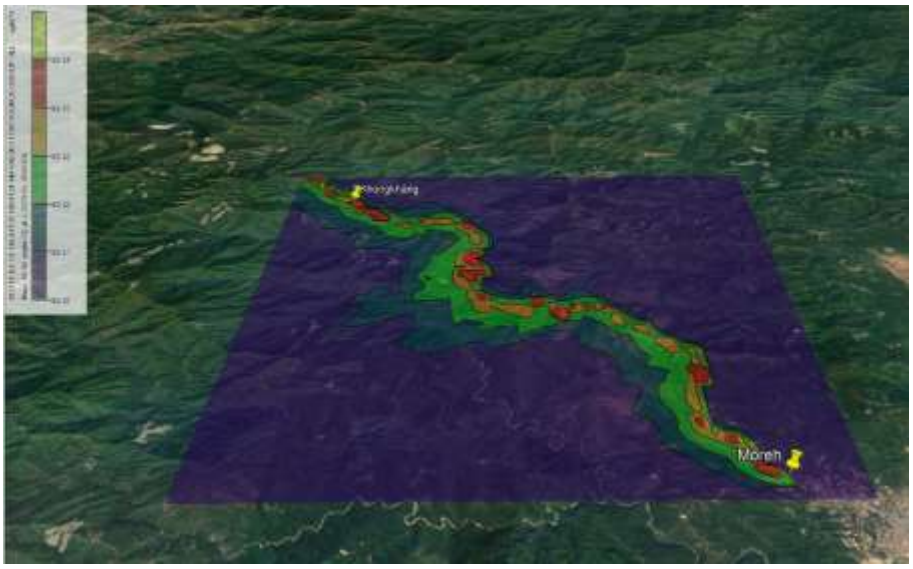
Annex 5



Spatial Distribution of PM_{10} for year 2030



Spatial Distribution of PM_{10} for year 2035



Spatial Distribution of PM_{10} for year 2040

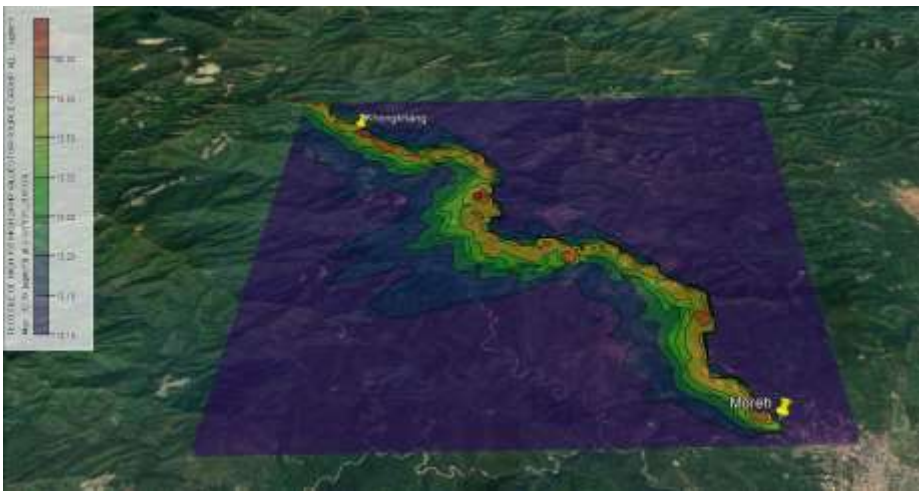
Figure 10: Spatial Distribution of PM_{10} (2020-2040)

Spatial Distribution of NOx for year 2020

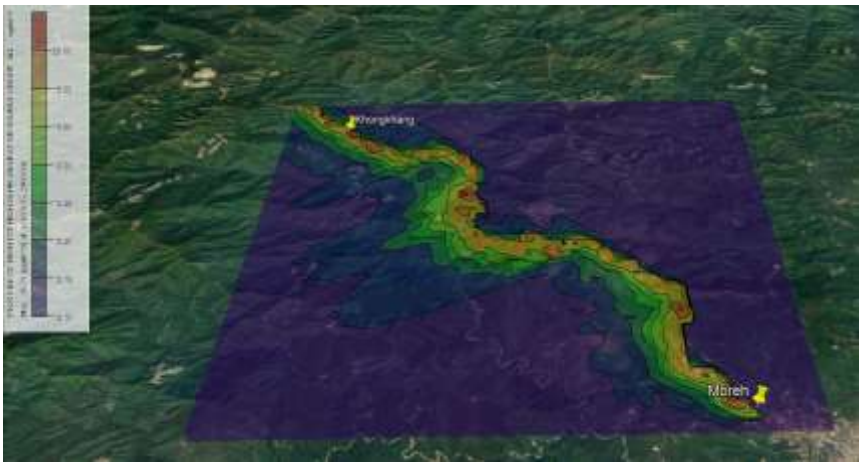
Annex 5

Spatial Distribution of NOx for year 2025

Spatial Distribution of NOx for year 2030

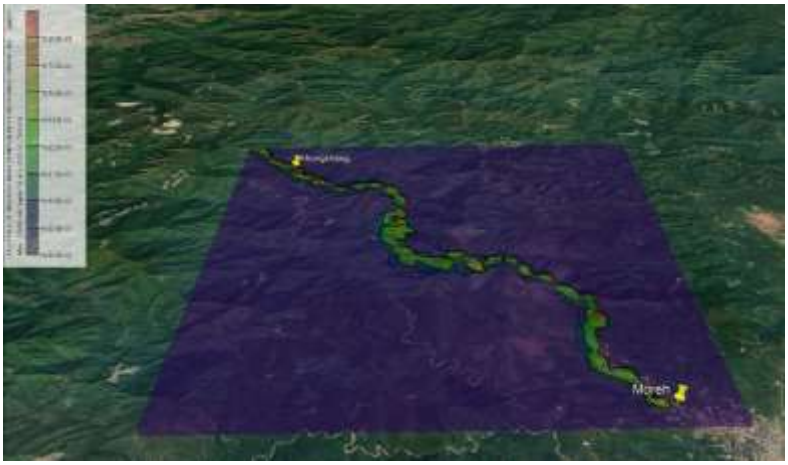


Spatial Distribution of NOx for year 2035



Spatial Distribution of NOx for year 2040

Figure 11: Spatial Distribution of NOx (2020-2040)



Spatial Distribution of SO_2 for year 2020

Spatial Distribution of SO_2 for year 2040

Figure 12: Spatial Distribution of SO_2 (2020-2040)

Annex 6: PREDICTED NOISE LEVELS

1. Federal Highway Administration's Traffic Noise Model (FHWA TNM) helps for highway traffic noise prediction and analysis. TNM computes highway traffic noise at nearby receivers. As sources of noise, it includes noise emission levels for the following vehicle types:

- Automobiles: all vehicles with two axles and four tires -- primarily designed to carry nine or fewer people (passenger cars, vans) or cargo (vans, light trucks) -- generally with gross vehicle weight less than 4,500 kg (9,900 lb);
- Medium trucks: all cargo vehicles with two axles and six tires -- generally with gross vehicle weight between 4,500 kg (9,900 lb) and 12,000 kg (26,400 lb);
- Heavy trucks: all cargo vehicles with three or more axles -- generally with gross vehicle weight more than 12,000 kg (26,400 lb);
- Buses: all vehicles designed to carry more than nine passengers; and
- Motorcycles: all vehicles with two or three tires and an open-air driver / passenger compartment.

2. The procedure for prediction of noise levels involves the following steps:

- Identification of various receivers
- Determination of land uses and activities which may be affected by the noise generated
- Assemble input parameters
- Application of the model

3. The description of the components to predict noise level are as follows:

- Receivers: TNM calculates the sound levels at the input receivers. In this study two type of receivers selected to assess the impacts of moving traffic on surrounding noise level. One, discrete receptor and second, grid receptor.
- Land uses: Land use along the road is obtained from the topographic drawings. This information provides the range of shielding and absorption factors to be applied at the various receivers.
- Input Parameters: Traffic volume for the projected period is obtained from the traffic projections. The total number of vehicles passing per hour by type - light, medium and heavy along with their average speed is used for predictions.
- Average Noise Level: All vehicles produce noise, which is taken as the base, and the cumulative noise at the receiver distance due to the whole traffic is estimated. The average noise level varies depending on the type of vehicle.
- Application of Model: Equivalent noise levels due to traffic at the receivers are estimated using Federal Highway Noise model. Equivalent Sound Level (T_{EQ}, denoted by the symbol, L_{AeqT}): Ten times the base-10 logarithm of the square of the ratio of time-average, mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T (where $T=t_2-t_1$), and the reference mean-square sound pressure of 20 : Pa, the threshold of human hearing, e.g., 1HEQ, denoted by the symbol, LAeq1H, represents the hourly equivalent sound level. L_{AeqT} is related to LAE by the following equation:

  $L_{AeqT} = L_{AE} - 10*\log10(t_2-t_1)$

  where LAE = Sound exposure level in dB

Sound Exposure Level (SEL, denoted by the symbol, L_{AE}): Over a stated time interval, T (where $T=t_2-t_1$), ten times the base-10 logarithm of the ratio of a given time integral of squared instantaneous A-weighted sound pressure, and the product of the reference sound pressure of 20:Pa, the threshold of human hearing, and the reference duration of 1 sec. The time interval, T, must be long enough to include a majority of the sound source's acoustic energy. As a minimum, this interval should encompass the 10 dB down points. Traffic data used in noise modelling are given below in Table 1:

Table 1: Annual average daily motorized traffic data

Year	2w	4w	LCV	HCV	Buses
2020	42	2962	304	127	8
2025	65	4627	474	199	12
2030	84	5974	613	257	15
2035	99	7096	728	305	18
2040	116	8250	846	354	21

Table 2: Equivalent Background Noise levels

Location		Khongkhang	Khudenthabi	Lokchao	Khudenthabi Army Checkpost	Moreh College
Night	Leq(dB)	45	43	46	46	42
Day	Leq(dB)	63	67	67	70	64

Table 3: Noise prediction in dB (A) along the road corridor (without Barrier)

Year	Distance from the edge of the road, m. (Left side)						Distance from the edge of the road, m. (Left side)				
	200	100	50	20	10		10	20	50	100	200
2020	38.4	45.7	53.1	57.8	59.8		59.8	57.7	52.9	44.6	38.5
2025	39.6	46.9	54.4	59.1	61.1		61.1	59	54.2	45.8	39.7
2030	40.6	47.9	55.4	60.1	62.1		62.1	60	55.2	46.8	40.6
2035	41.5	48.8	56.3	61	63		63	60.9	56.1	47.7	41.5
2040	42.4	49.7	57.2	61.9	63.9		63.9	61.8	57	48.6	42.5

Annex 6

Table 4: Predicted Noise levels at sensitive receptors along the project corridor for year 2020

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Type of Impact
Community Hall,Khudengthabi	LHS	412+400	412+500	5	67	62.6	68.3	1.3	No Impact
Angawadi Centre	LHS	412+500	412+600	5	67	62.6	68.3	1.3	No Impact
Church	LHS	412+600	412+700	5	67	62.6	68.3	1.3	No Impact
Market Area	LHS	414+400	414+700	5	70	62.6	70.7	0.7	No Impact
Army Camp	RHS	414+400	414+800	10	70	59.8	70.4	0.4	No Impact
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	57.1	64.8	0.8	No Impact
Community Hall	LHS	415+400	415+500	10	64	59.8	65.4	1.4	No Impact
Church	RHS	419+300	419+400	8	64	62.8	66.5	2.5	No Impact
Moreh college	LHS	421+500	421+700	50	64	53.1	64.3	0.3	No Impact

Table 5: Predicted Noise levels at sensitive receptors along the project corridor for year 2025

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Type of Impact
Community Hall,Khudengthabi	LHS	412+400	412+500	5	67	63.4	68.6	1.6	No Impact
Angawadi Centre	LHS	412+500	412+600	5	67	63.4	68.6	1.6	No Impact
Church	LHS	412+600	412+700	5	67	63.4	68.6	1.6	No Impact
Market Area	LHS	414+400	414+700	5	70	63.4	70.9	0.9	No Impact
Army Camp	RHS	414+400	414+800	10	70	61.1	70.5	0.5	No Impact
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	57.9	65.0	1.0	No Impact
Community Hall	LHS	415+400	415+500	10	64	61.1	65.8	1.8	No Impact
Church	RHS	419+300	419+400	8	64	63.1	66.6	2.6	No Impact
Moreh college	LHS	421+500	421+700	50	64	54.4	64.5	0.5	No Impact

Annex 6

Table 6: Predicted Noise levels at sensitive receptors along the project corridor for year 2030

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Type of Impact
Community Hall,Khudengthabi	LHS	412+400	412+500	5	67	64.5	68.9	1.9	No Impact
Angawadi Centre	LHS	412+500	412+600	5	67	64.5	68.9	1.9	No Impact
Church	LHS	412+600	412+700	5	67	64.5	68.9	1.9	No Impact
Market Area	LHS	414+400	414+700	5	70	64.5	71.1	1.1	No Impact
Army Camp	RHS	414+400	414+800	10	70	62.1	70.7	0.7	No Impact
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	59	65.2	1.2	No Impact
Community Hall	LHS	415+400	415+500	10	64	62.1	66.2	2.2	No Impact
Church	RHS	419+300	419+400	8	64	61.1	65.8	1.8	No Impact
Moreh college	LHS	421+500	421+700	50	64	55.2	64.5	0.5	No Impact

Table 7: Predicted Noise levels at sensitive receptors along the project corridor for year 2035

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Type of Impact
Community Hall,Khudengthabi	LHS	412+400	412+500	5	67	65.6	69.4	2.4	No Impact
Angawadi Centre	LHS	412+500	412+600	5	67	65.6	69.4	2.4	No Impact
Church	LHS	412+600	412+700	5	67	65.6	69.4	2.4	No Impact
Market Area	LHS	414+400	414+700	5	70	65.6	71.3	1.3	No Impact
Army Camp	RHS	414+400	414+800	10	70	63	70.8	0.8	No Impact
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	59.9	65.4	1.4	No Impact
Community Hall	LHS	415+400	415+500	10	64	63	66.5	2.5	No Impact
Church	RHS	419+300	419+400	8	64	61.7	66.0	2.0	No Impact
Moreh college	LHS	421+500	421+700	50	64	56.1	64.7	0.7	No Impact

Annex 6

Table 8: Predicted Noise levels at sensitive receptors along the project corridor for year 2040

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Noise level, dB	Noise due to traffic, dB	Equivalent Noise Levels, dB	Increase in noise levels, dB	Type of Impact
Community Hall,Khudengthabi	LHS	412+400	412+500	5	67	66.5	69.8	2.8	No Impact
Angawadi Centre	LHS	412+500	412+600	5	67	66.5	69.8	2.8	No Impact
Church	LHS	412+600	412+700	5	67	66.5	69.8	2.8	No Impact
Market Area	LHS	414+400	414+700	5	70	66.5	71.6	1.6	No Impact
Army Camp	RHS	414+400	414+800	10	70	63.9	71.0	1.0	No Impact
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	60.8	65.7	1.7	No Impact
Community Hall	LHS	415+400	415+500	10	64	63.9	67.0	3.0	No Impact
Church	RHS	419+300	419+400	8	64	62.9	66.5	2.5	No Impact
Moreh college	LHS	421+500	421+700	50	64	57	64.8	0.8	No Impact

4. **Observations**. Noise levels (Leq) near the receivers are found to be marginally higher than desired levels for the respective categories. However the increase in noise level due to project are within permissible limits at all the sensitive receptors. The predicted levels show increase in noise levels for future years at all receivers considering increase in traffic volume.

5. **Noise dispersion**. A small road corridor has been selected to develop noise contour for base year as well as future years also. The contour lines are generated by plotting a contour zone within 30 m distance from edge of the road on both side of the road. Due to model limitation, it is not possible to select the whole road corridor in the modelling domain. Therefore, spatial dispersion of noise has been shown with a small stretch of road. Figure 1 to 5 shows noise level contour around a small road corridor for year 2020, 2025, 2030, 2035 and 2040 respectively. The selected road stretch is small part of section -I, i.e., Khongkhang-Moreh road stretch. These predicted results are for peak traffic hours. During non-peak traffic hours, the noise levels are very less compared to noise level for peak traffic hours.

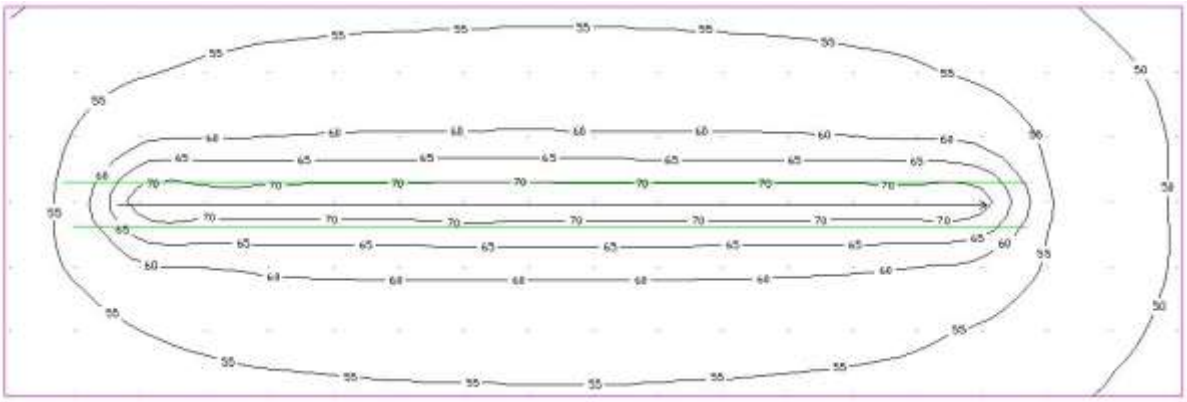


Figure 1: Noise contour for year 2020

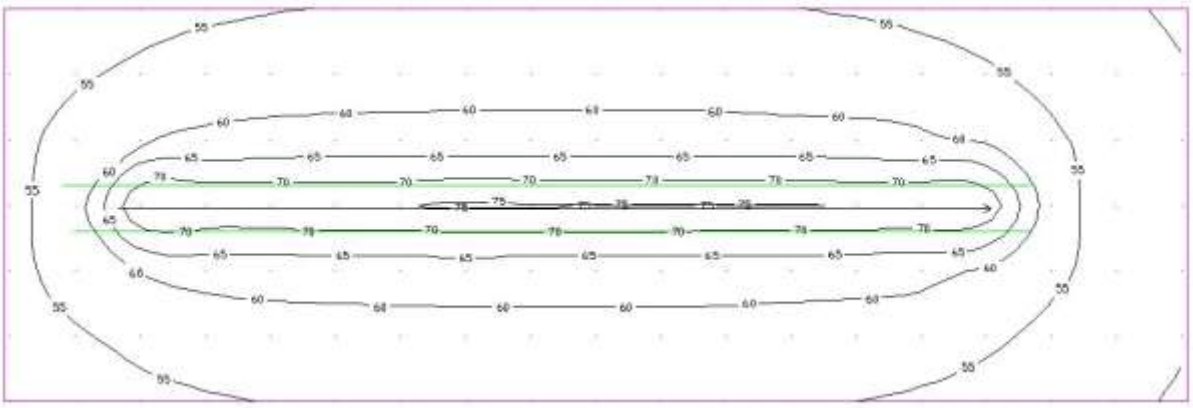


Figure 2: Noise contour for year 2025

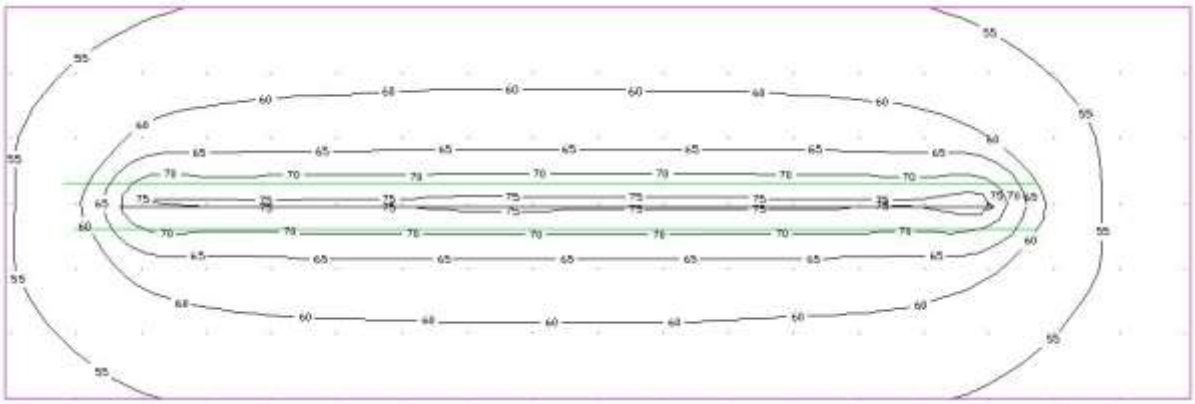


Figure 3: Noise contour for year 2030

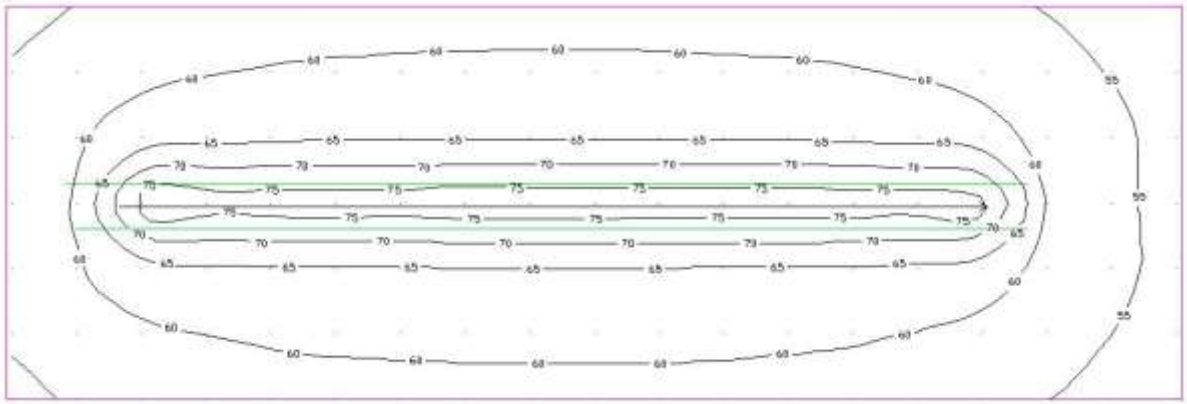


Figure 4: Noise contour for year 2035

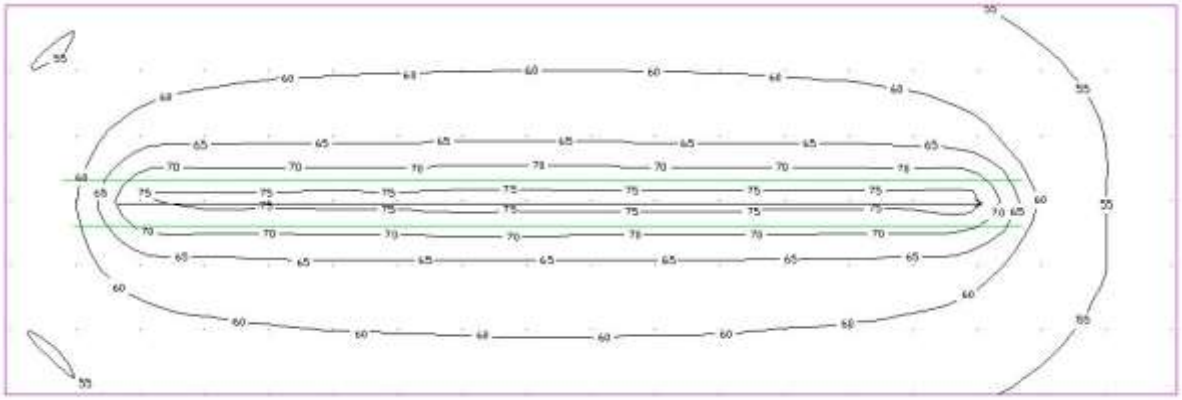


Figure 5: Noise contour for year 2040

Annex 7: GUIDELINES FOR PLANT MANAGEMENT

A. Purpose

- To ensure that statutory / regulatory requirements are complied with
- To ensure that safeguard measures are taken to avoid / mitigate / minimize environmental impacts

B. Site selection criteria

1. Following criteria are recommended for crusher and HMP. Further specific guidance maybe taken from the relevant national/state regulations or the consent to establish issued for the crusher, HMP or other plants and facilities:

- 500 m away from settlement, school, hospital on downwind directions and/or in accordance with the requirements of the Manipur Pollution Control Board (MPCB) requirements and compliance conditions issue with the consent to establish
- 1 km from any archaeological site
- 1 km from ecologically sensitive areas i.e. forest, national park, sanctuary etc.
- 500 m from rivers, streams and lakes
- 500 m from ponds
- 200 m from State and National Highway boundary
- away from agricultural land
- preference to barren land

2. Concrete batching plant maybe be located at least 500 m from the settlement, preferably on leeward side, whenever possible and/or in accordance with relevant national/local regulations or respective permission document.

3. The format for submission of details to the Engineer during finalisation of plant site is given as follows (Site identification for Plants).

C. Statutory Requirements

- Obtaining Consent-for-Establishment (CFE) under Air and Water Acts from the State Pollution Control Board (SPCB) before start of installation
- Obtaining Consent-for-Operation (CFO) under Air and Water Acts from the State Pollution Control Board (SPCB) before start of commissioning and trial run
- Complying with the terms and conditions laid down in the CFE and CFO, which generally include providing metallic road inside plant campus for movement of vehicles, plantation, periodic (monthly) pollution monitoring i.e. ambient air, noise and stack emission
- The suspended particulate matter contribution value at a distance of 40 m from a controlled isolated as well as from a unit located in a cluster should be less than 600 μg/m3 or as shall be prescribed by SPCB.
- Obtain certificates from manufacturer for Type Approval and Conformity of Production for Diesel Generator (DG) set/s.
- For DG sets of capacity up to 1000 kVA, the noise level at 1 m from the enclosure surface shall not exceed 75 dB (A).

D. Pollution control measures

- Dust control measures in stone crusher plant i.e. water sprinkling at primary crusher and secondary crusher, conveyor & return belts, covered conveyor system, chute at outfall of aggregates, cyclone separator, wind braking wall etc.
- For HMP, ensure adequate stack height as stipulated in CFE, install emission control devices such as bag house filters, cyclone separators, water scrubbers etc., as attached with the plant by the manufacturer or stipulated in CFE.
- Prefer bulk bitumen storage with mechanized handling facilities that storage in drums with manual operation at HMP to prevent / minimize bitumen spillage and thereby contaminating soil and ground water.
- Impervious platform for storage of bituminous and other liquid hazardous chemical
- Bag house filter / multi-cone cyclone for emission control. For bag house, cartridge filters reported to be more efficient than fabric filters
- Pollution control measures for Diesel Generator (DG) set i.e. stack height, acoustic enclosure etc.

- Greenbelt along the periphery of plant site.

SITE IDENTIFICATION FOR PLANTS

Construction Stage Report: One Time Date:
Installed Capacity (tph): Location of Plant (Ch. & offset):

Sl. No.	Item / Requirement	Details as per Actual
1	Predominant wind direction	
2	Size and area of the proposed plant site (m xm & Sq.m)	
3	Present land use (barren or fallow land having no prominent vegetation should be preferred)	
4	No dwelling units within 500 m from the plant boundary in downwind direction	
5	Distance of nearest boundary of State Highways and National Highways (should be at least 200 m from the plant boundary)	
6	Sensitive areas such as religious places, schools/educational institutions, reserved / protected forest, sanctuary etc. within 1 km (should be nil)	
7	River/Stream/Lake within 500 m and ponds within 500 m	
8	No other trees of girth>0.3m present and will be affected (no tree should be affected)	
9	Width of Haul road (m)	
10	Total Length of Haul Road (km)	
11	Length of non-metal Haul Road (km) (should be as minimum as possible)	

Documents to be attached:
Site plan showing wind direction, haul road and other environmental features.
Certified that the furnished information is correct and all relevant information as required is attached.

Contractor:

Annex 8: GUIDELINES FOR CAMP SITE MANAGEMENT

A. Purpose

1. Campsite of a contractor represents the single potentially most polluting location during implementation of any road project. Air pollution may be caused by emissions from Crushers, Hot-Mix, and Concrete Batching Plants. Water pollution may be caused by discharge of sediment, oil & grease, and organics laden run-off from these plants and their ancillary facilities as well as workshops, residential quarters for the labor. Land may be polluted due to indiscriminate disposal of domestic waste or (accidental) release of hazardous solids from storage areas.

2. While the installation and operation of Crushers and Hot-Mix Plants are regulated by the respective Pollution Control Boards, the other sources described above usually do not appear to be causes of significant concern. Items to be considered for labor camps are mentioned briefly in Clause 105.2 (as part of 105: Scope of Work) of the Ministry of Road Transport and Highways (MoRTH) publication: Specifications for Road and Bridge Works. Some specific requirements for labor accommodation and facilities are to be met by the Contractor in line with Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. Currently, there is no one-point guidance regarding the environmental management aspects of the Contractor's campsite. This guideline on Campsites is designed to fill this gap.

B. Scope

3. This guideline covers the Contractors' camp sites – whether used by in-house crew or by any sub-contractor's crew. It covers siting, operation, maintenance, repair and dismantling procedures for facilities for labor employed on project (and ancillary) activities as well as equipment and vehicles. ***It does not include siting, operation, maintenance, repair and dismantling of major plants – Hot-mix Plant, Concrete Batching Plant, Crusher or Wet Mix Macadam Plant.***

4. Siting, Establishing, Operation and Closure of Construction Camp.

a. **Potential Environmental Impacts.** Construction camps require large areas for siting facilities like major plants, storage areas for material, residential accommodation for construction labor and supervisors, and offices. Removal of topsoil and vegetation from the land to be utilized for camps is the first direct impact of any such establishment. In addition, local drainage may be impaired if proper drainage is not affected by grading. Other impacts may include damage to ecologically important flora and fauna, if campsites are located close to such areas. Water pollution because of discharge of sediment, fuel and chemicals is also a possibility. Pollution of land due to indiscriminate disposal of construction wastes including scarified pavement, concrete and even substantial quantities of domestic wastes from residential areas can also be potentially disastrous, especially if the site is reverted to its original use after the project (mostly agriculture).

b. **Mitigation Measures.**

5. **Siting of Construction Camps**. The following guidelines are recommended to avoid any environmental issues while siting construction camps. Further specific guidance maybe taken from the relevant national/state regulations or conditions issued with the consent to establish:

- Maintain a distance of at least 1 km from boundaries of designated Reserved Forests, Sanctuary or National Park area for locating any temporary or permanent camps.
- Maintain 500m from river, stream and lake and from ponds
- Maintain 200 m from the boundary of state and national highways
- Locate facilities in areas not affected by flooding and clear of any natural or storm water courses.
- Locate campsites in the (most prevalent) downwind direction of nearest village(s). The boundary of the campsite should be at a suitable distance from the nearest habitation and in compliance with relevant national or state regulations such as the state pollution control board requirements so that the incoming labor does not stress the existing local civic facilities.
- The ground should have gentle slope to allow free drainage of the site.
- Recorded consultations should be held with residents of the nearest settlement and/or their representatives to understand and incorporate where possible, what they would like to see within their locality.

Establishment, Operation, and Closure of Camps

- The facilities within the camp site should be laid out so that the separation distances suggested in other guidelines are maintained. A notional lay-out of the facilities except the major plants is included in this guideline.
- Topsoil from the area of the plant shall be stored separately for the duration of the operation of the camp and protected from being washed away, unless agreed otherwise in writing with the owner. If stored, it will be returned on to its original location at the time of closure of the site.
- The Contractor shall prepare, make widely available (especially to staff responsible for water and material management), and implement a Storm water Management Plan (SWMP) for (all) the site(s) following approval of the same by the Engineer.
- The Contractor shall prepare an Emergency and Spill Response Plan as per the requirements of Appendix 1 to Clause 501 of Specifications for Road and Bridge Works to cover the spillage of bitumen and/or chemicals like retarders, curing compounds, etc.
- The Contractor shall prepare a Waste Management Plan describing the types and quantities that are likely to be generated from within the camp site, with the period and duration during the construction schedule; methods to be adopted to minimize these; methods of removal, treatment and (on-site or off-site) disposal for each type; as well as location of final disposal site, if any.
- The Contractor shall provide safe ingress and egress for vehicles from the site and public roads and shall not impact existing through traffic.
- Water tankers with sprayers must be available at the camp site at all times to prevent dust generation.
- In case of stockpiles of stored material rising higher than wind-breaking perimeter fencing provided, sprinklers shall be available on site to prevent dusting from the piles during windy days.
- On completion of works, the Contractor shall restore the site to the condition it was in before the establishment of the campsite, unless agreed otherwise in writing with the owner(s) of the site(s). If such a written agreement has been made, the Contractor shall hand over the site to the owner(s) in accordance with such an agreement.

- Construction waste disposal should be disposed only at landfill facilities which are selected, designed, constructed and operated to ensure environmentally safe disposal, and these facilities have to be approved by the regulators.

6. Equipment and Vehicle-related issues.

a. **Potential Environmental Impacts.** The maintenance and repair of equipment and vehicles in Contractor's camp are activities that can have significant adverse impacts if not carried out properly. The concern mainly arises from discharge of wash water contaminated with oil and grease, whether from washing of vehicles or degreasing of equipment and vehicle parts. Vehicle washing, especially dirt from tires, also gives rise to sediment-laden run-off. No such discharges should be directly allowed into surface water bodies since they can be harmful to aquatic species.

b. **Mitigation Measures**

Vehicles

- All vehicles used by the Contractor must have copies of currently valid Pollution Under Control Certificates displayed as per the requirement of the Motor Vehicles Department for the duration of the Contract.
- All vehicles and equipment will be fitted with silencers and/or mufflers which will be serviced regularly to maintain them in good working condition and conforming to the standard of 75dB (A) at 1m from surface of enclosure.

Workshop and Maintenance areas

- These areas must have impervious flooring to prevent seepage of any leaked oil & grease into the ground. The area should be covered with a roof to prevent the entry of rainwater.
- The flooring shall be sloped to from both directions to one corner where an oil-and-grease trap with sufficient capacity should be installed. All discharges from the workshop area must pass through the trap to remove the floating oil and grease before entering the drainage system of the site. The trap should be designed to provide a hydraulic residence time of about 20 minutes for the peak hourly discharge anticipated from the area (as per following figure).
- Alternatively, degreasing can also be carried out using mechanical spray type degreaser, with complete recycle using an enclosure with nozzles and two sieves, coarse above and fine below, may be used as shown in the adjacent photograph. This arrangement will require some initial investment and running cost for the pump, but the payback period, in terms of the use of diesel, under Indian conditions, has been reported to be less than 1 year.

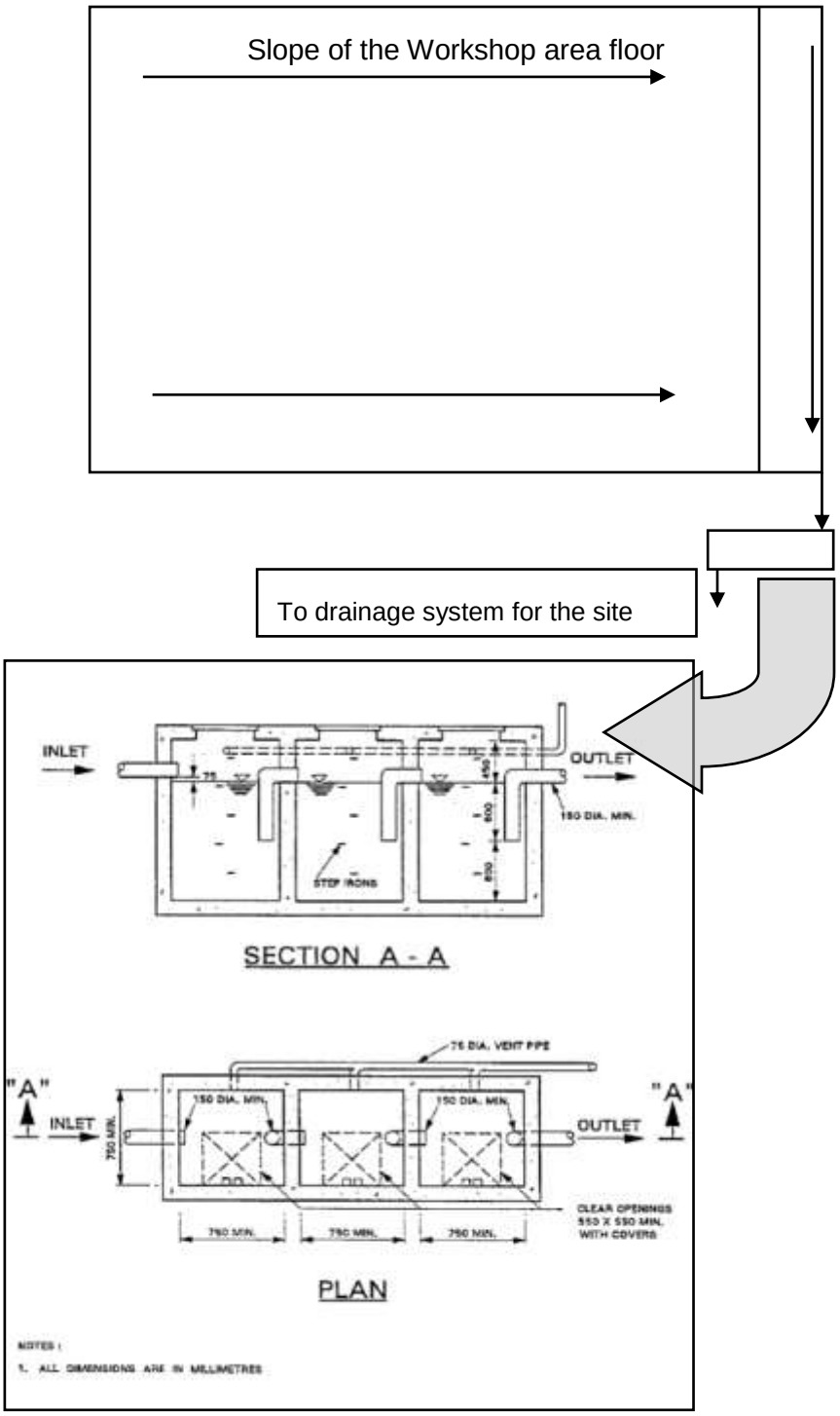


Figure 1: Workshop Area Pollution Control

- All the waste oil collected, from skimming of the oil trap as well as from the drip pans, or the mechanical degreaser shall be stored in accordance with the Environment Protection (Storage and Disposal of Hazardous Wastes) Rules, 1989. For this purpose, metallic drums should be used. These should be stored separately in sheds, preferably bunded. The advantage of this arrangement is that

it allows for accurate accounting in case the waste material is sold to oil waste recyclers or other users like brick-kiln owners who can burn such inferior fuel.

- A separate vehicle washing ramp shall be constructed adjacent to the workshop for washing vehicles, including truck mounted concrete mixers, if any, after each day's construction is over, or as required. This ramp should have an impervious bottom and it should be sloped so that it drains into a separate chamber to remove the sediment from the wash water before discharge. The chamber should allow for a hydraulic residence time of about 10 minutes for discharge associated with the washing of each truck. Following Figure 2 shows an outline sketch for a sedimentation chamber.

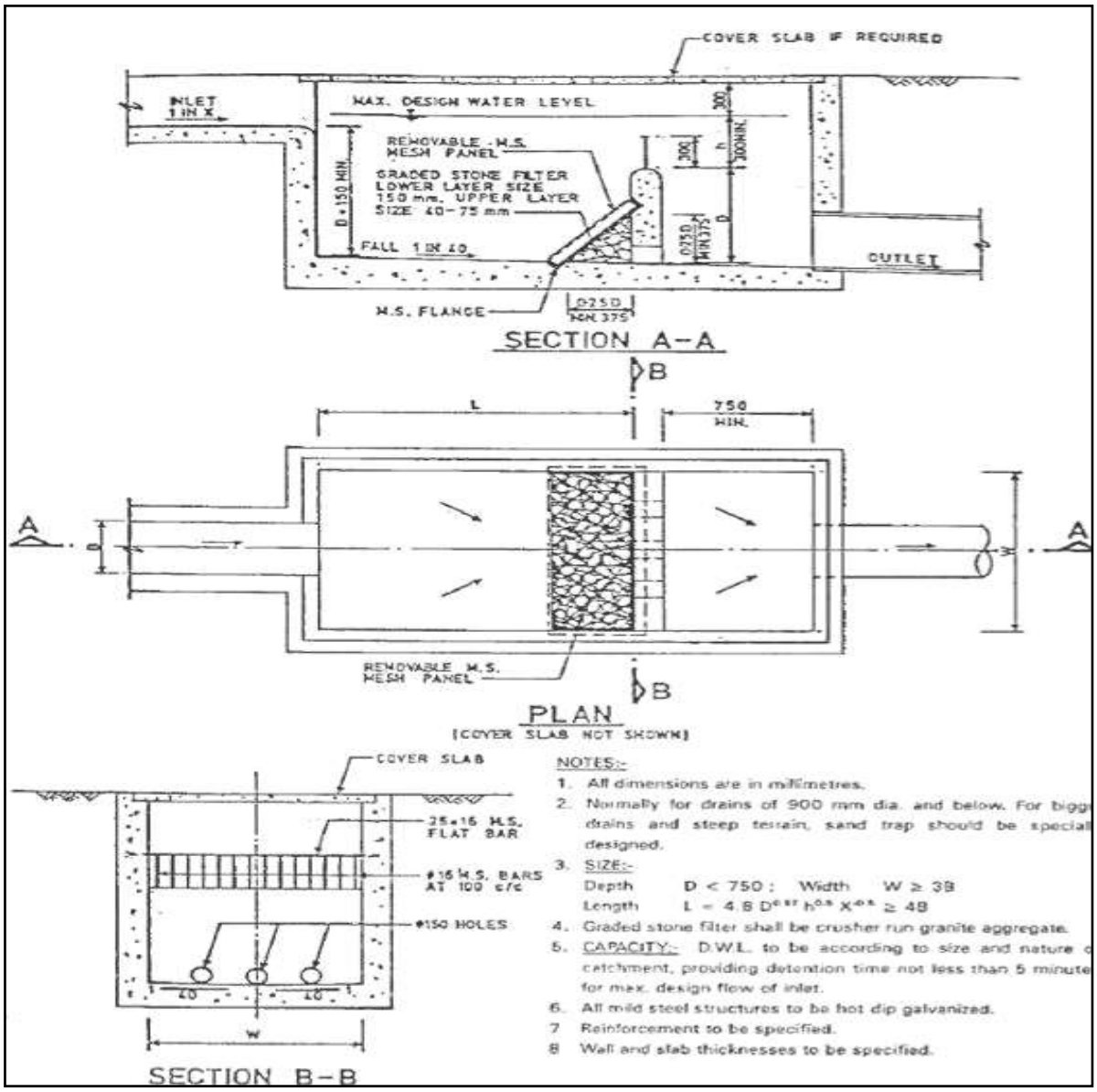


Figure 2: Sedimentation Chamber for vehicle washing ramp discharge

7. Facilities for Labour

a. Potential Environmental Impacts

8. The sudden arrival and relatively longer duration of stay of construction crew can cause substantial strain on the existing infrastructure facilities like water supply, sanitation and medical care, especially in rural areas. Pollution from domestic wastes can affect local sources of water supply and may harm the crew themselves as well as local residents. Improper sanitation and inadequate health care also potential bottlenecks that the Contractor can eliminate with relatively little effort.

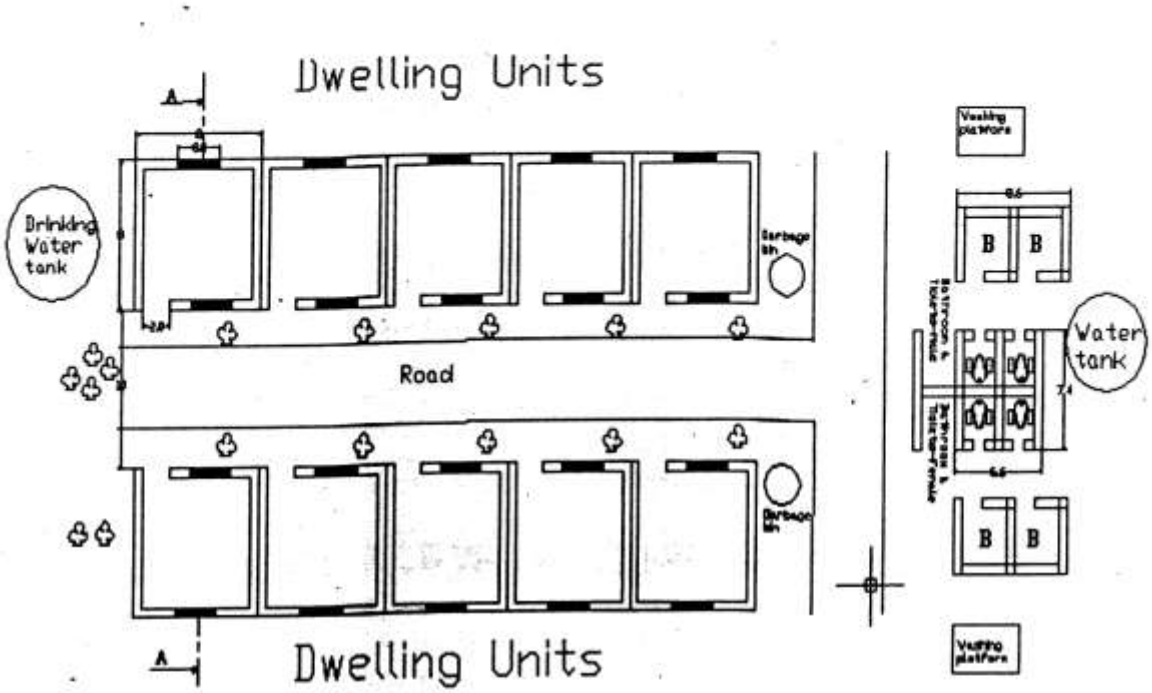
b. Mitigation Measures

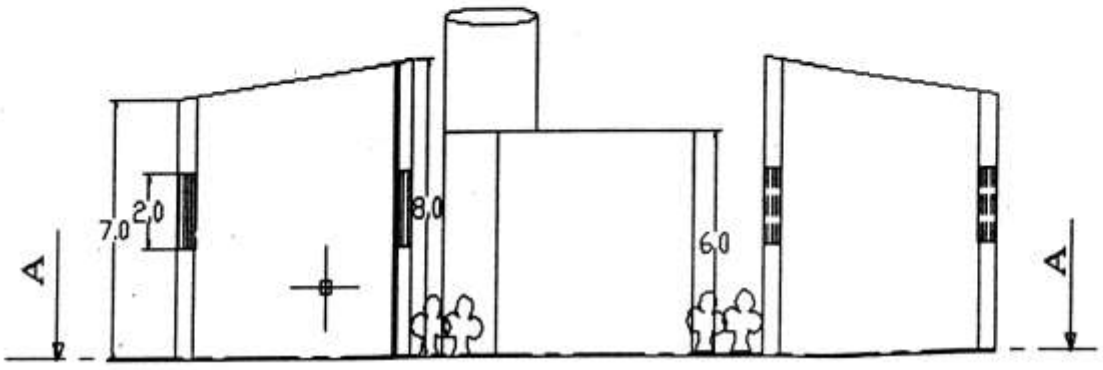
9. It should be emphasized that the Indian Law requires that the Contractor provide several facilities to for the workers as per Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. Some of the provisions described herein are more stringent to act as benchmark for improved environmental performance of road projects:

- The contractor shall provide free-of-charge temporary accommodation to all the labour employed for the project. The accommodation includes separate cooking place, bathing, washing and lavatory facilities. At least, one toilet will be provided for every 35 people and one urinal will be provided for every 20 persons. More toilets and/or urinals may have to be provided if the Engineer decides that these numbers are insufficient. In case female labourers are employed, separate toilet and urinals will be provided in locations clearly marked “Ladies Toilets” in a language understood by most labourers.
- The contractor shall ensure the supply of wholesome water for all the labour, including those employed by any other agency working for the contractor. These locations will be marked “Drinking Water” in the language most commonly understood among the labour. In hot season, the contractor shall make efforts to ensure supply of cool water. No water point shall be located within 15 m of any washing place, urinal, or latrine.
- The contractor shall ensure that adequate cooking fuel, preferably kerosene or LPG, is available on-site. The contractor will ensure that wood/ coal are not used as fuel on the site. Workers need to be made aware of this restriction. In cases where more than 250 labours are employed, canteen facility should be provided by the Contractor.
- A crèche must be provided in each campsite where more than 50 female labourers are employed, whether directly or indirectly, for the project or its ancillary activities.
- Contractor must provide adequate facilities for first-aid treatment at the campsite. A doctor / ambulance should be available on call for the duration of project implementation.
- The contractor shall obtain the approval of the Engineer for these facilities within 30 days of mobilization.

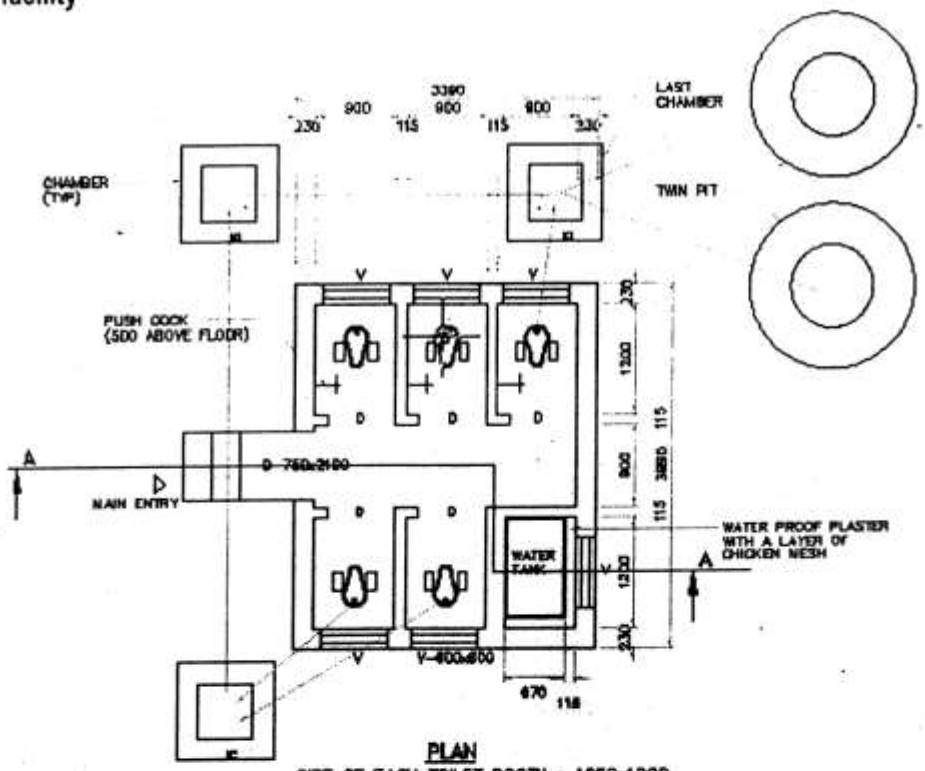
Annex 8

TYPICAL DRAWING OF WORKERS' CAMP SANITARY FACILITY

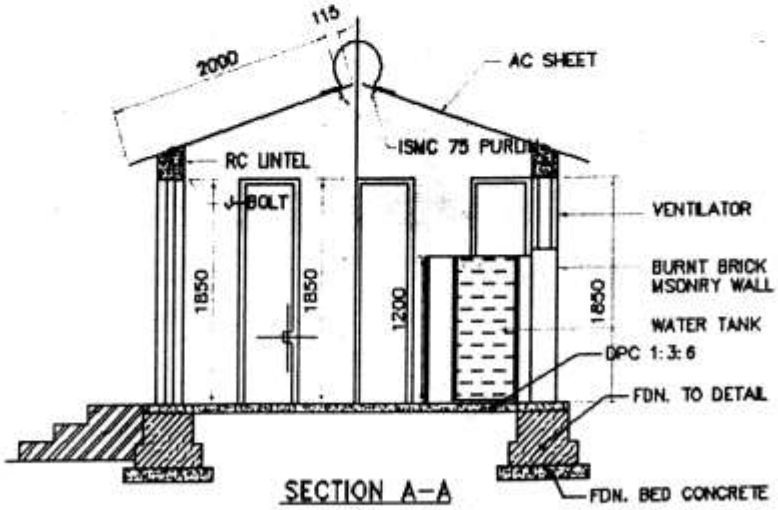




Sanitary facility



SIZE OF EACH TOILET BOOTH : 1050x1200
(TYPICAL WITH 8 WC ENCLOSURE FOR SCHOOLS, SHOPPING AREAS)

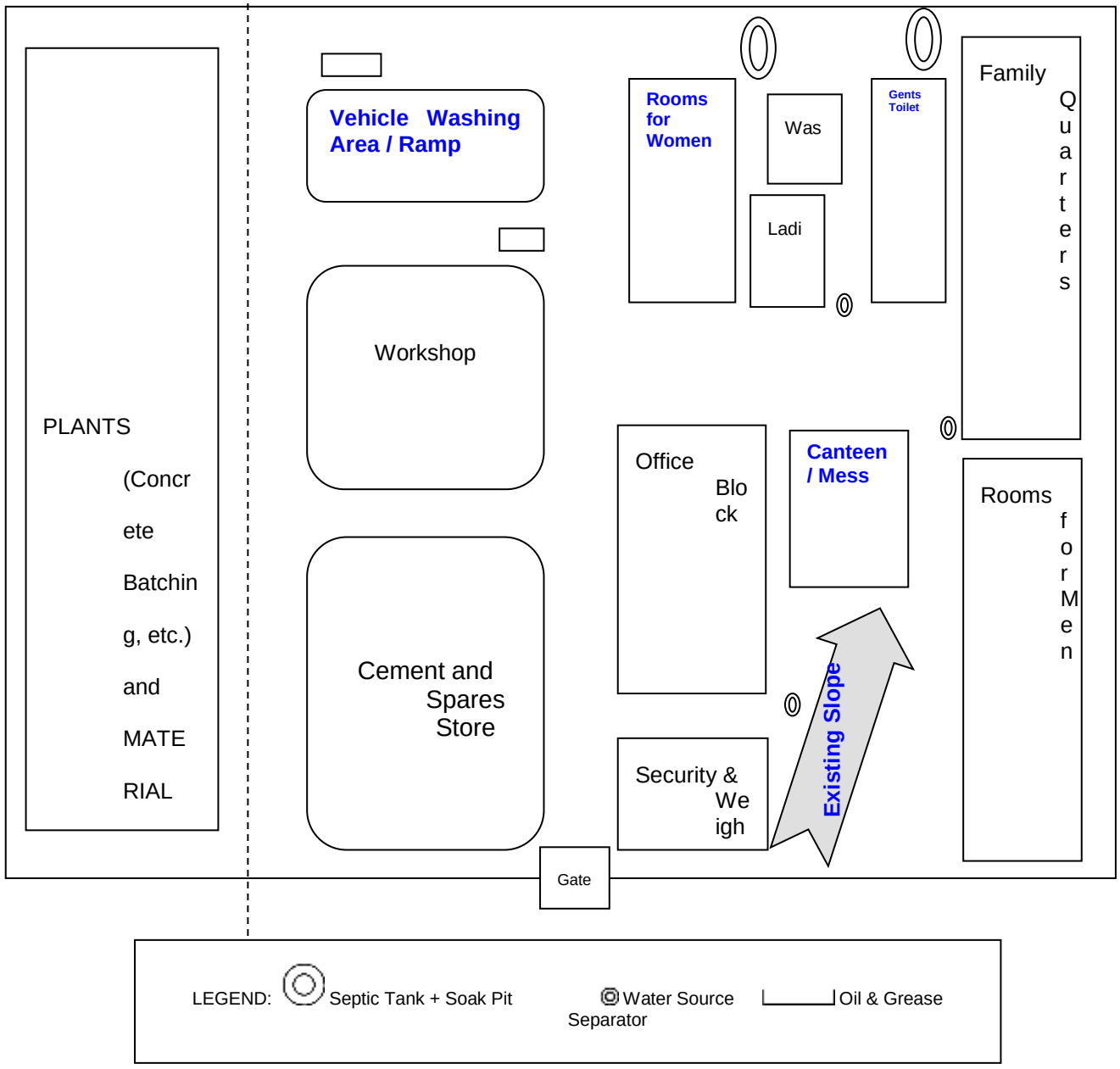


NOTES:

1. INSPECTION CHAMBER (IC) 600x600x600 DEEP WITH AIRTIGHT MH COVER
2. SEPTIC TANK & SOAK PIT AS PER SITE CONDITIONS

Annex 8

Layout of a Construction camp



Annex 9: GUIDELINES FOR DEBRIS DISPOSAL MANAGEMENT

A. Purpose

1. The following procedures should be followed for upkeep of storage and disposal sites:

- To maximize re-use of material generated during construction and
- To avoid environmental hazards due to improper disposal of construction waste material.

B. Procedure

- Contractor shall maintain register for keeping records on kilometer-wise quantities of material generated during grubbing, stripping, excavation and scarifying;
- Contractor shall re-use construction material to the extent possible based on engineering properties. Possible re-use areas are fill sections, embankment slope, village approach roads etc. Debris without bitumen could be used for backfilling of quarry / borrow areas as recommended by the Engineer. At locations identified for dumping of residual bituminous wastes, the dumping shall be carried out over a 60mm thick layer of rammed clay so as to eliminate the possibility of the leaching of the wastes into the ground water. The contractor shall ensure that the filled area is covered with a layer of preserved topsoil layer of preserved topsoil.
- Contractor shall estimate the chainage-wise quantities of various waste material to be disposed of;
- Contractor shall restrict waste disposal strictly at approved site/s only;
- Contractor shall prepare a plan including detailed lay out plan and cross-section for disposal of debris and bitumen waste and get approval of the same by the Engineer;
- Bentonite slurry or similar debris generated from pile driving or other construction activities shall be disposed such that it does not flow into the surface water bodies or form mud puddles in the area;
- Contractor and Engineer shall ensure that disposal areas are properly treated as per agreed plan;
- Contractor and Engineer's representatives shall undertake joint weekly inspection to ensure compliance of various environmental requirements.
- Engineer's representatives shall issue non-compliance if disposal site is not managed as per agreed plan;
- All arrangement for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary will be considered incidental to the work and should be planned and implemented by the contractor as approved and directed by the SC.
- Construction waste disposal should be disposed only at landfill facilities which are selected, designed, constructed and operated to ensure environmentally safe disposal, and these facilities have to be approved by the regulators.

C. Site Inspection

2. Weekly joint site inspection shall be undertaken for all the storage areas. The details of attributes, which are to be inspected, are given as follows. The Contractor shall ensure compliance of the requirements.

Annex 9

Details to be inspected for Monitoring Construction Material Reuse & Disposal

Attributes	Requirements
Construction material generation and re-use	• Segregating debris and bitumen during generation; • Segregating re-usable portion of debris and bitumen and storing preferably near areas of re-use; and • Temporary storage of waste material at sites as directed by the Engineer.
Waste disposal	• Disposal of waste material at approved disposal site within a week of generation; • Disposal site should be properly demarcated; • Proper leveling / grading at disposal site/s; • Recommended / agreed safeguard measures to avoid ground water contamination by leachate from disposal of scarified material are to be implemented; • Recommended / agreed safeguard measures to avoid soil erosion are to be implemented; • Recommended / agreed plan for surface treatment of waste disposal site/s are to be implement.

Annex 10: GUIDELINES FOR BORROW AREA MANAGEMENT

A. Purpose

1. Borrow areas are generally required to provide material for road construction sites, can have significant adverse environmental effects, especially on ecologically sensitive areas. Borrow areas can become environmental hotspots and can significantly affect the visual appearance of an area. Special mitigation and management measures are often required to avoid or minimise the environmental and social impacts of borrow areas.

B. Scope

2. These guidelines for borrow areas cover:

- statutory approvals
- environmental and social impacts of borrow areas
- selection of borrow areas
- operation of borrow areas
- rehabilitation of borrow areas

3. The guidelines seek to ensure that Contractors:

- comply with the regulatory requirements in force at the time
- reasonably manage any impacts
- reinstate and rehabilitate the land appropriately
- consult with affected communities

C. Impacts

4. Some of the potential impacts of borrow areas are:

- trucks transporting materials to the site causing air pollution, and noise and vibrations
- ponds of stagnant water forming in excavated areas giving rise to the breeding of mosquitoes and the spreading of malaria and other mosquito-borne diseases
- natural beauty of the landscape being affected by excavations and the removal of vegetation
- natural drainage systems in the area being affected by excavations
- agriculture land and productive soils being lost, especially in paddy field areas

5. Borrow areas are not generally specified in Contract documents but rather it is generally the responsibility of Contractors to identify borrow areas and obtain the necessary consent from land owner and approval from SC.

6. In IRC: 10 and Clause 305.2.2.2 of MoRTH Specification, exclusive guideline has been given for borrow areas located alongside the road and only some of the requirements have been indicated for borrow areas located outside the road land. Following guideline is proposed to supplement the existing stipulation in IRC:10 and Clause 305.2.2.2 of MoRTH Specification for Roads and Bridge Works:

D. Location

- Identify areas having present land use as barren land, riverside land. Otherwise, un-irrigated agriculture land or land without vegetation and tree cover;
- Prefer borrow areas on bed of irrigation water storage tank;
- Prefer areas of highland with respect to surroundings;
- Avoid locating borrow area close to any road (maintain at least 30 m distance from ROW and 10 m from toe of embankment, whichever is higher);
- Should be at least 1.5 km away from inhabited areas;
- Maintain a distance of about 1.5km from ecologically sensitive area i.e. Reserve Forest, Protected Forest, Sanctuary, wetland etc.;
- Maintain a distance of about 1.5 km from school, hospital and any archaeological sites;
- Having adequate approach road with minimum length of earthen road;
- Ensure that unsuitable soft rock is not prominent within the proposed depth of excavation which will render rehabilitation difficult;
- Depth of excavation should be decided based on natural ground level of the land and the surroundings, and rehabilitation plan. In case higher depth of excavation is agreed with backfilling by unsuitable excavated soil (from roadway), then filling should be adequately compacted except topsoil which is to be spread on topmost layer (for at least 20cm thick).

E. Operation

- Controlled operation as per agreed / approved plan;
- Preservation of topsoil at designated areas e.g. corners of the area etc.;
- Maintain necessary buffer zone in all directions and go for vertical cut within this area. Final cut slope should be maintained within the buffer zone;
- Step-wise excavation if borrow area is located on inclined area having more than 2% slope;
- Restricting excavation up to 2m for each stages of operation if allowed depth is more;
- Avoid cutting of any tree of girth size > 30cm19. if any tree cutting is inevitable, prior permission (written) from the competent authority should be taken and compensatory plantation has to be raised.

F. Rehabilitation

- Prior approval of Rehabilitation Plan considering terrain, land use and local need;
- Restricting operation as agreed by landowner and approved by the Engineer;
- Rehabilitation within agreed timeframe and before taking over;
- Integrate debris disposal and borrow area redevelopment.

G. Management Procedure

7. The important aspects of this procedure are:

[19] Plant having girth size more than 30cm is considered as tree.

- The first and foremost thing is to have tentative estimate of borrow material requirement chainage-wise. For this, BoQ quantity for earth work, which is given as total quantity for the entire package/milestone, has to be distributed chainage-wise. The requirement of borrow material chainage-wise then has to be estimated based on the suitability of roadway excavation material for reuse and BoQ.
- Contractor to site borrow areas fulfilling environmental requirements and obtaining one time approval of the Engineer both on quality as well as environmental consideration thereby integrating environmental safeguard measures into day-to-day activities;
- Contractor to submit environmental information in prescribed format for obtaining Engineer's approval, as given in the following format (Borrow Area Identification). The format has been so designed that it stipulates the requirements as well as what is actual for each borrow areas and could be easily understood by any person, whoever in-charge of identifying borrow areas;
- Contractor to submit Borrow Area Layout Plan as attachment to the format showing the land use of the proposed and surrounding area along with the presence of other environmental features such as water bodies, forests, settlement, temple and any sensitive receptor i.e. health and educational institution, roads etc. within a radius of 1.5km area from the boundary of the borrow area;
- Contractor to prepare and submit Block Contour Map of each borrow area (especially which are located close to road and on undulating terrain) for deciding on operation and redevelopment plan;
- Contractor to prepare Operation Plan and submit as attachment to the format including cross sections on both directions (x,y) mentioning natural ground level, depth of topsoil (if any), total depth of excavation, cut side slope and bed slope;
- Contractor to prepare Redevelopment Plan and submit as attachment to the format include cross sections on both directions (x,y) mentioning natural ground level, excavated profile, finished profile after redevelopment etc.;
- Contractor to maintain Borrow Material Register;
- Periodic joint inspections of each borrow area until rehabilitation is complete as agreed and approved.
- The checklist for periodic inspection is given in this appendix.

Annex 10

Borrow Areas Identification

Construction Stage Report: One Time Date:
Location of Borrow Area (Ch. & Offset): Revenue Survey No.:

Sl. No.	Item / Requirement	Details as per Actual (to be filled by Contractor & checked by Engineer)
1	Date of Borrow Area planned to be operational	
2	Current Land use (preference to barren land, riverside land, otherwise, un-irrigated agriculture land or land without tree cover)	
3	Size (Sq.m) and area (m x m) of Borrow Area	
4	Proposed maximum depth of pit in m (IRC 10 & Clause 305.2.2 of MoRTH Spec.)	
5	Details of riverside borrow area (inner edge should not be less than 10m from the toe of the bank and bottom of pit should not cut the imaginary line of 1:4 from embankment top)	
6	Borrow area in cultivable land (should be avoided or restricted to total depth of 45cm including preservation of 15cm topsoil)	
7	Quantity Available (Cum)	
8	Quantity of top soil to be removed (Sq.m & depth in cm)	
9	Details of preservation (storage) and management (re-use / re-laid) of top soil	
10	Width of Haul road (m)	
11	Total Length of Haul Road (km)	
12	Length of Non-metal Haul Road (should be as minimum as possible)	
13	No of settlements within 200 m of Non-metal Haul Road (should be as minimum as possible)	
14	Distance from settlement (should be minimum 1500 m)	
15	Should be away from water bodies. Give details of water bodies within 250 m.	
16	Details of water sources for dust suppression	
17	Quantity of water required for dust suppression i.e. sprinkling at borrow area and on haul road (Cum)	
18	Availability of water required for dust suppression (Cum)	
19	Details of ecologically sensitive area i.e. RF, PF, Sanctuary etc. within 1500m (should be nil)	
20	Details of school, hospital and any archaeological sites within 1500m (should be nil)	
21	Distance from nearby road embankment, fence line / boundary (should be minimum 30m from ROW and 10m from toe of embankment, whichever is higher)	
22	No of Trees with girth more than 0.3 m (No tree should be affected)	

Documents to be attached:

1) Site plan and layout plan of borrow area;
2) Proposed borrow area operation and redevelopment plan;
3) Written consent from competent authority for use of water for dust suppression

4) Written consent of landowner on agreed operation and redevelopment plan

Certified that the furnished information is correct and all relevant information as required is attached

Contractor’s Representative:

Annex 10

Checklist for Monitoring Borrow Area Operation & Management

Attributes	Requirements
Access road	• Only approved access road shall be used
Top soil preservation	• Top soil, if any, shall be stripped and stored at corners of the area before start of excavation for material collection; • Top soil should be re-used / re-laid as per agreed plan
Depth of excavation	• For cultivable (agriculture) land, total depth of excavation should be limited to 45 cm including top 15 cm for top soil preservation; • For riverside borrow area, the depth of excavation shall be so regulated that the inner edge of any borrow pit should not be less than 10m from the toe of the bank and bottom of pit should not cut the imaginary line of 1:4 from embankment top; • If borrow area is located within 1500 m of towns or villages, they should not exceed 30 cm in depth and should be properly drained; • Borrow areas close to ROW should be rectangular in shape with one side parallel to center line of the road and depth should be so regulated that it should not cut an imaginary line having slope of 1 in 4 projected from the edge of the final section of the embankment.
Damage to surrounding land	• Movement of man & machinery should be regulated to avoid damage to surrounding land.
Drainage control	• The surface drainage in and around the area should be merged with surrounding drainage; • No water stagnation shall occur.
Dust suppression	• Water should be sprayed on *kutcha* (earthen) haul road twice in a day or as may be required to avoid dust generation during transportation of material; • Depending on moisture content, 0.5 to 1.5% water may be added to excavated soil before loading during dry weather to avoid fugitive dust emission.
Covering material transport vehicle	• Material transport vehicle shall be provided with tarpaulin cover
Personal Protective Equipment	• Workers should be provided with helmet, gumboot and air mask and their use should be strictly enforced.
Redevelopment	• The area should be redeveloped within agreed timeframe on completion of material collection as per agreed rehabilitation plan.

Annex 11: GUIDELINES FOR QUARRY AREA MANAGEMENT

A. Purpose

1. Quarries generally required to provide material for road construction sites, can have significant adverse environmental effects, especially on ecologically sensitive areas. Quarries can become environmental hotspots and can significantly affect the visual appearance of an area. Special mitigation and management measures are often required to avoid or minimise the environmental and social impacts of quarries.

B. Scope

2. These guidelines for quarries cover:

- statutory approvals
- environmental and social impacts of quarries
- selection of quarries
- operation of quarries
- rehabilitation of quarries

3. The guidelines seek to ensure that Contractors[20]:

- comply with the regulatory requirements in force at the time
- reasonably manage any impacts
- reinstate and rehabilitate the land appropriately
- consult with affected communities

C. Impacts

4. Some of the potential impacts of quarries are:

- rock blasting causing air pollution, and noise and vibrations
- trucks transporting materials to the site causing air pollution, and noise and vibrations
- ponds of stagnant water forming in excavated areas giving rise to the breeding of mosquitoes and the spreading of malaria and other mosquito-borne diseases
- natural beauty of the landscape being affected by excavations and the removal of vegetation
- natural drainage systems in the area being affected by excavations

5. The procedure for identification and finalization of quarry site/s shall be as given below:

- Estimating the quantity of quarry material to be collected from each quarry area
- Only licensed quarry will be used
- New quarry will be at least 1.5 km away from the settlement, forest and other ecologically sensitive areas

[20] The EMP stipulations will be applicable even if contract use existing licensed quarry. In case contractor use the existing licensed quarry a copy of the quarry license and lease / sub-lease agreement should be submitted to the Project Proponent. Contractor shall submit a plan delineating how he shall comply with requirements stipulated in this plan and elsewhere in the EMP on quarrying activity.

- Away from water body
- Contractor shall identify alternative quarry sites along the whole corridor based on required quantity and environmental consideration as given in the following prescribed format of Quarry source identification.
- Contractor shall submit to the Engineer the detailed information / documents as prescribed in the format;
- Engineer shall undertake site inspection of alternate quarry sites and convey to Contractor on accepting a particular quarry site on environmental consideration;
- Contractor shall then take apply and obtain Quarry Lease Deed / License from the Department of Mines and Geology and provide copy of the same to the Engineer prior to operation;
- Contractor shall estimate water requirement for dust suppression at quarry sites during operation and for water spraying on kutcha (non-metal) haul road and ensure availability water by identifying sources and obtaining necessary permission;
- Contractor shall prepare quarry sites operation and redevelopment plan considering surrounding land uses, local needs and agreement with the landowner;
- Only licensed blaster i.e. short-firer certificate holder will be responsible for quarry blasting
- Permits for transportation, storage and use of explosive, as will be required, shall be obtained from the Controller of Explosive;
- Whenever so advised by the Engineer, controlled blasting e.g. using less charge, restricting depth and dia or drill holes, cut-off blasting etc., shall be undertaken.
- Quarry operation will be undertaken in stages with adequate benching

6. The procedure for environmentally sound operation and management of quarry sites is given below:

- Estimating the quantity of quarry material to be collected from each quarry area;
- Demarcating the entire quarry area by fencing and putting red-flag poles;
- Providing adequate metallic access road;
- Preserving topsoil from the quarry compound, if any, by stripping and stacking aside separately at corners;
- Carrying out blasting as per agreed operational plan complying with the requirements of MoRTH Specification (Clause 302 & 303) and Ministry of Environment, Forest and Climate Change (MoEFCC) as given below;
- Maintaining a Quarry Material Collection Register on daily material collection for each of the quarry area, which shall be produced to Engineer's representative as and when requested;
- Redeveloping the area within 2 months (or as will be agreed upon) of completion of quarry material collection;

D. Use of Explosive for Blasting

7. **General**. Blasting shall be carried out in a manner that completes the excavation to the lines indicated in drawings, with the least disturbance to adjacent material. It shall be done only with the written permission of the Engineer. All the statutory laws, regulations, rules, etc., pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

8. The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements. Prior to starting any phase of the operation the Contractor shall provide information describing pertinent blasting procedures, dimension and notes.

9. The magazine for the storage of explosives shall be built as per national / international standards and located at the approved site. No unauthorized person shall be admitted into the magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be displayed in the lobby of the magazine:

- A copy of the relevant rules regarding safe storage in English, Portuguese and in the language with which the workers concerned are familiar.
- A statement of up-to-date stock in the magazine.
- A certificate showing the last date of testing of the lightning conductor.
- A notice that smoking is strictly prohibited.

10. All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided to the satisfaction of the Engineer and in general not closer than 300 m from the road or from any building or camping area or place of human occupancy. In addition to these, the Contractor shall also observe the following instructions and any further additional instructions which may be given by the Engineer and shall be responsible for damage to property and any accident which may occur to workmen or the public on account of any operations connected with the storage, handling or use of explosives and blasting. The Engineer shall frequently check the Contractor's compliance with these precautions.

11. **Materials, Tools and Equipment**. All the materials, tools and equipment used for blasting operations shall be of approved type. The Engineer may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators, fuses, etc., shall be fresh and not damaged due to dampness, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed from the site immediately.

12. **Personnel**. The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

13. **Blasting Operations.** The blasting shall be carried out during fixed hours of the day preferably during the mid-day luncheon hour or at the close of the work as ordered in writing by the Engineer. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only.

14. The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. In advance of any blasting work within 50 m of any railway track or structures, the

Contractor shall notify the concerned Railway Authority of the location, date, time and approximate duration of such blasting operations.

15. Red danger flags shall be displayed prominently in all directions during the blasting operations. The flags shall be planted 200m and 500m from the blasting site in all directions for blasting at work site and quarry, respectively. People, except those who actually light the fuse, shall be prohibited from entering this area, and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning siren being sounded for the purpose.

16. The charge holes shall be drilled to required depths and at suitable places. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

17. When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

18. When blasting is done with dynamite and other high explosives, dynamite cartridges shall be prepared by inserting the square cut end of a fuse into the detonator and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3rd of the copper tube exposed outside. The paper of the cartridge shall then be closed up and securely bound with wire or twine. The primer shall be housed into the explosive. Boreholes shall be such size that the cartridge can easily go down. The holes shall be cleared of all debris and explosive inserted. The space of about 200 mm above the charge shall then be gently filled with dry clay, pressed home and the rest of the tamping formed of any convenient material gently packed with a wooden rammer.

19. At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a siren in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man-in-charge only. The man-in-charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the blasting site.

20. **Misfire**. In case of misfire, the following procedure shall be observed:

- Sufficient time shall be allowed to account for the delayed blast. The man-in-charge shall inspect all the charges and determine the missed charge.
- If it is the blasting powder charge, it shall be completely flooded with water. A new hole shall be drilled at about 450 mm from the old hole and fired. This should blast the old charge. Should it not blast the old charge, the procedure shall be repeated till the old charge is blasted.
- In case of charges of gelignite, dynamite, etc., the man-in-charge shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge. Alternatively, the hole may be cleared of 300 mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 150 mm away and parallel to it. This hole shall then be charged and fired when the misfired hole should explode at the same time. The man-in-charge shall at once report to the Contractor’s office and the

Engineer all cases of misfire, the cause of the same and what steps were taken in connection therewith.

- If a misfire has been found to be due to defective detonator or dynamite, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer for inspection to ascertain whether all the remaining materials in the box are also defective.

21. **Account**. A careful and day to day account of the explosive shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer at all times.

22. During quarry operation, periodic joint inspection should be carried out by the Contractor and Engineer's representatives.

23. A typical checklist for the same is given here.

Annex 11

Quarry Source Identification

Construction Stage Report: One Time Date:
Supervision Consultant: SMEC Contractor: Contract Package:
Location of Quarry (Ch. & Offset):

Sl. No.	Item / Requirement	Details as per Actual
1	Present land use (bare land with no prominent vegetation is preferred)	
2	Predominant wind direction	
3	Size and area of Quarry (m xm & Sq.m)	
4	Quantity Available (Cum)	
5	Quantity proposed to be collected (Cum)	
6	No of Trees with girth more than 0.3 m	
7	No Settlement within 1500 m of Quarry	
8	No water body within 1500 m of Quarry	
9	Width of Haul road (m)	
10	Total Length of Haul Road (km)	
11	Length of Non-metal Haul Road (km) (should be as minimum as possible)	
12	No of Settlements within 200m of Non-metal Haul Road (should be as minimum as possible)	
13	Quantity of water required for dust suppression i.e. sprinkling at borrow area and on non-metal haul road (Cum)	
14	Details of Water sources for dust suppression	
15	Availability of water required for dust suppression (Cum)	

Documents to be attached:

1) Site plan and layout plan of quarry site
2) Proposed quarry site operation and redevelopment plan
3) Written consent / lease agreement with the Department of Mines & Geology
4) Written consent from competent authority for use of water for dust suppression

Certified that the furnished information is correct and all relevant information as required is attached

Contractor's Representative:

Details to be inspected for Monitoring Quarry Area Operation & Management

Attributes	Requirements
Access road	• Only approved access road shall be used
Top soil preservation	• Top soil, if any, should be stripped and stored at designated area before start of quarry material collection; • Top soil should be re-used / re-laid as per agreed plan
Controlled blasting & safety	• Storage of explosive magazine as per threshold quantity with all the safety measures; • Handling of explosive by licensed blaster only; • Use low intensity explosive; • Check unfired explosive, if any, before drilling; • Carryout blasting at lean time only; • Cordoned the area within 500m radius with flagmen having whistle for signaling preparedness; • Using properly designed audio visual signal system i.e. siren and flagmen for blasting; • Keep ready an emergency vehicle near blasting area with first aid facility and with active emergency response system.
Damage to surrounding land	• Movement of man & machinery should be regulated to avoid damage to surrounding land.
Drainage control	• The surface drainage in and around the area should be merged with surrounding drainage;
Dust control	• Haul road should be made metallic; • Suitable dust arrester for drilling; • Water spraying at quarry complex, if required.
Covering material transport vehicle	• Material transport vehicle should be provided with tail board, and cover
Personal Protective Equipment	• Workers shall be provided with helmet, safety shoes, ear muffler and air musk and their use should be strictly enforced.
Redevelopment	• The area should be redeveloped within two months (or as agreed) on completion of material collection as per agreed plan.

Annex 12: DETAILS OF ISSUES DISCUSSED AT THE PUBLIC CONSULTATIONS

A. Details of Public Consultations

Sl. No.	Date and Location	Issues Discussed	Measures Taken	Participants
1.	Date: 23 February 2019 Village: Khongkhang District: Tengnoupal	• Presence of protected areas around project areas, • Environmental issues in the areas, • Impacts of the project in environmental quality, • School, Post office, Primary Health Centre, Electricity and drinking water supply facilities are available in the village. • Importance of road to the development of village • Peoples are aware about the project. • People perceived that subproject road will provide better transport facility and save time, money, and generate employment • No negative impacts perceived by the people. • Speed limit/restriction has been asked by villagers in the settlement area • Compensation should be in mode of cash for land and structure both. • Problem in restoration of their source of income of shopkeepers. Local people will fully cooperate to the govt. if local needs will be considered. • People will provide social and moral support to the project authority. • Local people will protest if govt will acquire more than 24m	• The subproject road will provide better road connectivity to the nearby facilities. • Proper safety measures for new road should be proposed in the design and it should be strictly follow during construction. • Employment to local skilled and unskilled laborers should be preferred during road construction and operation. • Compensation should be given for structure loss at earliest. • Effected CPR should be built by Govt. before starting of construction. • Govt. should construct a shopping complex near to this market and shop should be allotted to the effected persons. • Compensation should be distributed at least 6 month before from demolish of structure. • Compensation should be paid by Cheque to genuine person. • Govt. shouldn't acquire more than 24m.	12 Participants (9 man and 3 women) from village community including village heads, teachers, housewife, business owners, labours, farmers and students.

Sl. No.	Date and Location	Issues Discussed	Measures Taken	Participants
2.	Date: 23 February 2019 Village: Lokchao District: Tengnoupal	• Presence of protected areas around project areas, • Environmental issues in the areas, • Impacts of the project in environmental quality, • Bank, Secondary school, Post office, Primary Health Centre, Irrigation, Electricity and drinking water supply facilities are available in the village. • Importance of road to the development of village • Peoples are aware about the project. • People perceived that subproject road will provide better transport facility and save time, money, and generate employment • No negative impacts perceived by the people. • Speed limit/restriction has been asked by villagers in the settlement area. • Compensation should be in mode of cash for land and structure both. • Problem in restoration of their source of income of shopkeepers. Local people will fully cooperate to the govt. if local needs will be considered. • People will provide social and moral support to the project authority. • Local people will protest if govt will acquire more than 24m	• The subproject road will provide better road connectivity to the nearby facilities. • Proper safety measures for new road should be proposed in the design and it should be strictly follow during construction. • Employment to local skilled and unskilled laborers should be preferred during road construction and operation. • Compensation should be given for structure loss at earliest. • Effected CPR should be built by Govt. before starting of construction. • Govt. should construct a shopping complex near to this market and shop should be allotted to the effected persons. • Compensation should be distributed at least 6 month before from demolish of structure. • Compensation should be paid by Cheque to genuine person. • Govt. shouldn't acquire more than 24m.	17 Participants (12 man and 5 women) from village community including village housewife, business owners, labours, and farmers.

Annex 12

Sl. No.	Date and Location	Issues Discussed	Measures Taken	Participants
3.	Date: 23 February 2019 Village: Khudhengthabi District: Tengnoupal	• Presence of protected areas around project areas, • Environmental issues in the areas, • Impacts of the project in environmental quality, • Bank, Secondary school, Post office, Primary Health Centre, Irrigation, Electricity and drinking water supply facilities are available in the village. • Importance of road to the development of village • Peoples are aware about the project. • People perceived that subproject road will provide better transport facility and save time, money, and generate employment • No negative impacts perceived by the people. • Speed limit/restriction has been asked by villagers in the settlement area. • Compensation should be in mode of cash for land and structure both. • Problem in restoration of their source of income of shopkeepers. Local people will fully cooperate to the govt. if local needs will be considered. • People will provide social and moral support to the project authority. • Local people will protest if govt will acquire more than 24m.	• The subproject road will provide better road connectivity to the nearby facilities. • Proper safety measures for new road should be proposed in the design and it should be strictly follow during construction. • Employment to local skilled and unskilled laborers should be preferred during road construction and operation. • Compensation should be given for structure loss at earliest. • Effected CPR should be built by Govt. before starting of construction. • Govt. should construct a shopping complex near to this market and shop should be allotted to the effected persons. • Compensation should be distributed at least 6 month before from demolish of structure. • Compensation should be paid by Cheque to genuine person. • Govt. shouldn't acquire more than 24m.	28 Participants (19 man and 9 women) from village community including villages heads, councilors, housewife, business owners, labours, farmers and students

Sl. No.	Date and Location	Issues Discussed	Measures Taken	Participants
4.	Date: 25 February 2019 Village: Zomunnum (Chahnou) District: Tengnoupal	• Presence of protected areas around project areas, • Environmental issues in the areas, • Impacts of the project in environmental quality, • Bank, Secondary school, Post office, Primary Health Centre, Irrigation, Electricity and drinking water supply facilities are available in the village. • Importance of road to the development of village • Peoples are aware about the project. • People perceived that subproject road will provide better transport facility and save time, money, and generate employment • No negative impacts perceived by the people. • Speed limit/restriction has been asked by villagers in the settlement area. • Compensation should be in mode of cash for land and structure both. • Problem in restoration of their source of income of shopkeepers. Local people will fully cooperate to the govt. if local needs will be considered. • People will provide social and moral support to the project authority. • Local people will protest if govt will acquire more than 24m.	• The subproject road will provide better road connectivity to the nearby facilities. • Proper safety measures for new road should be proposed in the design and it should be strictly follow during construction. • Employment to local skilled and unskilled laborers should be preferred during road construction and operation. • Compensation should be given for structure loss at earliest. • Effected CPR should be built by Govt. before starting of construction. • Govt. should construct a shopping complex near to this market and shop should be allotted to the effected persons. • Compensation should be distributed at least 6 month before from demolish of structure. • Compensation should be paid by Cheque to genuine person. • Govt. shouldn't acquire more than 24m.	17 Participants (14 man and 3 women) from village community including villages heads, ward members, housewife, business owners, labours, farmers and students

Annex 12

Sl. No.	Date and Location	Issues Discussed	Measures Taken	Participants
5.	Date: 25 February 2019 Village: Moreh District: Tengnoupal	• Presence of protected areas around project areas, • Environmental issues in the areas, • Impacts of the project in environmental quality, • Bank, Secondary school, Post office, Primary Health Centre, Irrigation, Electricity and drinking water supply facilities are available in the village. • Importance of road to the development of village • Peoples are aware about the project. • People perceived that subproject road will provide better transport facility and save time, money, and generate employment • No negative impacts perceived by the people. • An underpass/foot over bridge has been demanded by peoples due to major transition of the peoples, Pets, including children and women to both side of the Market. • Compensation should be in mode of cash for land and structure both. • Problem in restoration of their source of income of shopkeepers. Local people will fully cooperate to the govt. if local needs will be considered. • People will provide social and moral support to the project authority. • Local people will protest if govt will acquire more than 24m	• The subproject road will provide better road connectivity to the nearby facilities. • Proper safety measures for new road should be proposed in the design and it should be strictly follow during construction. • Employment to local skilled and unskilled laborers should be preferred during road construction and operation. • Compensation should be given for structure loss at earliest. • Effected CPR should be built by Govt. before starting of construction. • Govt. should construct a shopping complex near to this market and shop should be allotted to the effected persons. • Compensation should be distributed at least 6 month before from demolish of structure. • Compensation should be paid by Cheque to genuine person. • Govt. shouldn't acquire more than 24m.	31 Participants (22 man and 9 women) from village community including villages heads, housewife, business owners, labours, farmers and students

Annex 13: DETAILS OF TRAINING PROGRAM

Module	Title	Objectives	Duration (Day)	Participants
1	Environmental Legislations and Bank's Safeguard Policies	• Brush up latest on environmental legislations • Brush up safeguard policies	1	PIU and CSC staff
2	Environmental Supervision and Monitoring	• EMP requirements • Implementation, Supervision and Monitoring Mechanism • Provision made in Contract Documents for Works • Provision made in contract Agreement for Supervision Services	1	PIU and CSC staff
3	Orientation Workshop on EMP Implementation	• EMP requirements • Implementation, Supervision and Monitoring Mechanism • Roles and Responsibilities of Contractors and SCs	1	PIU, Contractor and CSC
4	Focused Training on Specific Issue/s (three during course of implementation)	• Analyzing problems, referring stipulations in Contract and EMP and agreed to feasible solution within specified timeframe	0.5	PIU, Contractor and CSC

Annex 14: VIBRATION LEVEL ASSESSMENT STUDY

24. Vibration Produced by Construction Equipments. When the ground is subject to vibratory excitation from a vibratory source, a disturbance propagates away from the vibration source. The ground vibration waves created are similar to those that propagate in water when a stone is dropped into the water.

25. The duration and amplitude of vibration generated by construction equipments varies widely depending on the type of equipment and the purpose for which it is being used. The vibration from blasting has a high amplitude and short duration, whereas vibration from grading is lower in amplitude but longer in duration. In assessing vibration from construction equipments, it is useful to categorize the equipment by the nature of the vibration generated.

26. Review of available literature indicates that there is limited information available on vibration source levels from general construction equipment. The most comprehensive list of vibration source amplitudes is provided in the document entitled *Transit Noise and Vibration Impact Assessment* (Federal Transit Administration 2006)[i].

Table 1:Vibration generated from different construction equipments

Equipment	Reference PPV at 25 ft. (in/sec)
Vibratory Roller	0.21
Large Bulldozer	0.089
Caisson Drilling	0.089
Loaded Trucks	0.076
Jackhammer	0.035
Small Bulldozer	0.003

Sources: Federal Transit Administration 2006 (except Hanson 2001[ii] for vibratory rollers)

Using these source levels, vibration from these equipment can be estimated by the following formula:

$$PPV_{Equipment} = PPV_{Ref}\,(25/D)^{n}\ (in/sec) \qquad \text{……..(1)}$$

Where:

PPV_{Ref} = reference PPV at 25 ft.
D = distance from equipment to the receiver in ft.
n = 1.1, attenuation rate([iii])

27. **Vibration Impact Criteria**. International Guidelines and Standards present criteria for vibration related building damage in the form of threshold levels of vibration (peak particle velocity), as either a value or range of values. Key factors in determine these levels are as follows:

- the nature of the building including its construction, its condition, and whether is of historic importance;
- the likely extent of damage i.e. cosmetic, minor structural or major structural; and
- whether the source of vibration is continuous or a single event and the dominant frequency (Hz).

28. ***British Standard***. BS 7385[iv] : Part 1: 1990, *Mechanical vibration and shock - vibration of buildings - guidelines for the measurement of vibrations and evaluation of their effects on buildings*, discusses the principles for carrying out vibration measurements and processing the data. Part 2 of the Standard, *Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration* (BSI, 1993), suggests levels at which the following three categories of damage might occur.

- Cosmetic: The formation of hairline cracks on drywall surfaces or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction
- Minor Structural: The formation of large cracks or loosening and falling of plaster or drywall surfaces, or cracks through bricks/concrete blocks
- Major Structural: Damage to structural elements of the building, cracks in support columns, loosening of joints, splaying of masonry cracks, etc.

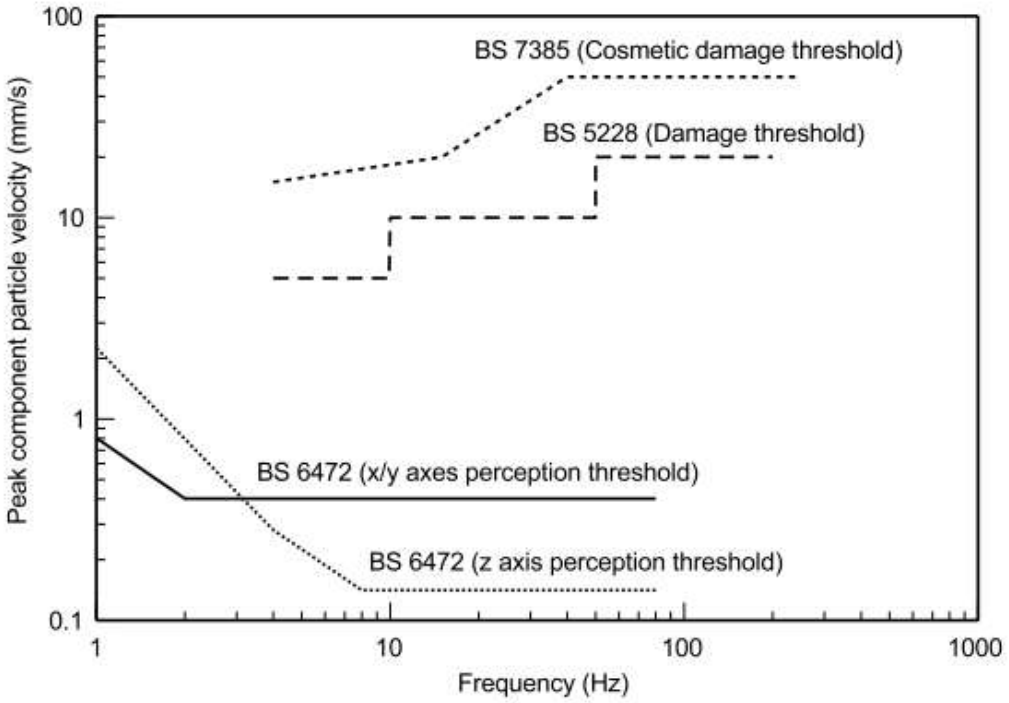


Figure 1: Thresholds provided by British Standards for human perception and damage to domestic structures by transient vibrations

29. ***Other National Standard*.** The criteria which will be used in this study are a combination of the recommendations of the Standards and Guidelines thought most relevant and are set out in Table 2 below. The British Standard BS 5228[v] sets out guideline values in terms of peak particle velocity for human response to construction works and these are shown out in Table 3 below.

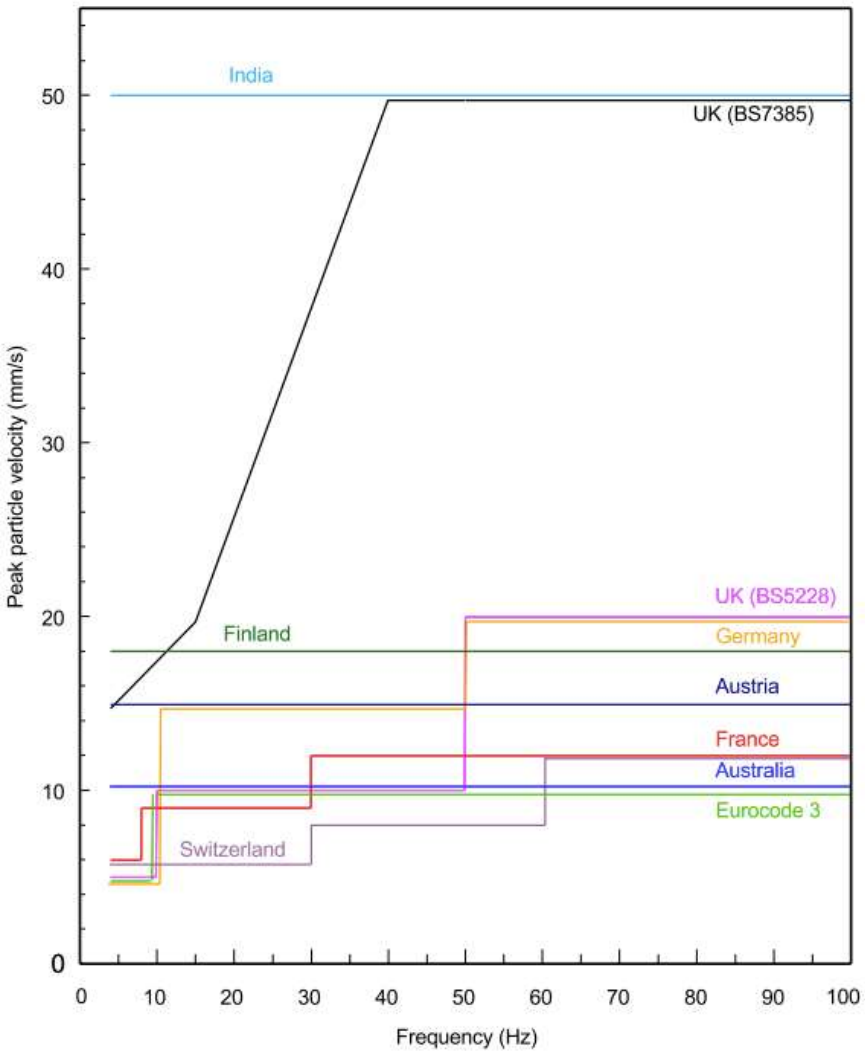


Figure 2: Summary of damage thresholds for transient vibration on domestic structures

Source: Hiller, D. M., & Crabb, G. I. (2000). Groundborne vibration caused by mechanised construction works[vi].

Table 2. Building Vibration Damage Assessment Criteria

Building Vibration Damage Risk Level	Building Description	Cosmetic Damage Threshold ppv (mm/s)	Source Reference for Criteria	Assumed Building Coupling Loss
	Extremely fragile historic buildings, ruins, ancient monuments	2	Caltrans/BART	n/a
High Risk A	Fragile buildings of clay construction with shallow (<1m) rubble footings	3	Caltrans	1
High Risk B	Fragile buildings of clay construction with concrete foundations/footings	3	Caltrans	0.5
Medium Risk	Residential brick built on concrete foundations/footings and light commercial	10	BS 7385/DIN 4150	0.5
Low Risk	Heavy commercial, industrial and framed buildings	25	BS 7385/DIN 4150	0.5

Table 3. BS 5228 Vibration Assessment Criteria for Human Perception

Vibration Level ppv (mms-1)	Description of Effect	Description of Impact
<0.3	Vibration unlikely to be perceptible	Negligible
0.3 to 1.0	Increasing likelihood of perceptible vibration in residential	Minor
1.0 to 10	Increasing likelihood of perceptible vibration in residential environments but can be tolerated at the lower end of the scale if prior warning and explanation has been given to residents	Moderate
>10	Vibration is likely to be intolerable for any more than a brief exposure to a level of 10mms-1	Major

30. ***Criteria for Human Perception to Vibration*.** The British Standard BS 5228 sets out guideline values in terms of peak particle velocity for human response to construction works and these are shown out in Table 3 below. Column three includes semantic descriptors of the scale of vibration impact which are equivalent to those commonly used in the assessment of construction vibration.

31. **Assessment of Vibration levels.** The vibration levels in this study have been calculated using the empirical formula given by FTA (equation 1), and the results are presented in Table 4 below:

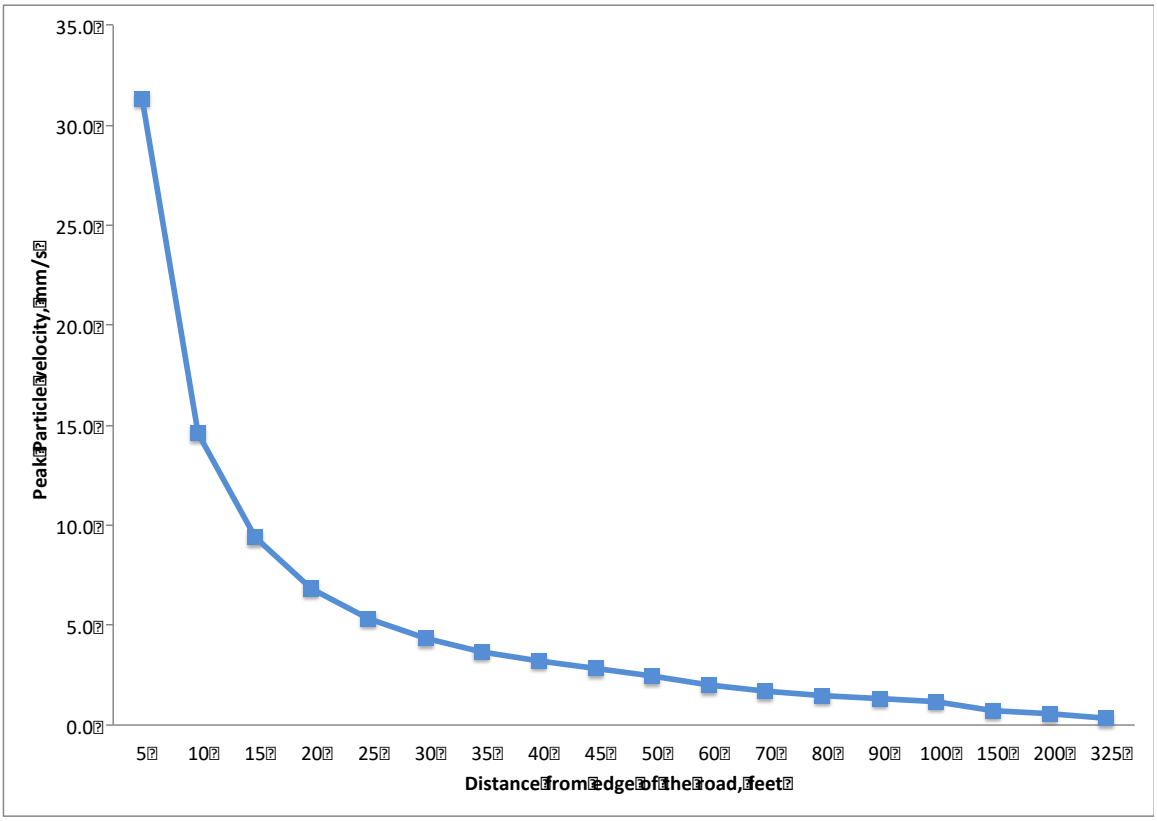


Figure 3: Vibration levels due to vibratory roller from edge of the road

From the above graph it is clear that buildings/structures within 4.5m from edge of the road will have major impact of vibrations due to vibratory roller, as per BS 7385/DIN 4150 standards.

32. ***Vibration assessment at sensitive receptors***. Vibration monitoring was carried out at the sensitive receptors along the alignment and monitoring results are presented in below table:

Table 4: Vibration impact assessment at sensitive receptors

Receptor	LHS/RHS	Road Chainage, KM		Offset from Road edge, m	Existing Vibration velocity, mm/s	Vibration due to vibratory roller, mm/s	Resultant Vibration velocity, mm/s	Increase in vibration level, mm/s	Type of Impact	Building Vibration Damage Risk Level
Community Hall,Khudengthabi	LHS	412+400	412+500	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Angawadi Centre	LHS	412+500	412+600	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Church	LHS	412+600	412+700	5	0.2	8.9	8.9	8.7	Moderate	Medium Risk
Market Area	LHS	414+400	414+700	5	0.1	8.9	8.9	8.8	Moderate	Medium Risk
Army Camp	RHS	414+400	414+800	10	0.1	7.8	7.8	7.7	Moderate	Medium Risk
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	0.4	3.4	3.4	3.0	Moderate	Medium Risk
Community Hall	LHS	415+400	415+500	10	0.2	7.8	7.8	7.6	Moderate	Medium Risk
Church	RHS	419+300	419+400	8	0.4	8.4	8.4	8.0	Moderate	Medium Risk
Moreh college	LHS	421+500	421+700	50	0.3	0.6	0.7	0.4	Minor	Low Risk

33. **Vibration Produced during Operation.** Because vehicles traveling on highway are supported on flexible suspension systems and pneumatic tires, these vehicles are not an efficient source of ground vibration. They can, however, impart vibration into the ground when they roll over pavement that is not smooth. Continuous traffic traveling on a smooth highway creates a fairly continuous but relatively low level of vibration. Where discontinuities exist in the pavement, heavy truck passages can be the primary source of localized, intermittent vibration peaks. These peaks typically last no more than a few seconds and often for only a fraction of a second. Because vibration drops off rapidly with distance, there is rarely a cumulative increase in ground vibration from the presence of multiple trucks. In general, more trucks result in more vibration peaks, though not necessarily higher peaks. Automobile traffic normally generates vibration amplitudes that are one-fifth to one-tenth the amplitude of truck vibration amplitudes. Accordingly, ground vibration generated by automobile traffic is usually overshadowed by vibration from heavy trucks.

34. Because vibration from vehicle operations is almost always the result of pavement discontinuities, the solution is to smooth the pavement to eliminate the discontinuities. This step will eliminate perceptible vibration from vehicle operations in virtually all cases.

35. **Mitigation Measures**

- A wave barrier is typically a trench or a thin wall made of sheet piles or similar structural members. The purpose of a barrier is to reflect or absorb wave energy, thereby reducing the propagation of energy between a source and a receiver. The depth and width of a wave barrier must be proportioned to the wavelength of the wave intended for screening.
- Adverse human response to construction vibration can be mitigated by good communication between the contractor and local residents. If occupiers of dwellings are informed of their nature, duration and potential vibration effects prior to the works, then adverse response will be less. Generally, the main concern relating to construction vibration is of damage to property and if this is not likely to occur, then this point should be made clear to residents.

36. **Summary**. The principal source of vibration is the operation of vibratory rollers during ground preparation. Buildings of the types found alongside the road have been classified, according to their sensitivity to vibration damage, with the categories including low, medium and high risk buildings.

37. From the study it is found that buildings/structures within 4.5m from edge of the road will have major impact of vibrations due to vibratory roller, as per BS 7385/DIN 4150 standards. The sensitive receptors will encounter moderate impact of vibrations due to construction equipment. The impact of vibrations due to road traffic will be negligible given the highway pavement is maintained at good condition. For the structures within 4.5 m from road edge, suitable mitigation measures should be adopted to minimize the vibration levels.

References

[i] Hanson, C. E., Towers, D. A., & Meister, L. D. (2006). Transit noise and vibration impact assessment (No. FTA-VA-90-1003-06).

[ii] Peck R B, Hanson W E and Thornburn T H (1974). Foundation Engineering. John Wiley and Sons, New York.

[iii] WOODS, R.D. and JEDELE, L.P., 1985. Energy-attenuation relationships from construction vibrations. American Society of Civil Engineers, Proceedings of ASCE Symposium on Vibration Problems in Geotechnical Engineering, Detroit, Michigan, G. Gazetas and E.T. Selig, Editors, pp. 229-246.

[iv] British Standard BS 7385, Evaluation and measurement for vibration in buildings. Pt 2. Guide to damage levels from ground borne vibration.

[v] British Standard BS 5228- 2. Code of Practice for noise and vibration control on construction and open sites. Part 2. Vibration. 2009.

[vi] Hiller, D. M., & Crabb, G. I. (2000). Groundborne vibration caused by mechanised construction works.

[vii] DIN 4150-3. Deutsche Norm. Structural Vibration. Part 3. Effects of Vibration on Structures. February 1999

[viii] Transportation- and Construction-Induced Vibration Guidance Manual, Jones & Stokes, J&S 02-039, Prepared for California Department of Transportation, Noise, Vibration, and Hazardous Waste Management Office, Sacramento, CA, June 2004.