Environmental Impact Assessment

Vol. 1 of 2

Project Number: 47341-004
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India: 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 for the Asian Development Bank. This is an updated version of the draft originally posted in June 2019 available on https://www.adb.org/projects/documents/ind-47341-004-eia.

CURRENCY EQUIVALENTS

(As of 20 May 2020)

Currency Unit	=	Indian rupee/s (₹)
₹1.00	=	$0.014
$1.00	=	₹75.6565

ABBREVIATIONS

AADT	–	Annual Average Daily Traffic
AAQM	–	Ambient air quality monitoring
ADB	–	Asian Development Bank
BDL	–	Below detectable limit
BOD	–	Biochemical oxygen demand
BOQ	–	Bill of quantity
CO	–	Carbon monoxide
COD	–	Chemical oxygen demand
CPCB	–	Central Pollution Control Board
AE	–	Authority Engineer
DFO	–	Divisional Forest Officer
DG	–	Diesel generating set
DO	–	Dissolved oxygen
DPR	–	Detailed project report
EFP	–	Environmental Focal Person
EHS	–	Environment Health and Safety
EIA	–	Environmental impact assessment
EMOP	–	Environmental monitoring plan
EMP	–	Environmental management plan
GHG	–	Greenhouse gas
GOI	–	Government of India
GRC	–	Grievance redress committee
GRM	–	Grievance redress mechanism
IEE	–	Initial Environmental Examination
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
NOx	–	Oxides of nitrogen
PAH	–	Polycyclic Aromatic Hydrocarbons
PCU	–	Passenger Car Units
PM	–	Particulate Matter
PIU	–	Project Implementation Unit

PPE	–	Personal protective equipment
R&R	–	Rehabilitation and Resettlement
RHS	–	Right hand side
ROW	–	Right-of-way
SAARC	–	South Asian Association for Regional Corporation
SH	–	State highway
SO_2	–	Sulphur Dioxide
SPCB	–	State Pollution Control Board
SPL	–	Sound Pressure Level
SPM	–	Suspended Particulate Matter
SPS	–	ADB Safeguard Policy Statement, 2009
TA	–	Technical Assistance
TDS	–	Total dissolved solids
TSS	–	Total Suspended Solids
UNESCAP	–	United Nations Economic and Social Commission for Asia and Pacific

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 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. 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 corridor traverse through the eastern part of Manipur state in India and mostly pass through rural areas. 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. The location of project alignment with another project component is shown in Figure 1.

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 project road starts near Khongkhang village about 65 km from Imphal. The first 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 is under Implementation. Therefore, the subproject road's starting point is considered at km 395+680 (end point of Package-2 road section) 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 kms length (refer Figure 1 Index Map).

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

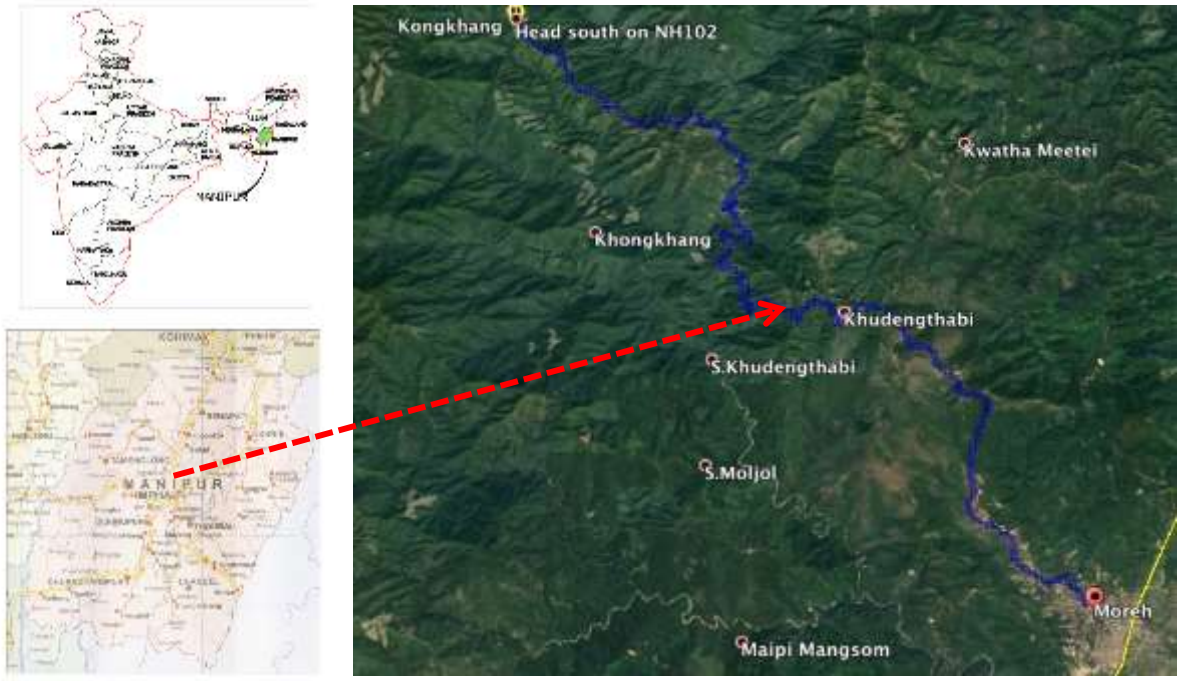

Figure 1: Index Map of the Subproject Road

5. The available ROW for this section is about 15 m only with hilly/rolling terrain. The major settlements along the project corridor are Khongkhang, Lokchao, Khudhengthabi, Chikim and Moreh.

6. No alternatives or bypass/alternative routes are proposed, as the project road section involves the improvement of existing NH-102 road section. The existing alignment has several advantages over a new alignment such as: less acquisition of forest and private land, shorter length of road passing through the wildlife sanctuary, existing NH section is geologically more stable, and cost of construction is lower for a 2 lane configuration road. Alternatives were however considered in road design such as cross sections, soil erosion and slope protections, hill cutting, drainage structures, rigid vs flexible pavement and others.

C. Description of the Environment

1. Physical Environment

7. **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

8. **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 1100 m 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.

9. ***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.

10. ***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).

11. ***Soil:*** 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.

12. 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.

13. **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 water potential, both ground as well as surface water. Important rivers that flow through the project region are the Lokchao and the Moreh.

14. The surface water body of Lokchao river is close to Project road. The distance between the Lokchao river and the project road varies from 10 to 35 m between chainage 404.000 km to 404.200 km. In addition to this, a few springs (Jhora) also cross the Project road.

15. **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 analyzed as per IS- 2488 (Part I-V). Ground water (drinking water) samples were analyzed as per IS: 10500-1991.

16. Water quality was monitored at five locations 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 show 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 of $CaCO_3$ 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 analyzed ground water samples is higher than the permissible standards. Other parameters analyzed like chloride, sulphate, fluorides are found well within standards. Overall, the ground water quality in the project areas is good.

17. **Air Quality.** Ambient air quality in the state is quite pure compared to other neighboring states. Except for few urban centers 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.

18. 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 but slightly higher than World Bank EHS guideline limit of 50 µg/m^3. The highest value of PM 10 is observed at Moreh (70.55µg/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 but slightly higher than the World Bank EHS guideline limit of 25 µg/m^3 . 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 is good.

19. **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.

20. 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

21. **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.

22. 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.

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

24. About 21.066 km length of the subproject road passes through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS) area on one side of road. The first section of 8.450km transverses through the eco-sensitive zone of YLWLS. Starting from Lokchao River Bridge to Khudhengthabi (chainage 404.130 to Chainage 413.230, length 9.100 km) the 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.

25. The land use 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

26. Local forest department officials were consulted to know the presence of any endangered species of trees within the formation width.

27. 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 will need to be removed from 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. The project will require diversion of 48.29 ha. forest land (about 2 m strip along the road) for widening of the road. This includes 14.19 ha from eco-sensitive zone and 34.10 ha from buffer zone of sanctuary. The forest land to be acquired is located along the existing road and comprises mostly natural habitat.

28. **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.

29. The Yangoupokpi Lokchao Wildlife Sanctuary (YLWS) hosts about 42 species of mammals, 74 species of aves, 29 species of reptiles, 6 species of amphibians and 86 species of fishes. Important faunal species reported in the sanctuary include *Manis pentadactyla* (Chinese Pangolin), *Hoolock hoolock* (Western Hoolock Gibbon), *Pavo muticus* (Green Peafowl), *Schistura reticulata*.

30. A critical habitat screening and assessment conducted for the project site following ADB SPS requirements and International Finance Corporation (IFC) performance standard (PF) 6. The assessment findings revealed that the project site is possible or actual Critical Habitat for: 12 freshwater fishes; one bird (Green Peafowl *Pavo muticus*), one mammal (Hume's Rat *Hadromys humei*), and the Yangoupokpi-Lokchao Wildlife Sanctuary Important Bird Area (Table 1; Section 3). Other faunal species found in the project area but do not trigger critical habitat are shaji (deer), fox, jackle, jungle cat, wild pig, monkey (langur), porcupine and pangolin. According to local communities in the project area movement of wildlife in the sanctuary is limited to core zones, and along the rivers/streams.

3. Socio-economic Environment

31. **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.

32. **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 available, is 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.

33. 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.

34. 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 tons.

35. **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 to 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 19,252 km, of which 8,795 km are unsurfaced roads.

36. The state is 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.

37. 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 unauthorized trade into authorized 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

38. Since the proposed project is an improvement of the existing road section in hilly terrain, no alternative alignment is proposed. Existing alignment has advantages over new alignment like land take from forest and private parties is less, length of road passing through wildlife sanctuary is less (new alignment will have huge impacts on biodiversity, existing NH section is geologically more stable, and cost of construction is lower for 2 lane configuration road. Alternatives were however considered in road design such as cross sections, soil erosion and slope protections, hill cutting, drainage structures, rigid vs flexible pavement etc. considering this having a new alternate alignment would have been uneconomic and had huge environmental impacts. 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

39. 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.

40. 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.

41. 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.

42. The project executing agency 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 has been 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, the draft EIA report has been disclosed to the public through the ADB website (in June 2019[2]), 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.

43. 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 executing agency level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the executing agency level will be forwarded to the GRC. The GRC will comprise members from the executing agency, implementing agency, Authority Engineer, contractor, local community local forestry and wildlife authorities.

F. Anticipated Environmental Impacts and Mitigation Measures

44. Based on analysis of project activities and environmental baseline conditions 17 valued environmental components (VECs) under physical, biological and social environment were identified. Impacts on each of these VECs during pre-construction and design stage, construction stage and operation stage was carried out. Impacts were determined to be minor, moderate or major based on a rating criteria of sensitivity of the VEC, duration of impact, area of impact and severity of impact.

45. The key positive environmental impacts of the project include improved slope stabilization through engineering and bioengineering measures; a net increase in area of good quality habitat by 15 ha through compensatory afforestation and habitat improvement activities inside the sanctuary such as development of land use plan for communities living inside the sanctuary; improved monitoring capacity of the sanctuary staff and improved access to healthcare and education facilities.

46. Most negative impacts are of moderate or minor risk. The only potential impact with high risk is the introduction of invasive species in the project area through the movement of construction vehicles and transport of soil and borrow material. Negative impacts with moderate risks include fishing of restricted range fish species and disturbance of aquatic habitat of the restricted range fish species; noise and disturbance and potential poaching. All

[2] https://www.adb.org/projects/documents/ind-47341-004-eia

these impacts are short term and expected to occur during construction. A long term impact with moderate risk includes obstruction of movement of wildlife species across the road. These include arboreal species such as the Western Hoolock Gibbons and Capped Langurs and smaller species such as Pangolins and Hume's Rat. The entire length of the project road passes through hills and forest areas and requires diversion of about 48.29 ha of mostly natural forest land outside the ROW belonging to the Forestry Department and 5 ha of mostly natural forest land inside the ROW belonging to NHIDCL. A total of about 2013 trees will need to be removed from the 53.29 ha of forest land. Given that the forest land to be removed is largely of average quality (100 trees/ha) it is estimated that of the 53.29 ha only about 13 ha is of good quality forest (1000 trees/ha).

47. A biodiversity action plan (BAP) has been developed to address the ecological risks mentioned above. It includes activities described in paras 48-49 below.

48. Risks related to invasive species, fishing, disturbance of aquatic habitat, noise and disturbance and poaching will be addressed through: contractual clauses requiring measures to prevent the spread of invasive species such as washing of construction vehicle tyres; prohibiting hunting and fishing; prohibiting the use of borrow material from within 200 m of river beds; prohibiting establishment of camps in the forest and sanctuary section of the road; restricting construction hours from 8am to 4pm; installation of information signage on wildlife; and creation of gentle slopes in wildlife movement areas. Measures such as rope ladders for arboreal species and ledges/shelves inside culverts for reptiles and amphibians have been included in the contractor's scope of works to facilitate movement of these species across the road. Speed control signages, informatory boards and strict monitoring have also been included in the EMP to minimize impacts on wildlife in the YLWLS.

49. The loss of the 48.29 ha of land under the Forestry Department and the 2013 trees will be compensated under a mandatory compensatory scheme under the government wherein an equivalent area of degraded forest or barren land will be improved and 6039 trees (1:3 ratio) will be planted. This mandatory compensation scheme is expected to result in the creation of only about 1.2 ha of good quality forest. An additional activity on development of a land use plan for seven communities living inside the sanctuary is expected to result in the creation of approximately 27.5 ha of good quality forests. Hence, a net gain of about 15 ha of good quality forests is expected under the project.

50. Other moderate and minor negative environmental impacts include dust; pollution of air and water; noise and disturbance for local communities during construction; land acquisition and impacts on 155 structures and 2 shrines; inconveniences caused by shifting of utilities; health and safety issues for construction workers and local communities located near the project road; soil erosion; contamination and siltation of surface water. These will be addressed through various mitigation measures included in the EMP such as regular sprinkling of water; enforcement of construction time limits; regular monitoring of air, water and noise; payment of compensation to affected people in accordance with the entitlement matrix in the Resettlement Plan (RP); regular public communication on shifting of utilities; enforcement of health and safety requirements in the work sites and camps; implementation of slope stabilization measures; management of solid and liquid waste and chemicals and other measures.

G. Environmental Management Plan

51. A fully budgeted environmental management plan, including the biodiversity action plan (BAP) 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.

52. 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 Engineer, Contractor(s), technical assistance (TA) consultants, external monitor and biodiversity organization and reporting mechanisms during implementation and operation phases.

53. The monitoring program includes regular site inspections and checks by the PIU under NHIDCL. The AE will conduct monthly and quarterly site inspections to monitor implementation of the EMP. The AE Environmental Specialist will monitor implementation of the EMP while the Biodiversity Specialist under an ADB TA will monitor implementation of the BAP. BAP monitoring will include maintaining records on road kills, wildlife accidents, poaching incidents etc. and checking the contractor's compliance with civil works components of the BAP during the construction stage and during the contractor's one year defect liability period during the operation stage. During the operation stage the Biodiversity Specialist will also monitor the effectiveness of the wildlife crossing structures (rope ladders and ledges in culverts) that were constructed.

54. Environmental monitoring reports covering activities under the EMP will be prepared by the AE on a monthly and semi-annual basis. Biodiversity monitoring reports covering biodiversity monitoring activities under the BAP will be prepared by the ADB TA consultant on a quarterly and semi-annual basis. All these reports prepared by the AE and ADB TA consultant will be submitted to the PIU for their review and endorsement. The environment and biodiversity semi-annual monitoring reports will be forwarded to ADB for disclosure on the ADB website. An External Monitor consultant will be recruited to conduct third party monitoring of environment safeguards including quarterly site inspections and preparation of semi-annul external monitoring reports which will also be submitted to the PIU and ADB. A Biodiversity Organization will be recruited to implement additional habitat improvement activities to enable the project to achieve no net loss or preferably net gain of biodiversity.

55. An environmental management budget of INR 210,956,140 (Indian Rupees twenty one crore, nine lakhs, fifty six thousand, one hundred and forty only) (USD 2.9 million) has been estimated for implementation of the EMP and BAP. This budget also includes cost of environmental monitoring and associated trainings.

H. Conclusions and Recommendations

56. The project road (Khongkhang-Moreh Road Section) proposed for improvement is classified as environment Category A project as per ADB SPS requirements. This is mainly because the project road passes through the ecologically sensitive area of the Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS). Environmental screening and assessment of likely impacts and rating of risks shows that with implementation of mitigation measures and habitat improvement activities the project will not result in significant residual environmental impacts.

57. A number of potential adverse impacts have been identified on issues related to dust, noise, pollution, soil erosion, waste, occupational health and safety, community health and safety and biodiversity. Most impacts were assessed to be of low to moderate risk. However, potential impacts on biodiversity were assessed to be of medium to high risk. Biodiversity impacts include loss of about 13 ha of good quality forests, potential mortality and destruction of habitat for wildlife species including 14 wildlife species (12 fishes, 1 bird, 1 mammal) that

trigger critical habitat, potential impacts on 1 Important Bird Area (IBA) and potential spread of invasive plant species.

58. Mitigation measures have been proposed and budgeted to address all the above identified impacts and risks in the EMP. As part of the EMP a Biodiversity Action Plan (BAP) has been prepared to mitigate biodiversity related risks. The BAP includes: measures to facilitate wildlife movement across the road; avoid disturbance of natural habitat including aquatic habitat in the project area; avoid the spread of invasive species; strict biodiversity monitoring; and implementation of habitat improvement activities to achieve no net loss or net gain of biodiversity under the project.

59. The EMP including BAP is a living document and will be subject to revision following finalization of the detailed design by the EPC contractor and pre-construction stage wildlife survey by a Biodiversity consultant. The EMP and BAP may undergo further revision during project construction if there is any change in project design and occurrence of unanticipated impacts. The environmental mitigation measures are itemized in the EMP and the Executing Agency (NHIDCL) shall ensure that the most recent EMP (including the BAP) and EMoP are included in the civil works contract agreement.

I. INTRODUCTION

A. Project Background and Rational

1. ADB has a regional cooperation program in four South Asian countries: Bangladesh, Bhutan, India and Nepal, called South Asia Subregional Economic Cooperation (SASEC[3]), which has been supporting regional cooperation in the transport sector through SAARC[4] and BIMSTEC[5] over a decade. Major contributions in this regard include assisting the SAARC Regional Multimodal Transport Study (SRMTS)[6] and BIMSTEC Transport Infrastructure and Logistics Study (BTILS).[7] 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.

2. 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).

3. The present subproject aims to widen and improve about 29.516 km of existing national highway to 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.

4. **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 Highway.[8] In India, the 4-laning development is ongoing under the National Highway Development Program (NHDP) up to 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 up to 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.

5. 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

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

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

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

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

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

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

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.

6. Cross-border trade 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 Government of India's (GOI's) Integrated Check post Program. GOI has also been in discussions with the Government of Myanmar on starting of a bus service between Imphal and Mandalay (about 820km).

7. Myanmar receives various support 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 sea port 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.

8. **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 up to 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.

9. 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 neighboring 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.

10. Traffic level between 1800 hrs and 0600 hrs were typically 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.

11. 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.

12. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance 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.

13. 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 are selected as sample subprojects and the latter as non-sample subprojects under the program. The list of ongoing and non-sample subprojects is 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)	90.560
3.	Imphal-Kanchup-Tamenglong-Tousem-Haflong (Manipur)	103.000
	Sub-Total A	**230.831**
II	**Tranche II subprojects**	
1.	AH-1: Imphal - Moreh Priority section (Imphal to Khongkhang village (km 330.000 to km 395.680)) in Manipur	65.680
2.	Mechi bridge (West Bengal)	1.500
3.	Additional financing for Imphal-Kanchup-Tamenglong state highway in Manipur	-
	Sub-Total B	**67.280**
III	**Tranche III subproject**	
1.	AH-1: Imphal - Moreh Last mile (Khongkhang – Moreh, from km 395.680 to km 425+196) in Manipur	29.516
	Sub-Total C	**29.516**
	Grand Total	**327.627**

14. 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 (EARF[9]) for the Project.

B. Subproject Road

15. 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 carriageway. No realignment

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

sections are proposed, and improvement is limited to existing road geometry. The location of project alignment is shown at Figure 2.

16. 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 packages 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 kms 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 terrain (from Khongkhang to Moreh). The total length (29.516 kms) of corridor traverses through forest area but with fair to poor surface condition (refer Figure 1 – Index Map).

17. The available ROW for the section from km 395+680 to km 425+196 is 15 m 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 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

18. 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 / minimize the environmental impacts, and
- preparing an environmental management plan for implementation.

19. 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

20. 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.

21. 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:

22. **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.

23. **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.

24. **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.

25. **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.

26. **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.

27. **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.

28. **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

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

- ***Chapter I - Introduction***: This section described the background information about the project and EIA study.
- ***Chapter II - Policy, Legal, and Administrative Frameworks***: this section summarizing the national and local legal and institutional frameworks that guided the conduct of the assessment.
- ***Chapter III - Project Description***: This section presents the key features and components of the proposed project.
- ***Chapter IV - Description of the Environment***: This section discussing the relevant physical, biological, and socioeconomic features that may be affected by the proposed project.
- ***Chapter V - 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 VI - Analysis of Alternatives***: This section covers analysis of various alternatives considered to minimize the overall impacts of proposed development and suggest most appropriate alternatives based of detailed analysis of impact and risk associated with each alternative.
- ***Chapter VII - 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 VIII - Grievance Redress Mechanism***: This section describing the formal and informal redress procedures for registering, resolving, and reporting complaints.
- ***Chapter IX - 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 X - 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.

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

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORKS

31. 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 (ADB) 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 categorization of the project,
- Summary of international treaties and applicability to the project

A. National (India) Environmental Policy Framework

32. 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
- Wild Life Protection.

33. 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.

34. 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.

35. 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, hot mix 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).

36. 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 summarized 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.

37. 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/Implementing Agency)						
1.	Implementing Project in Forest Area	Environmental Protection Act of 1986, Forest Conservation Act	Forest Clearance	Conservator of Forest, Government of Manipur	MORTH / NHIDCL	6-12 months
2.	Implementing Project in Protected Area	Wildlife Protection Act	Clearance from National Wildlife Board	Chief Wildlife Warden National Wildlife Board	MORTH / NHIDCL	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	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of	Consent-for-establishment	State Pollution Control Board	The Contractor	2-3 months

Sl. No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
	Generator Sets	1986 and as amended				
2	Operating camps, stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as amended	Consent-for-operation	State Pollution Control Board	The Contractor	2-3 months
3	Use and storage of explosive for quarry blasting work	India Explosive Act 1984	Explosive license for use and storage	Chief Controller of Explosives	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 labor	Labor Act	Labor license	Labor Commissioner	The Contractor	2-3 months

38. 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 100 km and involve additional right-of-way or land acquisition greater than 40 m on existing alignment and 60 m 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 (29.516 km), it does not fall under the purview of EIA notification. Therefore, an 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.

39. 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 Figures 4 to 6.

B. Social Regulatory Requirements of India and State

40. 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. Executing agency 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 Labor (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

41. 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

42. 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

43. 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. About 9.1 km length of the project road from Lokchao bridge to Khudengthabi (km 404.130 to km 413.230) is bordering the core zone of Yangangpokpi Lokchao Wildlife Sanctuary (YLWLS) on one side and from Khudengthabi to Moreh for 11.966 km (km 413.23 – km 425.196) it passes 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.

44. 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.

45. Due to the potential for significant ecological impacts during construction and induced ecological impacts during project operation stage the project falls under environment category A as per ADB Safeguard Policy Statement 2009.

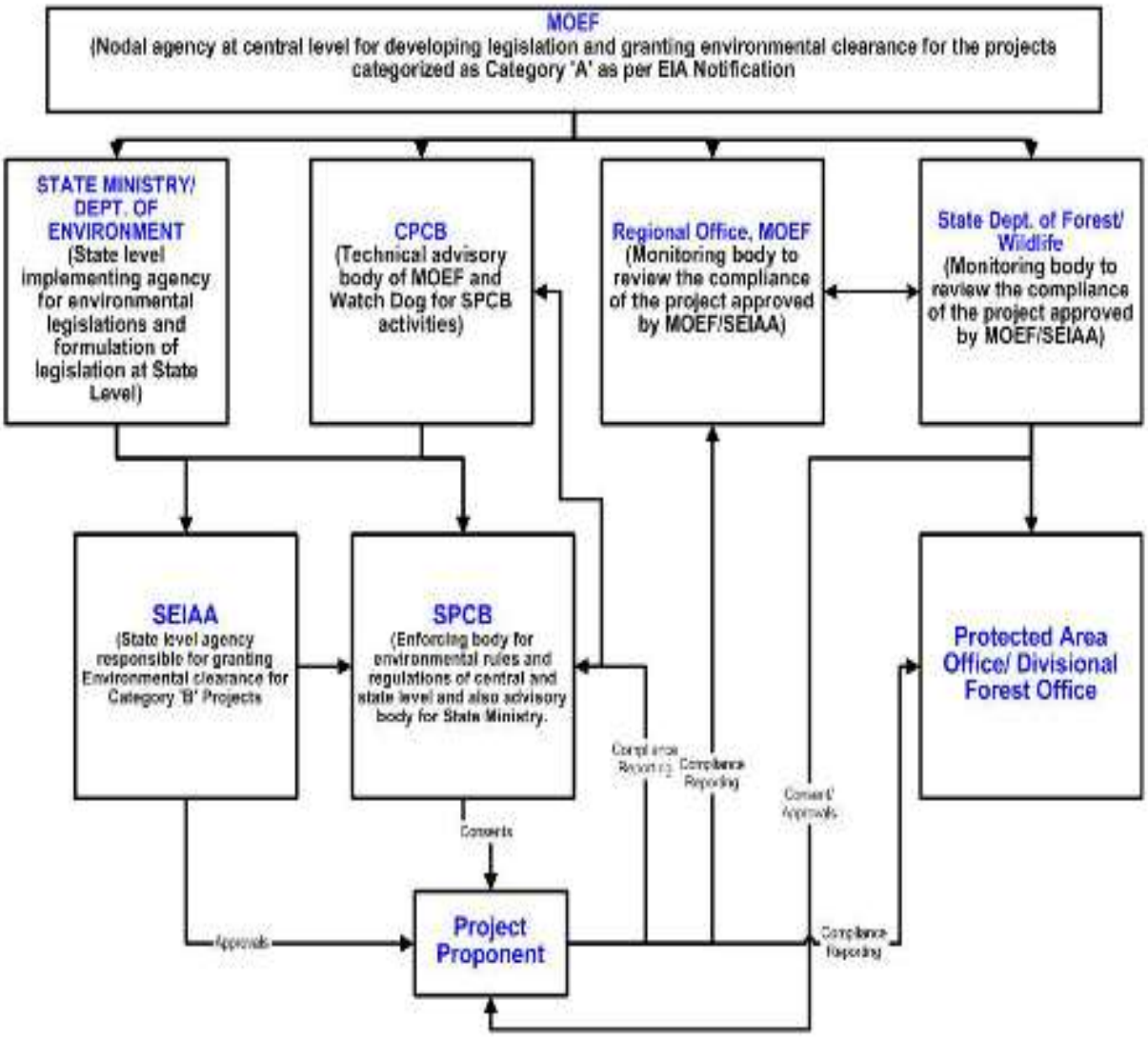


Figure 3: Environmental Legal Administrative Framework in India

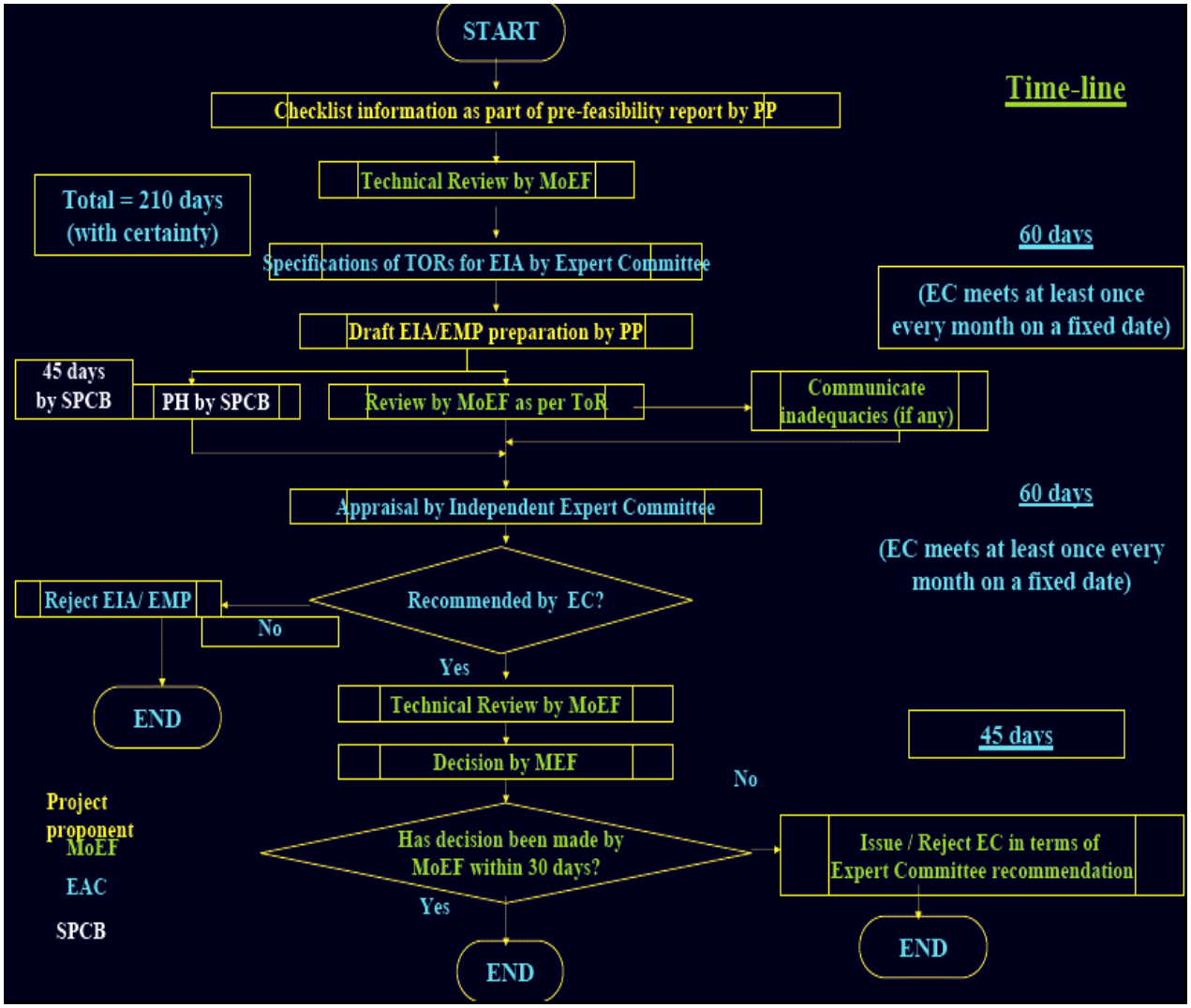


Figure 4: Environmental Clearance Process in India

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.

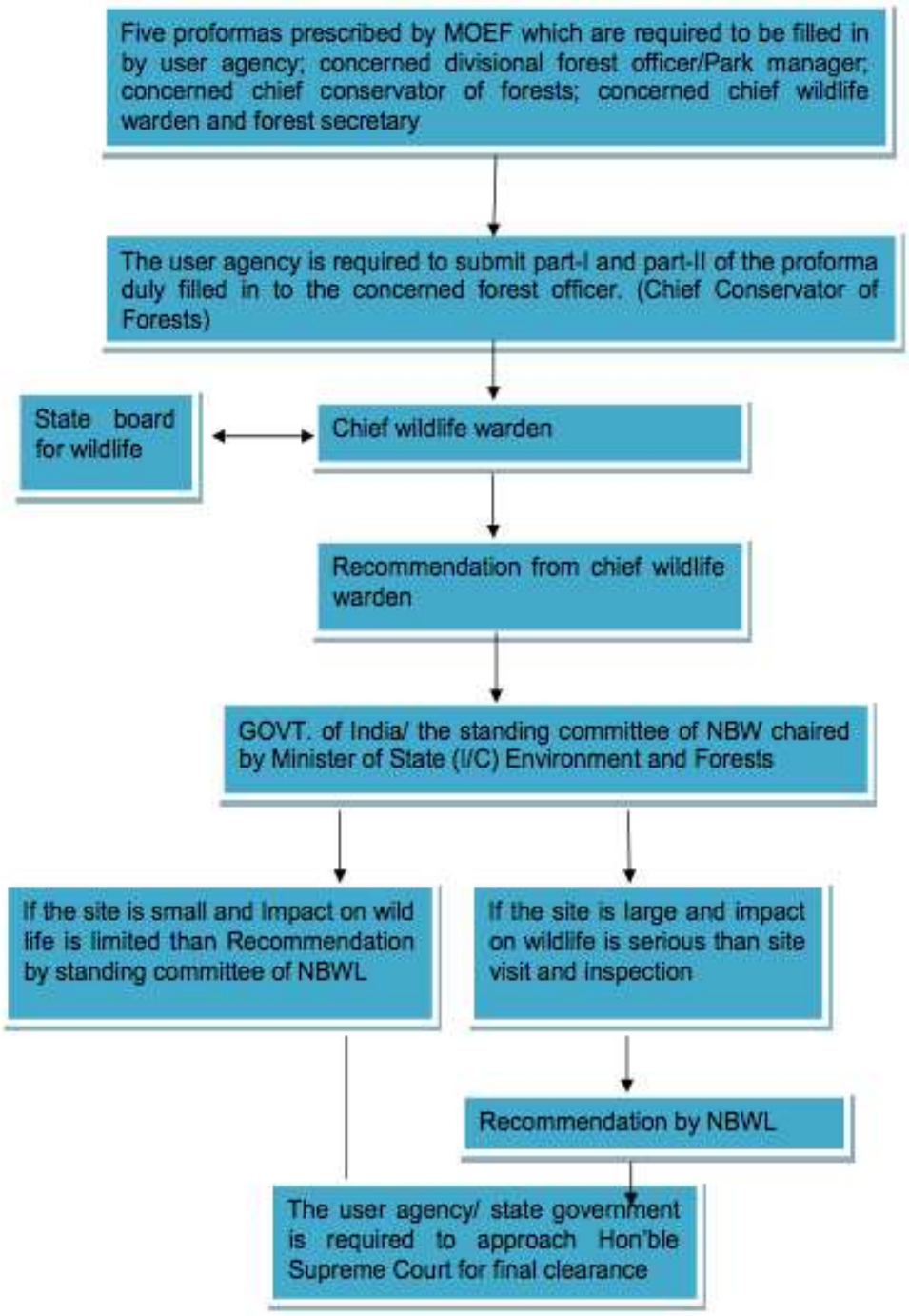


Figure 5: Procedure for Obtaining Wildlife Clearance in India

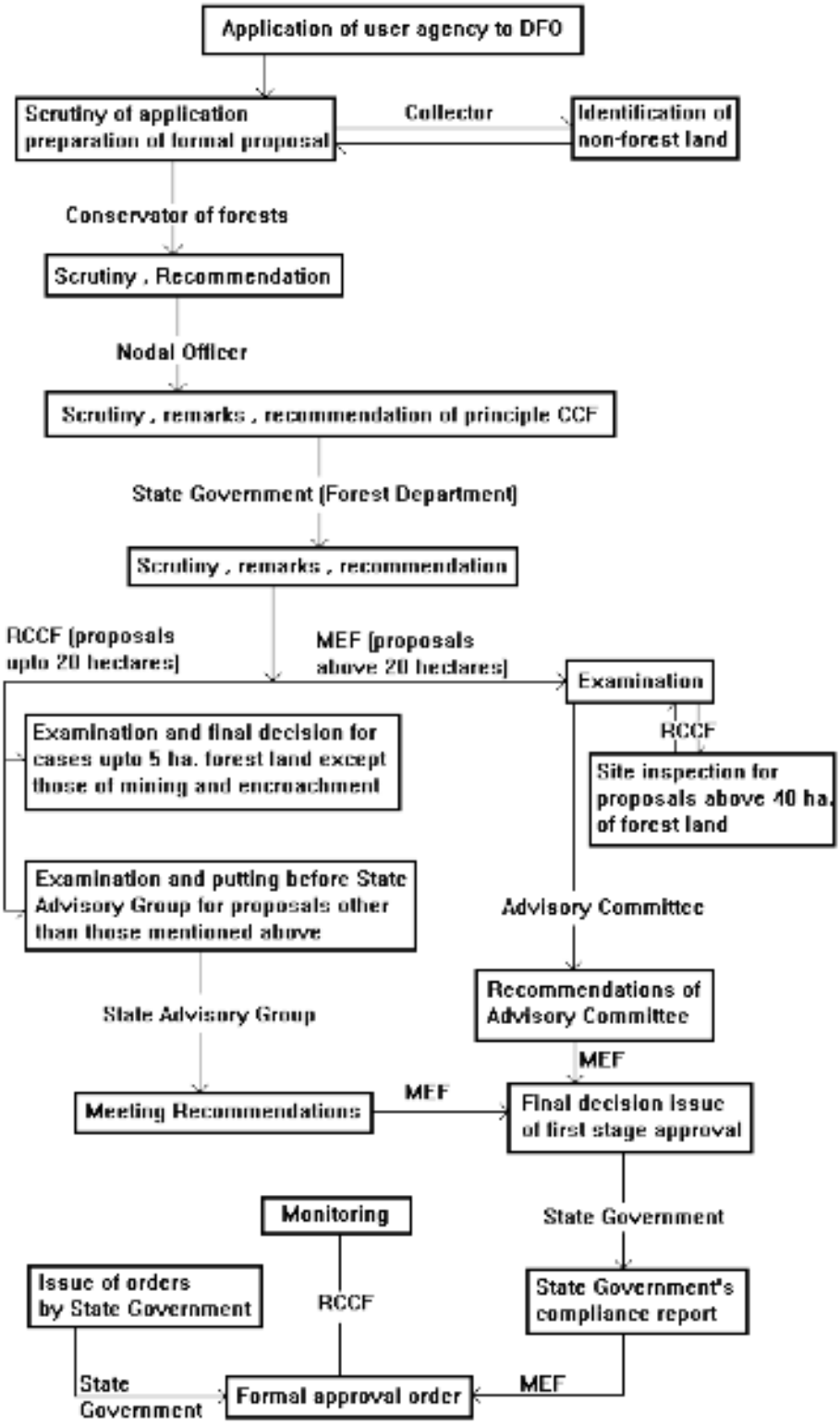


Figure 6: Procedure for Obtaining Forest Clearance

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

Step No.	Activity	No. of Days
21	The Range Officer sends the final list of trees to the concerned DFO for information	1
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

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

III. PROJECT DESCRIPTION

A. Type of Project

46. 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

47. 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.

48. 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.

49. 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.

50. 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).

51. 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.

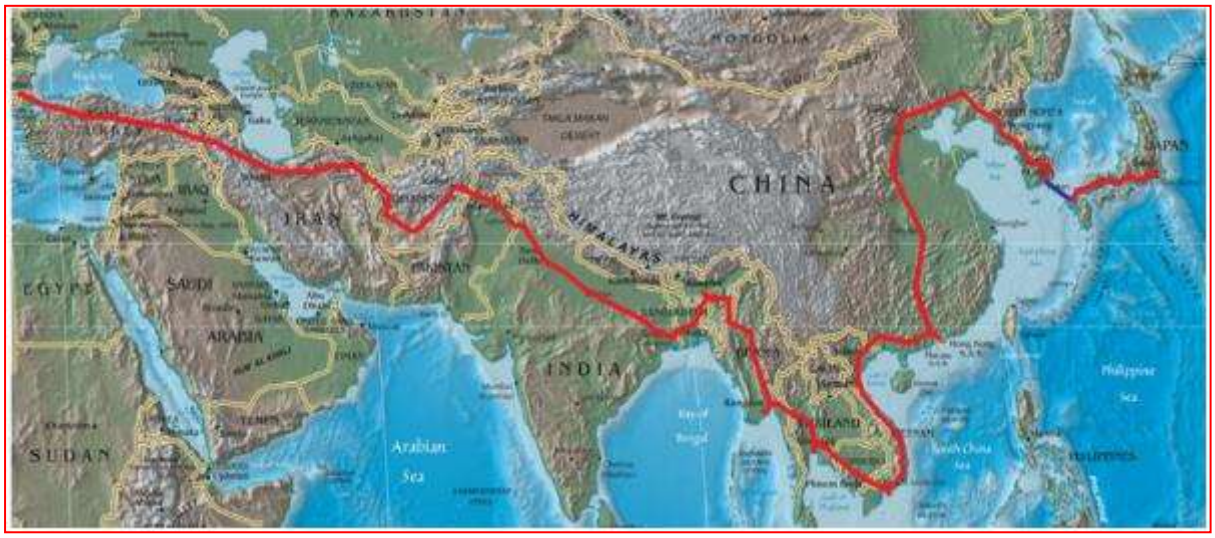


Figure 7: Map showing Asian Highway Network

52. Looking at the benefits of the project, the Government of India requested for a project preparatory technical assistance 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

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

54. The Imphal – Moreh road starts in Imphal city. The first 10 km section has already been upgraded to a 4-lane carriageway road by MORTH and approximately 65 km of the road has been sanctioned is currently under upgradation to a 4-lane road by NHIDCL. The 29.516 km project road continues from the 65km section and starts at km 395+680 at Khongkhang village and ends at Moreh (Myanmar Border) at km 425+196. The project road runs through hilly/rolling terrain and traverses forest areas throughout its entire length.

55. 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.

56. 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

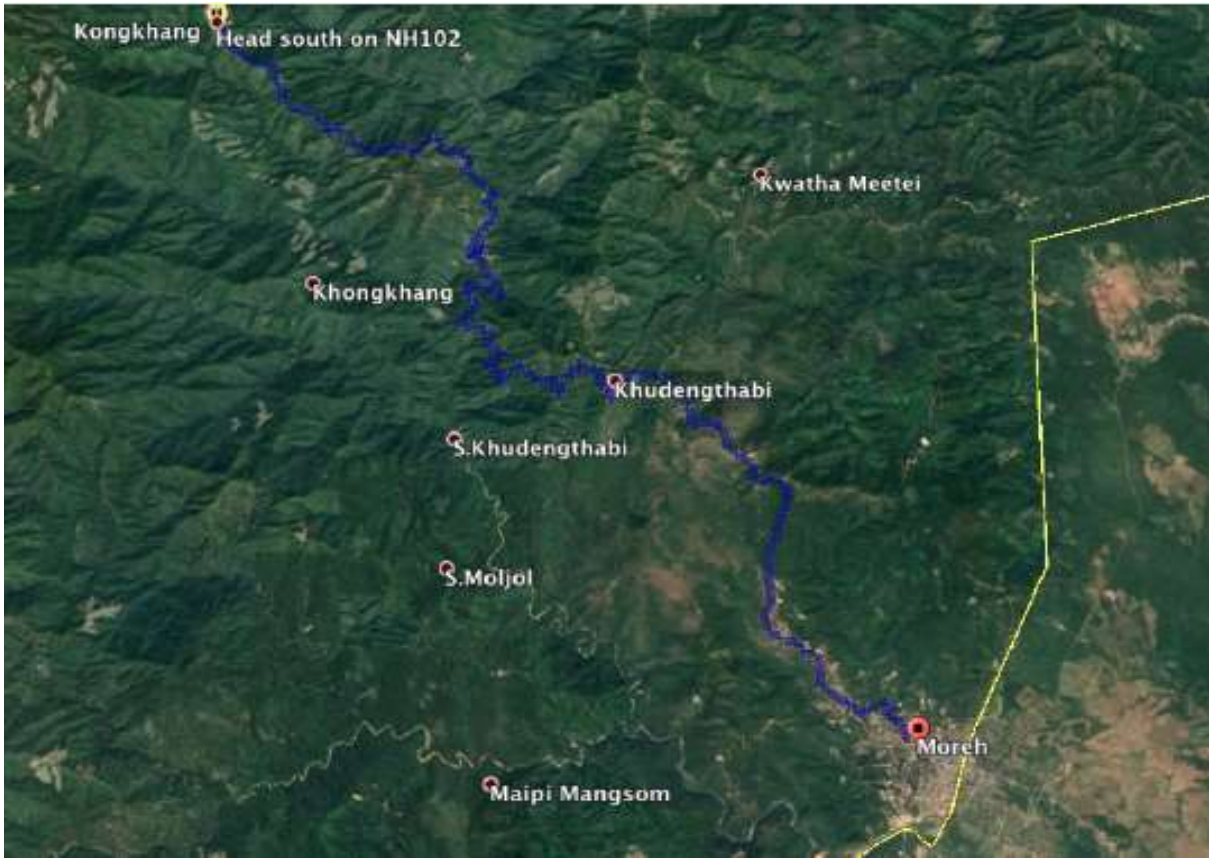


Figure 9: Project Alignment on Google Earth Image

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

Image 1: Khudhengthabi Village

Image 2: Moreh Town

58. **Chainage Reference System.** Since Kilometer stones are available along the project road, the same is followed from km 395+680 to km 425+196.

59. **Corridor Sections.** 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)	16.920
	2.	Khudengthabi – Moreh (From Km 412+600 to Km 425+196)	12.596
		Total Length	**29.516**

60. **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 the 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 isolated soil erosion spots 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 existing ROW is 15 m only.

61. 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.

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

63. **Segment 2: Khudengthabi - Moreh (From Km 412+600 to Km 425+196).** This segment starts from Khudengthabi village and ends before international border in Moreh town. The section passes through hilly/rolling terrain for its total length and the carriageway width 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 the developed area on both sides of the road; here only re-surfacing work is proposed. Furthermore, a bypass for Moreh Town has already been taken up as a separate assignment by NHIDCL. Moreh town is shown in Google earth image below in Figure 10.

64. 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 the bridge length (shown yellow in color) is maintained by Myanmar government.

Figure 10: Google image showing Road section in Moreh Town

65. **Project Network.** 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.

66. **Design Standards for the Project Road.** 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.

D. Proposed Improvement Works

67. 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

E. Engineering Surveys and Investigations

68. 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.

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

70. **Traffic Surveys.** 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.

71. 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.

72. 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.

73. 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

74. **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 AADT 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, Fire tender, 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

S. No	Vehicle Type	TVC 1	TVC 2
		HS 1	HS 2
23	Tractor	0	0
Total Fast Vehicles		1326	4682
Total Fast PCU's		0	0
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

75. **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	2023-28	2028-33	2033-38
Car/Van/Jeep	5.8	5.0	4.0
2-Wheeler	6.5	5.6	4.0
3-Wheeler	5.2	4.5	3.6
Bus	4.0	3.4	3.4
All Trucks	4.5	4.0	3.5
LCV	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

76. **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%

77. 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 (a): Year wise AADT. Projections for Project Road Sections (Veh's) HS1

Year	Motorcycle	Car (New Technology)	Three Wheeler	Medium Bus	Tractor - Trailor	Truck Light (2 axles)	Truck Medium (2-axles)	Truck Heavy (3-axles)	Truck Articulated (5 axles)	Car (Old Technology)	Mini Bus	Total
2023	2,034	4,427	841	91	5	720	688	117	2	0	33	**8,958**
2024	2,174	4,701	886	95	5	767	725	123	2	0	35	**9,514**
2025	2,324	4,993	933	100	5	817	764	130	2	0	36	**10,104**
2026	2,485	5,303	982	104	6	870	806	137	2	0	38	**10,732**
2027	2,656	5,631	1,034	109	6	926	849	144	2	0	40	**11,399**
2028	2,802	5,913	1,077	114	6	977	888	151	3	0	41	**11,972**
2029	2,956	6,208	1,123	118	6	1,031	929	158	3	0	43	**12,575**
2030	3,119	6,519	1,170	122	7	1,088	972	165	3	0	44	**13,208**
2031	3,291	6,845	1,219	127	7	1,147	1,016	173	3	0	46	**13,874**
2032	3,472	7,187	1,270	132	7	1,211	1,063	181	3	0	48	**14,573**
2033	3,624	7,475	1,313	136	7	1,259	1,106	188	3	0	49	**15,160**
2034	3,784	7,774	1,358	140	8	1,309	1,150	196	3	0	51	**15,772**
2035	3,950	8,085	1,404	144	8	1,362	1,196	203	3	0	52	**16,408**
2036	4,124	8,408	1,452	148	8	1,416	1,244	212	4	0	54	**17,069**
2037	4,306	8,744	1,501	153	8	1,473	1,294	220	4	0	55	**17,758**
2038	4,495	9,094	1,552	157	9	1,532	1,345	229	4	0	57	**18,474**
2039	4,693	9,458	1,605	162	9	1,593	1,399	238	4	0	59	**19,220**
2040	4,899	9,836	1,660	167	9	1,657	1,455	247	4	0	61	**19,995**

Table 11 (b): Year wise AADT. Projections for Project Road Sections (Veh's) HS2

Year	Motorcycle	Car (New Technology)	Three Wheeler	Medium Bus	Tractor -Trailor	Truck Light (2 axles)	Truck Medium (2-axles)	Truck Heavy (3-axles)	Truck Articulated (5 axles)	Car (Old Technology)	Mini Bus	Total
2023	4,186	4,010	3,649	29	0	759	546	121	2	0	33	**13,335**
2024	4,475	4,259	3,842	30	0	808	575	128	2	0	35	**14,154**
2025	4,784	4,523	4,046	32	0	861	607	134	2	0	36	**15,024**
2026	5,114	4,803	4,260	33	0	917	639	142	2	0	38	**15,949**
2027	5,467	5,101	4,486	35	0	976	674	149	2	0	40	**16,930**
2028	5,767	5,356	4,675	36	0	1,030	705	156	3	0	41	**17,769**
2029	6,084	5,624	4,871	38	0	1,087	737	163	3	0	43	**18,650**
2030	6,419	5,905	5,076	39	0	1,147	771	171	3	0	44	**19,574**
2031	6,772	6,200	5,289	40	0	1,210	807	179	3	0	46	**20,545**
2032	7,145	6,510	5,511	42	0	1,276	844	187	3	0	48	**21,565**
2033	7,459	6,771	5,698	43	0	1,327	877	194	3	0	49	**22,423**
2034	7,787	7,041	5,892	45	0	1,380	913	202	3	0	51	**23,314**
2035	8,130	7,323	6,092	46	0	1,435	949	210	3	0	52	**24,242**
2036	8,487	7,616	6,300	47	0	1,493	987	219	4	0	54	**25,206**
2037	8,861	7,921	6,514	49	0	1,553	1,027	227	4	0	55	**26,210**
2038	9,251	8,237	6,735	50	0	1,615	1,068	237	4	0	57	**27,253**
2039	9,658	8,567	6,964	52	0	1,679	1,110	246	4	0	59	**28,339**
2040	10,083	8,910	7,201	53	0	1,747	1,155	256	4	0	61	**29,468**

78. **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

79. 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

AA: Already Achieved & NA: Not Achieving

80. 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 up to 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

F. The Design

81. 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.

Design Standards

82. 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.

83. 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

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

Geometric Design Standards

85. The salient parameters for the geometric design of roads suggested are given in Tables 15 to 17.

Table 15: Design Speed

Type of Section	Ruling		Absolute Minimum
	Desirable	Minimum	
Rural	100 km/h	80 km/h	60km/h
Urban/Built up 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.

86. 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

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%.

87. 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 18.

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

88. 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.

89. 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.

90. 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

91. 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.

92. 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 requires 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

93. **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;

94. 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%
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 cross roads

Widening Options

95. 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.

96. 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.

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

98. In additional to all it is not advisable to shift side of widening so frequently as that will leads 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. So 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

Median

99. 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.

Paved Shoulders

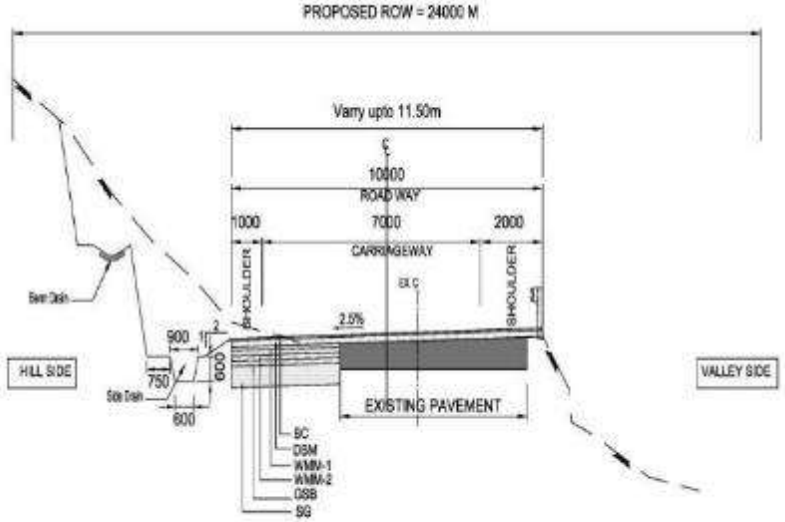
100. 2.0 m wide paved shoulders have been adopted as an improvement option strategy for many upgrading cases. IRC recommends 1.5 m wide paved shoulder on either side of carriageway of 2-lane width or more. The usefulness of a paved (or even hard) shoulder is beyond dispute. One of the most important uses of a shoulder is to provide space for movement of slow-moving vehicles and for routine and emergency parking of vehicles.

Typical Cross-sections

101. 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:

102. 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

OWNER : PWRD/MoRT&H/ SJDA

PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 9118 IND

CLIENT : ASIAN DEVELOPMENT BANK

DESIGN CONSULTANT : SHELADIA ASSOCIATES INC., USA

JOB No. : SAI 5448

TITLE : TYPICAL CROSS SECTION

DRAWING NO : A D B - 8 1 1 5 - D P R - T C S

REV. 0

SIZE : A2

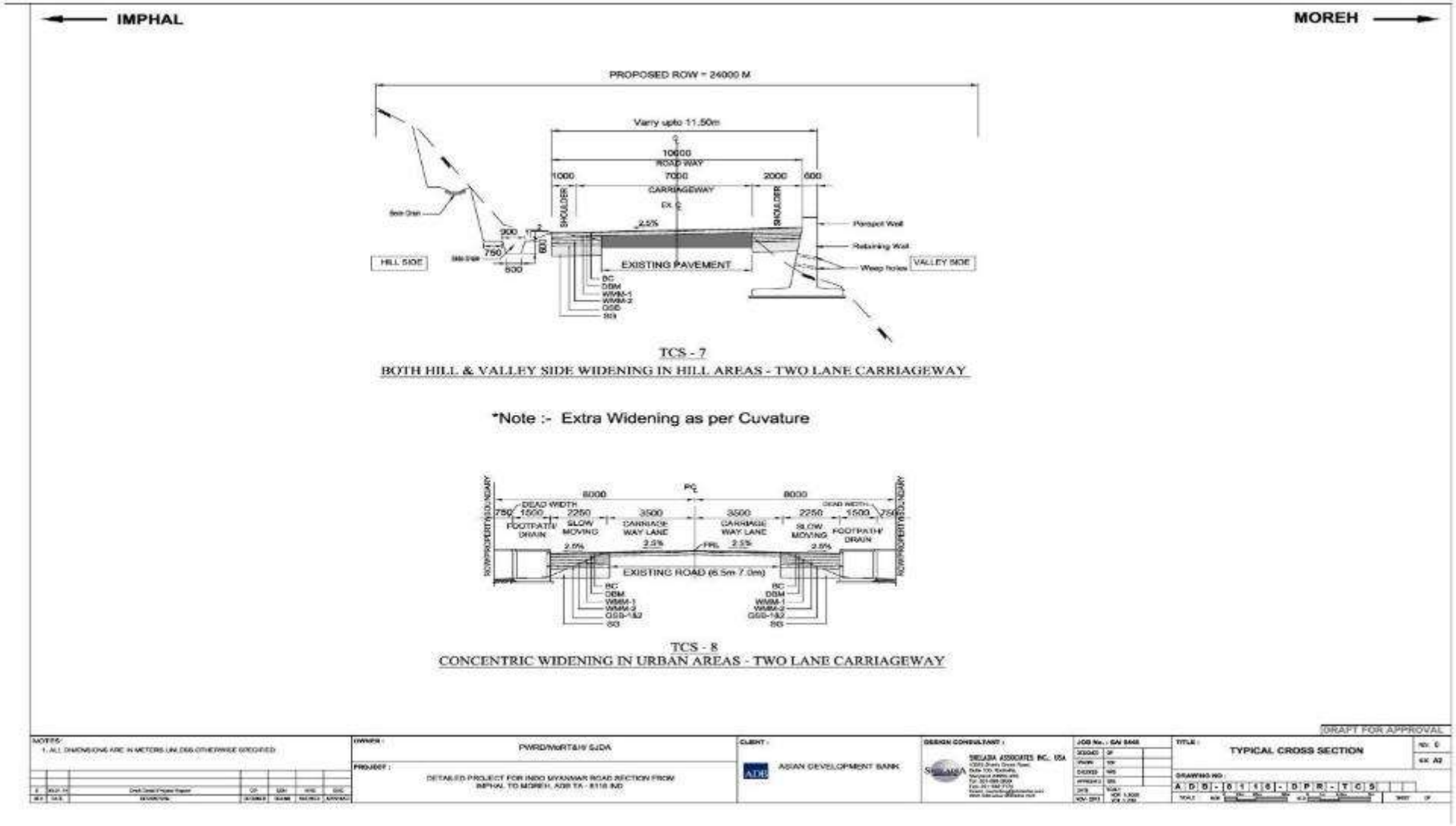


Figure 11: Typical Cross-section proposed for road widening

103. 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	Formation Width (m)	Type of Widening	Homogenous Section
	From	To					
1	395680	418000	22320	6	11.5	Eccentric (Hill Side)	1
2	418000	423200	5200	6	11.5	Eccentric (Hill Side)	2
3	423200	425196	1996	8	14.5	Concentric	

Embankment Height

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

Pavement Design

105. 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.

106. 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.

107. 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	Khongkhangto Khudengthabi	10	40	75	250	200
20	Khudengthabi to Moreh	10	40	75	250	200

Junction Improvement

108. 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.

109. **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.

110. **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.

Road Furniture and Markings

111. 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.

Safety Features

112. 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)

Truck Terminal, Truck Lay bays and Rest Area

113. 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.

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

Bus Bays / Way side Bus Stops

115. 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.

116. 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.

117. 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

Toll Plaza

118. 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.

Retaining Wall

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

Roadside Drain and Footpath

120. 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.

121. 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.

Paver Blocks in Urban Area

122. **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.

123. **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.

124. **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.

Drainage Design Standards

125. 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”.

Recommendation for Bridges

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

127. **Major bridge.** There are no major bridges that would be covered in this road section of study.

128. **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 12.9 m concentrically.

129. 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.

130. 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.

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

132. **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

133. **Culverts.** Referring to the standards highlighted in the previous sections, improvement proposal for culverts are prepared. The improvement proposals for culverts are given in the

DPR and included in the BOQ. Total 146 culverts are proposed in the project road section. In addition, there is provision made in the BOQ for 23 culverts. These additional culverts will be constructed if found necessary. 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 (reconstruction as box culvert)

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

Item Description	Numbers
No. of Culverts	29
Retained	0
Reconstruction	29
Additional provision	23

Shifting of Utilities

134. 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.

Road Construction Materials

135. 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.

136. 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.

137. 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.

G. Project Cost and Implementation Schedule

138. The cost of civil works including maintenance amounts to US$ 77.68 million for package 3 of Imphal - Moreh NH section. The cost estimates were provided by MORTH and NHIDCL based on the detailed project reports prepared by the consultant. MORTH and NHIDCL will revise the estimates during the implementation of the investment program from time to time, as required, and in accordance with results of bidding, changes in market prices etc.

139. It is proposed to carry out construction of the subproject road section under one contract package (EPC model for works and goods) 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 2020. The project is expected to complete in first quarter of 2024.

140. 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

H. Project Benefits

141. 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

142. 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.

143. 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
BIODIVERSITY AND ECOLOGY				
9	Terrestrial Flora/Vegetation	Type of vegetation, trees and flora	Once (over 2 week period)	Literature review, field sampling, and consultations
10	Fauna and Wildlife	Wildlife and Species	Once (over 2 week period)	Literature review, field surveys, and consultations with wildlife/forest officials and experts
SOCIO-ECONOMIC				

S. No	Attribute	Parameter	No. of Samples	Source
11	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, SO_2, 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 ImaKondongLairembi (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)
7	Transect walks and consultations for vegetation and biodiversity surveys	6	Along the alignment within buffer zone of sanctuary.

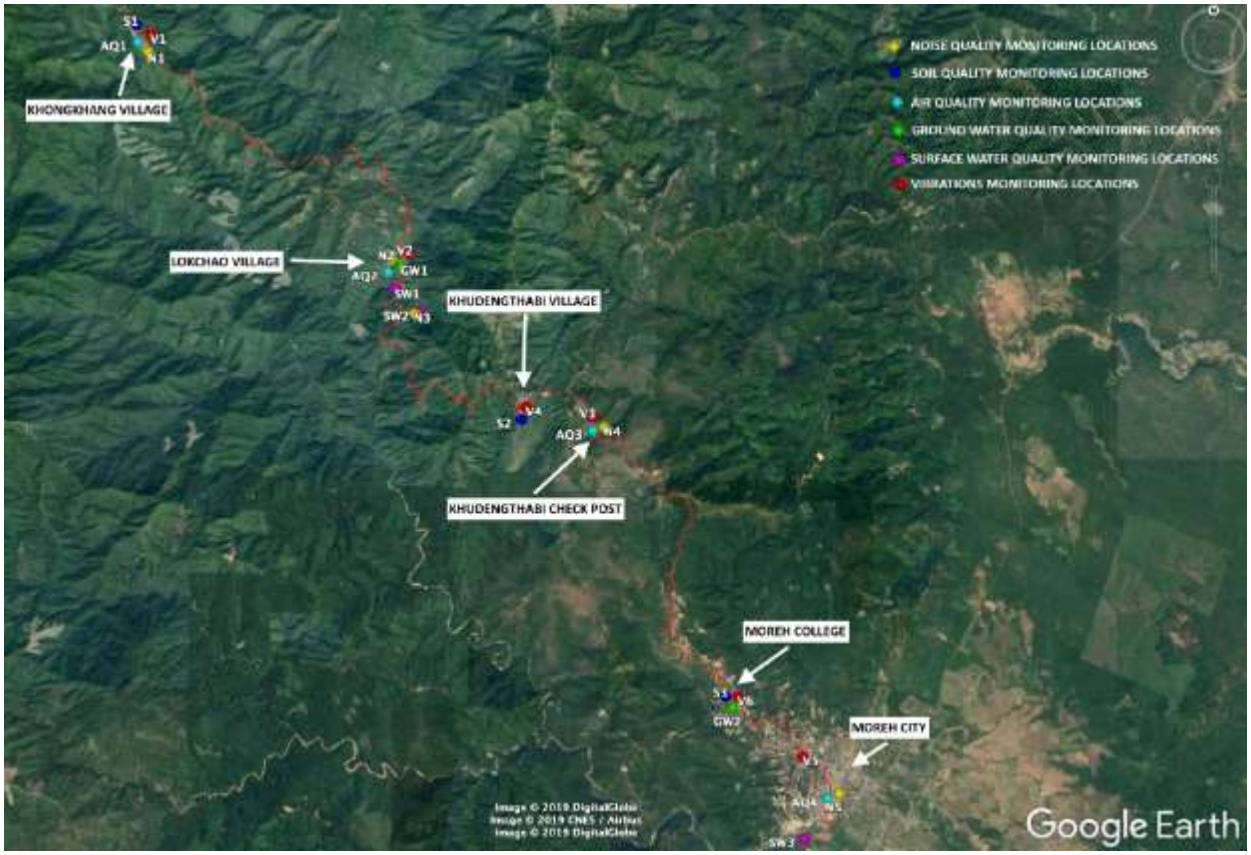
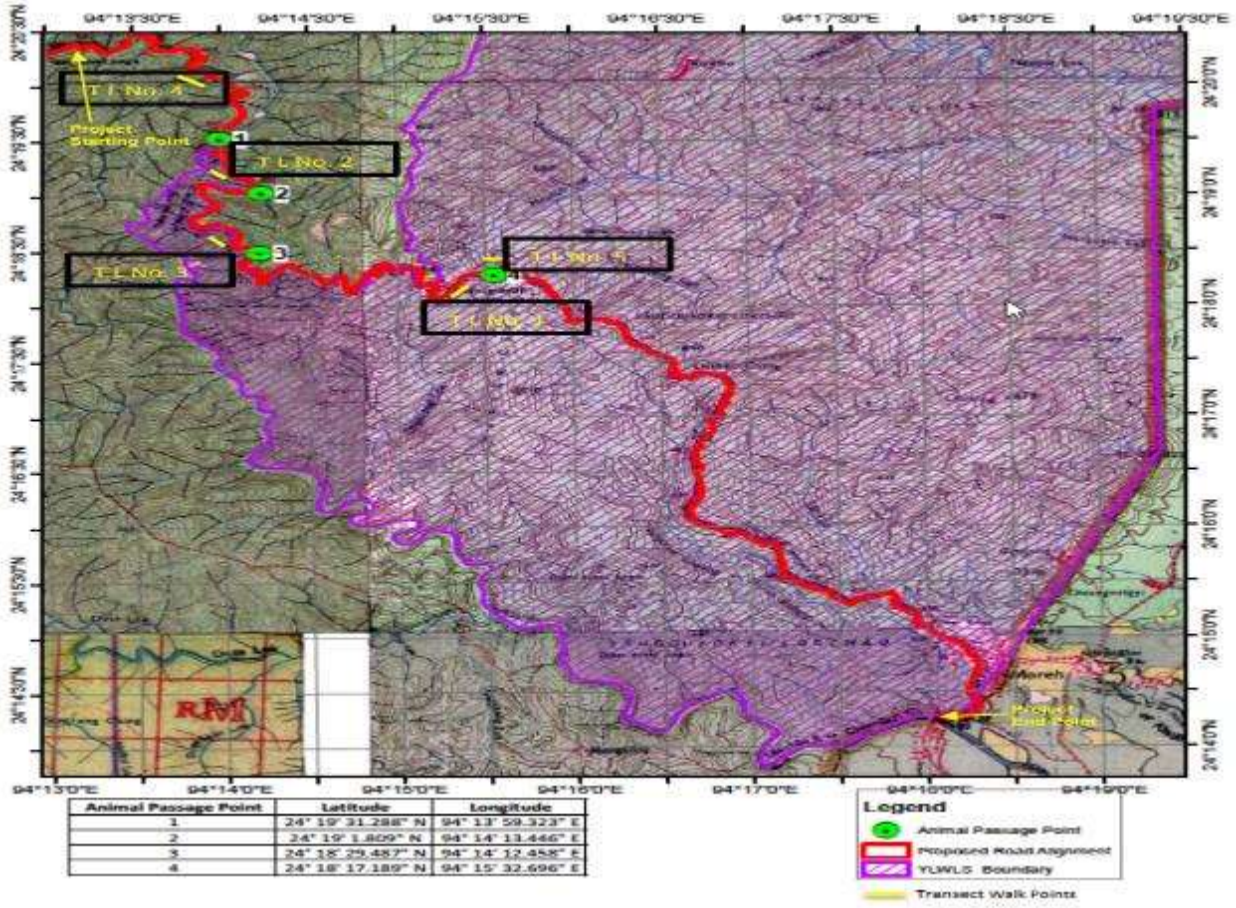


Figure 12 (a): Ambient Air and Noise, Vibration, Water and Soil Sampling Locations



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 12 (b): Transect Walk Locations for Biodiversity Assessment

B. Physical Environment

144. 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.

145. **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 lasts up to September. Intermittent rains continue even up to 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.

146. 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.

147. 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

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

149. The climatic conditions of the project area, Tengnoupal district is summarized in subsequent paragraphs.

150. **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.

151. **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.

152. The average rainfall in the state is around 1725 mm (Figure 12 (c)). 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 (c): Average Monthly Rainfall in Manipur

153. 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

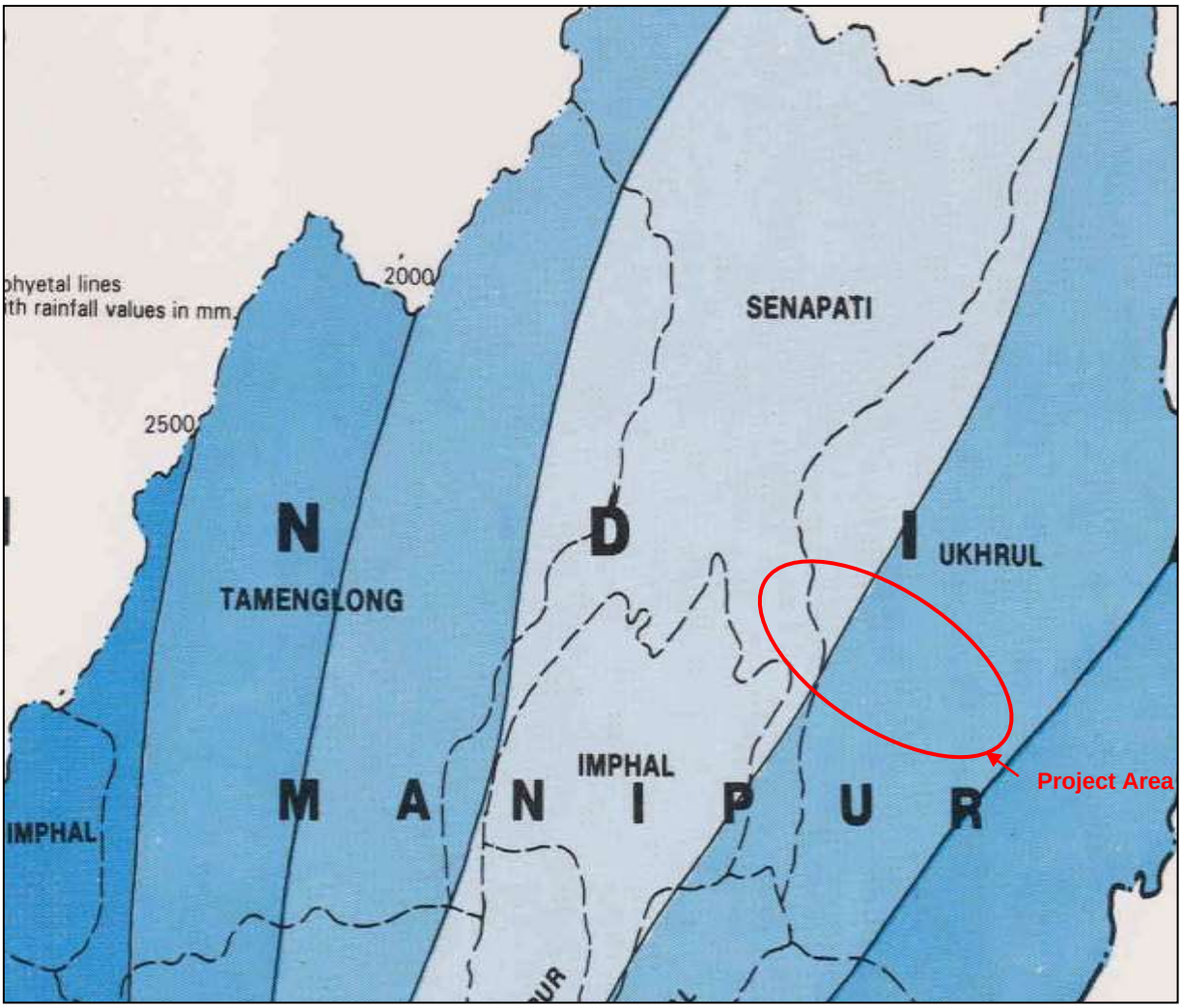


Figure 13: Average Annual Rainfall Map of Project Area

154. **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 up to October (24.0^{0}C), until the southwest monsoons have started to retreat. December (17.10^{0}C) and January (15.40^{0}C) are the coldest months. August temperature (25.00^{0}C) is the hottest in a year.

155. The average minimum temperature of the coldest month of January is 4.30^{0}C; and the average maximum temperature is 26.40^{0}C with the mean temperature 15.40^{0}C. 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 36.60^{0}C and minimum mean temperature is 4.20^{0}C with mean temperature of 20.40^{0}C.

156. 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).

157. 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

158. **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

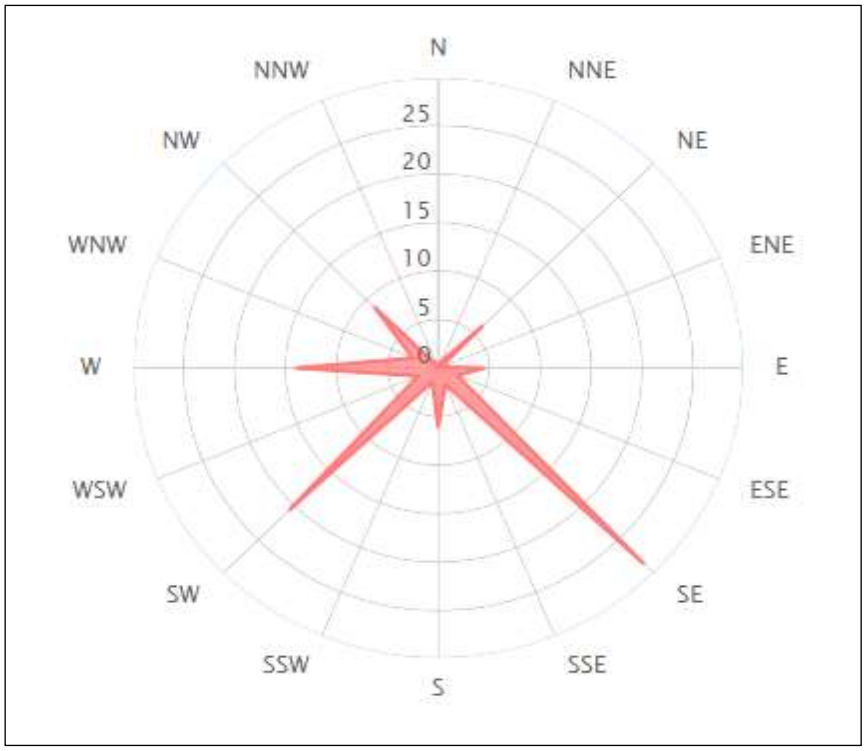


Figure 14: Annual Wind Direction and Distribution in (%) in Manipur

159. **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 center. 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.

160. 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.

161. 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 4: Typical Terrain along the Khongkhang-Moreh road Section

Image 3: Typical Terrain along the Road Section near Moreh

162. 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.

163. 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.

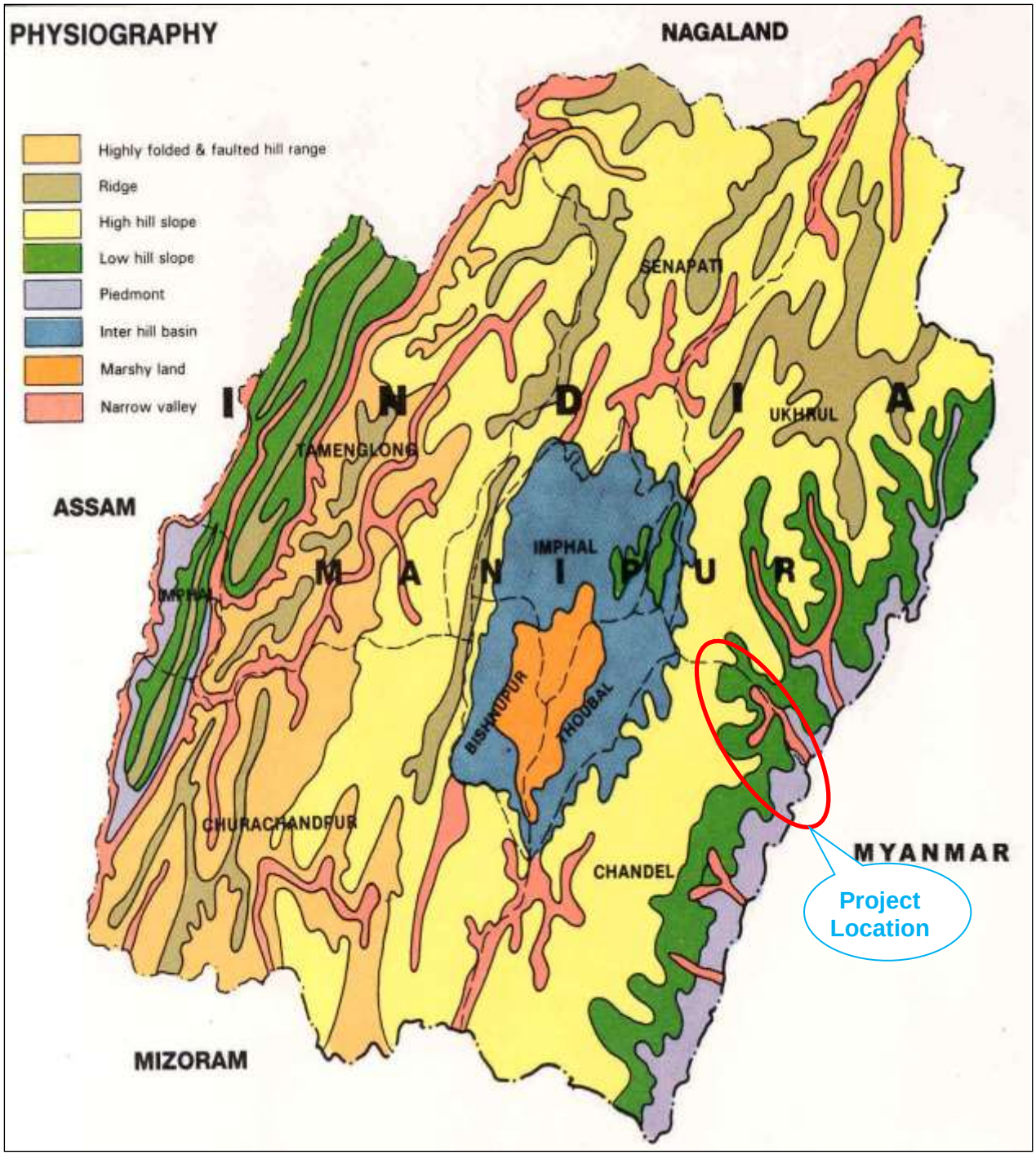


Figure 16: Physiological map showing in the Project Area

Source: Manipur Science & Technology Council (MASTEC), Imphal

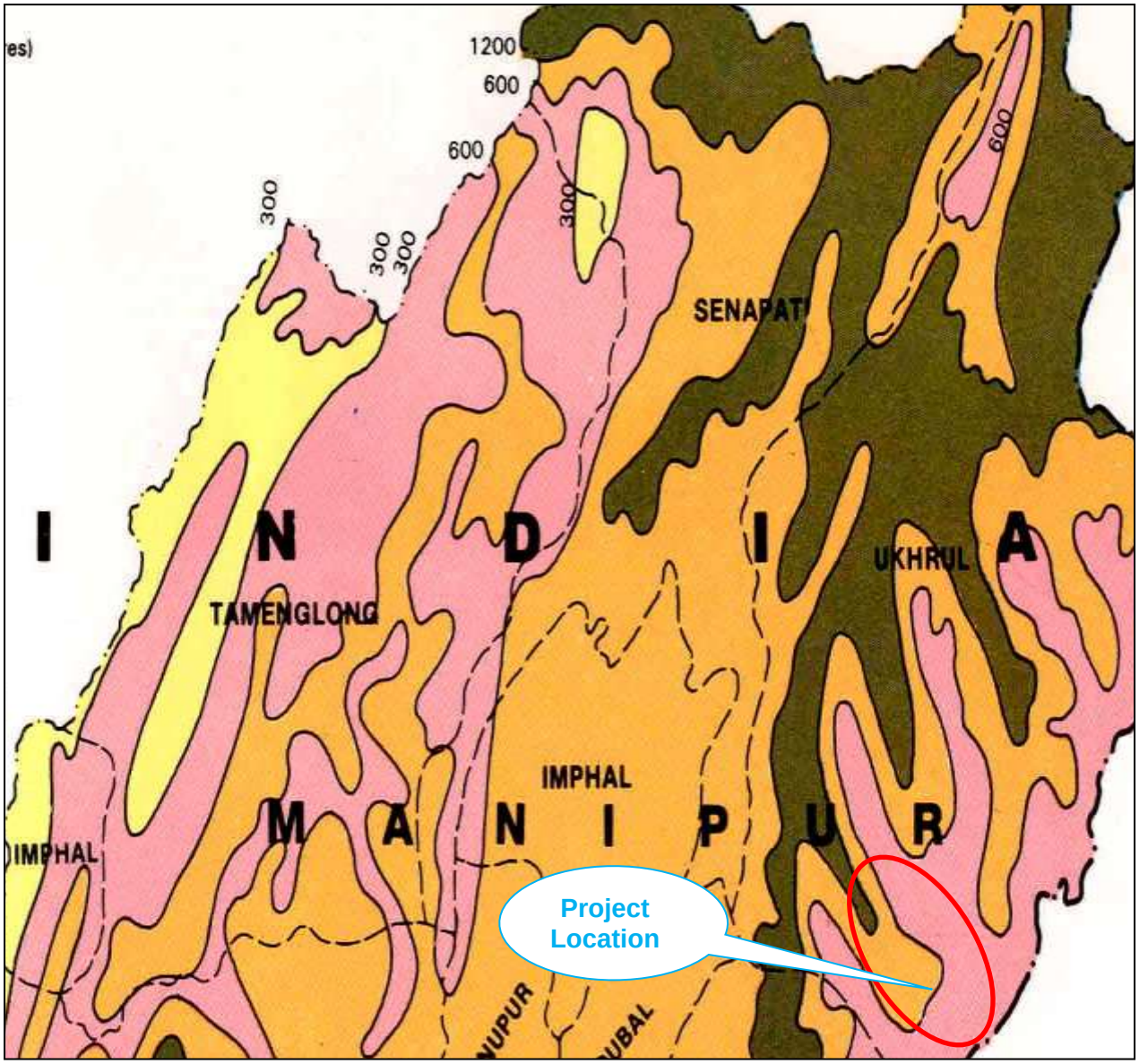


Figure 17: Altitudinal Zone Map of Manipur and Project Area

164. **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.

165. 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.

166. Detailed land use 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 arable land are the major land use followed by habitation and water bodies.

167. 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
Arable 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

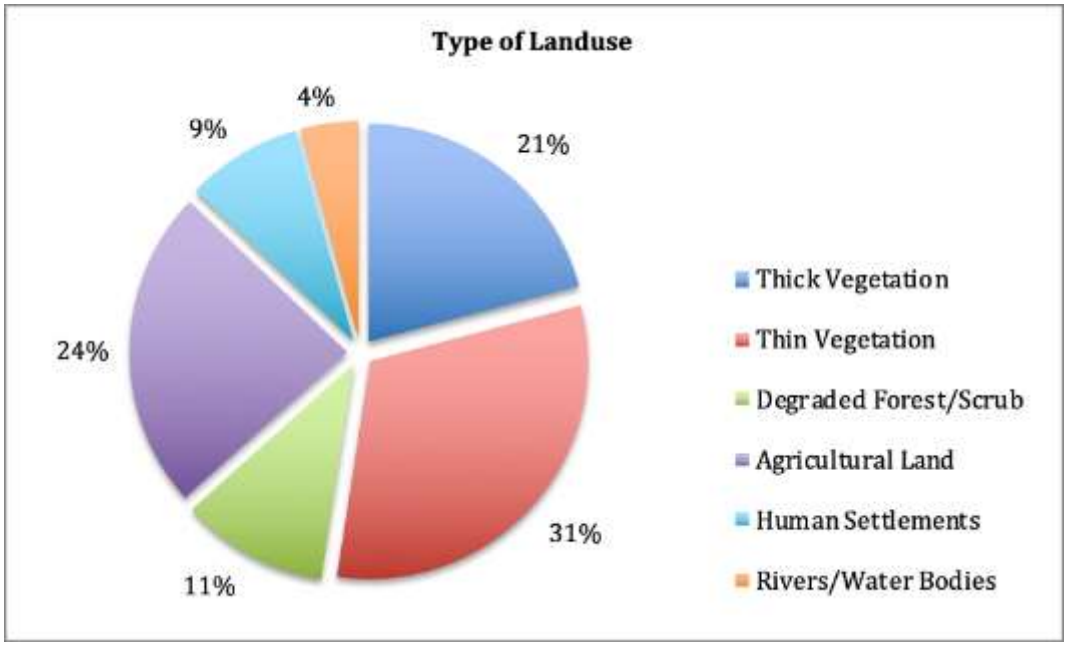


Figure 18: Land Use Distribution along the Project Road

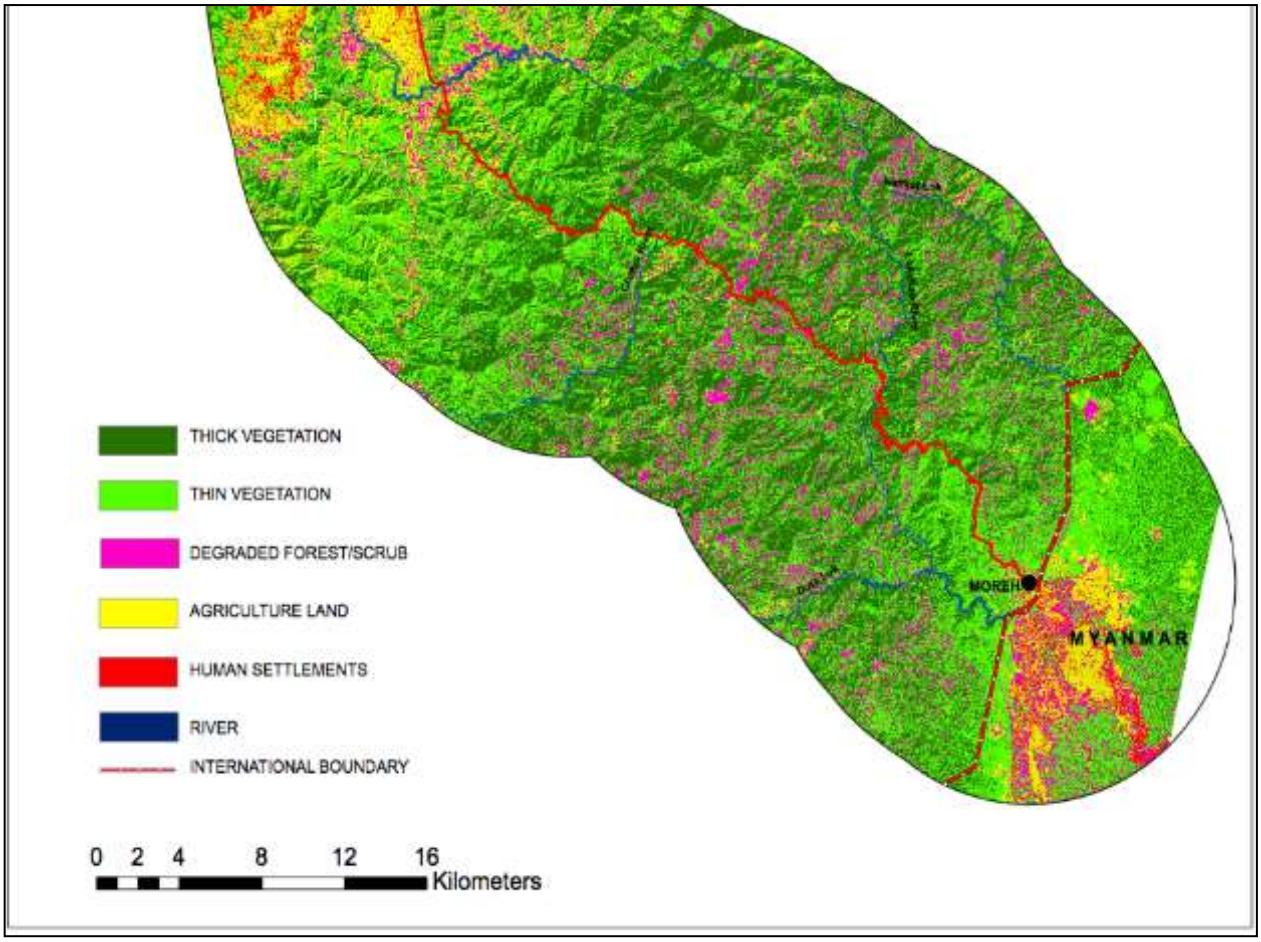


Figure 19: Land use Cover of the Project Area

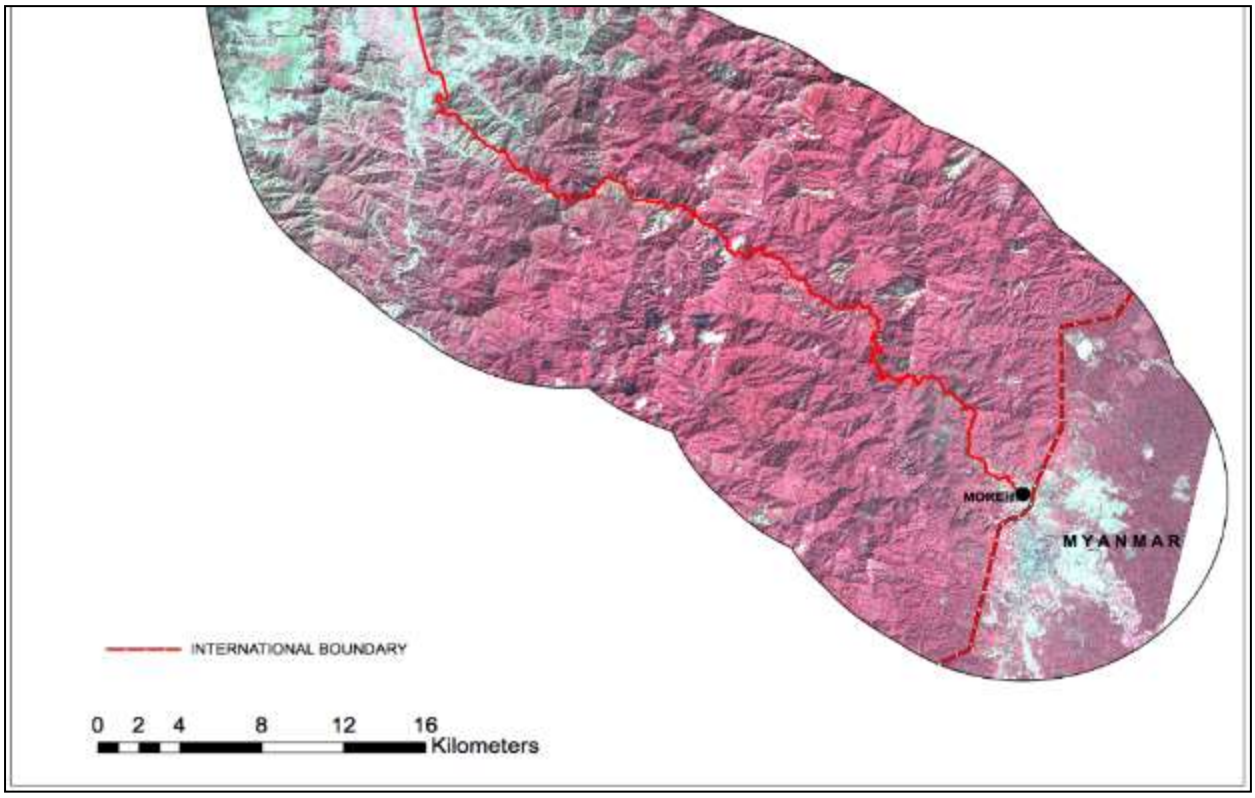


Figure 19a: FCC Scene Generated from Satellite Image for Subproject Area

168. **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.

169. 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.

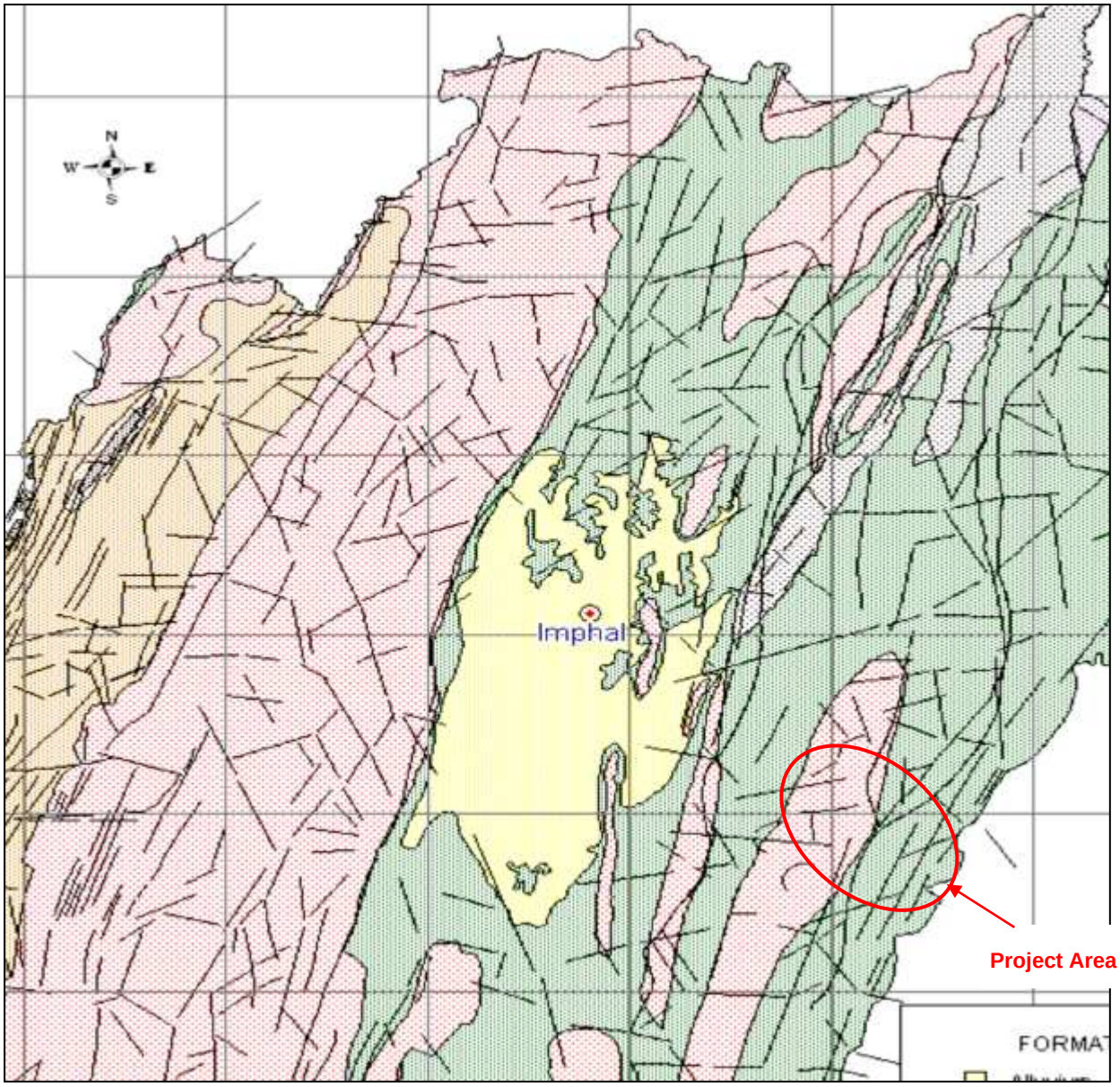


Figure 20: Geology and Stratigraphy of the Project area

Source: SOE Report, Government of Manipur

170. **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.

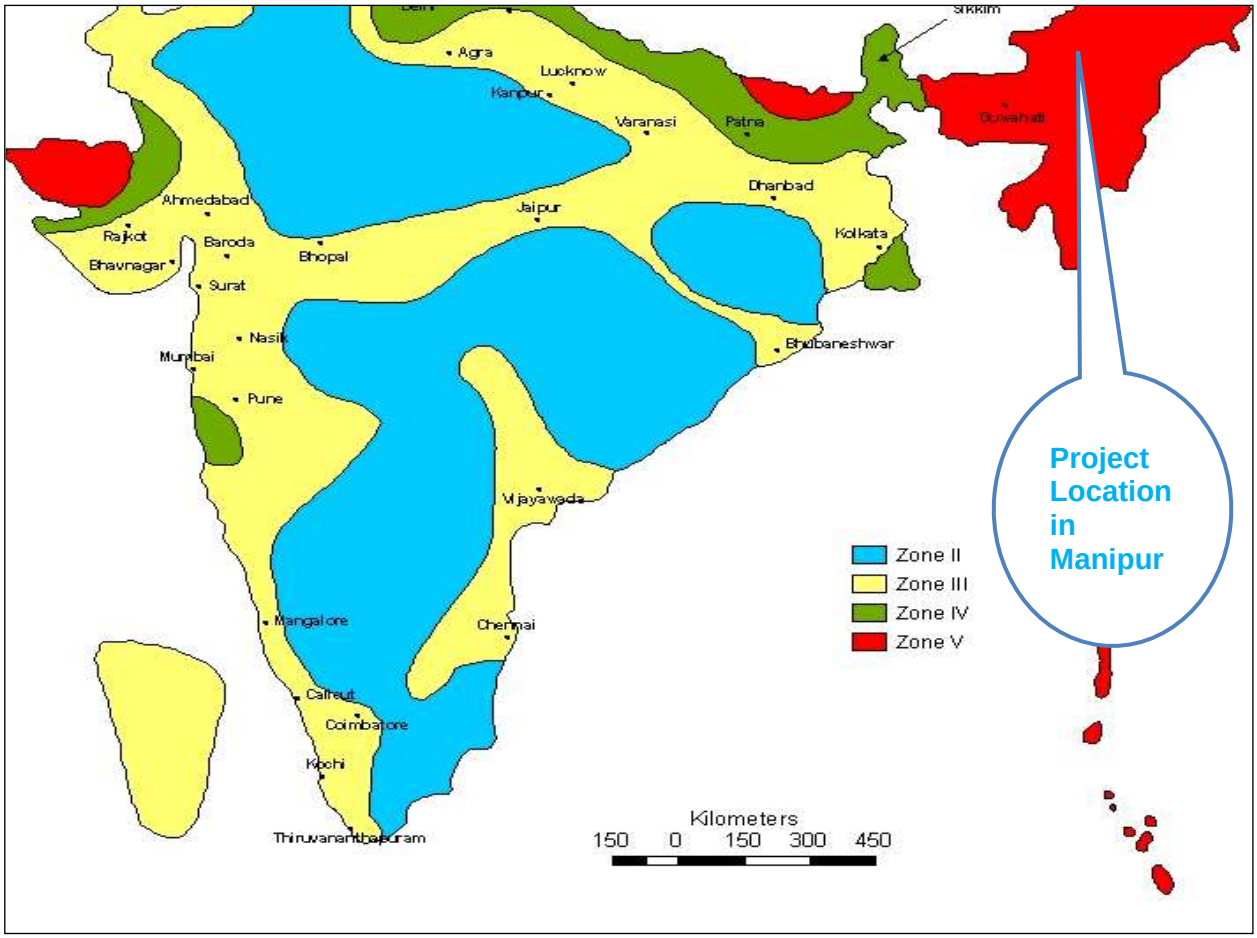


Figure 21: Seismic Zoning Map of India showing Project Location

Source: Envis, Government of Manipur

171. 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.

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

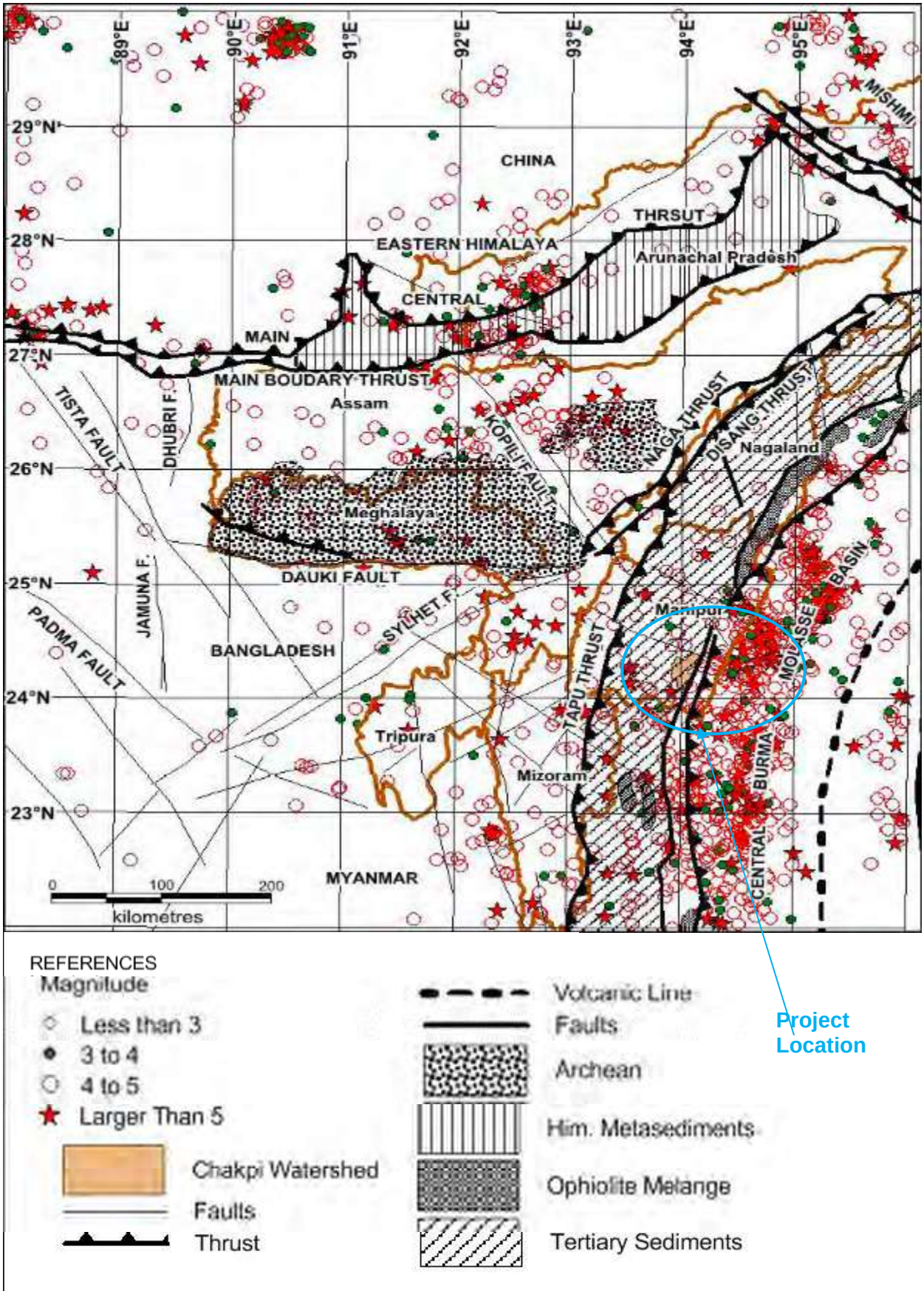


Figure 22: Seismotectonic Map of Manipur showing Project Location

Source: Manipur State Disaster Management Plan, Volume 1, Government of Manipur

173. **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.

174. 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.

175. The soil of Manipur belongs to 4 orders, 8 suborders, 13 great groups 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.

176. 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.

177. 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.

178. 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.

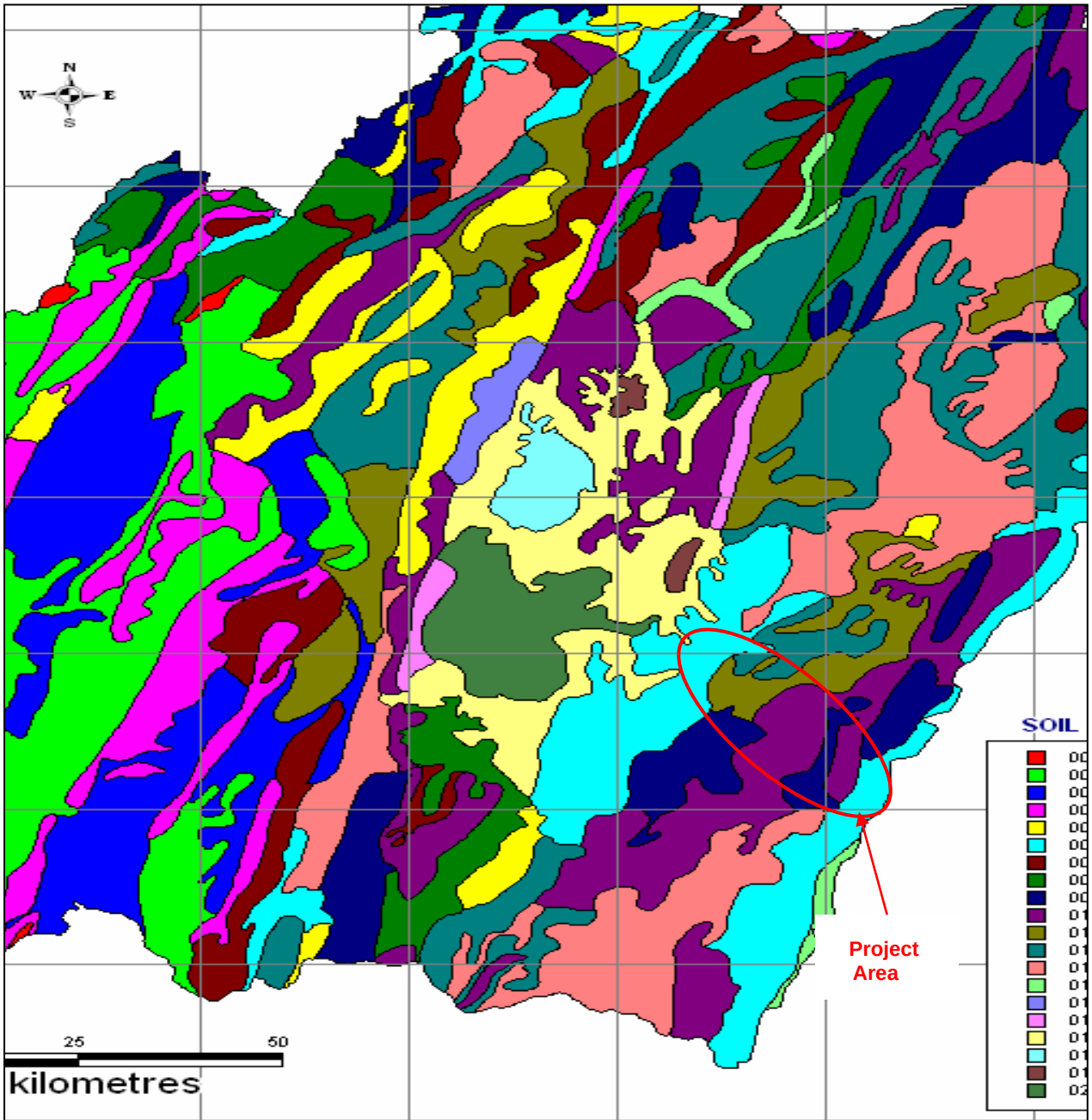
179. Chemical tests were carried out on soil at selected locations along the project road and the test results are given Table 34.

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	-	-	-	-

S. No.	Parameter(S)	Unit	Test Result		
			Khongkhang	Khudengthabi	Chikim (Moreh)
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
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

180. **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 5) 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 5: 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

181. 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.

182. 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.

183. 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.

184. **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).

185. 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 analyzed. Ground water (drinking water) samples were analyses as per IS: 10500-1991. Grab samples were collected from water source and were analyzed 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.

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

Image 6: Surface Water sample collection

187. 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 $CaCO_3$ 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 analyzed like chloride, sulphate, fluorides are found well within standards. Overall, the ground water quality in the project areas is 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

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
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
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

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
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

188. **Air Quality.** Ambient air quality in the state is quite pure compared to other neighboring states. Except for few urban centers 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.

189. 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.

Image 7: Air Quality Monitoring Station Setup at Khundhanthabi (AQ4)

190. 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.

191. 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.

192. 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

193. 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)

194. 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.

195. 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	1.00
2.	PM 10 and PM2.5	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.00
3.	Sulphur Dioxide	Improved West & Gaeke Method	Colorimeter	5.00
4.	Nitrogen Oxide	Jacob & Hochheiser modified (Na-Arsenite) Method	Colorimeter	5.00
5.	Carbon Monoxide	Gas Chromatograph		0.01

Sl. No.	Parameter	Technique	Instrument Used	Minimum Detectable Limit (µg/m^3)
6.	Hydrocarbons	Gas Chromatograph		0.01
7.	Lead	AAS Method after sampling using EPM 2000 filter paper	Atomic Absorption Spectrophotometer	0.01

196. 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 (µg/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
WBG Guideline Limits	50	25	40	20	-	-	-
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

197. It can be seen from the Table 39 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 but slightly higher than the World Bank EHS guideline limit of 50 µg/m^3. The highest value of PM10 is observed at Moreh (70.55µg/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 but slightly higher than the World Bank EHS guideline limit of 25 µg/m^3. Other parameters monitored i.e. NOx, SO_2 were found within the permissible limits for 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.

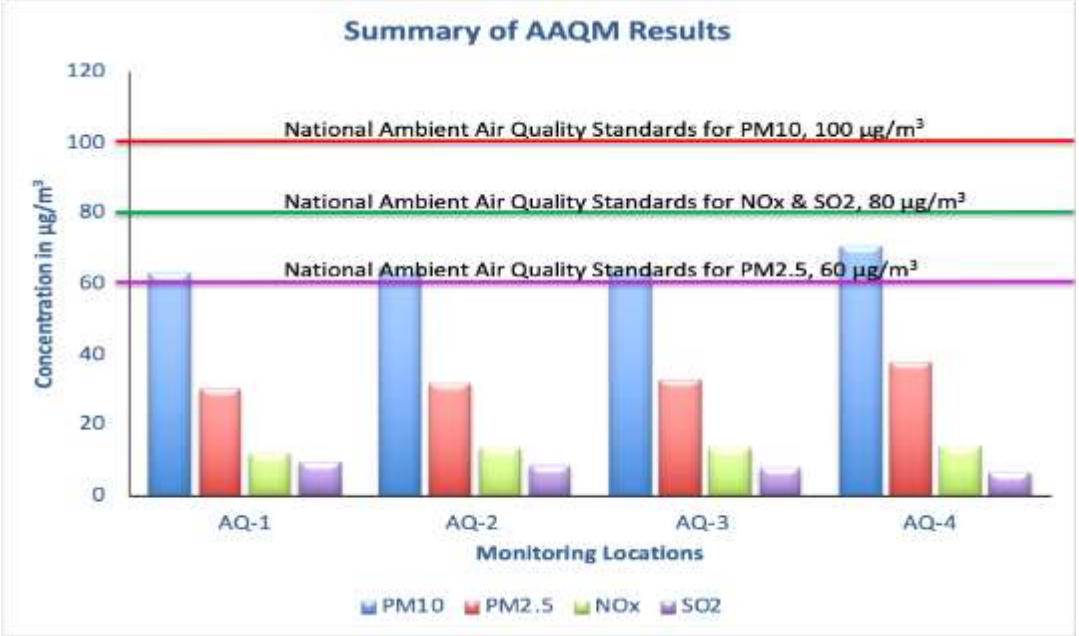


Figure 24: Air Pollutant Concentration in Ambient Air along the Project Area

198. **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.

199. 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.

200. 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

201. **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. The

monitoring was carried out only up to 10 pm as there is no traffic plying on this section of the project road during the night due to security reasons. No vehicles are allowed on this section of road after 6 PM by Indian security forces. Therefore, night-time monitoring may not be the true representative. However, considering no traffic, it is expected that noise levels will be within limits. 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.

202. **Presentation of Results:** Table 41 (and Figure 24 (a)) 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).

203. 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 up to 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

Figure 24 (a): Ambient Noise Levels along the Project Area

204. **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 42 (a) show the locations of the vibration monitoring.

Table 42 (a): 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"

205. **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 42 (b).

206. **Presentation of Results:** Table 42 (b) 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 42 (b): Vibration Levels (ppv) 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

207. **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.

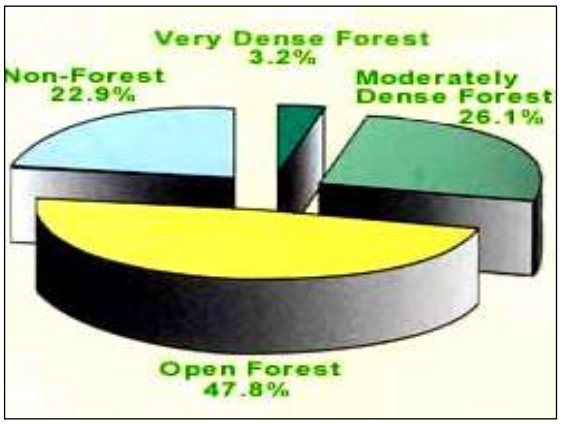


Figure 25: Distribution of Forests in the State

208. 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. Figure 25 show the distribution of forest area of Manipur. Table 43 and Figure 26 shows area under legal type of forest in the state of Manipur.

Table 43: 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[10]	4,171	24.00
3	Other Forest	11,780	67.60
4	Total	17,418	100.00

Source: State of Forest report, 2013

[10] A reserved forest and protected forest in India are terms denoting forests accorded a certain degree of protection. The main difference between these two categories of forests is that; in reserved forests the activities like grazing, hunting etc. are generally banned unless permission is granted for a particular reason. But in case of protected forests, mostly all these activities are allowed unless banned specifically.

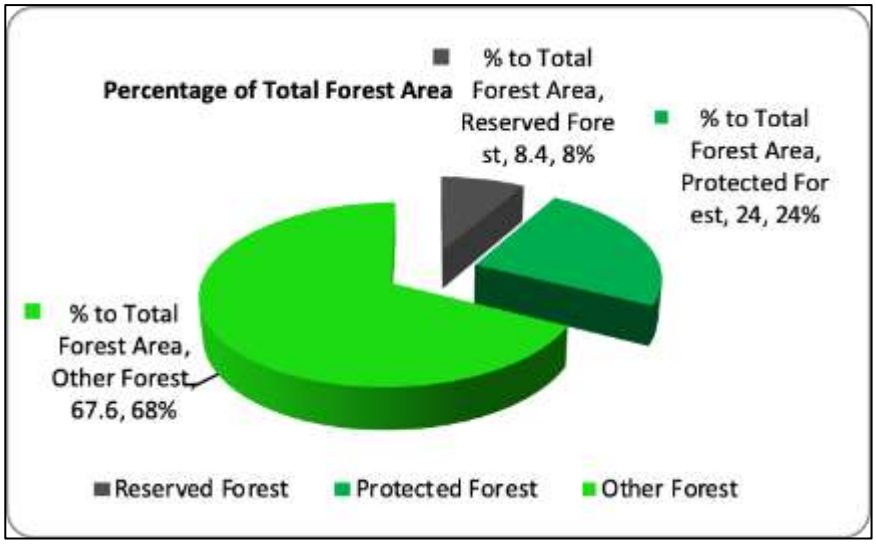


Figure 26: Recorded Forest Land of State
Source: Forest Department, Manipur, Annual Administrative Report, 2013-14

209. 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.

210. In Manipur, they are abounding 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.

211. The major species of vegetation available in the state include Teak, Uninthou, Khasi-pine, Dipterecarpes species, Michelia, Champa, Terminalia, species, CedrelaToona, SchimaWallichii etc.

212. 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 up to 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 44.

Table 44: 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, Schimawallichi, Gmelina arborea, Podocarpusnerifolium, Dillenia spp.*	300–900	2B/C2	Tropical Semi-evergreen forests
2.	*Tectonagrandis, Dipterocarpus turbinatus, Melanorrhoeausitata,*	300–900		Moist deciduous forests

Sl. No.	Characteristic species	Altitude Range (m)	Classification code	Forest Types adapted from Champion and Seth (1968)
	Dillenia, Xylia, Lagerstroemia, Terminalia, Gmelina, Bombax spp			
3.	*Quercus-Magnolia-Acer and conifers association*	1700-2700	11B/C1	East Himalayan Wet temperate forests
4.	*Prunus, Pyrus, Ligustrum, Taxus, Bucklandiapopulnea, Acer campbelli, Magnolia campbelli, Castanopsistribuloides*	Above 2700	-	Sub-Alpine Forests
5.	*Sub-climax state of grassland due to heavy biotic*	-	-	Grassy blanks
6.	*Bambusamanipureana and Dendrocalamusmanipureanus*	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

213. Vegetation along the project road section from Khongkhang to Moreh, are mostly covered by the thick 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.

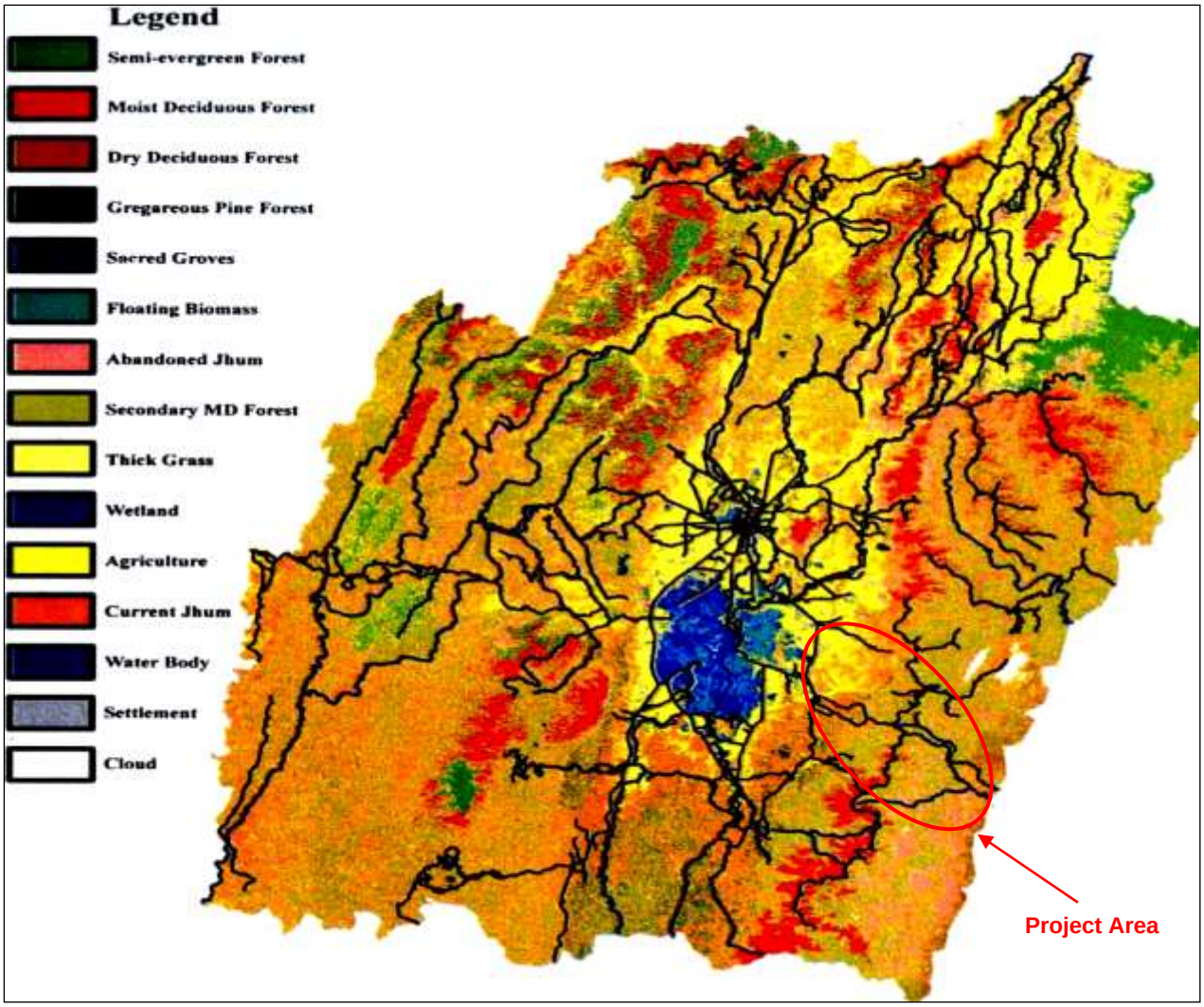


Figure 27: Vegetation Map of Manipur State

Source: MRSAC, Imphal

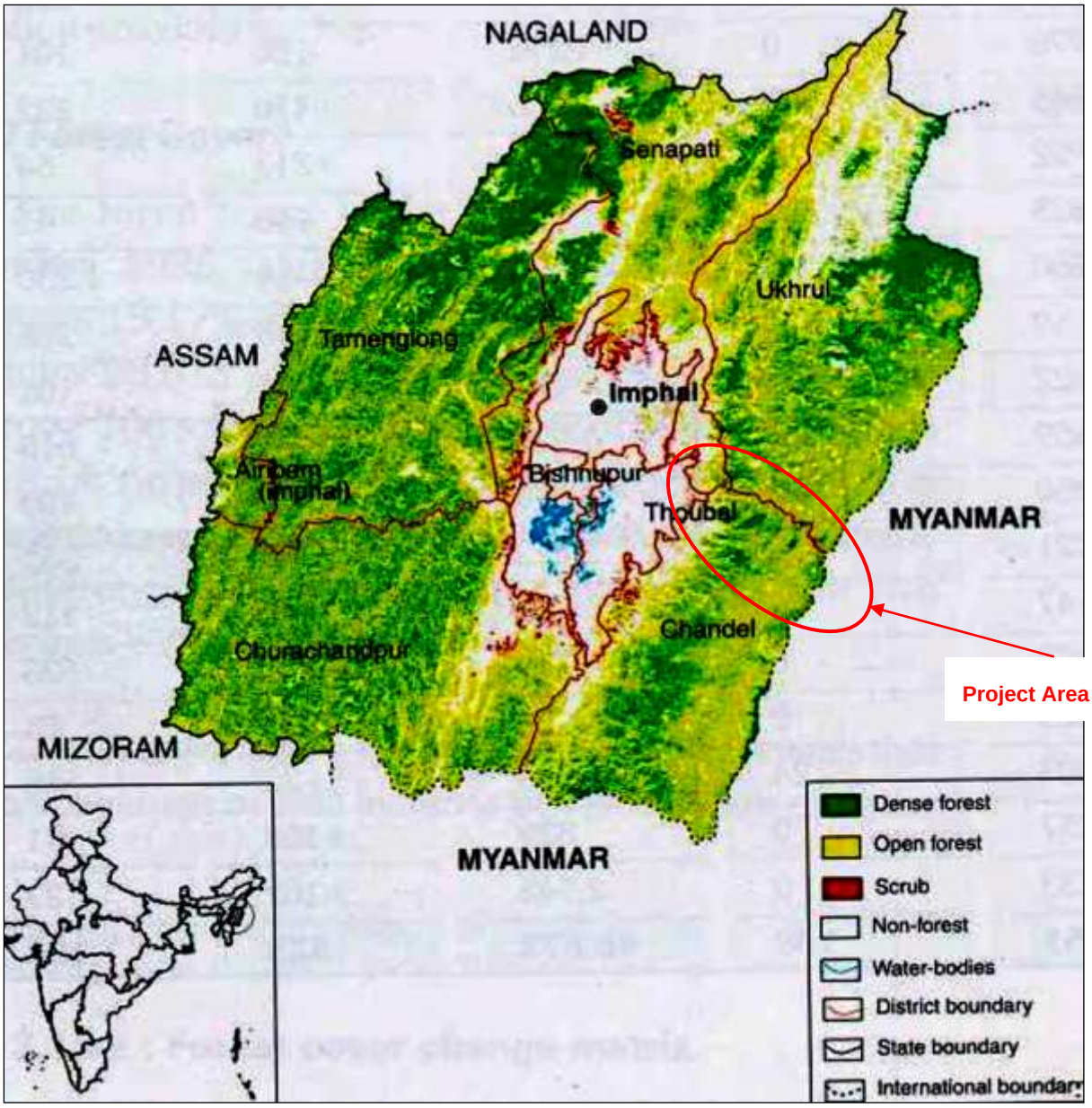


Figure 28: Forest Map of Manipur State

Source: State of Environment Report, Manipur

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

215. 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 Lokchao River Bridge to Khudenthabi village (chainage 404.130 to Chainage 413.23, length 9.100 km) alignment transverses along the border of Core Zone I and Tourism Zone. After Khudenthabi village up to 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 45.

Table 45: 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

216. 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 46 show details of the trees to be cut.

Table 46: 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[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, LairikHeibi, KongongThopki, 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

217. The project will require diversion of 48.29 ha. forest land (about 2 m strip along the road) for widening of the road. This includes 14.19 ha from eco-sensitive zone and 34.10 ha from buffer zone of sanctuary. Based on site visit findings and literature review some of the project area comprises degraded forests but areas to be cleared are overall broadly Natural Habitat (i.e., '*human activity has not essentially modified the area's primary ecological functions*': ADB 2009). Meetei *et al.* (2017) found high quality dense forest in Manipur to hold approximately 700-900 trees of ≥30 cm girth per hectare. These densities are at the high end of those found in other parts of India, and current densities in areas bordering the Project road are likely to be considerably lower owing to degradation and (in the east) some areas of naturally more open forest. On a precautionary basis, it is assumed that areas of natural vegetation to be cleared may hold 100 trees/hectare and be of around 50% of natural quality. As such, clearance of 2,013 trees equates to clearance of just over 20 ha of such degraded forest. Overall, including areas within the existing right of way, the Project is thus anticipated to clear 26 ha of natural vegetation.

218. **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

[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.

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 summarized herewith.

219. The main objectives of the vegetation study were 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 sloped 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. 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.

Image 8: Measuring DBH of tree on existing Khongkhang –Moreh road

Image 9: Inventory of tree in the corridor of impact along existing Khongkhang –Moreh road

Image 10: Floral species identification and data recording with forest officer along the road alignment

220. 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.

221. **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 47 present the floral species found in the project area (mostly in protected area of YLWLS) with their family and its IUCN status.

Table 47: Floral Species Recorded in the Project Area

Botanical Name	English Name (Common Name)	Family	IUCN Status
Pinus kesiya		Pinaceae	LC
Gnetum montanum		Gnetaceae	LC
Machilus macranthus		Lauraceae	NA
Fragaria daltoniana		Rosaceae	NA
Potentilla griffithii		Rosaceae	NA
Rosa multiflora		Rosaceae	NA
Rubus calycinus		Rosaceae	NA
Rubus pedunculosus		Rosaceae	NA
Dichapetalum gelonioides		Dichapetalaceae	LC
Bauhinia variegate		Caesalpiniaceae	LC
Cassia fistula		Caesalpiniaceae	LC
Clematis leschenaultiana		Caesalpiniaceae	NA
Chamaecrista mimosoides		Caesalpiniaceae	NA
Senna sophera		Caesalpiniaceae	NA
Acacia pluricapitata		Fabaceae	LC
Albizia myriophylla		Fabaceae	NA
Phanera glabrifolia		Fabaceae	NA
Calliandra guildingii		Fabaceae	LC
Mimosa pudica		Fabaceae	LC
Meizotropis pellita		Fabaceae	NA
Crotalaria juncea		Fabaceae	NA
Crotalaria pallida		Fabaceae	NA
Crotalaria sessiliflora		Fabaceae	NA
Dalbergia sissoo		Fabaceae	NA
Desmodium confertum		Fabaceae	NA
Desmodium laxiflorum		Fabaceae	NA
Desmodium microphyllum		Fabaceae	LC
Desmodium sequax		Fabaceae	NA
Desmodium triquetrum		Fabaceae	NA
Indigofera atropurpurea		Fabaceae	NA
Indigofera cassioides		Fabaceae	NA
Indigofera wightii		Fabaceae	NA
Smithia sensitiva		Fabaceae	LC
Spatholobus parviflorus		Fabaceae	NA
Dipterocarpus turbinatus		Dipterocarpaceae	VU
Dillenia pentagyna		Dilleniaceae	NA
Juglans regia		Juglandaceae	LC
Cannabis sativa		Cannabaceae	NA
Ficus benghalensis		Moraceae	NA
Ficus elastica		Moraceae	NA
Ficus geniculate		Moraceae	NA
Ficus racemosa		Moraceae	LC
Ficus religiosa		Moraceae	NA
Ficus semicordata		Moraceae	LC
Ficus squamosa		Moraceae	NA
Morus australis		Moraceae	NA
Strobilanthes zeylanicus		Moraceae	NA
Dipocyclos palmatus		Cucurbitaceae	NA
Epiphyllum phyllanthus	Climbing Cactus	Cactaceae	LC
Boehmeria platyphylla		Urticaceae	NA
Broussonetia papyrifera	Paper Mulberry	Moraceae	LC
Poikilospermum suaveolens		Urticaceae	NA

Botanical Name	English Name (Common Name)	Family	IUCN Status
Bixa orellana		Bixaceae	LC
Capparis multiflora		Capparaceae	NA
Crateva religiosa		Capparaceae	LC
Begonia roxburghii		Begoniaceae	NA
Hibiscus cannabinus		Malvaceae	NA
Hibiscus surattensis		Malvaceae	NA
Microcos paniculata		Malvaceae	LC
Triumfetta pilosa		Malvaceae	NA
Byttneria pilosa		Malvaceae	NA
Sterculia hamiltonii		Malvaceae	NA
Bombax ceiba		Malvaceae	NA
Bombax insigne var. polystemon		Malvaceae	CR
Actephila excelsa		Phyllanthaceae	NA
Baliospermum calycinum		Euphorbiaceae	LC
Breynia retusa		Phyllanthaceae	LC
Bridelia glauca		Phyllanthaceae	NA
Croton persimilis		Euphorbiaceae	NA
Euphorbia hypericifolia		Euphorbiaceae	NA
Homonoia riparia	Willow-Leaved Water Croton	Euphorbiaceae	LC
Phyllanthus emblica		Phyllanthaceae	NA
Phyllanthus virgatus		Phyllanthaceae	NA
Ricinus communis		Euphorbiaceae	NA
Flueggea virosa		Phyllanthaceae	LC
Garcinia cowa		Clusiaceae	NA
Combretum albidum		Combretaceae	NA
Vaccinium griffithianum		Ericaceae	NA
Callistemon linearis		Myrtaceae	NA
Osbeckia nutans		Melastomaceae	NA
Sonerila stricta		Melastomaceae	NA
Duabanga grandiflora		Lythraceae	LC
Celastrus stylosus		Calastraceae	NA
Rhamnus nepalensis		Rhamnaceae	NA
Cissus javanica		Vitaceae	NA
Tetrastigma bracteolatum		Vitaceae	NA
Vitis vinifera	Wild Grape	Vitaceae	LC
Leea asiatica		Vitaceae	NA
Boenninghausenia albiflora		Rutaceae	NA
Citrus maxima	Pomelo	Rutaceae	LC
Citrus medica	Heizang	Nimbu, Kagzi Nimbu	NA
Paramignya armata		Rutaceae	NA
Zanthoxylum acanthopodium		Rutaceae	LC
Zanthoxylum armatum		Rutaceae	LC
Rhus chinensis		Anacardiaceae	LC
Spondias pinnata		Anacardiaceae	NA
Catharanthus roseus		Apocynaceae	NA
Nerium oleander	Kaner	Apocynaceae	LC
Cascabela thevetia		Apocynaceae	LC
Calotropis gigantea		Apocynaceae	NA
Argostemma sarmentosum		Rubiaceae	NA
Coffea Arabica		Rubiaceae	EN
Gardenia jasminoides		Rubiaceae	NA
Leptopetalum biflorum		Rubiaceae	NA
Exallage ulmifolia		Rubiaceae	NA
Meyna spinosa		Rubiaceae	NA
Mussaenda incana		Rubiaceae	NA

Botanical Name	English Name (Common Name)	Family	IUCN Status
Ophiorrhiza pectinata		Rubiaceae	NA
Pavetta subcapitata		Rubiaceae	NA
Wendlandia glabrata		Rubiaceae	NA
Holmskioldia sanguinea		Lamiaceae	NA
Lantana camara		Verbenaceae	NA
Premna coriacea		Lamiaceae	NA
Premna herbaceae		Lamiaceae	NA
Stachytarpheta jamaicensis		Verbenaceae	NA
Tectona grandis		Lamiaceae	NA
Clematis javana		Ranunculaceae	NA
Stephania japonica		Menispermaceae	NA
Papaver bracteatum		Papaveraceae	NA
Capsella bursa pastoris	Shepherd's purse	Brassicaceae	LC
Cardamine hirsute		Brassicaceae	NA
Rorippa indica		Brassicaceae	NA
Myosoton aquaticum		Caryophyllaceae	NA
Fagopyrum esculentum		Polygonaceae	NA
Muehlenbeckia platyclados		Polygonaceae	NA
Persicaria capitata		Polygonaceae	NA
Persicaria chinensis		Polygonaceae	NA
Persicaria orientalis		Polygonaceae	NA
Polygonum rottboellioides		Polygonaceae	NA
Rumex nepalensis		Polygonaceae	NA
Chenopodium album		Amaranthaceae	NA
Altenanthera sessilis	Sessile Joyweed	Amaranthaceae	LC
Amaranthus viridis		Amaranthaceae	NA
Celosia argentea		Amaranthaceae	NA
Celosia polygonoides		Amaranthaceae	NA
Cyathula capitata		Amaranthaceae	NA
Gomphrena globosa		Amaranthaceae	NA
Ludwigia adscendens		Onagraceae	NA
Plantago asiatica		Plantaginaceae	NA
Eryngium foetidum		Apiaceae	NA
Hydrocotyle himalaica		Apiaceae	NA
Hydrocotyle sibthorpioides		Apiaceae	LC
Peucedanum dhana		Apiaceae	NA
Ageratum conyzoides		Asteraceae	LC
Ambrosia artemsifolia		Asteraceae	NA
Artemisia indica		Asteraceae	NA
Bidens pilosa		Asteraceae	NA
Blumea aromatica		Asteraceae	NA
Blumea balsamifera		Asteraceae	LC
Blepharis maderaspatensis		Acanthaceae	NA
Eranthemum pulchellum		Acanthaceae	NA
Gymnostachyum glabrum		Acanthaceae	NA
Justicia diffusa		Acanthaceae	NA
Nelsonia canescens		Acanthaceae	LC
Thunbergia alata		Acanthaceae	NA
Tunbergia grandiflora		Acanthaceae	NA
Impatiens balsamina		Balsaminaceae	NA
Impatiens tomentosa		Balsaminaceae	NA
Heliotropium indicum		Heliotropiaceae	NA
Ehretia lycioides		Ehretiaceae	NA
Clinopodium umbrosum		Lamiaceae	NA
Pogostemon cruciatus		Lamiaceae	NA

Botanical Name	English Name (Common Name)	Family	IUCN Status
Gomphostemma niveum		Lamiaceae	NA
Gomphostemma strobilinum		Lamiaceae	NA
Leonurus japonicas		Lamiaceae	NA
Nepeta ciliaris		Lamiaceae	NA
Isodon rugosus		Lamiaceae	NA
Salvia plebeia		Lamiaceae	NA
Salvia saxicola		Lamiaceae	NA
Scutellaria assamica		Lamiaceae	NA
Scutellaria barbata		Lamiaceae	NA
Cyanotis vaga		Commelinaceae	NA
Hedychium marginatum		Zingiberaceae	NA
Hedychium coronarium		Zingiberaceae	NA
Hedychium thyrsiforme		Zingiberaceae	NA
Zingber officinale	Ginger	Zingiberaceae	NA
Alpinia calcarata		Zingiberaceae	NA
Alpinia nigra		Zingiberaceae	LC
Curcuma angustifolia		Zingiberaceae	NA
Curcuma caesia		Zingiberaceae	NA
Blumea fistulosa		Asteraceae	NA
Blumea hieraciifolia		Asteraceae	NA
Lactuca virosa		Asteraceae	LC
Carthamus tinctorius		Asteraceae	NA
Centipeda minima		Asteraceae	LC
Chrysanthemum indicum		Asteraceae	NA
Conyza angustifolia		Asteraceae	NA
Eschenbachia leucantha		Asteraceae	NA
Cyathocline purpurea		Asteraceae	LC
Dichrocephala integrifolia		Asteraceae	NA
Emilia scabra		Asteraceae	NA
Ageratina adenophora		Asteraceae	NA
Ageratina altissima		Asteraceae	NA
Galinsoga parviflora		Asteraceae	NA
Inula grandiflora		Asteraceae	NA
Duhaldea eupatorioides		Asteraceae	NA
Lactuca sativa		Asteraceae	NA
Laggera alata		Asteraceae	NA
Sclerocarpus africanus		Asteraceae	NA
Senecio scandens		Asteraceae	LC
Sigesbeckia orientalis		Asteraceae	NA
Sonchus oleraceus		Asteraceae	NA
Synedrella nodiflora		Asteraceae	NA
Tagetes erecta		Asteraceae	NA
Acilepis aspera		Asteraceae	NA
Cyanthillium cinereum		Asteraceae	NA
Zinnia elegans		Asteraceae	NA
Nicotiana tabacum		Solanaceae	NA
Physalis minima		Solanaceae	NA
Solanum nigrum		Solanaceae	NA
Stemodia viscosa		Plantaginaceae	NA
Acanthus leucostachys		Acanthaceae	NA
Curcuma longa	Turmeric	Zingiberaceae	NA
Curcuma reclinate		Zingiberaceae	NA
Canna indica		Cannaceae	NA
Dianelia ensiolia		Asphodelaceae	NA
Streptopus simplex		Liliaceae	NA
Smilax roxburghiana		Smilacaceae	NA

Botanical Name	English Name (Common Name)	Family	IUCN Status
Colocasia esculenta	Wild Taro	Araceae	LC
Lasia spinosa		Araceae	LC
Pothos chinensis		Araceae	NA
Dioscorea melanophyma		Dioscoreaceae	NA
Areca catechu		Arecaceae	NA
Caryota urens	Fishtail Palm	Arecaceae	LC
Phoenix sylvestris		Arecaceae	NA
Pandanus furcatus		Pandanaceae	NA
Dendrobium chrysotoxum		Orchidaceae	NA
Dendrobium densiflorum		Orchidaceae	NA
Peristylus prainii		Orchidaceae	NA
Habenaria suaveolens		Orchidaceae	NA
Carex indica		Cyperaceae	NA
Cyperus diffusus		Cyperaceae	LC
Fimbristylis dichotoma		Cyperaceae	NA
Bambusa balcooa		Poaceae	NA
Bambusa burmanica		Poaceae	NA
Cynodon dactylon		Poaceae	NA
Melocalamus compactiflorus		Poaceae	NA
Pogonatherum crinitum		Poaceae	NA
Thysanolaena maxima		Poaceae	NA
NA: Not Assessed, DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR:Critically Endangered, EW: Extinct in the Wild, EX: Extinct			

222. 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.

223. ***Teak Forest:*** The foothills bordering the International Boundary is covered with teak. The associates are Terminalliachebula, Melanorrhoeausitata, Oroxylumindicum, etc.

224. ***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 Strychnosnux-vomica, Melanorrhoeausitata, Emblica officinalis, Cedrella serrata, etc.

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

226. ***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 Sacchurummunja, Cymbopogon spp., Mikania, Ageratum, etc.

227. **Endangered and Protected Flora.** Some of the important rare and endangered floral species in the protected areas[12] along the project road are *Tectonagrandis, Dipterocarpus turbinatus, Dipterocarpus tuberculaus, Melonarrhoeausitata, DuabangaSonnoroedes,*

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

Dilleniapentagyna, Terminalliatomentosa, Gmelina arborea, Bauhinia spps., some species of bamboos, orchids, etc.

228. 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.

229. 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.

D. Wildlife and Protected Area Network

230. The State has rich wildlife and has a large 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.

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

232. **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.

233. **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.

234. The details of sites are given in Table 48. 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 48: 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

235. Besides government published data, Integrated Biodiversity Assessment Tool (IBAT) has been used to screen and identify the key biodiversity areas in the project region. Following table present the details of protected areas and key biodiversity areas (KBAs) within 50 km buffer of the project road.

Table 48 (a): Protected Areas and KBAs as per IBAT Screening

Sl.	Protected Area /KAB	Distance	Remark
A.	**Protected areas**		
1	Keibul Lamjao National Park	50 km	Access for critical habitat
2	Loktak Lake	50 km	Access to biodiversity risk
3	Yangoupokpi Lokchao Wildlife Sanctuary	10 km	Access to biodiversity risk
B.	**Key Biodiversity Areas**		
4	Yangoupokpi Lokchao Wildlife Sanctuary	10 km	Access for critical habitat
5	Keibul Lamjao National Park	50 km	Access for critical habitat
6.	Loktak Lake	50 km	Access for critical habitat
7.	Loktak Lake and Keibul Lamjao National Park	50 km	Access for critical habitat
8.	Thaungdut	50 km	Access for critical habitat

236. In the state, in spite of its rich vegetation 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 conversion of the lakes into agricultural lands these migratory birds are seen in increasingly fewer members in recent times.

237. 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 the Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS) which is also an important bird areas (IBA). The zonation map (Figure 31) shows that a total 29.516 km length of the proposed project road passes through the sanctuary area on one side of road. Starting from Khongkhang village to Lokchao River Bridge (km 395+680 to km 404+130) for 8.450 km the alignment falls inside the ESZ of YLWLS. From Lokchao River Bridge to Khudenthabi village (chainage 404.130 to Chainage 413.230) for 9.100km the alignment traverses along the border of Core Zone I and Tourism Zone. From Khudenthabi village up to Moreh (Chainage 413.23 to 425.196) for 11.966 km the alignment passes the Buffer Zone of the sanctuary.

238. The Yangoupokpi Lokchao Wildlife Sanctuary has a diverse assemblage of wildlife, harboring 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, Tokkegekko, 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.

239. 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 49.

Table 49: 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)

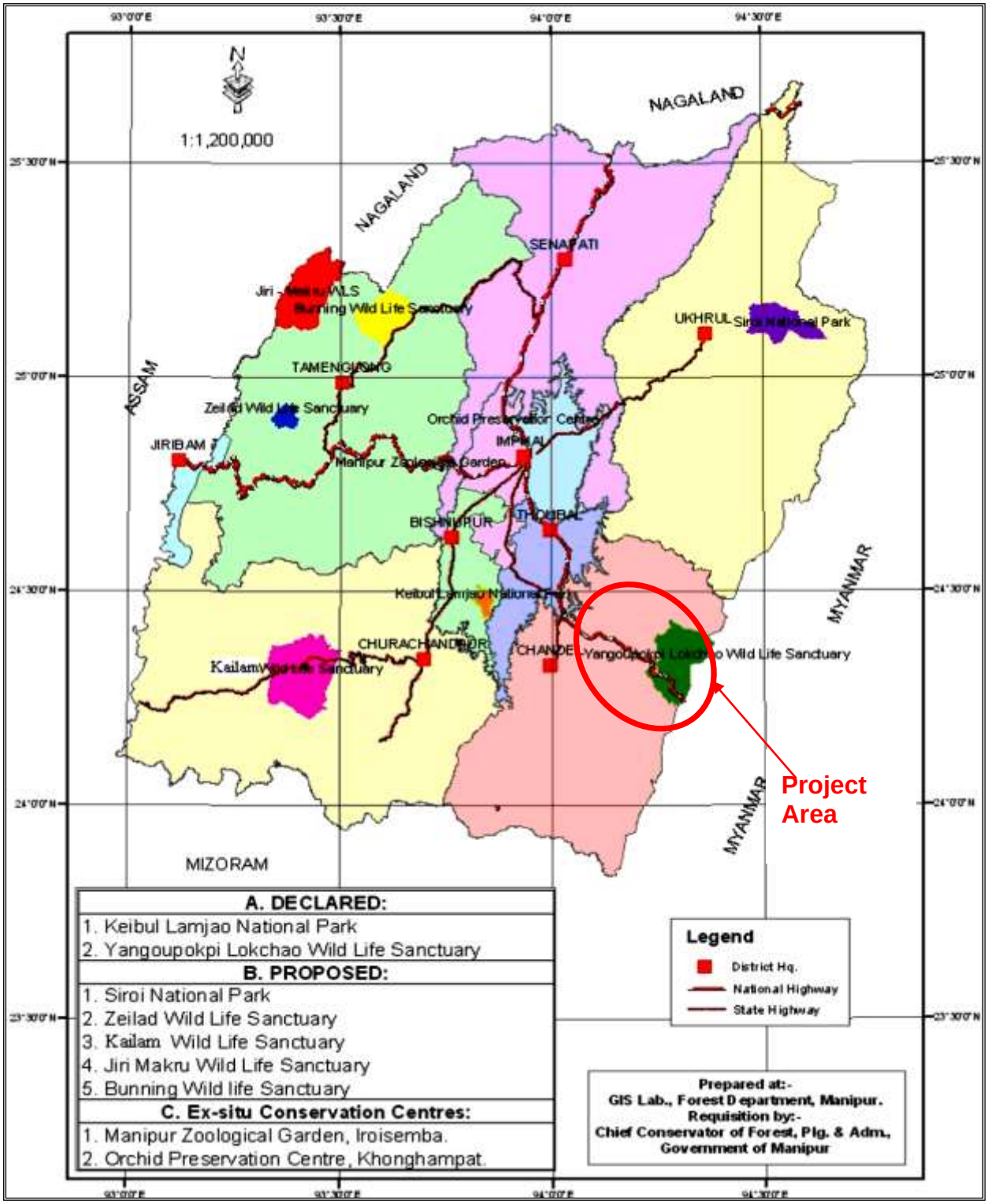


Figure 29: Protected Area Map of Manipur State

Source: Wildlife Wing, Forest Department, Government of Manipur

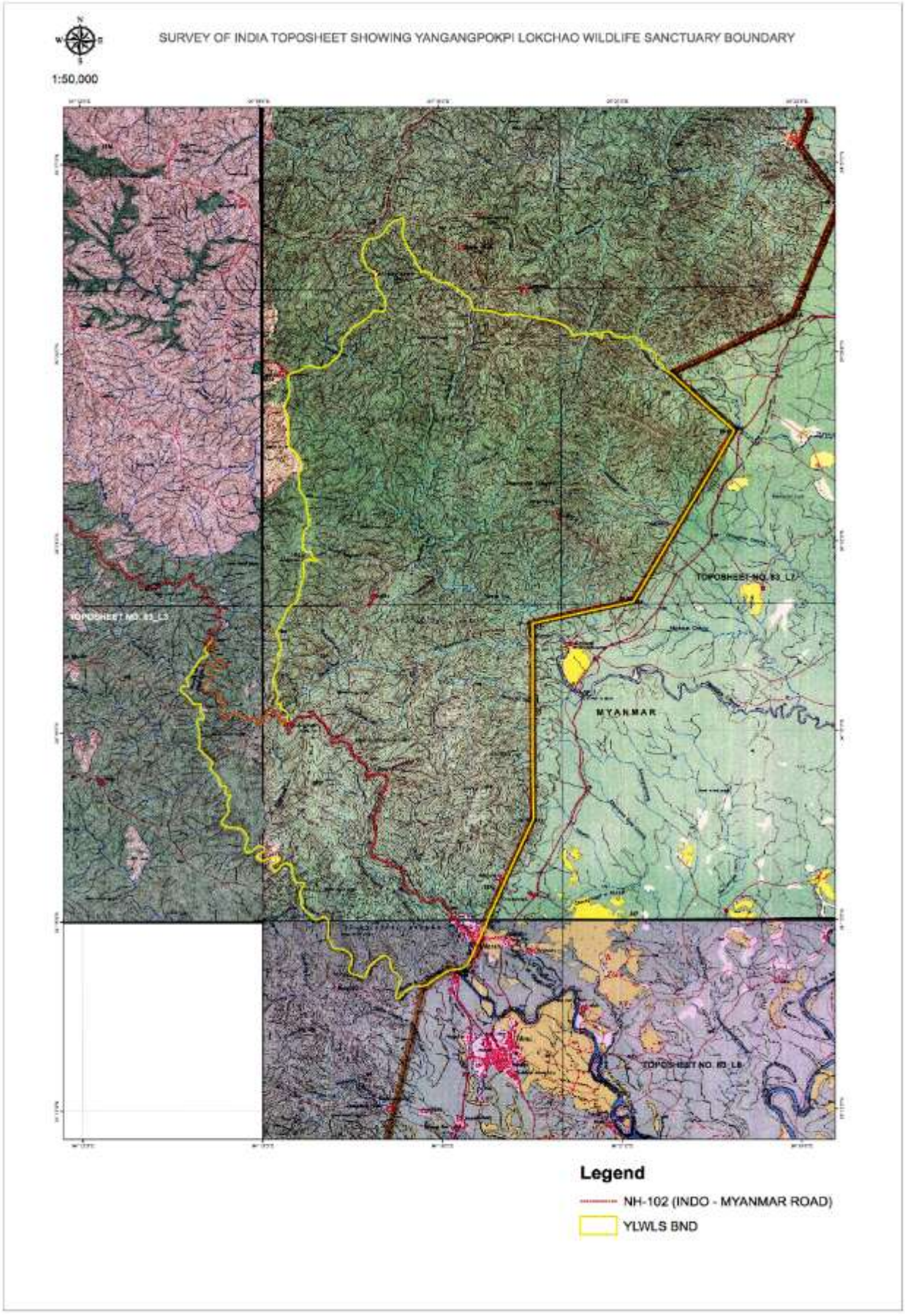


Figure 30: Project Road alignment on toposheet showing YLWLS boundaries

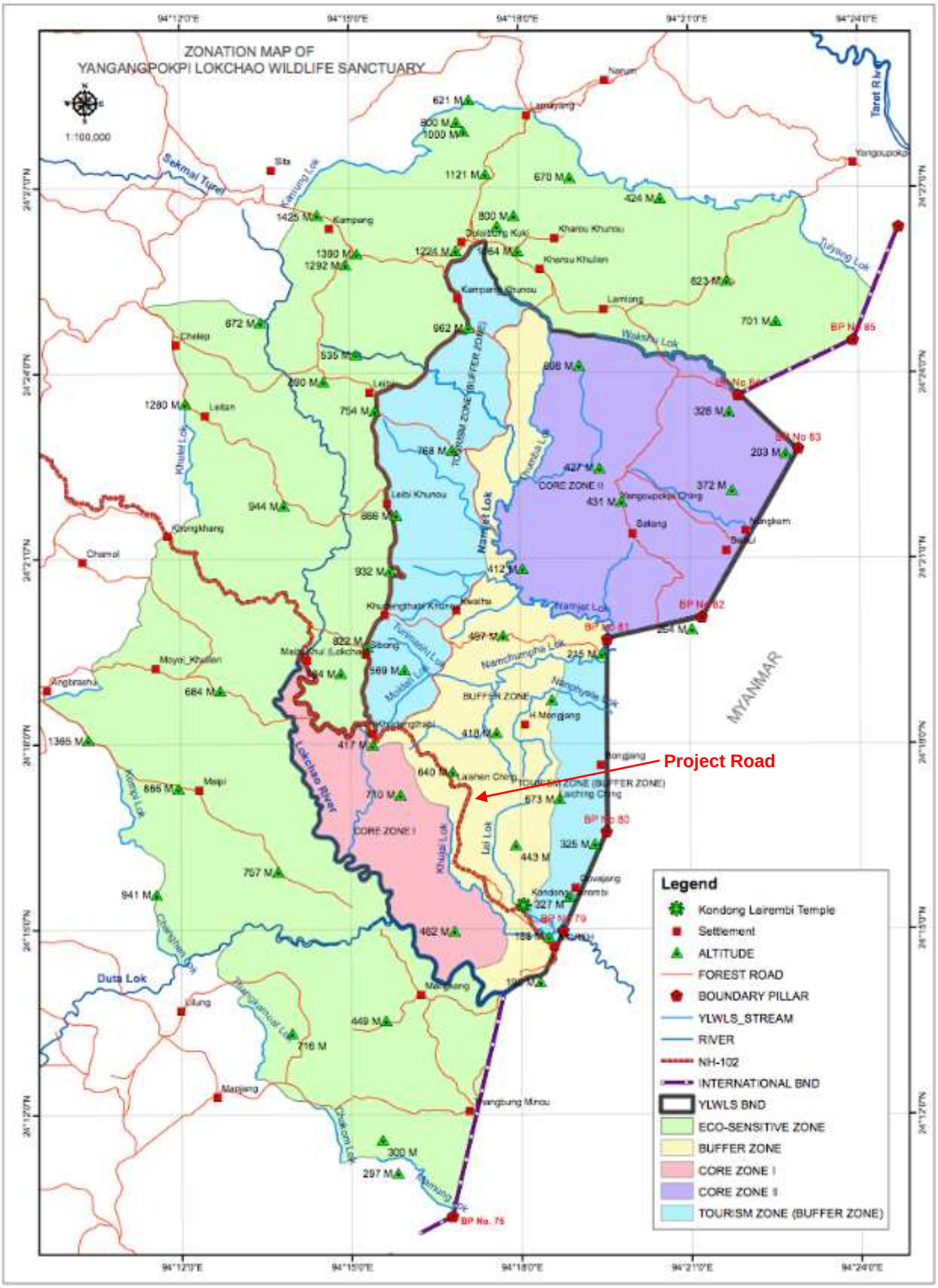


Figure 31: Zonation map of YLWLS showing project alignment

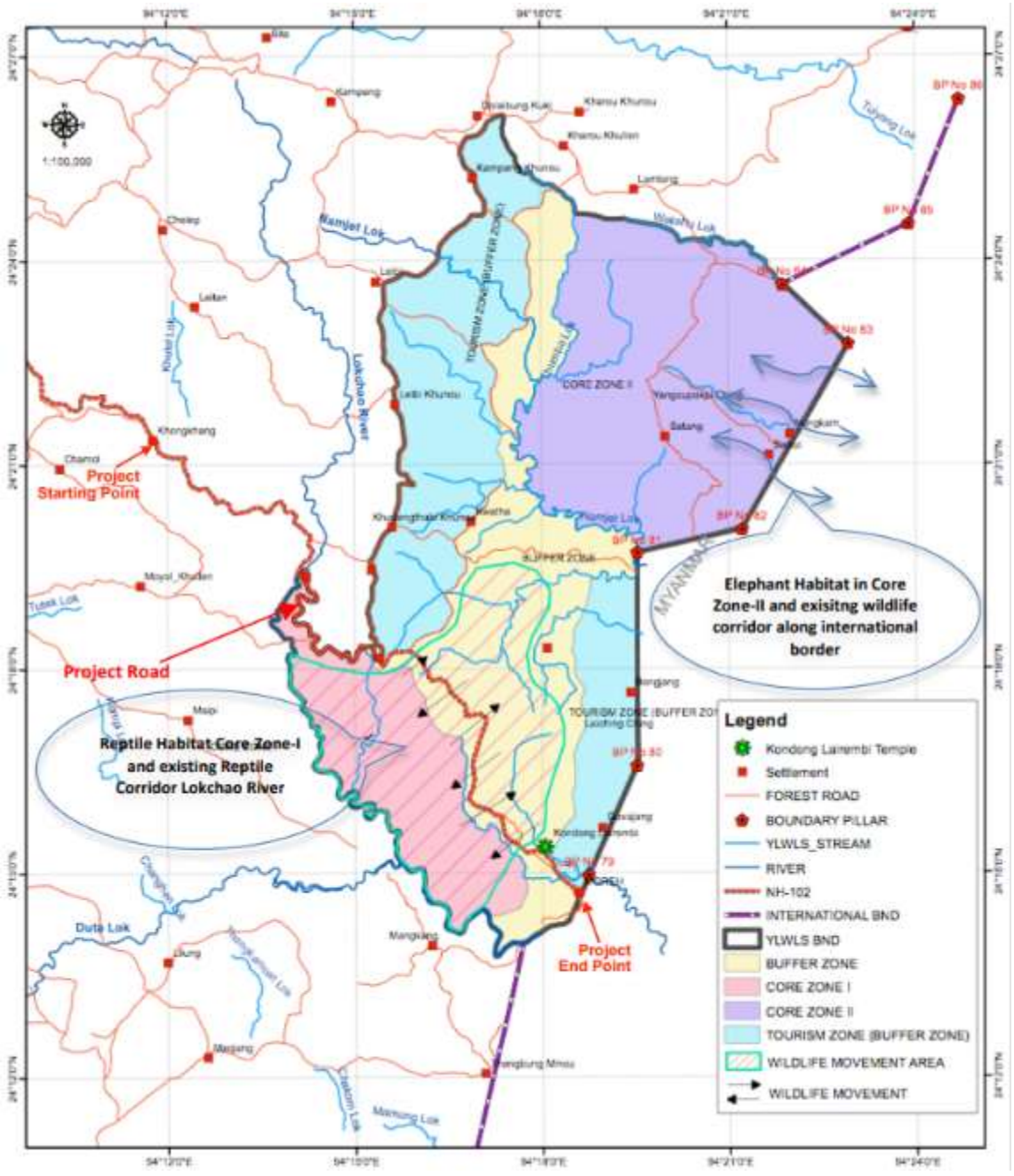


Figure 32: Habitat Map of project road along YLWLS

240. **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.

241. **Objectives and Methodology.** The main objective 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 methodology for field surveys were derived with due considerations to ground conditions and limitations. Considering the security concerns (movement of vehicles and people on the

project road section is not allowed by Indian security forces after 6 pm until 7 am) the field sampling was limited to day time only. The transect walk surveys points have also been selected in consultations with local forestry officials (as sampling inside sanctuary area is not allowed without clearance from the Wildlife Board at Central Government level). Therefore, 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 (points which were selected in consultation with forest officials within limitations) of varying lengths were set up in and along the project road alignment in order to document any direct wildlife observations encountered. The field samples were collected over a duration of two weeks by a team of experts supported by forestry officials and local people (2 biodiversity experts, 1 ex wildlife warden, and 2 local surveyors).

242. **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.

243. A transect 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.

244. 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.

245. 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.

246. 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 and pangolin.

247. 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, Tokkegokko, Leaf Turtle, a number of frogs which includes species of genus CylemysPolypedates, Fajerverya and Hoplobatrachus, etc.

248. 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. Table 50 present the faunal species in the protected areas of YLWLS and its IUCN status.

Table 50: Faunal Species Recorded in the Project Area

Scientific Name	*English Name (Common Name)*	Family	IUCN Status
FISHES			
Acantopsis choirorhynchos	Horse face loach	Cobitidae	LC
Gibelion catla	Catla	Cyprinidae	LC
Pterocryptis berdmorei		Siluridae	LC
Anguilla bengalensis	Indian Mottled Eel	Anguillidae	NT
Amblyceps mangois		Amblycipitidae	LC
Chanda nama	Elongate Glass Perchlet	Ambassidae	LC
Sperata aor	Long-whiskered Catfish	Bagridae	LC
Sperata seenghala		Bagridae	LC
Mystus bleekeri		Bagridae	LC
Hemibagrus menoda		Bagridae	LC
Hemibagrus microphthalmus		Bagridae	LC
Rita rita		Bagridae	LC
Xenentodon cancila		Belonidae	LC
Trichogaster fasciata		Osphronemidae	LC
Channa marulius		Channidae	LC
Cabdio morar	Morar	Cyprinidae	LC
Barilius dogarsinghi	Manipur Baril	Cyprinidae	VU
Opsarius barnoides	Pla Bai Phai	Cyprinidae	LC
Laubuka laubuca		Cyprinidae	LC
Cirrhinus reba	Reba Carp	Cyprinidae	LC
Chagunius nicholsi		Cyprinidae	LC
Devario naganensis		Cyprinidae	VU
Devario acuticephala		Cyprinidae	VU
Esomus danricus	Flying barb	Cyprinidae	LC
Garra gotyla	Gotyla	Cyprinidae	LC
Labeo calbasu	Karnataka labeo	Cyprinidae	LC
Labeo pangusia	Pangusia labeo	Cyprinidae	NT
Neolissochilus hexagonolepis	Katli	Cyprinidae	NT
Osterobrama cotio		Cyprinidae	LC
Systomus sarana	Olive barb	Cyprinidae	LC
Rasbora daniconius	Slender Barb	Cyprinidae	LC
Tor putitora		Cyprinidae	EN
Tor tor	mahseer	Cyprinidae	DD
Glossogobius giuris	Bareye Goby	Gobiidae	LC
Paracanthocobitis botia		Nemacheilidae	LC
Schistura manipurensis		Balitoridae	NT
Schistura vinciguerrae		Balitoridae	LC
Mastacembelus armatus	Spiny Eel	Mastacembelidae	LC
Mastacembelus alboguttatus		Mastacembelidae	LC
Macrognathus Pancalus		Mastacembelidae	LC
Macrognathus morehensis		Mastacembelidae	LC
Badis badis		Badidae	LC
Psilorhynchus microphthalmus		Psilorhynchidae	EN
Bagarius bagarius		Sisoridae	NT
Gagata cenia		Sisoridae	LC
Glyptothorax cavia		Sisoridae	LC
Glyptothorax pectinopterus		Sisoridae	LC

Scientific Name	*English Name (Common Name)*	Family	IUCN Status
Glyptothorax sinensis		Sisoridae	DD
Glyptothorax trilineatus	Three-lined Catfish	Sisoridae	LC
Channa orientalis	Smooth-breasted Snakehead	Channidae	VU
Amblypharyngodon mola		Cyprinidae	LC
Cirrhinus mrigala	Mrigal	Cyprinidae	LC
Cyprinion semiplotum	Assamese Kingfish	Cyprinidae	VU
Labeo bata	Minor Carp	Cyprinidae	LC
Labeo rohita	Rohu	Cyprinidae	LC
Syncrossus berdmorei	Tiger Botia	Cobitidae	NT
Botia histronica		Cobitidae	LC
Wallago attu		Siluridae	VU
Osteobrama belangeri		Cyprinidae	NT
AMPHIBIANS			
Polypedates leucomystax		Rhacophoridae	LC
Duttaphrynus melanostictus		Bufonidae	LC
Hyla annectans	Assam Treefrog	Hylidae	LC
Sphaerotheca breviceps		Dicroglossidae	LC
Hoplobatrachus tigerinus	Indian Bullfrog	Dicroglossidae	LC
Fejervarya limnocharis		Dicroglossidae	LC
REPTILES			
Rhabdops bicolor		Colubridae	NA
Hemidactylus bowringi	Bowring's Smooth Gecko	Gekkonidae	LC
Varanus bengalensis		Varanidae	LC
Varanus salvator	Common Water Monitor	Varanidae	LC
Ophiophagus hannah	King Cobra	Elapidae	VU
Naja kaouthia	Monocled cobra	Elapidae	LC
Amphiesma stolatum		Natricidae	NA
Rhabdophis himalayanus		Natricidae	NA
Xenochrophis punctulatus		Natricidae	LC
Oligodon albocinctus		Colubridae	NA
Xenochrophis piscator		Natricidae	NA
Bungarus fasciatus	Banded krait	Elapidae	LC
Python bivittatus	Burmese Python	Pythonidae	VU
Malayopython reticulatus (formerly as: Python reticulatus)	Reticulated Python	Pythonidae	LC
Dopasia gracilis		Anguidae	NA
Boigao Walli	Wall's Cat Snake	Colubridae	LC
Cyclophiops doriae		Colubridae	NA
Calotes versicolor		Agamidae	NA
Calotes jerdoni		Agamidae	NA
Pseudocalotes microlepis		Agamidae	NA
Calotes mystaceus		Agamidae	NA
Eutropis carinata		Scincidae	LC
Eutopis multifasciata	Common Mabuya	Scincidae	LC
Ptyas korros		Colubridae	NA
Nilssonia hurum	Indian Peacock Softshell Turtle	Trionychidae	VU
Indotyphlops braminus	Bootlace snake	Typhlopidae	NA
AVES			
Acridotheres tristis	Common Myna	Sturnidae	LC
Acridotheres albocinctus	Collared Myna	Sturnidae	LC
Acridotheres Fuscus	Jungle Myna	Sturnidae	LC
Gracupica contra	Asian Pied Starling	Sturnidae	LC
Sturnia malabarica	Chestnut-tailed Starling	Sturnidae	LC

Scientific Name	*English Name (Common Name)*	Family	IUCN Status
Dicrurus macrocercus	Black Drongo	Dicruridae	LC
Upupa epops	Common Hoopoe	Upupidae	LC
Accipiter badius	Shikra	Accipitridae	LC
Pandion haliaetus	Osprey	Pandionidae	LC
Treron phoenicopterus	Yellow-footed Green-pigeon	Columbidae	LC
Corvus macrorhynchos	Large-billed Crow	Corvidae	LC
Eudynamis scolopaceus	Western Koel	Cuculidae	LC
Motacilla alba	White Wagtail	Motacillidae	LC
Motacilla cinereal	Grey Wagtail	Motacillidae	LC
Pycnonotus jocosus	Red-whiskered Bulbul	Pycnonotidae	LC
Pycnonotus cafer	Red-vented Bulbul	Pycnonotidae	LC
Francolinus pondicerianus	Grey Francolin	Phasianidae	LC
Spilopelia chinensis	Eastern Spotted Dove	Columbidae	LC
Streptopelia tranquebarica	Red Turtle-dove	Columbidae	LC
Streptopelia decaocto	Eurasian Collared-dove	Columbidae	LC
Streptopelia senegalensis	Laughing Dove	Columbidae	LC
Treron phayrei	Ashy-headed Green-pigeon	Columbidae	NT
Treron bicinctus	Orange-breasted Green-pigeon	Columbidae	LC
Gallus gallus	Red Junglefowl	Phasianidae	LC
Polyplectron bicalcaratum	Grey Peacock-pheasant	Phasianidae	LC
Otus bakkamoena	Indian Scops-owl	Strigidae	LC
Coracias benghalensis	Indian Roller	Coraciidae	LC
Prinia socialis	Ashy Prinia	Cisticolidae	LC
Lonchura malacca	Tricoloured Munia	Estrildidae	LC
Lonchura maiabarica	Indian Silverbill	Estrildidae	LC
Lonchura punctulata	Scaly-breasted Munia	Estrildidae	LC
Lonchura striata	White-rumped Munia	Estrildidae	LC
Centropus sinensis	Greater Coucal	Cuculidae	LC
Todiramphus chloris	Collared Kingfisher	Alcedinidae	LC
Ceryle rudis	Pied Kingfisher	Alcedinidae	LC
Argya caudata	Common Babbler	Leiotrichidae	LC
Turdoides striata	Jungle Babbler	Leiotrichidae	LC
Pellorneum ruficeps	Puff-throated Babbler	Pellorneidae	LC
Monticola solitarius	Blue Rock-thrush	Muscicapidae	LC
Dryobates cathpharius	Scarlet-breasted Woodpecker	Picidae	LC
Jynx torquilla	Eurasian Wryneck	Picidae	LC
ipalensis	Spot-bellied Eagle-owl	Strigidae	LC
ops palpebrosus	Indian White-eye	Zosteropidae	LC
Lanius excubitor	Great Grey Shrike	Laniidae	LC
Saxicoloides Fulicata	Indian Robin	Muscicapidae	LC
Copsychus Saularis	Oriental Magpie-robin	Muscicapidae	LC
Aegithina Tiphia	Common lora	Aegithinidae	LC
Cecropis daurica	Red-rumped Swallow	Hirundinidae	LC
Ptyonoprogne concolor	Dusky Crag Martin	Hirundinidae	LC
Apus affinis	Little Swift	Apodidae	LC
Coturnix coturnix	Common Quail	Phasianidae	LC
Passer montanus	Eurasian Tree Sparrow	Passeridae	LC
Alauda gulgula	Oriental Skylark	Alaudidae	LC
Psittacula Eupatria	Alexandrine Parakeet	Psittacidae	NT
Psittacula Krameri	Rose-ringed Parakeet	Psittacidae	LC
Enicurus Schistaceus	Slaty-backed Forktail	Muscicapidae	LC
Francolinus	Black Francolin	Phasianidae	LC
Amaurornis Phoenicurus	White-breasted Waterhen	Rallidae	LC

Scientific Name	*English Name (Common Name)*	Family	IUCN Status
Milvus migrans	Black kite	Accipitridae	LC
Spilornis cheela	Crested Serpent-eagle	Accipitridae	LC
Saxicola caprata	Pied Bushchat	Muscicapidae	LC
Bambusicola fytchii	Mountain Bamboo-partridge	Phasianidae	LC
Lophura Leucomelanos	Kalij Pheasant	Phasianidae	LC
Pavo Muticus	Green Peafowl	Phasianidae	EN
MAMMALS			
Paradoxurus hermaphroditus	Common Palm Civet	Viverridae	LC
Vulpes bengalensis	Bengal Fox	Canidae	LC
Prionailurus bengalensis	Leopard Cat	Felidae	LC
Pardofelis marmorata	Marbled Cat	Felidae	NT
Felis temminckii	Asiatic Golden Cat	Felidae	NT
Funambulus Pennanti	Five-striped Palm Squirrel	Sciuridae	LC
Petaurista Petaurista	Red Giant Flying Squirrel	Sciuridae	LC
Bos gaurus	Gaur	Bovidae	VU
Canis aureus	Golden Jackal	Canidae	LC
Felis chaus	Jungle Cat	Felidae	LC
Arctictis binturong	Binturong	Viverridae	VU
Sus scrofa	Wild Boar	Suidae	LC
Prionodon Pardicolor	Spotted Linsang	Prionodontidae	LC
Petaurista alborufus	Red and While Giant Flying Squirrel	Sciuridae	LC
Panthera pardus	Leopard	Felidae	VU
Hylopetes Alboniger	Hylopetes alboniger	Sciuridae	LC
Manis crassicaudata	Indian Pangolin	Manidae	EN
Viverricula Indica	Small Indian Civet	Viverridae	LC
Paguma Larvata	Masked Palm Civet	Viverridae	LC
Arctonyx Collaris	Great Hog Badger	Mustelidae	VU
Neofelis Nebulosa		Felidae	VU
Golunda Ellioti	Indian Bust-rat	Muridae	LC
Mus booduga		Muridae	LC
Berylmys manipulus	Manipur White-Toothed Rat	Muridae	NA
Capricornis sumatraensis (Bechstein)	Himalayan Serow	Bovidae	NT
Cervus unicolor	Sambar	Cervidae	VU
Manis pentadactyla	Chinese Pangolin	Manidae	CR
Herpestes Urva	Crab-eating Mongoose	Herpestidae	LC
Martes flavigula	Yellow-throated Marten	Mustelidae	LC
Helarctos Malayanus	Sun Bear	Ursidae	VU
Ursus thibetanus	Asiatic Black Bear	Ursidae	VU
Pteropus giganteus	Indian Flying Fox	Pteropodidae	LC
Pipistrellus Coromandra		Vespertilionidae	LC
Pipistrellus paterculus	Mount Popa Pipistrelle	Vespertilionidae	LC
Eptesicus serotinus		Vespertilionidae	LC
Elephas maximus	Asian Elephant	Elephantidae	EN
Muntiacus muntjac	Southern Red Muntjac	Cervidae	LC
Macaca Mulatta	Rhesus Monkey	Cercopithecidae	LC
Hylobates hoolock	Western Hoolock Gibbon	Hylobatidae	EN

NA: Not Assessed, DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR:Critically Endangered, EW: Extinct in the Wild, EX: Extinct

249. **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 (Pycnonotusatriceps), Black-headed yellow bulbul (Pycnonotusmelanicterus), Purple woodpigeon (Columba punicea) and Batek were most commonly observed avifauna in the forest areas. The species of Blue-eared kingfisher (Alcedomeninting) were seen in forest areas adjoining to Lokchao river. Besides these birds, Purple wood pigeon (Columba punicea), Forest eagle owl (Bubonipalensis), Tawny eagle (Aquila vindhiana), Indian golden-backed three-toed woodpecker (Dinopiumjavanense) were also observed.

Table 51: 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 adsmilesalbrictus (Hodgson)*		

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

250. ***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 (Muntiocusmuntijak) and droppings of wild pig (Sus scorfa) at transect line no. 4 were observed. There is 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 Images 11-16 and Table 52.

Image 11: Deer Footmark in Transect No. 2 along Lokchao River

Image 12: Fruit bearing tree food for wild animal near Lokchao River

Image 13: Animal (deer) footmark in Transect No. 2 along Lokchao River

Image 14: Animal footmark in Transect No. 3 local stream of Lokchao River

Image 15: Animal (wild pig) footmark in Transect No. 4

Image 16: Bamboo forest habitat of wild pig in Transect No. 4

Images 11-16: Animal signs recorded in Transect survey in the YLWLS area along the proposed alignment

Table 52: Details of wild animals observed during survey

S. No.	Common Name *(Local Name)*	Scientific Name	Family	Identification	Location
1	Barking Deer *(Saji)*	*Munitacusmuntjak*	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)

251. ***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.

252. 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.

253. 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 amphibians. This region has Lokchao River to serve as water source for wild animal.

254. 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.

255. Locations of the animal tracks and different wildlife habitats are shown on map in Images 17-20 and in Figure 33.

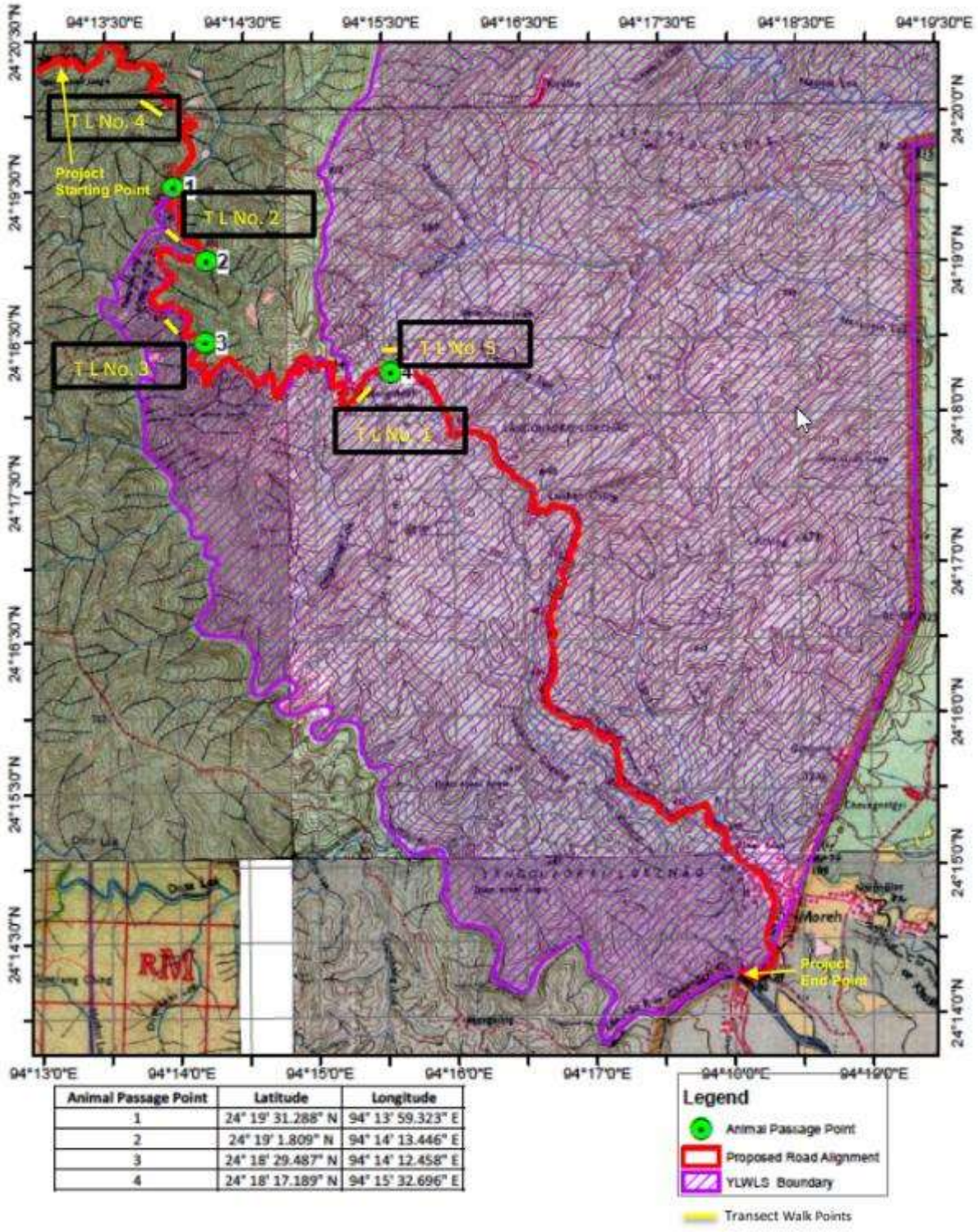
Image 17: Animal tracks from km 404+000 to 404+200(Lokchao River) possibly for reptiles &amphibians

Image 18: Possible animal track (deer & wild cats) during rainy season across alignment at km 405+700 to 405+900

Image 19: Route movement for between chainage at Km 408+500 to km 407+600

Image 20: Possible movement route for wild boar (pig) from hill to agriculture fields between chainage km 413+000 to km 413+300

Images 17-20: Locations of possible animal movement tracks crossing proposed alignment



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

256. **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) is endangered, Hog Badger (Arctonyxcollaris Cuvier), Python (Python molurusbivittatus) are threatened. Sabeng (Himalayan Serow), Small Indian Civet (Viverriculaindica), Gaur (Bos gaurs), Marbled Cat (Felis marmorata charltoni Gray) are considered vulnerable. Least concerns animals list includes Barking deer (Muntiacusmuntjak) 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	English Name (Common Name)	Category	
FISHES		**Schedule list of Act 1972**	**IUCN Status**
Opsarius barnoides	Pla Bai Phai	-	LC
Badis badis		-	LC
REPTILES			
Naja kaouthia	Monocled Cobra	II	LC
Python bivittatus	Burmese Python	II	VU
AVES			
Upupa epops	Common Hoopoe	-	LC
Corvus macrorhynchos	Large-billed Crow	-	LC
Motacilla alba	White Wagtail	-	LC
Motacilla cinereal	Grey Wagtail	-	LC
Spilopelia chinensis	Eastern Spotted Dove	-	LC
Gallus gallus	Red Junglefowl	-	LC
Polyplectron bicalcaratum	Grey Peacock-pheasant	-	LC
Otus bakkamoena	Indian Scops-owl	-	LC
Ceryle rudis	Pied Kingfisher	IV	LC
Monticola solitarius	Blue Rock-thrush	-	LC
Copsychus Saularis	Oriental Magpie-robin	-	LC
Spilornis cheela	Crested Serpent-eagle	-	LC
Lophura Leucomelanos	Kalij Pheasant	-	LC
MAMMALS			
Paradoxurus hermaphrodites (Pallas)	Common Palm Civet	I	LC
Vulpes bengalensis (Shaw)	Bengal Fox	-	LC
Felis bengalensis	Leopard Cat	I	LC
Pardofelis marmorata	Marbled Cat	I	VU
Bos gaurus	Gaur	I	VU
Felis chaus	Jungle Cat	-	LC
Sus scrofa	Wild Boar	III	LC
Panthera pardus	Leopard	I	VU
Manis crassicaudata	Kakchenchabi (Pangolin)	I	EN
Viverricula Indica	Small Indian Civet	-	VU
Paguma Larvata	Masked Palm Civet	-	LC
Arctonyx Collaris	Great Hog Badger	I	NT
Golunda Ellioti	Indian Bust-rat	-	LC
Capricornis sumatraensis (Bechstein)	Himalayan Serow	I	NT

Scientific Name	English Name (Common Name)	Category	
FISHES		**Schedule list of Act 1972**	**IUCN Status**
NA: Not Assessed, DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR:Critically Endangered, EW: Extinct in the Wild, EX: Extinct			

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

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

258. **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. As stated in chapter VI, section D, some of the local community people expressed concerns of forest degradation and reduction of wildlife populations indicated by the decreasing frequency of sighting of animals (Leopard Cat, Golden Cat, Monitor lizard, Porcupine and Pangolin) in the region.

E. Critical Habitat Assessment

259. Based on the information collected in section C and D and further desk-based review using IBAT screening, referring to the IUCN red list data and other relevant literature a critical habitat assessment (CHA) was carried out following ADB SPS requirements and IFC Performance Standard (PF) 6 and Guidance Note (GN) 6. The detailed CHA is provided in Annex 15.

260. 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. Hence, this section falls inside critical habitat.

261. Further analysis of the habitat type in the project area was carried out wherein a single Area of Analysis (AoA) was defined to encompass the Project road itself, a precautionary 5 km buffer to encompass any likely significant impacts, and the whole of the Yangoupokpi-Lockchao Wildlife Sanctuary which the road bisects (see Figure 35 below). The buffer is an arbitrary distance, but chosen to be sufficiently precautionary to ensure capture of impacts such as edge effects, hunting or disturbance by construction workers, and noise/dust/pollution impacts during construction. All rivers and streams are considered to be Natural Habitat. A single AoA was chosen in the absence of sufficient information on species' presence in the area to usefully identify multiple ecologically-suitable AoAs, even to the level of distinguishing terrestrial and aquatic AoAs. The AoA as defined is 350 km^2.

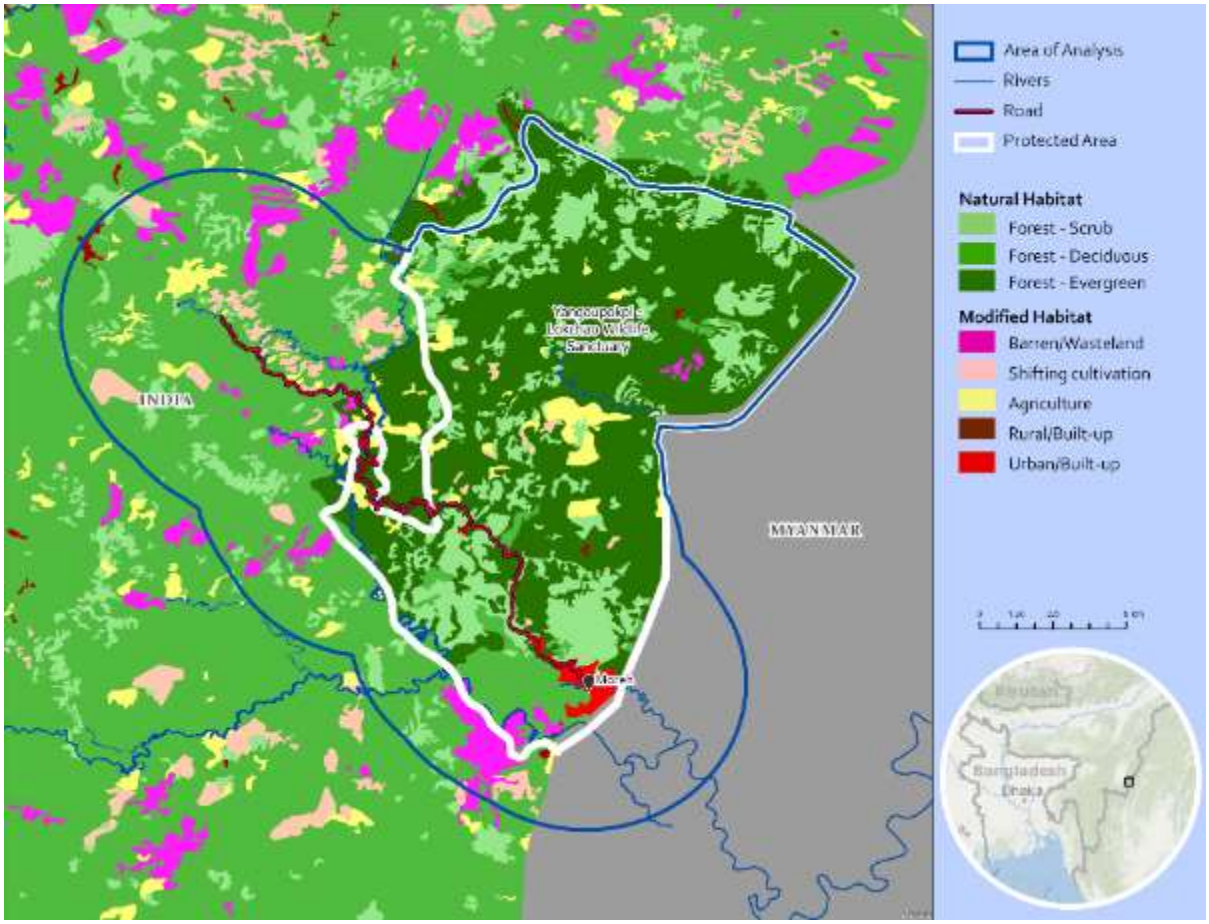


Figure 34. Map of Project area, showing locations of Area of Analysis and areas of terrestrial Natural and Modified Habitat.

262. Species based analysis following IFC PF 6 threshold criteria found the project area to be possible or actual Critical Habitat for 12 freshwater fishes, one bird, one mammal, and one internationally-recognized site as listed in Table 55 below. Significant uncertainty remains in the conclusions of this assessment, given very limited information on many of these species in the Project area. Nonetheless, this uncertainty is unlikely to substantially change the overall conclusions of this assessment. Although in some cases conclusions could be refined by further studies, on a precautionary basis the features listed in Table 54 should all be considered priority biodiversity for the Project to avoid, mitigate and – if necessary – offset impacts upon. In general, this will not pose challenges to the Project as most priority biodiversity is confined to forests, rivers and streams outside of the direct Project footprint. More extensive details of why each feature meets Critical Habitat criteria are given in Annex 15. On a precautionary basis, all terrestrial Natural Habitat and all rivers and streams are also considered to be Critical Habitat.

Table 54. Summary of Critical Habitat-qualifying biodiversity in the Project area

Biodiversity type	Species	Critical Habitat criterion qualified[13]						Justification
		1	2	3	4	5	6	
Mammal	Hume's Rat Hadromys humei		?					Might possibly support >10% of the global population of this restricted-range species, given high uncertainty over its distribution/population.
Bird	Green Peafowl Pavo muticus	?						Likely to support >0.5% of the global population of this globally Endangered species, though there is very limited information on current populations in the Project area.
Fish	Akysis manipurensis		?					Might possibly support >10% of the global population of this restricted-range species.
Fish	Barilius lairokensis		✓					This restricted-range species is only known from the Project area.
Fish	Devario yuensis	?	?					It is possible that >10% of the population of this globally Vulnerable restricted-range species occurs in the Project area, and thus possible that the loss of that area's population could result in a rise in the species' global threat status.
Fish	Laubuka khujairokensis	✓	✓					This globally Vulnerable restricted-range species is only known from the Project area, and loss of that population would risk extinction.
Fish	Macrognathus morehensis		?					Might possibly support >10% of the global population of this restricted-range species.
Fish	Neonoemacheilus morehensis		?					Might possibly support >10% of the global population of this restricted-range species.
Fish	Ngakha-Hangampal Pethia yuensis	✓						It is possible that the loss of populations of this globally Vulnerable restricted-range species in the Project area could result in a rise in its global threat status.
Fish	Psilorhynchus ngathanu		✓					On current knowledge, supports >10% of the global population of this restricted-range species.
Fish	Rasbora ornata	?	?					It is likely that this globally Vulnerable restricted-range species occurs in the Project area, possible that >10% of its global population occurs there, and possible that the loss of the population in the area could result in a rise in its global threat status.
Fish	Schistura phamhringi		✓					On current knowledge, supports >10% of the global population of this restricted-range species.
Fish	Schistura prashadi	?						It is likely that this globally Vulnerable restricted-range species occurs in the Project area, and

[13] ✓= likely to qualify area as Critical Habitat; ? = possibly qualifies area as Critical Habitat. Both based on available information.

Biodiversity type	Species	Critical Habitat criterion qualified[13]						Justification
		1	2	3	4	5	6	
								possible that the loss of populations in the area could result in a rise in its global threat status.
Fish	Schistura reticulata	✓	✓					Likely supports >10% of the global population of this globally Endangered restricted-range species.
Site	Yangoupokpi-Lokchao Wildlife Sanctuary Important Bird Area						?	Likely to qualify as an IBA/KBA because it probably supports >0.5% of the global population of the globally Endangered Green Peafowl , though there is very limited information on this species' populations in the area.

F. Socio-economic Environment

263. **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 55 presents the demographic features of the state and the North eastern region.

Table 55: 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

264. 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.

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

266. **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 56.

Table 56: 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.

267. **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.

268. 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.

269. **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.

270. The important fishes commonly found in the region's plain and river basins are Catlacatla, Labeorohita, Labeiocalbase, Cirrihinusmirigale, Clarius, batrachus, Rita rita, Heteropneuptusfonilis, Notopterusnontopterus, N. Chitala, Macrobrachumrosenbergii, M. malconsoni, M. Chapral, Channapunetatus C. gaehua, C. striatus.

271. **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 to 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.

272. **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.

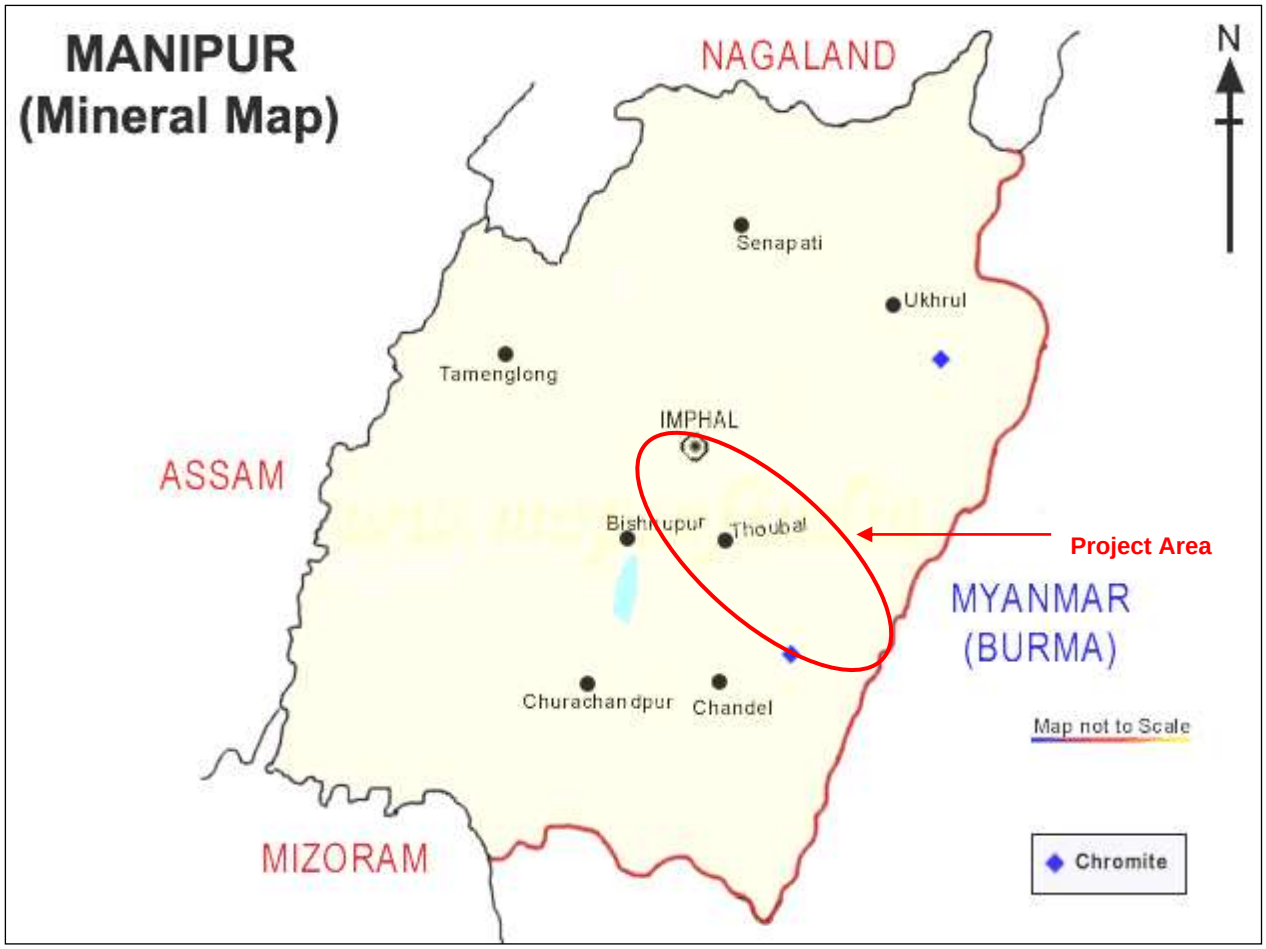


Figure 35: Mineral Map of Manipur State

273. **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.

274. **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.

275. **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 culture 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.

276. **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.

277. **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.

278. The various physical features along the project road are described in Table 57.

Table 57: 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. Methodology

279. The methodology of assessing environmental impacts from the project entailed clearly identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects a screening of project impacts during design and pre-construction (D), construction (C) and operation (O) stages of the project was carried out to identify the minor, moderate and major impacts to guide development of mitigation measures and ensure that there are no or minimal residual impacts.

280. **Identification of environmental components.** This includes identifying the valued environmental components (VEC) of the physical, biological, and human environments that are at risk of being impacted by the project. The VECs for this project which are based on the environmental baseline are:

(i) Physical environment – air quality and greenhouse gas emissions, land and soil, surface water quality and quantity, and groundwater quality and quantity;
(ii) Biological environment – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important areas;
(iii) Social environment – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural/heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

281. **Type of impact on the VECs:** The type of impact can be described as:

(i) **Positive:** Improvement in the quality of the VECs because of the project;
(ii) **Negative:** Degradation or reduction in the quality of the VECs because of the project;
(iii) **Neutral:** No noticeable change in VECs.

282. Area of impact assessment. The area covered for assessing direct project impacts include:

(i) An average of 25 m corridor along the existing road. This includes 10 m on the left, the existing road itself and 10 m on the right;
(ii) An average of 50 m surrounding the bridge locations.

283. In addition, a 4 km strip throughout the project alignment was studied for **indirect impacts**.

284. Significance **of impacts**. The assessment of the significance of the impacts on the VECs requires understanding the(i) sensitivity of each VEC within the project context; (ii) duration of impact; (iii) area of impact and (iv) severity of impact. The following sections elaborate the

(i) **Sensitivity of VEC**: The sensitivity of a VEC can be determined by the existing conditions of the VEC within the project area and existence of important VEC's within the project areas. Sensitivity of each VEC is described as high, medium or low as described below.
    (a) **Low:** No environmentally important areas (such as protected areas, natural or critical habitat areas, heritage sites, places of worship etc.) are located within the direct and indirect impact zone. The quality of

existing conditions of VECs is good or fair;

(b) **Medium:** There are one or more environmentally important areas within the indirect impact zone of the project area. The quality of existing conditions of VECs is good or fair;

(c) **High:** There are one or more environmentally important areas within the direct impact zone of the project area. The quality of existing conditions of the VECs is poor or degraded (such as poor air quality, high noise levels, poor water quality).

285. Based on baseline conditions in the project area and sensitivity criteria, the level of sensitivity of each VEC is provided in Table 58.

Table 58: Sensitivity of VECs in the project area

VEC	Sensitivity level	Remarks
1. Physical environment		
1.1 Air quality	Medium	The overall the air quality in the project area is good, permissible levels are not exceeded for the monitored parameters. However, the project passes through a protected area.
1.2 GHG emissions	Medium	Firewood burning is the major contributor in the ambient pollution load. Vehicular pollution is a secondary source of pollution in the state as the traffic density is low.
1.3 Surface water quality	Medium	Overall, the surface water quality in the project area is good, permissible levels are not exceeded for the monitored parameters. BOD values however indicate a moderate presence of organic compounds. Lokchao river forms part of the protected area.
1.4 Surface water quantity	Low	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.
1.5 Ground water quality	Low	Overall, the ground water quality in the project area is good, permissible levels are not exceeded for the monitored parameters.
1.6 Ground water quantity	Low	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.
1.7 Land degradation and pollution	Low	Forests along the project road are a mix of agriculture, open forest and dense forests. Land degradation and pollution is low.
2. Biological environment		
2.1 Trees, terrestrial and aquatic vegetation	Medium	The project passes through a protected area. However, the forest department has confirmed that there are no endangered flora species

VEC	Sensitivity level	Remarks
		which are likely to be affected by current project.
2.2 Fauna (mammals, birds, fishes, reptiles, amphibians)	High	About 21.06 km length of this the road is located within the Yangoupokpi Lokchao Wildlife Sanctuary. The Sanctuary is home to several vulnerable or endangered species, more specifically the pangolin.
2.3 Ecologically important areas)	High	The project is located in either the Yangoupokpi Lokchao Wildlife Sanctuary or the Ecologically Sensitive Zone (ESZ) surrounding it.
3. Social environment		
3.1 Private land and buildings	Low	Except for Moreh town there are only a few settlements along the project road. There will be negligible land acquisition as the proposed widening will be accommodated within existing ROW
3.2 Public property/ infrastructure/ utility structures	Low	The ROW is available for widening or even minimum improvement of road geometry. Impact on utility structures is not foreseen.
3.3 Noise	Medium	Existing noise levels are higher than the permissible limits for residential area in both daytime and night-time. Modelling has shown the expected increase in noise will be within 3dB.
3.4 Vibration	Medium	Ambient vibration levels are within the cosmetic damage threshold. However, vibration modelling has shown a moderate risk of damage to sensitive receptors during the construction phase.
3.5 Occupational health and safety	Medium	Traffic density at the existing road is low
3.6 Public health and safety	High	The expected increase in traffic potentially leads to an increase in unsafe situations
3.7 Physical cultural resources (PCR)	Low	There are no adverse impacts anticipated on historical places/monuments. However, there are few small shrines along the road.

286. **Duration of the impact:** Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-lived are used to describe the duration of impact:

(a) **Short-lived:** The impact disappears promptly;
(b) **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project;
(c) **Permanent:** The impacts are felt throughout the life of the infrastructure.

287. **Area of impact:** The area of impact entails the spatial scale of impact on one or more of the VECs. The terms regional, local and limited are used to describe the area of impact:

(a) **Limited**: The impact is felt within the direct impact zone;
(b) **Local**: The impact is felt within the indirect impact zone;
(c) **Regional**: The impact is felt beyond the indirect impact zone.

288. **Severity of impact**. The severity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criteria which is defined as high, medium or low as below:

(a) **High:** The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project;

(b) **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues; some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project;

(c) **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project.

289. Based on the sensitivity of the VEC and the rating of duration, area and severity of impact as described above, the overall significance of each impact was classified as major, moderate or minor as demonstrated in Table 59 below.

Table 59: Criteria for rating the significance of impacts

Significance	VEC Sensitivity	Duration	Area	Severity
Minor	Medium or Low	Short-lived or Temporary	Limited, Local or Regional	Low
	Low	Permanent	Limited	Low
Moderate	High or Medium	Temporary	Limited, Local or Regional	Medium
	Medium	Permanent	Limited	Medium
Major	High	Permanent or Temporary	Limited, Local or Regional	High
	High or Medium	Permanent	Local or Regional	Medium

290. **Screening of impacts**. Based on the rating criteria provided in Table 58, environmental impacts anticipated during the project design and pre-construction stage (D), construction (C) stage and operation (O) stage were screened for their level of significance as demonstrated in Table 59 below. The screening was carried out for impacts that are expected

without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant/major negative impacts that need to be prioritized for mitigation.

291. The significance of each environmental impact or project activity is indicated by the colors of the cells in the last column of the Table 60. Red indicates major negative impact, orange indicates moderate negative impact, yellow indicates minor negative impact and green indicates positive impact. The following section discusses the details of impacts on each of the VECs in line with the identification of major, moderate, and minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that there are minimal or no residual impacts.

Table 60: Screening of impacts on VECs

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
1. Physical environment						
1.1 Air quality (Medium sensitivity)	No impact due to design	D	N	N	N	N
	Vegetation clearing and removal of trees, quarrying, material transport and storage, drilling, blasting and hill cutting, pavement works, use of construction equipment	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Construction in forest and sensitive areas	O	-ve permanent	-ve limited	-ve low	-veminor
1.2 GHG emissions (Medium sensitivity)	GHG not exceeding standards	D, C, O	N	N	N	N
1.3 Surface water quality (Medium sensitivity)	Disruptions to the natural hydrology	D	-ve temporary	-ve limited	-ve medium	-ve moderate
	Construction in forest and sensitive areas, culvert and bridge construction, use of construction equipment, pavement works, labour camp activities	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	No anticipated impacts	O	N	N	N	N
1.4 Surface water quantity (Low sensitivity)	Disruptions to the natural hydrology	D	-ve temporary	-ve limited	-ve medium	-ve moderate
	Construction in forest and sensitive areas, culvert and bridge construction, drainage work, earthwork, quarrying, debris generation	C	-ve permanent	-ve limited	-ve low	-ve minor
	No anticipated impacts	O	N	N	N	N
1.5 Ground water quality (Low sensitivity)	No anticipated impacts	D	N	N	N	N
	Groundwater pollution due to labour camp activities	C	-ve temporary	-ve local	-ve low	-ve minor
	No anticipated impacts	O	N	N	N	N
1.6 Ground water quantity (Low sensitivity)	None	D, C, O	N	N	N	N

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
1.7 Land degradation/ pollution (Low sensitivity)	Changes in the local-level topography and appearance of the project site	D	-ve permanent	-ve local	-ve medium	-ve minor
	Drilling, blasting and hill cutting, earthwork, quarrying, pavement works, stripping of top soil, debris generation, oil and grease	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Soil erosion prevention	O	+ve permanent	+ve limited	+ve medium	+ve
2. Biological environment						
2.1 Trees, terrestrial and aquatic vegetation (Medium sensitivity)	Vegetation clearing and removal of trees	D	-ve temporary	-ve local	-ve medium	-ve moderate
	Drilling, blasting and hill cutting, road widening, Vegetation clearing and removal of trees, loss of mostly natural habitat	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Planting of trees, net gain of habitat	O	+ve permanent	+ve local	+ve medium	+ve
2.2 Fauna (mammals, birds, fishes, reptiles, amphibians) (High sensitivity)	Disruption of wildlife movement routes	D	-ve permanent	-ve limited	-ve high	-ve major
	New hill cutting and steep slopes, use of construction materials, labour camp. Spread of invasive species.	C	-ve temporary	-ve limited	-ve high	-ve major
	increased vehicle – animal collision; displacement of species due to traffic noise	O	-ve permanent	-ve limited	-ve medium	-ve moderate
2.3 Ecologically important areas including critical habitat (High sensitivity)	Loss of land from sanctuary area	D	-ve permanent	-ve limited	-ve medium	-ve moderate
	Labour camps, dust	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	No anticipated impacts	O	N	N	N	N
3. Social environment						
3.1 Private land and buildings (Low sensitivity)	180-200 temporary structure and two shrines likely to be affected due to widening of road section	D	-ve permanent	-ve local	-ve medium	-ve moderate
	Limited use of private land	C	-ve temporary	-ve local	-ve low	-ve minor
	Possible impacts are not directly attributable to the project	O	N	N	N	N

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
3.2 Public property/infrastructure/ utility structures (Low sensitivity)	Utility shifting preparation	D	-ve temporary	-ve local	-ve low	-ve minor
	Utility shifting	C	-ve temporary	-ve local	-ve low	-ve minor
	No anticipated impacts	O	N	N	N	N
3.3 Noise (Medium sensitivity)	Road widening will produce noise levels higher than ambient noise levels	D	-ve temporary	-ve local	-ve low	-ve minor
	Quarrying, material transport and storage, drilling, blasting and hill cutting, pavement works, culvert and bridge construction	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Incremental noise <3 dB	O	N	N	N	N
3.4 Vibration (Medium sensitivity)	None	D	N	N	N	N
	Construction machinery	C	-ve temporary	-ve local	-ve medium	-ve moderate
	Vibration due to uneven road surface	O	-ve temporary	-ve local	-ve low	-ve minor
3.5 Occupational health and safety (Medium sensitivity)	No anticipated impacts	D	N	N	N	N
	Labour camp, drainage work, culvert and bridge construction, stripping of top soil	C	-ve temporary	-ve local	-ve medium	-ve moderate
	No anticipated impacts	O	N	N	N	N
3.6 Public health and safety (High sensitivity)	No anticipated impacts	D	N	N	N	N
	Labour camp activities, material transport and storage, debris generation	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Better access to healthcare and education	O	+ve permanent	+ve limited	+ve medium	+ve
3.7 Physical cultural resources (PCR) (High sensitivity)	None	D, C, O	N	N	N	N

Note: +ve = positive impact; -ve = negative impact; C = construction stage; D = design & pre-construction stage; N = neutral; O = operation stage; VEC = valued environmental component

: positive impact : minor negative impact : moderate negative impact : major negative impact

B. Impacts on Physical environment

292. 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.

1. Air quality and Greenhouse gas emissions

Design and pre-construction stage – neutral impact

293. The subproject aims to improve a section of 29.516 km of the existing national highway no. 102 (NH-102), now renamed as Asian Highway 1 (AH-1). Based on the capacity augmentation the present road section is proposed for improvement and upgrading to a two lane configuration with shoulders and side drains. Since there are no proposed alternatives, the project design itself does not have an impact on the air quality or GHG emissions.

Construction stage – moderate negative impact

294. **Impact**. During construction air quality may be negatively impacted for short periods due to (i) the exhaust emissions from the operation of construction equipment and machinery; (ii) fugitive emissions from brick, concrete, and asphalt plants; (iii) the dust generated from the haulage of materials, exposed soils and material stockpiles, fugitive dust from earth-moving operations and demolition; (iv) cutting and filling of hill slope; (v) cleaning of the road; (vi) material loading; (vii) unloading; (viii) blasting activities and (ix) increased traffic congestion in construction areas. The impact is expected to be localized, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimized.

295. The adverse impacts on air quality during construction stage were classified and presented in Table 61. There are two types of pollution i.e. dust pollution and pollution from harmful gases.

Table 61: Impact on Air Quality during Construction Stage

Sl. No.	Impact	Source
1.	Generation of dust	• 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; • 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 leveling, clearing of trees, laying of asphalt, construction of bridges; • Concrete batching plants; • Asphalt mix plants – due to the mixing of aggregates with bitumen; and

Sl. No.	Impact	Source
		• Construction of structures and allied activities
2.	Generation of harmful emissions 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.

362. **Mitigation measures**. The project road length Khongkhang - Moreh section pass through forest areas and presently air/dust pollution is not a major issue. In order to suppress any negative impact from the generation of dust during construction there will be regular watering of the road surfaces or the application of emulsion coats near villages, where dust is a nuisance. Provisions will be incorporated into the contractor's contract to require the use of dust suppression measures.

363. 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:

- regular check-up and maintenance of construction equipment is required;
- idling of engines is strongly 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 minimize 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;
- bitumen heaters should be used and the use of wood for fuel prohibited.

364. **Residual impact.** With the proper application of the proposed mitigation measures a residual impact on the air quality during construction phase is not to be expected.

Operation stage – minor negative impact

365. **Impact.** To assess the likely impact on air quality 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.

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

367. ***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 62 at five locations along with future traffic growth.

Table 62: 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

368. ***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 factors used in the present study for different vehicles type are given in Table 63.

Table 63: 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	6.00
Nox	0.31	0.6	0.32	1.46	9.01	9.30
PM	0.02	0.22	0.04	0.28	0.55	1.24
SO_2	0.01	0.01	0.03	0.06	0.13	0.13

369. ***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.

370. ***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 center line of the carriageway to know the dispersion of pollutant from the road.

371. ***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 background pollutant concentrations that were taken for model predictions are listed in Table 64.

Table 64: Average concentration of pollutants

Pollutant	Microgram/m^3 (24hr)
CO	**0.0**
NOx	**13.0**
$PM_{2.5}$	**31.3**
PM_{10}	**63.8**
SO_2	**6.6**

372. ***Predicted Pollution Levels*:** The model has been setup and run to predict hourly average CO, PM2.5, PM10, NOx and SO_2 concentrations for the years 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 65 to 69 for proposed highway project.

Table 65: 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	0.9	0.6	0.6
2030	5.5	7.0	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	13.0	3.0	1.3	0.9	1.0
2040	7.9	10.0	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 limits							-								-
GOI limits							4000								4000

Table 66: 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		32.0	31.7	31.5	31.3	31.3	31.3	31.3

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
2035	31.4	31.4	31.4	31.5	31.7	31.9	32.1	32.0	31.8	31.6	31.4	31.3	31.3	31.3
2040	31.4	31.4	31.4	31.5	31.7	32.0	32.2	32.2	31.9	31.6	31.4	31.3	31.3	31.3
WB limits	25							25						
GOI limits	60							60						

Table 67: PM10 predicted concentrations (µg/m3) along the proposed road

Year	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)						
	-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	64.0	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	64.0	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	64.0	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 limits	50							50						
GOI limits	100							100						

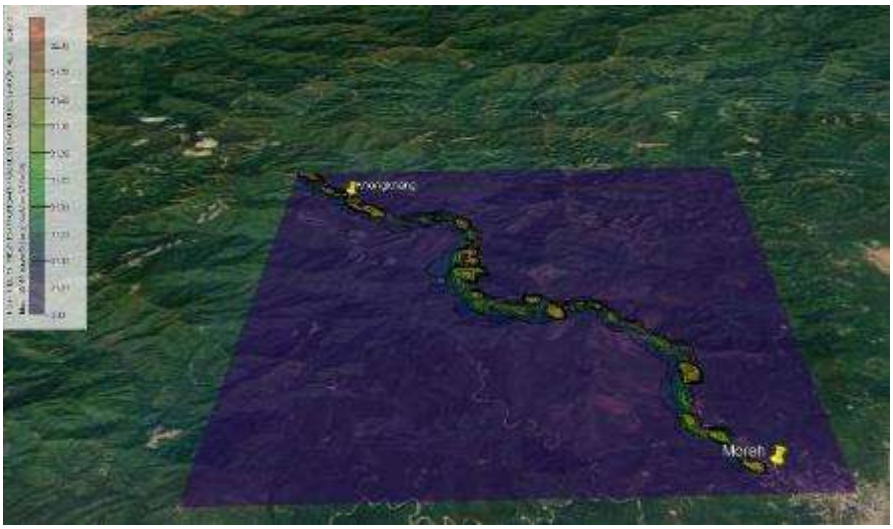
Table 68: NOx predicted concentrations (µg/m3) along the proposed road

Year	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)						
	-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	14.0	15.2	16.5	17.8	17.5	16.0	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	15.0	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	17.0	15.3	13.5	13.3	13.2	13.2
WB limits	40							40						
GOI limits	80							80						

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

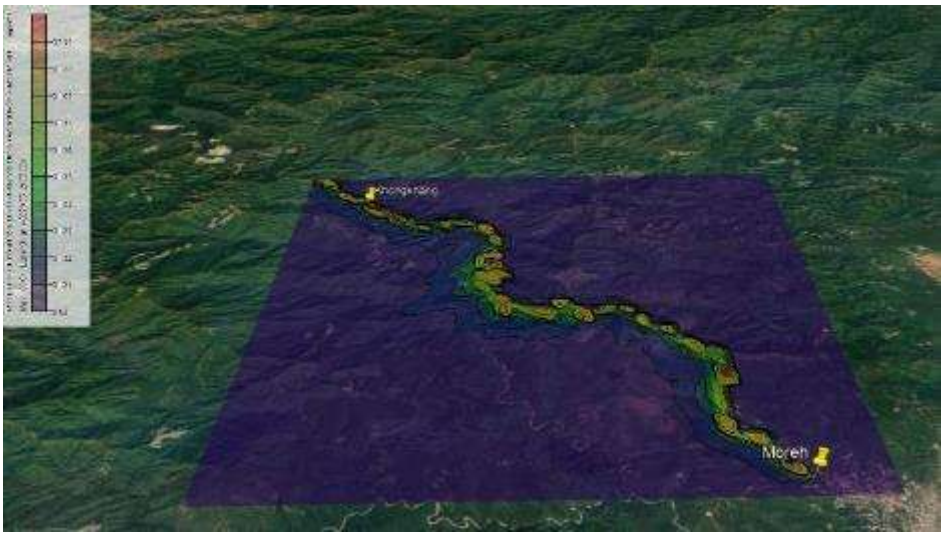
Year	SOx Concentration (µg/m3)													
	Distance from the centre line of the road, m. (Left side)							Distance from the centre line of the road, m. (Right side)						
	-200	-150	-100	-50	-20	-10	-5	5	10	20	50	100	150	200
2020	6.6	6.6	6.6	6.6	6.7	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6
2040	6.6	6.6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

373. In addition, the spatial distribution of hourly average predicted PM2.5 and PM10 concentrations have been plotted in Figures 36 and 37 respectively which shows that pollutant concentrations are decreasing when goes away from the curb 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

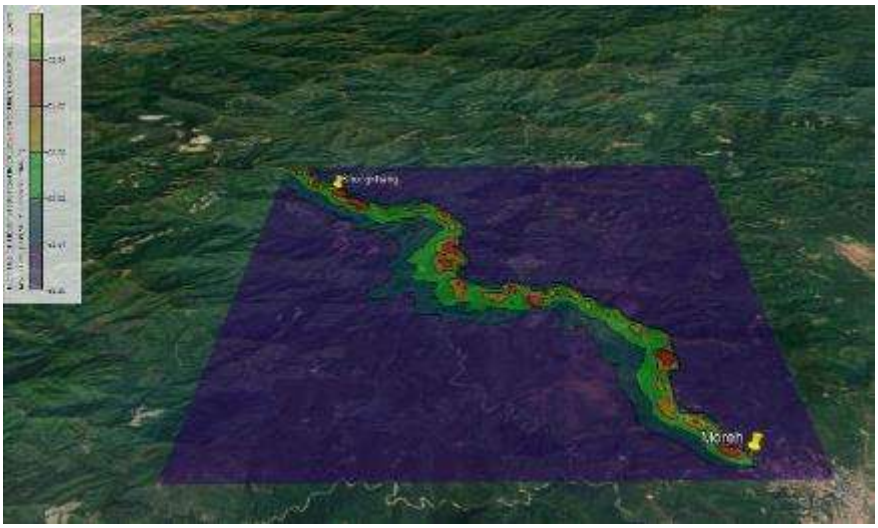
Spatial Distribution of $PM_{2.5}$ for year 2035

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

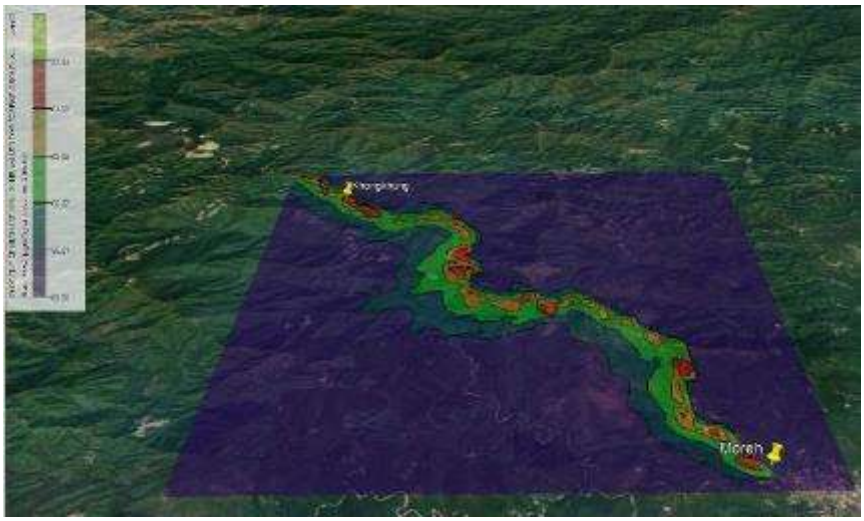
Figure 36: Spatial Distribution of $PM_{2.5}$ (2020-2040)

Spatial Distribution of PM_{10} for year 2020

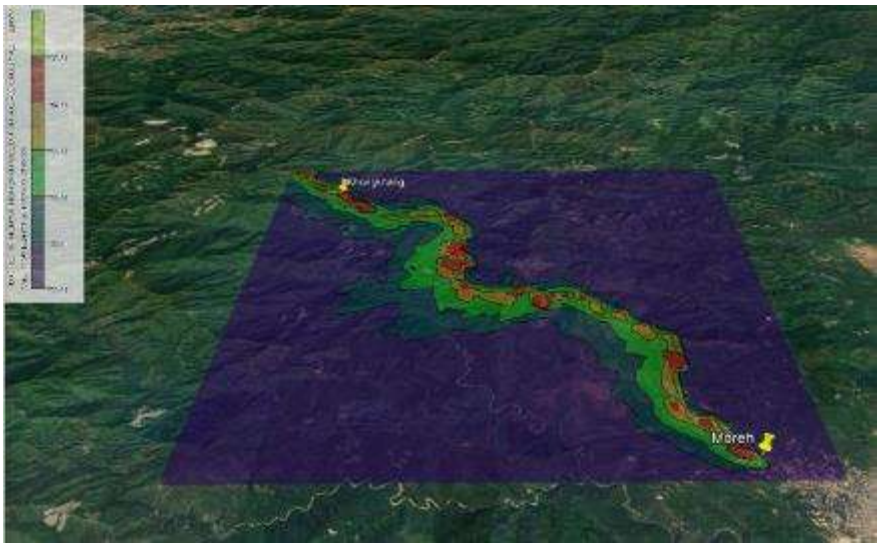
Spatial Distribution of PM_{10} for year 2025



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

374. **Mitigation measures**. 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, SO_2 and NOx over the existing ambient air quality are found to be within the National Ambient Air Quality Standards of CPCB but slightly higher than the World Bank EHS guideline limits for all the parameters monitored. Since the project will improve the road conditions it is not expected to cause significant increases in existing concentrations of pollutants. Therefore, no mitigation measures have to be taken.

375. **Residual Impact**. The model study shows that the project is not likely to cause air pollution in concentrations exceeding the National Ambient Air Quality Standards of CPCB and well as World Bank EHS standards. Therefore, the project will have no residual impact on the air quality.

2. Surface water quality and quantity

<u>Design and pre-construction stage – moderate negative impact</u>

376. During preliminary planning and design of this project, the Consultant has taken into account the need for:

- reduced incidence of slope failures due to inadequate drainage;
- providing adequate culverts/drains;
- providing side-drainage structures.

377. **Impact**. 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.

378. **Mitigation measures**. 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.

379. **Residual impact**. With the proper application of the proposed mitigation measures residual impacts on the surface water quality and quantity is not expected.

Construction stage - moderate negative impact

380. **Impact**. Construction water requirement (avg. 200 KLD 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.

381. 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.

382. 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. However, these impacts are expected to be minor as there are no perennial rivers along the proposed road alignment and construction will take place during dry period.

383. **Mitigation measures**. 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.

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

- maintain adequate vegetative cover above and below the road;
- maintain the natural course of water bodies (as much as possible) and avoid throwing debris into stream courses;
- 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 be lined to avoid percolation; and
- all debris and vegetation, clogging culverts are regularly cleared.

385. **Residual impact.** With the proper application of the proposed mitigation measures a residual impact on the surface water quality and quantity during construction is not to be expected.

Operation stage – neutral impact

386. Once construction is finished no impact on the surface water quality and quantity is expected. In order to check if unexpected erosion and siltation (including accidental spillage of pollutants from vehicles) in major water bodies is happening periodic surveillance will be conducted and mitigation measures will be taken if necessary.

3. Groundwater quality and quantity

Design and pre-construction stage – neutral impact

387. The use of groundwater is not envisaged in this subproject, water required for construction and construction sites will be sourced from surface water. Therefore, the design of the project has no impact on the quality or quantity of groundwater.

Construction stage - minor negative impact

388. **Impact.** The quality of the groundwater could be impacted at sites where process water or wastewater is generated and disposed of in an improper manner. This could be the case at labour camps, at temporary construction sites and at fuel stations.

389. **Mitigation measures**. Sewage generated at labour camps will be disposed in septic tanks which may be emptied periodically through local sewage disposal system. Latrines should be located away and downstream of any source for drinking water in order to prevent accidental contamination of drinking water sources. All latrines will be connected with a septic tank to ensure sewage is not released into the environment. Locations for fuelling and/or maintenance should be fitted with impervious flooring and a drainage system connected to an oil/water separator and settling tank to treat sewage before being discharged. More detail on the layout and requirements for labour camps and construction sites can be found in Annex 7: Plant Management and Annex 8: Camp Site Management.

390. **Residual impact**. With the proper application of the proposed mitigation measures a residual impact on the groundwater quality is not to be expected during construction.

Operation stage – neutral impact

391. During the operation stage of the project no impacts on groundwater quality or quantity are foreseen.

4. Land degradation and pollution

Design and pre-construction stage – minor negative impact

392. **Impact**. Construction activities of the project road will bring permanent changes in the local-level topography and appearance of the project site. There will be a change in aesthetic beauty of the project area mainly due to the earthwork.

393. The use of proper sources for stone and aggregates has become a major issue in most of the north-eastern 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.

394. 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.

395. 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.

396. The construction of hair-pin bends that are close to each other often adds to instability and should be prevented as much as possible.

397. **Mitigation measures.** During preliminary planning and design of this project, the Consultant has taken into account the need for:

- optimization of the centre line so that on all slopes below 60 degrees cut and fill have been equalized;
- temporary and permanent drainage systems to minimize soil erosion;
- optimum siting and control of quarries;
- mechanised construction methods.

398. 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 riverbeds 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.

399. 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 are applied for locating the borrow areas:

- If new borrow areas are opened for the project, they 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 minimize 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 away from forest/protected areas as per recommendations of local forest department;
- 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.

400. **Residual impact**. With the proper implementation of the proposed mitigation measures and low likelihood of the project requiring opening of new quarry sites the project is not expected to have a significant residual impact on the soil and local topography.

Construction stage - moderate negative impact

401. **Impact.** Scarring of landscape and potential landslides (rock slides/falls). There may be permanent changes in the landscape. Disposal of cut soils and debris at improper locations such as hillside below the road will make the area look untidy and unattractive. Disposal of waste and litter at improper locations and deforestation for firewood will make the area look dirty and unattractive.

402. 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.

403. 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.

404. 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. 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.

Image 21: Landslide Prone Location along Imphal - Moreh subproject Road

405. 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.

406. 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, if not containing Polycyclic Aromatic Hydrocarbons (PAH), is not regarded as a significant environmental hazard.

407. The project will require the import, transport, and use of fuel and oils. Minor diesel spills are common in region, especially around fuel stations.

408. **Mitigation measures**. During the construction phase the 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.

409. 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.

410. Mitigation measures for quarries are:

- aggregates will be first sourced from licensed quarry sites (which are in operation) that comply with environmental and other applicable regulations;
- quarries must use controlled and environmentally friendly quarrying techniques in order to minimize erosions and landslides (Annex 11 provides guidelines for quarry management);

- 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.

411. Mitigation measures for borrow areas are:

- 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.

412. Other mitigation measures to be taken during the construction phase are:

- blasting should not be carried out during busy periods and should use “controlled blasting” techniques in order to minimize damage to the topography, geology, and soil;
- 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;
- cut material should be disposed of in suitable depressions.

413. To mitigate the impacts of possible fuel spills the following measures will be applied:

- secondary containment around fuel tanks and at fuelling 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 riverbanks;
- the project will provide an opportunity to assist the PIU and contractors in improving fuel handling practices so as to minimize future fuel spillage.

414. 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 Kondong Lairembi village (temple).

415. 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.
- All hill/soil cutting areas should be re-vegetated as soon as construction activities are completed.
- 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.
- 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;
- control the disposal and ensure the vegetative stabilisation of spoil;
- 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 firewood.

416. 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.

417. **Residual impact.** With the proper application of the proposed mitigation measures the construction phase should not have any significant residual impact (except minor impacts for the initial years) on the soil or the local topography.

Operation stage – positive impact

418. Repairs to culverts and new drainage work will eliminate/reduce the soil erosion problems presently caused by poor cross drainage. The situation will remain good because this road passes through an area that is largely forested and trees and plants have the capacity to stabilize the soil and prevent soil erosion.

C. Impacts on Biological environment

5. Trees and vegetation

Design and pre-construction stage – moderate negative impact

419. **Impact.** The project road section (except Moreh town) passes though hilly terrain with forest areas and patches of agriculture fields. About 21.066 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 are expected. Nonetheless, land clearing will involve cutting of about 2013 trees and clearing of about 48.29 ha of forest land (outside the current ROW) and about 5 ha of forest land (inside the current ROW). 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.

420. **Mitigation measures**. To minimize loss of trees, the following mitigation measures have been 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 falling outside the sanctuary;
- 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;
- Budget provisions for following the mandatory afforestation program which requires planting trees at the rate of 1:3 for trees cut and improving a degraded forest at the rate of 1:1 for every ha of forest land acquired.
- Budget provisions and recruitment of a Biodiversity Organization (NGO or wildlife/forestry institute or consultancy firm etc.) to implement additional habitat improvement activities

421. **Residual impact**. As a result of the proposed afforestation program and additional habitat improvement activities it is expected that there will be a net gain of trees and vegetation under the project. It is expected that vegetation such as shrubs, herbs and bushes will re-establish themselves within one to two years after project construction. However, the trees will take longer (2-3 decades) to reach maturity. Hence, there will be no residual impacts in relation to smaller vegetation species such as shrubs, bushes etc. Residual impacts in relation to mature trees will be mitigated eventually after 2-3 decades after project construction.

Construction stage –moderate negative impact

422. **Impact.** 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 70 list out the locations of the forest area along the project road.

Table 70: 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

423. 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 71 present details of the trees to be cut due to proposed road improvement.

Table 71: 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[14] (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, LairikHeibi, KongongThopki, 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.

424. The project will require diversion of 48.29 ha. forest land (outside the current ROW) for widening of the road. This includes 14.19 ha from eco-sensitive zone and 34.10 ha from buffer zone of sanctuary (no land from core zone of sanctuary). An addition 5ha of forested land from inside the current ROW will need to be cleared. While some of the project area comprises degraded forests, areas to be cleared are overall broadly Natural Habitat. Meetei *et al.* (2017) found high quality dense forest in Manipur to hold approximately 700-900 trees of ≥30 cm girth per hectare. These densities are at the high end of those found in other parts of India, and current densities in areas bordering the Project road are likely to be considerably lower owing to degradation and (in the east) some areas of naturally more open forest. On a precautionary basis, it is assumed that areas of natural vegetation to be cleared may hold 100 trees/hectare and be of around 50% of natural quality. As such, clearance of 2,013 trees equates to clearance of just over 20 ha of such degraded forest. Overall, including areas within the existing right of way, the Project is thus anticipated to clear 25 ha of natural vegetation. Assuming 50% of this area is of good quality it is assumed that approximately Quality Hectares 13 of forest will be removed under the project.

425. A potentially significant indirect project impact on Critical Habitat is the introduction of invasive alien species (IAS). The Global Invasive Species Database (http://www.iucngisd.org/gisd) has records for 226 terrestrial or freshwater IAS in India, of which 134 are plants. IAS can spread rapidly once introduced, significantly modifying habitat for forest-dependent species, and present a very high risk to biodiversity globally. There is potential for construction machinery, equipment, or materials to introduce IAS to the Project site, particularly plants – e.g., as seeds within soil on machinery. Some of these species may not be introduced by the Project, but simply spread further. For example, the invasive American plant *Lantana camara* impacts forests by reducing recruitment of native tree species (Sharma & Raghubanshi 2007) and is already widespread in Manipur.

426. **Mitigation measures.** 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

[14] 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.

provided. The compensatory plan is being developed in consultation with local forest department.

427. As per the national mandatory afforestation program mentioned above, NHIDCL has paid the Forest Department to improve 48.29 ha of degraded forest near the Project area. Within that area, 6,039 native trees will be planted to compensate for those felled at the rate of 1:3. On a precautionary basis, it is assumed that only these trees will be planted and that at minimum 70% will survive for at least three years. This density of surviving trees (c. 87/ha) represents about 10% of that recorded in high quality dense forest in Manipur by Meetei et al. (2017). It also represents, when considering a 70% survival rate, about 10% of India's Forest Advisory Committee recommended compensatory afforestation rate of around 1,000 trees/ha (Kukreti 2019). Further, in a reasonable offset timeframe (20-30 years), these trees will not grow to maturity – perhaps reaching only 25% of their full size. Overall, this compensation action can thus be considered to have a positive benefit of 48.29 ha (area of tree planting) × 0.1 (quality gain to degraded habitat) × 0.25 (quality of planted trees at end of project life) = 1.20725 Quality Hectares (QH).

428. To meet the ADB SPS requirement of no net-loss of biodiversity an additional activity on improving habitat has been proposed inside the sanctuary. The recommended activity entails development of a sustainable landuse plan for 7 communities that are living inside YLWLS. This is proposed to be implemented by a Biodiversity Organization (NGO, Forestry/Wildlife Institute, consultancy firm etc.) in partnership with the local Forestry Department. A budget of $250,000 has been allocated for this activity. The habitat improvement activity may be modified or revised by the Biodiversity Organization if other options are found more suitable. However, the habitat improvement activity must ensure that the project results in compliance with ADB SPS's requirement on no net loss of biodiversity or net gain of biodiversity – at least 13 QH of habitat will be improved to compensate for the loss of 13QH of forest for the project road.

429. At this stage it is assumed that the sustainable land use plan will be implemented as the habitat improvement activity. Development of this plan is expected to result in organized and sustainable use of natural resources and hence result in improvement of habitat/forests surrounding the 7 communities. It is assumed that at minimum forests within 0.5km radius surrounding each community will be improved. Hence, a total of about 550ha will be improved. Following a conservative approach, it is assumed that at least 5% of this area will result in actual improvement. Hence, habitat quality gain across this area would equate to a biodiversity gain of approximately 27 Quality Hectares – more than double the estimated residual Project impacts of 13 QH.

430. In order to manage the risk of introducing or spreading invasive species into the forested area within which this Project is proposed, an Invasive Species Management Plan will be developed. This will include at minimum: pressure washing of vehicles, equipment and supplies before entry to Project roads (ideally at one access point before the Project); monitoring for invasive species across the Project area; and control/eradication of invasive species where found in the Project area. Washing need not use substantial amounts of water and can be replaced by brushing during any periods of low water supply.

431. **Residual Impact.** A mandatory compensatory afforestation program will be implemented by the Forestry Department as described above. It is expected that there will be a net gain of good quality forest. However, considering that it takes at least 2 – 3 decades for trees to reach maturity, it is expected that the net gain will fully take place some 20 – 30 years after project construction. Hence, there will be residual impacts in relation to loss of trees at the end of the project implementation period. However, this will eventually get mitigated over time as the trees grow.

Operation stage – positive impact

432. **Impact.** A net gain of about 15 QH of forest area is expected as a result of the mandatory compensatory afforestation program and additional habitat improvement activities to be implemented by the Biodiversity Organization. A summary of the net gain of biodiversity is provided in Table 72 below.

Table 72: Summary of Net Gain of Habitat

Loss of habitat			
Activity	**Area (ha)**	**Quality (%)**	**Quality Hectares (QH)**
Removal of 2013 trees from 48.28 ha of Forest Land (Assumption: 100 trees/ha in degraded areas, so only 20.13 ha of the land is actually forested)	20.13	50%	10.065
Clearing of vegetated land within ROW	5	50%	2.5
Total area of habitat lost	25.13		12.565 (A)
Habitat Compensation			
6039 trees to be planted at a ratio of 1:3 on the 48.28 ha of forest land (Assumptions: 1000 trees/ha is good quality; at 70% survival planting density is 87/ha; hence, 10% improvement; Planted trees reach only 25% of their full growth within project design life)	48.28	10% × 25% = 2.5%	1.207
2. Sustainable land use plan for 7 villages inside YLWS (7 villages x 0.5 km radius = 550ha)	550	5%	27.5
Total area of habitat compensated	598.28		28.7 (B)
Net Gain of Quality Hectares (B – A) = 15.5			

433. 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.

434. 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 T*ectonagrandis, Dipterocarpus turbinatus, Dipterocarpus tuberculaus, Melonarrhoeausitata, DuabangaSonnoroedes, Dilleniapentagyna, Terminalliatomentosa, Gmelina arborea, Bauhinia spps*., some species of bamboos, orchids, etc.

6. Fauna

Design and pre-construction stage – major negative impact

435. **Impact**. Species based analysis following IFC PF 6 threshold criteria found the project area to be possible or actual Critical Habitat for 12 freshwater fishes, one bird (Green Peafowl), one mammal (Hume's rat), and one internationally-recognized site - the YLWLS which is also an IBA for the Green peafowl (see Table 53 under chapter IV). Significant uncertainty remains in the conclusions of this assessment, given very limited information and challenges with field data collection due to significant security risks in the project area. Hence, on a precautionary basis the features listed in Table 53 should all be considered priority biodiversity for the Project to avoid, mitigate and – if necessary – offset impacts upon. In general, this will not pose challenges to the Project as most priority biodiversity is confined to forests, rivers, and streams outside of the direct Project footprint. More extensive details of why each feature meets Critical Habitat criteria are given in Annex 15.

436. The critical wildlife habitat tests using the biodiversity decision framework tool of IFC, World Bank as shown in Table 73 indicates that there will be no major or severe impacts on the critical habitat and species triggering critical habitat.

Table 73: 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 consulted in the process of environmental impact assessment and their views were incorporated in the design of the Project. (Please see chapter VII, table 87)
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?	Highly unlikely; With the implementation of the BAP risks for reduction of species triggering critical habitat (12 fishes, 1 bird, 1 mammal) is expected to be low.
6.	Will there be measurable adverse impacts, or likelihood of such, on the habitat's ability to support its	Highly unlikely; since project will avoid the damage of critical habitat area of YLWLS; will restrict felling of tall, matured and fruiting

Sl. No.	Question	Answer
	high value species and functions?	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.

437. Based on the wildlife species that trigger critical habitat and other wildlife species in the project area it is likely that the existing road already represents a significant barrier to wildlife crossings, particularly for arboreal species or larger species such as Green Peafowl and Western Hoolock Gibbon. This is particularly true for built-up areas in and westwards of Moreh town, now encompassing much of the length of the road in the reserve buffer zone along the road to the border. There is a limited amount that can be done to promote ecological connectivity in these built-up areas. Satellite imagery does suggest, however, potential for enhancing connectivity across the road in the 8.4 km of the road within the sanctuary's eco-sensitive zone and the westernmost 9.1 km of the road within the sanctuary (bordered to the south for most of its length by the core zone) as well as in some locations west of the reserve where good forest remains on both sides of the road.

438. **Mitigation measures**. The project design includes 2 bridges and 125 culverts. Ledges/shelves are proposed to be fitted on all the culverts to enable them to be used by smaller species such as the Hume's rate, pangolins and reptiles and amphibians. The two bridges (chainage km 405.540 and km 408.465) and 125 culverts provided in 21.066 km length of the alignment passes through or bordering the YLWLS. The locations of the two bridges and two culverts are also among the four animal/wildlife crossing points identified along the alignment. Additional provision of 23 culverts have been made in the BOQ, which can be constructed in sanctuary area if found necessary. 20 rope ladders have been proposed to be constructed across the road to enable movement of gibbons, langurs, and other arboreal species. A pre-construction stage wildlife survey will be carried out by the Biodiversity Consultant to confirm the exact location of the rope ladders and finalizing the design of the shelves/ledges to be fitted to the culvert.

439. **Residual impact**. Considering the presence of YLWLS some residual impacts are anticipated. However due to the proposed mitigation measures in the design the residual impact on the terrestrial fauna is expected to be low.

Construction stage - moderate negative impact

440. **Impact**. Given the presence of several restricted range fish species with populations possibly more than 10% of the global population in rivers in the project area there will be moderate risks for these fishes during construction. Only two minor bridges shorter than 60m in length will be improved under the project. However, bridge improvement works have potential for significant disturbance on aquatic habitat and species, and loud underwater noise can cause injury or mortality in some species through damage to internal organs after vibration

or bursting of the swim bladder (e.g., Halvorsen *et al.* 2012). Extraction of riverbed material for constructing the road could result in destroying the aquatic habitat of the fishes. However, borrow materials are generally sourced from barren land and rarely from the riverbeds and banks. Hence, the overall risk level for impacts on fishes is considered to be moderate.

441. Construction activities are likely to cause some disturbance to the wildlife population particularly in areas along 21.066 km length of project road which passes through buffer/tourism zones of YLWLS. 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.

442. 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. The risk of unsustainable exploitation of Hume's Rat by construction workers is considered to be a low. Given likely low populations of Green Peafowl in the area, the potential risk of unsustainable exploitation of this bird by construction workers is assessed to be of medium.

443. An overview of the impact assessment of the 12 fish species, Green pea fowl, Hume's rat and the IBA (YLWLS) which triggers critical habitat is provided in table 2 of appendix 12.

444. **Mitigation measures**. Road construction works will be allowed only during the dry season following winter timing from 8.00am till 4.00pm to minimize disturbance to wildlife. 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 of about 35km/hour will be posted on both sides of road in YLWLS area to caution travellers of possible dangers of collision with elephants. Exact location of signage posting will be determined by the Biodiversity Specialist/Consultant in consultation with the local Wildlife/Forestry officials. 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 Biodiversity Specialist in collaboration with the Wildlife/Forestry officials will determine plant species suitable for wildlife habitat enrichment.

445. Construction workers might 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 in the vicinity of the YLWLS area. Minimum distances between these construction facilities and the sanctuary areas will be as per the recommendations of the YLWLS/forest department and statutory environmental permits. 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.

446. In order to avoid and minimize other negative impacts on wildlife, 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.
- Wildlife information boards should be installed at the required project sites.
- Noise generating equipment like DG set, compressors will have acoustic enclosures. Noise generating activities should not be permitted during night.

- Speed limit signage warning drivers to move slowly at about 35 km/hour in wildlife movement areas.
- If any wild animal (except birds) 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
- 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 away from the forest stretches at suitable distances recommended by the environmental permits and local Forestry Department.
- Employment agreements should specify heavy penalties for illegal hunting, fishing, trapping and wildlife trading – all other ancillary works should also agree not to participate in such activities.
- Strict anti-poaching surveillance measures will be implemented, especially during project construction phase in the areas of YLWLS.

447. In addition to the above, measures described in the following paragraphs will be followed to avoid impacts on species triggering critical habitat criteria and other important endangered species.

448. **Use only existing licensed quarries outside of rivers and streams for sourcing aggregates.** Some existing licensed quarries may be situated within rivers or streams – particularly for sourcing sand and gravel. These may be having impacts, particularly downstream impacts, on these waterways, which are all considered Critical Habitat in the region of Manipur near the Project (Section 3.2). Further, any newly-established quarries – whether inside or outside of rivers and streams – have potential to clear Natural Habitat. These risks can be simply and effectively avoided by sourcing of all aggregates only from existing licensed quarries outside of rivers and streams.

449. **Avoid borrow pits in areas of Natural Habitat and within 200 m of waterways.** No borrow pits will be allowed at least 200 m next to waterways. This will help avoid risks of run-off and sedimentation impacting aquatic Critical Habitat. Further, to avoid additional Project impacts on Natural Habitat, no borrow pits will be established in areas of Natural Habitat. Borrow pits will therefore need to be established within the road right of way or in heavily degraded areas outside of the Project area.

450. **Design, install and maintain wildlife crossings under and over the road**. Connectivity for small- and medium-sized species, such as Hume's Rat and pangolins, can be facilitated by appropriate design of culverts under the road. Most studies on use of culverts for crossing roads by mammals have been carried out in Europe and North America. However, pangolins have been seen regularly using culverts to crossroads in Singapore (Lee *et al.* 2018). If appropriately designed, culverts of only 0.5-1 m diameter are generally considered sufficient to serve as crossings for small mammals, and 1-1.5 m diameter for medium-sized mammals such as coyotes in the United States (e.g., Clevenger *et al.* 2002). Pipe culverts will be replaced during the Project with 125 box culverts measuring 1×1 m or 1.5×1.5 m (S.Choukiker *in litt.* 2020), sufficiently large for most terrestrial species of conservation concern known from the Project area. Permanent ledges (ideally of concrete) can be placed inside culverts to facilitate movement of reptiles and amphibians. The culverts should not be lined with metal, which can corrode (with resultant toxicity for amphibians: Fitzgibbon 2001), should have walkways or ledges above potential water levels in order to allow animals to cross while avoiding water (e.g., IENE 2003; Figure 38), and should not exit directly into drains from which animals cannot escape.

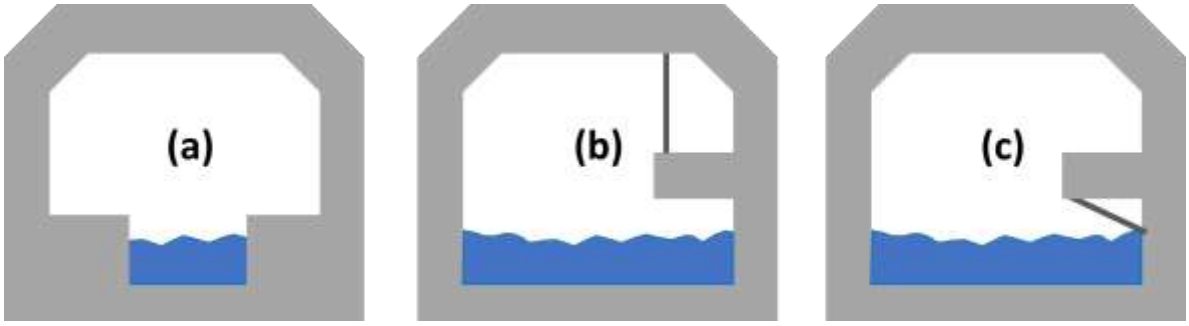


Figure 38. Schematic diagram of culverts with (a) walkways or (b) & (c) ledges above potential water levels in order to allow animals to cross while avoiding water (following IENE 2003)

451. Connectivity for arboreal species such as Western Hoolock Gibbon and Capped Langur could be enhanced by provision of arboreal bridges across the road. Bridges of up to 21 m in length (though not across roads) have, when appropriately designed, been used by Western Hoolock Gibbon in Assam and up to 12 m by Capped Langur (Das et al. 2009). While these species do not qualify the Project area as Critical Habitat, they are important and globally threatened components of the area's Natural Habitat. To ensure at least one passage within each individual's home range, crossings might be required approximately every 400 m along the road. However, neither species is widespread in the sanctuary, and so bridges would better be sited in fewer but more targeted locations based on knowledge of primate distribution from sanctuary staff and local people. Provisionally, it is estimated that 20 bridges may be suitable. Appropriate design should allow brachiation by gibbons (Figure 39) and be constructed of natural materials such as bamboo (Das et al. 2009). However, budget will be needed to maintain or replace these bridges at regular intervals, alongside other road maintenance.

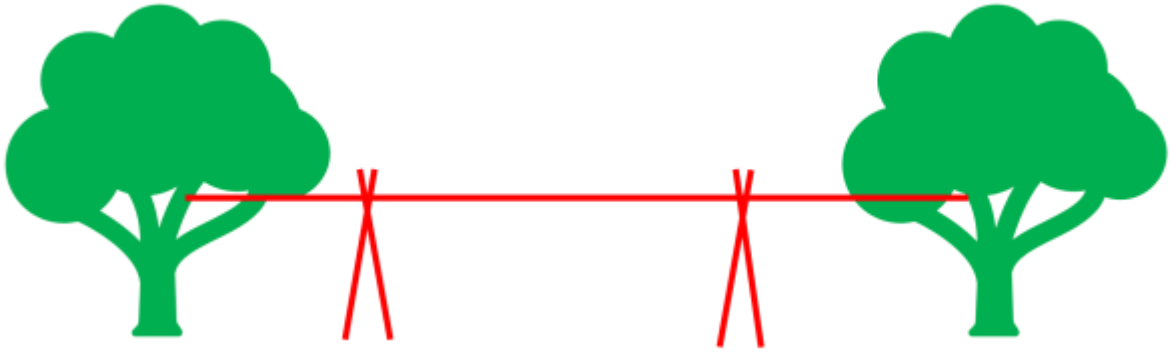


Figure 39. Schematic diagram of appropriately-designed gibbon bridge, allowing brachiation along its length, with trees in green and bamboo in red (following Das *et al.* 2009)

452. Culverts facilitating crossing under the road are sufficiently frequent that it is not considered a priority to site them in areas of frequent animal crossings. Further, there are particular challenges in conducting surveys in the Project area to determine crossing locations – travel along the road at night and surveys outside the road right of way are not allowed, and camera traps on the right of way are liable to high levels of loss or damage. It would, however, be practical and beneficial to conduct surveys to aid best siting of gibbon bridges. Such surveys would best be conducted by listening along the road in the morning for gibbon songs and interviews with local people and frequent road travellers in the afternoon, to determine areas where gibbons regularly occur near the road. They would ideally be conducted before construction begins, when disturbance to wildlife is at a lower level.

453. **Regulate against stopping alongside the road in the Yangoupokpi-Lokchao Wildlife Sanctuary, except in emergencies, advised by warning signs.** Increased traffic along the improved Project road is expected to result in greater traffic volumes. These may, in turn, result in increased disturbance and potentially increased illegal hunting, logging, or gathering of forest products (Sections 4.2.2-4.2.3). This risk could be substantially reduced by forbidding vehicles from stopping, other than for emergencies, within the protected area. Appropriate regulations should be put in place and advised by erection of 'No Stopping' warning signs. These should be erected at least every kilometer within the protected area, in both traffic directions. The road passes through the area for just over 21 km, necessitating at least 40 signs.

454. **Residual impact.** 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 and residual impacts on terrestrial fauna are expected to be insignificant.

Operation stage – positive impact

455. Following the impact assessment methodology used in MRDI (2019) (see appendix 12), residual impacts for Critical Habitat-qualifying ("priority") biodiversity and Natural Habitat, after the application of Project mitigation measures no significant residual impacts are anticipated on priority aquatic species or habitats by the operations phase of the Project. Similarly, residual impacts on other species not triggering critical habitat are expected to be low.

7. Ecologically important areas

Design and pre-construction stage – moderate negative impact

456. **Impact**. Ecologically important areas within the project area includes the YLWLS and rivers and aquatic habitat. The project includes rehabilitation of 2 minor bridges which pose medium risks for negative impacts on aquatic habitat harbouring restricted range fish species. There may also be a low risk of disturbance to aquatic habitat from sourcing of borrow material from riverbeds and banks for construction of the project road.

457. As discussed in para 424 on project impacts on flora the conversion of 48.29 ha of forest land and removal of 2013 is expected to result in the removal of 13 Quality Hectares of forest under the project.

458. **Mitigation measures.** Under the mandatory afforestation program approximately 1.2 Quality Hectares of forest will be improved (see details in para 426). An additional habitat improvement activity on developing a sustainable landuse plan inside the YLWLS will result in the improvement of 27 Quality Hectares of forest land (see details in para 427). Hence, habitat quality gain across this area would equate to a biodiversity gain of approximately 27 Quality Hectares – more than double the estimated residual Project impacts of 13 QH.

459. **Residual impact.** If the above mitigation measures get implemented as planned a net gain in forest land by 13 Quality Hectares is expected.

Construction stage - moderate negative impact

460. **Impact.** 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 also result from the following:

- increased forest harvesting for firewood, 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.

461. **Mitigation measures**. 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.

462. **Residual impact.** With the proper implementation of the proposed mitigation measures residual impacts from the project is expected to minimal.

Operation stage – positive impact

463. If the habitat improvement activities described in para 427 are implemented as planned an overall positive impact of more sustainable use of natural resources and improvement of forests is expected inside the sanctuary.

D. Impacts on Social Environment

464. The sensitive location such as school, college and hospital along subproject road within 100 meters from the edge of the existing road has been identified as given in Table 56. 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.

8. Private land and buildings

Design and pre-construction stage – moderate negative impact

465. **Impact**. 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. Community impacts are mostly due to the resettlement of people due to widening of the project road to 2 lanes.

466. 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. 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.

467. **Mitigation measures**. 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.

468. **Residual impact.** Since any foreseen impact on private land and buildings will be addressed in a separate resettlement plan no residual impacts are envisaged.

Construction stage –minor negative impact

469. **Impact.** At certain locations on the road, particularly at bridge/culvert 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.

470. **Mitigation measures**. In case private land is temporarily used during construction compensation will be paid for any loss of crops or the replacement of damaged structures. Most construction will be undertaken during the dry season when few crops are planted. Losses should be minimized during construction.

471. **Residual impact**. With adequate compensation for any damages resulting from using private land during construction no residual impacts are to be expected from construction.

Operation stage – neutral impact

472. 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.

9. Public infrastructure and utility structures

Design and pre-construction stage – minor negative impact

473. **Impact**. On the project road, utilities interfere with the ROW at few locations that will have to be shifted / removed prior to construction.

474. **Mitigation measures**. Before construction commences a detailed survey has to be carried out in order to list all utilities that will interfere with the road works. These utilities will have to be shifted before the works in close cooperation with the respective owners of the utilities.

475. **Residual impact.** With proper preparation no residual impacts are to be expected.

Construction stage –minor negative impact

476. **Impact.** 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.

477. **Mitigation measures.** Such hazard points will have proper signs indicating the nature of the problem envisaged. 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.

478. **Residual impact.** With the proper implementation of the proposed mitigation measures the construction of the project is not expected to have a residual impact on public utilities.

Operation stage – neutral impact

479. During the operation stage of the project no impact on public infrastructure and utilities is expected.

10. Noise and disturbance

Design and pre-construction stage – minor negative impact

480. **Impact.** 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.

481. 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 74.

Table 74: 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)

482. Piling, if necessary, will also cause noise and 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. The impact and sources of noise are summarised in Table 75.

Table 75: 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	• Mobilization 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.

483. Typical noise levels associated with various construction activities and equipment are presented in Table 76.

Table 76: Typical noise levels of principal construction equipment (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. December 31, 1971

484. **Mitigation measures**. By using noise reduction equipment, the hindrance from construction equipment can be minimized. By planning noise generating activities during daytime only hindrance to local residents can be minimized.

485. **Residual impact**. With the proper implementation of mitigation measures the project design is not expected to have a residual impact.

Construction stage - moderate negative impact

486. **Impact.** The noise levels indicated for various construction activities/equipment, while far exceeding permissible standards of CPCB and WB EHS for residential areas, will occur only intermittently. Still, these extremely high sound levels present real risk to the health of workers on- site.

487. 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.

488. 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.

489. Mitigation measures. 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.

490. Timely scheduling of construction activities, proper maintenance of construction machineries, use of personnel protective equipment, etc. will minimize these impacts.

491. 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.

492. 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.

493. **Residual impact**. With the proper implementation of the proposed mitigation measures the project construction is not expected to have any significant residual impact.

Operation stage – neutral impact

494. 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.

495. 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 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.

496. 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.

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

i. *Receivers*: TNM calculates the sound levels at the input receivers.
ii. *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.
iii. *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.
iv. *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.
v. *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 L_{AE} = Sound exposure level in dB[15]

[15] 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 77: 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

Table 78: 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 79: Predicted Noise Levels along the subproject road sections (dBA)

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

498. Prediction of operation stage noise modelling was carried out for day-time hours only as baseline data was collected only for 6am to 10pm. This is mainly because currently there is no traffic on the road after 6pm until 7am due to security issues in the project areas. Hence the noise predictions shown in Table 79 is for day time hours. Given the security risks in the project areas and military imposed restrictions on traffic movement on the highway from 6pm to 7am it is expected that night time noise levels will be low. Based on existing conditions it is expected that the current security issues and traffic restriction will remain at least for the next decade or so.

499. Table 79 shows 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 10 m. The predicted levels show increase in noise levels for future years at all receivers considering increase in traffic volume.

500. Table 80 below presents the existing and predicted noise levels for selected sensitive receptors that are closest to the project road. It is found that the incremental noise level due to current traffic and project traffic in 2035 will be less than 3 dB(A). Considering that sensitive

receptors that were closest to the road were selected, these are receptors that will experience highest level of noise generated by traffic. In addition, spot measurements at few sensitive receptors show much lower values compared to the traffic-based assessment indicating that there is noise attenuation by various existing barriers like trees, buildings etc. Therefore overall, the project is not expected to cause any noise impacts. The detailed noise assessment and prediction is presented in Annexure 6.

Table 80: Predicted Noise levels at sensitive receptors along the project corridor (Year 2035)

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	65.6	69.4	2.4	Insignificant
Angawadi Centre	LHS	412+500	412+600	5	67	65.6	69.4	2.4	Insignificant
Church	LHS	412+600	412+700	5	67	65.6	69.4	2.4	Insignificant
Market Area	LHS	414+400	414+700	5	70	65.6	71.3	1.3	Insignificant
Army Camp	RHS	414+400	414+800	10	70	63.0	70.8	0.8	Insignificant
T.M. Zomunnuam Village Primary SCHL	LHS	415+300	415+400	24	64	59.9	65.4	1.4	Insignificant
Community Hall	LHS	415+400	415+500	10	64	63.0	66.5	2.5	Insignificant
Church	RHS	419+300	419+400	8	64	61.7	66.0	2.0	Insignificant
Moreh college	LHS	421+500	421+700	50	64	56.1	64.7	0.7	Insignificant

501. 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. Figures 40 to 43 shows noise level contour around a small road corridor for year 2020, 2025, 2030, and 2035, 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 much less compared to noise level for peak traffic hours.

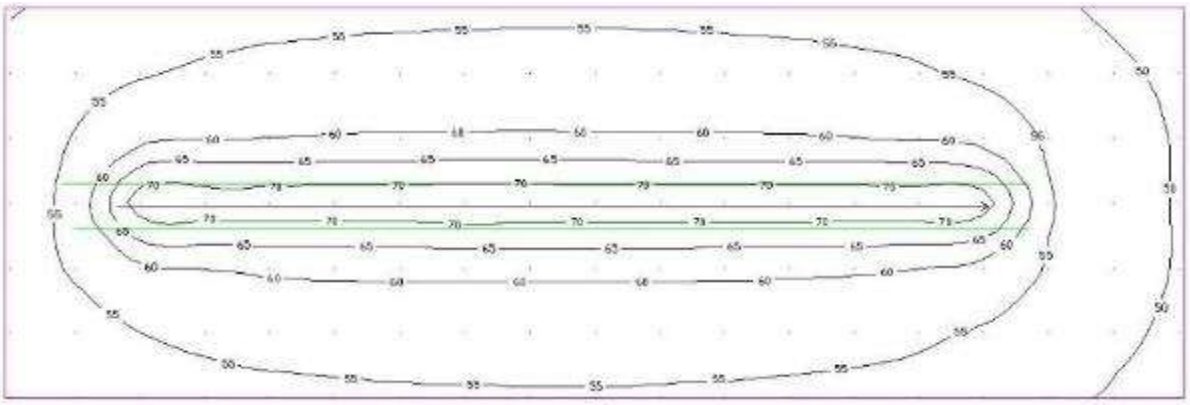


Figure 40: Noise contour for year 2020

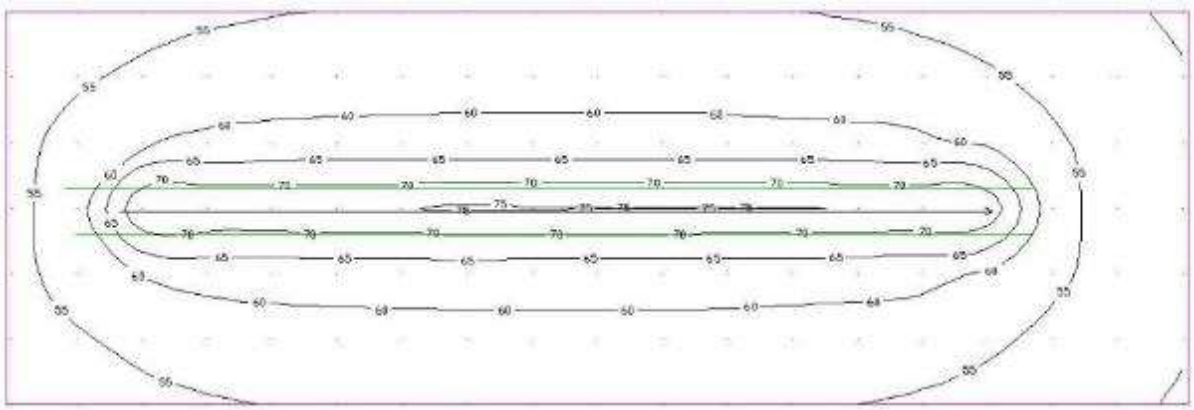


Figure 41: Noise contour for year 2025

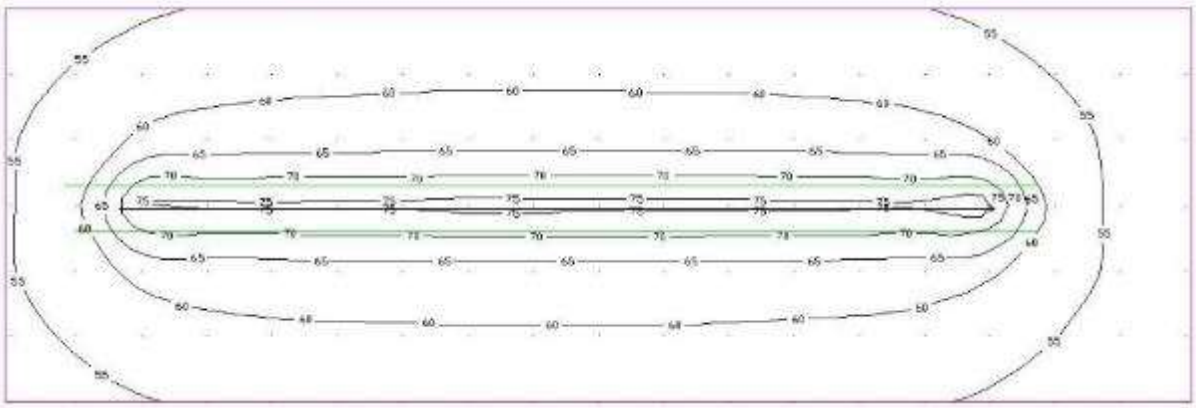


Figure 42: Noise contour for year 2030

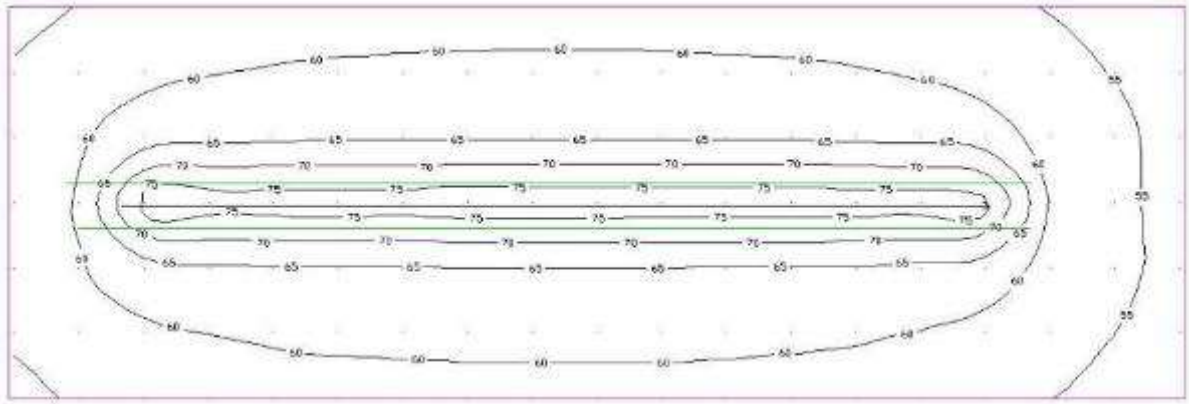


Figure 43: Noise contour for year 2035

502. Although estimated noise over the project duration shows higher noise levels at various receptor locations, an acceptable incremental increase of about 2.5 dB(A) is expected due to increased traffic over the designed life of the project (15 years). Most of this 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 planting of trees along the road therefore at present there are no physical noise barriers needed. However, the increase in noise is expected mainly for day-time hours as traffic is currently not allowed to travel on the road at night-time (6pm – 7am) due to security issues. It is expected that this situation will last for at least the next decade or so.

503. In case noise levels at sensitive receptors prove to be higher than expected the project foresees in installation of physical noise barriers at these sensitive locations. 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 kg/sqm). 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. In addition, traffic speed restrictions of 35 km/hour will be enforced in sections of the road with wildlife movement. This will further help to reduce traffic noise.

11. Vibration

Design and pre-construction stage – neutral impact

504. Existing ambient vibration levels at the sensitive receptors are low. Any impact on structures by means of vibration will be generated during the construction phase of the project, regardless of the design chosen.

Construction stage –moderate negative impact

505. 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.

506. The duration and amplitude of vibration generated by construction equipment 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 equipment, it is useful to categorize the equipment by the nature of the vibration generated.

507. 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)[16]

Table 81: Vibration generated from different construction equipments

Equipment	Reference PPV at 25 ft. (in/sec)
Vibratory Roller	0.210
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[17] for vibratory rollers)

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

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

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

D = distance from equipment to the receiver in ft.
n = 1.1, attenuation rate ([18])

509. 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 82: 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

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

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

[18] 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.

Building Vibration Damage Risk Level	Building Description	Cosmetic Damage Threshold ppv (mm/s)	Source Reference for Criteria	Assumed Building Coupling Loss
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 83: 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

510. **Impact.** Vibration monitoring was carried out at the sensitive receptors along the alignment and monitoring results are presented in Table 84. Details of study are given in Annex 14. The expected vibration levels during construction have been calculated using the empirical formula given by FTA (equation 1) and the results are presented in Table 84.

Table 84: 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

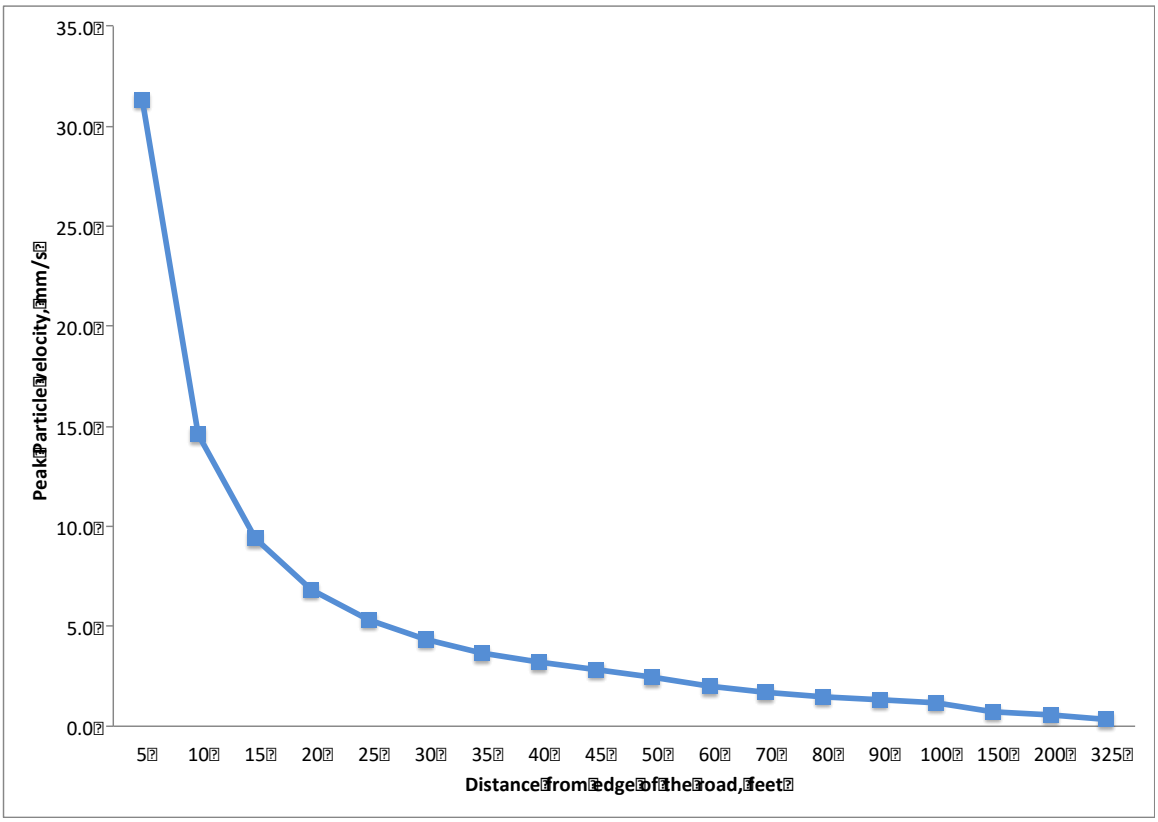


Figure 44: Vibration levels due to vibratory roller from edge of the road

511. 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. From the study it is found that buildings/structures within 4.5 m from edge of the road will have major impact of vibrations due to vibratory roller, as per BS 7385/DIN 4150 standards (see Figure 44). The sensitive receptors will encounter moderate impact of vibrations due to construction equipment.

512. **Mitigation measures**. For the structures within 4.5 m from road edge, suitable mitigation measures should be adopted to minimize the vibration levels. In case any structure is weak, a pre-construction survey of the building shall be done in detail by the Contractor, witnessed by the PMC as well as the property owner. Signed documents and photographic records will be kept as evidence to protect both the owner as well as the project from spurious claims.

513. 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.

514. 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.

515. **Residual impact.** With the proper implementation of the proposed mitigation measures the construction of the project is not expected to have a residual impact due to vibration.

Operation stage – minor negative impact

516. **Impact**. Because vehicles travelling 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 travelling 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.

517. **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.

518. **Residual impact**. The impact of vibrations due to road traffic will be negligible given the highway pavement is maintained at good condition.

12. Occupational health and safety

Design and pre-construction stage – neutral impact

519. No impacts on occupational health and safety are expected to derive from the design phase of the project.

Construction stage - moderate negative impact

520. **Impact**. 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;
- outbreaks of malaria, typhoid, cholera etc. amongst the labour force; and
  given the current COVID-19 pandemic there is also a risk of construction workers being exposed to this and other communicable viral diseases, particularly given construction is directly within the community and the transient nature of the construction workforce.

521. **Mitigation measures.** 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.

522. 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.

523. 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;
- ensure adequate security is provided to construction staff on site and at worker accommodation;
- workers will be required to undergo pre-employment medical screening and treatment (if required) and periodic health checks thereafter; and
- For COVID-19 related health and safety risk, the contractor will be required to prepare and implement a COVID-19 Action Plan.[19]

524. 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.

525. **Residual impact.** With proper implementation of the proposed mitigation measures the residual impact on occupational health and safety is expected to be low.

Operation stage – neutral impact

526. No impact on occupational health and safety is envisaged during operation phase of the project.

13. Community health and safety and local resources

Design and pre-construction stage – neutral impact

527. No impacts on community health and safety are expected to derive from the design phase of the project.

Construction stage –moderate negative impact

528. **Impact.** 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. The construction activities may also potentially result in adverse impacts to community health and safety such as construction traffic and accidents, and accidental spills of liquid materials.

[19] For COVID-19 national restrictions for containing the spread of COVID-19 must be complied with and in developing the health and safety management plan Government of India (https://www.mygov.in/covid-19) and World Health Organization guidance (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance) should be followed ensuring adequate sanitation and welfare facilities including for hand washing and personal protective equipment are provided to construction workers. Given the specialist nature of responding to COVID-19 public health officials/experts to be consulted.

529. **Mitigation measures.** To prevent problems between construction workers and the local communities, the contractor should provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment. During construction, benefits to local people can be maximized if the contractor recruit construction workers locally regardless of gender. Where possible, he/she should also not discriminate in the employment of women. The contractor will be required to develop a community health and safety plan which will also include emergency response and preparedness procedures.

530. The project will support a public health education programme for workers and villagers covering road safety, malaria, hygiene, sexually transmitted diseases, and COVID-19[20]. The district health departments will also be invited to participate in monitoring and educating communities and workers affected by the project.

531. **Residual impact.** With proper implementation of the proposed mitigation measures no residual impact is expected on the community health and safety.

Operation stage – positive impact

532. The improvements of the project road are 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, health and education, particularly in rural areas. Better access of agricultural goods to market will be important and a major contributor to poverty reduction. These benefits are likely to have a positive impact on community health.

14. Physical and Cultural Resources

533. There are no adverse impacts anticipated on historical places/monuments. However, there are few small shrines along the road. Care must be taken to clearly identify these structures before construction and avoid any damage to these structures. If necessary, these structures maybe moved after carrying out proper consultation with the local community people. Earthworks, as associated with the road construction/improvement works, or deriving from secondary sites such as quarries or borrow pits, may reveal sites or artefacts 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.

E. Induced and Cumulative Impacts

Adverse induced and cumulative impacts

534. 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.

[20] Particular attention to be paid to COVID-19 given construction is directly within the community and the transient nature of the construction workforce who could pass it to the community (especially those with existing medical conditions such as diabetes, heart and lung disease) and vice versa. Risk assessment to consider distribution and number of cases in India and Manipur in relation to home base of construction workers, options for travel to work – public or private transport, and the location of works and overnight worker accommodation. Particular attention will need to be paid to the ability of communities to comply with protective measures such as regular handwashing and for the local health care facilities capacity to deal with any infections. Given the specialist nature of responding to COVID-19 public health officials/experts to be consulted.

- 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 working close to the project road (mainly at Khongkhang, Lokchao, Khudengthabi and Moreh) will deteriorate during the construction period and afterwards during operation.

Positive induced and cumulative impact analysis

535. 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.

536. 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.

Induced and Cumulative Environmental Impacts

537. According to the ADB Environment Safeguards Sourcebook[21] 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.

538. **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.

539. 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

[21] Environment Safeguards, A Good Practice Sourcebook, Draft Working Document, December 2012

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 [22,23] 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 is 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);
- Timber and timber products (teak, hardwood & C class) – for use in 'Timber Park' at Moreh and for domestic demands: 50-60 truckloads 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 truckloads 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 point of view;
- Items of general trade & commerce: 40 to 60 truckloads daily. Items: Industrial goods & FMCG products, steel bars, cement, hardware, petroleum products, tyres, automobile parts, machinery, equipment, fabric, yarn, essential commodity products, tea, marine fish, crafts & handlooms products, minor forest products etc.

540. 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).

541. 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.

542. 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

[22] 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.

[23] Augmenting Bilateral Trade Between India &Myanmar, Country Report, Indian Chamber of Commerce, 2012

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.

543. Development of proposed new township[24] 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.

544. 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.

545. **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 traverses 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 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:

546. 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.

547. 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.

548. 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.

[24] Master Plan for new township at Moreh, Manipur (2013-2032) prepared by Town and Country Planning Organization, MoUD, Government of India.

549. 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 Biodiversity Consultant/Specialist will continue to monitor the effectiveness of these measures during the early stages of the project operation period and provide recommendations for improvement if necessary.

F. Expected Benefits from the Project

550. 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.

551. 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.

552. 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 lifestyles. Out-migration may result. There is also the likelihood of the relocation of homes and businesses to new road-side locations.

553. Likely adverse social impacts will include:

- 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.

VI. ANALYSIS OF ALTERNATIVES

A. Introduction

554. 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, alternative alignments would have cost implications and huge environmental impact therefore 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

555. **'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.

556. To avoid the large-scale acquisition of land and properties as well as impacts to the Yangoupokpi Lokchao Wildlife Sanctuary, 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.

557. '**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.

558. 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.

559. 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 85. 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 85: 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

560. 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.

561. 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.

562. No alternative alignments were assessed as part of the Khongkhang-Moreh section of NH-102.

563. 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 (new alignment will have about 35km length compared to 29.515 km).
- Land take from forest and private parties is less compared to new alignment, if proposed (70ha compared to 48.29 ha).
- Length of road passing through wildlife sanctuary is less (5 km length in core zone of wildlife sanctuary compared to none),
- NH section is geologically more stable (new section will be exposed to soil erosions and landslides), and
- Cost of construction is lower for 2 lane configuration road (for new 2 lane new road it will almost double compare to widening of existing road).

D. Alignment Modifications due to Environmental Considerations

564. 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

565. 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.

566. The final alignment considered after detailed survey and design is about 29.516 km 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

567. 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

568. 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

569. 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 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

570. 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 organizations/non-government organizations (NGOs),
- Government agencies, and

- Community leaders.

571. 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.

572. 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 no objection certificate 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;

573. The list of officials/ people contacted along with the venue, issues raised, date of consultation is presented on Table 86.

Table 86: 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 requirements of Manipur and GOI for the implementation of the Project.

Sl. No.	Name of Official Consulted	Department	Issue discussed
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. HeiriboTomba 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, Dept. of Environment Science, Manipur University, Imphal	Environmental quality and issues in the project areas. Research projects on biodiversity.
14.	Mr. Raj Kumar 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	Bird conservations programs in Yangoupokpoi Lokchao Wildlife Sanctuary, presence of threaten/endangered/vulnerable species of

Sl. No.	Name of Official Consulted	Department	Issue discussed
		Yangoupokpoi Lokchao 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

574. 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. Images 22-37 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.

Image 22: Consultation with Lokchao community head

Image 23: Consultation with Khudhengthabi community head

Image 24: Interview with local individuals from Khongkhang village during survey in ESZ area

Image 25: Interview with local individuals from village New Mongjang during survey in YLWLS

Image 26: Consultation with local community at Moreh

Image 27: Consultation with local community at Moreh

Image 28: Team discussion with DFO YLWLS for location identification for wildlife survey

Image 29: DFO-YLWLS at site near possible wildlife movement track crossing road near stream

Image 30: Interview with local individual who are visiting the forest area daily

Image 31: Discussion with village chief and local individuals from Khudhengthabi village after survey for verification of findings

Image 32: Interview with Lokchao village Chief for Wildlife Sanctuary area and animals' habitat

Image 33: Discussion with local from Lokchao village before survey for potential location of wildlife habitat

Image 34: Local community locating animal movement area from Core zone to ESZ of YLWLS

Image 35: Sign of animal (Sambhar) on paved road in ESZ in Khongkhang village

Image 36: Interview and discussion with village chief Khudhengthabi before start of survey in agriculture fields along the road

Image 37: Discussion with Lokchao village Chief after field survey along the road in Wildlife Sanctuary area for verification of findings

Images 22-37: Photographs of Consultations

575. 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 surveys in 2016. Details are given in Table 87.

Table 87: 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	-	
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)

576. 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.

577. Summary of public consultations through focused ground discussion (FGD) meetings organized is presented in Table 88.

Table 88: 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

578. 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.

579. 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.

580. 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.

581. 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. However, some people expressed concerns on the degradation of forests and reduction in wildlife due to development and human activities as they observed a reduction in the sighting of animals such as Leopard Cat, Golden Cat, Monitor lizard, Porcupine and Pangolin.

582. Overall, the general environmental conditions in the region are good and people have increased environmental awareness. Table 89 shows the result of public opinion survey carried out in the region.

Table 89: 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 vice versa.					

583. 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

584. 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.

585. 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.

586. Consultation will continue with these NGO's during finalization of EIA, and project implementation and operation.

F. Public Disclosure

587. The project executing agency 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

588. 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.

589. 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 executing agency level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the executing agency level will be forwarded to the GRC. The GRC will comprise members from the executing agency, implementing agency, Authority Engineer, contractor, local community, women groups and local forestry authority.

590. 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,
- Authority Engineers' main site office i.e. office of the Engineer's Representative; and
- NHIDCL's Branch Office i.e. Employer's field office.

591. 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.

592. 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 45 shows that Grievance Redress Mechanism.

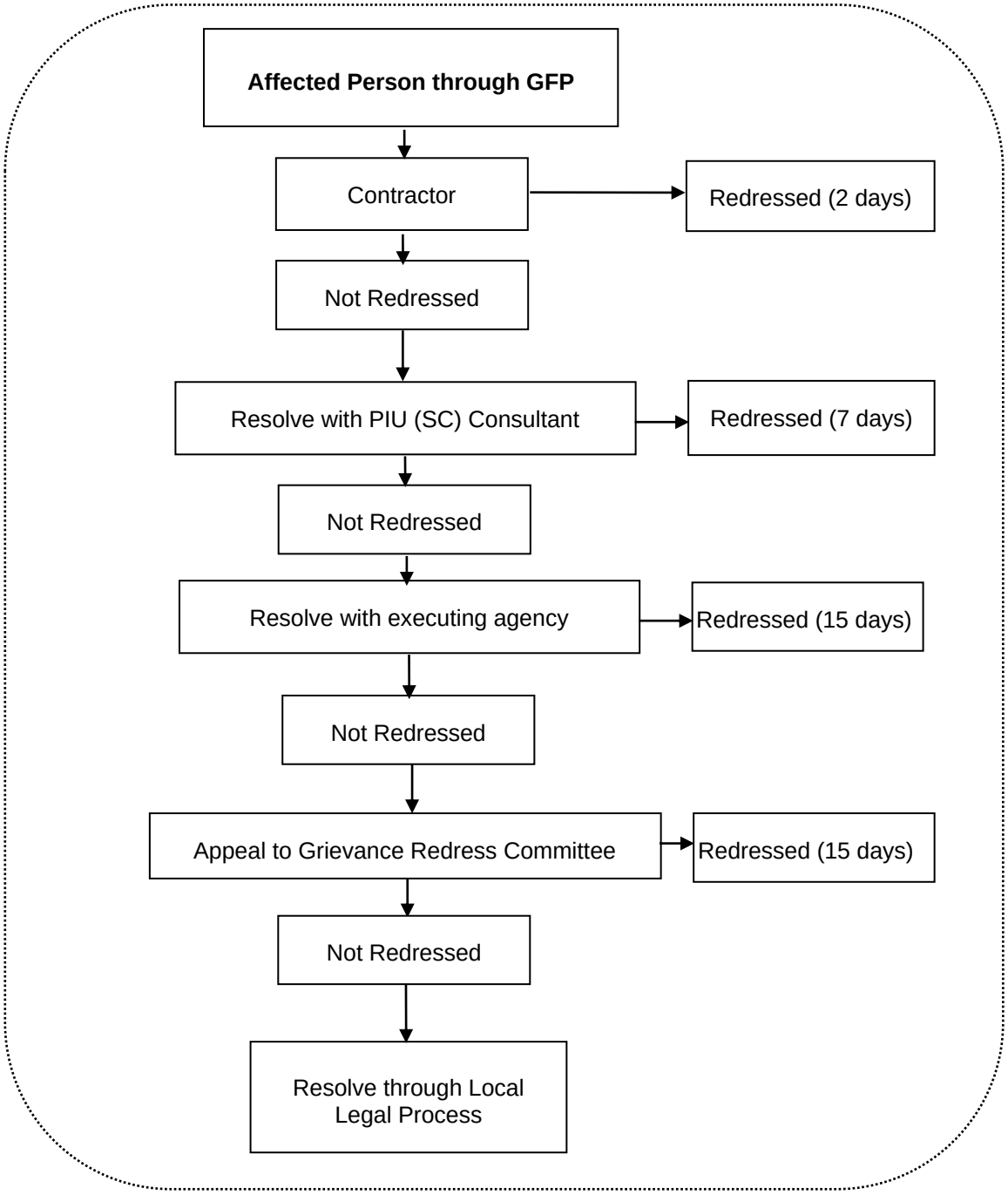


Figure 45: Grievance Redress Mechanism

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

593. 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.

594. 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 construction and operation; and
- Institutional arrangements to implement the EMP.

B. Objectives of Environmental Management Plan

595. The main objectives of this EMP are:

- To ensure compliance with Asian Development Bank's applicable safeguard policies, and regulatory requirements of the Government of Manipur and 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. Environmental Management Plan Matrix

596. The EMP matrix provided in Table 91 follows the environmental impacts and proposed mitigation measures for the 17 valued environmental components (VECs) identified and discussed in Chapter V. The matrix provides an implementable plan with recommended mitigation measures for each anticipated impact and also assigns responsibilities for implementation, supervision and monitoring.

597. The EMP matrix includes actions for the Biodiversity Action Plan (BAP) to mitigate and compensate for ecological impacts identified in the BAP provided as Appendix 12. Table 3 of the BAP lists out potential impacts and mitigation measures for each of the critical habitat qualifying wildlife species and ecological area. Mitigation measures from Table 3 have been integrated into the overall project EMP provided in Table 90.

D. Environmental Monitoring and Reporting Program

598. The 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.

599. An environmental monitoring plan (EMOP) has been developed to monitor the implementation of the EMP and track effectiveness of the mitigation measures. The EMOP matrix 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 91. Key features of the EMOP is described in the following paragraphs.

600. **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, NO_x 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.

601. ***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 (NO_x) and Sulphur Dioxide (SO_2). 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).

602. ***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.

603. ***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.

604. ***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 3 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.

Table 90: Environmental Management Plan Matrix

Note: This EMP Matrix will form part of the Conditions of Contract (CoC) for all contractors. PIU – Project Implementation Unit of NHIDCL, AE-Authority Engineer

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
A. DESIGN AND PRE-CONSTRUCTION STAGE				
I. Physical environment				
1. **Surface water quality and quantity** - Construction of culverts and bridges.	- Disruptions to the natural hydrology - Worsening of erosion problems	- Maintain natural courses of rivers and streams - Temporary diversions restored to their natural course as soon as possible - No disposal of construction debris in waterways	PIU	PIU
2. **Land degradation and pollution** - Road widening and related earthworks; - Collection, quarrying and use of stone, aggregates and sand. - Construction of hair-pin bends	- Permanent changes in the local-level topography and appearance of the project site. - Slope failure at quarry sites; - Road side instability due to stone collection; - The construction of hair-pin bends close to each other may add to instability. -	- Aggregates will be sourced from licensed local quarries; - Sand will be taken from quarries or river beds after prior permission from competent authority; - every new quarry and borrow area is subjected to a site-specific environmental investigation according to an approved plan; - new quarry and borrow areas must be left in a safe condition or restored to a productive land use; - borrow areas are not established in ecologically sensitive areas and should obtain necessary clearances including environmental clearance as required under EIA Notification 2006 and other GOI regulations; - 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; - borrow areas must be located away from the road and hill slopes as well as settlements facing the road, so as to minimize visual impacts.	PIU	PIU
II. Biological environment (Mitigation measures from Table 3 of Annex 15 have been incorporated here. Please check Annex 15 for further details on biodiversity action plan)				

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
3. Trees and vegetation - Clearing of vegetation from mostly natural habitat areas for hill cutting and other road improvement works; - Removal of trees	- Loss of 48.29 ha of forest land outside current ROW and 5ha of forest land inside current ROW; - Loss of 2013 trees - Net loss of 13 ha of good quality forest -	- Minimise removal of vegetation and width of road expansion in Yangoupokpi-Lokchao Wildlife Sanctuary to the extent possible. - Widening is restricted to minimum width in the length passing through YLWLS. Widening is proposed on the other side of the YLWLS; - the road improvement works will adopt Environmentally Friendly Road Construction (EFRC) methods and should minimise environmental impacts from inadequate drainage and/or slope failures and should assist in maintaining, or repairing, forest cover; - Mandatory compensatory afforestation program to improve 48. 29 ha of degraded forest and plant 6039 trees (@1:3) resulting in the improvement of 1.2ha of good quality forest.	Forest Dept./ PIU/EPC contractor	PIU/AE
4. Fauna - Location of the road in critical habitat of 12 fish species, 1 bird (Green Peafowl), and 1 mammal (Hume's rat) - Location of the road in habitat of other wildlife species not triggering critical habitat (CH) such as Western Hoolock Gibbon, Pangolin, Capped Langur and other species	- Damage and disruption of wildlife movement routes for wildlife species triggering CH and other species not triggering CH - Damage of aquatic habitat of 12 fish species triggering CH	- Design rope ladders for Western Hoolock Gibbon, Capped Langurs and other arboreal species - Design ledges/shelves to be fitted to 125 culverts within 21km passing through or near the sanctuary. These will be for use by smaller species such as Pangolins, Hume's rat and other reptile and amphibians - Undertake pre-construction wildlife surveys and update biodiversity action plan (BAP) to identify specific location for placing the rope ladders for the Western Hoolock Gibbon, Capped Langur and other arboreal species. - The design includes two bridges and 125 culverts within the 21 km length (one in every 170 m) of the alignment passing through or bordering the YLWLS, which can also serve as underpass for the wildlife/animal crossings.	EPC contractor/AE PIU Biodiversity Consultant Contractor + Biodiversity Consultant	PIU/AE

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
5. **Ecologically important areas** - Location of the project road inside a wildlife sanctuary and IBA	- Conversion of 48.29 ha with 2013 trees of forest land of the sanctuary to road ROW resulting in a net loss of 13 ha of good quality forest - Disturbance of ecological balance	- The loss of trees will be mitigated through the reforestation program (see terrestrial flora); - Re-vegetation of cut slopes and hillsides and support plantation of rare and endangered indigenous species as prioritized in the wildlife management plan of YLWLS where possible; - Mandatory compensatory afforestation program to improve 48. 29 ha of degraded forest and plant 6039 trees (@1:3) resulting in improvement of 1.2ha of good quality forest. - Development of additional habitat improvement activities – sustainable land use plans for 7 communities inside the sanctuary. This activity is estimated to result in the improvement of 27ha of good quality forest	PIU Forestry Dept. PIU/Biodiversity Organization	PIU
III. Social environment				
6. Private land and buildings - Road widening	- Resettlement of people; - Relocation of structures including 2 shrines	- A separate plan is prepared to address these issues	PIU	PIU
7. **Public property/ infrastructure/ utility structures** - Shifting of electric lines, water pipes, sewage lines, gas pipes and telecom lines	- Temporary outages of public utility services	- Before construction commences a detailed survey has to be carried out in order to list all utilities that will interfere with the road works; - Together with the respective owners of the utilities plans will be prepared how and when these utilities will be shifted before the works commence.	Utility Agencies/ PIU	AEPIU
8. **Noise and disturbance** - Operation of construction equipment and	- Increased noise levels causing discomfort to local residents, workers and local fauna	- Use of noise reduction equipment; - Planning noise generating activities during daytime.	AE/PIU	PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
machinery, hauling of materials and blasting works				
9. Health and safety (H&S) - Operation of construction equipment and machinery, hauling of materials and blasting works	- Construction activities causing health and safety risks to workers and communities.	- For all construction works comply with Government of India rules and regulations for the protection of workers. - For all construction works undertake risk assessment and prepare H&S plan in accordance with WBG EHS Guidelines for clearance by ADB, considering occupational and community H&S and including adherence to emergency preparedness and response plan with communication systems and protocols to report an emergency situation. - In undertaking H&S risk assessment and planning adequate attention to be given to the risks associated with COVID-19 pandemic and other communicable viral diseases. National restrictions for containing the spread of COVID-19 must be complied with and in developing the health and safety management plan Government of India (https://www.mygov.in/covid-19) and World Health Organization guidance (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance) should be followed. Contractor to ensure adequate sanitation and welfare facilities including for hand washing and personal protective equipment are provided and to consider the ability of communities to comply with protective measures such as regular handwashing and for the local health care facilities capacity to deal with any infections. Emergency preparedness and response plan to deal with situation should any construction worker or community member be diagnosed with COVID-19 during the course of the works. Given the specialist nature of responding to COVID-19 public	AE/PIU	PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
		health officials/experts to be consulted in undertaking the risk assessment and management planning for COVID-19. - Contractor to conduct training on occupational health and safety for all construction workers including refreshers. To include training for PIU and all Contractor management and construction workers including subcontractors before commencement of works. - Contractor to conduct training of workers on emergency preparedness and response procedures in case of an occupational or community health and safety incident during construction works.		
B. CONSTRUCTION STAGE				
I. Physical environment				
1. Air quality and GHGs - Operation of construction equipment and machinery; - Emissions from brick, concrete and asphalt plants; - Haulage and stockpiling of materials; - Controlled blasting and earthworks.	- Temporary localized increase in levels of dust and air pollutants including SO_2, NO_x and HC	- regular check-up and maintenance of construction equipment; - idling of engines is strongly 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 minimize dust generation and identify equipment to be used; - vehicles delivering loose and fine materials should be covered with tarpaulin 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;	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- bitumen heaters should be used, the use of firewood is prohibited		
2. Surface water quality and quantity - Use of surface water for construction and domestic use - Rehabilitation of existing bridges - Use and maintenance of construction equipment - Labour camps	- 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 - Soil erosion and downstream turbidity at bridge locations - Soil erosion due to changes in natural drainage systems. - Pollution due to use and maintenance of construction equipment; - Pollution caused by labour camps	- maintain adequate vegetative cover above and below the road; - maintain the natural course of water bodies (as much as possible) and avoid throwing debris into stream courses; - 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	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
		- all debris and vegetation, clogging culverts must be regularly cleared.		
3. Ground water quality and quantity - Operation of labour camps, temporary construction sites and fuelling stations	- Pollution of groundwater at sites where process water or wastewater is generated and disposed of in an improper manner.	- Sewage generated at labour camps should be disposed of in an environmentally sound manner. - Latrines should be located away and downstream of any source for drinking water in order to prevent contamination of drinking water sources. - Locations for fuelling and/or maintenance should be fitted with impervious flooring and a drainage system connected to an oil/water separator and settling tank to treat sewage before being discharged. - The layout of labour camps and construction sites should comply with the requirements in Annex 7: Plant Management and Annex 8: Camp Site Management	Contractor	AE/PIU
4. Land degradation/ pollution - Road construction through mountainous terrain with steep and unstable slopes; - Cutting and filling of hill slope for road improvement works - Disposal of cut soil, debris and waste at improper locations - Operation of quarry and borrow areas	- Scarring of landscape and potential landslides or rock falls; - Dirty and unattractive area due to presence of waste materials; - Soil erosion might lead to clogging of side drains, leading to spill-over of rainwater runoff; - Improper restored abandoned quarry and borrow areas can lead to soil erosion and vector borne diseases due to stagnant water.	- Excavation and earthworks should only be undertaken during the dry season; - Embankment grades should not be too steep; - The existing vegetation on slopes outside the immediate area of construction must remain undisturbed during construction and/or upgrading; - Cut slopes should be re-vegetated immediately after widening activities - 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 shall be monitored, and remedial actions initiated at the earliest possible time; - logging immediately above road should be restricted to reduce erosion/landslide potential; - quarrying along road ROW should be restricted;	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- blasting should not be carried out during busy periods and should use 'controlled blasting' techniques in order to minimize damage to the topography, geology and soil; - Cut material should be used in the construction works as much as possible, otherwise it has to be disposed of at proper disposal sites. The management of debris has to comply with the requirements in Annex 9: Debris Disposal Management. - Mitigation measures for quarry sites are: • Aggregates will be sourced from licensed operational quarry sites that comply with environmental and other applicable regulations on labour, dust suppression and the use of environmentally friendly quarrying techniques; • regular monitoring of the quarries by concerned authorities to ensure compliance with environmental management and monitoring measures; - Mitigation measures for borrow areas are: • Demarcation of the actual extent of area to be excavated; • 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. • 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:		

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- To mitigate the impacts of possible fuel spills the following measures will be applied: • secondary containment around fuel tanks and at fuelling 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 riverbanks; • the project will provide an opportunity to assist the PIU and contractors in improving fuel handling practices so as to minimize future fuel spillage. - Quarry and borrow sites must comply with the requirements in Annex 10: Borrow Area Management and Annex 11: Quarry Area Management.		
II. Biological environment (Mitigation measures from Table 3 of Annex 15 have been incorporated here. Please check Annex 15 for further details on biodiversity action plan)				
5. Trees and vegetation - Clearing of vegetation for hill cutting and other road improvement works; - Removal of 2013 trees	- Spread of invasive species by construction vehicles and machinery and transport of earth and construction material/debris - Loss of 48.29 ha of forest land outside current ROW and 5ha of forest land inside current ROW resulting in loss of 13 good quality ha of forest; - Loss of 2013 trees - Loss of habitat for terrestrial fauna. - Fragmentation of habitat due to loss of vegetation cover	- Avoid introduction of new invasive species to, and spread of existing invasive species within, the Project area through: washing of vehicles, equipment and supplies before entry to the Project area; monitoring for invasive species; and control/eradication of invasive species where found - Prohibit cleaning of construction vehicles/equipment within 300 m of waterways/drains - Use cuttings in construction; dispose of unsuitable cuttings away from Natural Habitat - Immediately plant native grass and tree species on cut slopes to reduce erosion - Prohibit collection, sale or purchase of timber/firewood by staff and contractors, with heavy penalties applied - Implement mandatory compensatory afforestation program to improve 48. 29 ha of degraded forest and	Contractor/ Forest Dept.	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	- Unintentional loss of vegetation cover due to landslides or dumping of cuttings - Degradation of vegetation due to timber/firewood collection	plant 6039 trees (@1:3) resulting in the improvement of 1.2ha of good quality forest. - Re-vegetation of cut slopes and hillsides; - Support plantation of rare and endangered indigenous species as prioritized in the wildlife management plan of YLWLS. - Habitat enrichment activities such as planting of native bamboos, fruiting and fodders trees will be carried out in collaboration with the Wildlife/Forestry Officials		
6. Fauna - Road widening activities, including hill cutting and steep slopes - Use of construction equipment; - Presence of labour camps	- Damage and disruption of wildlife movement routes for wildlife species triggering CH and other species not triggering CH - Degradation of aquatic habitat during construction from sedimentation, dust, sewage, or other construction waste - Degradation of habitat from hydrological changes - Increase in human-animal conflicts - Mortality of wildlife species triggering CH and others due to unsustainable exploitation by construction workers - Mortality of individuals due to vehicle collision	- Use only existing licensed quarries outside of rivers and streams for sourcing aggregates - Avoid borrow pits in areas of Natural Habitat and within 200 m of waterways - Only undertake earthworks during the dry season - Construct rope ladders for Western Hoolock Gibbon, Capped Langurs and other arboreal species - Install ledges/shelves in 125 culverts within 21km passing through or near the sanctuary for use by smaller species such as Pangolins, Hume's rat and other reptile and amphibians - Train staff and contractors in good environmental practice, and prohibited activities - Road construction works will be allowed only during dry season following winter timing from 8.00am till 6.00pm; - Total controlled blasting will be implemented if rock blasting is unavoidable; - Road signs will be posted on both sides of the road in YLWLS area to caution travellers of possible dangers of collision with wildlife and to limit travelling speed. Exact location of signage posting will be determined by Biodiversity Specialist along with	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	- Displacement of species due to noise, presence of machinery and equipment and presence of construction workers. - Injury and mortality of fishes due to underwater construction noise	Environmental Specialist in consultation with the Wildlife conservator; - Apply 20-30 km/hr speed limits for construction vehicles in Yangoupokpi-Lokchao Wildlife Sanctuary - Ensure contractors supply all necessary food, cooking fuel and appropriate housing - Restrict bridge construction works to the dry season - Avoid piling and blasting during construction the bridges - Maintain natural courses of rivers and streams - Restrict bridge construction works to the dry season in order to limit hydrological changes, erosion and runoff from construction areas - Restore temporary diversions to their natural courses as soon as possible - Prohibit siting of construction camps and disposal of construction waste within 500 m of waterways - Noise generating equipment like DG set, compressors and construction machinery will be equipped with acoustic enclosures and/or mufflers; - If any wild animal (except birds) comes within 100m from the construction site, construction works must immediately stop and resume only after the wild animal has moved away. - No construction or labour camps will be allowed close to the YLWLS area and biological Corridor. These sites to be selected in consultation and with prior approval from forest/wildlife department. - The contractor will clearly brief the construction workers on strict forestry rules on illegal harvesting of forest products, poaching of wildlife and illegal fishing; - Employment agreements should specify heavy penalties for illegal hunting, trapping and wildlife trading		

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
		– all other ancillary works should also agree not to participate in such activities; - Contractor will ensure supply of all necessary food items, cooking fuel and proper housing to prevent illegal hunting and tree felling; - Strict anti-poaching surveillance measures need to be implemented, especially during project construction phase in the areas of YLWLS.		
7. Ecologically important areas - road construction activities; - the cutting of hillsides and other earthworks; - quarrying, preparation and transfer of stone chips.	- Accumulation of dust on the surrounding vegetation; - increased forest harvesting for firewood, construction timber, forage, medicinal plants and other products - Conversion of 48.29 ha with 2013 trees of forest land of the sanctuary to road ROW resulting in a net loss of 13 ha of good quality forest - Disturbance of ecological balance	- water sprinkling should be properly and regularly undertaken, so that dust deposition problem on vegetation is minimised; - all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites; - all necessary wooden building material 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. - Implementation of additional habitat improvement activities – sustainable landuse plans for 7 communities inside the sanctuary to achieve a net gain of biodiversity. -	Contractor Biodiversity Organization	AE/PIU
III. Social environment				
8. Private land and buildings - Temporary road diversions	- Traffic may have to be diverted across private land adjacent to the road.	- Financial compensation for loss of crops or replacement of damaged structures.	Contractor/AE	PIU
9. Public property/ infrastructure/ utility structures	- Hinder and nuisance for road users.	- Proper signs indicating the nature of the problem envisaged; - Contractor will ensure that information on the timing of works and notifications of road closure (if any)	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
- Traffic diversions and temporary road closures		is provided via the local media (radio, TV, newspaper etc.) or through the local community heads.		
10. **Noise and disturbance** - Operation of construction equipment and machinery, hauling of materials and blasting works	- extremely high sound levels present real risk to the health of workers on- site; - sensitive areas within 100 m the roadways will be affected temporarily; - construction noise will affect the most communities living close to the construction zone	- Proper PPEs for on-site workers; - In construction sites within 500 metres of a settlement, noisy operations should cease between 22:00 and 06:00 hrs - To further 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). - Regular maintenance of construction vehicles and machinery; - Noise generating equipment and construction machinery will be equipped with acoustic enclosures and/or mufflers; - Timely scheduling of construction activities and communication to affected receptors; - Use of noise barriers where necessary.	Contractor	AE/PIU
11. **Vibration** - Operation of vibration rollers during ground preparation	- Model study shows buildings/structures within 4.5m from edge of the road will have major impact of vibrations; - Model study shows sensitive receptors will encounter moderate impact of vibrations due to construction equipment	- Use of wave barriers where structures are within 4.5m from the edge of the road; - Timely inform occupants of dwellings near the edge of the road of the nature, duration and potential vibration effects of the works	Contractor	AE/PIU
12. Occupational health and safety - Housing of up to 200 people for about two years	- Increase in the potential for the transmission of diseases and illnesses;	- Contractor must control the construction site, keep it clean and provide facilities such as dust bins and collectors for the temporary storage of all waste;	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
- Work in hazardous conditions	- Accidents and incidents due to hazardous working conditions	- 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; - All personnel working at vulnerable site locations will wear proper PPEs like (but not limited to) safety helmets, eye and ear protection and strong footwear; - Contractor must ensure that proper rescue equipment, fire extinguishers and first-aid equipment is available at all work locations at all times; - Contractor must submit and obtain approval for a health and safety plan prior to the commencement of work, provide adequate health care facilities and arrange pre-employment medical screening and treatment (if required) and periodic health checks thereafter for employed personnel; - support a public health education programme for workers and villagers covering road safety, malaria, hygiene, and sexually transmitted diseases with participation of the district health departments; - construction workers to be given medical check-up including checks for COVID-19 symptoms before being allowed on site; - provide PPE for workers in accordance with Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard in EHS Guidelines on OHS with additional PPE provided as needed for COVID-19 risks; - ensure employees are able to take time off sick without being penalized, including any self-isolation for COVID-19 that is required.		
13. **Community health and safety**	- Conflict between community and migrant workers	- the contractor should provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment;	Contractor	AE/PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
- Presence of labour camps		- Contractor should maximize recruitment of local construction workers regardless of gender; - Contractor will ensure affected communities are pre-informed of emergency procedures included in the agreed community health and safety plan and as appropriate given proximity of residents to works included in their mock drills etc. - contractors staff and local communities will also be given awareness raising in COVID-19, HIV/AIDS, other communicable diseases, and sexual, exploitation, abuse and harassment with strict penalties (e.g. immediate removal from site) for any non-compliance of workers to an agreed code of practice - display posters to promote handwashing and respiratory hygiene etc. - wherever possible, the contractor should not discriminate and should proactively encourage the employment of suitably skilled women on the project.		
C. OPERATION STAGE				
I. Physical environment				
1. Air quality and GHGs - Increase in traffic volume	- Increased levels of emission of typical transport related pollutants (PM 2.5, PM10, CO, SO_2 and NO_x)	- Atmospheric dispersion modelling shows that the project is not likely to cause air pollution in concentrations exceeding the National Ambient Air Quality Standards of CPCB as well as World Bank EHS standards in the next 20 years.	PIU	SPCB
2. Surface water quality and quantity - Functionality of implemented mitigation measures	- Unexpected erosion and siltation in major water bodies	- Periodic surveillance to check on siltation of major water bodies due to the completed road works	PIU	PIU

Activity/Valued Environment Component	Negative Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
II. Biological environment (Mitigation measures from Table 3 of Annex 15 have been incorporated here. Please check Annex 15 for further details on biodiversity action plan)				
1. Trees and terrestrial vegetation - Status of forests improved under the project to achieve net gain of forests	- low survival rate of trees planted - Poor performance of habitat improvement activities	- Monitor the forest improved to compensate for the 48.29 ha of forest and 2013 trees. Take remedial measures to ensure survivability rate after three years is at least 70% - Check the effectiveness of additional habitat improvement activities (sustainable landuse plans for 7 communities inside the sanctuary) and make adjustments and revisions to improve effectiveness. -	Forest Dept./ PIU Biodiversity Organization	PIU
2. Terrestrial fauna - Effectiveness of implemented mitigation measures	- Displacement of species due to noise from normal traffic or maintenance activities - Increased poaching from increased traffic through the area. - Mortality of individuals due to vehicle collision - Unforeseen human-animal conflicts	- Regulate against stopping alongside the road in the Yangoupokpi-Lokchao Wildlife Sanctuary, except in emergencies, advised by warning signs - Apply 20-30 km/hr speed limits for construction vehicles in Yangoupokpi-Lokchao Wildlife Sanctuary - Install speed breakers and animal crossing warning signs in Yangoupokpi-Lokchao Wildlife Sanctuary - Periodic surveillance and maintenance works to ensure that the rope ladders and culverts with ledges/shelves are effective in facilitating wildlife passage	YLWLS/ PIU	PIU
III. Social environment				
1. Noise - Increase in traffic volume	- Unexpected hindrance experienced by sensitive receptors	- Installation of additional noise barriers at sensitive receptor locations	PIU	PIU
2. **Vibration** - Road use by heavy trucks	- Nuisance experienced by occupants of dwellings near the edge of the road	- smoothen the pavement to eliminate the discontinuities	PIU	PIU

Table 91: Environmental Monitoring Plan (EMoP)

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							
Pre-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)	• Along the project road at different zone as suggested by AE for regular monitoring • At construction camps, hot mix plant and equipment yards locations	Once prior to start of construction	Continuous 24 hours/ or for 1 full working day Noise day time and noise time	Include additional measures in the EMP Provide noise barriers	Contractor Through approved monitoring agency	Authority Engineer, PIU
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 AE for regular monitoring • At hot mix plant and equipment 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	Authority Engineer, PIU
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 AE 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	Authority Engineer, PIU
Water Quality							

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
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	Authority Engineer, 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	Authority Engineer, 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	Authority Engineer, 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	Authority Engineer, PIU

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
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	Authority Engineer, 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	Authority Engineer, 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	Authority Engineer, 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
Wildlife (Follow details in biodiversity monitoring plan given in Table 6 of Annex 15)							
Pre-construction	Locations where Western Hoolock Gibbons and Capped Langurs are found along the road to identify locations for	Forest area and YLWLS areas	Once prior to construction (2 weeks	-	Corrective measures in BAP in coordination	Biodiversity Consultant	PIU, YLWLS authorities, ADB

Environmental Features / Stage	Parameters and Standards	Location	Frequency	Duration	Action Plan in case criteria exceeds the standards	Responsible party	
						Implementation	Supervision
	placing the rope ladders Wildlife presence, wildlife movement/crossing areas, accidents Cases of poaching		sampling period)		with wildlife authorities		
Construction	No of wildlife accidents Cases of poaching Dead animals on or next to road Appropriate canopy crossings (20) and ledges within all culverts (125) installed Number of animals of each species using crossings	Forest area and YLWLS area	Once every quarter	-	Corrective measures in coordination with wildlife authorities	Biodiversity Consultant	PIU, YLWLS authorities
Operation	No if wildlife accidents Number of animals of each species using crossings	Forest area and YLWLS area	One every six month for first 2 years	-	Corrective measures in coordination with wildlife	Biodiversity Consultant /PIU	PIU, YLWLS authorities, ADB

Note: PIU – Project Implementation Unit (NHIDCL), AE- Authority Engineer or Authority's Engineer

E. Institutional Arrangements

605. The Ministry of Road Transport and Highways (MORTH) will be the executing agency for the project and the implementing agency 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. Executing agency together with implementing agency 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 executing agency
- NHIDCL as subproject PIU and its environmental unit;
- Authority's Engineer i.e. Engineer;
- Biodiversity Consultants;
- Contractors;
- External monitor;
- Biodiversity Organization

606. The PIU will have an Environmental and Social Management Unit (ESMU). 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. ESMU 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.

607. 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.

608. PIU may engage independent agencies for carrying out environmental quality monitoring activities. The Authority Engineer shall be interacting with these agencies and facilitate them in carrying out such activities.

609. The Authority Engineer (AE) will have 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 environmental safeguard measures through supervision, monitoring and reporting on the same. Efforts must be made by the AE 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 AE 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 AE to supervise implementation of safeguard measures. His role would be more on advisory. He will assist the Team Leader of AE 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, AE 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.

610. The Biodiversity Specialist to be recruited under ADB TA 9761 will be responsible for carrying out the pre-construction wildlife survey and monitoring implementation of the BAP activities to be implemented by the contractor during project construction and until the end of the contractor's defect liability period. The Biodiversity Specialist will be assisted by 2 assistants. They will conduct quarterly monitoring during project construction and prepare semi-annual biodiversity monitoring reports. The terms of the reference of the Biodiversity Specialist is provided in Annex 16.

611. Besides, the Team Leader of AE 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 AE 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.

612. 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 biodiversity related activities. The terms of reference of the external monitor is provide in Annex 17.

613. To help the project comply with the ADB SPS requirement of no net loss of biodiversity and preferably a net gain a Biodiversity Organization will be recruited under the project to implement additional habitat improvement activities. The terms of reference of this organization is provided in Annex 18.

614. Responsibilities of various agencies involved in the project implementation are described in following paragraphs.

615. **Ministry of Roads Transport and Highways (MORTH).** As the executing agency MORTH'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 executing agency 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 implementing agency 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.

616. **Project Implementation Unit (PIU), National Highways Infrastructure Development Corporation Ltd. (NHIDCL).** NHIDCL will be the implementing agency for the project. A PIU within NHIDCL will be responsible for implementing environment safeguard requirements in accordance with the EIA, EMP and BAP at the subproject and site level. Specific responsibilities on environment safeguards of the PIU are:

- Ensure timely recruitment and mobilization of the environmental specialist under the Authority Engineer and the External monitor.
- Coordinate with the Forestry Department and support ADB TA consultants on biodiversity monitoring and habitat improvement activities.
- 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 available.
- 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 executing agency office.
- If any problems or long delays are encountered when processing the clearance documents, immediately alert the authorized officer at the executing agency level and seek ways resolve the problem at the soonest.
- Ensure that all necessary regulatory clearances are obtained prior to commencing any civil work of the respective contract package or road section.
- Ensure that the most recent version of the EMP (including BAP) and EMOP which include required mitigation measures and monitoring requirements with defined Bill of Quantity (BOQ), forms part of contractor's agreement
- Ensure that contractors have access to the EIA report including EMP, EMOP.
- Ensure that the Engineering Procurement and Construction (EPC) contractor updates the EMP, EMOP based on detailed design
- 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 equipment and facilities as detailed in EIA/IEE.
- With the support of the environmental officer of the contractors and AE ensure that the contractor implements the EMP (including BAP) and EMOP as given in the latest version of the EIA report.
- In case of unanticipated environmental impacts during project implementation stage, with the support of AE 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 if the project needs to be redesigned or there are unanticipated environmental impacts immediately inform ADB and jointly agree on whether the EIA needs to be revised or whether only the EMP and/or EMOP and/or BAP needs to be revised
- Conduct regular (monthly) site visits to ensure that the contractor is complying with the EMP, EMOP and BAP and the AE is conducting regular supervision and monitoring as outlined below in the next paragraph
- Ensure effective implementation of Grievance Redress Mechanism to address affected people's concerns and complaints.

- Conduct public consultations during project construction to seek feedback of the local community people and ensure that the project is not having adverse impacts on them
- Review, verify and endorse the monthly and semi-annual environmental monitoring reports submitted by the AE
- Review and endorse the quarterly and semi-annual biodiversity monitoring reports submitted by the biodiversity consultant
- Review and endorse all reports submitted by the Biodiversity Organization
- Review and endorse the quarterly and semi-annual environmental monitoring reports submitted by the external monitor
- Submit semi-annual environmental monitoring reports submitted by the AE and external monitor to ADB and make these reports available for public disclosure.

617. **Authority Engineer.** The Authority Engineer (AE) will support the PIU to supervise and monitor environment safeguard requirements in accordance with the EIA, EMP, and EMOP. The AE will include a team of environmental specialists and assistants. Details of environment safeguards related responsibilities of the AE is provided below.

- Conduct monthly site visits to check on the status of environment safeguards in relation to air, noise, water, soil, occupational health and safety
- Based on site visits and monthly reports submitted by the contractor prepare monthly environmental monitoring reports for the review and approval of NHIDCL
- Compile the monthly monitoring reports into semi-annual environmental monitoring reports and submitted and further submission to ADB for disclosure on the ADB website.
- In coordination with PIU, ensure that all necessary regulatory clearances are obtained prior to commencing any civil work of the respective contract package.
- Ensure that the EPC contractor updates the EMP and EMoP based on detailed design and implements them properly.
- Review and approve environment related sub plans such as camp layout plan, traffic management plan, borrow area management plan, construction debris management plan etc. to be submitted by the contractor
- Provide technical guidance to the contractor to ensure they 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 equipment and facilities as detailed in EIA.
- In case of non-compliances with the EMP and EMOP prepare a corrective action plan and ensure it is implemented
- In case during project implementation if the project needs to be redesigned or there are unanticipated environmental impacts immediately inform the PIU and provide recommendation on whether the EIA and EMP and EMOP needs to be revised
- Support the PIU to ensure effective implementation of Grievance Redress Mechanism to address affected people's concerns and complaints.
- Ensure regular consultations are taking place with affected communities and key stakeholders during construction as well as operation phases of the project.

618. **Biodiversity Consultant**. The Biodiversity consultant (BC) to be recruited and financed under ADB TA 9761[25] will support the PIU to supervise and monitor implementation of biodiversity components of the EIA, EMP, and EMOP. The BC will include a biodiversity expert to be supported by field assistants. Details of BC's responsibility is provided below.

[25] ADB Project 53225-001 IND: Strengthening Capacity to Design and Implement Transport Infrastructure Projects

- As mentioned in the BAP (Appendix 12) conduct pre-construction stage wildlife survey for identifying locations where Western Hoolock Gibbon and Capped Langurs are found to finalize locations for installing the rope ladders. Further details are provided in the TOR for the Biodiversity activities in Annex 16.
- Ensure that the EPC contractor designs and constructs the rope ladders and installs shelves/ledges in 125 culverts in the road section passing through and near the sanctuary boundary
- Conduct at least quarterly site visits to check on implementation of ecological activities and mitigation measures provided in the BAP (Table 3) which has been integrated in the EMP (Table 89)
- Based on site visits prepare quarterly biodiversity monitoring reports for the review and approval of NHIDCL
- Compile the quarterly monitoring reports into semi-annual biodiversity monitoring reports and submit it to NHIDCL for further submission to ADB for disclosure on the ADB website.
- Ensure that the EPC contractor updates the biodiversity components of the EMP and EMoP based on detailed design and implements them properly.
- Review and approve environment related sub plans such as camp layout plan, traffic management plan, borrow area management plan, construction debris management plan etc. to be submitted by the contractor
- Provide technical guidance to the contractor to ensure they understand their responsibilities to mitigate and minimize biodiversity impact associated with their construction activities.
- In case of non-compliances with the EMP, EMOP and BAP prepare a corrective action plan and ensure it is implemented.
- In case during project implementation if the project needs to be redesigned or there are unanticipated environmental impacts immediately inform the PIU and provide recommendation on whether the EIA and EMP, EMOP and BAP needs to be revised.
- Ensure regular consultations are taking place with affected communities and key stakeholders during construction as well as operation phases of the project.

619. **External Monitor.** The External Monitor will conduct third party monitoring of environment safeguard and wildlife protection activities. The following are a summary of the key responsibilities of the External Monitor. The terms of reference for this position is provided in Annex 17:

- Review the EIA, EMP and BAP to understand the background environmental and biodiversity issues of the subproject.
- Conduct third party monitoring of the implementation of the EMP, EMOP and BAP by the contractor and supervisory activities of the AE/AE through quarterly site visits and review of environment safeguard and wildlife protection related documents maintained by the contractor, AE/AE and PIU.
- Advise the PIU on the need for corrective actions if any.
- The External Monitor must not be involved in the day to day implementation and supervision of environment safeguards under the project
- Based on the observations from the site visits and review of documents and monitoring reports prepared by the contractor and AE/AE prepare semi-annual reports for submission to the PIU and onward to ADB for disclosure on the ADB website.

620. **Biodiversity Organization (BO).** This organization maybe an NGO or Forestry/wildlife institute or consultancy firm specialized in biodiversity or similar organizations. The BO will be

recruited and financed under ADB TA 9852[26]. Their responsibility is to implement additional habitat improvement activities to ensure that the project achieves the ADB SPS requirement of no net loss of biodiversity or preferably a net gain.

621. Based on the existing conservation challenges in YLWLS and habitat/tree compensatory activities that will be implemented under the project, the recommended approach to achieving a net gain in biodiversity is developing land use plans for 7 communities living inside the sanctuary. The selected Biodiversity Organization will first verify the feasibility of this approach in consultation with local communities and relevant government authorities. Assuming feasibility is verified, the Organization will then plan detailed activities for developing land use plans, and work with the local Forest Department/YLWS to implement these activities. The land use plans must be prepared in close consultation with, and under the approval of, the local Forest Department. If sufficient land use plans are not feasible, the Organization will work with NHIDCL, ADB and the local Forest/Wildlife Department to identify and support an alternate plan to achieve net gain in biodiversity. The terms of reference for the Biodiversity Organization is provided in Annex 18.

622. **ADB.** 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 executing agency and implementing agency 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 implementing agency on the format, content, and scope of the EIA or IEE reports and annual and/or semi-annual monitoring reports for submission to ADB.

623. **EPC Contractor.** 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.

624. 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;

[26] ADB Project 53136 - 001: REG: Improving safeguard implementation in South Asia.

- 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.

625. As mentioned above, there will be a 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 these 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, AE and Contractor who would be mobilized for this project. One day environmental orientation workshop will be organized by the PIU after most staff of the AE and contractor has been mobilized. The training program is included in Annex 13.

F. Environmental Reporting System

626. The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the AE, who in turn shall report to the PIU. All reporting by the contractor and AE shall be on a monthly basis. The AE will compile the monthly reports into semi-annual environmental monitoring reports and submit them to the PIU. The PIU shall be responsible for preparing targets for each of the identified EMP activities.

627. The PIU will review and endorse the monthly and semi-annual environmental monitoring reports submitted by the AE. The PIU will forward the semi-annual environmental monitoring reports to ADB for disclosure on the ADB website during the project construction period. During the operation stage the PIU will compile and submit annual environmental monitoring reports to ADB during the project operation stage until the Project Completion Report (PCR) is finalized.

628. 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. 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.

629. A summary of the key environment safeguards activities and reporting system to be followed under the project is provided in the Table 92 below.

Table 92: Environmental Reporting System

Activity	Responsibility	Outputs	Deliverable to ADB	Period
Appointment of Contractor Environmental Focal Person (EFP)	Contractor	Appointment letter submitted to PIU through AE	Included in semi-annual environmental monitoring report	At least 45 days before start of construction
Induction training of contractors	AE	Training materials and training proceedings	Included in semi-annual environmental monitoring report	At least 30 days before start of construction
On-site training and field level guidance	AE	Records of training and field level guidance provided	Included in semi-annual environmental monitoring report	Continuously as needed during construction
Develop methodology for implementing habitat improvement activities	BO	Submit inception report to PIU	PIU to submit Inception report	Within 3 months of commencement
Conduct pre-construction biodiversity survey	BC	Submit biodiversity survey report to PIU	PIU to forward to ADB	Before physical works commence
Monthly reporting				
Environmental self-monitoring report	Contractor	Completed checklist submitted to AE and PMU	None	Monthly starting from commencement date
Site inspection	AE, PIU	Inspection report prepared for inclusion in monthly monitoring report	None	Monthly after commencement date
Quarterly reporting				
Site inspection	BC	Inspection report on findings of biodiversity monitoring	BC to submit to PIU and ADB	Quarterly after commencement
Site inspection	EM	Inspection report submitted to PIU for review and endorsement	None	First inspection within 3 months of commencement
Semi-annual				
Semi-Annual Monitoring report	AE	Consolidated monthly monitoring reports submitted to PIU for review and endorsement	PIU to further submit to ADB for disclosure on ADB website	No later than 7 months after commencement of works
Semi-Annual Monitoring report	BC	Consolidated quarterly reports submitted to PIU for review and endorsement	PIU to further submit to ADB for disclosure on ADB website	No later than 7 months after commencement of works

Table 92: Environmental Reporting System

Activity	Responsibility	Outputs	Deliverable to ADB	Period
Semi-annual external monitoring report	EM	Report on third party monitoring findings submitted to PIU for review and endorsement	PIU to further submit to ADB disclosure on ADB website	First external monitoring report to be submitted within 8 months of commencement of works
Semi-annual progress report	BO	Submit report to PIU	PIU to submit all BO reports to ADB and YLWLS/Forestry Dept	Starting 9th month after commencement
Draft final biodiversity report	BO	Submit report to PIU		On 22nd month since commencement
Final Biodiversity report	BO	Submit report to PIU		On 23rd month since commencement

AE: Authority Engineer; BC: Biodiversity Consultant; BO: Biodiversity Organization; EM: External Monitor; PIU: Project Implementation Unit

G. Environmental Management Budget

630. An environmental management budget of INR 210,956,140 (Indian Rupees twenty-one crore nine lakhs fifty-six thousand one hundred forty only) (USD 2.8 million) has been estimated for implementation of the environmental management plan. This budget also includes cost of implementing the BAP activities, environmental monitoring and associated trainings. A detail of environmental management budget is given in Table 93.

Table 93: 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				163,200,000	
A.1.5	Compensatory Afforestation					
A.1.6	Net Present Value (NPV)					
Total (Rupees) Amount Deposited by NHIDCL					**163,200,000**	
B.	**Environmental Monitoring**					
						PIU through Approved Monitoring Agency
B.1	Ambient air quality monitoring during pre-construction, construction and operations phases	36	No.	8,000	288,000	
B.2	Ambient noise level monitoring during pre-construction, construction and operations phases	36	No.	2,000	72,000	
B.3	Water quality monitoring of surface water during construction and operations phases	24	No.	5,000	120,000	
B.4	Water quality monitoring of drinking water during construction and operations phases	18	No.	5,000	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.	**Enhancement of common property resources as per directed by the engineer including the following items**					Contractor through BOQ
C.1	Provision and erection of cement concrete, standard sitting benches including clearing of the area around the benches.	30	No.	1,000	30,000	
C.2	Boundary fencing with barbed wire fencing of approved make and specification including provision and erection of struts	300	Rm.	550	165,000	

SL. No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE (Rs.)	AMOUNT (Rs.)	RESPONSIBILITY
D.	**Biodiversity Action Plan (Please refer to Annexes 15, 16 and 18 for further details)**					
D.1	Pre-construction wildlife survey and biodiversity monitoring during construction and post construction	1	lumpsum		12,964,020	Biodiversity consultant
D.2	Installation of rope ladders for use by Western Hoolock Gibbon, Capped langur and other arboreal species. Installation of shelves/ledges to 125 culverts in the road section falling inside/near the sanctuary. Measures to prevent spread of invasive species. Signage for speed reduction and informatory signboards on wildlife.	1	lumpsum		5,307,120	Contractor
D.3	Habitat improvement activities to achieve no net loss and preferably net gain of biodiversity	1	lumpsum		18,900,000	Biodiversity Organization
E.	**External Monitor**					
E.2	External Environment and Wildlife monitoring services	1	lumpsum	95,80000	95,80000	PIU
F.	**Environmental Training**					
F.1	Training at site as per Annex-13 **of EIA.**	1	lumpsum	5,00,000	5,00,000	PIU through Authority Engineer
				Grand Total (Rupees)	**2,10,956,140**	

* Cost estimate is preliminary based on the current unit rates. Therefore, this estimate is tentative only.

X. CONCLUSIONS AND RECOMMENDATIONS

631. The project road (Khongkhang-Moreh Road Section) proposed for improvement is classified as environment Category A project as per ADB SPS requirements. This is mainly because the project road passes through the ecologically sensitive area of the Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS). 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. Environmental screening and assessment of likely impacts and rating of risks shows that with implementation of mitigation measures and habitat improvement activities the project will not result in significant residual environmental impacts.

632. Adverse impacts and risks expected from upgradation of the road are:

- Loss of about 53 ha (48.29 ha + 5 ha) of forest land with 2013 trees resulting in a net loss of 13 ha of good quality forest;
- Potential impacts on 12 fish species, 1 bird (Green Peafowl), 1 mammal (Hume's rat) that trigger critical habitat and other wildlife species that do not trigger critical habitat such as Western Hoolock Gibbon, Capped Langur and Pangolin
- Impacts on roadside flora and fauna particularly on sections of road passing through Yangoupokpi Lokchao Wildlife Sanctuary (YLWLS);
- Temporary risk illegal harvesting of trees, poaching and fishing by construction workers during construction
- Potential impacts on spread of invasive species from construction activities
- 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;
- 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
- Risks related to spread of communicable diseases particularly COVID-19
- Low risk long terms impacts of poaching from increased traffic.

633. Mitigation measures have been proposed and budgeted to address all the above identified impacts and risks in the EMP. 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. As part of the EMP a BAP has been prepared to mitigate biodiversity related risks. The BAP includes: measures to facilitate wildlife movement across the road; avoid disturbance of natural habitat including aquatic habitat in the project area; strict biodiversity monitoring; and implementation of habitat improvement activities to achieve no net loss or net gain of biodiversity under the project.

634. Application of the mitigation 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. Hence, with implementation of the EMP and BAP it is expected that residual environmental impacts will be insignificant.

635. 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.

636. 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.

637. The EMP including BAP is a living document and will be subject to revision following finalization of the detailed design by the EPC contractor and pre-construction stage wildlife survey by the Biodiversity Consultant. The EMP and BAP may undergo further revision during project construction if there is any change in project design and occurrence of unanticipated impacts. The environmental mitigation measures are itemized in the EMP and the Executing Agency (NHIDCL) shall ensure that EMP (including the BAP) and EMoP are included in the bid document and civil works contract agreement.