

# Environmental Impact Assessment (FINAL)

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April 2014

## BHU: SASEC Road Connectivity Project Nganglam – Dewathang Highway

Prepared by Department of Roads, Ministry of Works and Human Settlement, Royal Government of Bhutan for the Asian Development Bank.

## **CURRENCY EQUIVALENTS**

(as of 25 February 2014)

Currency unit	–	Ngultrum (Nu)
Nu1.00	=	\$0.0161331
\$1.00	=	61.9844 Nu

## **ABBREVIATIONS**

AADT	:	Annual Average Daily Traffic
ADB	:	Asian Development Bank
AIDS	:	Acquired Immune Deficiency Syndrome
BC	:	Biological Corridor
BDBL	:	Bhutan Development Bank Limited
BHU	:	Basic Health Unit
BoBL	:	Bank of Bhutan Limited
BOQ	:	Bill of Quantity
CC	:	Construction Contractor
CCA	:	Climate Change Adaptation
CGI	:	Corrugated Galvanized Iron
CITES	:	Convention on International Trade in Endangered Species
CO	:	Carbon Monoxide
CO <sub>2</sub>	:	Carbon Dioxide
CPCB	:	Central Pollution Control Board
CSC	:	Construction Supervision Consultant
DA	:	Dzongkhag Administration
DCPA	:	Dungsam Cement Project Authority
DFO	:	Divisional Forest Office
DGM	:	Department of Geology and Mines
DOFPS	:	Department of Forests and Park Services
DoR	:	Department of Roads
DT	:	Dzongkhag Tshogdu
DYT	:	Dzongkhag Yargay Tshogdu
EA	:	Environmental Assessment
EC	:	Environment Clearance
EFRC	:	Environment Friendly Road Construction
EIA	:	Environmental Impact Assessment
EMO	:	Environmental Management Officer
EMP	:	Environmental Management Plan
ES	:	Environmental Specialist
EU	:	Environmental Unit
FHWA	:	Federal Highway Administration
FMU	:	Forest Management Unit
FNCA	:	Forest and Nature Conservation Act

FNCR	:	Forest and Nature Conservation Rules
GIS	:	Geographic Information System
GLOF	:	Glacial Lake Outburst Flood
GNHC	:	Gross National Happiness Commission
GPS	:	Global Positioning System
GRC	:	Greviance Redress Committee
GRF	:	Government Reserved Forest
GRM	:	Greviance Redress Mechanism
GT	:	Geog Tshogchung
GYT	:	Geog Yargay Tshogchung
HC	:	Hydrocarbon
HIV	:	Human Immunodeficiency Virus
IEEs	:	Initial Environmental Examinations
IPCC	:	Intergovernmental Panel on Climate Change
IUCN	:	International Union for Conservation of Nature
KWS	:	Khaling Wildlife Sanctuary
MOAF	:	Ministry of Agriculture and Forests
MoEA	:	Ministry of Economic Affairs
MOEF	:	Ministry of Environment and Forest
MoHCA	:	Ministry of Home and Cultural Affairs
MoWHS	:	Ministry of Works and Human Settlement
NDH	:	Nganglam-Dewathang Highway
NEC	:	National Environment Commission
NEPA	:	National Environmental Protection Act
NFEC	:	Non Formal Education Centre
NOC	:	No Objection Certificate
NOx	:	Nitrogen Oxides
NRDCL	:	Natural Resources Development Corporation Limited
NSB	:	National Statistic Bureau
OHS	:	Occupational Health and Safety
PHCB	:	Population and Housing Census of Bhutan
PIA	:	Project Influenced Area
PM10	:	Particulate Matter 10 microgram
PM2.5	:	Particulate Matter 2.5 microgram
PMU	:	Project Management Unit
PPM	:	Parts per Million
PPTA	:	Project Preparatory Technical Assistance
3Rs	:	Reduce Recycle and Reuse
RBP	:	Royal Bhutan Police
RE	:	Resident Engineer
REA	:	Rapid Environment Assessment
RECOP	:	Regulation Environmental Clearance of Projects

RGoB	:	Royal Government of Bhutan
RICBL	:	Royal Insurance Corporation of Bhutan Limited
RMNP	:	Royal Manas National Park
RNP	:	Road Network Project
RNP II AF	:	Road Network Project (II) Additional Financing
ROW	:	Right of Way
RSTA	:	Road Safety and Transport Authority
SASEC	:	South Asian Subregional Economic Cooperation
SOx	:	Sulphur Dioxide
STDs	:	Sexually Transmitted Diseases
USEPA	:	United States Environment Protection Act
WCD	:	Wildlife Conservation Division
WHO	:	World Health Organization
WS	:	Wildlife Specialist
WWF	:	World Wildlife Fund

#### **WEIGHTS AND MEASURES**

AADT	-	Annual Average Daily Traffic
dB	-	Decibel
Ha	-	Hectare
Km	-	Kilometer
km <sup>2</sup>	-	Square kilometer
M	-	Meter
Mt	-	Metric ton
Vpd	-	Vehicles per day

#### **NOTE**

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

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## **EXECUTIVE SUMMARY**

### **A. Introduction**

1. 68.3km Nganglam-Dewathang Highway (NDH) is one of the components of SASEC Road Connectivity Project (No.39225-034). It is a scale up of Road Network Project (RNP) II with the objective to construct east-west lateral highway through southern Bhutan. The highway is expected enhance the country's road transport connectivity by improving access to regional and global markets throughout the country. Other components of SASEC Road Connectivity Project include:

- Pasakha Access Road (1.2km) including a Land Customs Station,
- Phuentsholing Bypass road (about 2.8km), and
- Phuentsholing Mini Dry Port

2. NDH sub-project is classified as environment category A project due to the likelihood of significant adverse environmental impacts as a result of project implementation. The detailed environmental impact assessment (EIA) studies have been carried out in accordance with the relevant laws and regulations of RGoB and safeguard policy of the ADB.

3. The draft EIA report prepared as part of the feasibility study (2011) was updated at the time of detailed design (2013). EIA recommendations have been incorporated in the detailed design of NDH. The updated draft final EIA report was disclosed on the ADB website on 2nd December 2013, in accordance with the 120 days disclosure requirement of the ADB's Safeguard Policy Statement 2009 for environment category A projects.

4. The final EIA report will be submitted to the National Environment Commission (NEC) for the environmental clearance (EC) before the start of the civil works.

5. Following sections present the important findings of the updated EIA study.

### **B. Description of the Project**

6. NDH is planned to connect two satellite townships of Nganglam and Dewathang, in the south of Bhutan. It is approximately 68.3 km in length. Roughly for 15km, the NDH will follow the existing farm road from Nganglam to Chokhorling. Similarly, it will also follow about 4.5 km coal mining and Dewathang municipal roads from Rishore till Gortap at Dewathang. The NDH sub-project falls within 26.75 – 27.0 North latitude. NDH sub-project henceforth is referred to as the Project. Major settlements along the NDH are Nganglam town, Dezama, Yargaywoong, Gazawoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang town. The study area covering 1.5km on either side of the road center line is described as the Project Influenced Area or Project Area.

7. The RNP II design and construction standards of 5.5 m carriageway width and 7.5 m formation width and longitudinal drainage structures are applied for the proposed road. 3 bridges (over Menchudrangri, Tsokhiri and Dui River) and over 346 culverts will be constructed as cross drainages.

8. Construction of the road is expected to commence during the last quarter of 2014 and expected to complete it by 2018.

9. Total estimated civil construction cost of the NDH is Nu. 1,919,616,000/- (Ngultrum One billion nine hundred nineteen six thousand six hundred sixteen thousand) only. The

environmental management cost comes to around Nu.267,476,133/- which is about 14% of the total project cost. The climate change adaptation cost comes to around 5.4% (Nu.110,288,935) of the total project cost.

### **C. Consultation, Grievance and Disclosure Mechanism**

10. In line with the requirements of the ADB's safeguard policy and the RGOB regulations, public consultations have been carried out both at the feasibility and the detailed design phase of the project preparations. Stakeholders included national policy makers, interest groups; local governments and affected communities.

11. The communities within the project area are supportive of the proposed project as it is expected to bring about the socio-economic benefits through provision of all-weather road connectivity in their region. In support of the project, the communities have provided the project acceptance letters (Refer Appendix D). However, the concerns were raised with regard to land and property acquisitions; and subsequent compensations. Affected persons preferred land substitution to cash compensation.

12. At the national level, the consultation workshops were carried out both during the feasibility (workshop held on 14th November 2011) and detailed phase (workshop held on 19th November 2013). Main issues discussed were: i) difficulties of proper spoil disposal practice in a road stretches where slope is greater than 60%; ii) the need for proper environmental protection measures while constructing road through the biological corridor; iii) protection and rehabilitation of endangered/protected flora (such as rare Eagle wood/Indian Aloe wood) if found inside the construction zone during the project implementation; and iv) the necessity for implementation of compensatory plantation in government barren lands in consultation with local forestry officials and the communities.

The concerns and issues raised by the stakeholders are incorporated in the Final EIA report. Further public consultations will be carried out during project implementation by both environmental and social components of the project. The grievance redress mechanism will be established within the project management, to resolve any grievances that may arise during the course of project implementation.

### **D. Environmental Conditions, Adverse Impacts and Mitigation Measures**

#### **1. Physical Resources**

13. Project area falls under hot and humid subtropical region of Bhutan, receiving an average annual precipitation of 3741.22 mm, and with maximum average temperature of 28.8°C in August and minimum average of 9.9°C in January. The construction works are planned to be carried out during dry winter seasons. The construction activities will cause air and noise pollutions. The ambient air and noise levels will be measured prior to the construction works and will be monitored regularly during the construction period. Regular water spraying, at least twice a day will be carried out to minimize the dust pollutions in all settlement areas. Noise pollution during construction is inevitable but it will be controlled by restricting the construction to daytime only from 8am to 5pm within settlements; and from 8am to 4pm within the critical wildlife habitat at Regi area.

14. Roadway excavation and earthworks will lead to slope instabilities and failures. The increasing rainfall intensity because of the climate change effects coupled with weak geology of

the Himalayan foothills will lead to increased slope failures and soil erosions. The slope failure and erosion will damage downhill wildlife habitat and private properties. It will also cause excessive sedimentation of downstream water bodies and thereby affecting aquatic ecology. Environmental Friendly Road Construction (EFRC) methods with balance cut and fill; and the Climate change adaptation (CCA) measures of improved drainage designs and slope stabilizations structures are incorporated in the detailed design to minimize the slope instabilities. Wherever feasible, the unstable slopes identified during the feasibility study were avoided. Further, the catch wall or log/boulder barriers along with the bioengineering applications are proposed to stabilize the cut slopes. Compensatory plantations will be carried out in vacant government land and in the abandoned construction camps.

## **2. Biological Resources**

15. NDH falls mostly to the north of the Biological Corridor (BC) connecting Royal Manas National Park and the Khaling Wildlife Sanctuary. About 6 km stretch of the NDH from chainage km9 – km15 following the existing farm road to Chokhorling from Nganglam passes through the BC. The widening and excavation works may damage habitat and disrupt wildlife movements. To minimize the adverse impacts following mitigation measures will be implemented:

- To the maximum possibility, the widening will be limited to 7.5m
- Spoil will be transported and dumped at the designated site.
- EFRC techniques such as balance cut and fill, gentle slopes will be maintained for all wildlife crossing points, and bioengineering will be employed to minimize the wildlife habitat destruction.
- Bioengineering and compensatory plantation will be carried out in all dumpsites after the completion of construction works.
- No construction or labour camps will be placed within the BC.
- Construction works will be restricted to day light hours (8am-4pm) to minimize the disturbance to wildlife
- Speed limit and wildlife corridor signages will be erected to prevent accidents and disturbances of wildlife.

16. Sub-tropical broadleaf forest is dominant in the project area. The study has recorded 120 tree species, 64 shrub species, 40 herbs, 34 climbers, 15 epiphytes, 15 underground rhizome, sucker and rhizomatous herbs, 7 endemic plants, 17 plants with medicinal value, 5 recognized threatened plants and 3 plants recorded under CITES Appendix II have been recorded in the project area. Although, not sighted, but there are a likely chances of finding rare and protected Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*) in the project area; owing to the existence of favourable climatic conditions for its growth. The road construction will require removal of around 9700 trees. The vegetation removal works may also damage may the rare endangered and protected species. Depending on the availability of government barren land in the project area, a compensatory plantation (1:1) will be carried out to offset the loss of floral species during road construction. Environmental Specialist (ES) hired under Construction Supervision Consultant (CSC) will be trained to identify the rare endangered and protected flora. During preconstruction stage, ES will carry out survey along the proposed alignment to determine the existences of threatened or endangered and protected flora. If the important flora is encountered, ES will notify the local Divisional Forestry Office (DFO) through the Project Coordination Unit (PCU) and will carry out recusing, rehabilitation and restoration works.

17. Feasibility study has identified the Regi area between Tsokhiri (Chowkiri) and Duiiri Rivers as an important wildlife habitat due to presence of saltlick (at the base of Regi landslide),

mud pools, relatively undisturbed forests and perennial river systems. The area is also known for the elephant migratory routes. About 31 wild mammals; 90 birds; 12 reptiles and amphibians; and 15 fish species are recorded within the project area. IUCN red listed, endangered Asian Elephant (*Elephas maximus*) is the “keystone species” found in the project area. It is regarded elephant as an “umbrella species” as their conservation will also protect a large number of other species occupying the same area. Retrieved on February 11, 2014, from <http://www.iucnredlist.org/details/7140/0>. Other important endangered species found is Rufous necked-hornbill (*Aceros nipalensis*). Road construction through Regi area; and the construction of bridges over Tsokhiri and Duiri Rivers will damage wildlife habitats (including saltlicks) and elephant migratory routes. In order to minimize the impacts, the following mitigation measures are proposed to be carried out:

18. Prior to the start of construction, Wildlife Specialist (WS) along with ES will survey and determine the exact locations of all known elephant migratory paths. During construction, temporary passages will be kept for all known migratory paths. The permanent crossing points will be developed with gentle slope that is deemed suitable for elephant crossings by the WS and the DFO. Elephant corridor and speed limit signage will be erected on both sides before entry into the important elephant crossing points and the habitat areas.

19. Bridges over Tsokhiri and Duiri Rivers will be constructed as per their designs. Since banks of Tsokhiri is used as migratory paths by elephants. The approach road to and from the bridge will have gentle slopes for easy elephant movement. In the case of Duiri river area, the elephant use river and its banks to move up and downstream, therefore Duiri Bridge will be constructed with 10m high to allow elephant easily pass through. The bridges and other structures will be blended into natural surroundings.

20. For minimizing the impacts on Rufous necked-Hornbill, the felling of tall, matured and fruiting trees will be strictly prohibited except under unavoidable conditions. WS and ES will jointly carry out surveying and identifying the trees that need total protection during pre-construction.

21. Further as long term mitigation measures, the habitat enrichment activities such as planting of native bamboos, fruiting trees (e.g. *Ficus* species) and fodders trees will be carried out within and outside the critical habitat zone. WS in collaboration with DFO will determine the suitable plant species for elephant and hornbill habitat enrichment. By enhancing the quality of wildlife habitats, project is expected to help reduce the human-wildlife conflicts in the region.

### **3. Socio-economic and Cultural Resources**

22. NDH falls under Pemagatshel and Samdrup Jongkhar Dzongkhags/Districts. And there are three geogs or blocks; namely Norbugang, Chokhorling and Dewathang in the project area. According to Dzongkhag Statistics, 2010 of Pemagatshel and Samdrup Jongkhar dzongkhags, the combined population is about 61,083 persons. While the population of affected geogs of Norbugang, Chokhorling, and Dewathang is 11,323 persons. About 6,162 people (in approximately 1037 households) live along the 3 km (1.5km on either side of road centerline) Project Area. Sharchocka or Tshangla speaking people are main inhabitants of the project area. There are no indigenous people or tribes. The principal crops grown in the project area include paddy, maize, millet, pulses, oranges, areca nut and cardamom.

23. Project will acquire approximately 63 acres of mostly private land (46.03 acres of dry land; 1.16 acres of wetland; 15.81 acres of orchard land); 14,727 Nos. of fruit trees; 19 Nos. of

fodder trees; 106 Nos. of private trees; and 56 Nos of temporary and permanent structures. The land and properties acquisition will lead to loss of productive agriculture land, destruction of cash crops and also render people homeless.

24. Land and property acquisition will be carried out as per the Resettlement Plan prepared separately as part of the project. The compensation, land substitution, and resettlement will be carried out prior to the start of civil works. Qualified engineer will carry out the valuation of structures that needs to be acquired. As far as possible land substitution will be provided within the same geog. Land Compensation Rate 2009 will govern the compensation payment. As far as possible, road corridor and widening will be limited to 7.5m only. Parallel grievance mechanisms under environment and resettlement components of the project will provide opportunities for affected people to bring cases before the appropriate government authority.

25. There are about 29km farm road from Nganglam to Chokhorling, 4.5km coal mine road Rishore to Chenari, and about 4 km municipal road inside Dewathang town.

26. Road widening works will disrupt of local traffic movement on existing farm and coal mining roads. Unsafe work sites will result in accidents and injuries to the passerby particularly to the school going children. To minimize the impacts, the construction works will scheduled in consultation with the local authority and the affected communities. The safety of passing school children will be accorded highest priority. Safety guards will be placed in all hazardous sites which will be marked with appropriate warning signage. In the event of any misfortunes, the contractor will take full responsibilities to evacuate injured to the nearest health center; and will bear the entire medical expenses and also provide the adequate compensation.

27. Settlements located downslope of the roadways will be affected due to falling debris during constructions. Chokhorling village is likely to be affected the most; if no mitigation measures are applied. To avoid human accidents and minimize property damages at Chokhorling, 3 layers of gabion catch wall of approximately 1m in height and 250m long each, will be constructed below the road alignment prior to the start road of construction work. Similarly, in other areas depending on site conditions, boulder and log barriers will be built to minimize or avoid downhill damages.

28. Community water supply systems at locations along specific roadways can be put out of commission during construction, disadvantaging local people. Damages will occur to water intake and pipelines of drinking water supply of Drangnalashingborang, Dezama, Shuguri, Chokhorling, Khalatsho, Rishore and Dewathang communities. Impact on Chokhorling watershed is expected to severe as the road passes through it. Therefore, to avoid or minimize the impact, 3 layers of gabion catch wall of approximately 1m in height and 300m long each, will be constructed below the road alignment prior to the start road of construction work. The temporary water supply will be provided through alternative sources during construction. Permanent restoration will be carried out after completion construction works.

29. All villages inside the project area are now electrified through the Rural Electrification Project supported by ADB and other donors. The road construction is likely to damage electricity and telephone poles which will result in loss electricity supply and telephone connections. The project will avoid the damage of public utilities by limiting the road formation cutting to 7.5m wherever feasible. However, if the damages are unavoidable, relocation and restoration will be carried out in consultation with Bhutan Power Corporation and Bhutan Telecom. During the relocation period, project will provide temporary alternatives power provisions for the affected communities.

30. There are few religious, historical and cultural sites in the project area such as Meme Lungkhangma Nye (Sacred Rock); Thujaycholing Lhakhang/temple at Chokhorling; Luu (sacred boulder) at Chenari and Gesar Dala lhakhang at Dewathang. These religious sites will be avoided by restricting road width to 7.5m. Construction of 3m high and 200m long gabion retaining or breast wall is proposed to protect Thujaycholing Lhakhang at Chokhorling.

## **E. Environmental Management Plan**

31. The generic Environmental Management Plan (EMP) prepared during feasibility study has been updated to detailed site specific EMP. If required, it will be further updated during preconstruction and construction periods. DoR through project management will be responsible for updating of EMP, seeking environment clearance, incorporate environmental conditions in bidding documents and monitor the implementation EMP by the contractor.

32. Project will be implemented by Project Coordination Unit (PCU), which will be headed by the Project Coordinator (PC). Under PCU there will two Project Management Units (PMU) since there will be two separate contract packages<sup>1</sup> for NDH construction. The Project Managers of respective PMUs will be assigned as environmental focal persons from the DOR side. Construction Supervision Consultant (CSC) which will be hired by PCU will include Resident Engineers (RE); site inspectors (SE); climate change adaptation specialist (CCAS); wildlife specialist (WS); and environmental specialist (ES). RE along with the SE will carry out day to day monitoring of EMP implementation within their respective construction sites; while ES and WS will carry out the intermittent EMP implementation monitoring of the overall project. Construction Contractor (CC) will recruit or appoint their site engineer as their environmental focal person; who will be responsible for day to day implementation of the environmental management plan. ES will assure the accuracy and completeness of reporting by the contractor and compiling monthly reports into quarterly summaries to be forwarded to the PCU and to the ADB. Quarterly reports are also sent to the DoR's Environment Management Unit (EMU).

33. Government agencies and staff may also be involved in monitoring environmental performance on the Project, including EMU at DoR, the Wildlife Conservation Division (WCD) under DoFPS and the Environmental officers working for NEC at dzongkhag administrations. Dzongkhag Environmental Committee will have the authority to monitor and enforce construction impact mitigation measures alongside other responsible agents, specifically where impacts have a direct effect on the local community.

## **F. Conclusion and Recommendations**

34. Based on the environmental assessment, the associated potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the measures as stated in the EIA and the EMP.

35. Nganglam-Dewathang Highway is considered as a critical missing link between eastern and western section of Bhutan. The implementation of the project will directly benefit almost 17% of Bhutan's population (about 123,254 persons) through provision of shorter and safer route within the country. Overall, it will improve the socio-economic conditions of the area surrounding the project site and the country as a whole.

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<sup>1</sup> Contract packages – i) Nganglam-Tsokhiri Section (ND01) and ii) Tsokhiri-Dewathang Section (ND02).

## I. INTRODUCTION

### A. Project Background

36. The Department of Roads (DoR) under the Ministry of Works & Human Settlement (MoWHS) is entrusted with the responsibility of survey, design, construction and maintenance of roads in Bhutan. Since, the road construction began in 1960s, more than 10,578 kilometer (DoR 2013) of motorable roads has been constructed. Being a landlocked country, an efficient road network system for a country is of paramount importance to support developmental activities and encourage domestic as well as international trade.

37. In line with the Road Sector Master Plan (RSMP) 2007-27, the DOR has initiated series of road development activities in Bhutan particularly the second east-west highway along the southern belt of the country. The ongoing ADB financed Road Network Project (RNP) II is the most notable of all. RNP II includes the following road segments; (i)Manitar-Raidak, (ii)Raidak-Lhamoizingkha, (iii)Panbang-Nganglam, (iv)Samdrupcholing–Samrang and (v) Tsebar-Mikuri-Durungri roads which are at varying stages of completion.

38. In addition to ongoing RNP II, the ADB TA 7803-BHU for RNP II additional financing (RNP II AF) covered the remaining road segments of the second east-west highway that were not included under RNP II. The road segments or sub-projects that were studied for their feasibility under RNP II AF are provided in the Table 1.

**Table 1: Candidate Road Segments**

Sl. No.	Road Name	Length	Coverage
1	Lhamoizingkha-Sarpang highway	115 km	Dagana and Sarpang Dzongkhags <sup>2</sup>
2	Gelephu-Panbang highway	87 km	Sarpang and Zhemgang Dzongkhags
3	Nganglam – Dewathang Highway	68.3 km	Pemagatshel & Samdrup Jongkhar Dzongkhags
4	Samrang-Jomotsangkha highway	84 km	Samdrup Jongkhar Dzongkhags

39. Except for Gelephu-Panbang road segment, the feasibility studies inclusive of Environmental Impact Assessment (EIA) studies of three other road segments have been carried out. Of the three road segments, the Nganglam – Dewathang Highway (NDH) was found to be most viable economically, and was selected to be financed under the SASEC Road Connectivity Project (No.39225-034).

40. The Nganglam – Dewathang Highway sub-project is classified as environment category A project as it required construction of 68.3km new road through biological corridor, natural habitats, steep terrain and will need felling of approximately 9700 trees.

41. Hence, the detailed environmental study for Nganglam – Dewathang Highway was carried out under SASEC road connectivity project over a period of 7 months starting from April 2013 till January 2014. The draft final EIA report was disclosed on December 2, 2013 as required by the ADB's safeguard policy requirements. This final report presents the findings of updated EIA study on the NDH sub-project.

<sup>2</sup> Dzongkhags – Districts (Bhutan is administratively sub-divided into 20 districts)

42. In addition to this NDH sub-project, there are three other sub-projects or components under the SASEC Road Connectivity Project, namely; i) 1.2km Pasakha Access Road including a Land Customs Station at Alay, ii) 2.8km Phuentsholing Bypass road, and iii) Mini Dry Port at Phuentsholing. All three sub-projects are classified as category B environmental sub-projects and falls under Phuentsholing Thromde<sup>3</sup> area, about 184km (areal distance) to the west of Nganglam-Dewathang sub-project. Initial Environmental Examinations (IEEs) reports have been prepared and disclosed for all three sub-projects.

## **B. Purpose of the Report**

43. This report presents the findings and results of the updated Environmental Impact Assessment (EIA) study for the NDH sub-project. The investigative process involves characterizing activities related to development of the proposed roadways and predicting impacts on environmental resources. The investigation encompasses the affected area of the sub-project in respect to the road segment being proposed, the various phases of sub-project development from preconstruction through operations, and the types of environmental resources potentially affected. This report is a presentation of the findings resulting from this process. Mitigation measures are proposed for potential impacts and impacts that cannot be avoided, and within the context of the Environmental Management Plan (EMP), monitoring indicators are specified. The environmental assessment is done under the guidance of the policies of the Asian Development Bank (ADB) and the Royal Government of Bhutan (RGoB) and includes chapters on description of the project, environmental resources, alternatives considered, environmental impacts and mitigation measures, mitigation and monitoring plan, economic assessment and public consultation procedures. Appendix A contains the terms of reference for the EIA which was approved by the National Environmental Commission (NEC).

## **C. Project Area (Study Area)**

44. The area that will be impacted by the sub-project during construction and operation does not coincide with its ultimate physical boundaries. The type and range of various expected direct and indirect environmental impacts therefore need to be fully understood at the earliest possible stages of the EIA study.

45. Based on the results of the initial scoping of potential environmental impacts and the identification of sensitive receptors we have identified the following geographical areas likely to be affected at the various stages of the sub-project:

46. During construction, temporary and permanent impacts will occur both on-and off-site. The most direct physical impact will be on-site in the area of the actual physical interventions which is mostly about 15-20 m band along the 68.3 km of NDH construction. In some cases, it may extend more than hundred meters downhill along the steep terrain with slope above 60%. The probable road sections where the likely impact could be 100m or more are provided:

- Km 21 – Km 23 between Yargeywoong – Chokhorling
- Km 26 – km 28, a steep slope above Chokhorling village (Settlement)
- Km 30 – km 40 between Chokhorling and Khalatsho village
- Km 50 – km 56 after Regi landslide (or after crossing important wildlife habitat)
- Km 58 – km 60 after Duiiri bridge crossing

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<sup>3</sup> Thromde – Municipality (Administered by an elected mayor called Thrompon)



47. During operation of the road, most impacts will be confined to the area that will be affected by construction impacts. This statement however, does not apply to off-site noise and air pollution impacts due to operation of vehicles. Off-site operational impact may affect settlements and sensitive habitats that are found along the proposed highway. Therefore, 3.0 km Project Influence Area or project area which is 1.5 km on either side of the road centerline has been considered for comprehensive impact assessments.

48. Hence, the boundaries of the study or project area will vary according to the impacts expected at different phases of the sub-project.

49. Nganglam-Dewathang highway sub-project will be hereafter referred to as “Project” and sub-project area as “Project Area” to maintain consistency in reporting.

#### **D. Data Sources, Collection, Analysis, Reporting and Status of EIA**

50. Primary observation from site surveys and published information are the two main types of source material. Field surveys were jointly carried out with the engineering and social and resettlement teams both at the feasibility and detailed design phases.

##### **1. Feasibility Study**

51. Feasibility study was carried out over period 4 months starting from October 2011 – March 2012. The environmental baseline data which included physical, biological and socioeconomic components were collected using both structured and non-structured questionnaires.

52. Physical baseline data on air, noise and water quality for this EIA study were derived from a “Comprehensive *EIA Report*” prepared in 2000 by SGS India Limited for Dungsam Cement Project Authority (DCPA). It provides baseline data for both rural and urban settings, which are similar to that of proposed NDH project area. However, an additional baseline data on air, noise and water will be collected for NDH project area prior to the start of construction works with the financial and the technical assistance of ADB. These baseline data will be used for subsequent monitoring during construction and operational phase.

53. Ecological data were collected using transect survey method which estimates the occurrence of flora and fauna within project area. The survey was carried out during dry season in the November, 2011.

54. Spatial information with regard to road alignment and other features were collected using Global Position System (GPS) and from the existing topographic and land cover maps.

55. Both primary and secondary data were compiled and analyzed using Geographic Information System (GIS) and other statistical software. Based on the analysis, the likely impacts were predicted; and subsequent mitigation measures were proposed, to minimize, to offset and to avoid the predicted impacts. Feasibility phase EIA report was prepared under guidance of ADB safeguard policy and RGOB’s environmental laws and regulations. The Rapid Environment Assessment (REA) checklist was prepared to comply with ADB safeguard policy statement 2009. The EIA report was disclosed to the various stakeholders, which included Department of Forest and Park Services (DOFPS), Department of Geology and Mines (DGM), Gross National Happiness Commission (GNHC), Ministry of Economic Affairs (MoEA), and the

Local governments (of Lhamoizingkha Dungkhag<sup>4</sup>, Samdrup Jongkhar Thromde, Sarpang and Zhemgang Dzongkhags) on 14 March 2012.

56. The feasibility EIA study team included the following officials and experts:

**Table 2: Key Officials or Experts that assisted in carrying out the EIA studies**

S.No	Name	Designation	Expertise
1	Mr. Janusz Sobieniak	Team Leader, RNP II AF	Road, Highway and Pavement Engineering
2	Mr. J.P. Sharma	Asst. Dy. Team Leader, RNP II AF	Road and Civil Structural Engineering
3	Mr. Tempa Thinley	Deputy Project Coordinator, RNP II AF	Road/Geotechnical Engineering
4	Mr. P.L. Sharma	Geotechnical Expert	Geotechnical and Material Engineering
5	Mr. Rajesh Pradhan	Social and Resettlement Expert	Social Impact Assessment and Resettlement Planning
6	Mr. Sonam Wangchuk	Senior Forester, Forest Range Office, Nganglam	Forest and Wildlife Management
7	Mr. Tashi Phuntsho	Junior Engineer, Dzongkhag Administration, S/Jongkhar	Civil Engineering
8.	Mr. Karma Duptho	Junior Engineer, Drungkhag Administration, Nganglam	Civil Engineering

## **2. Detailed Design Study**

57. Detailed design study was carried out over a period of 6 months starting from April 2013 to January 2014. Additional data were collected on flora and fauna particularly for the sensitive and critical habitat through a transect surveying. It was carried out with the assistance of wildlife expert from the Wildlife Conservation Division of the Department of Forests and Park Services. Local inhabitants were also interviewed to gain more insight into the pattern of the wildlife movement within and across the project area.

58. The updated social and resettlement data from the Resettlement Planning Document (January 9, 2014) of SASEC road connectivity sub-project was used to update the socio-economic impacts considered under the EIA study.

59. Detailed engineering survey using total station has mapped the road alignment and other important features along the road corridor. The road alignment was finalized by considering engineering, economics, social, climate change effects and environmental study recommendations. Based on the final alignment, further environmental assessments were carried out and accordingly updated the EIA report and the EMP. The detailed site specific EMP prepared will become an integral part of the construction contract document. Environmental mitigation measures are itemized and budgeted under the Bill of Quantity (BOQ) and this should

<sup>4</sup> Dungkhag – Sub division of District (Dungkhag will usually have two to three administrative blocks under it)

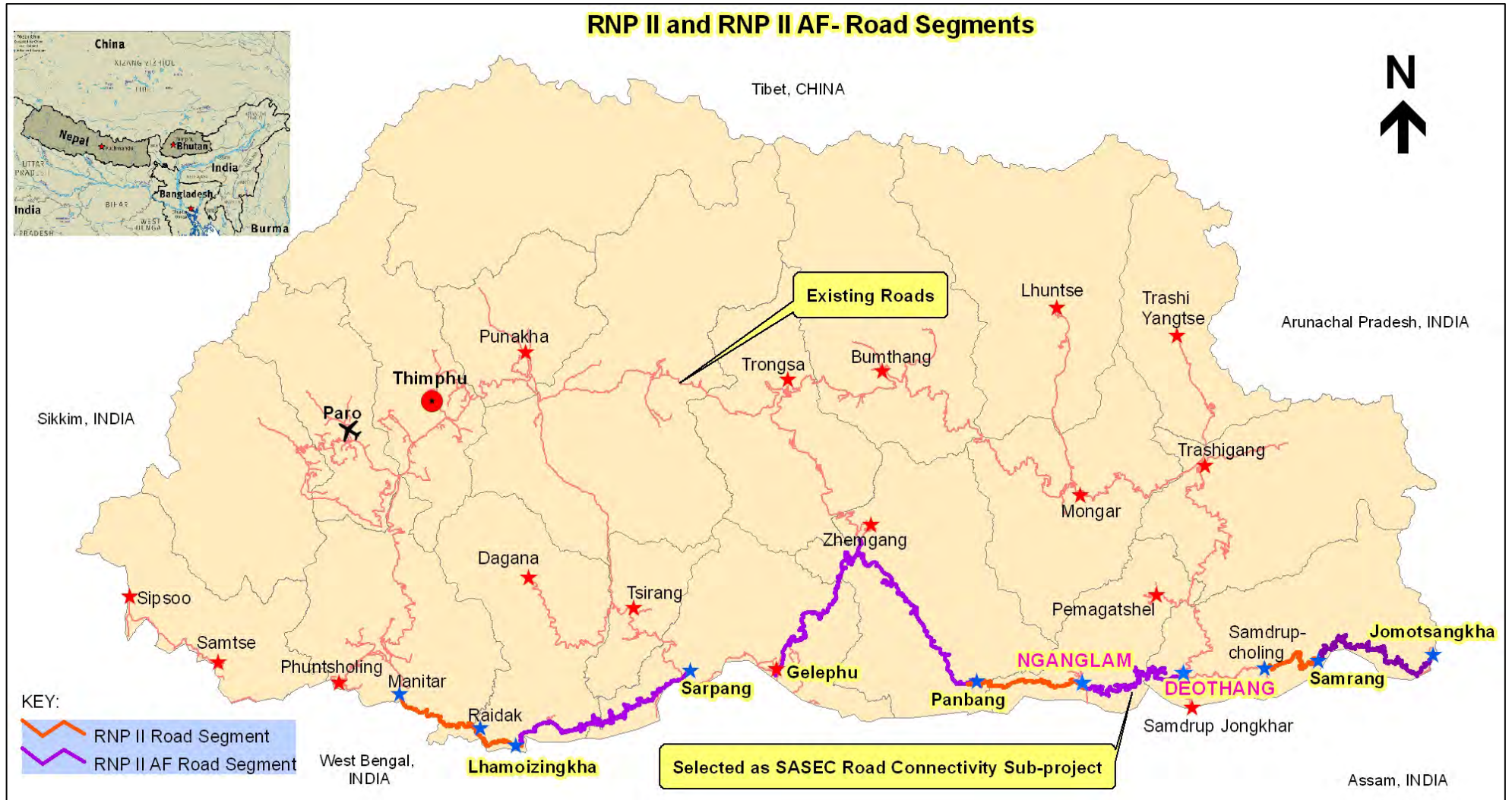
act as an incentive for the contractor to comply with the environmental conditions of the sub-project.

60. Table 3 indicates the team members were involved during the detailed design team to update the draft EIA report and EMP.

**Table 3: Key experts involved assisting in updating of EIA report**

<b>Sl. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Expertise</b>
1	Mr. Niralal Rai	Team Leader, Detailed Design Team	Highway Engineering
2	Mr. P.L Sharma	Geotech, Engineer, Detailed Design Team	Geotechnical Engineering
3	Mr. Sherab Chojay	Design Engineer, Detailed Design Team	Road design
4	Mr. Rajendra Pradhan	Structural Engineer, Detailed Design Team	Structural & Bridge engineering
5	Mrs. Tshering Yangchen	Social Expert, Detailed Design Team	Social Impact Assessment and Resettlement Planning
6	Mr. Dorji Rinchen	Environment Specialist, Detailed Design Team	Environment Impact Assessment
7	Mr. Sonam Wangchuk	Senior Forester, Nganglam Range	Forest and Wildlife Management
8	Mr. Leki Wangdi	Beat Officer, Dewathang Beat	Forest and Wildlife Management

Figure 1: Location SASEC Road Connectivity Project



## II. ENVIRONMENTAL POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

### A. International Environmental Policy

61. Bhutan is party to twelve multilateral environmental agreements including those on biodiversity, climate change-Kyoto protocol, desertification, endangered species and hazardous wastes. Those with particular relevance to the sub project include:

- UN Framework Convention on Climate Change signed on 11 June 1992 and ratified on 25 August 1995.
- Kyoto Protocol to the United Nations Framework Convention on Climate Change. Instrument of accession signed on 26 August 2002, and a member after Kyoto came into force from 2005.

62. Relevance: Road construction and subsequent operation are not carbon neutral, contributing to a small overall increase in continuous CO<sub>2</sub> emissions due to construction vehicular use, and one-time-only release of carbon due to removal of biomass in road right-of-ways of the road. Long term releases due to land use changes brought about by the road usage are also expected to occur.

63. **UN Convention on Biological Diversity signed 11 June 1992 and ratified 25 August 1995.** Relevance: Project potentially has both beneficial and adverse impacts on biodiversity. Beneficial impacts stem from improved access to an area where biodiversity resources are found, particularly bringing increased number of tourists for nature or ecotourism. Adverse impacts from improved access causing resource exploitation and land use changes that affect biodiversity.

### B. ADB's Safeguard Policy Statement

64. ADB policy requires that an Environmental Impact Assessment (EIA) Report be prepared by the borrower in accordance with ADB EA requirements and that loans or grants are classified according to their potential impact on the environment. Since the proposed sub project requires new road construction (highway standard) and the section road passes through critical wildlife habitat, the sub project is classified as Environmental Category A project. Accordingly, the detailed EIA study was carried out in accordance with the ADB's "*A Good Practice Sourcebook, Draft Working Document, Environment Safeguard, December 2012,*" which is similar to that of RGOB's EIA guideline for the road and highway project. The ADB Rapid Environmental Assessment (REA) Checklist for Roads and Highways has been completed for the project (Appendix D), which, for similar reasons, indicates that the project should be classified as Category A.

### C. RGoB's Environmental Protection Legislation

65. Bhutan has well defined institutional and legislative framework for the protection of environment encompassing air; water; noise; flora and fauna; biodiversity, sensitive habitats and other natural resources. The description of relevant legislations and regulations are provided in the following sections while the table II-2 summarizes the applicable ones.

66. **National Environmental Protection Act:** This act came into force on 31st July 2007. It is an act to provide for the establishment of an effective system to conserve and protect environment through the national environment commission or its successors, designation of

competent authorities and constitution of other advisory committees, so as to independently regulate and promote sustainable development in an equitable manner. It is guided by environmental principles, which states that the people and the government in succession shall perpetually strive to consider and adopt its developmental policies, plans and programs in harmony with the environmental principles. These include the fundamental right to a safe and healthy environment with equal and corresponding duty to protect and promote the environmental wellbeing of the country; intergenerational equity to ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations; middle path strategy for development; precautionary principle – where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation. Therefore, a developmental activity shall be strategically planned and executed in harmony with the carrying capacity of the country's sensitive ecological settings and geographical terrains; principle of 3Rs to be used for forestalling or limiting environmental impact from the start; polluter pays principle for the costs of containment, avoidance, abatement, medical compensation, mitigation, remediation and restoration. The uniformity of the system of environmental protection shall be guaranteed by the government, the local governments and the private sector through appropriate policies, plans and programs such as environmental assessment processes, regulations, incentives, fiscal policies and other instruments; right to information, where every individual has the right to be informed about the state of the environment and all activities which are being proposed that could affect the environment; access to justice – any individual whose right to a safe and healthy environment has been affected or is likely to be affected shall have the right to seek legal redress. Sovereign rights principle – the state has sovereign rights over renewable and non-renewable natural resources within the limits of its national jurisdiction. Conservation of natural resources shall be based on a participatory approach aimed at achieving an equitable sharing of the costs and benefits of conservation among resource users; principle of payment for environmental services – a person using or extracting natural resources shall be liable to pay for ecosystem/environmental services. The act empowers “the national environment commission” as an independent authority and the highest decision making body on all matters relating to the environment and its management in the country. The commission shall exercise the jurisdiction and powers and discharge the functions and duties conferred or imposed by or under this act. Chapter iv describes protection of environmental quality; chapter v describes protection of forest, biodiversity and integrity; chapter vi describes environmental financing and incentives; chapter vii describes right to environmental information and citizens' participation; chapter viii describes procedure for inspections and verification and; chapter ix describes enforcement, offences and penalties.

**67. Environmental Assessment Act 2000:** The Royal Government of Bhutan has in place detailed policies regarding environmental assessment that are founded in the Environmental Assessment Act (2000). The National Environmental Commission (NEC) through its Secretariat is empowered to implement the EA Act, which sets out the guidelines for obtaining an environmental clearance (EC) for a project. Article 9 states that if the activity is going to be implemented by a Competent Authority (CA), the Application for Environmental Clearance is to be forwarded to the NEC for approval. The application for an EC must include a description of potential environmental effects. The Secretariat of the NEC determines if the information provided is sufficient to identify effects, and if not the Secretariat can request that environmental assessment documents be prepared, following approved terms of reference. Additional information may be required by the NEC Secretariat if the EIA is considered incomplete. The EC is issued when the Secretariat is satisfied that a) effects are foreseeable and acceptable, b) the applicant is capable of carrying out the terms of the EC, c) the Project is seen to contribute to sustainable development of the country, d) the interests of concerned people have been

taken into account, and e) the project is consistent with the Nation's environmental commitments. Once a decision is made, the environmental terms, description of mitigation measures and non-technical summary of the EC are made available to the public. The Secretariat also controls and monitors compliance with the terms of the EC (Art. 34.2). The EA Act provides right of access to work sites for monitoring and penalty provisions in cases of offense under the Act, including providing false information, denying access and other infractions.(Art. 49). The EA Act contains rules for appeals, dispute resolution, and other provisions.

68. **Regulation for the Environmental Clearance of Projects 2001:** The Regulation for the Environmental Clearance of Projects (February 2001) provides further information to supplement the EA Act. Upon receipt of the application for the EC a total period of 1-3 months will be taken by NEC for issuing the EC. Official clearance from other concerned agencies is required for Projects within sensitive areas (Art. 17). Only upon receipt of all other clearances and No Objection Statements as given in table II.1 will the EC be issued. The EC is valid for a period of five years or less, but may be renewed in cases where the Project is in compliance with the EC. Minimum requirements for public consultation are set forth in Section 31 of the Regulation. These include written notice to local communities, newspaper notices, facilitation of consultation, and provision of a minimum period of time for the public to comment on the EIA. The Regulation specifies that the EC will contain binding mitigation and compliance measures and appropriate means for monitoring, recordkeeping and reporting. The EC Regulation sets out requirements and formats that are similar to those of ADB.

69. The Regulation requires that environmental units be established in agencies and projects, and while there is an Environment Unit within the Department of Roads<sup>5</sup>, it is not fully empowered. Staff who received training is no longer with the unit. Current staffing of the EU includes one active personnel and the unit has difficulty in contributing to field activities.

70. **Guideline for Application for Environmental Clearance for Highways and Roads 2004:** A further guideline document has been promulgated by the NEC, called the Guideline for Application for Environmental Clearance for Highways and Roads. This guideline describes information needed for inclusion in an application for an EC, which according to the guideline is done preliminary to the preparation of an EIA Report. Specific requirements for project information are consistent with what is provided in the current EIA Report. Among those requirements are no-objection certificates that are provided by affected parties, as listed in Table 4.

**Table 4: No Objection Statements under RGoB Policy**

<b>Agency/concerned people to issue NOC</b>	<b>Why/When</b>
Dzongkhag /Thromde	Dzongkhag/Thromde Administrative approval
DoFPS	Should the project damage or acquire Tsamdrog or Sokshing or involve felling of trees, wildlife habitat, wildlife movement tracks and riverside quarrying or small-scale quarrying or located within boundary of a protected area
Department of Culture	Should the project be located within 50m of a cultural or religious site

<sup>5</sup> The Unit was established in 2007 during implementation of the Rural Access Project funded by World Bank.

Municipal Authority	within 50m of a public park
Private property owners	Should the project acquire private property
Department of Health	within 50m of hospital
Department of Education	within 50m of school
Department of Energy	Should the project require the relocation of power transmission line
Bhutan Telecom Limited	Should the project require relocation of telephone lines
Department of Roads	Should the project require access from highways and feeder roads
National Environment Commission	All new road construction projects need an environmental clearance from NEC. However, the EC will be issued only upon receipt of all necessary No Objection statements enlisted above.

71. **Strategy for Air Quality Assessment and Management in Bhutan 2010:** The strategy paper defines and sets the ambient air quality standards of Bhutan with the view to protect human health; agricultural; natural vegetation and ecosystems; and environment in general. It establishes link between air pollutants and its sources in the context of Bhutan. The road construction and its operation have been named as one of the sources of air pollutants such as PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>x</sub> and NO<sub>x</sub>. The strategy paper outlines technical requirement and methodology for conducting air quality monitoring. But at the same time, it also highlights the limitations of carrying out air quality monitoring in Bhutan for the want of monitoring equipment and the necessary technical capacity.

72. **Waste Prevention and Management Act of Bhutan 2009:** The Act covers all forms of waste; solid, liquid, gaseous, hazardous or non-hazardous produced through any form of activities. It ensures that wastes in whatever form to be properly handled, stored, disposed, reused or recycled or treated to prevent harming the environment. Avoidance, elimination and reduction of waste at the source are accorded the top priority in waste management. Development agencies such DOR will need to formulate and establish the waste management system in line with principles of 3R (Reduce, Recycle and Reuse).

73. **Forest and Nature Conservation Act (FNCA), 1995:** The Forest and Nature Conservation Act (FNCA), 1995 includes policies for activities that are prohibited in forested areas and stipulates activities that need special permits from the Department of Forests and Park Services. Clause 10 (a) i)–x) describes types of activities such as forest clearing, tree felling, hunting and polluting that are not allowed in Government Reserved Forests. Clause 22 mentions that all wild animals whether enlisted under Schedule I (totally protected species) or not, cannot be killed, injured, captured or collected unless under special conditions of self-protection and other genuine reasons.

74. **Forest and Nature Conservation Rules 2006:** Further to the FNCA, the Forest and Nature Conservation Rules of Bhutan updated in 2006 provides rules for many of the activities that will be undertaken in the project, such as clearing and felling of trees, blasting and others. Clause 14 1) and 2) describes activities that are prohibited and restricted in forested areas. Clause 55 outlines procedures for sourcing stone, sand, gravel, rock, peat and surface soil from forested areas. Clause 61 1)–5) provides an account of various forms of prohibitions within protected areas and special requirements necessary for carrying out specific development activities. Clause 64 provides information on activities prohibited for the purpose of wildlife protection/conservation.



75. Biodiversity protection provides an additional framework within which the Project must develop due to the presence of national parks and wildlife sanctuaries within range of the project area. These management areas were established to enable protection of the rich biodiversity resource of the region.

76. **Biological Corridor Rules 2007:** Biological corridor (BC) rules have been promulgated in July 2007 as an addendum to Forest and Nature Conservation Rules 2006. “Biological Corridor” means an area set aside to connect one or more protected areas, which shall be conserved and managed for the safe movement of wildlife. BC is managed centrally by the Department of Forest and Park Services (DOFPS). Any form of construction activities are prohibited inside the BC except with a written permit or authorization from the Department based on technical regulation. Any person who, within a Biological Corridor conducts any activity undertaken in contravention of prohibitions listed under Rule 116 (1.1) and (1.2) shall be guilty of an offense punishable under these Rules.

77. **Land Acquisition Regulations:** The basis for land tenure is the Land Act 1979 (Last amended in 2007). Under this act, the acquisition of any land, constructions or other property occurs in accordance with the procedures established. Land use of the project area assists in identifying land ownership. Land use is classified under Chuzhing<sup>6</sup>, Kamzhing<sup>7</sup>, Tsamdrog<sup>8</sup> and Sokshing<sup>9</sup>. Forest land can be classified under broad leaf, coniferous, scrub land and wetland. The ownership can be either (a) “private” or (b) “public”. For private land, the number of affected families’ needs to be identified. This data will be used to work out resettlement requirements and compensation payable. “Affected Families” are those who own or occupy the area and are dependent on it for their livelihood. They may or may not be the actual land owner. The key points of the Act applicable for the project are:

78. As far as possible the Government shall provide land substitution instead of cash compensation while acquiring land.

79. Allotment of all substitute land shall be from the same Dzongkhag.

80. In case the project acquires a house, the compensation for any category of house whether built with RCC/brick/stone masonry or in traditional style, shall be paid on the basis of evaluation carried out in each case by a qualified engineer appointed by a competent authority.

81. The Land Compensation Rate, 2009 governs the compensation of land and structures to be acquired by the project.

82. **The Local Government Act of Bhutan, 2007:** On enactment of this Act, the Dzongkhag Yargay Tshogdu Chathrim, 2002, the Geogs Yargay Tshogchung Chathrim, 2002, and the Bhutan Municipal Act, 1999, shall be amended as per the articles of the Local Governments’ Act of Bhutan 2007. Till the amendment of Dzongkhag and Geog Yargay chathrims, the environmental provisions of chathrims will remain valid and these are explained in following section.

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<sup>6</sup> Chuzhing – Wet land (Paddy land)

<sup>7</sup> Kamzhing – Dry land Agriculture

<sup>8</sup> Tsamdo – Grazing land

<sup>9</sup> Sokshing – Government forest registered in individual name, used basically for collection of leaf litters and firewood for domestic consumption

**83. Dzongkhag Yargay Tshogchung Chatrim and Geog Yargay Tshogchung 2002:**

The Chathrim were enacted to support the decentralization policy and empower locally elected community bodies (DYTs and GYT) with the authority and responsibility to decide, plan and implement development programmes and activities, including those concerning environmental management. Powers and functions vested in the DYT and GYT in relation to environmental management are specified below.

84. Environment-related provisions in DYT Chathrim, 2002 Article 8 of the DYT Chathrim 2002 gives the DYT the power and function to: Promote awareness and dissemination of national objectives (section 3); Adopt procedures and rules to implement national laws, wherever relevant (section 10); and make recommendations on activities with major environmental impacts such as construction of roads, extraction and conservation of forests, mining and quarrying (section 13).

85. Article 9 of the DYT Chathrim 2002 gives the DYT the power and function to adopt and enforce regulations with respect to: designation and protection of monuments and sites of cultural and historical interests (section 1); designation and protection of areas of special scenic beauty or biodiversity, such as dzongkhag parks and sanctuaries (section 2); control of noise pollution (section 8); establishment of quarries and mines in accordance with Mines and Mineral Management Act 1995; and protection of public health as per prevailing national guidelines or Acts (section 14).

86. Article 10 of the DYT Chathrim, 2002, gives the DYT broad administrative power and function to give direction and approval on: construction of farm and feeder roads (section 5); forest management plan including extraction, conservation and forest road construction in accordance with the FNCA (section 8); protection of forests, tsamdo and all types of government and community lands from illegal house and similar construction and other encroachments (section 19); control of construction of structures, whether on national, communal or private lands, within 50 feet of highways, including enforcement of measures such as cessation of construction and demolition of the structures (section 20); choice of trekking routes and camps for tourists (section 22); and mobilization of voluntary actions in times of natural catastrophes and emergencies (section 26).

87. Article 13 of the DYT Chathrim 2002 gives the Dzongkhag Administration the powers and functions to: construct farm and feeder roads, in conjunction with the NEC (section 5); determine the choice of design, construction methods and building materials for forms, which do not have to follow standard designs in conformity with acceptable technical and structural norms (section 12); and approve allocation of timber permits as per the rules and regulations issued by the MoA from time to time (section 16).

88. Environment-related provisions in GYT Chathrim 2002 Article 8 of the GYT Chathrim 2002 gives the GYT the power and function to adopt and enforce regulations at the geog level with respect to: safe disposal of waste (section 1); control and prevention of pollution of air, soil and water (section 2); sanitation standards (section 3); control of communicable livestock diseases within the geog in accordance with the Livestock Act 2001 (section 4); allocation of safe and clean drinking water from water supply schemes (section 5); allocation of irrigation water, in accordance with the provision of the Land Act 1979 (section 6); and protection and harvesting of edible forest products in the local area in accordance with the Forest and Nature Conservation Act 1995 (section 8).

89. Article 9 of the GYT Chathrim 2002 gives the GYT broad administrative power and function at the geog level with respect to: administration, monitoring and review of all activities that are part of the geog plan, including the maintenance of community properties such as lhakhangs, goendeys and their nangtens, chhoerten, mani dangrem, water supply schemes, irrigation channels, footpaths, mule tracks, farm and feeder roads, suspension and cantilever bridges, micro-hydels, basic health units and outreach clinics, lower secondary school and community schools, and extension centers of the RNR sector (section 2); conservation and protection of water resources, lakes, springs, streams, and rivers (section 7); custody and care of communal lands, community forests, including sokshing and nyekhor tsamdo, medicinal herbs and prevention of illegal house construction and all other types of encroachments on land and forests (section 8); and prevention of construction of structures, whether on national, communal or private lands, within 50 feet of highways falling in local area (section 9).

90. **Rules and Regulation on Explosives:** As the project will require huge quantity of explosives this rules and regulations is very important particularly pertaining to import, transportation and handling of explosives. The Department of Law and Order under the Ministry of Home and Cultural Affairs is the custodian of this Rule and Regulation.

91. **General Rules and Regulations on Occupational Health and Safety (OHS) in Construction, Manufacturing, Mining and Service Industries 2006:** The purpose of the OHS Rules and Regulations is to assure safe and healthful working conditions for working men and women as well as other persons present at workplaces from work related risks to their health, safety, and well-being. The Rules shall apply to all employers and workers (both Bhutanese and non-Bhutanese) of licensed manufacturing, mining and service enterprise, constructions, body corporate incorporated under the Companies Act 2000 of the Kingdom of Bhutan, and any other agency employing large number of workers at the work site(s). Annexure II describes Minimum Safety Standards for the Construction Industry. This includes personal protective and life-saving equipments, fire protection hand and power tools, signs, signals & barricades, Material handling, storage, use and disposal, Scaffolds, Excavations, Electrical works, Sanitation and Hygiene.

92. **Mines and Minerals Act 1995:** The Mines and Minerals Management Act 1995, provides framework for exploring mineral resources in the country. This also complements the EA Act 2000 as it has provisions for environmental requirements. This Act requires the project to seek site clearance for sand and stone quarrying needed for the road construction.

**Table 5: Summary of Environment and other applicable legislation and guidelines**

Legislation	Key Requirement	Applicability		Reasons for Applicability
		Construction	Operation	
National Environment Protection Act (NEPA) 2007	NEPA in its preamble states that Bhutan shall adhere to the principles of sustainable development and respect international environmental laws such as UFCC & UNCBD	Applicable	Applicable	There will be greenhouse gas emission as a result of one time removal of biomass for road construction and by operation of construction equipment; and also due to subsequent vehicular operation
Environment Assessment Act, 2000	Act requires the competent authority (CA) (DOR/MoWHS) to prepare EIA report as	Applicable	Applicable	The project road require environmental Clearance as it entails construction of new road (primary national

Legislation	Key Requirement	Applicability		Reasons for Applicability
		Construction	Operation	
	per the approved terms of reference			highway) of 68.3km in length through dense forest
Regulation for Environment Clearance of Projects (RECOP) 2002 and Guideline for Application for Environmental Clearance for Highways and Roads, 2004	Minimum public consultation requirement set.  Affected communities or stakeholders have to be informed through written notice or newspaper.	Applicable	Not-Applicable	NDH passes through settlements such as Nganglam, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang. It also passes close to school, sacred sites, temples and electricity and telephones utilities.
Strategy for air quality assessment and management in Bhutan, 2010	Baseline ambient quality of the all sensitive areas such as settlements and critical habitat areas has to be determined for future air quality monitoring. Baseline air quality will be assessed prior to the start of construction works.	Applicable	Applicable	Road construction is expected to cause air pollution mainly due to construction generated dust and emissions from operation of construction equipment.  Although minimal, some air pollution is also expected to occur during operation of road.
Waste Prevention and Management Act of Bhutan, 2009	To protect human health through protection of environment with proper handling, storage and disposal of hazardous and non-hazardous wastes	Applicable	Applicable	Road construction will generate huge amount of spoil which will need to be disposed of safely to prevent downstream water pollution and siltation. Construction works also expected to generate other solid (municipal waste) and hazardous liquid waste. Hazardous waste such spent oils will have to stored and recycled wherever feasible.  During operation, there are chances of spilling both hazardous and non-hazardous waste during transportation.
Forest and Nature Conservation Act (FNCA) 1995 Forest and Nature Conservation Rules (FNCR) 2006 Rules on Biological Corridor 2007	FNCA and its regulations require the proponent to process and seek the forestry clearance prior to the start construction. FNCR rule 9 (2.9) sets out the procedure for tree felling. Only the marked trees within the prescribed construction	Applicable	Applicable	NDH will pass through Biological corridor, sensitive habitat and through government reserved forest.  Proponent will have to process for the forestry clearance or permit for the construction of road through biological and government reserved forest. Project will require tree felling

Legislation	Key Requirement	Applicability		Reasons for Applicability
		Construction	Operation	
	<p>corridor can be felled. FNCR strictly prohibits killing, injuring, destroying, capturing or collecting of wildlife.</p> <p>Schedule I provides the totally protected wildlife of Bhutan.</p>			<p>which needs to be carried out as per FNCR rules.</p> <p>NDH passes through important wildlife habitat (in Regi area). Wildlife protection measures such as construction of wildlife crossing, signages and setting speed limits will be required.</p>
Land Act 1979 (amended 2007) Land Compensation Rate 2009	<p>Act requires any land acquisition whether public or private to be done as per the established procedure.</p> <p>For private land acquisition, the number of affected families' needs to be identified. Resettlement plan and compensation have to be worked out.</p> <p>Act also requires Government to provide land substitution instead of cash compensation while acquiring land. Allotment of all substitute land shall be from the same Dzongkhag.</p> <p>For structural acquisition, compensation has to be carried out qualified engineer.</p> <p>Land compensation Rate 2009 will govern the compensation of land and structures.</p>	Applicable	Not-Applicable	<p>Project will acquire about 63.91 acres land. About 96% of the land belongs to private owner.</p> <p>Total of 208 households are directly affected by the project. 6 semi-permanent structures will need to be acquired. About 14,857 numbers of fruit and fodder trees falls within road ROW and will be acquired.</p> <p>Resettlement Plan has been prepared which works out the compensation of land and other structural acquisitions. Resettlement Plan will be fully implemented prior to the start of civil construction work.</p>
The Local Government Act of Bhutan, 2007, Dzongkhag Yargay Tshogchung Chatrim Geog Yargay Tshogchung 2002	<p>Local government Act and the chathrim provide local governments with following power:</p> <p>To provide No-objection Certificate or clearance for projects</p> <p>Monitor developmental activities such as road</p>	Applicable	Applicable	<p>Project falls within two Dzongkhags/districts of Pemagatshel and Samdrup Jongkhar. Dzongkhag administrations have power to provide administrative clearances for the projects that fall within their administrative boundary.</p> <p>Road construction activities</p>

Legislation	Key Requirement	Applicability		Reasons for Applicability
		Construction	Operation	
	<p>construction and their impacts on the communities and environment</p> <p>Enforce regulation of protection of monuments and sites of cultural and historical interest</p> <p>Enforce 50feet ROW<sup>10</sup> regulations which prohibits the construction any unauthorized structures within ROW</p> <p>Enforce waste management regulations</p> <p>Protection of water sources and other water bodies within their jurisdiction</p>			<p>will be monitored by Dzongkhag and geog authorities.</p> <p>The construction activities will generate waste particularly excavated material.</p> <p>Dzongkhag and Geog administrations will be involved in identifying and approval of identified disposal sites prior to construction.</p> <p>Road construction within settlement areas is likely to damage water sources and supply line. Project management in consultation Geog authorities will come up with alternative measures during construction as well as agree and implement permanent restorations works after construction.</p> <p>During operation, the presence of road will attract unwanted road settlements. Dzongkhag and Geog authorities will monitor and prevent such illegal encroachment within 50feet ROW.</p>
General Rules and Regulations on Occupational Health And Safety (OHS) in Construction, Manufacturing, Mining and Service Industries 2006	OHS Rule prescribes the minimum safety standards to be followed for the construction works. This includes personal protective and lifesaving equipments, fire protection hand and power tools, signs, signals & barricades, Material handling, storage, use and disposal, Scaffolds, Excavations, Electrical works, Sanitation and Hygiene.	Applicable	Applicable	During construction, project will employ large number of workers who will be working in hazardous condition. The OHS rules will have to be strictly implemented to minimize health and life risk associated while constructing road through hazardous condition. During operational period, safety of road maintenance workers will have to be ensured through provision of OHS rule.

#### D. Conclusion

<sup>10</sup> ROW – Right of Way is 50 feet either side from the road center line.

93. The project is being developed within a framework based on the policies and guidelines of the ADB and the laws, regulations and guidelines of the RGoB. In regard to ADB, the ADB's Good Practice Sourcebook for Environment Safeguard, December 2012 and the Safeguard Policy Statement (SPS 2009) are the framework documents. The RGoB framework documents are the Environmental Assessment Act (2000), and Regulation for the Environmental Clearance of Projects (2002). Other regulations of the RGoB require prior clearance for project activities.

### **III. PUBLIC CONSULTATION, DISCLOSURE AND GRIEVANCE MECHANISM**

#### **A. Stakeholder Analysis**

94. Stakeholders include institutions and cohorts of individuals affected either beneficially or adversely, directly or indirectly, by the Project. Those affected adversely are commonly referred to as Affected Persons (APs). APs may experience environmental impact or be entitled to compensation due to land taken or property lost. Their number is certainly less than that comprising the group of beneficially affected given the nature of the project and the project proponent, a national agency following a national transport development plan.

95. Local stakeholders are cohorts of individuals inhabiting the directly linked or affected geogs of Norbugang and Chokhorling of Pemagatshel, Rishore and Chenari of Samdrup Jongkhar and Dewathang Municipality. Those adversely affected by environmental impact include those directly exposed to construction impacts due to their proximity to the road, those entitled to compensation for structures and land for constructions, those along haul routes of construction materials, and those who may be affected by long term impacts stemming from the roadway during its operation. Stakeholders benefiting from the Project include virtually all groups which are engaged in economic pursuits in the area, whether it be transport of agricultural, manufactured and handicraft products to market, sourcing of resources and raw materials, sale of products in an expanded market or the purchase of those goods. Local government benefits through closer ties with national agencies.

96. The list of local stakeholder groups thus is comprised of a) those directly affected by adverse environmental impact during construction, b) those entitled to compensation due to relocation of buildings and taking of land, c) those indirectly affected over the long term due to various forms of cumulative impact, d) a variety of identifiable groups (farmers, suppliers, etc.) that benefit from the economy associated with road transport, and e) local government administrators. Women also form an identifiable stakeholder group as they may be adversely affected during construction. For example; women and children in the vicinity of road construction will be particularly affected due to damage of drinking water supply as they will be the ones who will have to fetch water from faraway places.

97. National stakeholders include groups making up the citizenry of the Nation and the various groups within the Royal Government of Bhutan. List of officials consulted for this study is attached as Appendix E, section 6 other key stakeholders consulted. Adversely affected groups at this scale may be those with a stake in natural resource conservation that perceive negative effects during construction and cumulative impact during operation. The EIA aims to address these concerns. Benefits for groups at regional and national levels stem from increasing connectivity for transfer of goods and services in both private and public sectors and improved governance including better resource management.

#### **B. Process of Public Involvement**

##### **1. Early Screening**

98. The Project conforms to the Road Sector Master Plan (2007-2027) and the 10th Five-Year Plan (2008–2013) that prioritizes completion of the southern east–west corridor. Both these documents were reviewed and approved by government stakeholders, indicating broad consensus in the RGoB for the proposed roadways. The structure of government assures that local community representatives are aware of master plans that include the proposed roadways.



## 2. First Stage of Public Consultation

99. The Department of Roads (DoR) on behalf of the Consultant wrote official letters to the Dzongkhag (District) and Dungkhag (sub-District) administrations to inform the public living in the study area of the proposed road project. The Dzongkhags and Dungkhags in turn informed the public through Geog administrations. Affected Dzongkhags of Pemagatshel and Samdrup Jongkhar were informed of the impending detailed study inclusive of environmental and socio-economic assessment studies. The EIA and Social/Resettlement Assessment team jointly conducted public consultation according to a prescribed format and in accordance with the following objectives:

100. To inform the public and present details regarding the proposed project, its design and anticipated function (the reason it is being built), steps to implement the time frame.

101. To ask local residents about their road transport needs (both short term and long term). To explore whether or not the proposed project is consistent with their needs and goals.

102. Participants were specifically asked their views on issues related to the road development works, beneficiary and affected groups, impacts of the road development works due to existing conditions and expected impacts from proposed rehabilitation measures, priorities for transport, environmental issues, community participation and women's issues.

**Table 6: Location, Attendance and Timing of Public Consultations**

<b>Geog, Dzongkhag</b>	<b>Location of Meeting Held</b>	<b>Attendance</b>	<b>Time and Dates</b>
Chokhorling, Pema Gatshel	Yargaywoong	Male=10 Female=0 Total =10	9.00Am, 19/11/2011
	Thujaycholing Lhakhang, Chokhorling	Male=17 Female=13 Total =30	2.00Pm; 19/11/2011
Dewathang, Samdrup Jongkhar	Chenari, Dewathang	Male=20 Female=17 Total =37	4.30Pm; 26/11/2011

## 3. Second Stage of Public Consultation

103. National public consultation held in Thimphu provided an opportunity for government and NGO stakeholders along with interested citizens to provide comment and ask questions concerning the project, potential environmental impacts and mitigation measures. The meeting held on 14 March 2012 for one-half day at the conference hall of the Ministry of Works and Human Settlement in Thimphu. The meeting was attended by representatives from ADB, DoR, DoFPS/Wildlife Conservation Division, Gross National Happiness Commission (GNHC), Ministry of Finance, Department of Geology and Mines (DGM), Ministry of Economic Affairs (MoEA), and the Local governments (Lhamoizingkha Dungkhag, Samdrup Jongkhar Thromde, Sarpang and Zhemgang Dzongkhags). The consultants presented a brief description of the project and described potential impacts that were identified in the environmental assessment process. Questions and comments were taken from the audience during a session that lasted for an hour. The important issues raised in the national workshop are as following:

- In the light of practical difficulties of having proper spoil disposal particularly while constructing road in a steep terrain (slope more than 60%), the NEC recommended that such problems are specifically mentioned in the EIA report.
- The representative from the NEC commended the idea of working cooperatively with other agencies such as Sunkosh Hydropower Project in developing road section from Lhamoizingkha to Kerabari. It was recommended to have further such cooperation in other road sections under RNP II AF to harmonize the various development activities and reduce the overall impacts on the environment.
- NEC also commended ADB and DoR for considering the climate change and adaptation issues under PPTA, RNP II AF for the future road construction. This is the first of its kind in the road sector in Bhutan.
- The representative of the Department of Geology and Mines (DGM) recommended the use of updated Geological Maps (which is being updated currently) during the detailed design.

104. The consultants responded to some of these directly, while others were noted and considered in the final reassessment of the EIA report covering its contents, and the comprehensiveness of the assessment process that contributed to that. The comments have been incorporated into the findings and recommendations of the EIA and EMP. List of participants can be found in Appendix D.

**Figure 2: Public Consultation at Chokhorling**



**Figure 3: Public Consultation at Rishore**



**Figure 4: National Consultation Workshop**



**Figure 5: Protected Area Zoning Workshop**



**Figure 6: Geog Consultation, Chokhorling**

**Figure 7: Public Consultation, Chokhorling**



**Figure 8: Dzongkhag Consultation, S/J**



**Figure 9: Geog Consultation, Dewathang**



**Figure 10: Consultation with CFO, S/J**



**Figure 11: Final National Consultation**



#### **4. Presentation of EIA findings to the Park Managers & Wildlife Specialists**

105. On the request of the Wildlife Conservation Division (WCD) under Department of Forest and Park Services (DoFPS), the EIA findings of the RNP II AF feasibility study were presented in the opening session of two day workshop on consultative zoning of the protected areas of Bhutan. The workshop was carried out with the aim to revise the current Protected Area Zoning

Policies of DoFPS to take in account of changing development scenarios in Bhutan. It was attended by the Park Managers, Forest and Wildlife Specialists and Wetland Management Expert which was graced by the Director General of the Department of Forests and Park Services. Then Director General (Mr. Karma Dukpa) in his address to the workshop participants commended the efforts taken by the Department of Roads to preserve the environment while planning, designing and constructing roads. Similarly, the participants including the representatives of the WCD expressed appreciation of RNP II AF project for putting protection of wildlife and their habitats as top priorities while planning for road development.

## **5. Final Stakeholder Consultation**

106. The final national stakeholder workshop for the presentation of revised/updated EIA Report was held on 19 November 2013 at the conference hall of the Ministry of Works and Human Settlement in Thimphu. It was attended by representatives from ADB, DOR, Policy and Planning Division of MOWHS, Wildlife Conservation Division and Department of Forest and Park Services of Ministry of Agriculture and Forestry Services and Detailed Design Team, Kyinkhor Consultancy Service. *List of participants is attached in the appendix D Section 9.* The important comments on the findings of the updated EIA report were:

- About 2km stretch of the proposed NDH will follow the existing Nganglam-Chokhorling farm road that passes through biological corridor which connects the Royal Manas National Park (RMNP) and the Khaling Wildlife Sanctuary (KWS). DOFPS will issue forestry clearance with detailed terms and conditions of dos and don'ts while widening the existing farm road through the sensitive biological corridor. In general, the detailed design proposes a gentle slope cutting, restricted tree felling and proper spoil disposal to avoid damage to the critical habitats.
- Utility infrastructure such as electric and telephone poles that need relocation, to be thoroughly documented in the detailed design and the EIA report. The process for relocation and restoration works to be initiated before the start of actual civil construction works.
- Protected and endangered flora, if found inside the construction zone, during construction period, need to be relocated by informing local forestry office before proceeding with further construction works.
- Compensatory plantation to be carried out by project in consultation with the local forestry office on barren government land. The cost of compensatory plantation to be included in the overall EMP budget.
- Locations for all three bridges; over Kirungri, Chowkiri and Dui River have changed during the detailed design with the aim to shorten the overall alignment, to avoid massive Regi landslide, and thick forested and rocky stretch along Dui River.
- Climate change issues which are highlighted in the separate climate change study of NDH carried out under the SASEC Road Connectivity Project to be fully incorporated into the EIA report.

107. The comments and suggestions made during final stakeholder consultation workshop have been incorporated into the final EIA report.

## **C. Summary of Public Acceptance and Opinion**



108. The main purpose of the consultation was to present the proposed project, illicit issues and concerns that the people in the impact area may have relevant to the proposed development and discuss the environmental requirement for projects of this type. In general, the people living within the sub-project influenced area welcomed the prospect of building new highway from Nganglam to Dewathang as this will bring about economic development opportunities for this remote region. *Project Acceptance Letters from the public living within the PIA are attached as Appendix D Section 4 and 5.* However, the following issues were raised by people that are relevant to the proposed road development project:

109. **Water Supply:** People of PIA (Nganglam, Drangnalashing Borang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang) expressed their concerns on damage and disruption of their water supply system and their watersheds during road construction. The request was made to provide alternative water supply arrangement during road construction and reinstate their damaged water supply as soon as possible. Protection/mitigation measures have been included in the design.

110. **Religious and Cultural Assets:** People of Yargaywoong, Chokhorling and Dewathang requested to avoid damage of their important religious and cultural assets such as Meme Lungkhangma Labtsha (Nye-Sacred Holy Stone located close road alignment at km 12+700), Thujaycholing Lhakhang or temple located at chainage km 26+620, Big Boulder (Lu- Snake Goddess) at Chenari karphu at chainage Km 65+500, Chenari Phodrang (Nyepo-Sacred Rock) at chainage Km 66+000 and Gesar Dala Lhakhang at chainage km 67+240. Protection/mitigation measures have been included in the detailed design.

111. **Private Properties:** People of Rishore, Chenari and Dewathang settlements expressed concerns of road widening damaging their private properties such as land, houses, shops and boundary fences along the road alignment from Rishore to Dewathang termination point. People expressed the need for appropriate compensations for the lost properties particularly houses so that they could rebuild without problem. In the case of land loss, they preferred land substitution against cash compensation.

112. **Institutional Properties:** Communities of Rishore and Chenari raised the concerns of road widening affecting the playground and academic buildings of Dewathang Lower Secondary Schools. The need for proper protection of the institutional building and the playground has been recommended by the public.

#### **D. Information Disclosure**

113. During the public consultation, the description of the project attributes in the local context provided to members of the public that attended consultation. It was noted that the project will be funded by the ADB. The meetings were held in conjunction with field surveys. Specific aspects were described of the RGoB policy on resettlement and compensations for lost land and assets.

114. The draft EIA has been discussed with the respective Dzongkhags and Dungkhags and their comments and suggestions received have been incorporated in the design.

115. Furthermore, ADB's Safeguard Policy Statement 2009 and the Public Communications Policy Review 2011 require the EIA report prepared be reviewed by the ADB and disclose that same on its website for wider public dissemination.

## **E. Further Public Involvement and Grievance Mechanism**

### **1. Mechanisms for resolution of conflicts and appeals procedures**

116. The project will be implemented through participatory<sup>11</sup> approach involving local communities and local government organization such as Geog Tshogchung (GT) and Dzongkhag Tshogdu (DT). Through this participatory process, and with the provision of fair compensation and grievance redress mechanism, acceptance of the project will be enhanced and complaints reduced. Nevertheless, during the process of its implementation, there will be issues that individuals or groups who feel that they are not given adequate attention or the issues are not properly addressed. Therefore, in this light, project will establish a Grievance Redress process in the existing mechanism of local committees (Geog Tshogchung, Dzongkhag Tshogdu), and the Dzongkhag/Dungkhag which will hear complaints and facilitate in providing solutions. If the issue is not resolved, the individual/group may approach DoR and if the issue remains unresolved, people would have the right to approach RGoB as per traditional practices.

### **2. Procedures and Time Frame for Grievance Redressal**

117. A grievance redress mechanism will be established to receive and facilitate the resolution of concerns, complaints and grievances of affected people and relevant agencies on the social and environmental performance of the project in a time bound and transparent manner. The project specific GRM is not intended to bypass the government's own redress process, rather it is intended to address project affected people's concerns and complaints promptly, making it readily accessible to all segments of affected persons and is scaled to the risks and impacts of the project. While the affected person or party may submit their complaints concerning the project to any relevant agency, the steps recommended for the GRM are:

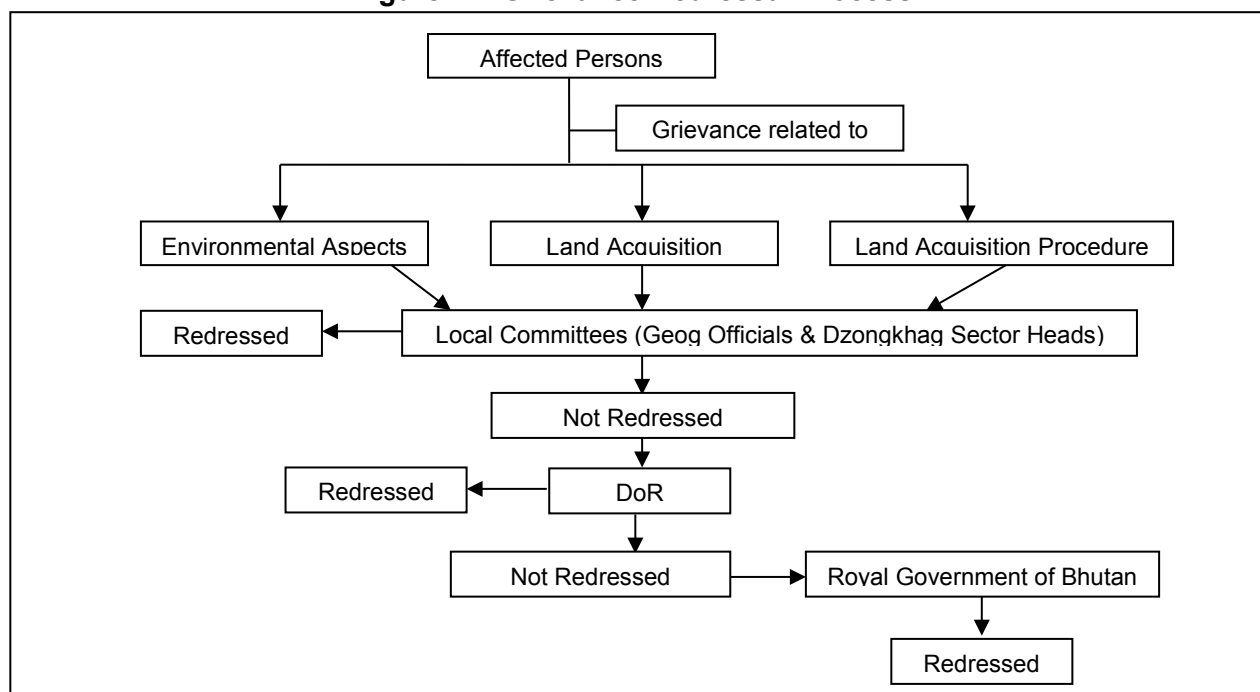
118. **Step 1:** If any affected person or party faces grievances related to environment, land acquisition or resettlements, he/she can approach the contractor, construction supervision consultants or site staff of DOR and PT directly at the site level.

119. **Step 2:** If grievances are not addressed at the site level, the affected person or party can lodge a written grievance to the grievance redress committee (GRC) comprising of Sector Heads of the Dzongkhag Administration as well as Geog Officials. The affected person or party may also skip step 1 and directly file written grievance to the GRC. All grievances which cannot be address at the site level should be forwarded to the grievance redress committee within 15 days from the receipt of complaint. The committee must respond within 15 days. Further, the GRC will treat grievances of both male and female affected persons equally and address them fairly.

120. **Step 3:** If the affected person or party is not satisfied with the decision or he/she receives no response within 15 days of registering the grievance, he/she can approach the DOR and finally, can appeal to the Royal Government of Bhutan or His Majesty the King.

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<sup>11</sup> The rural communities in Bhutan are organized into *geog* (block) development groups for discussion and self-help. All households are required to be at the meetings that will be called by the *Gup* (Head of the block). In this context, the planning process is essentially participatory with priorities and needs identified by communities and passed through the "*Geog Tshogchung*" (Block Development Committees) to the "*Dzongkhag Tshogdu*" (District Development Committees) and then to the *Dzongkhag* (District Administration) and Royal Government.

**Figure 12: Grievance Redressal Process**

## **IV. DESCRIPTION OF PROJECT**

### **A. Development Context**

121. The region is under-served by a national road network system, and there is no interconnecting roadway across the southern breadth of the country. As a result, the RGoB through the ADB's assistance is implementing RNP II which encompasses the construction of five road sections (Manitar-Raidak, Raidak-Lhamoizingkha, Panbang-Nganglam, Tsebar-Mikuri-Durungi and Samdrupcholing-Samrang highways). In addition to ongoing RNP II, the ADB TA 7803-BHU had carried out the feasibility studies of the remaining road sections (Lhamoizingkha-Sarpang, Gelephu-Panbang, Nganglam-Dewathang and Samrang-Jomotsangkha highway) of the second east-west highway that were not included under RNP II. Of these four road sections, the Nganglam – Dewathang highway (NDH) was found to be most viable economically, and hence was selected for financing under the SASEC Road Connectivity Project. Based on the detailed design the EIA for this road has been further updated.

122. Segments of roadway (inclusive of NDH section) proposed under RNP II AF have been identified by the Department of Roads and conform to the Road Sector Master Plan (2007-2027) approved by the Government as well as the 10th Five-Year Plan (2008–2013) that prioritizes completion of the southern east–west corridor.

123. Lack of access to markets and social services is a major constraint on poverty alleviation in this area. The Bhutan National Poverty Reduction Strategy prioritizes the extension and improvement of physical infrastructure as a strategic means for combating poverty. ADB recognizes the importance of connectivity and accessibility of remote rural areas as a key component of its transport development strategy. Improved access to markets and services contributes potentially greater economic benefit than that calculated on the basis of vehicle miles travelled, the common means of calculating roadway benefits. The inclusion of roads to otherwise isolated communities further multiplies benefits gained from the roads.

### **B. Description of Nganglam-Dewathang Highway Alignment**

124. The proposed NDH lies in the South-East part of the country falling under the Dzongkhags of Pemagatshel and Samdrup Jongkhar. The proposed road starts from small industrial town of Nganglam under Pemagatshel Dzongkhag and ends at Dewathang Municipality under Samdrup Jongkhar Dzongkhag. Major settlements along the road alignment are Nganglam town, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang town.

125. From Nganglam till Km 15 near Yargaywoong will follow the existing farm road (Nganglam-Chokhorling Geog Centre farm road) with minor readjustment. The middle section from Km 15 to Rishore under Dewathang Geog will be new construction and passes mostly through forests and the settlements of Yargaywoong, Chokhorling and Khalatsho. The last section from Rishore till the termination point at chainage Km 68 will follow existing coal mine and Dewathang Municipal roads.

126. The proposed highway is the important link bridging east and west through Panbang and Tingtibi. Considering the importance, this roadway is accorded highest priority by the RGoB for implementation under SASEC Road Connectivity Project.



## **C. Existing Roads**

### **1. Farm Road**

127. Road Act of Bhutan, 2004 defines farm road as a road that links agricultural farmland areas to national highways and other roads primarily to enable the transportation of inputs to the farm and agricultural produce to the market. These roads are unpaved, unreliable and normally unserviceable during the monsoon seasons due to lack of side drains as well as proper cross drainages. Farm road is normally built with 4 - 5.0m formation width and 3.5m as a carriage width. Normal traffic is estimated to be as low as 204 per annum at the time of opening year 2018.

128. Of the total of 29km of farm road from Nganglam-Chokhorling, initial 15km will be widened and upgraded to Nganglam-Dewathang highway. Figure IV-1 provides the view of the existing existing farm road near Nganglam.

129. About 6km (from Chainage Km9 till Km15) of the existing farm road passes along the northern portion of the Biological Corridor. Biological corridor is a stretch of forest connecting two protected areas – the Royal Manas National Park (RMNP) and the Khaling Wildlife Sanctuary (KWS).

### **2. Mining Road**

130. Mining road means a road constructed and maintained for the purposes of mining and exploration under a mining lease (Road Act of Bhutan, 2004). The standard of mining road is similar to that of farm road. It is unpaved and used only during mining season which start from late September till end of April coinciding with dry season. Of the total 5.5km mining road, the last 2km will be widened and upgraded to a highway standard.

### **3. Dewathang Municipal Road**

131. Municipal or Thromde road means all types of roads located within the municipal boundary not otherwise designated as primary and secondary national highways (Road Act of Bhutan, 2004). There are total of about 7km of Dewathang Municipal road, of which about 2.5km from Chenari till termination at Gortap, Dewathang will be widened and upgraded to a highway standard. Standard of municipal road under Dewathang is lower than secondary national highway standard with single lane paved road. Figure IV-2 shows the existing municipal road at Dewathang.

**Figure 13: Nganglam-Chokhorling Farm Road**



**Figure 14: Dewathang Municipal Road**

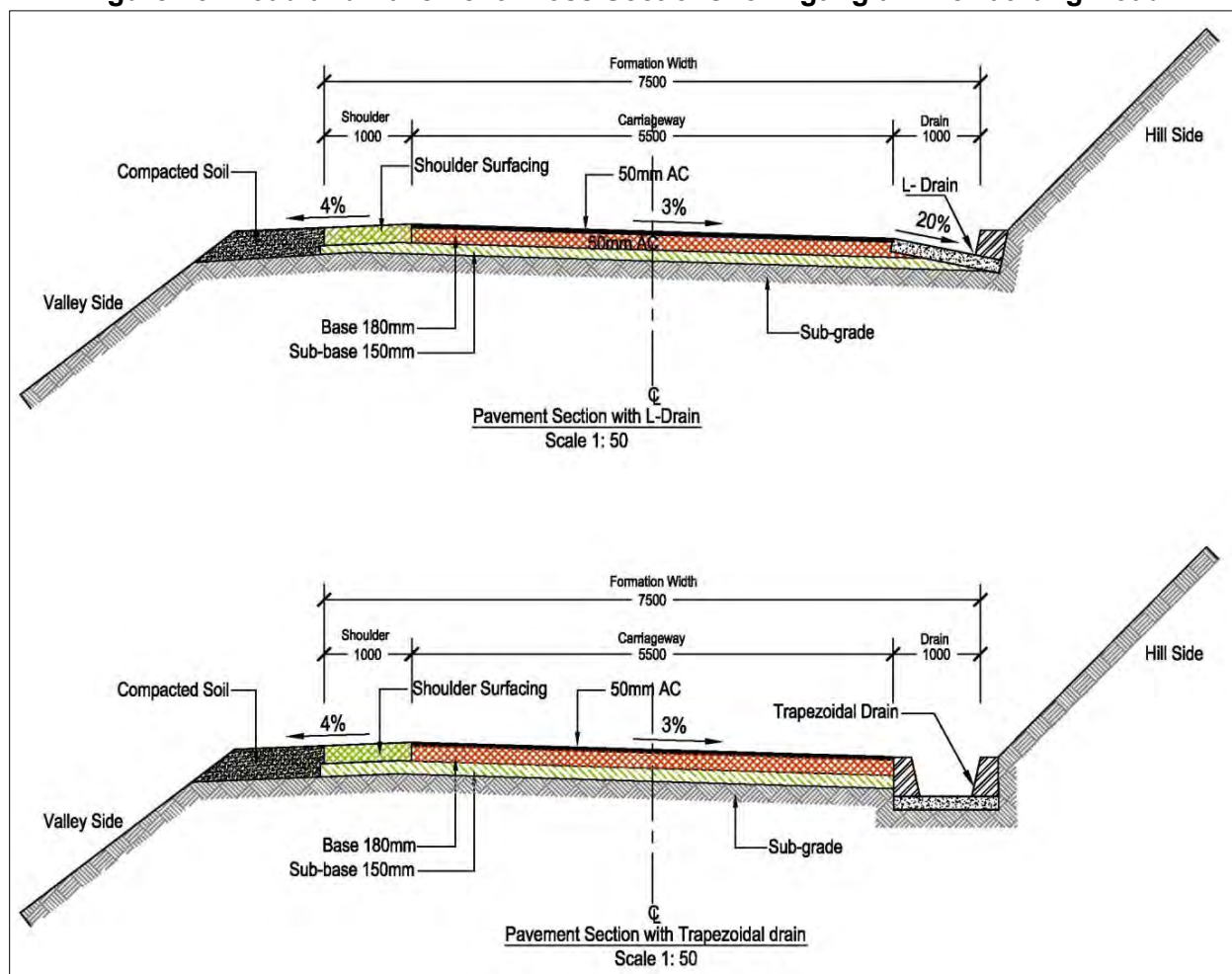


## D. Nganglam-Dewathang Highway Design Standards

132. Nganglam-Dewathang highway standard falls in between Primary and Secondary National Highway categories of Bhutan with formation width of 7.5m and carriage width of 5.5m. DOR's standard for Primary National Highway is with 10.5m formation width and 6.5m carriage width; while Secondary National Highway is with 7.5m formation width and 3.5m carriage width.

133. Geometric design of a highway concerns with the dimensions and layout of visible features of the highway such as alignment, sight distance and intersections. The basic principles of geometric design are to provide roadway facilities that are safe and economical and that consider environmental and social impacts. Earnest efforts have been made to adopt appropriate standards that ensure minimal environmental damages and negate the effects of climate change.

**Figure 15: Road and Pavement Cross Sections for Nganglam-Dewathang Road**



Source: Draft Final Report, Vol.1 (Detailed Design of Nganglam-Dewathang Highway), December 2013

134. EFRC principles and the recommended climate change adaptation measures have been incorporated in the design. EFRC design takes into consideration “cut & fill mass balancing” techniques; avoiding box cuts and high cuts to minimize environmental damages and optimize cost of construction. Bio-engineering in conjunction with small scale civil engineering structures are adopted for slope stabilization and water management. Gabions are proposed in unstable

and marshy areas for convenience in construction and cost considerations. Detailed and site specific EMPs have been prepared for environment management during construction.

135. The design guidelines provided under the following documents have been used to arrive at suitable design standards for the project road:

- Guidelines of Road Classification System and Delineation of Construction and Maintenance Responsibilities, May 2009;
- Road Survey & Design Manual, 2005;
- Guidelines on Standard Work items for common road projects, August 2010;
- Manual for Pavement Markings, 2007;
- Manual for Road Signs, 2007;
- Manual for EFRC & Bio-engineering, 2002;
- Environment Code of Practice, Roads & Highways, 2000.

#### **E. Cost, Size, Magnitude and Extent**

136. The total project cost for all project components was estimated to be \$50 million during PPTA study (2011-2013), including design and construction supervision.

137. Detailed design estimates construction cost to be about \$30.715 million exclusive of resettlement cost, and supervision cost as provided in Table 7. The environmental management and climate change adaptation costs are inbuilt into the road construction cost which is about 17.2% and 5.4% respectively of the total construction cost. The details of environmental management cost are provided under the section IX of this report.

**Table 7: Summary of Cost estimate**

Sl. No.	Items	Estimated cost in millions		Remarks
		Nu.	US\$	
1	Establishment costs	31.753	0.504	
2	Site Clearing, Grubbing & Removals	6.625	0.105	
3	Earth Excavation, Transport & Filling	610.896	9.696	
4	Subgrade Preparation	19.233	0.305	
5	Subbase & Base works	334.763	5.312	
6	Bituminous works	276.609	4.390	
7	Stone Masonry works	212.937	3.380	
8	Gabion works	60.727	0.964	
9	Concrete works	53.660	0.852	
10	Cross Drainage works	12.554	0.200	
11	Bridges	45.497	0.722	
12	Drains & Protection works	134.550	2.135	
13	Bio-engineering works	4.090	0.065	
14	Traffic signs	22.662	0.360	
15	Day Works	1.659	0.263	
Sub Total		1828.215	29.253	
5% Contingencies		91.401	1.462	
<b>Total</b>		<b>1919.616</b>	<b>30.715</b>	
* 1US\$ = Nu.63.00				

Source: Draft Final Report, Vol.1 (Detailed Design of Nganglam-Dewathang Highway), December 2013

## **F. Schedule for Approval and Implementation**

138. The Project is expected to be submitted for ADB Board approval within the first half of 2014. The duration of the construction phase (the Project) is about 3.5 years starting last quarter of 2014. The Construction Supervision Consultant (CSC) will be procured later under a separate contract. The project will be constructed under two separate contracts including the bridges as provided in Table IV-2.

### **1. Contract Package No.1 – ND01**

139. This package will include the road section from Km 0 (Nganglam) to 43.8 (Tshokhiri bridge) and the estimated cost under this package is Nu.1,119.8 million. One bridge over Menchudrangri, 16 m span is also included in this package. This is the biggest package out of the two packages. This package is expected to be completed in 3.5 years.

### **2. Contract Package No.2 – ND02**

140. This package will include the road section from Km 43.8(Tshokhiri) to km 68.3 (Dewathang) and the estimated cost under this package is Nu. 796.3 million. Two major bridges, 24 m span over Tshokhiri and 30 m span over Duiuri are included in this package. This package is expected to be completed in 3 years.

**Table 8: Contract Packages**

<b>Package No.</b>	<b>Road Section &amp; Length</b>	<b>Bridges</b>	<b>Proposed contract</b>	<b>Total Cost (Nu. in</b>
ND01	Km 0-43 = 43 km	Menchudrangri at Km 42.3	ICB/3.5 years	1,119.82
ND02	Km 43-68 = 25 km	Tshokhiri at Km 43.8 & Duiuri at Km 57.3	ICB/3 years	796.35

Source: Draft Final Report, Vol.1 (Detailed Design of Nganglam-Dewathang Highway), December 2013

## **G. Methods and Timing of Construction**

141. The contract will be awarded generally to local contractors, since they have proven competent under the RNP II project. Mobilizing the construction work consists of setting up construction camps, equipment yards and service facilities, and importation of equipment to the site. Aggregate crushing and grading, concrete batch plants and other associated facilities need to be set up according to the schedule of implementation for the work. Road construction will proceed from an existing point of access from both ends; namely from Nganglam and Dewathang. The work will be awarded in two separate contracts as mentioned in previous section to speed up the construction works.

142. Survey of the right-of-way and clearing of harvestable timber is required prior to award of the construction contract, overseen by DoFPS and the DoR, as described in the EMP and stipulated by DoFPS regulations. Construction zones extend over 5.0 km stretches in which a progressive sequence of activities takes place, depending on location and terrain.

143. Clearing of remaining brush and grubbing of below ground vegetation; removal of vegetation down slope to form a log/brush soil-retention barrier; rough grade and cut; blasting of rock and excavation of cuts; baring of foundation rock down-grade for support of gabions and retaining walls; grade-up and down-slope; fill and bench; stabilize slopes; compact and grade

sub-base materials; and application of road surfacing. Parallel to this sequence is the construction of hydraulic structures.

#### **H. Construction Materials**

144. Construction materials particularly the stones shall be quarried along the roadside. The potential quarries are identified are; area after Dezama, Kirungri, Muru ri and Khalatsho. These quarries are expected to be small with localized operations and do not fall within sensitive habitat and biological corridor. They are also located safe distance from the settlements (at least 500m away). In addition, there are other good quarry materials along the Nganglam-Dewathang road offering rock materials of various sizes for use in masonry construction and fill. Some materials from road cutting can be used for fill and masonry construction.

145. Sand is one of the important construction material required. The material investigation under detailed design study recommends sand to be imported from existing sand quarries at neighbouring Indian state of Assam – i) Barpeta (10km from Nganglam) and ii) Pagla and Bada Nadi. The study also found a suitable sand quarry at Yangbari, some 30km from Nganglam town which will require a separate environmental clearance to be processed.

146. Cement will be procured from Dungsam Cement Plant. Rest of the construction materials will be imported mainly from India and abroad.

#### **I. Construction Technology and Equipment**

147. The environmental friendly road construction technology and equipment will be used for construction of the proposed road. Some of main construction equipment that will be used is Hydraulic Excavator; JCB Loader/Backhoe; Road Rollers, 10T Tippers trucks; Aggregate Processing Plant 250 T/hr; Batch, compressors, etc.

## **V. DESCRIPTION OF ENVIRONMENT**

148. This chapter describes the existing environmental settings in the study area. In order to identify any potential impact on and to the natural and socioeconomic environment, it is essential to have a thorough understanding of the nature of the existing environment prior to commencement of the proposed activities. This acts as a need to characterize the existing baseline environmental and socio-economic conditions including establishing the prevailing conditions for a range of media through primary monitoring, undertaking focused surveys and the collection of secondary information from various published sources. It includes the physical environment comprising of air, water and land components, the biological environment and socio-economic environment. The major purposes of describing the environmental settings of the study area are:

- To assess the existing environmental quality, as well as the environmental impacts of the future developments being studied;
- To identify environmentally significant factors or geographical areas that could preclude any future development.

149. Additional purposes of the baseline studies is to provide sufficient information so that decision makers alien with the general location can develop an understanding of

- The project need
- Environmental characteristics of the study area

150. The objective of the present study is to assess comprehensive environmental impacts due to proposed road development. The current environmental quality status around the identified project sites represents the baseline status for proposed NDH project.

### **A. Physical Environment**

#### **1. Geology, Soil and Seismology**

151. The project area is characterized by four distinct geological formations such as Manas, Duiiri, Shetikhola and I-III formations (Refer Figure V-1). Formations making up the Lower Himalayan Belt are most prominent in the project area.

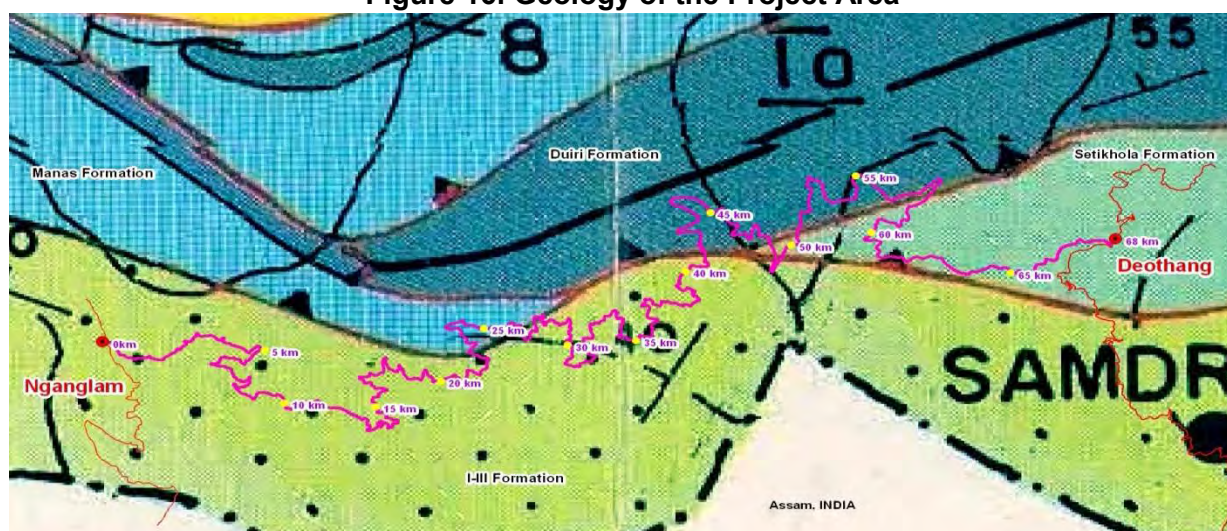
- Manas formation comprised of dolomite, limestone, quarts and conglomerates,
- Duiiri formation is mainly characterized by hard phyllite with quartzite, Siltstone and Diamicitte.
- Shetikhola formation is comprised of feldspathic sandstone, sandstone, siltstone, shale, carbonaceous shale and coal.
- I-III formation which is dominant in the lower latitude is comprised of sandstone, siltstone, shale and clay

152. Each of these formations is bounded by thrust faults with the higher plate to the north (see Figure V-1). Relative movement of these plates accompanied by monsoon precipitation gives rise to the high incidence of landslides and rapid progression of geological change. While all these formations are of Precambrian origin, tectonics and crustal movement are recent and unstable. Large landslides occur in the area. The I-III formation, composed of sandstone, is especially weak and subject to landslides. Throughout the area there are evidences of

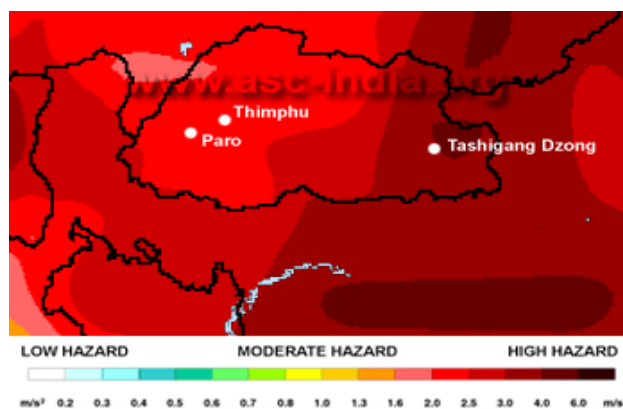


geological processes occurring within the time frame of decades, if not years. Bhutan lies in a region with high to very high seismic hazard that increases towards the eastern parts of the country (see Figure V-2). Historically, earthquakes in the magnitude 5.0-6.0 range have been experienced and at least one magnitude 7.0 event is thought to have occurred in the 1700's in eastern Bhutan and adjoining parts of India (ASC 2009). However there is an absence of other large magnitude seismic events in Bhutan noted in the historical records (Drukpa, et. al., undated) and a 'seismic gap' exists over the region of Bhutan in the large magnitude earthquake event sequence stretching from Nepal into Assam (see Figure 4-5). This may be due to the uplift of the Shillong Plateau in Meghalaya state, northeastern India, and relief of stress in boundary faults along the southern stretch of Bhutan. (Tobgay, undated). Still there is general agreement in the literature that Bhutan lays in a zone of high earthquake risk. Determining the seismic hazard zone is difficult due to lack of historical data; however if the seismic hazard zoning of similar areas in India is extended, Bhutan falls within seismic risk zones IV and V.

**Figure 16: Geology of the Project Area**

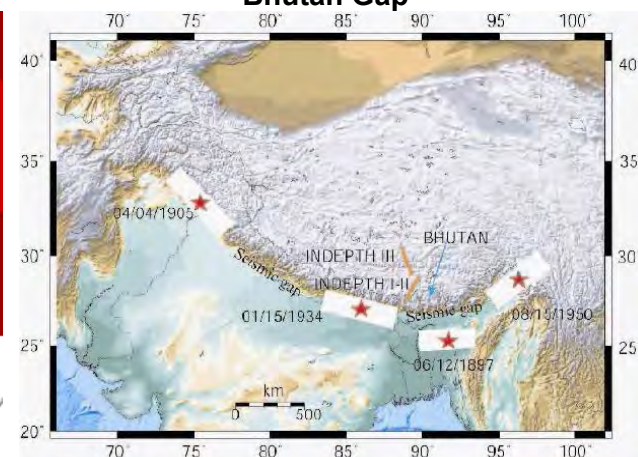


**Figure 17: Seismic Hazard Map of Bhutan**



Source: ASC 2009

**Figure 18: Major Seismic Events and Bhutan Gap**



Source: Tobgay, Undated

153. Soils are made up of decomposed colluvium boulders and breakdown materials derived from tectonic processes. Gravel, sand, stone, and smaller-graded soil materials (sandy silts and clays) are found on hillsides. In river beds these materials are graded by natural processes. Soil loss and replenishment is rapid. Top soil is observed to be thin in upslope, and generous amounts are found on slopes due to relatively recent orogeny.

**Table 9: Geology and Instabilities along the road sections**

Sl. No.		Instabilities	Mitigation Measures
1	Km 0+900	Bedrock is weak and highly weathered (loose gravelly silt of sandstone and phyllite).	<ul style="list-style-type: none"> <li>Bioengineering</li> <li>Maintenance of back slope is recommended</li> </ul>
2	Km 2+900	Unstable site with dark grey carbonaceous shale with marshy hill side	<ul style="list-style-type: none"> <li>Bioengineering</li> <li>Catch drains needed at hill side</li> </ul>
3	Km 3+300 – Km 3+380	Slopes are unstable due to seepage and presence of dark grey carbonaceous shale	<ul style="list-style-type: none"> <li>Bioengineering</li> <li>Catch drains needed at hill side</li> </ul>
4	Km 5+500 – Km 6+000	Presence of the loose dark grey clay soil and water in some location	<ul style="list-style-type: none"> <li>Proper water management through construction of appropriate drainage</li> </ul>
5	Km 6+000 – Km 8+000	Presence of landslide, seepage or marshy in Shuguri area	<ul style="list-style-type: none"> <li>Proper water management through construction of appropriate drainage</li> <li>Compensatory plantation for protection of watershed</li> </ul>
5	Km 27+500 – Km 27+900	Presence of seepage or marshy area (Watershed) above Chokhorling village	<ul style="list-style-type: none"> <li>Proper water management through construction of appropriate drainage</li> <li>Compensatory plantation for protection of watershed</li> </ul>
6	Km 50+000	<p>Regi slide is still an active land slide area. Although loose, weathered and weak phyllite and quartzite debris cover overlying the harder and stronger bed rock of bed rock has been eroded down and the slide has stabilized at its southern side. However, the crest of the slide consisting of thick colluviums of loose materials and weathered rocks is found still active. Further dark grey clay consisting of highly weathered phyllite and carbonaceous shale to southeast is also found to be active.</p> <p>(Note: The exposed rocks containing natural minerals near the base of Regi slide is being actively used as Salt lick area by</p>	<ul style="list-style-type: none"> <li>Road alignment has been shifted on the saddle above the Regi slide to avoid the active slide area altogether</li> </ul>



Sl. No.		Instabilities	Mitigation Measures
		wildlife). This is the main salt lick site in the vicinity.	
7	Km 64+000 – Km 66+000	Minor slope cut failure expected in some marshy areas in between Rishore and Chenari village.	<ul style="list-style-type: none"> <li>• Proper water management through construction of appropriate drainage</li> <li>• Construction of retaining/Breast walls</li> <li>• Compensatory plantation for protection of watershed</li> </ul>

Source: Detailed Design Study, December 2013

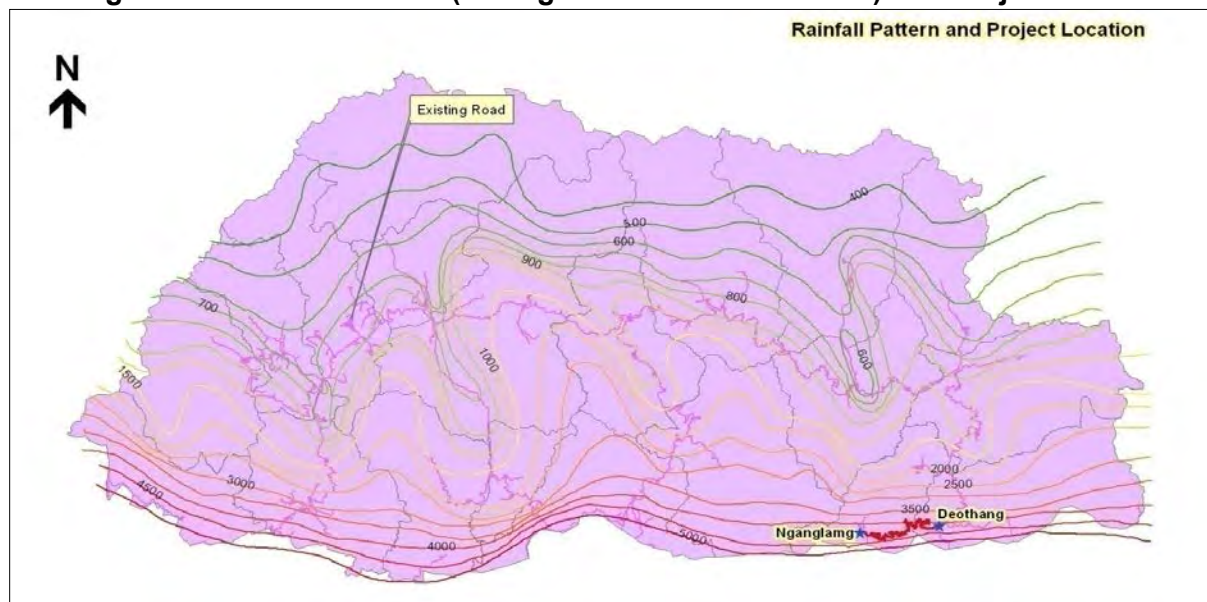
## 2. Meteorology and Climate

154. Climate and meteorology of a place can play an important role in the implementation of any developmental project. Meteorology is also the key to understand local air quality, as there is an essential relationship between meteorology and atmospheric dispersion involving wind in the broadest sense of the term.

155. The country can be divided into three distinct climatic zones corresponding to the three main geographical divisions. Bhutan's climate is as varied as its altitudes and, like most of Asia; it is affected by the monsoons. The climate is humid and subtropical in the southern plains and foothills, temperate in the inner Himalayan valleys of the southern and central regions, and cold in the north, with year-round snow on the main Himalayan summits. NDH falls under the hot humid and subtropical southern region of Bhutan.

156. Temperatures vary according to elevation. In the south where proposed road project fall, a hot, humid climate helps maintain a fairly even temperature range of between 15° C and 30°C year-round, although temperatures sometimes reach beyond 35°C in the valleys and the plains bordering India during the summer.

**Figure 19: Rainfall Pattern (average annual rainfall in mm) and Project Location**



157. Annual precipitation ranges widely in various parts of the country as shown in the figure V-4. In the severe climate of the north, there is only about 40 mm of annual precipitation-primarily snow. In the temperate central regions, a yearly average of around 1,000 mm is more common, and 7,800 mm per year has been registered at some locations in the humid, subtropical south, ensuring the thick tropical forest. Table V-2 provides the summary of temperature and rainfall of project area.

158. Project area receives an average annual precipitation of 3741.22 mm. The maximum mean monthly rainfall occurs during July with average rainfall of 935.82 mm and the mean minimum monthly rainfall of 4.0 mm takes place in the month of November.

159. August is observed as the hottest month of the year having mean daily maximum temperature of 28.92°C while, January is the coldest month having mean daily minimum temperature of 10.7°C.

**Table 10: Average Temperature and Rainfall (from year 2005-2011) of Dewathang**

Month	Mean max. temp (°C)	Mean min. temp (°C)	Average temp (°C)	Total rainfall (mm)
January	20.62	10.7	15.46	<b>21.22</b>
February	22.22	12.48	17.56	<b>24.12</b>
March	25.02	15.66	20.24	<b>91.82</b>
April	25.94	17.28	21.72	<b>363.37</b>
May	27.24	19.66	23.44	<b>402.87</b>
June	28.14	21.36	24.64	<b>696.45</b>
July	28.56	22.08	25.3	<b>935.82</b>
August	28.92	21.94	25.52	<b>537.52</b>
September	28.08	21.1	24.54	<b>456.63</b>
October	27.54	17.9	22.6	<b>196.75</b>
November	24.6	15.06	19.72	<b>8.57</b>
December	22.02	12	12.9	<b>6.08</b>
<b>Average/Total</b>	<b>25.74</b>	<b>17.27</b>	<b>21.14</b>	<b>3741.22</b>

Source: Statistical Yearbook of Bhutan, 2005-2011

### **3. Climate Change Trends**

160. Climate change is real and underway, and its consequences seen clearly everywhere including in Bhutan. Mountainous countries such as Bhutan are likely to be among the communities most vulnerable to the adverse impacts of climate change. Second National Communications prepared by National Environment Commission (NEC) highlights issues of climate change on hydropower, agriculture, biodiversity, glaciers and glacial lake outburst floods (GLOF) and their adaptations required. However, the NEC report does not cover impacts of changing climate and adaptation issues on transportation or road sector which is vital infrastructures for any country. Therefore, ADB has funded a separate study to examine climate change issues, vulnerabilities and adaptation needed for the road sector under the TA-7608 REG: "Enabling climate change response in Asia and the Pacific – building resilience to disaster and climate change impacts (sub-project 2)."

161. The findings of the climate change study shows that like rest of the eastern Himalayas, Bhutan is also experiencing increase of temperature. NEC projects that by 2010-2039 Bhutan's temperature is expected to increase by 0.8°C; and by year 2040-2069, the increase will be

roughly 2.4 °C. Similarly, the precipitation is also projected to increase roughly 10% and 20% by year 2010-2039 and 2040-2069 respectively.

162. NEC's projection for occurrence of extreme temperature and intense precipitation for Bhutan conforms to IPCC (2007) projection for the Himalayan region of South-east Asia. Thus Bhutan is likely to face increased climate change induced disasters such as draught, prolong heat waves, intense rainfall and flooding. Without suitable adaptive measures, the prolong heat wave and, intense rainfall and flooding will damage infrastructures including roads. The climate change study has recommended set of adaptation measures to minimize these impacts. Climate change impacts and adaptations measures are reproduced under chapter VII.

## B. Air Environment

163. The existing quality of the air environment serves as an index for assessing the pollution load and the assimilative capacity of any region and forms an important tool for planning project activity in the area.

164. Comprehensive three seasons (summer, post monsoon & winter) baseline air quality assessment was carried out by Dungsam Cement Project Authority (DCPA) in 2000 at seven locations in Nganglam and adjacent areas. The sampling sites included both urban and rural landscapes:

- i. Nganglam cement plant site and Nganglam High School areas representing urban landscape. NDH takeoffs from Nganglam town which is close to the sampling location of Nganglam Higher Secondary School.
- ii. Upper Chenkari, Menchu, Gasher and Dechilling representing the rural landscapes which are similar to settlements such as Dezama, Yargeywoong, Chokhorling and Khalatsho under NDH project area. There are no factories or industrial establishments in these areas.

165. For the purpose of establishing baseline ambient air quality condition for NDH project; ambient air quality data for all three seasons collected under DCPA study 2000 for Nganglam town (urban) and Menchu (rural) areas has been adopted and presented Table 11 .

**Table 11: Baseline Ambient Air Quality of Urban and Rural Locations**

Location	Season	Min	Percentiles					Max	A.M	G.M
			10	30	50	85	95			
Existing ambient SPM levels										
Nganglam (Urban)	Summer	30	30	36	39	40	44	44	38	37.7
	Post Monsoon	33	33	36	41	45	52	52	42	41.6
	Winter	34	34	34	35	38	39	39	38.1	37.6
Menchu Village (Rural)	Summer	25	25	31	36	43	44	44	36.3	35.8
	Post Monsoon	22	22	23	24	28	32	32	25.9	25.7
	Winter	26	26	28	33	36	39	39	32.6	32.3
Ambient SO <sub>2</sub> Levels										
Nganglam (Urban)	Summer	6	6	6	6	7	7	7	6.3	6.3
	Post Monsoon	6	6	6	8	9	11	11	8.3	8.1
	Winter	6	6	7	8	10	11	11	8.5	8.3
Menchu Village (Rural)	Summer	6	6	6	6	7	7	7	6.2	6.2
	Post Monsoon	4	4	6	6	6	7	7	5.9	5.8

Location	Season	Min	Percentiles					Max	A.M	G.M
			10	30	50	85	95			
	Winter	6	6	6	6	6	6	6	6	5.9
<b>Ambient NOx Levels</b>										
Nganglam (Urban)	Summer	6	6	6	6	6	7	7	6.12	6.11
	Post Monsoon	6	6	6	7	8	10	10	7.5	7.4
	Winter	6	6	6	6	6	7	7	6.1	6.1
Menchu Village (Rural)	Summer	6	6	6	6	6	6	6	6	5.9
	Post Monsoon	4	4	6	6	6	6	6	5.2	5.2
	Winter	6	6	6	6	6	6	6	6	5.9

Source: Comprehensive EIA Study of Dungsam Cement Plant, Nganglam, 2000

166. DCPA study concluded that the pollutants (SPM, SOX, NOX) observed for all locations both in urban and rural areas were below WHO; CPCB, India; World Bank; and NEC Bhutan standards. Table 12 provides the national ambient air quality standards of Bhutan for three separate areas.

**Table 12: NEC's Ambient Air Quality Standards (Maximum Permissible Limits in µg/m<sup>3</sup>)**

Parameter	Industrial Area	Mixed Area*	Sensitive Area**
<b>Total Suspended Particulate Matter</b>			
24 Hour Average	500	200	100
Yearly Average	360	140	70
<b>Respirable Particulate Matter (PM 10)</b>			
24 Hour Average	200	100	75
Yearly Average	120	60	50
<b>Sulfur Dioxide</b>			
24 Hour Average	120	80	30
Yearly Average	80	60	15
<b>Nitrogen Oxides</b>			
24 Hour Average	120	80	30
Yearly Average	80	60	15
<b>Carbon Monoxide</b>			
8 Hour Average	5000	2000	1000
1 hour Average	10000	4000	2000

\* **Mixed Area** means area where residential, commercial or both activities take place,

\*\* **Sensitive Area** means area where sensitive targets are in place like hospitals, schools, sensitive ecosystems.

167. However, under the current SASEC Road Connectivity Project, ADB will include TA component to procure air quality monitoring equipment and training of project staffs on air quality monitoring works. The baseline ambient air quality data for the project will be established prior to the start of road construction works.

### C. Noise Environment

168. Unwanted noise and unpleasant sounds are generally classified as noise pollution. Normally a person begins to identify sounds when a level of 10 to 15 dB is reached. The other end of the scale is known as the threshold of pain (140 dB), or the point at which the average person experiences pain. Noise is generally measured in frequency-weighted scales and noise qualities measurements are generally represent in the 'A' level and reported as dB (A).

169. Comprehensive four season noise pollution study has been carried out by Dungsam Cement Project Authority in 2000 reveals that daytime noise equivalent “Ld” of the Nganglam area varies between 36-65 dB(A) whereas nighttime noise equivalent “Ln” varies between 35-46 dB(A). The noise levels of both day and night are within the national limit for Industrial (Ld 75 dB (A) & Ln 70 dB (A)) and Commercial Area (Ld 65 dB (A) & Ln 55 dB (A)). However, Nganglam being commercial and industrial hub, the noise level exceeds the national limits for residential area; Ld 55 dB (A) & Ln 45 dB (A). Similarly, noise levels for Rishore, Chenari and Dewathang will exceed the national limits for residential area due to the coal mining operation and transportation of coal through the settlements.

170. There are no industries and commercial activities and hence no noise pollutions in the area such as Dezama, Yargaywoong, Chokhorling and Khalatsho. Baseline noise data will be collected prior to construction works for all sensitive locations including for an important natural habitat between Tsokhiri and Duiiri Rivers.

#### **D. Hydrology and Water Quality**

171. Bhutan has four major river systems: the Drangme Chhu or Manas; the Punatsang Chhu; the Wang Chhu and the Amo Chhu. Each flows swiftly out of the Himalayas, southerly through the Duars to join the Brahmaputra River in India. There are no major rivers systems in the project area except for the three minor rivers–Kirungri, Chowkiri and Duiiri which originates from inner Himalayas.

172. Kirungri flows southwest and runs for about 4 km parallel to the proposed road alignment before joining the Manas. The Kirungri River covers a total length of 32.0 km with the watershed area of 32.4 sq km from the bridge point (chainage Km 4.4). The river originates from the inner Himalayan Mountains and passes through settlements of Dezama and Nganglam before joining Manas. It is joined by other small tributaries along its path to Manas.

173. The Chowkiri/Tsokhiri River covers a total length of 21 km with the watershed area of 68.7sq km from the bridge point (chainage 43.8 km). The river originates from the inner Himalayan Mountains and passes through settlements of Khalatsho before joining Duiiri and flow towards Indian Plain. It is joined by four other major streams along its path to Indian Plain.

174. Similarly, the Duiiri River covers a total length of 29 km with the watershed area of 146 sq km from the bridge point (chainage 57.1km). The river originates from the inner Himalayan Mountains and passes through steep valleys of Orong and Dewathang before being joined by Chowkiri and flow towards Indian Plain. It is joined by seven other major streams along its path to Indian Plain.

175. Numerous small streams drain mountain slopes in the project area. Flow lines of these upland streams are steep, often 40% or more. As streams converge into rivers and the size of the upstream catchment increases, flow lines flatten with overall gradients in the range of 0.5%.

176. After approximately 4.4 km from the takeoff point in Nganglam the route crosses Kirungri River. There is an existing Bailey bridge over Kirungri constructed under Nganglam-Chokhorling farm road development.

177. Towards the eastern side nearing Dewathang, the alignment crosses one small river – Mechudrangri; and two bigger rivers - Tsokhiri and Duiiri. Over all on this alignment, three new bridges and 357 culverts (59 slab culverts and 288 Hume pipe culverts) will be required. All

bridges will be single span and concrete built. The major hydrology along this road segment has been presented in Figure 20.

**Table 13: Major River crossing along the NDH**

Sl. No.		River	Bridges Span (m)	Downstream Water Users		
				Downstream Community	No. of HHs	Type of Use
1	Km 4+400	Kirungri	40m (Existing Bailey bridge)	-	-	-
3	Km 41+000	Menchudrangri	16m	-	-	-
2	Km 43+800	Tsokhiri	24m	-	-	-
4	Km 57+100	Duiri	30m	-	-	-
Total			110m			

Source: Field survey, 2011 and Detailed Design Report, December 2013

### 1. Surface Water Quality

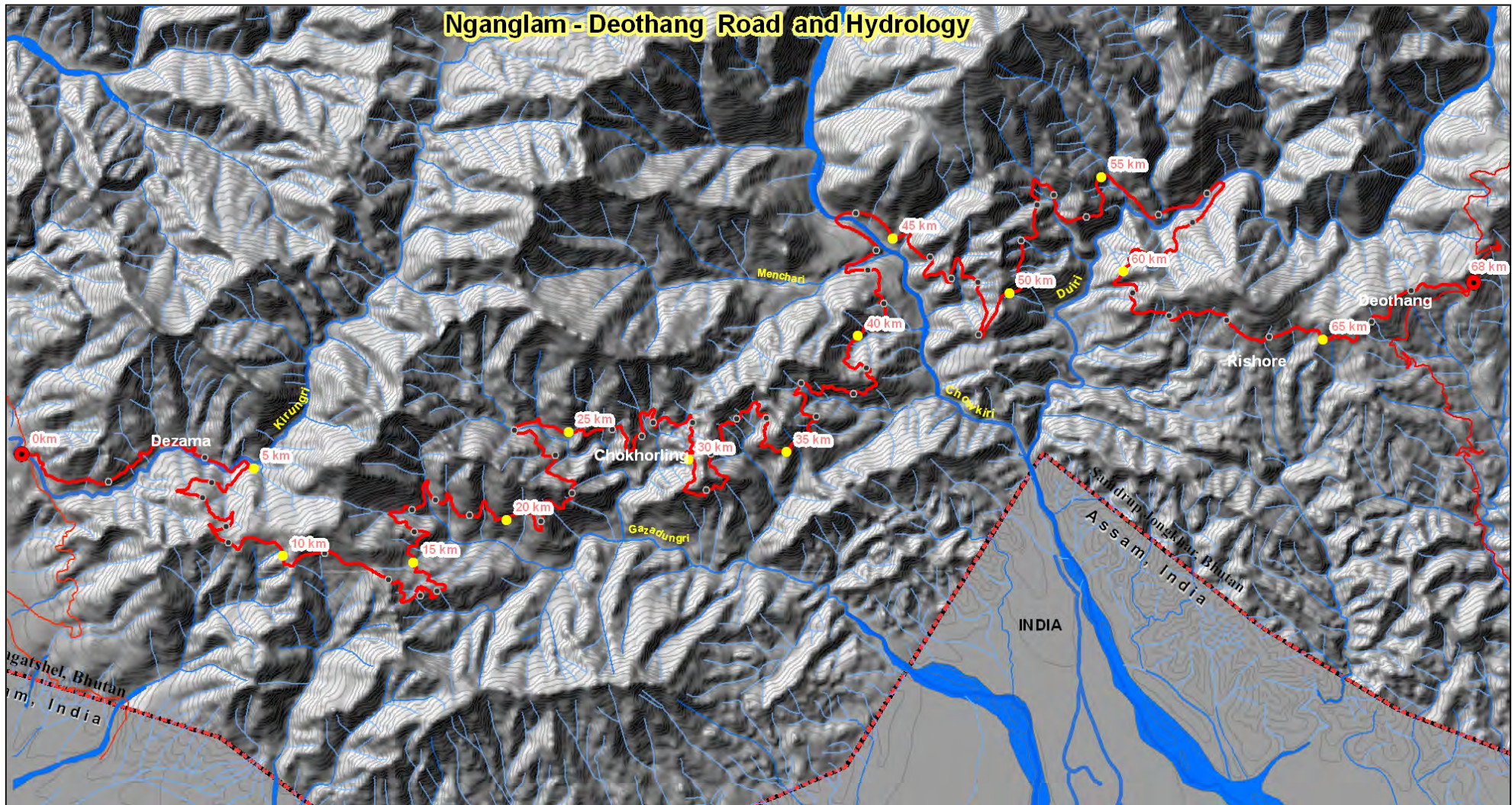
178. Environmental water quality, also called ambient water quality, relates to water bodies such as lakes, rivers, and streams. Water quality standards for surface waters vary significantly due to different environmental conditions, ecosystems, and intended human uses. Toxic substances and high populations of certain microorganisms can present a health hazard for non-drinking purposes such as irrigation, swimming, fishing, and rafting, boating, and industrial uses. These conditions may also affect wildlife, which use the water for drinking or as a habitat. Modern water quality laws generally specify protection of fisheries and recreational use and require, as a minimum, retention of current quality standards.

179. Except for Kirungri River which passes through Industrial town of Nganglam, the quality of other rivers and streams are very good owing to absence or very low human population and industrial establishment. The quality of Kirungri River water is equally good until it passes through Nganglam Township from where the effluents such as domestic and industrial wastes start seeping into this pristine water body. Under EIA study 2000, DCPA has carried out Kirungri River water sampling for four seasons at two locations; i) near Royal Bhutan Army camp before entering Nganglam town; and ii) DCPA site after passing through Nganglam town. Results of water quality analysis of two locations show that pH (7.0-7.4); Total Dissolved Solid (high of 290mg/l during monsoon); heavy metals (very low and some even below detection level); nitrate and phosphates (high of 12mg/l during monsoon); and dissolved oxygen (high of 6.8mg/l during winters) are all within the limit set by the National Environment Commission of Bhutan. As result of the study, Kirungri water quality has been assessed as fairly good and can be used for drinking and other domestic needs and is also amenable to the growth of aquatic life.

180. Additional baseline water quality data for all major water bodies (Kirungri, Tshokhiri and Duiri) including the drinking water sources within the project area will be collected prior to the start of road construction works. This baseline data could be used for subsequent water quality monitoring during construction period.



Figure 20: Hydrology of the project area





## E. Biological Environment

### 1. Protected Area

181. Nganglam–Dewathang road does not fall inside any of the protected areas of Bhutan (Refer Figure 23). The road alignment falls mostly to the north of the biological corridor connecting Royal Manas National Park and the Khaling Wildlife Sanctuary. For about 6.0 km stretch from chainage km9 - km15 passes through the biological corridor (Refer 24).

### 2. Critical Wildlife Habitat

182. The area between Tsokhiri (Chowkiri) and Duiri Rivers has been identified as critical wildlife habitat due to presence of salt lick (at the base of Regi landslide), migratory route, mud pools and relatively undisturbed forests with perennial river systems. The salt lick, which consists of black clayey mud and white rock salt at the base of Regi land slide, is the important attraction for wildlife from adjacent forest, both within Bhutan and even across the border from India. The gentle slopes and ridge along Regi area, and the river beds Tsokhiri and Duiri Rivers are used by elephants as migratory and foraging routes. Elephants are known to move to higher grounds during summer seasons and back to a lower elevation during dry winter season. Other important wildlife species that are known to visit the area are Gaur (*Bos gaurus*), Himalayan Black Bear (*Selenarctos thibetanus laniger*), and Leopard (*Panthera pardus*).

**Figure 21: Black Clayey Mineral, Regi Saltlick**



**Figure 22: White Rock Salt, Regi Saltlick**



183. Until as recent as late 1990s, Tsokhi including Khalatsho areas were widely settled area. The people from Khar, Tsebar and Yurung blocks/geogs of Pemagatshel Dzongkhag used to migrate to Khalatsho and Tsokhi during winters with their livestock and stay there till the end of cold season. This practice of seasonal migration was put to end with the government order due to the potential threat from militancy movement of northeast India. As a result people from north stopped coming to their wintering ground at Khalatsho and Tsokhi forever.

184. And over the years, even the original inhabitants of Khalatsho village started migrating out, also due to the threat of increased Indian insurgency activities in the area and ever-increasing human-wildlife conflicts. Today there are only 7 households in the area which was once widely settled. The area has become fallow and forest regeneration has taken place encouraging the wildlife to return. It is now considered by the Department Forest and Park Services as an important wildlife habitat. The figure 25 represents the important wildlife habitat within the project area



**Figure 23: Bhutan Conservation Areas and Nganglam-Dewathang Highway**

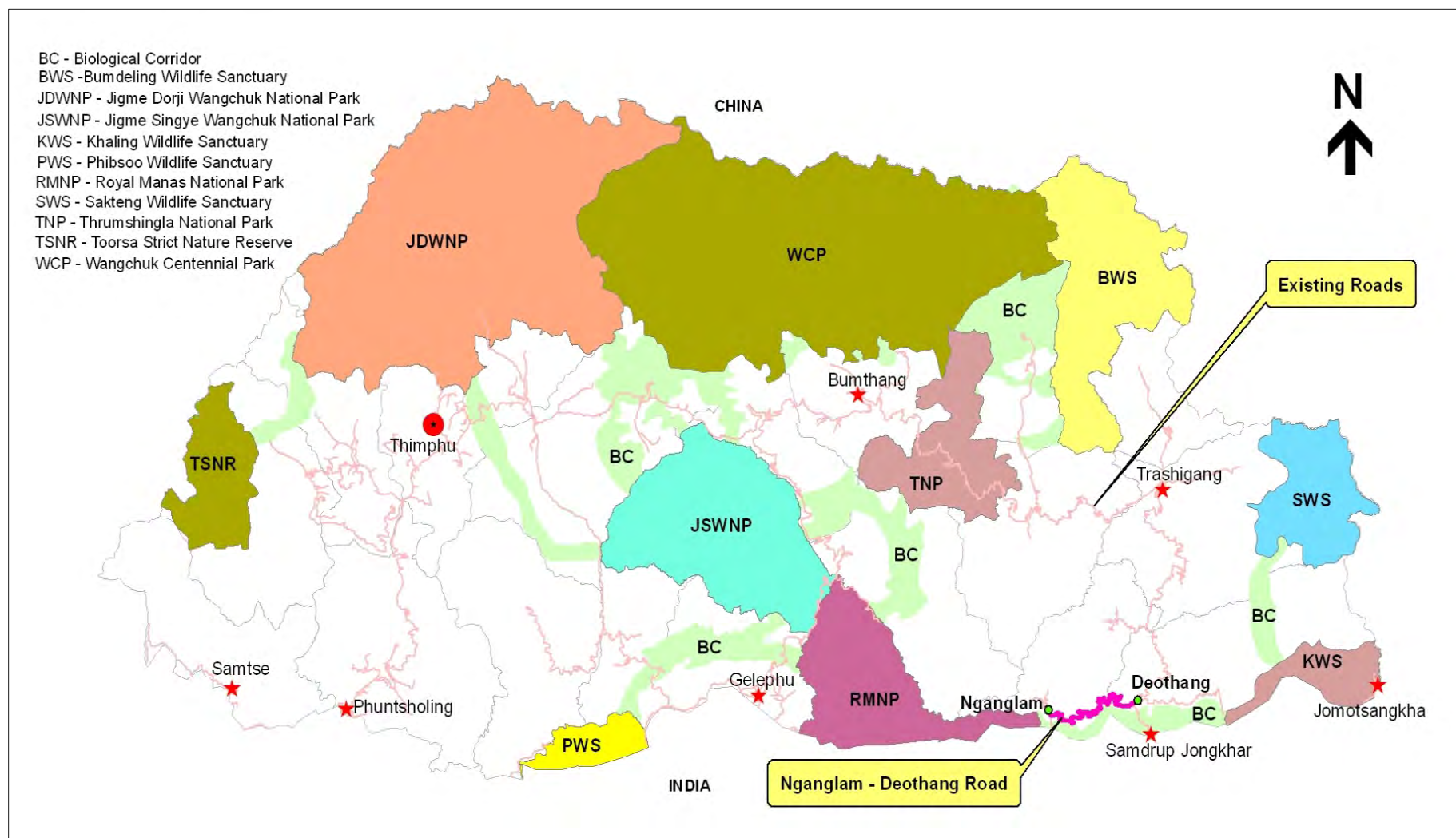


Figure 24: Biological Corridor and Nganglam-Dewathang Highway

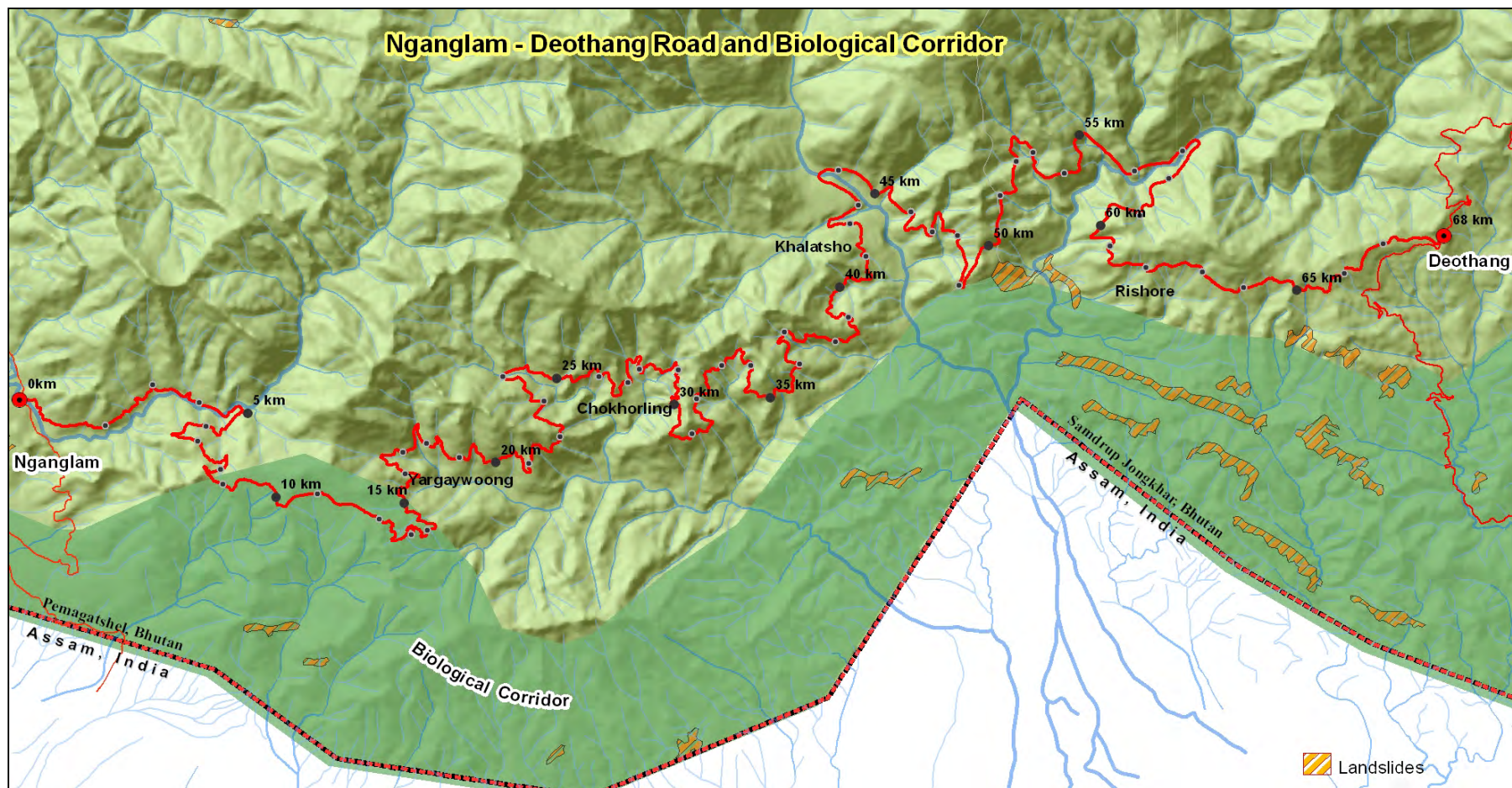




Figure 25: Critical Wildlife Habitat and Nganglam-Dewathang Highway

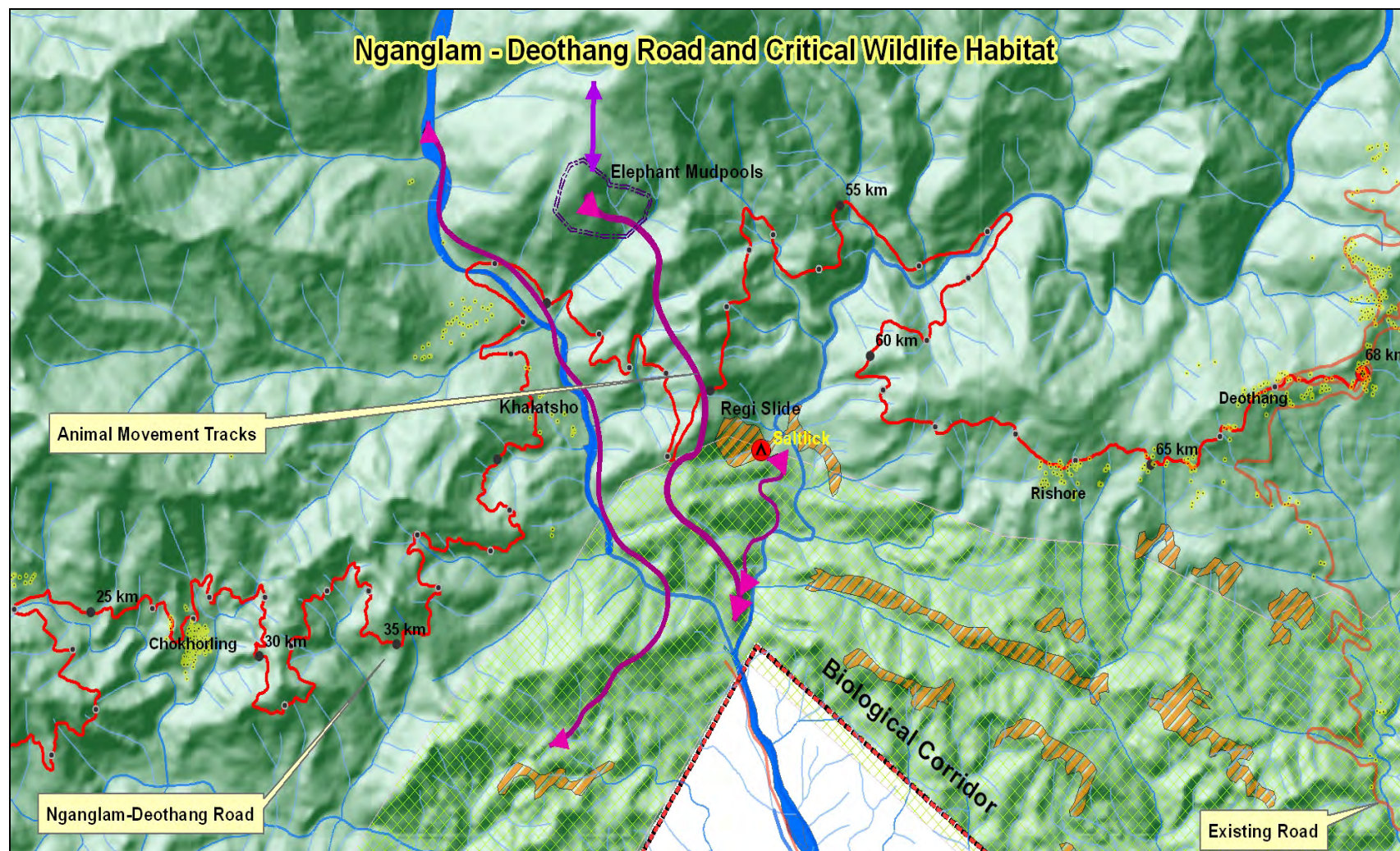
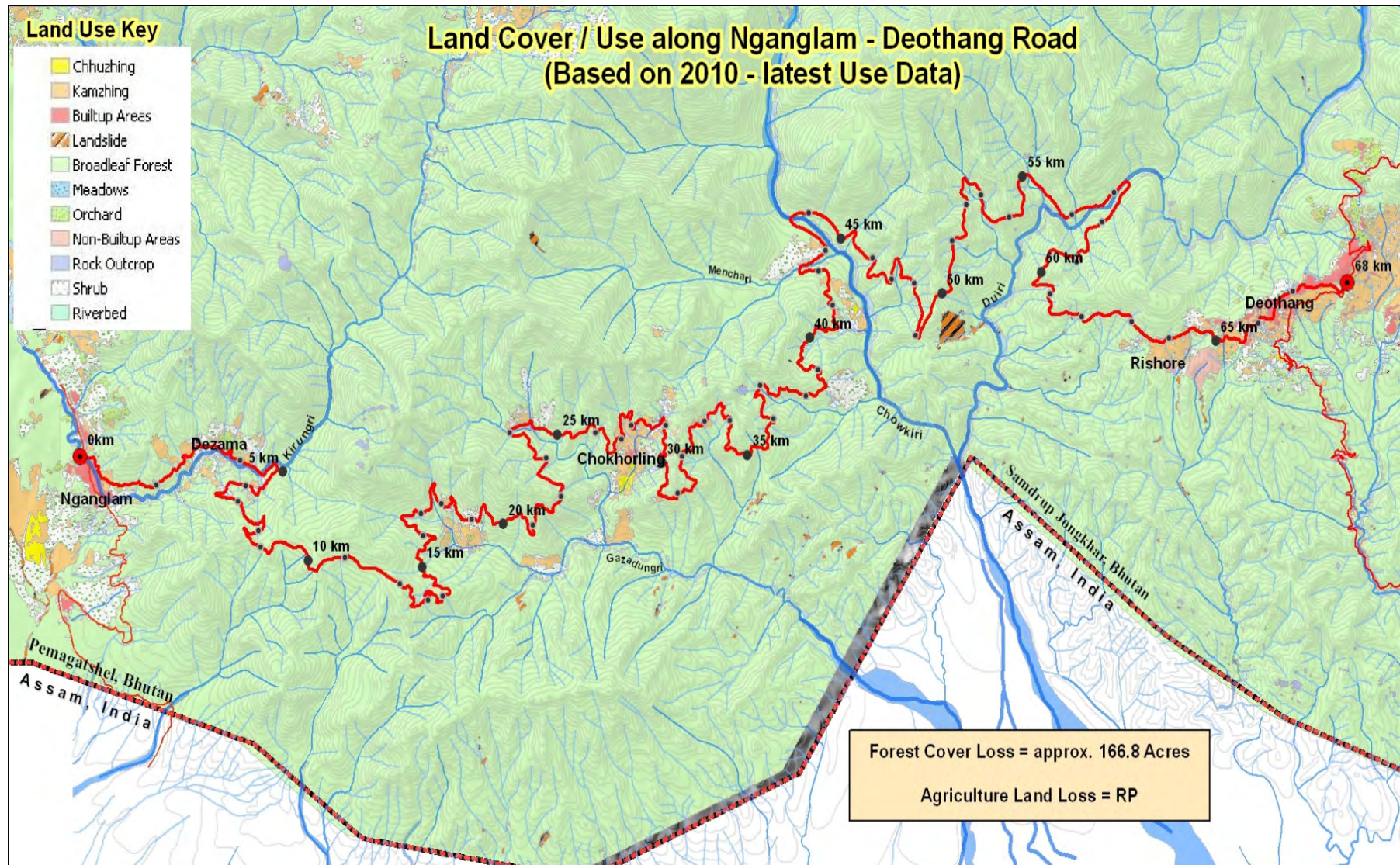




Figure 26: Land use or cover along the project road



### 3. Forest Resources and Land Cover

185. **General.** As per NSB's Statistical Yearbook of Bhutan, 2011, about 87.7% of the Pemagatshel and 86.9% of Samdrup Jongkhar Dzongkhag are under true forest cover. Pemagatshel has the slightly higher percentage of agriculture land (5.1%) than Samdrup Jongkhar (4.3%) in relation to its land area. Broadleaf forests are dominant in both Dzongkhags. The land cover details of the project affected Dzongkhags are provided in Table 14.

**Table 14: Land Cover figures of Pemagatshel and Samdrup Jongkhar Dzongkhags**

Dzongkhag	Land Cover Area (in Ha)				
	Forest	Meadows	Agriculture	Built-up	Others
Pema Gatshel	90,366.08	103.04	5,255.04	206.08	7,109.76
Samdrup Jongkhar	163,169.52	375.53	8,073.98	375.53	15,584.66
<b>Total Area (Ha)</b>	<b>253,535.60</b>	<b>478.57</b>	<b>13,329.02</b>	<b>581.61</b>	<b>22,694.42</b>

Source: Statistical Year of Bhutan 2011

186. **Land Use Change and Forests Loss.** As per Land Cover and Area Statistic 1997 of MoAF, Pemagatshel Dzongkhag had only about 53% of its land area (518km<sup>2</sup>) under forest cover. However, the recent statistics (NSB's Statistical Yearbook of Bhutan 2011) show the mark increase of forest area from 53% to 87.7% over the period of 15 years. Similarly, Samdrup Jongkhar had only about 76% of its area (2308km<sup>2</sup>) under forest cover. There is a mark increase in Dzongkhag's forest cover from 76% to 86.9% over the same duration. These could be attributed mainly to ban of widely practiced shifting cultivation, rural-urban migration and resettlement program carried out by the RGoB in 1990s. Figure V-11 illustrates the land cover and use pattern within the project area.

187. Using latest land use information (Land cover 2010 of MOAF) subsequent analysis, it is estimated that around 63.91 acre of agriculture land, 166.8 acres of forest land and 5.93 acres of municipal areas could directly or indirectly be lost to the proposed road development. Table 15 provides chainage wise land use details along NDH.

**Table 15: Land Use or cover along the NDH**

Chainage (Km)		Length (m)	Area in Acre considering 15m Direct Impact Zone	Land Cover/Land Use
From	To			
0+000	5+000	5,000.00	18.53	Predominantly Agriculture including Orchard
5+000	6+000	1,000.00	3.71	Riparian Forest
6+000	9+000	3,000.00	11.12	Agriculture and Fallow Land
9+000	18+000	9,000.00	33.36	Forest
18+000	19+000	1,000.00	3.71	Agriculture and Fallow Land of Yargaywoong
19+000	24+000	5,000.00	18.53	Forest and Steep Rocky Area
24+000	31+000	7,000.00	25.95	Agriculture and Fallow Land of Chokhorling
31+000	40+000	9,000.00	33.36	Regenerated Forest (Old Tseri area)
40+000	42+000	2,000.00	7.41	Agriculture and Fallow Land of Khalatsho

Chainage (Km)		Length (m)	Area in Acre considering 15m Direct Impact Zone	Land Cover/Land Use
From	To			
42+000	45+000	3,000.00	11.12	Riparian Forest along Chowkiri River
45+000	60+000	15,000.00	55.60	Thick Forest
60+000	63+000	3,000.00	11.12	Regenerated Forest
63+000	66+400	3,400.00	12.60	Agriculture area through the Settlement Rishor and Chenari
66+400	68+000	1,600.00	5.93	Through Municipal Areas of Dewathang
<b>Total</b>		<b>68,000</b>	<b>252.05</b>	

Source: Field survey, 2011 and updated in November 2013

## F. Forest Types within the Project Area

188. NDH generally falls under sub-tropical forest with altitude ranging from 200–1000 m above sea level. The initial section of the alignment from Nganglam town to Dezama and Shuguri villages passes through an agricultural area which consists of mainly Kamzhing, and orange orchard. The road passes through a broad-leaved forest in most sections of the road from Shuguri to Dewathang except passing small stretch in farmland at Yargaywoong, Chokhorling, Khalatsho and Rishore to Chenari and urban area from Chenari to Dewathang.

189. Bamboo and banana forests are common in the area. About 120 tree species, 64 shrub species, 40 herbs, 34 climbers, 15 epiphytes, 15 underground rhizome, sucker and rhizomatous herbs, 7 endemic plants, 17 plants with medicinal value, 5 recognized threatened plants and 3 plants recorded under CITES Appendix II have been recorded along NDH alignment (Table 16 to Table 25). 15 rare tree species found in the project area are *Ficus elastic*, *Michelia champaca*, *Phoebe golparaensis*, *Dillenia pentagyna*, *Dillenia indica*, *Sapium baccatum*, *Putrangiba assamica*, *Cannarium sikkimensis*, *Mangifera sylvestris*, *Careya arborea*, *Diplocknema butyraceae*, *Vitex heterophylla*, *Phoenix humilis*, *Trachycarpus martianus* and *Caryota urens*. 7 rare shrubs are *Piper mulesua*, *Crotolaria sp.*, *Flemingia sp.*, *Todalia asiatica*, *Citrus lemon*, *Cipadessa baccifera* and *Tithonia diversifolia*; 2 rare herbs are *Lindenbergia perviflora* and *Arisaema sp.*; 3 rare climbers are *Adena trilobata*, *Adena cardiophylla*, *Dioscorea deltoidea*; 6 plant species of *Lithocarpus elegans*, *Boehmeria macrophylla*, *Zanthoxylum oxyphyllum*, *Agapetes serpens* and *Hydrocotyle himalaica* and *Rubia charaefolia* are endemic to Eastern Himalayas and *Musa griersonii* is endemic to Bhutan; 5 species of *Entada rheedii* subsp. *Sinohimalensis*, *Mucuna pruriens*, *Hodgsonia macrocarpa*, *Tournefortia hookeri* and *Dioscorea bulbiflora* are near threatened plant species as per the Red data List of Bhutan. *Alsophila spinulosa* syn. *Cyathia spinulosa* and *Dioscorea deltoidea* are listed under CITES Appendix II and rare in the project area. There may be possibility that Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*), the totally protected plant species under Schedule II of Forest and Nature Conservation Act 1995 and listed in red list under CITES Appendix II may occur in the project area although not recorded during the field surveys. During field surveys, existence of *Aquilaria malaccensis* within the project area could not be ascertained. However, as per the information gathered from local resident, this rare tree species is found in undisturb areas in the wild. It is therefore required to protect *acquilaria* tree before it is virtually exhausted in the wild state.

190. The forest area all the way from Nganglam till Khalatsho village and nearing Rishore, Dewathang are heavily disturbed. Shifting cultivation or slash and burn cultivations are widely

practiced where huge forested areas are cleared and burnt for agricultural purposes. Only the forest between Khalatsho and Duiri is pristine and undisturbed. This forest is the habitat to Asian Elephant, Tiger, Gaur, Wild Pig, Sambar, Leopard, Wild Dog/Dhole, etc.

**Table 16: Tree species recorded in the Project Area**

Sl. No.	Botanical Name	Family	Local Name	Availability	IUCN Status
1	<i>Engelhardia spicata</i>	10. Juglandaceae	Mauwa (Lh.); Mur shing, Tshos shing (Sh.),	LC	NA
2	<i>Castanopsis indica</i>	13. Fagaceae	Aule katus (Lh.); Tsai shing (Sh.)	A	NA
3	<i>Castanopsis clarkei</i>	13. Fagaceae	Tsai shing (Sh.)	LC	NA
4	<i>Lithocarpus elegans</i>	13. Fagaceae	Arcaula (Lh.)	C	NA
5	<i>Lithocarpus fenestrata</i>	13. Fagaceae	Arcaula (Lh.)	C	NA
6	<i>Lithocarpus pachyphylla</i>	13. Fagaceae	Patptate (Lh.)	LC	NA
7	<i>Celtis tetrandia</i>	14. Ulmaceae	Khari (Lh.); Phantang shing (Sh.)	C	NA
8	<i>Trema orientalis</i>	14. Ulmaceae	Chhib shing (Sh.)	C	NA
9	<i>Ficus semicordata</i>	15. Moraceae	Barchongma (Sh.),	C	NA
10	<i>Ficus oligodon</i>	15. Moraceae	Chongma (Sh.); Fig	C	NA
11	<i>Ficus subisinsa</i>	15. Moraceae	Eng. Fig; Gugai chongma (Sh.)	C	NA
12	<i>Ficus glomerata</i>	15. Moraceae	Eng. Fig; Dumri (Lh)	C	NA
13	<i>Ficus hookeriana</i>	15. Moraceae			NA
14	<i>Ficus virens</i>	15. Moraceae	Phi shing (Sh.); Kabra, Pakkar, Dumri (Lh.)	C	NA
15	<i>Ficus elastic</i>	15. Moraceae	Brong shing (Sh.)	R	NA
16	<i>Ficus spp.</i>	15. Moraceae		C	NA
17	<i>Morus macroura</i>	15. Moraceae	Kimbu (Lh.); Tshende (Dz.), Sengdeng (Sh.)	LC	NA
18	<i>Artocarpus chama</i> ; <i>A chaplasha</i>	15. Moraceae	Lathar (Lh.); Yetsushing (Sh.); Hindi Chaplash	LC	NA
19	<i>Artocarpus lacucha</i> ; <i>A.lakoocha</i>	15. Moraceae	Borhar, Dewa (Lh.); Hindi: Lakooch	LC	NA
20	<i>Boehmeria rugolosa</i>	16. Ueticaceae	Dar (Lh.); Dongtsong shing (Sh.)	LC	NA
21	<i>Talauma hodgsoni</i>	34. Magnoliaceae	Balukath (Lh.); Kadering shing (Sh.)	LC	NA
22	<i>Michelia champaca</i>	34. Magnoliaceae	Champai shing (Sh.); Aule chanp (Lh.)	R	NA
23	<i>Polyalthia semiarum</i>	35. Annonaceae	Runchi (Lh.)	LC	NA
24	<i>Knema tenuinervia</i>	36. Myristaceae	Rate balayo (Lh.); Duruka (Med.)	LC	NA
25	<i>Phoebe golparaensis</i>	39. Lauraceae	Bonsum (Lh.); Seychanglu shing (Sh.)	R	NA
26	<i>Phoebe hainesiana</i>	39. Lauraceae	Angare (Lh.)	LC	NA
27	<i>Phoebe lanceolata</i>	39. Lauraceae	Jhangri-khat (Lh.)	LC	NA
28	<i>Cinnamomum tamala</i>	39. Lauraceae	Tespar shing (Sh.); Tespatta (Lh.)	LC	NA
29	<i>Cinnamomum cicciodaphne</i>	39. Lauraceae	Malagiri (Lh.)	LC	NA
30	<i>Cinnamomum impressinervium</i>	39. Lauraceae		LC	NA
31	<i>Litsea sebifera</i>	39. Lauraceae	Nengshing (Sh.)	LC	NA



Sl. No.	Botanical Name	Family	Local Name	Availability	IUCN Status
32	<i>Saurauia napaulensis</i>	49. Sauraraceae	Gogun (Lh.)	LC	NA
33	<i>Dillenia pentagyna</i>	53. Dilleniaceae	Tatari (Lh.)	R	NA
34	<i>Dillenia indica</i>	53. Dilleniaceae	Panchphale (Lh.)	R	NA
35	<i>Actinodaphne obovata</i>	54. Actinidaceae	Runchipat (Lh.)	C	NA
36	<i>Schima wallichii</i>	56. Theaceae	Puyam(Dz.); Zalashing (Sh.); Chilaune (Lh.)	A	NA
37	<i>Garcinia sopsopia</i>	57. Guttiferae	Khomang shing (Sh.); Kusum (Lh.)	R	NA
38	<i>Altingia excelsa</i>	65. Hamamelidaceae	Dhing shing (Sh.); Shetikhath, Jhigkri (Lh.)	LC	NA
39	<i>Darris sp.</i>	76. Leguminosae		LC	NA
40	<i>Erythrina arborescens</i>	76. Leguminosae	Khar shing (Sh.); Chhase (Dz.)	C	NA
41	<i>Albizia lebbeck</i>	76. Leguminosae	Khirdang laishing (Sh.); La-siris (Lh.)	C	NA
42	<i>Albizia chinensis</i>	76. Leguminosae	Sershing (Sh.); Siris (Lh.)	C	NA
43	<i>Albizia procera</i>	76. Leguminosae	Sershing (Sh.); Siris (Lh.)	C	NA
44	<i>Acrocarpus fraxianifolius</i>	76. Leguminosae	Mandane (Lh.)	LC	NA
45	<i>Cassia fistula</i>	76. Leguminosae	Donga (Med.); Dongka shing (Sh.); Rajbriksh (Lh.)	C	NA
46	<i>Sapium baccatum</i>	84. Euphorbiaceae	Ankhataruwa (Lh.)	R	NA
47	<i>Mallotus philippinensis</i>	84. Euphorbiaceae	Sindure (Lh.)	C	NA
48	<i>Macaranga pustulata</i>	84. Euphorbiaceae	Malata (Lh.)	C	NA
49	<i>Macaranga denticulata</i>	84. Euphorbiaceae	Malata (Lh.)	C	NA
50	<i>Macaranga peltata</i>	84. Euphorbiaceae	Malata (Lh.)		NA
51	<i>Ostodes paniculata</i>	84. Euphorbiaceae	Bepari (Lh.)	A	NA
52	<i>Bridelia retusa</i>	84. Euphorbiaceae	Gayo (Lh.)	C	NA
53	<i>Baccaurea sapinda</i>	84. Euphorbiaceae	Gothampaise (Sh.); Kusum (Lh.)	LC	NA
54	<i>Putranjiva assamica</i> ; <i>P. roxburghii</i> Will. F.B.I v. 336; <i>E. D. P</i> 1433 <i>Nageia putranjiva</i> F. I. III. 766.	84. Euphorbiaceae	Thongpa shing (Sh.); Hind. & Beng. Jia-putta, Putranjiva; Santal. Pitoj	R	NA
55	<i>Zanthoxylum budrunga</i>	86. Rutaceae	Hougi shing (Sh.)	LC	NA
56	<i>Evodia fraxinifolia</i>	86. Rutaceae	Khanakpa (Lh.)	C	NA
57	<i>Micromelum integerrimum</i>	86. Rutaceae		R	NA
58	<i>Ailanthus grandis</i>	87. Simaroubaceae	Gokul (Lh.); Somo shing (Sh.)	LC	NA
59	<i>Garuga pinnata</i>	88. Burseraceae	Aule dabdabe (Lh.); Warong shing (Sh.)	LC	NA
60	<i>Cannarium sikkimensis</i>	88. Burseraceae	Poikar (Dz.); Poskar (Sh.)	R	NA
61	<i>Amoora wallichii</i>	89. Meliaceae	Lasune (Lh.); Wagore dore sey (Sh.)	LC	NA
62	<i>Amoora rohituca</i>	89. Meliaceae	Lasune (Lh.); Wagore dore sey (Sh.)	LC	NA
63	<i>Heyna trijuga</i>	89. Meliaceae	Ankhataruwa (Lh.)	LC	NA
64	<i>Cedrela toona</i>	89. Meliaceae	Tooni (Lh.)	LC	NA
65	<i>Mangifera sylvestris</i>	92. Anacardiaceae	Borang-am (Sh.); Amp (Lh.); Mango (Eng.)	R	NA



Sl. No.	Botanical Name	Family	Local Name	Availability	IUCN Status
66	<i>Leana coromandalica</i>	92. Anacardiaceae		C	NA
67	<i>Spondias pinnata</i>	93. Anacardiaceae	Amaru (Lh.); Amar shing (Sh.)	A	NA
68	<i>Rhus griffithii</i>	93. Anacardiaceae	Balayo (Lh.)	C	NA
69	<i>Rhus chinensis</i>	93. Anacardiaceae	Robtang shing (Sh.); Datrid (Med.)	C	NA
70	<i>Acer obolongon</i>	94. Aceraceae	Phirpiri (Lh.)	LC	NA
71	<i>Acer thomsonii</i>	94. Aceraceae		LC	NA
72	<i>Sapindus rarak</i>	95. Sapindaceae	Nakapani (Dz.); Kiling (Sh.), Ritha (Lh.)	LC	NA
73	<i>Bischofia javanica</i>	104. Bischofiaceae	Kainjal (Lh.); Goile (Dz.)	LC	NA
74	<i>Hovenia acerba</i> syn. <i>Dulcis</i>	108. Rhamnaceae	Pumoloto (Dz.); Bange (Lh.)	LC	NA
75	<i>Zizyphus mauritiana</i>	108. Rhamnaceae	Baer (Lh.); Khangkhaling (Sh.)	LC	NA
76	<i>Zizyphus recurba</i>	108. Rhamnaceae	Baer (Lh.); Khangkhaling (Sh.)		NA
77	<i>Eleocarpus veruna</i>	111. Eleocarpaceae	Badrased (Lh.); Gasha thungshing (Sh.)	C	NA
78	<i>Kydia calycina</i>	113. Malvaceae	Kubinde (Lh.); Chambagtang shing (Sh.)	C	NA
79	<i>Bombax ceiba</i>	114. Bombacaceae	Simal (Lh.); Pemageser (Sh.)	C	NA
80	<i>Sterculia villosa</i>	115. Sterculiaceae	Phrang shing (Sh.); Odal (Lh.)	C	NA
81	<i>Pterospermum acerifolium</i>	115. Sterculiaceae	Hatipaile (Lh.); Mongnang laga (Sh)	C	NA
82	<i>Pterogota alata</i>	115. Sterculiaceae	Badam shing (Sh.); Hathipaile (Lh.)	C	NA
83	<i>Gynocardia odorata</i>	118. Flacourtiaceae	Gante (Lh.); Dorkho shing (Sh.)	LC	NA
84	<i>Casaeria glomerata</i>	118. Flacourtiaceae	Lathikath (Lh.)	C	NA
85	<i>Tertrameles nudiflora</i>	126. Datisceae	Maina-kath (Lh.)	LC	NA
86	<i>Lagerstroemia parviflora</i>	129. Lythraceae	Sidha (Lh.); Buram shing (Sh.)	C	NA
87	<i>Duabanga grandiflora</i>	131. Sonneratiaceae	Lampate (Lh.); Khirdanglai shing (Sh.)	C	NA
88	<i>Careya arborea</i>	133. Lacethidaceae	Kubinde (Lh.)	R	NA
89	<i>Terminalia myriocarpa</i>	136. Combretaceae	Panisaj (Lh.); Bakhal shing (Sh.)	C	NA
90	<i>Terminalia belerica</i>	136. Combretaceae	Barra (Lh.); Baru (Med.; Sh. & Dz.)		NA
91	<i>Alangium chinense</i>	141. Alangiaceae	Benthong or Shoskum shing (Sh.)	C	NA
92	<i>Pentapanax sp</i>	143. Araliaceae	Gu shing (Sh.); Chinde (Lh.)		NA
93	<i>Heteropanax fragrans</i>	143. Araliaceae	Bale totola, Gykure (Lh.); Baha-bu-toh or Kekchi shing (Sh.)	C	NA
94	<i>Trevesia palmata</i>	143. Araliaceae	Tokpulu shing (Sh.); Phutta h.	C	NA
95	<i>Diplocknema</i>	153. Sapotaceae	Yika (Dz.); Pinse (Sh.);	R	NA

Sl. No.	Botanical Name	Family	Local Name	Availability	IUCN Status
	<i>butyraceae</i>		Chewri (Lh.)		
96	<i>Alstonea scholaris</i>	162. Apocynaceae	Chatiwari; Nimthomo shing	C	NA
97	<i>Holarrhena antidysenterica</i>	162. Apocynaceae	Khirra (Lh.)	LC	NA
98	<i>Plumeria rubra</i>	162. Apocynaceae	Pagoda tree (Eng.)	LC	NA
99	<i>Wrightia tomentosa</i>	162. Apocynaceae	Khirra (Lh.)	C	NA
100	<i>Adina cordifolia</i>	164. Rubiaceae	Karam (Lh.)	LC	NA
101	<i>Neolamrackia cadamba</i>	164. Rubiaceae	Kadam (Lh.)	C	NA
102	<i>Cordia oblique</i>	167. Boraginaceae	Yam shing (Sh.)	LC	NA
103	<i>Callicarpa arborea</i>	168. Verbenaceae	Thulu shing (Sh.); Khalema (Kh.); Guinli (Lh.)	A	NA
104	<i>Premna bengalensis</i>	168. Verbenaceae	Gineri (Lh.)	LC	NA
105	<i>Gmenila arborea</i>	168. Verbenaceae	Kholom shing(Sh.);Gamari (Lh.)	LC	NA
106	<i>Vitex heterophylla</i>	168. Verbenaceae	Panch pate (Lh.)	R	NA
107	<i>Sterospermum colais</i>	174. Bignoniaceae	Aba shing (Sh.); Parari (Lh.)	LC	NA
108	<i>Sterospermum chilonoides</i>	174. Bignoniaceae	Parari (Lh.)	C	NA
109	<i>Oroxylum indicum</i>	174. Bignoniaceae	Namkaling or Tsampaka (Lh.); Totola (Lh.)	C	NA
110	<i>Viburnum cylindricum</i>	182. Caprifoliaceae	Yumeling shing (Sh.); Ghora-kahri (Lh.)	C	NA
111	<i>Vernonia sp</i>	187. Compositae		C	NA
112	<i>Phoenix sylvestris</i>	234. Arecaceae (Palmae)		LC	NA
113	<i>Phoenix humilis</i>	234. Arecaceae		R	NA
114	<i>Phoenix sp.</i>	234. Arecaceae	Thakal (Lh.)		NA
115	<i>Trachycarpus martianus</i>	234. Arecaceae	Lari (Sh.)	R	NA
116	<i>Caryota urens</i>	234. Arecaceae	Brungshing or Thakchung (Sh.); Rangbhang (Lh.)	R	NA
117	<i>Calamus spp.</i>	234. Arecaceae	Phekri Bet (Lh.)	LC	NA
118	<i>Plectocomia himalayana</i>		Tokri Bet (Lh.); Tikir (Sh.)	R	LC
119	<i>Pandanus furcatus</i> ; <i>P. nepalensis</i>	235. Pandanaceae	Tarica (Lh.); Perumnang shing or Gelpotashor (Sh.)	LC	NA
120	<i>Pandanus unguifer</i> ; <i>P. minor</i>	235. Pandanaceae	Perumnang shing or Gelpotashor (Sh.)	LC	NA

Field survey, November 2011 and Jun-Sept 2013 Note: A-Abundance, C-Common; LC-Less Common; R-Rare; NA-Not Assessed

**Table 17: Shrubs recorded in the Project Area**

Sl. No.	Botanical name	Family	Local name	Availability	IUCN Status
1	<i>Boehmeria macrophylla</i>	16. Urticaceae		A	NA
2	<i>Boehmeria penduliflora</i>	16. Urticaceae		C	NA
3	<i>Pauzolia sanguine</i>	16. Urticaceae	Yongiba (Sh.); Chiple (Lh.)	A	NA
4	<i>Debregeasia velutina</i>	16. Urticaceae	Tusare (Lh.)	C	NA
5	<i>Dendroconide sinuate</i>	16. Urticaceae	Phronglo (Sh.); Jangorba	C	NA
6	<i>Cannabis sativa</i>	17. Cannabaceae	Phagpa nam (Sh.)	C	NA
7	<i>Aconopogon molle</i>	24. Polygonaceae	Kochoma (Sh.)	C	NA
8	<i>Piper mullesua</i>	50. Piperaceae	Peepla (Sh.); Pipiling (Med.)	R	NA

Sl. No.	Botanical name	Family	Local name	Availability	IUCN Status
9	<i>Piper pedicellatum</i>	50. Piperaceae		C	NA
10	<i>Rubus</i> sp.	74. Rosaceae		C	NA
11	<i>Desmodium</i> sp.	76. Leguminosae		C	NA
12	<i>Cassia tora</i>	76. Leguminosae	<i>Theka dorji</i> (Med.); <i>Keker dorji</i> (Sh.),	VC	NA
13	<i>Cassia occidentalis</i>	76. Leguminosae		C	NA
14	<i>Cassia floribunda</i>	76. Leguminosae		C	NA
15	<i>Cesalpinia cucullata</i>	76. Leguminosae	<i>Bokshi kangra</i> (Lh.)	C	NA
16	<i>Mimosa pudica</i>	76. Leguminosae	<i>Boari jhar</i> (Lh.)	C	LC
17	<i>Tephrosia candida</i>	76. Leguminosae	<i>Kumchimo shing</i> (Sh.),	C	NA
18	<i>Crotalaria</i> sp.	76. Leguminosae		R	NA
19	<i>Crotalaria cytisoides</i>	76. Leguminosae	<i>Bainang lebi</i> (Sh.),	VC	NA
20	<i>Dalbergia pinnata</i>	76. Leguminosae		C	NA
21	<i>Flemingia</i> sp.	76. Leguminosae		R	NA
22	<i>Desmodium gyriodes</i>	76. Leguminosae	<i>Mardum kumchimo shing</i> (Sh.),	C	NA
23	<i>Croton cordatus</i>	84. Euphorbiaceae	<i>Phikhiru</i> (Sh.); <i>Supari</i> or <i>Halaunre</i> (Lh.)	C	NA
24	<i>Gauania leptostachya</i>	84. Euphorbiaceae		C	NA
25	<i>Fleuggea virosa</i>	84. Euphorbiaceae	<i>Goikhang shing</i> (Sh.)	C	NA
26	<i>Recinus communis</i>	84. Euphorbiaceae	<i>Chamaling</i> (Sh.)	C	NA
27	<i>Todalia asiatica</i>	86. Rutaceae	<i>Khaitorzu</i> , <i>Kapur</i> (Sh.)	R	NA
28	<i>Citrus limon</i>	86. Rutaceae	<i>Numpang</i> (Sh.)	R	NA
29	<i>Cipadessa baccifera</i>	89. Meliaceae		R	NA
30	<i>Rhamnus nepalensis</i>	108. Rhamnaceae		C	NA
31	<i>Leea asiatica</i>	110. Iteaceae	<i>Boram shing</i> (Sh.)	C	NA
32	<i>Abroma angustifolia</i>	113. Malvaceae	<i>Ulat cambal</i> (Beng.)	C	NA
33	<i>Abelmoschus</i> sp.	113. Malvaceae		LC	NA
34	<i>Melastroma nepalensis</i>	134. Melastromaceae		LC	NA
35	<i>Maesa chisia</i>	150. Myrsinaceae	<i>Khuberbu</i> (Sh.)	A	NA
36	<i>Maesa macrophylla</i>	150. Myrsinaceae	<i>Khuberbu</i> (Sh.)	A	NA
37	<i>Jusminum</i> sp.	158. Oleaceae		C	NA
38	<i>Buddleja asiatica</i>	159. Loganiaceae	<i>Binsenpate</i> (Lh.)	C	NA
39	<i>Tabernaemontana divaricata</i>	162. Apocynaceae	<i>Baramase</i> (Lh.); <i>Waatokase</i> (Sh.)	C	NA
40	<i>Uncaria scandens</i>	164. Rubiaceae	<i>Gogthur Zu</i> (Sh.)	LC	NA
41	<i>Musaenda roxburghii</i>	164. Rubiaceae		C	NA
42	<i>Coffea bengalensis</i>	164. Rubiaceae		C	NA
43	<i>Cephalanthus</i> sp.	164. Rubiaceae		C	NA
44	<i>Clerodendrum viscosum</i>	168. Verbanaceae	<i>Mokomo</i> (Lh.)	C	NA
45	<i>Holmskioldia sanguine</i>	168. Verbanaceae		C	NA
46	<i>Elsholtzia</i> sp.	170. Labiatae		LC	NA
47	<i>Solanum verbascifolium</i>	171. Solanaceae		C	NA
48	<i>Brugmansia suaveolens</i>	171. Solanaceae	<i>Dung momnang</i> (Sh.)	LC	NA
49	<i>Solanum torvum</i>	171. Solanaceae		C	NA
50	<i>Strobilanthus</i> sp.	175. Acanthaceae		C	NA
51	<i>Justicia adhatoda</i>	175. Acanthaceae	<i>Khatsarim</i> (Sh.)	C	NA
52	<i>Phlogacanthus</i>	175. Acanthaceae	<i>Bashakha</i> (Sh.)	C	NA

Sl. No.	Botanical name	Family	Local name	Availability	IUCN Status
	<i>thyrsifolia</i>				
53	<i>Sambucus adnata</i>	182. Caprifoliaceae		LC	NA
54	<i>Chromolaena odorata</i>	187. Compositae	<i>Banmara</i> (Lh.); <i>Ambertala</i> (Sh.)	VC	NA
55	<i>Artemisia</i> sp.	187. Compositae	<i>Meringma</i> (Sh.)	C	NA
56	<i>Xanthium indicum</i>	187. Compositae		C	NA
57	<i>Tithonia diversifolia</i>	187. Compositae		R	NA
58	<i>Pterocanthus</i> sp.	175. Acanthaceae		LC	NA
59	<i>Phlogacanthus thyrsiformis</i>	175. Acanthaceae	<i>Bashakha, Chuwa</i> (Lh.)	C	NA
60	<i>Justica adhatoda</i>	175. Acanthaceae	<i>Asuro</i> (Lh.); <i>Khatsirin</i> (Sh.)	C	NA
61	<i>Dendrocalamus hamiltonii</i>	233. Graminae	<i>Choya bans</i> (Lh.); <i>So</i> (Sh.), <i>Baa</i> (Dz.)	C	NA
62	<i>Thysanolaena maxima</i>	233. Graminae	<i>Tsakusha, Beshawee</i> (Sh.)	C	NA
63	<i>Wallichia densiflora</i>	234. Arecaceae (Palmae)	<i>Saitsam</i> (Sh.); <i>Thakal</i> (Lh.)	LC	NA
64	<i>Wallichia disticha</i>	234. Arecaceae	<i>Saitsam</i> (Sh.); <i>Thakal</i> (Lh.)	LC	NA

Field survey, November 2011 and Jun-Sept 2013

**Table 18: Herbs recorded in the Project Area**

Sl. No.	Botanical name	Family	Local name	Availability	IUCN Status
1	<i>Elatostema</i> sp	16. Urticaceae	<i>Gogleto</i> (Lh.)	VC	NA
2	<i>Pilea</i> sp.	16. Urticaceae		C	NA
3	<i>Girardina diversifolia</i>	16. Urticaceae	<i>Gom jazu</i> (Sh.)	C	NA
4	<i>Urtica ardens</i>	16. Urticaceae	<i>Sisnu</i> (Lh.); <i>Zocha</i> (Dz.); <i>Jazu</i> (Sh.)	C	NA
5	<i>Laportia terminates</i>	16. Urticaceae	<i>Sisnu</i> (Lh.)	C	NA
6	<i>Chenopodium</i> sp.	31. Chenopodiaceae	<i>Bethu</i> (Lh.)	C	NA
7	<i>Alternanthera pungens</i>	32. Amaranthaceae		VC	NA
8	<i>Amaranthus</i> sp.	32. Amaranthaceae		C	NA
9	<i>Oxalis</i> sp.	78. Oxalidaceae		C	NA
10	<i>Bistorta</i> sp.	91. Polygalaceae		C	NA
11	<i>Aconopogon molle</i>	91. Polygalaceae		C	NA
12	<i>Persicaria</i> sp.	91. Polygalaceae			NA
13	<i>Impatiens</i> sp.	99. Balsaminaceae		C	NA
14	<i>Triumfetta pilosa</i>	112. Tiliaceae		C	NA
15	<i>Urena lobata</i>	113. Malvaceae	<i>Brengpa shing</i> (Sh.)	C	NA
16	<i>Sida acuta</i>	113. Malvaceae	<i>Lishong rogpu</i> (Sh.)	C	NA
17	<i>Abelmoschua</i> sp.	133. Malvaceae		C	NA
18	<i>Hydrocotyle asiatica</i>	143. Araliaceae		C	NA
19	<i>Solanum nigrum</i>	171. Solanaceae		C	NA
20	<i>Solanum khasianum</i>	171. Solanaceae	<i>Banthozu</i>	C	NA
21	<i>Physalis divaricata</i> var. <i>microcarpa</i>	171. Solanaceae	<i>Pokpokpa</i> (Sh.)	C	NA
22	<i>Datura stramonium</i>	171. Solanaceae		C	NA
23	<i>Scoparia dulcis</i>	173. Scrophulariaceae	<i>Chini jhar</i> (Lh.)	C	NA
24	<i>Lindenbergia perviflora</i>	173. Scrophulariaceae		R	NA
25	<i>Plantago</i> sp.	181. Plantaginaceae	<i>Tsashoma</i> (Sh.)	C	NA
26	<i>Bidens pilosa</i>	187. Compositae	<i>Zumphu robu</i> (Sh.)	VC	NA
27	<i>Bidens bipinnata</i>	187. Compositae		VC	NA

Sl. No.	Botanical name	Family	Local name	Availability	IUCN Status
28	<i>Ageratum conyzoides</i>	187. Compositae		VC	NA
29	<i>Acmela clava</i>	187. Compositae		VC	NA
30	<i>Crassocephalum crepidiodes</i>	187. Compositae	Ngangkunchi (Sh.)	VC	NA
31	<i>Eclipta prostate</i>	187. Compositae		C	NA
32	<i>Galingsoga perviflora</i>	187. Compositae		C	NA
33	<i>Galingsoga pedicellatum</i>	187. Compositae		C	NA
34	<i>Xanthium indicum</i>	187. Compositae		C	NA
35	<i>Segesbeckia orientalis</i>	187. Compositae	Woongchilo rokpu (Sh.)	C	NA
36	<i>Arisaema</i> sp.	210. Araceae	Buchilato (Sh.); Cobra plant	R	NA
37	<i>Colocasia</i> sp.	210. Araceae	Sokpa (Sh.)	C	NA
38	<i>Hedychium</i> sp.	224. Zingibericeae		C	NA
39	<i>Commelina diffusa</i>	228. Commelinaceae		A	NA
40	<i>Carex</i> sp.	232.. Cyperaceae		C	NA

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**Table 19: Climbers recorded in the Project Area**

Sl. No	Botanical name	Family	Habit	Availability	IUCN Status
1	<i>Tinospora cordifolia</i>	47. Menispermaceae	Climber	LC	NA
2	<i>Stephania glabra</i>	47. Menispermaceae	Twiners	C	NA
3	<i>Cissumpelos</i> sp	47. Menispermaceae	Climbers	C	NA
4	<i>Piper bedloides</i>	50. Piperaceae	Climbing shrub	C	NA
5	<i>Piper longum</i>	50. Piperaceae	Climbing shrub	C	NA
6	<i>Derris acuminata</i>	76. Leguminosae	Large woody climbers	C	NA
7	<i>Derris</i> sp	76. Leguminosae	Large climbers	C	NA
8	<i>Millittia pachycarpa</i>	76. Leguminosae	Large woody climbers	C	NA
9	<i>Mucuna macrocarpa</i>	76. Leguminosae	Woody climbers	LC	NA
10	<i>Mucuna pruriens</i>	76. Leguminosae	Twiners	C	NA
11	<i>Entada reedhii</i> subsp. <i>Sinohimalaica</i>	76. Leguminosae	Large climbers	C	NA
12	<i>Pueraria phaseoloides</i>	76. Leguminosae	Woody twiners	C	NA
13	<i>Shuteria involucrate</i>	76. Leguminosae	Climbers	C	NA
14	<i>Cissus repens</i>	109. Vitaceae	Climbers	A	NA
15	<i>Tetrastigma</i> sp.	109. Vitaceae	Climbers	A	NA
16	<i>Adena trilobata</i>	121. Passifloraceae	Woody climbers	R	NA
17	<i>Adena cardiophylla</i>	121. Passifloraceae	Woody climbers	R	NA
18	<i>Hodgsonia macrocarpa</i>	128. Cucurbitaceae	Climbers	LC	NA
19	<i>Tricosanthes</i> sp.	128. Cucurbitaceae	Climbers	A	NA
20	<i>Solena amplexicaulis</i>	128. Cucurbitaceae	Climbers	C	NA
21	<i>Clematis</i> sp.	152. Ranunculaceae	Climbers	LC	NA
22	<i>Beaumontia grandiflora</i>	162. Apocynaceae	Large woody climbers	C	NA
23	<i>Cryptolepis buechanani</i>	163. Asclipidaceae	Climbers	C	NA
24	<i>Paederia foetida</i>	164. Rubiaceae	Climbers	A	NA
25	<i>Hedyotis scandens</i>	164. Rubiaceae	Large climbing shrub	C	NA
26	<i>Uncaria scandens</i>	164. Rubiaceae	Woody climbers	LC	NA

Sl. No	Botanical name	Family	Habit	Availability	IUCN Status
27	<i>Argyria venusta</i>	165. Convolvulaceae	Large twiners	A	NA
28	<i>Thunbergia coccinea</i>	175. Acanthaceae	Climber shrub	A	NA
29	<i>Thunbergia grandiflora</i>	175. Acanthaceae	Climbing shrub	A	NA
30	<i>Plumbago zylanicum</i>	181. Plumbaginaceae		LC	NA
31	<i>Mikania macrantha</i>	187. Compositae	Twining perennial herb	VC	NA
32	<i>Dioscorea deltoidea</i>	188. Dioscoreaceae	Twining perennials	R	NA
33	<i>Dioscorea bulbiflora</i>	188. Dioscoreaceae	Twining perennials	VC	NA
34	<i>Dioscorea</i> sp.	188. Dioscoreaceae	Twining perennials	C	NA

Field survey, November 2011 and Jun-Sept 2013

**Table 20: Epiphytes recorded in the Project Area**

Sl. No	Botanical name	Family	Local name	Availability	IUCN Status
1	<i>Shelfleria venulosa</i>	143. Araliaceae		C	NA
2	<i>Agapetes serpens</i>	149. Ericaceae		LC	NA
3	<i>Aeschynanthus</i> sp.	177. Gesneraceae		LC	NA
4	<i>Hoya</i> sp.	177. Gesneriaceae		LC	NA
5	<i>Aeschynanthus sikkimnesis</i>	177. Gesneriaceae		LC	NA
6	<i>Oberonia falconeri</i>	209. Orchidaceae		C	NA
7	<i>Dendrobium chrysanthum</i>	209. Orchidaceae	Chang (Sh.)	LC	NA
8	<i>Symbidium aloifolium</i>	209. Orchidaceae	Chang (Sh.)	LC	NA
9	<i>Symbidium</i> sp.	209. Orchidaceae		LC	NA
10	<i>Dendrobium</i> sp.	209. Orchidaceae		LC	NA
11	<i>Ceologyne</i> sp.	209. Orchidaceae	Chang (Sh.)	LC	NA
12	<i>Pothos catcartii</i>	210. Araceae	Sanu kanchirna (Lh.)	C	NA
13	<i>Raphidophora grandis</i>	210. Araceae	Kanchirna (Lh.); Brengla (Sh.)	C	NA
14	<i>Colocasia</i> sp.	210. Araceae	Sogpa (Lh.)	C	NA
15	<i>Cutleya</i> sp.	224. Zingiberaceae		LC	NA

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**Table 21: Diverse habit of underground rhizome, sucker and rhizomatous herbs**

Sl. No	Botanical name	Family	Local name	Availability	IUCN Status
1	<i>Colocasia</i> sp.	210. Araceae	Sokpa (Sh.); Dowa (Dz.); Eng. Taro; Mane (Lh.); Kutchu (Bengali.)	C	NA
2	<i>Amorphophallus bulbifer</i>	210. Araceae	OloNabantho (Sh.)	LC	NA
3	<i>Arisaema</i> sp.	210. Araceae	Ruginang asham (Sh.)	C	NA
4	<i>Acorus calamus</i>	210. Araceae	Bartsi (Sh.)	LC	LC
5	<i>Amorphophallus nepalensis</i>	210. Araceae	Ruginang asham (Sh.)	C	NA
6	<i>Musa griersonii</i>	223. Musaceae	Shinang laishing (Sh.)	LC	NA
7	<i>Musa</i> sp.	223. Musaceae	Laishing (Sh.); Kola (Lh.)	C	NA
8	<i>Zingiber</i> sp.	224. Zingiberaceae	Borang saga (Sh.)	C	NA
9	<i>Curcuma aronitica</i>	224. Zingiberaceae	Jung (Sh.); Doim (Dz.)	C	NA
10	<i>Kaempferia rotunda</i>	224. Zingiberaceae	Buin champa (Sh.)	LC	NA
11	<i>Hedychium elipticum</i>	224. Zingiberaceae	Khui-see (Sh.)	LC	NA

Sl. No	Botanical name	Family	Local name	Availability	IUCN Status
12	<i>Hedychium sp.</i>	224. Zingiberaceae	Khi saga (Sh.)	LC	NA
13	<i>Cosstus lucerus</i>	225. Costaceae	Beth laure (Lh.)	LC	NA
14	<i>Phryniun puvenerve</i>	227. Marantaceae	Laburlaga (Sh.); kopat, Kufyer, Kawaipat (Lh.)	C	NA
15	<i>Phryniun placentarium</i>	227. Marantaceae	Laburlaga (Sh.); kopat, Kufyer, Kawaipat (Lh.)	C	NA

Field survey, November 2011 and Jun-Sept 2013

**Table 22: Endemic species recorded in the Project Area**

Sl. No	Botanical name	Family	Habit	Endemic to	Availability	IUCN Status
1	<i>Lithocarpus elegans</i>	13. Fagaceae	Tree	E. Himalaya	C	NA
2	<i>Boehmeria macrophylla</i>	16. Urticaceae	Shrub	E. Himalaya	C	NA
3	<i>Zanthoxylum oxyphyllum</i>	86. Rutaceae	Shrub	E. Himalaya	LC	NA
4	<i>Agapetes serpens</i>	149. Ericaceae	Epiphytes	E. Himalaya	LC	NA
5	<i>Hydrocotyle himalaica</i>	144. Apiaceae	Herb	E. Himalaya	VC	NA
6	<i>Rubia charaefolia</i>	164. Rubiaceae	Climbers	E. Himalaya	C	NA
7	<i>Musa griersonii</i>	223. Musaceae	Sucker	Bhutan	R	NA

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**Table 23: Plant species with medicinal value recorded in the Project Area**

Sl. No.	Botanical name	Family	Local/medicinal	Habit	Part used	ICUN Status
1	<i>Knema tenuinervia</i>	36. Myristicaceae	<i>Duruka</i> (Med.); <i>Rate Balayo</i> (Lh.)			NA
2	<i>Tinospora cordifolia</i>	47. Menispermaceae	<i>Gurjo</i> (Lh.); <i>Geloi</i> (Hind.); <i>Letey</i> (Med.)	Climber	Stem	NA
3	<i>Cassia tora</i>	76. Leguminosae	<i>Theka dorji</i> (Med.)	Shrub	Seed	NA
4	<i>Entada rheedii</i> subsp. <i>Sinohimalensis</i>	76. Leguminosae	<i>Ning zhosha</i> (Med.); <i>Pangra</i> (Lh.); <i>Kolokpa</i> (Sh.)	Climber	Seed	NA
5	<i>Erythrina arborescens</i>	76. Leguminosae	<i>Khelmaz shosha</i> (Med.); <i>Kharshing</i> (Sh.)	Tree	Seed	NA
6	<i>Piper mullesua</i>	50. Piperaceae	<i>Pipiling</i> (Med.)	Shrub	Seed	NA
7	<i>Piper longum</i>	50. Piperaceae	<i>Pipiling</i> (Med.)	Climbing shrub	Seed	NA
8	<i>Recinus communis</i>	84. Euphorbiaceae	Chamiling	Shrub	Seed	NA
9	<i>Phyllanthus Eemblica</i>	84. Euphorbiaceae	<i>Churu</i> (Med.)	Tree	Seed	NA
10	<i>Canarium strictum</i>	88. Burseraceae	<i>Poikar</i> (Med.); <i>Poskar</i> (Sh.)	Tree	Fresh resin	NA
11	<i>Rhus chinensis</i>	93. Anacardiaceae	<i>Datrid</i> (Med.); <i>Robtang shing</i> (Sh.)	Tree	Fruit	NA
12	<i>Abroma angustifolia</i>	113. Malvaceae	<i>Ulat cambal</i> (Beng.)	Shrub	Root	NA
13	<i>Adena trilobata</i>	121. Passifloraceae	<i>Dakor meji</i> (Sh.)	Climber	Root	NA

Sl. No.	Botanical name	Family	Local/medicinal	Habit	Part used	ICUN Status
14	<i>Adena cardyophylla</i>	121. Passifloraceae	<i>Dakor laji</i> (Sh.)	Climber	Root	NA
15	<i>Beaumontia grandiflora</i>	162. Apocynaceae	<i>DukmoNAnyung</i> (Med.); <i>Gothale phul</i> (Lh.)	Large climber	Stem	NA
16	<i>Scoparia dulcis</i>	173. Scrophulariaceae	<i>Chini jhar</i> (Lh.)	Herb	Entire plant	NA
17	<i>Justicia adhatoda</i>	175. Acanthaceae		Shrub	Flowers	NA

Field survey, November 2011 and Jun-Sept 2013

**Table 24: Recognized Threatened Plants recorded in the project area**

Sl. No	Botanical name	Family	Habit	Status	Availability	ICUN Status
1	<i>Entada rheedii</i> subsp. <i>Sinohimalensis</i>	76. Leguminosae	Large Climbers	NT	C	NA
2	<i>Mucuna pruriens</i>	76. Leguminosae	Climbers	NT	C	NA
3	<i>Hodgsonia macrocarpa</i>	128. Cucurbitaceae	Climbers	NT	R	NA
4	<i>Tournefortia hookeri</i>	174. Boraginaceae	Climbers	NT	C	NA
5	<i>Dioscorea bulbiflora</i>	188. Dioscoreaceae	Twining	NT	A	NA

Source: Red list data of Bhutan

**Table 25: CITES Plants recorded in the Project Area**

Sl. No.	Botanical name	Family	Availability	Status	ICUN Status
1	<i>Alsophila spinulosa</i> syn. <i>Cyathia spinulosa</i>	Cyathaceae	R	CITES Appendix-II	NA
2	<i>Alsophila brunoniana</i> syn. <i>Cyathia</i>	Cyathaceae	R	CITES Appendix-II	NA
3	<i>Dioscorea deltoidea</i>	188. Dioscoreaceae	R	CITES Appendix-II	NA

Field survey, November 2011 and Jun-Sept 2013

## G. Forest Management

191. There are basically three types of forest – government owned national forest including Forest Management Units<sup>12</sup> (FMU), community forest, sokshing (government forest registered to an individual person or household) and private tree plantations. The government forest is being conserved by the Department of Forests and Park Services while community forest is managed by the village or a community. The Sokshing is Government Reserved Forest (GRF) managed by private individual or communities for leaf litter as mold, and private tree plantation and the private forests are owned and managed by an individual or the household.

192. Apart from Government Reserved Forest land, there are no Forest Management Units (FMUs) and Sokshings in the project area.

## H. Endangered and Protected Flora

193. Although no endangered or protected plant species as listed in Schedule I–Forest and Nature Conservation Rules of Bhutan, 2000 is observed or reported in the project site; there is possibility of occurrence of Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*), the totally

<sup>12</sup> FMUs are geographic areas of government reserved forests that are scientifically managed for purposes of logging and conservation.



protected plant species under Schedule I of Forest and Nature Conservation Act 1995 in the project road area.

## **I. Terrestrial and Aquatic Fauna**

### **1. Mammals**

194. A detailed transect field survey on mammals was conducted along the proposed road alignment and within the critical wildlife habitat area of Regi for a period of 20 days in the month August-September 2013. Mammal evidences like scats, kills, digging, wallowing, dropping, dung, feeding sites, nest sites, mud/tree marks, bedding, and remains (hairs, quill, skin, bones etc.) and tree markings were recorded. Wherever possible samples of evidences were collected for further confirmation of the species and in some cases photographs were taken for record and identification. Field guides like Mammals of Bhutan by Wangchuk et al (2004), Indian Mammals by Vivek Menon, Mammals of the Indian Subcontinent by K.K. Gurung and Raj Singh, and Hand Manual on scats and foot marks of mammals prepared by Pralad Yonzon were used for identification of mammal species and their evidences. All evidences along transects were recorded for small as well as large mammals.

195. 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 and crop damage by wild animals were also collected from local people during the informal interviews. The field guides referred above were also used for recognition of species by villagers during informal interviews.

196. As result of detailed survey, it was confirmed that there are about 31 species of wild animals inhabiting the study area particularly the critical wildlife habitat. The Asian elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Himalayan Black Bear (*Selenarctos thibetanus laniger*), Tiger (*Panthera tigris tigris*), Leopard (*Panthera pardus*) and Black Panther are reported in the project area. During the field surveys, common wild animals spotted in the study areas included Barking Deer (*Muntiacus mutjak*), Assamese Macaque (*Macaca assamensis*), Asian Elephant (*Elephas maximus*), Malayan Giant Squirrel (*Ratufa bicolor*), Himalayan Yellow-throated Marten (*Martes flavigula*), Pallas Squirrel (*Callosciurus erythraeus*), Wild Pig (*Sus scrofa*) and Capped langur (*Trachypithecus pileatus*). Fresh foot prints and fresh dungs of Asian Elephant (*Elephas maximus*), Gaur (*Bos gaurus*) and Sambar (*Cervus unicolor*) were observed during the field surveys. As per the verbal communication of village Tshogpa, Tiger (*Panthera tigris tigris*) appeared in Khalatsho village in May 2013 and Leopard (*Panthera pardus*) appeared and killed one female calf in Yargaywoong village in June 2013.

197. As per the International Union for Conservation of Nature (IUCN) red lists for Bhutan and the region, the endangered species are Asian Elephant (*Elephas maximus*), Tiger (*Panthera tigris tigris*), Capped Langur (*Trachypithecus pileatus*) and Wild Dog/Dhole (*Cuon alpinus primaevus*); threatened to endangered species is Himalayan Black Bear (*Selenarctos thibetanus laniger*), threatened species is Sloth Bear (*Melursus ursinus*) and the venerable species are Gaur (*Bos gaurus*), Assamese Macaque (*Macaca assamensis*), Small Indian Civet (*Viverricula indica*), Large Indian Civet (*Viverra zibetha*), Common Otter (*Lutra lutra*) and Himalayan Serow (*Capricornis sumatraensis*). As per categorization for Bhutan in Schedule I of Forest and Nature Conservation Act, the totally protected mammal species are Asian Elephant (*Elephas maximus*), Tiger (*Panthera tigris tigris*), Leopard/Black Panther (*Panthera pardus*), Leopard Cat (*Prionailurus bengalensis/Felis bengalensis*), Himalayan Black Bear (*Selenarctos*

thibetanus laniger), Sloth Bear (*Melursus ursinus*), Gaur (*Bos gaurus*) and Himalayan Serow (*Capricornis sumatraensis*).

198. During stakeholder discussions, it was pointed out that many animals such as Elephant and Gaur migrate from India into the southern belt of Bhutan to visit for salt lick. A list of wild animals known to inhabit the project area is shown in Table 26.

**Table 26: List of Wild animals found in the project area with their IUCN and National Status**

Sl. No.	Scientific Name	Common Name	IUCN Status	FNCA Status	Existence confirmed through
1	<i>Elephas maximus</i>	Asian Elephant	Endangered	Totally Protected	Spotted
2	<i>Bos gaurus</i>	Gaur	Vulnerable	Totally Protected	Fresh dung and hoof marks
3	<i>Panthera tigris tigris</i>	Tiger	Endangered	Totally Protected	Reported by Locals
4	<i>Selenarctos thibetanus laniger</i>	Himalayan Black Bear	Threatened to Endangered	Totally Protected	-do-
5	<i>Melursus ursinus</i>	Sloth Bear	Threatened	Protected	-do-
6	<i>Panthera pardus</i>	Leopard	Lower Risk	Totally Protected	-do-
7	<i>Panthera pardus</i>	Black Panther	Lower Risk	Totally Protected	-do-
8	<i>Macaca assamensis</i>	Assamese Macaque	Vulnerable	Common	Spotted
9	<i>Muntiacus muntjak</i>	Barking Deer	Lower Risk	Common	Barking
10	<i>Sus scrofra</i>	Wild Pig	Lower Risk	Common	Digging and wallowing
11	<i>Hysterix indica</i>	Indian Porcupine	Lower Risk	Common	Quill siting
12	<i>Trachypithecus pileatus</i>	Capped Langur	Endangered	Uncommon	Spotted
13	<i>Cuon alpinus primaevus</i>	Wild Dog/Dhole	Endangered	Uncommon-	Reported by Locals
14	<i>Vulpes bengalensis</i>	Bengal Fox	Lower Risk	Common	Reported by Locals
15	<i>Martes flavigula</i>	Himalayan Yellow-Throated Marten	Lower Risk	Common	Spotted
16	<i>Callosciurus erythraeus</i>	Pallas Squirrel/ Red-bellied Squirrel	Lower Risk	Common	Spotted
17	<i>Ratufa bicolor</i>	Malayan Giant Squirrel	Lower Risk	Common	Spotted
18	<i>Hysterix brachyura</i>	Himalayan Crestless Porcupine	Lower Risk	Common	Reported by Locals
19	<i>Manis pentadactyla</i>	Chinese Pangolin	Lower Risk	Totally Protected	Reported by Locals
20	<i>Cervus unicolor</i>	Sambar	Lower Risk	Common	Bones & antlers
21	<i>Nemorhaedus goral hodgsonii</i>	Goral	Lower Risk	Common	Droppings and hoof marks
22	<i>Felis chaus</i>	Jungle Cat	Lower Risk	Common	Reported by Locals
23	<i>Felis bengalensis</i>	Leopard Cat	Lower Risk	Totally	Reported by

Sl. No.	Scientific Name	Common Name	IUCN Status	FNCA Status	Existence confirmed through
				Protected	Locals
24	<i>Lepus nigricollis</i>	Blacknaped Hare	Lower Risk	Common	Reported by Locals
25	<i>Dremomys lokriah</i>	Orange-bellied Squirrel	Lower Risk	Common	Spotted
26	<i>Callosciurus pygerythrus</i>	Hoary-bellied Squirrel	Lower Risk	Common	Spotted
27	<i>Paradoxurus hermaphrodites</i>	Common Palm Civet	Lower Risk	Common	Reported by Locals
28	<i>Viverricula indica</i>	Small Indian Civet	Vulnerable	Common -	Reported by Locals
29	<i>Viverra zibetha</i>	Large Indian Civet	Vulnerable	Common	Reported by Locals
30	<i>Lutra lutra</i>	Common Otter	Vulnerable	Common	Reported by Locals
31	<i>Capricornis sumatraensis</i>	Himalayan Serow	Vulnerable	Totally Protected	Hoove marks and droppings

Detailed field survey, August-September 2013

## 2. Birdlife

199. Subtropical broad-leaved forests are the richest habitats of bird species among all the forest types. During the field survey nearly 90 different bird species were recorded. Table 27 provides the list of birds found in the project area. Among these the Rufous-necked Hornbill (*Aceros nipalensis*) is listed as globally threatened as per Birdlife International categorization and IUCN and it is also totally protected species under FNCA 1995. While Great Hornbill (*Buceros bicornis*) is listed as near threatened by IUCN but it is not listed under Schedule I as a protected species in the Forest and Nature Conservation Act of Bhutan. As per categorization for Bhutan, there are about 13 rare/uncommon bird species in the project area which include Wreathed Hornbill (*Aceros undulates*), Green Imperial Pigeon (*Ducula aenea*), Golden Eagle (*Aquila chrysaetos*), Himalayan Griffon (*Gyps himalayensis*), Pied Kingfisher (*Ceryle rudis*), Slaty-headed Parakeet (*Psittacula himalayana*), Blue-capped Redstart (*Phoenicurus coeruleocephalus*), White-winged Redstart (*Phoenicurus erythrogaster*), White-crowned Forktail (*Enicurus leschenaultia*), Grey Peacock Pheasant (*Polyplectron bicalcaratum*), Spotted Owlet (*Athene brama*), Red-wattled Lapwing (*Vanellus vanellus*) and Black Stork (*Ciconia nigra*).

**Table 27: List of Avifauna found in Project Area with IUCN and National Status**

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
1	<i>Aceros nipalensis</i>	Rufous-necked Hornbill	Globally Threatened	Totally Protected
2	<i>Buceros bicornis</i>	Great Hornbill	Near Threatened	Common
3	<i>Aceros undulates</i>	Wreathed Hornbill	Least Common	Uncommon
4	<i>Dendrocitta formosae</i>	Grey Treepie	Least Common	Common
5	<i>Dendrocitta vagabunda</i>	Rufous Treepie	Least Common	Common
6	<i>Dicrurus leucophaeus</i>	Ashy Drongo	Least Common	Common
7	<i>Dicrurus macrocercus</i>	Black Drongo	Least Common	Common
8	<i>Dicrurus remifer</i>	Lesser Racket-tailed Drongo	Least concern	Common
9	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	Least concern	Common
10	<i>Dicrus hottentottus</i>	Spangled Drongo	Least concern	Common

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
11	<i>Streptopelia chinensis</i>	Spotted Dove	Least concern	Common
12	<i>Streptopelia orientalis</i>	Oriental Turtle Dove	Least concern	Common -
13	<i>Chalcophaps indica</i>	Emerald Dove	Least concern	Common -
14	<i>Ducula badia</i>	Mountain Imperial Pigeon	Least concern	Common
15	<i>Ducula aenea</i>	Green Imperial Pigeon	Least concern	Rare
16	<i>Myophonus caeruleus</i>	Blue Whistling Thrush	Least concern	Common
17	<i>Monticola cinclorhynchus</i>	Blue-capped Rock Thrush	Least concern	Common
18	<i>Hypsipetes leucocephalus</i>	Black Bulbul	Least concern	Common
19	<i>Pycnonotus cafer</i>	Red-vented Bulbul	Least concern	Common
20	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	Least concern	Common
21	<i>Pycnonotus cafer</i>	Red-vented Bulbul	Least concern	Common
22	<i>Acridotheres tristis</i>	Common Myna	Least concern	Common
23	<i>Gracula religiosa</i>	Hill Myna	Least concern	Common
24	<i>Ictinaetus malayensis</i>	Black Eagle	Least concern	Common
25	<i>Spilornis cheela</i>	Crested Serpent Eagle	Least concern	Common
26	<i>Aquila chrysaetos</i>	Golden Eagle	Least concern	Rare
27	<i>Gyps himalayensis</i>	Himalayan Griffon	Least concern	Rare
28	<i>Accipiter virgatus</i>	Besra	Least concern	Common
29	<i>Blythipicus pyrrhotis</i>	Bay Woodpecker	Least concern	Common
30	<i>Celeus brachyurus</i>	Rufous Woodpecker	Least concern -	Common -
31	<i>Picus flavinucha</i>	Greater yellownape	Least concern	Common
32	<i>Picus xanthopygaeus</i>	Streak-throated Woodpecker	Least concern	Common -
33	<i>Lanius cristatus</i>	Brown Shrike	Least concern	Common
34	<i>Megalaima australis</i>	Blue-eared Barbet	Least concern	Common
35	<i>Megalaima Virens</i>	Great Barbet	Least concern	Common
36	<i>Megalaima asiatica</i>	Blue -throated Barbet	Least concern	Common
37	<i>Pericrocotus flammeus</i>	Scarlet Minivet	Least concern	Common
38	<i>Halcyon smyrnensis</i>	White-throated Kingfisher	Least concern	Common
39	<i>Megaceryle lugubris</i>	Crested Kingfisher	Least concern	Common
40	<i>Alcedo Hercules</i>	Blyth's Kingfisher	Least concern	Common
41	<i>Ceryle rudis</i>	Pied Kingfisher	Least concern	Rare
42	<i>Psittacula himalayana</i>	Slaty-headed Parakeet	Least concern	Uncommon
43	<i>Melanochlora sultanea</i>	Sultan Tit	Least concern	Common
44	<i>Chaimarrornis leucocephalus</i>	White-capped Water Redstart	Least concern	Common
45	<i>Phoenicurus coerulescephalus</i>	Blue-capped Redstart	Least concern	Rare
46	<i>Phoenicurus erythrogaster</i>	White-winged Redstart	Least concern	Rare
47	<i>Rhyacornis fuliginosus</i>	Plumbeous Water Redstart	Least concern	Common
48	<i>Enicurus schistaceus</i>	Slaty-backed Forktail	Least concern -	Common -
49	<i>Enicurus scouleri</i>	Little Forktail	Least concern	Common
50	<i>Enicurus leschenaultia</i>	White-crowned Forktail	Least concern	Rare
51	<i>Copsychus saularis</i>	Oriental Magpie Robin	Least concern	Common
52	<i>Motacilla alba</i>	White Wagtail	Least concern	Common
53	<i>Yuhina nigrimenta</i>	Black-chinned Yuhina	Least concern	Common
54	<i>Yuhina zantholeuca</i>	White-bellied Yuhina	Least concern	Common

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
55	<i>Garrulax leucolophus</i>	White-crested Laughingthrush	Least concern	Common
56	<i>Garrulax albogularis</i>	White-throated Laughingthrush	Least concern	Common
57	<i>Garrulax ruficollis</i>	Rufous-necked Laughingthrush	Least concern	Common
58	<i>Hirundo rustica</i>	Barn Swallow	Least concern	Common
59	<i>Corvus macrorhynchos</i>	Large billed Crow	Least concern	Common
60	<i>Corvus splendens</i>	House Crow	Least concern	Common
61	<i>Abroscopus superciliosus</i>	Yellow-bellied Warbler	Least concern	Common
62	<i>Seicercus affinis</i>	White-spectacled Warbler	Least concern	Common
63	<i>Cettia fortipes</i>	Brownish-flanked Bush Warbler	Least concern	Common
64	<i>Cettia flavolivacea</i>	Aberrant Bush Warbler	Least concern	Common
65	<i>Cissa chinensis</i>	Common Green Magpie	Least concern	Common
66	<i>Apus affinis</i>	House Swift	Least concern	Common
67	<i>Apus pacificus</i>	Fork-tailed Swift	Least concern	Common
68	<i>Collocalia brevirostris</i>	Himalayan Swiftlet	Least concern -	Common -
69	<i>Tephrodornis gularis</i>	Large Woodshrike	Least concern	Common
70	<i>Oriolus trailii</i>	Maroon Oriole	Least concern	Common
71	<i>Hierococcyx sparveroides</i>	Large Hawk Cuckoo	Least concern	Common
72	<i>Lophura leucomelanos</i>	Kalij Pheasant	Least concern	Common
73	<i>Gallus gallus</i>	Red Jungle Fowl	Least concern	Common
74	<i>Polyplectron bicalcaratum</i>	Grey Peacock Pheasant	Least concern	Uncommon
75	<i>Sasia ochracea</i>	White-browed Piculet	Least concern	Common
76	<i>Merops leschenaultia</i>	Chestnut-headed Bee-eater	Least concern	Common
77	<i>Upupa epops</i>	Common Hoopoe	Least concern	Common
78	<i>Otus sunia</i>	Oriental Scops Owl	Least concern	Common
79	<i>Otus bakkamoena</i>	Collared Scops Owl	Least concern	Common
80	<i>Athene brama</i>	Spotted Owlet	Least concern	Rare
81	<i>Vanellus vanellus</i>	Red-wattled Lapwing	Least concern	Uncommon
82	<i>Pomatorhinus erythrogenys</i>	Rusty-cheeked Scimitar Babbler	Least concern	Common
83	<i>Phalacrocorax carbo</i>	Great Cormorant	Least concern	Common
84	<i>Ciconia nigra</i>	Black Stork	Least concern	Uncommon
85	<i>Cinclus pallasii</i>	Brown Dipper	Least concern	Common
86	<i>Ficedula superciliosa</i>	Ultramarine Flycatcher	Least concern	Common
87	<i>Eumyias thalassina</i>	Verditer Flycatcher	Least concern	Common
88	<i>Culicicapa ceylonensis</i>	Grey-headed Canary Flycatcher	Least concern	Common
89	<i>Sturnus contra</i>	Asian Pied Starling	Least concern	Common
90	<i>Cephalopyrus flammiceps</i>	Fire-capped Tit	Least concern	Common

Field survey, November 2011 and Jun-Sept 2013

### 3. Reptiles and Amphibians

200. According to Wangyal (2013), Bhutan has 36 species of amphibians (34 anurans, one caudata, one caecilian), 83 species of reptiles (57 snakes, 20 lizards, one crocodile, five turtles).

About five species of amphibians and seven species of reptiles has recorded during field survey. All recorded species are categorized as least concern under IUCN Red list except for Indian python (*python morulus*) which is categorized as lower risk/near threatened. List of amphibians and reptiles recorded in the project area are provided in Table 28.

**Table 28: Reptiles and Amphibians in Project Area**

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
<b>Amphibians</b>				
1	<i>Amolops gerbillus</i>		Least Concern	
2	<i>Amolops marmoratus</i>		Least Concern	
3	<i>Clinotarsus alticola</i>		Least Concern	
4	<i>Duttaphrynus melanostictus</i>	Asian Common Toad	Least Concern	
5	<i>Xenophrys major</i>	Glandular Horned Toad	Least Concern	
<b>Reptiles</b>				
1	<i>Ahaetulla prasina</i>	Asian vine snake or the oriental whipsnake	Least Concern	
2	<i>Calotes versicolor</i>	Changeable Lizard	Not Assessed	Common
3	<i>Daboia russelii</i>	Eastern Russell's Viper	Least Concern	Common
4	<i>Hemidactylus frenatus</i>	Common House Gecko	Least Concern	Common
5	<i>Naja kaouthia</i>	Monocled Cobra	Least Concern	Common
6	<i>Ptyas mucosus</i>	Oriental Rat snake	Not Assessed	Common
7	<i>Python morulus</i>	Indian Python	Lower Risk/Near threatened	-

Field survey, November 2011 and Jun-Sept 2013

#### 4. Aquatic Life

201. There are 49 fish species, of which 42 are native and 7 are introduced in Bhutan (<http://www.mongabay.com/fish/data/Bhutan.htm>). Only one fish species, the Golden Mahsheer (*Tor putitora*) is a totally protected species under schedule I of Forest and Nature Conservation Act of Bhutan, 1995.

202. No past surveys of fish species has been noted for Kirungri, Tsokhiri and Duri Rivers. According to local fishermen, there are around 15 different known fish species (Table 29) in the rivers within the project area. There are no endangered or threatened or protected fish species in the rivers within the project area. The common fishes found in the rivers are *Schizothorax* spp., *Glyptothorax trilineatus* (Bayna/Kabre), *Labeo* spp. (Gardi), *Macroglyptothorax aculeatus* (Spiny eel), *Acrossocheilus hexagonalepis* (Katley), *Channa maurilus* (Snakehead), *Barilins* spp. (Fageta), *Garra gotyla gotyla* (Buduna/Chinya). Amongst three rivers, Tsokhiri and Duri River are known to harbour most of the fish species including freshwater prawn and crabs. Fish population of Duri River and Chowkiri River are almost depleted at the international border due to widespread illegal fishing.

**Table 29: List of Fishes in Project Area with IUCN and National Status**

S No	Scientific names	Common names	IUCN Status	FNCA Status
1	<i>Schizothorax progastus</i>	Asala/ Menjai	Least Concern	Common
2	<i>Puntius Sarana</i>	Punti	Least Concern	Common

S No	Scientific names	Common names	IUCN Status	FNCA Status
3	<i>Cirrhina lata</i>	Gauma	Not Assessed	Common
4	<i>Barilius shaera</i>	Hill trout	Not Assessed	Common
5	<i>Gogangra viridescens</i>		Not Assessed	Common
6	<i>Barilius vagra</i>	Koksa	Least Concern	Common
7	<i>Barilius barna</i>	Puti	Least Concern	Common
8	<i>Garra gotyla gotyla</i>	Pattar chat/ Lohari	Not Assessed	Common
9	<i>Glyptothorax trilineatus</i>	Bayna / Kabre	Not Assessed	Common
10	<i>Macrognathus armatus</i>	Spiny eel	Not Assessed	Common
11	<i>Acrossocheilus hexagonalepsis</i>	Katley	Not Assessed	Common
12	<b><i>Garra annandalei</i></b>		Least Concern	Common
13	<i>Channa maurilus</i>	Snakehead	Not Assessed	Common
14	<i>Badis badis</i>	Badis	Least Concern	Common
15	<i>Acanthocobitis botia</i>	Mottled loach	Least Concern	Common

Field survey, November 2011 and Jun-Sept 2013

## J. Socio-Economic Environment

### 1. Population, Households and Ethnicity

203. The proposed road falls under Pema Gatshel and Samdrup Jongkhar Dzongkhags (Districts). There are three Geogs (Blocks) (namely Norbugang, Chokhorling and Dewathang) and Dewathang municipality.

204. The total population of the affected Dzongkhags/districts of Pemagatshel and Samdrup Jongkhar is 61,083. While the population of affected Geogs/blocks of Norbugang, Chokhorling, Dewathang and the municipality of Dewathang is 11,323 persons.

205. However, there are 12 main settlements including Nganglam and Dewathang urban areas that directly along the 3.0 km Project Influenced Area (PIA) with the total population of 6,162 persons (1037 households) and average family size of 5.9 as shown in table V.19. Sharchhokpa or Tshangla speaking people inhabit the PIA.

**Table 30: Population and Households of the Project Affected Dzongkhags, Geogs and Villages**

Dzongkhag, Geog, Village, Towns	Male	Female	Total Population	Total Household
<b>Pema Gatshel Dzongkhag</b>	<b>11,784</b>	<b>11, 997</b>	<b>23,777</b>	<b>5,530</b>
<b>Norbugang Geog</b>	<b>1975</b>	<b>1754</b>	<b>3729</b>	<b>437</b>
<i>Nganglam Throm/Town</i>	621	397	1018	179
<b>Chokhorling Geog</b>	<b>1423</b>	<b>957</b>	<b>2380</b>	<b>256</b>
<i>Drangnalashing Borang, Suzagag, Khalaktangzor, Dezama and Shuguri</i>	300	200	500	50
<i>Shaitan Brangsa, Yargaywoong</i>	200	150	350	15
<i>Gazawoong, Chokhorling</i>	600	400	1000	134
<i>Khalatsho</i>	23	7	30	7
<b>Samdrup Jongkhar Dzongkhag</b>	<b>19,122</b>	<b>18,184</b>	<b>37,306</b>	<b>8,479</b>
<b>Dewathang Geog</b>	<b>1150</b>	<b>1420</b>	<b>2570</b>	<b>360</b>
<i>Reshore, Chenari, Khorpam, Yezor, Sib, Gaykheree,</i>	300	350	650	95
<i>Dewathang Throm/Town</i>	1377	1267	2644	557

Source: EIA Field Survey, November 2011 and PHCB 2005

## 2. Main Occupation

206. Majority of the people residing within PIA are engaged in farming and livestock rearing. During offseason, particularly during winter months, people also work on off-farm jobs as labourers and potters to supplement their meager income from agricultural activities. People living close by or within the urban areas are engaged in commerce or small businesses.

## 3. Market Centres and Business Facilities

207. Nganglam and Dewathang are two main market centres within the PIA with number of business establishment such as shops, restaurants, hotel and bars. Very few shops are found in between two centers, along the proposed road. The details of business establishment within the PIA are provided in the Table 31.

**Table 31: Type and Number of Business Establishment in Project Area**

Villages/Town	Hotel & Lodge	Restaurant & Bar	General Shop
Nganglam Throm/Town	3	50	40
Dezama	0	3	0
Yargaywoong	0	2	0
Chokhorling	0	3	0
Khalatsho	No	No	No
Rishore and Chenari	No	0	4
Dewathang Throm/Town	1	16	25

Source: EIA Field Survey, November 2011

## 4. Local Economy

208. Apart from urban areas of Nganglam and Dewathang, the economy of the project area is mainly based on subsistence agriculture and that too on horticulture. Until recently, people have been entirely dependent on export of oranges to neighbouring India and Bangladesh for their cash income. However, orange export businesses have fallen sharply in recent years due to decreasing yields as a result of citrus greening; a plant disease caused by virus affecting orange trees. In order to diversify the sources of cash income for the people, the government has encouraged people to take alternative cropping such as cultivation of high value organic vegetable for export. This is expected to offset the loss of income from the orange export business.

## 5. Farming Pattern and Livestock

209. Major crops that are cultivated in the project area are maize, millet, potato, beans etc. Rice cultivation used to be done in Khalatsho area but it was abandoned due to wildlife encroachment and the damage of only irrigation canal in the area. Majority of the people own orange orchard and it has been the main cash crop in the area for decades.

210. Apart these, livestock rearing and backyard poultry farming have also been integral part of their subsistence living. The efforts are now made by the government to encourage the people to rear high quality cattle breeds and establish commercial poultry farms to increase their cash income.

## 6. Health and Sanitation



211. Major health problems associated with local people are gastric, water borne diseases, gynaeco related diseases, bath, respiratory diseases, skin, malnutrition, typhoid, worm etc. Sanitation awareness among local people is on the rise and many of them have toilets in their home.

212. As per the PHCB 2005, about 5.8% and 2.9% of the total population of Samdrup Jongkhar and Pemagatshel Dzongkhags respectively were disabled population. The disabled population includes the people with seeing, hearing, moving and mental problems. Within the PIA, Chokhorling village of the Chokhorling Geog of Pemagatshel Dzongkhag has the highest disabled population with more than 7 households out of 134. One of the reasons of high disabled population within Chokhorling village would be as a result of remoteness (inaccessible in the past as there were no motorable road) of the settlement with very little contact with outside world, which led to inbreeding and thus high incidences of disabilities amongst their offspring. The proposed road construction from Nganglam to Dewathang does not directly affect any of the disabled households.

## 7. Public Services and Infrastructures

213. **Education.** There are 11 educational institutions including formal, non-formal and tertiary institution within the PIA. Primary schools are found in all major settlements. Nganglam and Dewathang towns have one higher secondary schools each. All three affected geogs or blocks of Norbugang, Chokhorling and Dewathang have Non-Formal Education Centres (NFEC) where basic learning is provided to uneducated adults. A tertiary learning institute, the Jigme Namgyal Polytechnic offering diploma courses in Civil, Electrical and Mechanical engineering is located at Dewathang. Most of the children in the PIA are enrolled in the school. Literacy rate has been estimated to be below 60 percent for the PIA.

**Table 32: Educational Facilities**

Sl. No	Institution Type	Norbugang	Chokhorling	Dewathang	Total No	Remarks
1	CPS	1	1	-	2	
2	PS	-	-	-	-	
3	LSS	1	-	1	2	
4	MSS	-	-	1	1	
5	HSS	1	-	1	2	
6	NFEC	1	1	1	3	
7	Others	-	-	1	1	Jigme Namgyal Polytechnic, Dewathang

Source: EIA Field Survey, November 2011

214. **Health Facility.** There is one Hospital (Royal Bhutan Army hospital) at Dewathang and a Basic Health Unit (BHU) each at Nganglam and Chokhorling. The remote areas are served through Out Reach Clinics and there are 4 such clinics in the PIA.

**Table 33: Health Facilities**

Sl. No	Education Type	Norbugang	Chokhorling	Dewathang	Total No	Remarks
1	Hospital	-	-	1	1	Royal Bhutan Army Hospital
2	Basic Health Unit (BHU)	1	1	-	2	

3	Out Reach Clinic	1	-	3	4	
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Source: EIA Field Survey, November 2011

215. **Communication.** All settlements within the PIA are covered by cellular network of Bhutan Telecom Ltd. Use of mobile phone is quite popular and still on the rise. Conventional landline telephone facilities are found in Nganglam and Dewathang urban areas. There are two post offices (one each in Nganglam and Dewathang) which have been serving the local people for decades.

216. **Electricity.** At the time of feasibility study, rural electrification works were being carried out to connect settlements of Chokhorling, Yargaywoong and Khalatsho to a national grid. By the end of 2012, all settlements under the project area have been electrified. Prior to national grid connection, solar lighting is widely used in Chokhorling, Yargaywoong and Khalatsho. The proposed road construction is likely to damage rural electricity supply lines and poles particularly between Nganglam–Yargaywoong and Rishore–Dewathang.

217. **Water Supply.** Piped drinking water supply facilities provided through Rural Water Supply Scheme are available in all settlements through gravity flow schemes and natural springs. The water supply schemes generally use spring sources located in higher altitudes. The water is conveyed by pipes from the sources to the public taps through gravity flow. These taps are located in common places so that each serves a few households. Some houses in few settlements have private connection. The road construction will affect water sources and the supply pipelines.

218. **Irrigation.** Irrigation facilities are seen rarely within PIA as there are no wetland paddy cultivations. Only one defunct irrigation system is found at Khalatsho which is damaged erosion and landslides. The agriculture activities or farming is totally dependent on rainfall.

219. **Industries.** Apart from Dungsam Cement and Bhutan Polymers Industries at Nganglam; and Coal mining at Rishore, Dewathang; there are other industries within the PIA. There are few flour mills in the PIA. Women generally are skilled weavers and this skill can be promoted to increase the income.

220. **Financial Institution.** Nganglam has the branch offices of Bank of Bhutan Limited (BoBL), Royal Insurance Corporation of Bhutan Limited (RICBL), and Bhutan Development Bank Limited (BDBL). While Dewathang has a only BoBL branch office. The people of Chokhorling and Norbugang geogs use the services of financial centers located at Nganglam whereas the people of Rishore and Chenari get from the financial center at Dewathang.

221. **Land holding pattern.** The land holdings pattern observed in the project influenced area are:

- 13.6% of population holding less than 1 acre
- 46% holding 1-5 acres
- 40% holding 5-10 acres

222. The average land holding for the project area is 5.7 acres.

223. **Settlement, poverty and migration.** Most of the settlements within PIA are of clustered type due to limited inhabitable areas. Houses are mostly of one or two storied types with corrugated galvanized iron (CGI) sheet roofing while some are with thatch roofing. Reinforced cement concrete buildings are seen in market centres at Nganglam and Dewathang.

**Figure 27: Bamboo House at Chokhorling****Figure 28: Two storied House at Chokhorling**

224. A study carried out jointly by World Bank and National Statistical Bureau (NSB) in 2010, “*Small area estimation of poverty in rural Bhutan*,” indicates high prevalence of poverty within PIA; with poverty rate of 20-30%. Among the three affected geogs, Dewathang has the highest poverty rate of 30%. But this may change as the orange export business of Chokhorling geog falls due to damage of their orange orchards by citrus greening (plant disease caused by virus). The poverty incidences amongst the people of Chokhorling Geog may increase.

225. The Population and Housing Census of Bhutan 2005 shows that around 8,129 and 12,467 people out migrated from Pemagatshel and Samdrup Jongkhar Dzongkhags. The main reasons for out migration are due to lack of educational and job opportunities, resettlement and human wildlife conflict.

226. Khalatsho village under Chokhorling Geog has suffered worst out migration in their history. As per geog census registration, there are total of 117 registered landholders at Khalatsho but in reality there are only 7 households who are actually residing in the area. The main reasons cited for out migration are human-wildlife conflict (wildlife encroachment and destruction of crops) and the inaccessibility of the area particularly during rainy seasons.

#### **K. Religious, Cultural, Historical and Archaeological Resources**

227. The historical and religious sites found within PIA (within Row and outside the road alignment) are provided in Table 34.

**Table 34: Religious, Cultural and historical sites within PIA**

Name		Location	Impact (Yes or No)	Distance from road	Remarks
Rock Painting of Guru Padma Sambhava	0+000 km	Nganglam Town	No	250 m	No impact is expected
Zangtopelri/ Temple	-	Nganglam Town	No	2 km	No impact is expected
Community Temple	4+000 km	Dezama	No	500 m	No impact is expected
Lungkhangma Nye	11+880 km	Lungkhangma Labtsha, Yargaywoong	Yes	2m	Lungkhangma literally mean split rock which is considered sacred by

Name		Location	Impact (Yes or No)	Distance from road	Remarks
					locals. People claim to see imprint of Guru Padma Sambhava inside the split rock. No direct impact is expected.
Thujaycholing Lhakhang/Temple and Stupa	26+620 km	Chokhorling	Yes	15m	Road construction may affect the foundation of the temple with risk of landslide and slope failure. Road is shifted away from temple. Slope protection work shall be implemented
Tshampa Chorten (Small stone stupas)	27+200 km	Chokhorling	Yes	10m	No impact to Chortens or stupas
Gyesar Dala Lhakhang	67+240 km	Dewathang Town		3-4m	Road widening will be restricted to 7.5m. Hence no impact is expected
Dantak Memorial Stupa	67+400 km	Dewathang Town	Yes	0m	Road widening will be restricted to 7.5m. Hence no impact is expected
Gortap Dungkhori Mani (Prayer Wheel)	68+000 km	Near the termination point of proposed road	No	14 m	No impact is expected.

Source: Field Survey, November 2011

**Figure 29: Meme Lungkhangma Labtsha**



**Figure 30: Thujaycholing temple at Chokhorling**



#### **L. Potential Development Area**

228. Many of the places, areas and settlements within PIA of the project have the potentialities in various sectors. These sectors and their potentialities have been mentioned in Table 35.

**Table 35: Development Potential Area**

Sl. No.	Development potential area	Description of potential development
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1	Nganglam	Industrial town
2	Dezama and Shuguri	Tourism, vegetable production
3	Shuguri-Yargaywoong	Bird watching and Nature tourism
4	Yargaywoong and Chokhorling	Cultural tourism
5	Khalatsho and Bafudar	Rice Production
4	Chowkiri – Duri	Eco-tourism (bird watching, botanical tour)
5	Rishore	Increased Coal Mining Opportunities
6	Dewathang	Business Center

Source: Field Survey, November 2011

## **VI. ANALYSIS OF ALTERNATIVES**

### **A. No-project Alternative**

229. Construction of roads in Bhutan poses immense challenges. In line with the technical challenge, the Government has become increasingly aware of environmental damages associated with road development, including impacts on forests due to construction of the roadway, potential impacts on the seasonal and daily movement of animals, erosion and landslides that obstruct the road and cause a hazard for travelers, and potential land use changes. A guideline is now in use by the Department of Roads related to environmentally sound road construction practices (DoR 2004), which provides the means for minimizing impacts.

230. Benefits stem from improved transport links in the southern part of the Country. Without the project there is little means for improving public services or utilizing resources produced in the area to contribute to the national economy. Some 61,083 persons inhabit the Dzongkhags served by the Project, which is 9.6% of the national population, and for the most part this segment of the population is weakly linked to the national economy. Many young people currently leave the area because opportunities are few for participation in the national economy. Public services and economic opportunities will increase for these people as a result of improved transport connectivity. National economic growth can be accelerated due to the proximity of the project area to India. Trade and production links can be enhanced by improved transportation.

231. In addition, the Government has long been concerned about security of its citizens along the southern boundary of the country. Currently, access for many of the areas to be served is only by passage through India. Bhutanese nationals face risks along the route through India. Hence the project roads will serve an alternative and safer passage for Bhutanese travelers.

232. There are positive as well as negative effects on forests and biodiversity. Negative effects are brought about by direct forest loss and potential felling of timber as well as poaching of animals. At the same time beneficial effects stem from improved access for patrolling of biodiversity protection areas. DoFPS staffs have been trained to upgrade skills and knowledge for effective patrolling and anti-poaching. But patrolling areas depends in part on access, and roads can help in this regard.

233. Benefits stemming from the project in terms of security, access, national development and poverty alleviation are far greater than the potential and expected negative environmental impacts. Hence, the EIA addresses environmental impacts in conjunction with economic and social impacts and concludes there is no potential for severe, long term or irreversible impact, which would give rise to justification for the no project alternative.

### **B. Location and Alignment Alternatives**

#### **1. Suitability in terms of Project Objectives**

234. The Technical Assistance Report prepared at the feasibility study stage sets out the impact and outcome as “road network efficiency in the southern east–west corridor and sub-regional connectivity, contributing to expanded economic development and regionally balanced development, leading to poverty reduction.” The anticipated road segments studied were seen to span and link up important centres of population in the southern part of the Country. The

proposed national highway alignment location was found to be practical for contributing to an east-west corridor along the southern boundary of the Country.

### C. Alignment Alternatives Assessed under PPTA Study

235. 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 highway segment are considered in regard to potential environmental impacts alongside length, cost and communities provided access.

236. The three alternative alignments were assessed as part of the Nganglam-Dewathang highway feasibility studies. Two of the alignments—80 km top alignment (AB) and 88 km border alignment (EF) were DoR's alignments from the Road Sector Master Plan. Under the PPTA, the new alignment of 74.5km from C to D was proposed and studied in relation to the two alignments from the road sector master plan. The comparative analysis was carried out based on various environmental factors and the cost of construction as shown in Table 36.

**Table 36: Comparison of Alternate Alignments for NDH**

<b>Environmental Parameter</b>	<b>TOP Alignment (AB)</b>	<b>Middle Alignment (CBD)</b>	<b>Border Alignment(EF)</b>
Total Length	80 km	74.5 km	88 km
Use of Existing Road	Nil	19km (15 km farm road and 4km coal mine and Dewathang Municipal road)	4km Coal Mine and Dewathang municipal Roads
Major Bridges required	4	3 (1 Bailey Bridge existing)	5
Agriculture Land take up	19 acres	63 acres	Nil
Forest Land take up	277 acres	166.8 acres	326 acres
Sensitive Habitat & Biological Corridor (BC)	Does not pass through BC but through purely dense forest.	6 km through BC and mostly through modified habitat.	88km through BC and dense forest
Slope Stability	Passes through stable but steep and highly rocky areas	Pass through stable area	Pass through weak geology and unstable areas
No of villages directly benefited	5 settlements (Nganglam, Chokhorling, Rishore, Chenari, Dewathang)	Nganglam, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari, Dewathang	Nil
Cost of Construction (Unit cost Nu.25.65 million/km provided by Detailed Design Study)	2,052 Million	1,910.9 Million	2,257.2 Million

237. Result of comparative analysis suggests the middle alignment (CBD) to be the best possible alignment. The middle alignment has following advantages over other two alignment options:

- The middle alignment (CBD) is the shortest of the three alignments.
- It requires only 3 bridges since it uses the existing Bailey bridge over Kirungri River.
- 15km farm road from Nganglam-Chorkhorling and over 4km Rishore coal mine and Dewathang municipal road will be widened to National highway standard.
- Although it requires acquisition of 63.91 acres of private land, it connects all major settlements along Nganglam-Dewathang. And it is line with the wishes of people living in the project area. They expressed the need of highway nearer to their settlements to accrue direct benefits from the improved transport link.
- .Although it passes 2km through Biological Corridor and important natural habitat, it requires less forest clearance comparing to other two alignments. Top alignment (AB) passes through dense undisturbed natural forest while border alignment (EF) passes entirely through sensitive biological corridor.
- It passes through geological stable zones. The top alignment (AB) will require more blasting as it passes through rocky terrain. On the other hand, the border alignment (EF) passes through the geological fragile areas of Himalayan foothills.
- It will cost substantially less to construct than other two alignments.

238. Therefore, middle alignment (CBD) has been recommended for further detailed engineering, social and environmental studies. The detailed alignment study carried out during detailed design phase is provided in the next section.

#### **D. Final Detailed Design Alignment**

239. The final alignment considered after detailed survey and design is about 68.3km in length, which is 6.5 km shorter than original PPTA alignment (74.5km). Following improvements have been carried out:

- Bridge locations for all three bridges have been moved downstream thus shortening road length to 68km. Existing bridge over Kirungri River will be used.
- Road has realigned nearer to Yargaywoong village at the request of the villagers
- For 15km from Nganglam-Lungkhangma, the NDH will follow the farm road.
- As per the final alignment about 6km of proposed road will follow the farm road that passes through biological biological corridor.
- Regi slide has been avoided. Road will pass through the first saddle above Regi slide.

#### **E. Technology and Roadway Standards**

240. RNP II design standard with 7.5m formation and 5.5m carriage width will be used for NDH construction. It is the intermediate standard between Primary (10.5m formation & 6.5m carriage width) and Secondary National Highway (7.5m formation & 3.5m carriage width) standards of Bhutan. It is comparatively cheaper than Primary National Highway without much compromise on the design standards.

241. Other technological variables concern the application of environmental safeguards in the construction of the roadway: removal and harvest of marketable timber from the right-of-ways,



placement of spoil materials in designated locations rather than disposal down the slope of the mountain (which destroys further forest resources), and other practices set out in the DoR guidelines for environmentally sound roadway construction. General Rules and Regulations on Occupational Health and Safety (OHS) in Construction, Manufacturing, Mining and Service Industries 2006 will guide occupational health and safety for construction workers.

## **F. Design**

242. Design considerations are many on the Project, and most are related to technical issues that are addressed by the engineering team. Design issues that relate to environmental considerations fall into a few categories: location, where the location may impact environmental resources; safety, where the design of the roadway may affect safe use (and hence an aspect of the social environment); durability due to environmental effects on the roadway from geotechnical and hydrological variables; and design features that might minimize effects on wildlife. Design issues related to location have been considered elsewhere in this section. Safety features include sight distance (always poor on mountain passages) in relation to roadway width and turn-outs, use of guard rails and signage to protect drivers. Recommendations are incorporated into the detailed design. Likewise long term use of the pavement structure is considered in the type of surface treatment to be used on the roadway, with an eye for ease of maintenance.

## **G. Operation**

243. Maintenance is a major factor in operations and ongoing requirements are reduced by sound design that takes into account the geotechnical conditions of the roadway, provides correct placement and adequate capacity for cross drainage, assures that slopes are stabilized and prevents the occurrence of scouring in areas subject to contact with flowing water. In general the project has been designed to minimize maintenance requirements during the operation of the roadways.

244. Access along the Nganglam-Dewathang highway will be closely monitored in order to prevent illegal fishing and poaching of wildlife and forest resources from the nearby forest areas. The ability to obtain access to the forests directly from reaches of the roadways will likewise be strictly limited to legitimate purposes. This is to limit the opportunity for an increase in poaching of animal parts and forest products, and to use the roadway for better management of these resources.

## **H. Cleaner Technology and Environmental Management**

245. Cleaner technology during the project can be achieved through the use of proper equipment that are well maintained and hence generate less pollution of air, noise and water.

246. Roadway operations provide opportunity for introduction of cleaner technology through policies enacted nationally. These have to do with vehicle performance and emissions. The government has taken steps towards improving air quality by requiring better quality fuel, conducting emission tests, and banning import of reconditioned vehicles (Kuensel 2004). Sulfur content of diesel at 500 PPM is the lowest in the region, and Euro 2 Vehicle emission standards came into force in March 2008. Import licenses are only given for vehicles that meet the Euro 2 standards or above. Euro 2 is a light duty vehicle standard that came into effect in Europe in 1996 (1.0, 0.7 and 0.08 gm/km for CO, NO<sub>x</sub> and PM respectively). Other cleaner technology introduced in the automotive sector includes banning the import of two wheelers with two-stroke

engines, importation of unleaded petrol, waiving of import taxes/duties for motor vehicle spare parts and import ultra-low sulfur diesel.

## **I. Conclusion**

247. Alternatives including the no-project alternative, alignments for roadway segment, and technology, design and construction alternatives have been consistently weighed throughout the development of the detailed design. Alternatives have been selected that represent environmentally sound engineering judgment and the one that benefit communities most. The engineering team is attuned to environmental factors that need to be incorporated into the design both to improve the safety of the roadways and to reduce maintenance over the long term. The environmental and social safeguard team has made substantive input into the engineering design, working closely with the engineering team in the field and office to determine the most beneficial solutions. The outcome is a proposal that minimizes potential environmental impact to the extent possible during construction.

Figure 31: Alignment Alternatives options considered under PPTA

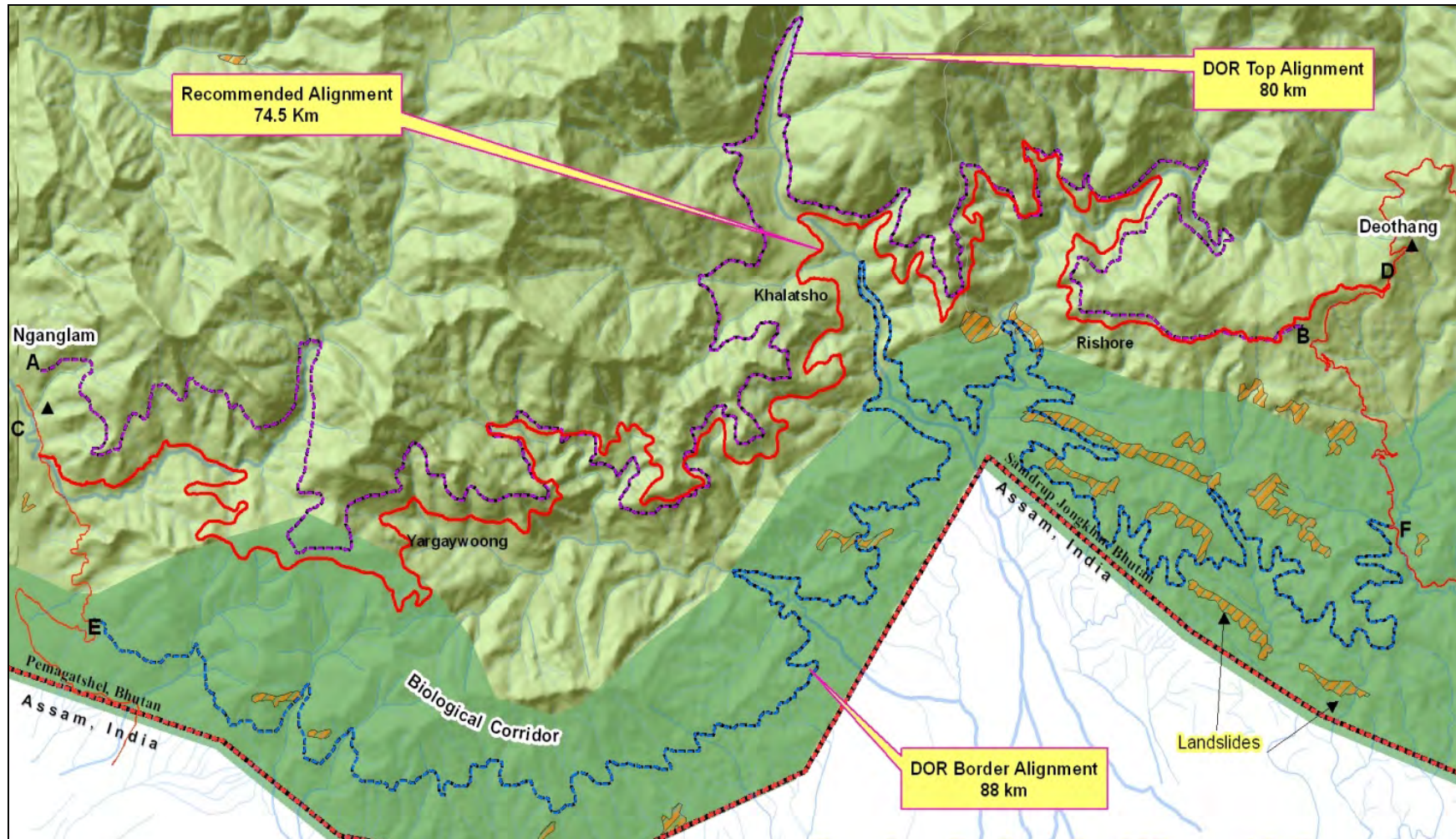
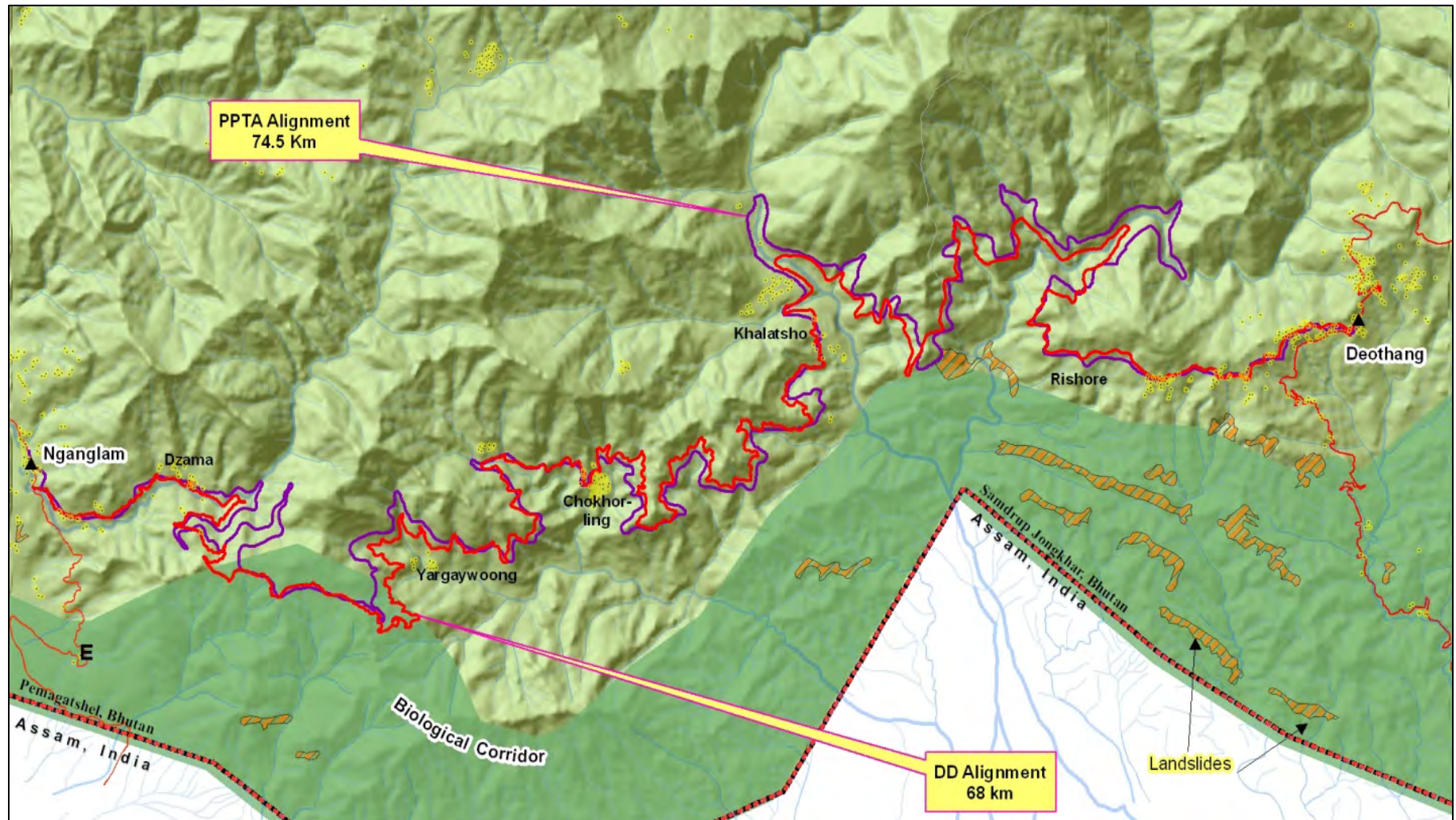




Figure 32: Final Alignment considered under Detailed Design



## VII. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

### A. Introduction

248. This section provides an assessment of the positive and adverse impacts on the environment in the immediate vicinity of the study area resulting from the development of the project, and the corresponding mitigation and enhancement measures to negate such adverse impacts.

249. It is envisaged that the NDH development will bring about direct and indirect beneficial impacts such as; i) increase in employment opportunities and income; ii) increase in trade and businesses; iii) decrease in rural-urban migration; iv) increase in land value; v) increased agricultural production; vi) promotion of cottage or small scale industries; vii) improvement in accessibility and saving of transport cost; viii) enhancement of social services and; viii) improved biodiversity protection patrolling.

250. The major environmental issues regarding the construction of the road are related to i) design of road; ii) temporary impacts of mobilization and construction; iii) problems of pollution related to disposal of sewage, waste fuel and oils, and other solid wastes generated during construction and operations; iv) wildlife habitat destruction; v) impacts associated with increased road traffic, vi) air pollution from dust and emission from equipment and vehicles and vii) Occupational Health and Safety.

251. This section presents potential adverse environmental impacts of the proposed highway development and identifies mitigation measures to prevent or avoid, offset and minimize the impacts in the pre-construction, construction and operational phases of the project.

### B. Physical Environment

#### 1. Greenhouse Gas Contribution

##### a) Loss of Carbon Stock from Biomass Removal

252. **Construction:** The construction of the NDH will change the biomass carbon stock due to the removal of wood along the right-of-way (ROW). The project will convert a total of 68 hectares of broadleaf sub-tropical forest into road right-of-way. The loss in carbon stock was estimated following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories:

$$L_{\text{wood-removals}} = \{H \times BCEF_r \times (1+R) \times CF\}$$

Where:

H = annual wood removal, assumed 163 m<sup>3</sup>/ha biomass above ground for Bhutan

R = ratio of below-ground mass to above-ground biomass in tonnes dry matter (d.m.)

= 0.45 tonne root/tonne shoot for sub-tropical humid forest

CF = carbon fraction of d.m. tonne C,

= 0.45 tonne C/tonne d.m. for tropical and sub-tropical forest

BCEFr = biomass conversion and expansion factor ( $\text{m}^3$  of removal)<sup>-1</sup>

= 2.25 for humid tropical natural forest

253. The loss in carbon stock was estimated at 7,109.36 tonnes for the loss of above ground biomass.

#### b) Vehicular Greenhouse Gas Emission

254. **Operation:** The ADB requires the borrower to promote the reduction of greenhouse gas emissions related to the project and has set a significance threshold level of 100,000 tonnes of CO<sub>2</sub>e per year. Projects with direct and indirect emissions exceeding the threshold are required to include in the EIA an evaluation of alternative to minimize or offset emissions. The average annual vehicular GHG emissions from NDH were estimated using general equation at the project life mid-point<sup>13</sup> ay year 2029.

$$\text{Emission} = A \times EF \times (1-ER)/100$$

Where:

A= activity, taken as kilometer travelled by each type of vehicle in 2029, km

EF= CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emission factors, in g/km

ER = emission reduction efficiency, is set at 0 as GHG vehicular emission is uncontrolled

255. The average annual daily traffic (AADT) for 2029 were interpolated from the traffic data provided in Detailed Design Report (2013). Table 37 revealed that trucks and passenger cars are the dominant users accounting for 43% and 39%, respectively. Diverted traffic mostly coming from the India Border account for 18% of the total AADT.

**Table 37: AADT for NDH by Stretch, 2029**

Stretch	Length	AADT, 2029				
		Car	Minibus	Bus	Trucks	Total
Nganglam-Km16	15	554	358	41	407	1,359
Km16-Rishore	49	364	26	14	398	802
Rishore-Dewathang	4	424	130	23	687	1,263

Source: Detailed Design Report, December 2013

256. The GHG emission factors for Bhutan in-use vehicles were used to the extent available. The CO<sub>2</sub> emission factors developed by the Government of India Central Pollution Control Board/Ministry of Environment and Forest (CBCP/MOEF)<sup>14</sup> (2007) for vehicles widely used in Bhutan were used. However, no published data for CH<sub>4</sub> and N<sub>2</sub>O factors area available for Bhutan in-use vehicles and instead USEPA<sup>15</sup> (2011) derived factors were used as surrogate. The following emission factors were used for this project.

<sup>13</sup> As advised by RSES

<sup>14</sup> Draft (2007) Report on Emission Factor Development for Indian Vehicles; The Automotive Research Association of India.

<sup>15</sup> Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009, EPA 430-R-11-005

**Table 38: GHG Emission Factors**

GHG	Emission Factor, g/km				Remarks
	Car	Minibus	Bus	Trucks	
CO <sub>2</sub>	126.37	327.29	817.52	837.5	CO <sub>2</sub> emission of Zen, Alto, Matiz, WagonR for cars, Eicher 10/diesel for minibus, Eicher 20/diesel for bus and trucks
CH <sub>4</sub>	0.01075	0.000625	0.000625	0.0031875	CH <sub>4</sub> and N <sub>2</sub> O from passenger cars in-use in 2009, diesel light duty trucks for in-use vehicle from 1996-2009, and diesel heavy duty trucks for vehicles in use from 1960-2009. USEPA
N <sub>2</sub> O	0.002375	0.0009375	0.000938	0.003	

257. Given the projected AADT for year 2029, the activity rate of kilometer travelled was estimated for each road section as provided in Table 39.

258. The CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions for each type and vehicle and road stretch are given in the succeeding Table 40. The weighted total CO<sub>2</sub>e emission is calculated at 119,605 tonnes using the global warming potentials of 23 and 298 for CH<sub>4</sub> and N<sub>2</sub>O, respectively.

**Table 39: Projected travel by vehicle type and road section, 2029**

Section	Projected Km Travelled, 2029			
	Car	Minibus	Bus	Trucks
Nganglam-km16	8,307.66	5,367.69	611.36	6,099.04
Km16-Rishore	17,845.13	1,271.31	696.05	19,484.32
Rishore-Dewathang	1,694.46	520.00	90.10	2,747.90

**Table 40: GHG Emission Estimate for Nganglam-Dewathang Road**

Road Section	Car	Minibus	Bus	Trucks
	CO <sub>2</sub> t/yr			
Nganglam-km16	383.19	641.23	182.43	1,864.40
Km16-Rishore	823.11	151.87	207.70	5,956.11
Rishore-Dewathang	78.16	62.12	26.89	840.00
Road Section	CH <sub>4</sub> t/yr			
	Car	Minibus	Bus	Trucks
Nganglam-km16	0.032597176	0.0012245	182.4258	1864.4004
Km16-Rishore	0.070019812	0.00029002	207.6972	5956.1126
Rishore-Dewathang	0.006648657	0.00011863	26.88569	839.99939
Road Section	N <sub>2</sub> Ot/yr			
	Car	Minibus	Bus	Trucks
Nganglam-km16	0.007201702	0.00183676	0.000209	0.0066784
Km16-Rishore	0.015469493	0.00043503	0.000238	0.0213353
Rishore-Dewathang	0.001468889	0.00017794	3.08E-05	0.003009

259. With a gross vehicular GHG emission exceeding the 100,000 tonnes CO<sub>2</sub>e/yr and an additional loss in carbon stock from tree cutting, mitigation measures are required by the ADB. To partially off-set these emissions, the Project will implement compensatory plantation at a rate of 1:1, more specifically patches of grassland and degraded forest with a total area of 68 hectares will be converted to plantation forest under the project. The increase in carbon stock



due to change in land use from degraded to plantation forest was estimated following the IPCC procedure:

$$\Delta C_{\text{conversion}} = B_{\text{after}} - B_{\text{before}} \times \Delta A_{\text{to\_other}} \times CF$$

Where:

$\Delta C_{\text{conversion}}$  = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr<sup>-1</sup>

$B_{\text{after}}$  = biomass stocks on land type immediately after the conversion, tonnes d.m. ha<sup>-1</sup>  
= 5.0 tonnes d.m./ha net biomass growth for plantation forest

$B_{\text{before}}$  = biomass stocks on land type before the conversion, tonnes d.m. ha<sup>-1</sup>  
= assumed 0 for grassland

$\Delta A_{\text{to\_other}}$  = area of land use converted to another land-use category in a certain year, ha yr<sup>-1</sup>  
= 68 ha.

$CF$  = carbon fraction of dry matter, tonne C (tonnes d.m.)<sup>-1</sup>  
= 0.47 tonnes C/tonne d.m.

260. The change in biomass carbon stock from re-forestation of grassland to plantation forest is estimated at 159.8 tonnes C/yr

261. Further, the NDH during operations will reduce the travel distance between Nganglam and Dewathang by 103 kms from the Samdrupjongkhar-Tamalpur-Rangia-Patshasala route. This travel distance reduction will translate to lower GHG emission from the diverted traffic. A total of 758 vehicles are expected to divert to the project road each day by year 2029 comprised of 349 cars, 12 buses, and 397 trucks. Using the same procedure, the avoided GHG emissions were estimated at 14.55 tons CO<sub>2</sub>e/yr.

## 2. Air Quality

262. Air quality is affected during construction and operations of roadways.

263. **Construction:** Air emissions during construction arise from the operation of construction vehicles, blasting and clearing of rubble, operation of quarry pits and hauling of materials. Emissions from rock crushing operations, aggregate drying and hot mix plants also degrade air quality. The problem is present wherever construction is taking place in varying degrees, but is generally not so great as to affect regional air quality; however impacts are most severe where there are communities, homes, businesses and institutional buildings in the vicinity of construction that causes local ground level air quality to deteriorate.

264. Mitigation measures are aimed at dampening dust emissions from disturbed soil and roadway construction surfaces and removing operations that contribute to point source emissions from the vicinity of communities. The contractor will be required to regularly water roadway surfaces wherever there are communities (homes, businesses, schools) nearby. The Road segments through Nganglam (takeoff), Drangnalashing Borang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang settlements will need spraying of water to lessen the dust pollution during construction. Spraying will be done twice daily or at such frequency as is needed to minimize impacts. The contractor will provide near complete coverage of these critical sections. For Nganglam-Khalatsho section, water can be collected from Kirungri River, Yargaywoongri stream, Gazawoongri stream and Tsokhiri River. While for Khalatsho – Dewathang section; water can be collected from Tsokhiri, Duri and

Dungsamchhu Rivers. In each section, minimum of 2 water tankers will be deployed for the water spraying activities.

265. Dust and fumes can be further reduced in community areas by regular removal of construction debris and spoil piles, and clean-up after completion of a section; and traffic controls to reduce contact between the public and construction activity. All vehicles transporting materials should be covered properly.

266. All rock crushing, cement preparation, aggregate drying and surface treatment preparation operations (whether bituminous asphalt or spray seal mixes) should be removed a sufficient distance (at least 500m) from habitations and community environments to assure there are no community impacts. Areas where dust accumulates should be watered regularly. Locations for these facilities must be approved by the PMU.

267. All equipments, machinery and vehicles used for the project must be well maintained in order for proper functioning as well as reduction in air pollution.

268. **Operations:** During operations, air emissions from vehicles can affect air quality, with consequent impacts on human health and the living environment. Since these roadways will not bear a heavy traffic load, it is expected that vehicular air emissions during operation will not pose a particular problem. However, it is possible to evaluate the impact based on an assumed traffic volume and worst case meteorological conditions.

269. Emissions of concern are oxides of nitrogen (NO<sub>x</sub>), particulate matter (PM) and hydrocarbons (HC). The SCREEN III model has been used for evaluating effects on air quality.

270. The traffic projections provided in the detailed design report, 2013 was used to estimate the emissions and pollution dispersion of key parameters. The traffic volume at year 2029 or mid-point the project life was taken as representative of the road user activities.

**Table 41: Projected Traffic by Road Stretch, 2029**

Stretch	Length	AADT, 2029					
		Car	Minibus	Bus	Trucks	Total	Veh-Km
Nganglam-Km16	15	554	358	41	407	1359	20386
Km16-Rishore	49	364	26	14	398	802	39297
Rishore-Deothang	4	424	130	23	687	1263	5052
Total	68						64,735

271. Emission factors developed for Indian vehicles were used to estimate NO<sub>x</sub>, PM, and HC emissions. These factors were developed by the Central Pollution Control Board of the Ministry of Environment and Forest, Government of India. The emission factors for cars are applicable to gas-fed passenger cars like the Indica, Ford Ikon, Maruti Swift, Hyundai Getz, Fiat Pailo, Esteem, Hyundai Accent, and Honda City. For buses, emissions applicable for diesel-fed heavy commercial vehicles (HCV) were used representing Eicher (5.9lt), TELCO LP1510 (5.9lt), Eicher 20/16RHP (4.9lt), TELCO 1510 (5.9lt), AL 3, and Comet (6.4lt). Finally for trucks, diesel-fed HCV trucks with engine displacement greater than 6.0lt emissions were used.

272. To assess the emission impacts from the vehicular use, the USEPA SCREEN III model to predict the ambient concentrations of NO<sub>x</sub>, PM, and HC assuming the road as ground released area source with a 1-meter released height. Regulatory options were selected for rural area, report worst-case scenario maximum ground concentration in all directions and full meteorology conditions, automated distance array, and mixing and anemometer heights. The maximum ground concentrations and corresponding distances from the road center lines are provided in Table 43.

**Table 42: Emission Factors, g/km**

Emission Factor	Car	Bus	Trucks
	g/km		
NO <sub>x</sub>	0.09	11.24	9.3
PM	0.002	2.013	1.24
HC	0.12	2.4	0.37
CO	0.84	13.1	6
CO <sub>2</sub>	172.95	817.52	762.39

Source: CPCB/MOEF.

273. Estimated ambient concentrations of the project area are given in Table VII-8 along with WHO and NEC ambient criteria for NO<sub>x</sub> and PM. No ambient criterion is provided for hydrocarbons, which is generally regulated at the exhaust pipe. HC is a reactive mix of hydrogen and carbon atoms that contributes to the production of ozone in the atmosphere. The SCREEN III model estimate shows that ambient concentrations of air pollutants are less than ambient criteria set by WHO and NEC.

**Table 43: SCREEN III Model Results on Maximum Ground Concentration and Distance**

Parameters	Maximum ground concentration (µg/NCM)	Distance from Road Center Line, meter (m)
NO <sub>x</sub>	1.639	51
PM	2.544	
HC	0.313	

**Table 44: Estimated Ambient Yearly Concentrations and Standards (µg/m<sup>3</sup>)**

	NO <sub>x</sub>	PM	HC
<b>Ambient Concentrations</b>	1.639	2.544	0.313
<b>WHO criteria</b>	200-400	150-250	None
<b>NEC criteria:</b>			
<i>Industrial Area</i>	120	200	None
<i>Mixed Area</i>	80	100	None
<i>Sensitive Area</i>	30	75	None

274. These values confirm that the effects of vehicular traffic on ambient air quality along the roadways are minor. Vehicular emissions along the roadway are unlikely to degrade air quality significantly.

### 3. Noise

275. Noise emissions during construction and operation may affect wildlife and community values.

276. **Construction:** Noise impacts originate from the operation of construction equipment in the vicinity of homes, institutional buildings, and stores, and from rock blasting to clear roadbed in hillside areas.

277. 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 45. 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. However, the number of buildings or houses that are likely to be impacted by noise during construction is estimated based on noise/distance relationship mapping using available topographic maps and Google images.

278. During construction, varying degree of noise impacts are likely to be felt by the communities of Nganglam town, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Gazawoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang settlements. The number of houses or buildings that will be exposed to different levels of noise impacts by distances is provided in Table 46. Rishore, Chenari and Dewathang have higher number of houses within 100m of construction zone. Although temporary in nature, the construction noise will affect the most communities living close to the construction zone.

279. 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. Baseline noise will be established for all sensitive areas prior to construction and follow up noise monitoring will be carried out during the construction.

**Table 45: Construction Noise / Distance Relationship**

Distance from Construction Site (m)	Range of Typical Noise Levels (dBA)
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: Dept. of Transportation, State of Wisconsin (USA)

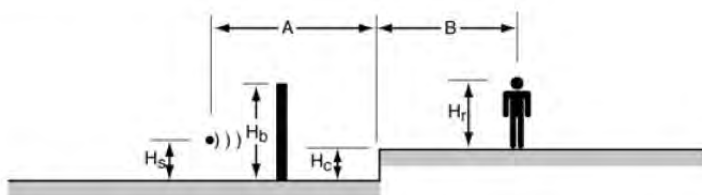
**Table 46: Construction Noise / Distance Relationship**

Settlements	Number of Houses Exposed to Different Noise Levels				
	75-95 dBA at 15m	63-83 dBA at 50m	59-79 dBA at 100m	55-75 dBA at 150m	49-69 dBA at 300m
Nganglam	0	6	6	39	72
Drangnalashingborang	1	13	11	7	6
Dezama	2	5	7	8	8
Shuguri	0	3	1	0	0
Yargaywoong	0	1	0	1	7
Gazawoong	0	0	2	3	0
Chokhorling	1	2	1	5	66

Settlements	Number of Houses Exposed to Different Noise Levels				
	75-95 dBA at 15m	63-83 dBA at 50m	59-79 dBA at 100m	55-75 dBA at 150m	49-69 dBA at 300m
Khalatsho	0	1	1	3	3
Rishore	2	10	3	21	26
Chenari	4	28	12	10	21
Dewathang	11	49	17	23	55

280. As provided in Table 46, predicted noise level in 21 houses in Drangnalashingborang, Dezama, Chokhorling, Rishore, Chenari, and Dewathang could reach 75-95dB(A) which is beyond standards on the assumption of terrain and sound diverges with distance. However, as pointed in the report most of the receptor houses are not located at the same plane as the vehicular noise sources which will allow the ground to attenuate noise as illustrated below:

Example 2: Receiver elevated



$$\text{For } H_b \geq H_c,$$

$$H_{eff} = \frac{H_s + 2H_b - H_c + H_r}{2}$$

$$\text{For } H_b \leq H_c,$$

$$H_{eff} = \frac{H_s + H_c + H_r}{2}$$

Source: FTA (2006). Transit Noise and Vibration Impact Assessment

281. Installing a noise barrier with a height  $H_b$  along the road shoulder will not matter if it is lower than the adjacent ground level  $H_c$ . At a 15m distance from the road centerline, a 2-storey house (12m) located on an elevated ground of 3m and using the following equations, a noise level of 102dB will be attenuated to 67dB with or without the noise barrier. At this level, there will be no impact on institutional land uses and moderate impacts on residential structures where people normally sleep.

#### Ground Factor

For soft ground:

$$G = \begin{cases} 0.66 & H_{eff} \leq 5 \\ 0.75 \left( 1 - \frac{H_{eff}}{42} \right) & 5 \leq H_{eff} \leq 42 \\ 0 & H_{eff} \geq 42 \end{cases}$$

$L_{dn}$  or  $L_{eq}$

$$= (L_{dn} \text{ or } L_{eq})_{at 50 ft} - 20 \log \left( \frac{D}{50} \right) - 10G \log \left( \frac{D}{50} \right) \quad \text{for stationary sources}$$

$$= (L_{dn} \text{ or } L_{eq})_{at 50 ft} - 10 \log \left( \frac{D}{50} \right) - 10G \log \left( \frac{D}{42} \right) \quad \text{for fixed-guideway rail car passbys}$$

$$= (L_{dn} \text{ or } L_{eq})_{at 50 ft} - 10 \log \left( \frac{D}{50} \right) - 10G \log \left( \frac{D}{29} \right) \quad \text{For fixed-guideway locomotive and rubber-tired vehicle passbys, highway vehicle passbys and horns}$$

282. Similarly, construction noise is likely to impact the sensitive buildings and their occupants along NDH. Sensitive buildings falling within different construction noise zones are provided in Table 47. The details of noise impacts and possible mitigation measures for sensitive receptors are provided below:

283. Gesar Dala Lhakhang/ temple at Dewathang lie within 15m of construction zone. There will be noise some impact on the temple and its occupants but it will be for short duration as there are no major earthworks and excavations are required. Only about 1-2m widening will be carried out. In addition, construction works will be carried out from 8am-5pm to lessen noise pollution.

284. Dewathang Army hospital lies within 50m of construction zone. Under normal flat surface condition, it is expected that noise level of 63-83 dBA will be felt by the occupants during the constructions. However, hospital is located on the ridge top while the proposed highway construction will be carried at more than 20m downslope. The side slope act as a natural noise barrier. Nonetheless, construction activities will be restricted between 8am-5pm to further minimize the noise impacts.

285. Dewathang Primary School falls within 100m of construction zone. Under normal flat surface condition, it is expected that noise level of 59-79 dBA will be felt by the school children and others during construction. However, school is located on the higher slope than the proposed highway construction. There is about 20-30m height difference between school and the proposed highway construction site. The side slope act as a natural noise barrier. Further, to minimize noise impacts, the construction works (particularly operation of Excavator and other machineries) near the school will be carried out mostly during school off-hours (7am-9am and 3.30pm-7pm) and on holidays (Saturdays & Sundays).

286. Thujaycholing Lhakhang/temple at Chokhorling falls within 50m of construction zone with the expected noise level of 63-83 dBA to be felt under normal flat surface conditions. Since the proposed highway is located about 30-45m downslope; the construction noise impact will be limited as the side slope will act as a natural noise barrier. Construction activities will be carried out from 8am-5pm to minimize the noise impact.

**Table 47: Construction Noise / Distance Relationship**

Settlements	Sensitive Buildings Exposed to Different Noise Level				
	75-95 dBA at 15m	63-83 dBA at 50m	59-79 dBA at 100m	55-75 dBA at 150m	49-69 dBA at 300m
Nganglam	-	-	-	-	Pry School +BHU
Drangnalashingborang	-	-	-	-	-
Dezama	-	-	Lhakhang	-	-
Shuguri	-	-	-	-	-
Yargaywoong	-	-	-	-	-
Gazawoong	-	-	-	-	-
Chokhorling	-	Lhakang	-	-	-
Khalatsho	-	-	-	-	-
Rishore	-	-	-	-	-
Chenari	-	-	-	-	-
Dewathang	Lhakhang	Hospital	Pry School	-	Polytechnic

287. Saltlick area is the most sensitive site in the project area, as it attracts wildlife, both from within Bhutan and across the border from India, for mineral or salt lick. The impact of noise on wildlife visiting saltlick will be minimal as it is located more than 400m away from the proposed highway, at the base of Regi Landslide, roughly at an elevation of 400m above sea level. The proposed highway will pass through the saddle above the Regi land slide at an elevation of

more than 630m above sea level; on the other face of the same mountain slope. In addition to this, the thick vegetation, deep gullies and ridges in the area will act as natural noise barriers, limiting the noise travel and thereby noise pollution; unlike in the plain areas.

288. Rock blasting to clear right-of-way is also a noise and safety hazard. Rock blasting will be required for road segments, between Yargaywoong to Chokhorling; Chokhorling to Khalatsho, saddle above Regi slide to Duri area. There will be considerable on impact on human and wildlife alike as a result of blasting. Therefore, the contractor will prepare a blasting procedure requiring area restrictions; prior warning of workers, and the cattle herders and others passing through the area; restrictions on the timing of blasts; and worker safety procedures. The blasting activities will be carried out strictly during the daytime (8am-4pm) to prevent disturbance to wildlife during the night, dawn and dusk. The contractor shall employ blasters experienced in controlled blasting recognized by MOWHS. The purchase, transport, storage and use of explosive shall be carried out in accordance with Blasting Manual (Reini Schramli, 1999), which is available at Ministry of Works and Human Settlement (MoWHS) and the Explosives Rules issued by the Ministry of Home and Cultural Affairs (MoHCA). Total controlled blasting will be exercised. Blasting will be minimized within the wildlife habitats.

289. **Operations:** During operations, noise emissions disturb community life and the living environment. Noise impacts from vehicles travelling along these roadways are not expected to be significant due to the light traffic loads and low density of settlements. The traffic volume shown in the Table 48 is used for purposes of noise prediction:

**Table 48: Recommended bioengineering methods**

<b>Traffic Data (Vehicles/hr)</b>	
Automobiles	25
medium trucks	10
Heavy trucks	5
Speed	40 km/hr

290. Noise ratings for these vehicles were taken from the International Institute of Noise Control Engineering (2001)<sup>16</sup> developed for motor vehicles in German constant-speed urban traffic measured in three years is presented in the succeeding Figure. For automobiles, medium trucks, and heavy trucks the noise ratings are 77 dBA, 87 dbA, and 90 dBA, respectively.

291. At worst case scenario, it was assumed that peak noise will be generated when one of each vehicle type are using the a specific section of the road, Using the formula:

$$L = 10 \log_{10} \left( \sum_{i=1}^n 10^{(L_i / 10)} \right)$$

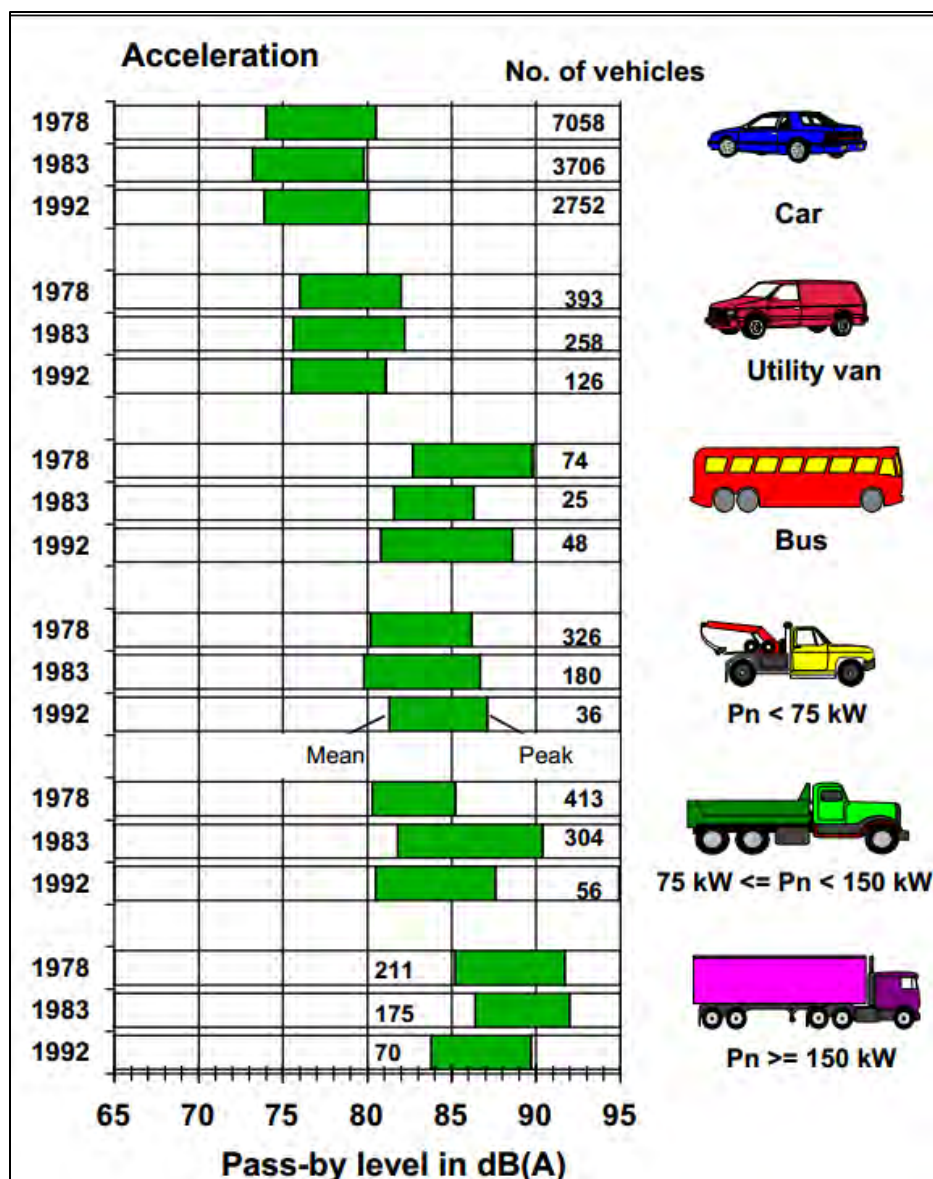
Where L = predicted noise level

Li= rated noise rating

**Figure 33: Noise rating of various road vehicles**

<sup>16</sup> Ulf Sandberg (2001). "Noise Emissions of Road Vehicles Effect of Regulations Final Report 01-1." Institute of Noise Control Engineering Working Party on Noise Emissions of Road Vehicles (WP-NERV). Swedish National Road and Transport Research Institute.





292. The predicted noise level was 91.9 dB(A) which is high enough to cause annoyance to majority of the population. However, with the same condition as presented in the construction phase assessment, this will reduce to 60.9 dB(A) on an elevated receptor 30 me away from the road.

#### 4. Soils and Tectonics

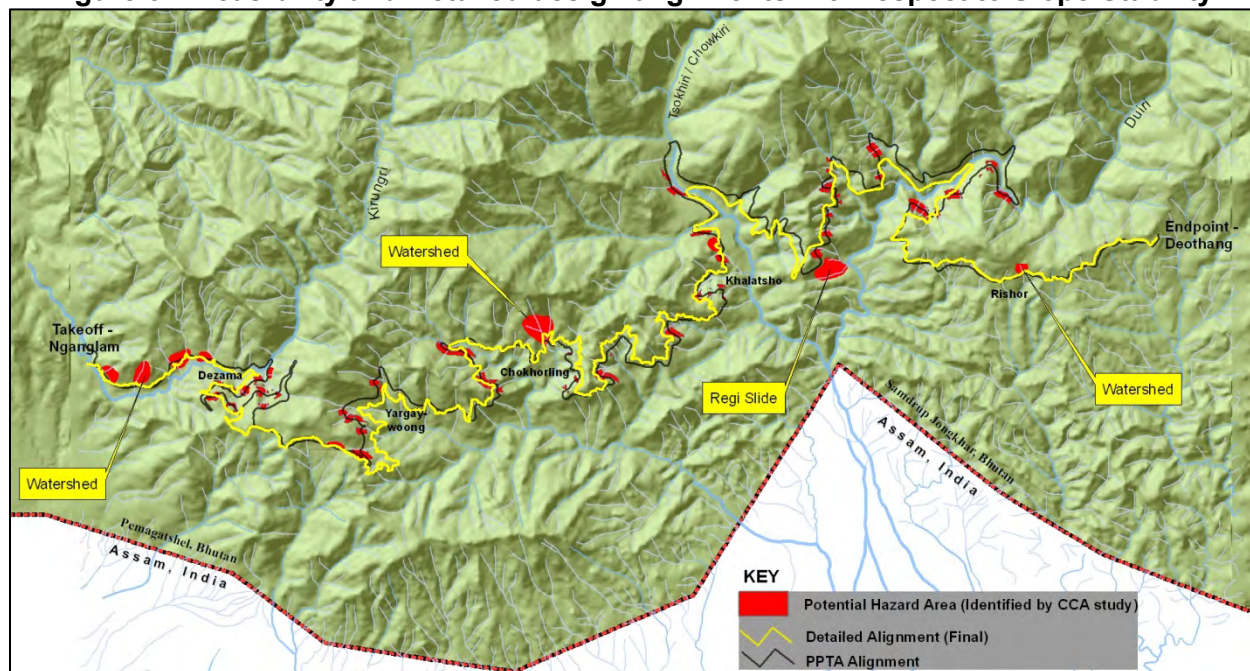
293. Impacts on the soil environment occur from a number of causes during the detailed design, construction and operation stages of the roadways.

294. **Detailed Design:** The project road falls inside high rainfall and weak soil and geological zones coupled with climate change effects (extreme temperatures and rainfalls), the likelihood of landslides and erosion are high both during construction and operation stages. Hence, Environmental Friendly Road Construction (EFRC) methods to minimize landslides and enable slope stability have been built into the design.

295. In accordance with EFRC guidelines, the cut and fill method requiring balancing of mass has been adopted in detailed design. However, the road construction in the mountainous terrain is highly challenging particularly the safe disposal of construction spoils. Detailed design study has identified the potential spoil disposal sites at chainages 0+650, 0+850, 4+500, 8+100, 11+250, 12+200, 14+500, 16+250, 20+000, 24+500, 25+250, 27+250, 29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500.

296. A number of bioengineering techniques can be used to stabilize soils both during construction and for finishing slopes for long range operational integrity. These techniques consist of benching, grading and seeding slopes, use of petroleum (plastic) or natural fiber geotextile fabrics, and tree planting, and their use is applicable throughout the project area in varying degrees. Further the Field Handbook of Bioengineering produced by DoR is referred to while proposing bioengineering methods for specific road segments. The unstable slopes that were been identified during feasibility study have been avoided wherever feasible to minimize the further slope instabilities (Figure 34).

**Figure 34: Feasibility and Detailed design alignments with respect to Slope Stability**



297. For areas that are particularly wet or marshy; with the likelihood of increased erosion and problems of slope failure both during construction and operation, an appropriate drainage structures (trapezoidal drains) as well as mechanisms such as horizontal drains taking into account of extreme rainfalls is considered in the detailed design works.

298. Sites for carrying out bioengineering and engineering applications have been assessed during detailed design study. The bioengineering applications such as direct seeding, broadcasting, brush layering, hedge brush layering, live staking/palisade, planting with wildlings, sodding/turfing, planting with seedlings and wooden fencing are proposed to mitigate slope failure, stabilize slope and drain the water seepage and marshy area in locations provided in Table 49. Only the native plant species are proposed to be used for bioengineering works.

**Table 49: Recommended bioengineering methods**

Chainage	Bioengineering method	Botanical name	Local name
0+500, 4+250, 6+500, 7+250, 8+000, 0+850, 12+000, 15+500, 20+000, 23+200, 28+200, 34+000, 55+250, 60+100, 64+000, 66+500,	Planting of wildings	<i>Morus laevigata</i>	<i>Tshende</i> (Dz <sup>17</sup> ); <i>Kimbu</i> (Lh <sup>18</sup> .)
		<i>Altingia excelsa</i>	<i>Jhikri</i> , <i>Seti kath</i> (Lh.); <i>Ding shing</i> (Sh.)
		<i>Albizia lebbeck</i>	<i>Khirdang- laishing</i> (Sh <sup>19</sup> .); <i>Laa siris</i> (Lh.)
		<i>Ficus semicordata</i>	<i>Barchongma</i> (Sh.); <i>Khaneo</i> (Lh.)
		<i>Michelia champaca</i>	<i>Champai-shing</i> (Sh.); <i>Chanp</i> (Lh.)
12+000, 28+100,	Turfing	<i>Phoebe golparensis</i>	<i>Sechanglo-shing</i> (Sh.); <i>Bonsum</i> (Lh.)
6+500, 7+250, 8+000, 0+850, 12+000, 15+500, 17+500, 20+000, 23+200, 28+200, 34+000, 55+250, 60+100, 64+000,	Live Staking	<i>Erythrina arboresens</i>	<i>Kharshing</i> (Sh); <i>Phaledo</i> (Lh.)
		<i>Erythrina stricta</i>	<i>Kharshing</i> (Sh.); <i>Phaledo</i> (Lh.)
0+850, 12+000, 15+500, 17+500, 23+200, 28+200, 34+000, 60+100, 64+000, 67+500,	Palisades	<i>Justicia adatoda</i>	<i>Khatsirim</i> (Sh.)
		<i>Viburnum erubescens</i>	
		<i>Bridelia retusa</i>	<i>Gayo</i> (Lh.)
6+500, 7+250, 8+000, 0+850, 12+000, 15+500, 17+500, 20+000, 23+200, 28+200, 34+000, 55+250, 60+100, 64+000,	Seed broadcasting	<i>Duabanga grandiflora</i>	<i>Drangnanglaishing</i> (Sh.); <i>Lampate</i> (Lh.)
		<i>Artemisia sp.</i>	<i>Titepati</i> (Lh.) <i>Khempa shing</i> (Dz.)
0+850, 12+000, 15+500, 17+500, 28+200, 34+000, 55+250, 64+000,	Brush Layering	<i>Callicarpa arborea</i>	<i>Khalema</i> (Kh.); <i>Guinle</i> (Lh.); <i>Thulushing</i> (Sh.)
12+000, 28+100, 66+500, 67+000	Turfing	<i>Dendrocalamus hamiltonii</i>	<i>Bans</i> (Lh.); <i>Bamboo</i> (Eng <sup>20</sup> )
25+000, 28+120, 29+200, 67+000	Planting of slip	<i>Thysonolaena maxima</i>	<i>Tsakusha</i> ; <i>Beshawi</i> (Sh.)

Source: Detailed design Survey, 2013

299. **Construction.** The roads will mostly be cut into the side slopes of mountains ranging from 35° to 80°; hence the zone of construction is constricted in terms of access and disposal of spoil material. Impacts in the form of landslides and erosion may occur due to cutting and excavation of the roadbed, on the upslope from barren rock or loosely held conglomerate materials that are variably stable during construction and shall be removed sufficiently to provide clear space for the roadbed and working shoulders and to assure stability over the long term period of use. The surplus spoils from roadway cutting shall be disposed off in the pre-identified dumpsites at Km 0+650, 0+850, 4+500, 8+100, 11+250, 12+200, 14+500, 16+250,

<sup>17</sup> Dz – Dzongkha (Bhutan's National language)<sup>18</sup> Lh – Lhotshamkha (Dialect of southern Bhutan or Nepalese language)<sup>19</sup> Sh – Sharchopkha (Dialect of eastern Bhutan)<sup>20</sup> Eng - English

20+000, 24+500, 25+250, 27+250, 29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500. Down slopes shall also be stabilized to maximum possible extent; however, in area where slope is greater than 60%, construction debris will inevitably fall downhill. Likely debris fall places are between chainages Km21 to Km23, Km33 to Km36, Km50 to Km56 and km58 to Km60. Experiences from the past and ongoing ADB assisted Road Network Project show that at least 60-70% of construction debris from the first cut will be lost downhill in a steep area with slopes more than 60%.

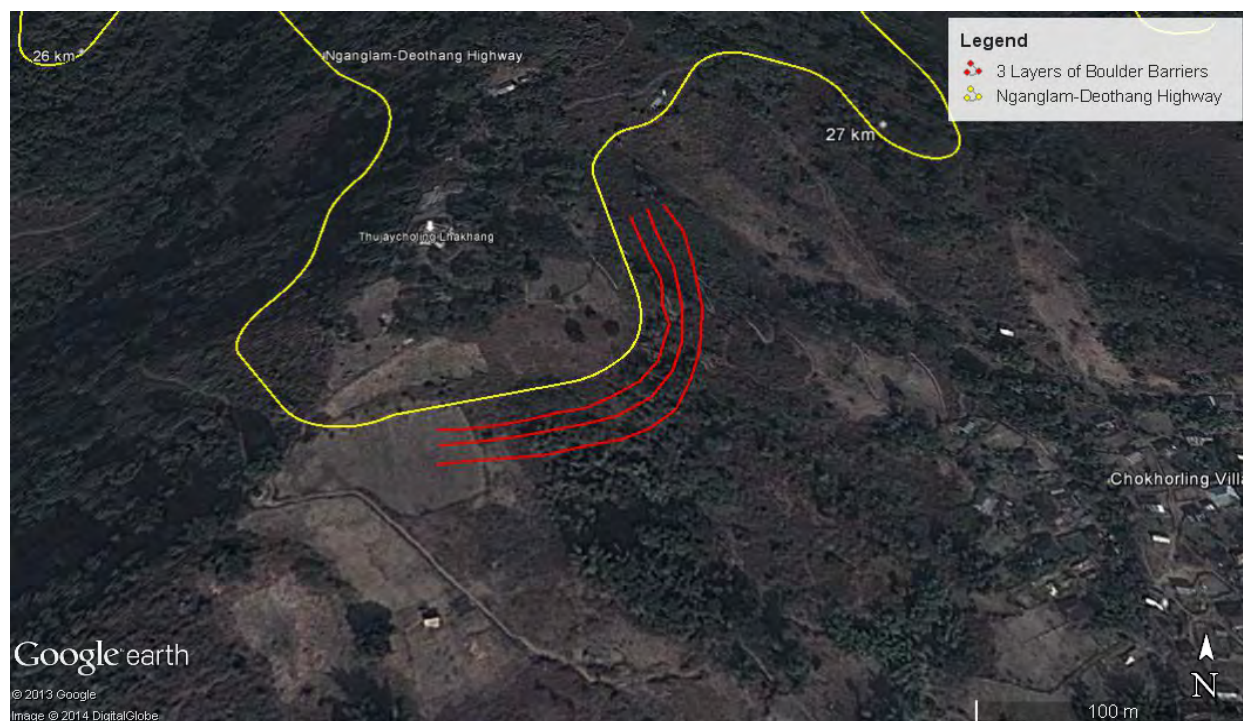
300. The slope failures and rock falls downslopes during earthworks and excavations would damage private properties; cause accidents and injuries; damage vegetation; harm wildlife; and cause siltation of downstream water bodies; thereby damaging an aquatic ecology. Chokhorling village is likely to be impacted most, as the proposed road passes through the upper slopes of the village. Unregulated or haphazard construction practices would cause the construction debris to fall downhill resulting in damage of houses, farmlands and cause injuries and accidents to human and animals alike. To minimize or avoid human accidents and damages of village properties at Chokhorling; a 1mx1m gabion catch wall over 200m long is proposed to be constructed prior to the start of road construction. Similarly, in other areas (including an important wildlife habitat of Regi area), boulder or log barriers will be constructed below the road to minimize or avoid damages wildlife habitat and private properties. In the event of accidents and injuries due to falling debris, contractor will take full responsibility of evacuating the injured to the nearest medical center. The contractor will also be liable for the payment of appropriate compensation including the medical expenses.

301. Although there will be no use of borrow area for NDH construction due to presence of excessive excavated material. However, under certain circumstances, if use of borrow areas is necessary than it will result in formation of open pits. This can lead to issues of erosion. Hence, after use of borrow areas; it will be properly restored by filling with unwanted material generated from the construction works. The top soil of the borrow area must be kept aside and reused to seal the borrow areas at the end of its use. Bioengineering works will be carried out for slope stabilization.

302. Construction material particularly sand will be either imported from neighbouring Indian state of Assam or will be quarried from Yangbari which is 32km from Nganglam. The haulage of sand from these areas will degrade existing road conditions and generate air pollution impacts along the haulage routes. Potential stone quarries are identified during detailed design near Dezama, Kirungri, Muru ri and Khalatsho area. Establishing quarries close to settlements and failure to properly grade and contour a quarry location at closure leads to potential hazard from personal accident or slope failure. This can also result in adverse impacts on the drainage in quarry areas.

**Figure 35: Gabion catch walls or Boulder Barriers proposed at Chokhorling village**



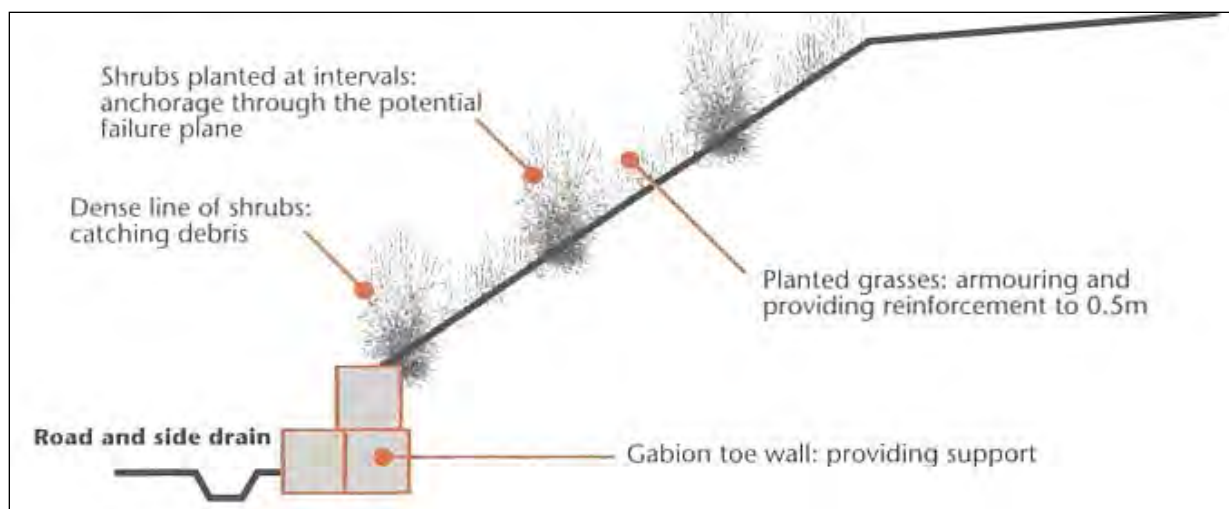


303. The need for stone quarries shall be minimized as far as possible by using the materials cut from the roadway alignment. In the event that quarries are required in a particular area, the contractor along with the supervision consultant will carry out detailed investigation of identified quarries. A development plan shall be prepared by the contractor that estimates approximate quantities and final contours. Blasting procedures shall be put into place for the development of quarries. Necessary government clearances (particularly from Department of Geology and Mines and National Environment Commission) for land and resource use shall be obtained by the contractor prior to commencement of work in the area.

304. **Operations:** Instabilities and landslides will be major concern along the proposed NDH; therefore, the Environmental Friendly Road Construction (EFRC) Concept has been incorporated into the detailed design of the project. Figure 36 provides a sample bioengineering concept that will be implemented during NDH construction. EFRC method and techniques for excavation and earth works with provision of adequate support and drainage structures will minimize or prevent problems of erosion and landslides during operation. In addition maintenance engineers shall develop and apply means for predicting slope failures in advance and buttress slopes where necessary.

305. Soils also affect roadway durability and life. Slumping of the roadbed is known to occur in locations throughout the country. Climate change induced extreme heat and intense precipitation will further aggravate the situation. The good engineering practices by providing horizontal drains across the sub-grade to relieve pore water can increase the soil stability. This engineering solution will be applicable where there is excessive soil moisture and underground seeps; particularly along marshy slopes of Shuguri.

**Figure 36: Hypothetical Site Requiring Civil and Bioengineering Work**

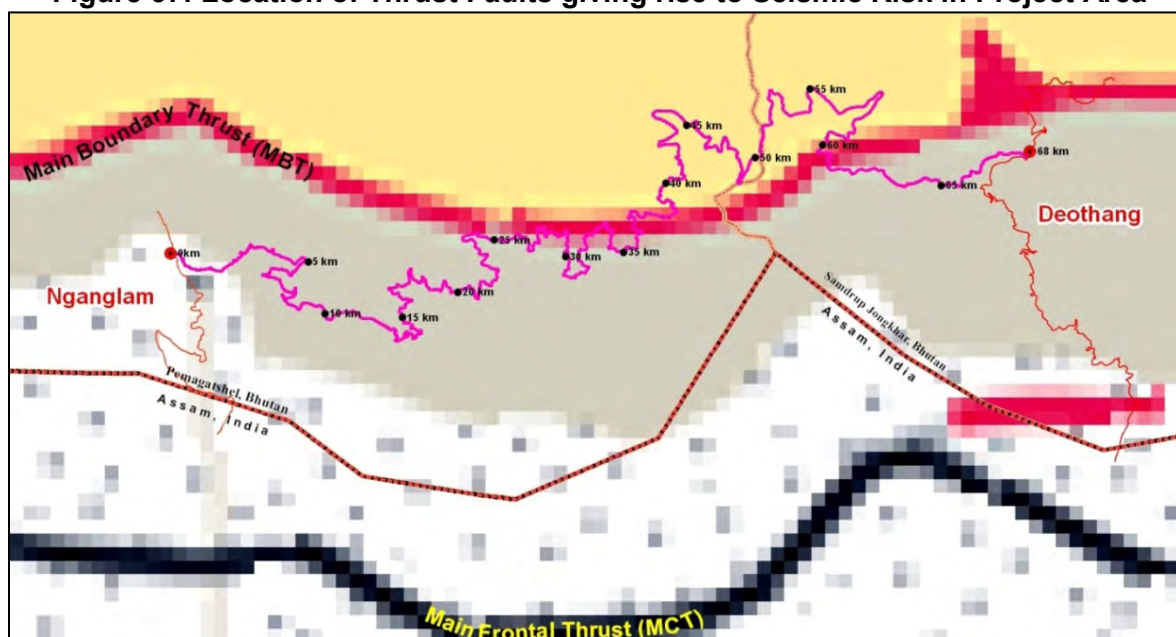


Source: Roadside Bioengineering, Department of Roads, HMGN

306. Bioengineering techniques applied during the construction will become effective over the operations period of the project. It is likely that some of the techniques proposed may not work or the plants used may not regenerate as expected. To avoid this, the freshly planted seedlings and other plant material will need to be monitored and necessary steps will need to be taken to maximize plant growth. Immediately replacement of plants that do not survive will need to be made.

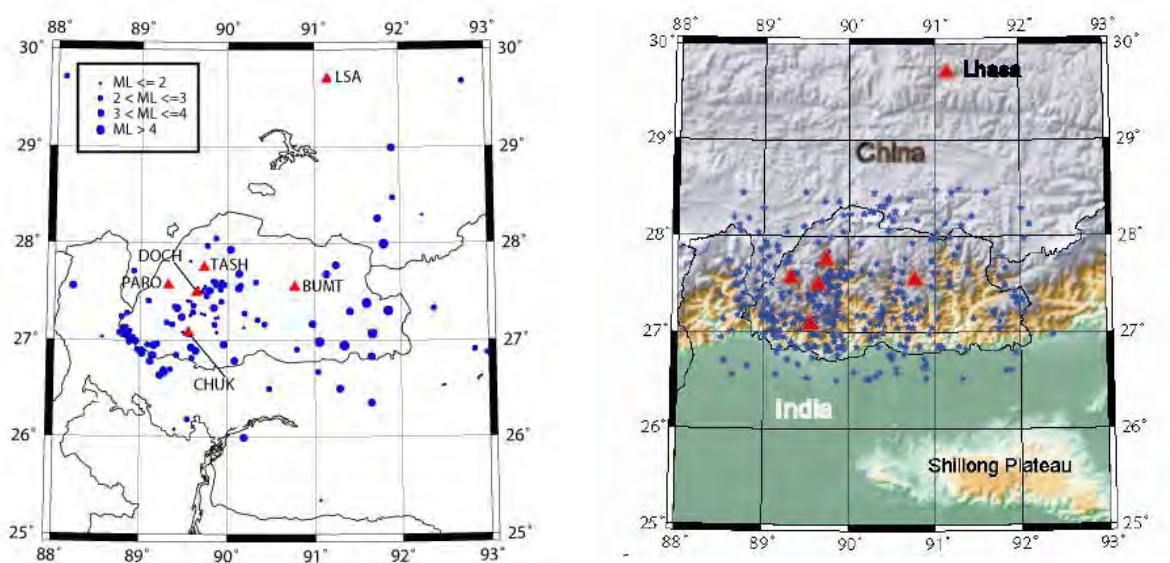
307. Over the long term, seismic events may cause damage to the roadway and adjacent property, and result in loss of life. The risk of earthquake is ever-present in Bhutan and criteria must be applied to determine whether a given location is acceptable. The road segment is located close to major fault zone, a main boundary thrust fault as shown Figure 37.

**Figure 37: Location of Thrust Faults giving rise to Seismic Risk in Project Area**



**Figure 38: Seismic Event Record for Bhutan**

(left: Gee, 2004; right: Univ. of Texas El Paso) from Tobgay, undated



308. Seismic risk is said to be greater in the eastern side of the Country, and perhaps greater toward the south.

309. Seismic even though actual recorded events are more populated toward the west (though still to the south, see Figure 38). Hazard maps show the 10% probability of exceedance in 50 years (e.g. a 475 year return period) for peak ground acceleration equal to the hazard ranking in m/sec, for example, a ranking of '4' is equal to 4 m/sec peak ground acceleration. The overall project area falls within hazard zones 3 (high risk).

310. Risks have been identified from field investigations include rapid and severe ravine development that transports debris and gravel down steep hillsides causing landslide such as huge Regi slide. Earth tremors, geology and bedding of rocks in the area and dispersive soils may be the causes.

311. Earthquake risk is incorporated into the detailed design of structures. Bhutan does not have its own earthquake structural code; however for the border areas, the adjacent Indian Roads Congress (IRC) standards are used by the DoR. Analysis programs used for geotechnical design of high embankments, cut slopes and foundations incorporate both vertical and horizontal accelerations. Special measures to improve stability may include soil nailing, use of mesh/shotcrete, horizontal drains, bioengineering and gabion walls. These methods have been successfully applied in the geotechnical design of the Rural Access Project implemented by DOR with the technical and financial assistance from World Bank, in a location with similar geotechnical conditions.

## 5. Water Resources and Water Quality

312. Effects on local drainage, river flow and water quality can occur during construction and during the operation of roadways. Inadequate drainage may undermine the performance and long term durability of road surfaces and foundations. The impacts may be further aggravated by the climate change induced extreme/intense rainfalls beyond the capacity for the structures cope with.



313. Construction activities may also interfere with access to water supplies and roadway hydraulic structures may be inadequate to cope with heavy storm water discharge. Flow of water mobilizes sediment that can degrade downstream water quality and potentially cause temporary damming and subsequent flooding of the adjacent land.

314. A complex relationship exists between the road and the water environment that must be mutually accommodated to guarantee the integrity of the road structure and avoid impact on the water resource.

315. **Detailed Design:** Nganglam-Dewathang road falls under high rainfall zone with total annual rainfall of nearly 4000 mm per annum. The climate change is expected to bring about extreme precipitation and flooding which will lead to blockage of surface drains and damage the pavement surfaces. It will also cause edge fraying, a safety hazard and eventual failure of the road surface. The impact could be felt over whole road section including settled area namely; Nganglam, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang. The critical section lies between Km3-Km9, where the road passes Dezama and winds on the slopes of Shuguri on the left bank of Kirungri River.

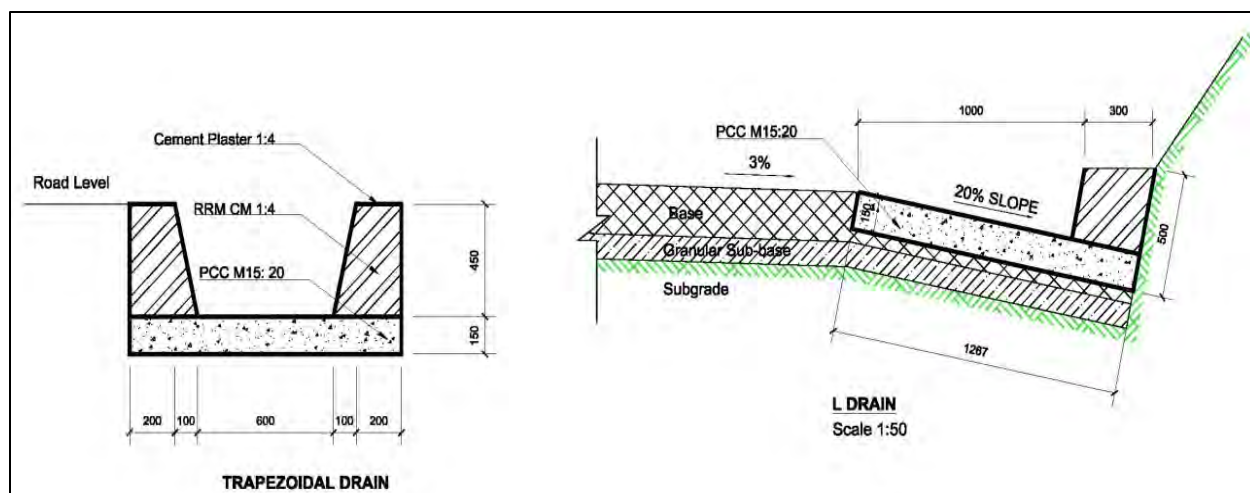
316. Therefore, the design of roadside drainage in community areas and other critical areas have been given utmost attention to assure that the roadway surface does not concentrate rainfall and cause damage to local properties and the side slopes. Engineering and hydrological criteria have been applied in the design of drainage structures. In addition, the detailed design has also incorporated the following climate change adaptation (CCA) measures:

317. Using the sheet flow or discharge estimation methods, storm water flow was estimated and accordingly side drains were designed. About 42000m of Trapezoidal drain is designed and now proposed to be constructed in all high storm water discharge areas (including settled area) and about 26000m of L-Drain is proposed in a comparatively less discharge area. Further, under CCA application, the profile for L-Drain has been improved (from traditional slope of 15% to 20%) for better discharge. Figure 39 provides trapezoidal and L-drain designs adopted for NDH.

318. Around 58 numbers of Box culvert with diameter 3-5m width and 288 numbers of Hume pipe with diameter greater than 900mm is proposed to be constructed as relief cross drainage to prevent blockage and flooding. The cross drainages are designed and proposed based on 50 Year ARI (storm return period) as recommended by the hydrological study for bridge and culvert design.

319. High intensity or continuous precipitation over a period has potential to trigger material slides. Historically there has been a clear correlation between adverse weather events and landslides, and it is likely that the future will be the same. The geotechnical assessments show the presence of number of landslide or slope failure vulnerable areas which could be triggered by extreme precipitations as result of climate change. Shuguri unstable area and active Regi slide are the major ones. Regi slide located between Km 49-Km50 is avoided by realigning the road section that once pass through top of the slide.

**Figure 39: Trapezoidal and L-Drains Designs adopted for NDH**



Source: Detailed Design Report, December 2013

320. **Construction:** Earthwork, excavation and indiscriminate disposal of spoil could damage the fragile mountain slopes and increase the slope instabilities. The slope instabilities, and subsequent failures coupled with soil erosion, triggered due to heavy rainfall during monsoon; will cause chain of induced impacts on the natural and the man-made environment. The sedimentation of downstream water bodies will damage aquatic habitat and agricultural farm lands. The impact will be trans-boundary in nature as all the rivers and rivulets from the project area flow towards the plains of Indian state of Assam.

321. To minimize or avoid the induced impacts, the recommended designs and structures proposed under the detailed design will be implemented during the construction stage. The contractor will implement water and slope management through civil and bioengineering applications. 42000m of lined trapezoidal drains will be constructed in all critical areas with high storm water discharge and along the settlements of Nganglam, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang. 26000m of lined L-drains will be constructed in less discharge areas particularly along the alignments on ridges and hilltops. 58 Nos of Slab culverts with 3-5m span will be built on streams with high discharge volume. 288 Nos of Hume Pipes with diameter greater than 900mm will be constructed as relief cross drains to accommodate the increasing intensity of rainfall. Cross drains will be placed along the natural gullies to prevent damages of downhill vegetation; and land private properties.

322. Construction activities increase loss of soil from surfaces exposed to rain and flowing water, increasing sediment loss to rivers and streams. Slope erosion occurs during rainy periods in vulnerable areas. Land clearing and excavation will be stopped in rainy days. Overall the construction works carried during dry seasons from late September till May.

323. Temporary measures to reduce erosion involve placement of log or stone barriers at the base of slopes in accordance with recommended EFRC construction methods provided by DoR. This will on one hand prevent disruptions and formation of temporary dams in the streams and rivers and on the other hand reduce resultant visual scars on the topography.

324. Long term mitigation involves application of civil and bioengineering techniques such as seeding and stabilizing slopes, in order to reduce sediment loss and minimize the induce

impact. Costs for sediment control during construction has been incorporated into the detailed budget estimate and incorporated into the contract bid.

325. Operation of equipment storage and repair facilities and fuel depots can lead to improper disposal of oily waste and fuel spills. Poor housekeeping in equipment and supply yards causes soil and water pollution. The contractor is responsible for installing secondary containment around fuel tanks and at fuelling stations, and for prevention of oil and fuel spills from equipment repair and refueling operations.

326. **Operations:** It is imperative to implement the mitigation measures (including climate change adaptations) proposed during the detailed design stage while constructing the NDH to minimize negative impacts on the water resources during operation of the road segments. Without proper mitigation measures, heavy rainfall will cause flooding; plugging of drains and cross drains; and ultimately damage the road surface; cause erosion and siltation of downstream water both within Bhutan and across the border in India.

327. Appropriate civil structures and bioengineering application during construction will prevent erosion and slope failures that will in turn check downstream siltation and flooding. Construction of check dams particularly on fast flowing mountains stream will reduce the flow velocity and thus prevent damage road structure and slope failures. The installation of check dams will be based on site conditions as identified by the site engineer.

328. Further, during operations, as recommended by the climate change study, a regular and timely maintenance of side drains; removal of debris from culverts; cleaning and protecting bridge foundations; repairing or constructing slope protection structures; and application of bioengineering will prevent slope failure and erosion.

329. Long term issues of heavy metal or oil contamination from road run off is expected to be minor due to the minimal traffic. However, incase of oil spills or other forms of pollution related to road accidents, procedures have been laid out under the emergency response plan in section F of this chapter.

## **C. Biological Environment**

### **1. Forests**

330. The Dzongkhags encompassing the roadway alignment are mostly forested. Hence, it is unavoidable that forests will be displaced in order to provide locations for the roadways, and as a result natural habitats will be lost. Road Act specifies a right-of-way width of 100 ft (32.5 m) for highway; however it is estimated that clearance of a 15 m width for roadway construction will be sufficient at many locations. Vegetation cover along the roadway alignments is derived from the land use maps shown in Figure 26I.

331. **Detailed Design and Pre-Construction:** The clearance from DoFPS is one of the important prerequisites to obtain an Environmental Clearance from the National Environment Commission of Bhutan. About 9700 trees will be removed prior to the construction of NDH. DOR will carryout tree marking in accordance with the forestry rules before felling of trees for the project. All paperwork and approvals will be obtained well ahead in time to prevent delays in construction.

332. Clearing marketable timber prior to construction will be done to assure the process is kept transparent and revenues are used for legitimate purposes. Where there is a potential for a net gain from harvesting trees in the right of way, the DoFPS will prepare a survey and inventory of the commercial timber present on public lands prior to construction of any given road segment, in accordance with the official procedures of the DoFPS as contained in the Forest and Nature Conservation Rules of Bhutan (2006). In locations where there is financial justification, the marketable timber will be handed over to Natural Resources Development Corporation Limited (NRDCL), the authorized Government Agency, prior to mobilizing construction in a given area.

333. Right-of-ways will be clearly marked to avoid removal of vegetation unnecessarily. Felling of tall, matured and fruiting trees will be damage the nesting and food sources of Rufous necked hornbills (*Aceros nepalensis*). Prior to the tree felling, Environmental and Wildlife specialists (WS) will conduct survey and record tall fruiting trees particularly the ficus trees along the ROW. Felling of fruit trees will be prohibited until and unless it is totally unavoidable. In addition felling of trees will be restricted to the dry winter season after the wildlife have migrated to the plains to avoid interfering wildlife activities in the mountainous areas during the summer season..

334. To prevent disposal of spoil materials on the lower slope below the roadway grade and hence destruction of forests and vegetation preliminary locations; spoil will be transported to the pre-identified dumpsites with the consent of the construction supervision consultant (CSC).

335. **Construction:** A total of about 167 acres of forest will be displaced for the project roads out of a total land area of about 237 acres to be cleared area (see Table V-5). As per Land Cover and Area Statistic 1997 of MoAF, Pema Gatshel Dzongkhag had only about 53% of its land area (518km<sup>2</sup>) under forest cover. However, the recent statistics (NSB's Statistical Yearbook of Bhutan 2011) show the mark increase of forest area from 53% to 87.7% over the period of 15 years. Similarly, Samdrup Jongkhar had only about 76% of its area (2308 km<sup>2</sup>) under forest cover which increased to 86.9% over the same duration. These could be attributed mainly to ban of widely practiced shifting cultivation, rural-urban migration and resettlement program carried out by the RGoB in 1990s. Placement of the roadways results in small percent of reduction in existing forest cover.

336. The magnitude of impact is judged to be moderate, and Government rules do not require any offset measures involving planting of trees elsewhere. Still, a budget for compensatory planting of trees is provided in the project allocation. The official procedure for assuring that the Government obtains economic value from the timber should be enforced. Trees and other usable wood products shall be marked by the staff of Department of Forest and Park Services (DoFPS). After the marking of trees is completed, it shall be handed over to Natural Resources Development Corporation Limited for extracting prime logs and disposal of logs in local markets through auction.

337. Following the removal of marketable timber, the construction contractor will be responsible for clearing unmarketable trees and brush remaining in the construction right-of-way, and will obtain the necessary government permit for cutting the remaining trees and clearing the land at the time construction begins in the particular area.

338. Clearing of forested right-of-ways in anticipation of road construction may extend into adjacent forests causing loss of habitat, which adds to the total amount of forests lost due to the project. A significant impact occurs if trees are unnecessarily removed outside the boundaries of

the construction zone. Rights-of-way will be demarcated before clearing begins, and the DoFPS will clearly mark and delineate trees requiring removal, as is their current practice. Re-vegetation or compensatory plantation (using species mentioned in the appendix E) of the fresh cut slopes and road shoulders will be carried out immediately after construction works in each road segment. This will help to regain loss of vegetated areas from the clearing and cutting works. In addition compensatory tree plantations will be carried out in suitable spaces particularly at Drangnalashingborang, Shuguri, Chokhorling watershed areas, Khalatsho, Rishore, Chenari and Dewathang. Any organized removal of trees from public lands outside the boundary of the construction area shall be punishable as a criminal offense.

339. Cut of slopes need to be justified through analysis and experience. Widening of the standard width of right-of-way should be approved by the PMU supervisor. Disposal of spoil materials and any other forms of construction debris over the edge of the hillside is prohibited (unless unavoidable in slope greater 60%), and spoil materials are to be disposed off at designated locations, as determined during the detailed design phase prior to the commencement of construction on any given road segment. The Contractor is responsible for prohibiting the removal of trees where such removal is unnecessary for the construction of the roadway.

340. During construction, the importation of workers can lead to further forest destruction. Construction activities displace forest and natural habitats. Workers confined to construction camps may fish, hunt, cut trees and gather firewood that lead to the destruction of local biological resources. They may destroy rare and threatened and endangered plants, herbs and medicinal plants, endemic plants, and a plant listed in Schedule I of FNCA 1995 (Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*)). While the degree of impact is difficult to predict, forest resources abound and impacts can be expected to occur in the absence of controls on workers. The potential for these impacts will be most severe where workers are located in remote settings far from public facilities and markets, especially if food and other necessities are not available. The PMU will instruct contractors to prohibit workers from destruction of rare, threatened and endangered floral species. Environmental specialist (ES) recruited as part of CSC will be trained to identify the rare, endemic and protected plants. Prior to jungle clearance or tree felling, ES will survey the road segment to verify the existence of any threatened and endangered plants within the road ROW. If there are any, then ES through PMU will inform the local Division Forestry Office (DFO) and jointly carry out rescuing and relocation of plant species. The signages indicating rescue and relocation of protected plant species must be posted. The strict forestry rules and regulations prohibiting hunting, fishing and firewood gathering will be made aware to the worker population. The contractor will provide construction camps with food supplies and supply cooking fuels/gas to construction workers to refrain them from using fuel wood for cooking and warming purposes. The necessary fuel wood for cooking and warming should be provided from legitimate sources or otherwise stockpiled from materials cleared from the roadway alignment according to other rules set out in the contract specifications.

341. Burning plant matter in the construction zone is also prohibited since clearing of new right-of-way in forested areas by burning can lead to conflagrations, habitat destruction and regional air pollution. The contractor shall avoid burning plant residue by placement of materials into stockpiles outside the line of construction, preferably in contours along slopes below the roadway grade, thus contributing to soil retention and re-growth.

342. Cutting and clearing side hill slopes by blasting and removal of rubble by wasting material down the slope must be prohibited. Disposal of spoil materials on the lower slope

below the roadway grade destroys forests and contributes to sediment loss. The contractor shall dispose of all spoil materials in designated spoil disposal locations identified by the detail design consultant and verified by the PMU.

343. Stone crushing operations required for road construction generate a lot of dust and noise. As a result the areas and forests surrounding rock crushing sites are covered in a layer of dust. This will negatively impact the natural growth of the trees and shrubs. Regular water spraying (at least twice daily) in and around the stone crushing machinery will be necessary.

344. **Operation.** The Table 50 illustrates the traffic forecast for NDH starting from the operation period of 2018 till 2033. On an average about 919 vehicles are expected to ply along NDH daily by 2018 which is roughly about 38 vehicles per hour. And by 2033, AADT is expected to be 2963 vehicles only. Therefore traffic along NDH is negligible which is even less than rural traffics of most countries in the world. Hence the impacts of pollution on the forest will be negligible.

**Table 50: Average Annual Daily Traffic (AADT) Forecast for NDH**

Year	Passenger Car	Bus/LCV	Trucks/2-Axle/3-Axle	Total
2018	365	239	315	919
2023	603	421	527	1551
2028	895	648	694	2237
2033	1196	867	900	2963

Source: Detailed Design Report, December 2013

345. Bioengineering application and compensatory plantation carried out during construction may result in problems such as poor regeneration and survival. Necessary re-plantation and other remedial actions will need to be taken as part of the maintenance of the roads during operations.

## 2. Wildlife

346. **Detailed Design and Pre-construction:** Roadways may form a barrier that blocks the daily and seasonal movement of wildlife during the operational life of the project. Alignment for new roadway may interfere with the movement of animals that move daily between mountain slope and valley bottom to water at rivers and to search out food and salt licks. Seasonal migration of wild animals also may be affected by the presence of roads. Changes in diurnal patterns on a seasonal basis and migration between foraging areas to maintain habitat size may also be effected by road alignments.

347. According to WWF article on Conservation of Asian Elephant in Bhutan (Retrieved on February 11, 2014 [http://www.panda.org/who\\_we\\_are/wwf\\_offices/bhutan/projects/index.cfm?uProjectID=BT0884](http://www.panda.org/who_we_are/wwf_offices/bhutan/projects/index.cfm?uProjectID=BT0884));

*"In Bhutan, the estimated elephant habitat is around 2,000km<sup>2</sup> (WWF, 2000) and resident population about 60 to 100 animals (Santiapillai & Jackson 1990, IUCN). Elephants are mostly confined to the southern foothills from Dhansiri Chhu in the east, to Sipsu in the west, along the Indo-Bhutan border. RMNP, PWS and KWS and their corridors provide healthy habitats for the elephants. Elephants are traditionally seasonal migrants in these areas; moving from thick forests in Bhutan to grasslands in India during the winter (November to April)*

*and returning to Bhutan in the summer months (May to October). According to Indian experts, the habitat in Bhutan should be able to accommodate between 100-300 elephants.”*

348. Within the project area, elephant is known to migrate mainly through small corridor along Regi slopes; along the banks of Tsokhiri and Duiri Rivers. Regi area is also known for the presence of saltlick which attracts elephant as well as other wildlife.

349. According IUCN, Asian elephant's habitat area ranges anywhere between 30km<sup>2</sup> to over 600km<sup>2</sup>. “Given their requirements for large areas, elephants are regarded as an “*umbrella species*” because their conservation will also protect a large number of other species occupying the same area. They are also a premier “*flagship species*” and are sometimes regarded as a “*keystone species*” because of their important ecological role and impact on the environment, 2013”. Retrieved on February 11, 2014, from <http://www.iucnredlist.org/details/7140/0>

350. So in this light, mitigation measures will dwell mainly around the protection of elephant habitat and their migratory paths. In doing so, it is expected to directly benefit other wildlife species inhabiting the same area. The road construction through important habitat of Regi area between Tsokhiri and Duiri Rivers will cause following impacts:

351. Placement of roadway near rivers banks and constructions of bridges overs Tsokhiri and Duiri Rivers will block or disrupt the elephant migration pathway. In order to allow free movement of elephant, 10 meter high bridge over Duiri River is proposed and designed since the elephant movement is along the riverbed. On the other hand, the banks of Tsokhiri River are designed with gentle slopes that is deemed suitable by WS and DFO for easy the wildlife movements.

352. Construction of road on the slope of Regi area and through the saddle above Regi slide will damage the elephant migratory path. CSC's Wildlife specialist (WS) along with ES and the Forest and Wildlife Expert from the Territorial Forest Divisional Office (DFO) will assess and determine all possible migratory paths within Regi and other areas. And based on their findings and the recommendations, elephant corridor (crossing points) will be built with gentle slopes to enable easy elephant movements.

353. Road construction may damage of vital saltlick at the base of Regi land slide. The feasibility alignment which passed right through the Regi slide would directly affect the saltlick located its base. However, during the detailed design, the road has been realigned; it is now kept on the other face of the same slope and passes through the saddle above the Regi slide. There will be no direct impact on saltlick as well as to the wildlife that comes for consuming minerals.

354. No construction camps; quarrying; establishment of batching plant; and stone crushing plants are planned to be constructed within the important habitat and along the migratory pathways.

355. **Construction:** NDH follows 6km existing farm road through the Biological Corridor connecting RMNP and KWS, from chainage Km9-Km15; and it also passes through Regi important wildlife habitat area from Km43-Km50. Construction of road through these sensitive areas will damage habitats and disturb wildlife migratory pathways.

356. NDH will follow almost entirely the Nganglam-Chorkhorling farm road up to Chainage Km15 from the takeoff point at Nganglam; including 6km from chainage Km9-Km15, on the



northern part of the Biological Corridor that connects the RMNP and KWS. This part of biological corridor has been once a farming land; cultivated through a shifting cultivation process (using slash and burn technique). Hence, there are no sensitive habitats within this area. Nonetheless, since the area now forms part of the biological corridor; no new alignment will be cut in this area; only 3-4m widening of the existing farm road will be carried out. The farm road is on an average 4m wide. Gentle side slopes will be maintained for easy wildlife crossings in places where there are evidences of animal movements based on the recommendations of the ES.

**Figure 40: Wildlife Corridor Signage**



**Figure 41: Existing Bridge over Kirungri**



357. Road construction through critical wildlife habitat at Regi area will require completely new cuttings through the dense forests and steep slopes. The critical wildlife habitat tests using the biodiversity decision framework tool of IFC, World Bank as shown below; indicates that there will no major or severe impacts on the critical habitat and its endangered species such as Asian elephant and Rufous necked Hornbill. The main predicted impact is the damage and disruption of elephant migratory routes; and loss of food sources and the nesting sites for Hornbills.

**Table 51: Critical Wildlife Habitat Tests using biodiversity Decision Framework Tool as required by SPS**

Critical Wildlife Habitat of Regi	
Question 1	Is the site legally protected or proposed for protection?
Answer	No
Question 2	Is the site critical habitat?
Answer	Yes. It is the habitat of endangered Asian elephant and Rufous necked-Hornbill
Question 3	Will the project reduce populations of any recognized critically endangered or endangered species?
Answer	No; since the critical habitat of Regi area is small part of the overall habitat available for Asian elephants and Rufous necked Hornbills.
Question 4	Will there be measurable adverse impacts, or likelihood of such, on the habitat's ability to support its high value species and functions?
Answer	No; since project will avoid the damage of critical saltlick area; will restrict felling of tall, matured and fruiting trees; provide temporary migratory passage during construction; and restore or build permanent elephant crossing points. Further, safety feature such as elephant corridor signage and speed limit will be erected to minimize the wildlife-vehicle collisions.
Question 5	Will there be a loss in habitat which will compromise the persistence of a viable and representative host ecosystem?

Answer	No; since the road formation cutting will be restricted to 7.5m wherever feasible and important wildlife sites such as mud pools and saltlick areas are avoided altogether.
	Any remaining impacts will be mitigated by implementing suitable mitigation measures recommended by the EIA report and under the EMP.

358. Steep road cuts will form a barrier to wildlife movements and disrupt the elephant migration. It is generally known that elephant migrates to the hilly areas of Bhutan during rainy or summer seasons and back to India during dry winter seasons. WS along with ES in consultation with the forest and wildlife expert of the DFO will determine the exact elephant migratory routes and the timing of their migration for planning and execution of road construction. The survey shall be carried out in advance prior to the start of civil works in the critical habitat areas. Road construction works will be allowed only during dry season (from Late September till May) following winter timing from 8.00am till 4.00pm to minimize the disturbance to wildlife. Total controlled blasting will be implemented if rock blasting is unavoidable. Blasting will be carried out during daytime (from 8.00am till 4.00pm) only. Gentle side slope will be maintained wherever there are known wildlife crossings (as per the recommendations of ES). The gentle slopes will be maintained in all known migratory paths. Spoil will be disposed to the pre-identified dump sites. Elephant corridor and speed limit signages will be posted on both sides of Regi area to caution travelers of possible dangers of collision with elephants. Exactly location of signage posting will be determined by WS and ES in consultation with the DFO. Further as long term mitigation measures, the habitat enrichment activities such as planting of native bamboos, fruiting and fodders trees will be carried out. WS in collaboration with DFO will determine the suitable plant species for elephant habitat enrichment. There will be strict compliance monitoring by WS & ES while constructing road through Regi area.

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

360. **Operation:** Access to conservation areas or important wildlife habitat area could lead to increased poaching of wildlife and illegal harvesting of forest products. However, it is difficult to predict the extent of impact or benefit from a road across the sensitive area. Direct access should be strictly circumscribed for any illegal operation, while access for Foresters will be facilitated.

361. However, in longer run it is expected that benefits from the road for conservation will outweigh impacts as it will facilitate the regular monitoring of the area by the forestry officers. Currently, during dry season, it takes a day on foot to reach the Regi area while in summers it is totally inaccessible due to lack of bridges. Because of the remoteness of the area and limited monitoring, there is widespread illegal logging, fishing and poaching of wildlife from across the border. Therefore, all-weather road will facilitate regular forest patrolling and monitoring which will minimize the wildlife poaching and illegal logging.

362. Operation of motor vehicles may cause collisions with wildlife. However it is expected that direct collisions between vehicles and wildlife will not be frequent because these are not high speed roads, drivers are generally intent on observing road conditions, and vehicle traffic loading is not great. Nevertheless, WS will monitor vehicle-wildlife collision; assess the use and

effectiveness of wildlife crossings; and wildlife corridor and speed limit signages. Based on the findings of survey and monitoring; further rectification works will be carried out.

### 3. Summary of Impacts on Forest and Biodiversity

363. Actions and potential effects on the biological resource include the following:

- Direct forest loss from clearing for roadways and improper placement of spoil materials. The loss of forest due to clearing of roadway alignments is estimated to be 166.8 acres, which is about 0.027% the total forest cover 253,535 ha under Pemagatshel and Samdrup Jongkhar districts where NDH is located. The loss of land is forest land is negligible.
- Depletion of forest resources by workers during construction. Small amounts of land will be used for placement of worker and construction camps. Only stone quarry locations are potentially-forested areas. Other forest resource losses associated with workers during construction include harvesting of firewood and animal products from forests, which is restricted under terms of the construction contract. Enforcement of this restriction and assurance that sufficient food & fuel supplies are provided to workers should be enough to limit the impact to a negligible amount.
- Improved access to forest areas result in illegal logging and animal poaching. Both impacts and benefits stem from the roadways in respect to this impact. Logging and wild animal poaching that already occur may be reduced through better access for policing operations by local authorities. On the other hand, if enforcement is lax, then there is likely to be an increase in illegal logging and animal poaching as a result of improved access. This will lead to destruction of rare, threatened and endangered plants, herbs and medicinal plants, endemic, threatened & endangered plants, plants listed in Schedule I of FNCA (Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*) and red list plants under CITES Appendix II (*Alsophila spinulosa* syn. *Cyathia spinulosa*, *Alsophila brunoniana* syn. *Cyathia* and *Dioscorea deltoidea*). It is not possible to quantify these effects; however the need for adequate enforcement of conservation laws at the local level seems necessary to prevent serious impacts of these types. The overall impact is expected to be neutral, e.g. while there is better access for poaching and illegal logging, there is also improved surveillance as a result of new road links that pass through forested areas.
- Traffic interference with animal movement and possible collisions. Interference of traffic with animal movements, though a significant issue (in itself), is judged to be minor in the context of the project, given that mitigation measures have been integrated in the road design. In addition provision for reviewing the effectiveness of the measures and revising them if necessary during the early stages of operation have been included in the EMP.
- Accelerated land use changes in areas near roadways lead to further forest clearing and habitat. Road of course bring about land use change during their operational lives. Once easements are opened into forest areas, there is little likelihood of a reversal of the effect. Due to stringent RGoB policies and regulations, the change in land use during operational phase of road will be negligible.
- The overall impact of the above factors on forests and biodiversity is as follows:

Direct displacement of forests by roads:	minor
Depletion of forest by workers during construction:	nil
Improved access contributing to illegal logging and poaching:	nil
Interference with animal movements and vehicle collisions:	minor
<u>Accelerated land use changes near roadways:</u>	<u>minor</u>
<u>Overall impact:</u>	<u>minor</u>

## D. Socioeconomic Environment

### 1. Land Tenure

364. **Pre-construction:** Project will acquire approximately 63 acres of mostly private land (46.03 acres of dry land; 1.16 acres of wetland; 15.81 acres of orchard land); 14,727 Nos. of fruit trees; 19 Nos. of fodder trees; 106 Nos. of private trees; and 56 Nos. of temporary and permanent structures. The land and properties acquisition will lead to loss of productive agriculture land, destruction of cash crops and also render people homeless due to damage of structures.

365. Land and property acquisition will be carried out as per the Resettlement Plan prepared separately as part of the project. The compensation, land substitution, and resettlement will be carried out prior to the start of civil works. Qualified engineer will carry out the valuation of structures that needs to be acquired. As far as possible land substitution will be provided within the same geog. Land Compensation Rate 2009 will govern the compensation payment.

366. Titles to land will be provided to households within the framework of the RGoB land ownership policy. Parallel grievance mechanisms under environment and resettlement components of the project will provide opportunities for affected people to bring cases before the appropriate local government authority.

367. NDH construction will follow RNPII design with 7.5m formation to minimize the land take and property acquisitions.

368. **Operation:** With the opening of new roads and easier access public lands can be encroached upon for private use. Changes in pricing structure of land occur in the wake of new roads, irrigation and other services, providing renewed incentive to encroach on public lands, especially in areas where cadastral surveys are incomplete, or where the action might be overlooked or ignored by local authorities. However, due to stringent RGoB policies and regulations, public land encroachment for private use during operational phase of road will be negligible.

### 2. Labour Rights during Construction

369. **Construction:** In the employment of labour to construct the roadways, rigorous living and working conditions can affect worker health. While health impacts are difficult to predict or quantify, the contractors are required to provide adequate living and working conditions (with sufficiently ventilated living quarters) for workers. Occupational health and safety are priority

concerns for the ADB. Borrowers are expected to ensure that contractors working under the loan provide workers with a safe and healthy working and living environment.

370. The contractor will provide labourers and others resident at the site lodging in a camp setting outside of any danger zone, safe drinking water, adequate washing and bathing facilities for maintaining personal hygiene, provide pit toilets and access to health care. Guidance for disposition of worker camps can be found in the Government's Rules and Regulations Governing Employment Agencies in Bhutan, 2006, and Rules and Regulations on Occupational Health and Safety in Construction, Manufacturing, Mining and Service Industries, 2006.

371. Work site accident and injury to workers may also occur, since roadway construction is a high risk occupation in which injury is common. While impacts are difficult to predict, experience shows that attention to appropriate safety measures in the work place by the construction contractor can eliminate most accidents. Preventive measures include training and appropriate incentives to comply with health and safety standards. The contractor will establish and maintain a safety and accident prevention program involving provision of adequate protective gear and clothing, well maintained construction equipment, training for workers to assure they are adequately skilled in their jobs, and recordkeeping related to accident frequency combined with measures to correct deficiencies that have shown to be the cause of accidents. Contractor will ensure the availability of first aid kit at the construction sites. In the event of accident and injuries, the contractor will take full responsibilities of immediate evacuation of injured person to the nearest medical centers. Contractor will also be responsible for health and safety insurance of construction workers. An injured person will be adequately compensated. Guidance for the program can be found in the previously referenced Government Rules and Regulations.

372. The location and maintenance of construction camps may interfere with the normal life of nearby communities. Location of construction camps along the elephant migratory path will increase the chance of human-elephant conflict. The wild elephants are known to destroy any structures that lie in their pathways and even harm humans during the close encounters. No construction camps will be placed inside Regi wildlife areas where elephants frequently move up and downstream.

373. Sanitary waste and litter can degrade the local environment in the vicinity of construction camps. Wherever possible the camp facilities should be located 500 m away from communities. No forested areas will be used for locations of construction and worker camps. The contractor will provide sanitary facilities (dry pit or pour flush latrines) for workers and arrange for disposal of solid waste in accordance with local practice, which at a minimum will provide for collection, burning and burial of rubbish at controlled sites away from human habitation.

374. Construction workers may introduce the threat of HIV/AIDS and other sexually transmitted diseases (STDs) and other diseases. The contractor and PMU will undertake an awareness program among workers to avoid the risk of transmitting STDs and other diseases.

### **3. Public Liability of Contractor and Damage to Local Infrastructure**

375. Slopes may become unstable during construction and cause a hazard for workers and nearby people. The contractor is responsible for preventing any public liability by assuring that slopes are stable at the end of construction in a given work area and for avoiding hazard to workers, adjacent property and people. All necessary safety measures such as restriction of movements; placement of flagmen; erection of cautionary signage; provision of temporary safe

passages; and catch walls or log/boulder barriers will be put in place in all critical sections; to avoid accidents, injuries and damage of private and community properties or infrastructures.

376. Road construction works will have following direct or indirect impacts on communities living along the proposed NDH:

377. Widening of existing roads; namely, Nganglam-Chokhorling farm road, Rishore Coal mine and Dewathang Municipal roads will impede free movement of local traffic and will cause accidents and inconveniences to the commuters during construction period. These impacts are unavoidable. However, these can be minimized through proper work scheduling and providing regular window period for the public movement. The public movement schedules will be decided in consultation with the local government and the affected communities. Timing of school children movement and their safety will be given utmost importance. Flagmen or safety guards will be placed on both ends of the construction sites. The hazardous areas will be clearly marked with red flags and cautionary signage to avoid accidents. In the event of any misfortunes, the contractor will take full responsibilities to evacuate injured to the nearest health center; and will bear the entire medical expenses and also provide the adequate compensation.

378. Road constructions will damage the traditional mule track and foot trails (at Chainages Km12+000, 16+000, 28+750, 40+000.) affecting free movement of locals. Temporary passage will be provided for all known existing foot trails and mule track during the construction. And permanent restorations will be carried out after the road construction.

379. Settlements located downslope of the roadways will be affected due to falling debris during constructions. Chokhorling village is likely to be affected the most; if no mitigation measures are applied. To avoid human accidents and minimize property damages at Chokhorling, about 1mx1m gabion catch wall with sufficient length (approximately 200m) is proposed to be constructed below the road alignment prior to the start road of construction work. Figure 42 shows the location for catch wall construction. Similarly, in other areas depending on site conditions, boulder and log barriers will be built to minimize or avoid downhill damages.

380. Road construction works and material transport through the settlements of Drangnalashingborang, Dezama, Shuguri, Chokhorling, Khalatsho, Rishore, Chenari and Dewathang will generate dust and noise pollution affecting the local environment. Regular sprinkling of water, at least twice a day will be carried out in all settled areas to reduce the dust pollution. Construction activities will be restricted to daylight hours from 8.00am till 5.00pm to limit the construction noise exposure of the local inhabitants.

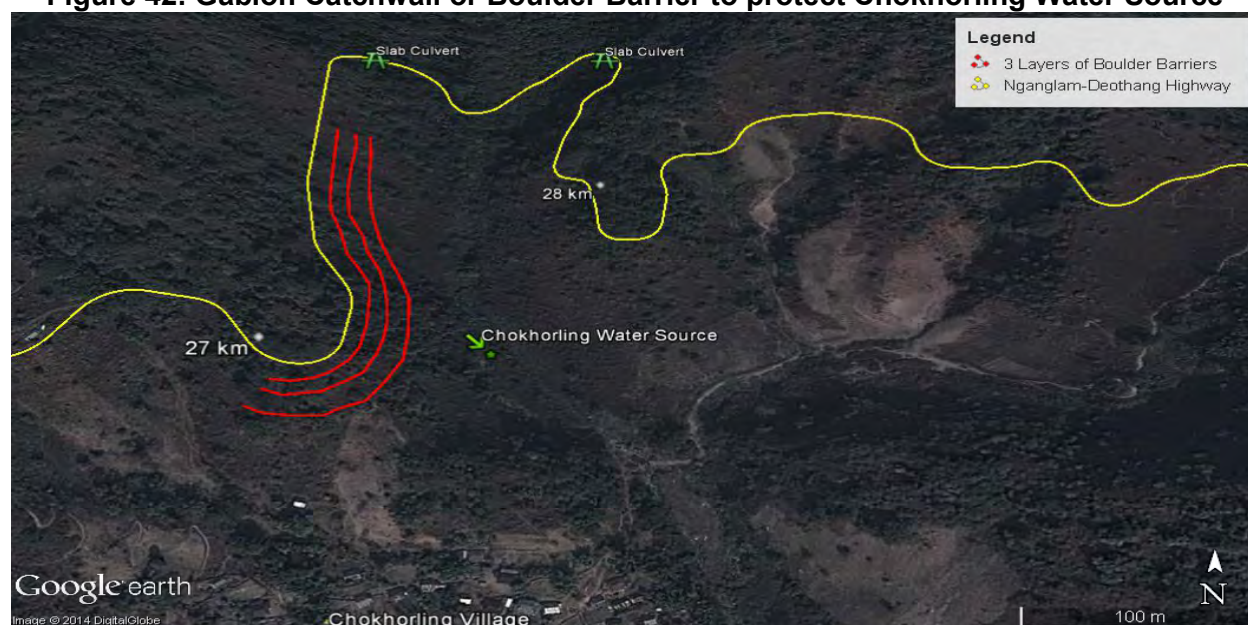
381. Community water supply systems at locations along specific roadways can be put out of commission during construction, disadvantaging local people. Damages will occur to water intake and pipelines of drinking water supply of Drangnalashingborang, Dezama, Shuguri, Chokhorling, Khalatsho, Rishore and Dewathang communities. Prior to start of the construction, temporary water supply will be provided through alternative sources. Permanent restoration will be carried out after completion construction works. The details of water supply infrastructures are provided in Table 52.

382. Road construction through the watershed of Chokhorling will damage and disrupt drinking water supply for the village. Prior to the construction, alternative water supply arrangement will be made. If necessary, water storage tanks will be relocated above the road alignment. To avoid damages of watershed, boulder barrier or gabion wall of 1mx1m dimension



will be constructed along the slope facing the watershed, to arrest falling debris during road construction. Further, to minimize the damage of local water table, two slab culverts of 5m x 3m will be constructed with minimum excavations of culvert foundations. Permanent restoration of water supply system will be carried out after the completion of the road construction. Compensatory plantations with native plant species will be carried out in all watershed areas. Figure 41 provides the approximate locations of proposed 3 layers of Gabion catch walls or boulder boulders to protect the watershed and water sources of Chokhorling village.

**Figure 42: Gabion Catchwall or Boulder Barrier to protect Chokhorling Water Source**



**Table 52: Water supply infrastructures that is likely to be damaged**

Sl. No	(Km)	Water Infrastructures	Impact
1	0+100	Water Supply Pipe	Water supply pipeline will be damaged during widening of existing road
2	1+600	Watershed/Source and Water Tank	Marshy watershed area from where water tank was constructed for private water supply for Drangnalashingborang village. Road widening will damage the water tank and watershed.
3	1+000 to 4+000	Water supply pipeline	Water supply pipelines for Nganglam Royal Bhutan Army Outpost, Drangnashingborang, Dezama village runs parallel to existing farm road.
4	7+500	Water Supply Pipelines	Water supply line will be damaged during construction
5	19+700	Water source and supply line	Water source and supply line will be damaged during construction
6	27+500 – 27+700	Watershed, water source and water collection tanks	Road passing through Chokhorling village goes right through watershed or source. During road construction may lead to permanent damage of watershed or source causing drinking water shortages in the area.
7	40+250	Water source and	Road through Khalatsho area may damage



Sl. No	(Km)	Water Infrastructures	Impact
		collection tanks	water source and collection tanks during road construction.
8	64+000 – 66+400	Water source and supply lines	The area between Rishore and Chenari is critical because of the presence of number natural springs which are tapped by locals for drinking purposes. The road construction may lead to permanent damages to this spring waters leading shortage of drinking water. There are no other alternative drinking water supplies in the area lest the Dewathang Polytechnic Water supply is shared with the community.
9	66+800 – 67+400	Water supply pipelines	There are number of water supply pipelines that run parallel to existing road. Important water supply lines are that of Dewathang Royal Bhutan Army Hospital and Jigme Namgyal Polytechnic. The water is being brought some 9-12 km away from Naylang using free gravity fall. The road widening in the area will definitely damage pipeline will lead severe water shortage for the Dewathang Primary, Polytechnic and the hospital.
10	67+700 – 68+000	Water supply pipelines	Water supply pipeline for Dewathang

Source: Field Survey, November 2011 and Detailed Design, December 2013

383. Electricity supply lines and power poles that are close to alignments may be disturbed leading to disruption of local electricity supply. About 22 numbers of electricity supply poles (some with support wires) and 2 transformers are located within the ROW along the Dezama and Rishore - Dewathang road section; at chainages, 0+100, 2+350, 4+100, 27+000, 62+420, 63+290, 63+390, 63+900, 63+950, 64+550, 64+580, 65+060, 65+110, 65+230, 65+280, 65+310, 65+430, 65+440, 65+450, 65+470, 65+500 and 65+700. Similarly, about six telephone poles and lines are located at chainages 73+210, 73+280, 73+400, 73+430, 73+610, 73+640. 4 telephone poles and lines have to be relocated and 2 telephone poles will require support walls to protect from damage.

384. Resettlement Plan (RP) is prepared taking into account of possible of damages of public utilities. RP requires the project to relocate and restore both electricity supply and telephone connections prior to the start of construction. Temporary power supply will be provided while relocation and restoration works are being carried out. Local authorities and affected communities will be consulted before the relocation activities. Bhutan Power Corporation Ltd (BPCL) will implement relocation and restoration works. Similarly, relocation and restoration of telephone connections will be carried out in consultation with Bhutan Telecom Ltd.

#### 4. Cultural or Religious Sites and Archeological Remains

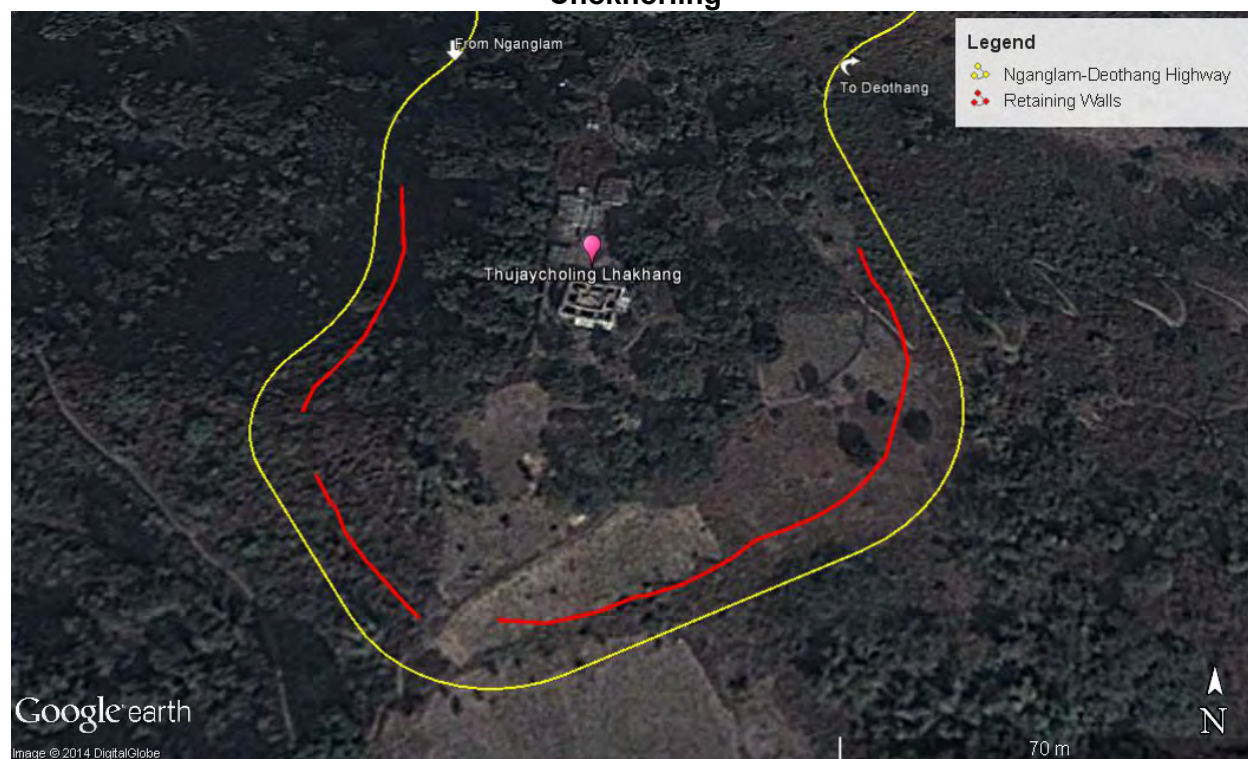
385. **Construction:** In the process of construction, damage can occur to religious/cultural monuments and archaeological monuments and unearthed evidence. There are no indications of existence of any archaeological remains within in the project area. However, still, in the event any are uncovered, the contractor will halt construction upon their discovery and notify the PMU

Supervisor, who will contact the relevant government authority to investigate and undertake recovery. Work must remain halted at the specific location until recovery is complete.

386. There are few cultural and religious sites such as Thujaycholing Lhakhang above Chokhorling village, Meme Lungkhangma Labtsha (Sacred Holy stone), Big Boulder (Lu-Snake Goddess) above road at Chenari Karphu and Chenari Phodrang- Nyepo falling within right of ways.

387. Thujaycholing Lhakhang/temple structures and the footpath leading to it will get damaged during road excavation works. To protect temple foundation about 200m retaining wall along with bioengineering works are proposed and incorporated into the detailed design. All spoils materials will be transported to the pre-identified disposal sites. Temporary passage is to be provided during the construction and permanent footpath will be built after completion of road construction.

**Figure 43: Proposed Retaining or Breast Wall for Protection of Thujaycholing temple at Chokhorling**



388. No impact is expected on Meme Lungkhangma Labtsha (Sacred Holy stone) as road widening (of existing farm road) will be carried out on the opposite side slope of the sacred site.

389. Similarly, no impacts are expected on Big Boulder (Luu- abode of Snake Goddess) as road widening will be limited to 7.5m and the alignment will be shifted 1-2m away from the boulder. No excavation will be carried out in the immediate surroundings of the boulder.

390. Chenari Phodrang- Nyepo and Gesar Dala lhakhang is outside the 7.5m road construction corridor and hence there are no impacts on these sites.

## **5. Long Term Use of Roadway**

391. **Detailed Design:** Accidents involving fuel and hazardous materials along roadways pose a community risk and damage the environment of rivers and streams. The EMP should be strictly implemented during construction to prevent such accidents. The roadway should be equipped with signage related to hazardous driving conditions and pullouts for passage of vehicles around tight curves and in areas where sight distance is less than the roadway standard.

392. **Operation:** Litter may accumulate along roadways near communities and markets, causing an aesthetic nuisance and environmental health hazard. DOR will institute an anti-littering campaign along roadway stretches significantly affected by the problem. Rubbish bins will be placed at strategic locations in community surroundings to reduce roadway litter

393. The conversion of government forest and agriculture land into private or commercial land is rare in Bhutan due to strict and stringent application of rules and regulations. Only likely scenario in the wake of roadway development is reutilization of fallow agricultural areas, followed by crop intensification.

394. The majority of impacts on social infrastructure is positive and come about through improved markets, increase in employment opportunity and household income, better public services such as education and health care and increased access to consumable goods. Negative long term trends of out-migration from rural to urban locations may be reversed by improved roadway access. There are no significant negative impacts on social infrastructure expected as a result of the Project.

## **E. Cumulative and Induced Impact Assessment**

### **1. Cumulative Impacts**

395. According to the ADB Environment Safeguards Sourcebook<sup>21</sup> 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.

396. Existing significant projects with environmental implications in the project area is the newly operationalized Dungsam cement factory<sup>22</sup> close to Nganglam and the coal mine in Rishore near Dewathang. The cement factory is located about 20 km away from the starting point of the project road in Nganglam, while the coal mine in Rishore is located close to km 63.8 of the road which falls closer to the road end point.

397. Environmental issues associated with the operation of the cement factory in Dungsam are air pollution (dust and fumes), solid (industrial) waste, noise and vibration and potential water pollution. Most impacts from the cement factory are restricted to the factory area and larger valley in which it is located. The traffic generated from the factory which is mainly for import of raw materials and transport of cement to Bhutan and India takes a route different to that of the project road. Given these conditions and the fact that the road take off point is

<sup>21</sup> Environment Safeguards, A Good Practice Sourcebook, Draft Working Document, December 2012

<sup>22</sup> The Dungsam Cement Factory just started commercial operation in January 2014.

located 20 km away from the factory in a different valley the additional or cumulative impact of the road project to the impacts of the factory are negligible.

398. Environmental issues associated with the operation of the coal mine in Rishore is mainly soil erosion as the key activity of the mine is extracting coal from the mountains in the area. Other issues are dust, noise and vibration generated from the operation of equipments and vehicles transporting the coal out of the mine area towards Samdrupjongkhar. The trucks transporting coal currently use the existing road within Dewathang municipality. This existing road comprising 4.5 km (63.8 km to 68.3 km) forms part of the project road. Hence improvement of this road section under the project will facilitate smoother transport of the coal out of the mine. The road project will not have any additional or cumulative impacts on the issue of erosion as there will be comparatively less slope cutting works involved as there is already an existing road in the coal mine area. During the construction period the main additional impact from the project will be dust, noise and road safety issues due to operation of construction equipments and vehicles in addition to the already existing traffic from the mine. Various mitigation measures such as sprinkling of water, limiting working hours, posting precautionary signages and assigning flagmen and others have been included in the EMP to address these concerns during the construction stage. During the operation period the main additional long term impact will be air pollution, noise and road safety concerns from the additional new traffic that will come from Nganglam to Dewathang. As discussed in section B. 1 in this chapter the projected annual average daily traffic for 2029 is only about 1,263 in the Rishore to Dewathang section which is fairly low. Hence the additional impacts are expected to be low. Nevertheless, provisions for road maintenance, monitoring for vehicle emissions and constructing noise barriers (if necessary) and others have been included in the EMP during operation stage.

399. Currently there is no 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. Given the above information on existing projects in the project area and the lack of information on future projects it can be concluded that based on existing information cumulative impacts from the project as a whole will be minimal. Appropriate mitigation measures have been included in the EMP for possible short term and long term impacts which may arise particularly in the Rishore coal mine area.

## **2. Induced Impacts**

400. Of the 68.3 km of road, about 49 km comprises construction of a new road in dense forests which also passes through remote villages. The new road will create a new route of travel from Nganglam to Dewathang which is located further east. The construction of two new national highways which are almost complete will connect Nganglam to Panbang on the western side and Gyelposhing to the north (in relation to the location of Nganglam in south eastern Bhutan)<sup>23</sup>. Hence, the project road will also create new access from Panbang and Gyelposhing to Dewathang through Nganglam. These new connections together will bring better overall connectivity within south eastern Bhutan.

401. This new connectivity is expected to induce socio economic development specifically within the project area as well as the larger south eastern part of Bhutan. However many

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<sup>23</sup> These two national highways are located in different directions and different valleys located far away from the project road. Hence the project road is not expected to bring any cumulative impacts in addition to those already generated by these projects. In addition, the construction of these two highways will be complete by the time the project road construction begins.

negative environmental impacts can also be induced as a result of opening up a new road. Positive and negative induced impacts that can be expected in future are listed below:

a) Potential positive Induced Impacts:

- More business and trade opportunities for the Nganglam and Dewathang town and other settlements in between due to the increased traffic passing through them
- Creation of new opportunities for development and trade of agricultural products such as mandarin for the rural communities in the project area
- Easy access for improving other development facilities such as schools and hospitals within the project area
- Easier access for forestry authorities for conducting monitoring activities for illegal felling of trees or poaching

b) Potential negative Induced Impacts:

- Air pollution and noise due to the new and increased traffic generated
- Problems of safety for the local communities generated by the new and increased traffic
- Illegal felling of trees or sourcing other natural resources and poaching
- Vehicle wildlife collision

402. 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 Euro 3 standards, construction of noise barriers and others have been included in the EMP during operation stage.

403. The new road will open up the forested area between Chokorling and Dewathang. The local forestry officials have expressed that the new 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 bridges. The Wildlife Specialist under the Construction Supervision Consultant's team will continue monitoring the effectiveness of these measures during the early stages of the project operation period and provide recommendations for improvement if necessary.

## **F. Emergency Response Plan**

### **1. Introduction**

#### **a. What is Emergency Response Plan?**

404. Emergency Response Plan (ERP) can be defined as the organization, coordination and implementation of a range of measures to prevent, mitigate, respond to, overcome and recover from the consequences of emergency events affecting the construction workers, travelers, communities, its assets and the environment.

## **b. Purpose of Plan**

405. This Emergency Response Plan (ERP) is intended to provide information, strategies and procedures relating to all aspects of emergency management, which comprise:

- a) Prevention of emergencies;
- b) Preparation for emergencies;
- c) Response to an emergency; and
- d) Recovery following an emergency.

406. It includes emergency management procedures and administrative structures to be established and nominates functional roles and responsibilities for the management of emergencies during road construction and operations. Duty statements and specific management plans with procedures for certain road sections at particular risk have been developed.

## **2. Prevention and Mitigation**

### **a. Introduction**

407. Prevention and mitigation activities work toward eliminating or reducing the impact of a hazard and increasing the resilience of an affected community to recover from the consequences of a hazard.

408. PCU/PIU/CSC has responsibilities to assure that contractors implement the prevention and mitigation of emergencies relating to road construction activities and assets.

409. Typical prevention and mitigation actions will include:

- Setting, coordinating and reviewing the emergency response policy and programs for road construction;
- Management and monitoring of asset condition;
- Liaise with the Dzongkhag, Geog, and Municipal emergency managers
- Review and update the risk register(s), taking into account of any new or emerging risks across road construction zones and activities.

### **b. Emergency Planning Group (EPG)**

410. One Emergency Planning Group (EPG) will be formed for each contract package. The Project Managers (PM) of the will be the Emergency Response Coordinator (ERC) at the sub-project level. The members of EPG will include CSC's Resident Engineer (RE) and Site Inspectors (SI); and Contractors' PM and Site Supervisors. In addition, the The EPG will also take role of Emergency Reponse Group (ERG) during emergencies.

### **c. Function**

411. The function of the EPG/ERG is to coordinate and oversee arrangements to ensure that contractor meets its emergency management obligations.

412. The EPG will attend to the following duties:

- Regular meetings of the EPG with appropriate meeting protocols;
- Regularly review and update the Emergency Risks;

- Initiate programs, procedures and activities to mitigate the risk to life and property within project's jurisdiction, including increasing public awareness;
- Arrange for and manage testing and exercising of the emergency plan particularly specific plans and procedures;
- Seek funding support for emergency management related projects and programs;
- Ensure operational debriefs are undertaken after all major emergency events, and that a report is prepared and distributed and if refinements to the procedures are identified, they are issued and the Plan subsequently amended at review
- Ensure that members are appropriately trained and are competent in specific emergency management.
- Formally review the Plan on a regular basis as necessary
- Review the effectiveness of the EPG, and
- Communicate the activities of the Group to Project Coordination Unit/DOR.

#### **d. Reporting**

413. The Group will report its activities (including provision of minutes), and the currency of the Plan, to the DOR and ADB as part of the semi-annual environmental monitoring report through PCU.

#### **e. Emergency Risk Management**

414. Emergency planning requires an identification and assessment of the hazards likely to cause an emergency. Emergency Risk Management focuses on reducing risk by modifying aspects of the source of the risk, the community or the environment - because it is impossible to completely prevent emergency situations from occurring.

415. The main benefits of the emergency risk management process are:

- The process focuses on the causes of risk (rather than on emergencies that may result from risk);
- The process uses tools and approaches and terms that are common to other risk management and planning approaches, enabling appropriate prioritisation of treatments for action (e.g. such as capital works or maintenance); and,
- Provides a sound basis to access funding/grants, monitor insurance costs and minimise opportunity for litigation.

#### **f. Potential Hazards Identified**

416. Road construction activities as well as the road operations will encounter with number of potential hazards which could result in damaging affects on workers; communities and their assets; and wildlife and its habitats. Some of the significant probable hazards that would give rise emergencies are described as below:

417. **Slope failure and landslide.** Nganglam-Dewathang Highway (NDH) construction requires slope cutting and excavation on steep mountain sides for almost entire route. Irregular slope cutting and haphazard blasting will weaken the slope and cause instabilities in the area; thereby potentially increasing the possibility of mass movements such as catastrophic slope failures or landslides. The huge landslides/debris flows may have damaging affect on both communities and the wildlife habitats. Although all communities living along the NDH is likely to be at risk of slope failure disaster but the risk is quite high for communities of Yargaywoong and



Chokhorling as their settlements lie on downslope of the proposed road construction sites. Similarly, the risk of landslide hazard is high for critical wildlife habitats amongst others.

418. **Fire and explosions.** Although at this stage, there no estimates of explosive material requirement for the NDH construction; the experiences from the past projects shows that it will require import and use of huge quantities (tons of it) of explosive materials for rock cutting during the road constructions. Improper transport, storage and usage of dangerous explosive materials may lead to catastrophic explosions and fires which may result in wide spread damage of nearby assets, loss of lives and damage to the wildlife habitats.

419. **Fuel/hazardous substance spillage.** Large scale hazardous substance spillages related disaster or emergencies both during road construction and operation stage is quite eminent. During construction, accidental spillage of the construction fuel, lubricants, and bituminous products into the surrounding environment and water bodies is quite high. Similarly, during operation, risk of accidental spillages of petroleum and hazardous material is also high which may have detrimental impact on the surrounding environment.

420. **Occupational Health and Safety Hazard.** In general any construction works and in particularly road construction works through rugged mountainous terrain involves high risks or hazards on occupational health and safety of workers. Accidental injuries and death as well as other emergencies are common in high risk work zones. Falling boulders, landslides, fire and vehicular accidents or accidents involving mechanical equipments may result in injuries with subsequent life and death emergencies for workers.

421. **Vehicular-Wildlife Collision.** One of the critical emergencies that would arise during road operations is from potential vehicular-wildlife collisions, which will result in injuries or even death to either or both to human or wildlife involved. Although, these may happen all along the proposed road, the risk is quite high in the critical wildlife habitat area as it is known to contain the wildlife migratory routes.

#### **g. Review of Risks**

422. **General.** The EPG will maintain and review the risk/hazard register on a regular basis usually biannually or following an incident.

423. The review will:

- Take account of any new or emerging risks that relate to emergency management and project assets. This may include consideration of:
  - Any new developments;
  - Changes in land use;
  - Hazard mapping studies;
  - Changes in community behaviour, numbers, composition and/or patterns (e.g. increasing traffic flows on particular roads etc.); and,
  - Resource availability
- Priorities for risks control;
- Identify opportunities and mechanisms to treat and mitigate risks;
- Take account of new or changed risk controls; and,
- Identify the resources required to control risks, and identify the means to attain those resources.

424. Contractor will reduce the likelihood and consequence of emergency events through risk control measures, which broadly cover:

- Process treatment or procedure, and
- Physical treatment or measure.

425. **Processes and procedures.** This covers systems and procedures that enable Contractor to have proficient emergency management arrangements including:

- Asset Management and Program Delivery;
- Training and Awareness of Contractor's or project staff;
- Robust, adequate risk management and reporting systems for all construction activities;
- Risk assessment meetings with local government and communities along the project corridors.
- Estimating and budgeting for emergency management, training or risk treatments.

426. **Physical treatments for emergency avoidance.** Physical treatments cover physical mitigation measures and functionality that are carried out for emergency avoidance.

*Slope failure and landslide hazard:*

- Slope cutting and excavation will be carried out as per the detailed design and under the instruction and supervision of the site Resident Engineer.
- Total controlled blasting using experienced blaster will be carried out.
- Any loose rocks or hanging slopes will be brought down and leveled them to reduce future slope failure and subsequent landslide hazards.
- Retaining and breast walls will be constructed all along the the area with high slope instabilities
- Gabion walls, log or boulder barriers will be constructed as per detailed design in areas where potential landslide hazards are high for communities (e.g., Yargaywoong & Chokhorling settlements) and wildlife habitats (e.g., Regi critical wildlife habitat).
- During road operations, regular slope inspection and monitoring will be carried out with subsequent maintenance or construction new slope retaining structures will be carried out.

*Fire and Explosion:*

- Transportation, handling and storage of explosive material will follow the prevailing rules ("Explosive rules of the Ministry of Home and Cultural Affairs") of the Royal Government of Bhutan.
- Explosive material or components such as gelatin, fuse, cords etc. will be stored in a separate steel containers which are fire as well as theft proof. The explosive material containers will be furthered put in separate custom built explosive material store (house).
- The explosive storage house will be made of metal instead wood which are susceptible fire hazard.
- Temporary construction fuel such as petrol and diesel depot will be placed away from the explosive stores to prevent accidental fire and explosion.

*Fuel/Hazardous substance spillage:*

- Construction fuel and hazardous substance will be placed in safe place (temporary fenced depot) away from water bodies.
- Secondary containment facilities will be developed to prevent accidental spillage surrounding environment.
- Appropriate tankers or vehicles will be used for transportation of construction fuels and other hazardous substances.

#### Vehicular-Wildlife Collision

- Structural measures such as safety barriers and other traffic control devices including, signage (e.g. speed reductions) as per the design and the instruction of wildlife expert;
- Appropriately resourced response and maintenance units (provided by contractors).

### **h. Preparedness**

427. **Preparedness activities.** Preparedness ensures that arrangements and resources are maintained in a state of readiness to be mobilized and deployed for response and recovery to an emergency event.

428. The EPG oversees the adequacy and currency of Contractors preparedness for an emergency. Contractor undertakes, and will continue to undertake the following preparedness activities:

- Reviewing and updating the Emergency Management Plan, any sub-plans and Response Procedures;
- Ensure all officers are aware of, and hold sufficient competency to perform, their emergency management roles and responsibilities, as detailed in the Emergency Response Procedures;
- Arrange training and education programs for staff and construction workers.
- Conducting exercises to test specific aspects of the Emergency Management Plan, and its sub-plans or procedures;
- Establishing processes for lessons learned including conducting debriefs and reviews of other emergency events or exercises that are relevant to project;
- Having supporting systems in place for response and recovery e.g. cost capture, and documents and records management;
- Emergency equipment and supplies (fire extinguishers, first aid kit, eye wash, emergency shower, potable water etc.)
- Continual review, evaluation and auditing of emergency management arrangements, identifying and promoting opportunities for improvement.

429. **Exercises.** The EPG is required to test or exercise the Plan and its sub-plans and procedures to determine effectiveness and efficiency of emergency management arrangements, and identify opportunities for improvement.

430. Exercises can cover:

- Field exercises— where the scenario is created (e.g. slope failure and landslides/Fire and explosion) and emergency responders approach the scenario as though it were a real situation;

- Desktop exercise – Where the scenario is described and participants discuss their roles and can examine various aspects and alternatives. This can include testing a procedure or process.

431. If a field exercise is being planned independently of other emergency response agencies, it is especially important to advise the local emergency services of the exercise details, so the exercise does not disrupt their response to genuine emergency calls.

432. The EPG shall conduct debriefs following the exercise to identify what worked well, and what are the opportunities for improvement.

433. **Training.** The EPG shall review staff and contractor competency and currency of emergency management training, and identify training needs for committee members, staff &/or contractors including sharing and learning from other emergency response organization such as Department of Disaster Management.

434. **Administration and Finance.** The Contractor will be responsible for the keeping financial or budgetary for provision for emergency response. The EPC will coordinate and provide administration support during emergency situation.

#### i. Response

435. Response is defined as actions taken to minimize the effects of an emergency event, and to limit the threat to life, property and the environment. EPG and contractor undertake response. All hazards one way or other affect the surrounding environment which includes workers, communities, settlements, and wildlife habitats.

436. Response covers:

- Initial assessment and reporting of the event, location and identified communication methods
- Actions including:
  - On-Site Management of the situation;
  - Coordination of resources (off-site coordination) to support the on-site management;
  - Notify appropriate response personnel;
  - Shut down operations and evacuate the immediate work area or hazard zone;
  - Account for personnel at the designated assembly area (s);
  - Assess the need for site evacuation, and evacuate the site as warranted;
  - Conduct Incident Notification, and Reporting of the situation to stakeholders
  - Notify and submit reports to DOR and ADB as required
  - Ending response actions when the situation is resolved.

437. Table 53 illustrates the management authority and responsibilities during emergencies.

**Table 53: Emergency Management Responsibility**

S.No	Emergencies	Management Authority	Response
1.	Slope failure and landslides	Emergency Response Group (ERP) for every sub-project during	<ul style="list-style-type: none"> <li>• Disaster zone will be temporarily closed for pedestrian and vehicular traffic till the return of normalcy declared</li> </ul>

S.No	Emergencies	Management Authority	Response
		<p>minor emergencies.</p> <p>For large scale disaster - National Committee for Disaster Management (NCDM) through Dzongkhag Disaster management Committee (DDMC)</p> <p>Department of Roads (DOR), Dzongkhag Disaster Management Committee (DDMC) and to National Committee for Disaster Management (NCDM) during operations.</p>	<ul style="list-style-type: none"> <li>Contractor will evacuate injured workers, and communities living in the area</li> <li>Emergency medical treatment will be sought if there are any life-threatening injuries (such as severe bleeding, loss of consciousness, breathing or heart stoppage).</li> <li>Under emergency medical situation, ERC will assume charge of situation until the ambulance arrives or until the injured person is admitted to the emergency room</li> <li>Notify and submit report to PCU/DOR</li> <li>During road operations, Executive Engineer (EE) of Road Maintenance Division of DOR will take charge of any landslide hazard emergencies along the highway in similar manner as described above.</li> <li>If there is large scale landslide and flooding beyond the capacity of local emergency or disaster response team, EE will through head office, DOR inform the Dzongkhag Disaster Management Committee (DDMC) and to National Committee for Disaster Management (NCDM) for disaster management support and relieve effort.</li> </ul>
2.	Fire and Explosion	<p>Emergency Response Group (ERP) for every sub-projects during construction</p> <p>For large scale disaster - National Committee for Disaster Management (NCDM) through Dzongkhag Disaster management Committee (DDMC)</p> <p>Department of Roads (DOR) and Fire Service Division of Royal Bhutan Police (RBP) during operations.</p>	<ul style="list-style-type: none"> <li>Disaster zone will be temporarily closed for pedestrian and vehicular traffic till the return of normalcy declared</li> <li>Contractor will evacuate injured workers, and communities living in the area</li> <li>Emergency medical treatment will be sought if there are any life-threatening injuries (such as severe bleeding, loss of consciousness, breathing or heart stoppage).</li> <li>Under emergency medical situation, ERC will assume charge of situation until the ambulance arrives or until the injured person is admitted to the emergency room</li> <li>If small fire posing minimal safety or health hazards will be controlled with onsite fire extinguishers without evacuating site. When in doubt evacuate. Follow incident reporting to higher authorities, PCU/DOR and RBP.</li> <li>During road operations, Executive Engineer of Road Maintenance Division of DOR will take charge of any fire emergencies due to vehicular accidents carrying hazardous substances along the highway in similar manner as described above.</li> <li>If there is large scale explosion and fire beyond the capacity of local emergency or disaster response team to manage, EE will through head office, DOR inform the Dzongkhag Disaster management Committee (DDMC) and to National Committee for Disaster Management (NCDM) for disaster management support and relieve effort.</li> </ul>
3.	Fuel/Hazardous	Emergency Response	<ul style="list-style-type: none"> <li>Disaster zone will be temporarily closed for</li> </ul>

S.No	Emergencies	Management Authority	Response
	Substance Spillage	<p>Group (ERP) for every sub-projects during construction</p> <p>Department of Roads (DOR), RBP, and National Environment Commission (NEC) during operations</p>	<p>pedestrian and vehicular traffic till the return of normalcy declared</p> <ul style="list-style-type: none"> <li>Contractor will evacuate injured workers, and communities living in the area</li> <li>Emergency medical treatment will be sought if there are any life-threatening injuries (such as severe bleeding, loss of consciousness, breathing or heart stoppage).</li> <li>Under emergency medical situation, ERC will assume charge of situation until the ambulance arrives or until the injured person is admitted to the emergency room</li> <li>If small spill posing minimal safety or health hazards will be controlled with onsite spill kits (easily available is sawdust which readily absorbs any spill) without evacuating site. When in doubt evacuate. Follow incident reporting to higher authorities, PCU/DOR and NEC.</li> <li>During road operations, Executive Engineer of Road Maintenance Division of DOR will take charge of spills due to vehicular accidents carrying hazardous substances along the highway in similar manner as described above.</li> </ul>
4.	Vehicular-Wildlife collision	<p>Emergency Response Group (ERP) for every sub-projects during construction</p> <p>Department of Roads (DOR), Road Safety and Transport Authority (RSTA) and Wildlife office under Territorial Divisional Forest Office (DFO) during operations</p>	<ul style="list-style-type: none"> <li>If accidents occur during construction period, contractor will responsible for evacuation of injured persons</li> <li>Emergency medical treatment will be sought if there are any life-threatening injuries (such as severe bleeding, loss of consciousness, breathing or heart stoppage).</li> <li>Under emergency medical situation, ERC will assume charge of situation until the ambulance arrives or until the injured person is admitted to the emergency room</li> <li>During road operation period, under emergency medical situation, RSTA and RBP along with EE will assume charge of situation until the ambulance arrives or until the injured person is admitted to the emergency room</li> <li>Injured wild life as result of collision with passing vehicle will be rescued with the help of DFO and placed it the nearest forest centre for treatment and recuperation. The recuperated animal will be released back into the wild.</li> <li>During road operations, number of vehicular-wildlife collisions will be recorded, monitored and assessed by Wildlife expert hired as part of the CSC for the initial part of the road operations.</li> <li>Based on the assessment, the wildlife expert will recommend further mitigation measures to avoid future wildlife-vehicular collisions.</li> <li>Once the term for wildlife expert expires, the EE will assign the junior engineer (JE) to take the</li> </ul>

S.No	Emergencies	Management Authority	Response
			responsibility of managing emergencies related to vehicular-wildlife collisions in coordination of DFO.

**j. Recovery**

438. Recovery is defined as measures which support emergency affected individuals and communities in the reconstruction of physical infrastructure and restoration of emotional, economic, and physical well-being.

**k. Recovery Management**

439. EPG along with contractor will typically manage the road construction while DOR manage road operations:

- Damage assessment and categorization;
- Management of the demolition process;
- Provision of temporary services;
- Reinstatement of traffic signals;
- Road and bridge repairs
- Maintenance of environmental and workplace standards.



## **VIII. ECONOMIC ASSESSMENT**

440. This section characterizes the economic consequences of negative and positive impacts on environmental resources prior to and following the proposed mitigation measures described in the previous chapter. Whereas the sequential actions have been reviewed and impacts described, followed by mitigation measures, in this chapter the focus is on the resources that remain affected following mitigation and their value in the real economy, or system of monetary exchange.

441. Mitigation measures are intended to minimize impacts on specific environmental resources. Many of the proposed measures are necessary, or constitute good engineering practice, for project implementation. These measures have no associated implementation cost that can be attributed to environmental protection. Other measures, otherwise necessary, are reoriented to reduce related environmental impact, and still other measures that are strictly related to environmental protection.

442. Reference is made to the project economic analysis that has identified and quantified overall project benefits stemming from improved security and access, shorter travel times and distances, better provision of government social services, greater availability of jobs and income earning opportunities, improved markets for farm products, opportunities for securing and managing forest and wildlife conservation areas, and other benefits expected to derive from the project. These benefits are weighed against the environmental and social impacts of the project, which for the most part cannot be clearly quantified in monetary terms; however it is evident that benefits outweigh costs.

443. Quantification in monetary terms is difficult for many of the impacts and benefits for a variety of reasons. These include a) determining whether the measure should be included as an environmental cost or benefit; b) determining its magnitude and economic value; c) assigning a share of the cost to the 'environmental' category (as opposed to some other category of cost/benefit such as occupational, governance, or project management); and d) determining a suitable discount rate for calculation of the present worth of future costs and benefits. Assumptions must be made in each case to quantify economic impacts.

### **A. Physical Resources**

444. Air and water pollution and degradation of water and soil resources constitute impacts on physical resources caused by the project.

445. Air emissions are brought about by construction activities from equipment and vehicle emissions, from dust due to blasting and earthmoving operations, and from the movement of vehicles along unsealed roads. These air pollutants can have an economic impact in areas where there is exposure of human receptors. Economic impacts result from additional effort (time, materials and energy resources) in cleaning exposed surfaces where dust has settled in homes, shops and institutional buildings. Health impacts include increased respiratory exposure and eye damage resulting in costs related to medical treatment and time off work and school. Economic impacts during the operations phase are due to similar causes, e.g. costs associated with cleaning exposed surfaces and health impacts from air emissions from moving vehicles and interred dust along unsealed roadway surfaces.

446. Economic impacts during the construction phase due to air pollution (dust and fumes) can be estimated based on the number of small business and institutional establishments along

the construction right of way. For each of 11 main settlements that are directly served by the roads, estimate all such establishments with construction in the vicinity of each lasting two months, requiring added cleaning of indoor space for one hour per day at a time-value of Nu 21 (National Minimum Wage of Nu.165 divided by 8 working hours) for an overall economic value of Nu 252,000. Health impacts may be estimated by assuming a cost for medical treatment (say Nu 50 per visit) for respiratory illness and/or eye injury for some number of affected people (say 300), and lost time from work or other productive activity (say 1,000 days at Nu 165), for an economic value of Nu 180,400.

447. Economic impacts during the operations phase due to air pollution are expected to be nil, since the severity of such impacts are judged to be minor.

448. Water pollution during the construction phase occurs when sediment, and potentially oil, grease and spilt fuel is released to streams and drainage channels as a result of construction activity. Economic impacts occur if water sources are damaged by pollution or altered in a way that makes access more difficult. Costs are associated with the increased time required for obtaining water for household use and possibly with health damage from ingesting polluted water. Economic impacts during the operations phase stem from costs related to increased travel time to access household water in locations where sources have been irrevocably altered, costs incurred from damage to irrigation systems that were not accommodated by the placement of the road, and costs associated with flooding that stems from inadequate development of drainage channels below culverts that concentrate flow, including abrupt total or partial devastation of crops.

449. An economic impact during the construction phase due to water pollution is expected to be nil, since there is no significant impact on water quality due to the project. Economic cost due to interruption of potable or irrigation supply can be estimated based on assumptions about the number, frequency and duration of such interruptions and the time-value of persons required to haul water from other locations. If 10 such supplies are interrupted once only for a period of two weeks before resumption of the supply (since the mitigation measures call for assuring continuity of supplies in construction zones), requiring hauling of water from other locations for 400 families, requiring an additional hour per day each at a time-value of Nu 21/hr, the resulting economic cost is Nu 117,600. Economic impact due to interruption of irrigation supply is considered to be nil. Economic impact during the operations phase due to deterioration of water quantity and quality is considered to be nil. Economic benefit related to water quantity and quality is considered to be nil.

450. Soil degradation during the construction phase occurs due to loss of topsoil and possibly the deposition of sediment in agricultural fields where flooding occurs. The latter phenomenon may also occur during the operations phase. Economic impacts stem from loss of agricultural productivity in affected areas. However the amount of economic damage related to soil degradation is considered to be nil.

## **B. Biological Resources**

451. Reduction of forest cover, loss of wildlife habitat and reduced species diversity and productivity constitute impacts on biological resources caused by the project. Benefits accrue from improved access for management of forest resources and prevention of incursion by poachers.

452. Forest cover is affected during construction by the direct placement of roads, secondary losses related to placement of spoil and use of areas for construction camps, and possibly by construction workers that cut trees for fuel used in cooking and warmth. Economic impacts are related to the un-recovered value of trees and other non-timber forest products and to the carbon fixation value of displaced forests. Both negative and positive impacts occur during the operations phase: increased access to forests lead to cutting of trees and chronic land use change over time; however access also allows for improved protection of forest resources. Economic losses during operations may stem from the un-recovered value of forests if no compensatory tree plantation is carried out. Economic benefits generated from the sales of timber acquired from the clearing of forests and forests that are left in place due to improved management, along with the carbon fixation value.

453. The estimated economic value due to loss of forest cover during the construction phase is nil. Even though 166.8 acres or 68 ha of forest will be displaced, the Government has in place the means to recover economic value from the trees removed from the construction easement, hence no loss is incurred. Encroachment by construction workers that cut trees for fuel is considered to be insignificant given mitigation measures put into place. There is a carbon fixation value associated with forests variously estimated at \$3/Mt-C, \$150/ha-forest and \$132/ha as a mean value for total forest products and services (Merlo, 2005). Assuming the latter value and converting to Ngultrum yields a total value for the 68 ha of forest lost due to the project of Nu 565,488/-. If \$3/Mt-C is used, the value is Nu 1343,669/-.

454. Loss of wildlife habitat and reduced species diversity and productivity are brought about by the reduction of forest areas, the harvesting of animals for food by construction workers and by poaching (during operations of the road). Economic impacts are related to the un-recovered market value of the displaced wild animals when sold as meat and possibly the willingness of tourists to pay for visiting animal habitats and seeing wild animals in the wild. Both negative and positive impacts occur during the operations phase: increased access leads to increased poaching; while improved access also reduces the transaction costs associated with the willingness of tourists to pay for seeing wildlife habitats, while also providing the facilities and means for improved protection of animal resources.

455. The un-recovered market value of the displaced wild animals when sold as meat is considered as nil due to the lack of a market for wild meat in Bhutan. The willingness of tourists to pay for visiting wildlife habitats and seeing wild animals in the wild is nil due to the lack of access to areas within Bhutan affected by the project. Economic value of benefits related to improved access (reduced transaction costs associated with the willingness of tourists to pay to visit the area, and improved protection of animal resources), while real benefits, are not estimated due to the absence of any means for gaining a fix on the related values.

### **C. Socio-economic Resources**

456. Socioeconomic resources are affected negatively during construction by direct destruction of social assets, including water supply systems, irrigation systems, health care, educational facilities and the private properties (land, structures and tree plantations). Table 55 summarizes information gained during the field assessment of social impacts regarding resettlement/relocation, land acquisition and damage compensation. The Table 55 summarizes the numbers of affected households along the specific road segments that require resettlement, partial land acquisition, and/or entitlement for damages to property. It also provides summary cost of land acquisition and damage compensation for fruit trees.

**Table 54: Summary of Resettlement, Relocation and Compensation**

Lands	Affected land (acres)	Dry land (acres)	Wet land/ Paddy (acres)	Cash crop land (acres)	Affected household	Total cost estimates (Nu)
	63	46.03	1.16	15.81	208	43,552,932.00
Structures	56 Nos					10,025,619.00
Fruit Fodder and private trees	Fruit tree: 14,727 Nos Fodder trees: 19 Nos Private Trees: 106					6,265,732.00
Vulnerable group	Women headed households: 68 HHs. <b><u>Assistance recommended:</u></b> proposed Nu. 200/day/household for 3 months.					1,224,000.00
<b>Total cost estimates in Nu</b>						<b>61,068,283.00</b>

Source: Adopted from Resettlement and Land Acquisition Budget of Resettlement Plan, January 2014

#### **D. Physical Cultural Resources**

457. Physical cultural resources are affected negatively during construction by noise, dust and fumes, so long as these resources are sufficiently close to the construction zone. Economic impacts are related to their consequent loss of value. Physical cultural resources, including natural scenic locations, are affected negatively during operations by improved access, with consequent loss of value. At the same time, improved access reduces transaction costs associated with visiting the location, increasing the net gain from the overall willingness to pay for making the visit.

458. Economic costs and benefits associated with impacts on physical cultural resources including tourism resources are either nil or uncountable due to lack of any means for assessing costs or benefits. Table 56 provides overall monetary value of the economic impact of the project.

**Table 55: Summary of Economic Impacts**

Environment	Impacts	Amount (Nu)	Remarks
Physical	Economic impact due to dust pollution	252,000.00	Economic value of cleaning of dust
	Economic impact due to dust pollution	180,400.00	Loss of productive time because of respiratory illness, eye injury etc caused by dust pollution
	Economic impact due to water pollution and disruption	117,600.00	Damage and disruption of drinking water supply
Biological	Economic value of lost forest cover (166.8 acres or 67.5ha)	565,488.00	
	Loss of Carbon fixation value	1,343,669.00	
Socio-Economic	Loss of private properties such as land, structures and private plantations	61,068,283.00	Resettlement Cost
<b>Total Economic Impact value (Nu.)</b>		<b>63,527,440.00</b>	

## IX. ENVIRONMENTAL MANAGEMENT PLAN

459. The primary focus of the EMP is mitigation of environmental impacts occurring in the natural and social environment. The EMP consists of the following parts: (i) acquisition of prior clearances and no-objection certificates, (ii) a listing of environmental impacts and mitigation measures, responsibilities and their estimated costs; (iii) the environmental monitoring program for construction and operation periods; and (iv) the implementation framework of institutional and job responsibilities for mitigation and monitoring.

460. Mitigation measures that are the responsibility of the construction contractor have been included in the construction tender documents. The EMP is a draft document that will be revised during the prior construction and even during construction period according to preferred practices by the Asian Development Bank and the National Environment Commission of Bhutan.

### A. Acquisition of Prior Clearances and No-Objection Certificates

461. The primary focus of the Environmental Management Plan (EMP) is mitigation of environmental impacts occurring in the natural and social environment. The EMP consists of the following parts: (i) acquisition of prior clearances and no-objection certificates, (ii) a listing of environmental impacts and mitigation measures, responsibilities and their estimated costs; (iii) the environmental monitoring program for construction and operation periods; and (iv) the implementation framework of institutional and job responsibilities for mitigation and monitoring.

462. Mitigation measures that are the responsibility of the construction contractor have to be included in the construction tender documents. The EMP is a draft document that will be revised during the prior and even during the construction according to preferred practice by the Asian Development Bank.

### B. Mitigation Measures

463. Table 57 summarizes the status of clearances and no-objection certificates that are already obtained or are likely necessary for implementation of the construction works.

**Table 56: Status of Clearance and No-objection Certificates**

Agency or Group	Purpose and Status	Responsible Party	Timeframe
National Environment Commission	Environmental clearance required for Road up gradation and construction works. <b>Status: EIA report is prepared and will be submitted to NEC for Review and granting of Environmental Clearance</b>	DoR	Prior to construction
Dzongkhag	Administrative approval <b>Status: Administrative approvals acquired</b>	DoR	Prior to construction
DoFPS	Removal of trees in road construction <b>Status: Forest Clearance is obtained</b>	DoR	Prior to construction
Department of Culture	Location near cultural and religious sites <b>Status: No objection Certificates obtained</b>	DoR	Prior to construction

Agency or Group	Purpose and Status	Responsible Party	Timeframe
Private property or land owners	Consultation carried out and private land will donated by the communities: <b>Status: No objection Certificates obtained</b>	DoR GA & DA	Prior construction to
Royal Bhutan Army (RBA)	Within 50m of hospital Status: locations to be identified in detailed design. <b>Status: No objection Certificates obtained</b>	DoR	Prior construction to
Department of Education	Within 50m of school Status: locations to be identified in detailed design. <b>No objection Certificates obtained</b>	DoR	Prior construction to
BPCL	Relocation of power transmission line <b>Status: No objection Certificates obtained</b>	DoR	Prior construction to
Department of Roads	Access from highways and feeder roads <b>Status: No objection Certificates obtained</b>	DoR	Prior construction to

**Table 57: Detailed Site Specific Environmental Management Plan**

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
<b>Impacts on Air Quality and Noise During Construction</b>									
1	Construction activities: Excavating, grading, finishing etc. near communities area and wildlife habitat zones	Dust, fumes and noise in the vicinity of the worksite will cause air and noise pollution affecting communities and their properties; and forest resources and wildlife.	<ul style="list-style-type: none"> <li>Reduce dust level by spraying water within construction zone and haulage route using water tanker at least 2 times a day in all sensitive areas.</li> <li>For Nganglam-Khalatsho section water can be collected from Kirungri, Yargaywoongri, Gazawoongri and Tsokhiri Rivers.</li> <li>For Khalatsho-Dewathang section, water can be collected from Tsokhiri, Duiiri and Dungsamchhu Rivers.</li> <li>Each road sections will deploy minimum of 2 water tanker each.</li> <li>Remove and dispose construction debris promptly to pre-identified disposal sites</li> <li>Working hours in all settlement areas will be restricted between 8.00am-5.00pm.</li> <li>Implement noisy activities (such as drilling) intermittently rather than continuously especially in areas with settlements, schools, hospitals etc.</li> <li>Timely maintenance of construction vehicles</li> <li>Limit unauthorized vehicular movements</li> </ul>	<p>Sensitive areas: Nganglam town, Drangnalashingb orang, Dezama, Shuguri, Yargaywoong, Gazawoong, Chokhorling, Khalatsho, Rishore, Chenari, &amp; Dewathang,</p> <p>Wildlife Habitat: Km9-Km15 Km43-Km51</p>	<p><u>Monitoring Indicator:</u> Air (PM10) and noise level measurements</p> <p>Dust pollution; or complain of local residents</p>	<p>Air (PM10) and noise measurement</p> <p>Observations</p> <p>Public discussion</p>	Construction Contractor (CC)	Construction Supervision Consultant (CSC), Environmental Specialist (ES) and Project Management Office (PMU)	<p>Baseline condition on air and noise will be established prior to the start of construction.</p> <p>Monitoring will be carried out every month during construction.</p>
2	Operation of Quarries and borrow pits	<p>Location of quarries and borrow pits in unstable area and inside wildlife habitats will damage habitats and disturb wildlife;</p> <p>Quarries near community settlements will cause air and noise pollution.</p>	<ul style="list-style-type: none"> <li>Quarrying will be restricted inside the wildlife habitats and near the community settlements.</li> <li>Sand quarrying will be prohibited along Tsokhiri and Duiiri River as these forms part of important wildlife habitats</li> <li>Sand will be imported from neighbouring Assam if identified sand quarry at Yangbari is not materialized</li> </ul>	<p>Potential Sand quarry is identified at Yangbari, 32km from Nganglam</p> <p>Potential rock quarries identified near Kirungri, Mururi and Khalatsho</p>	<p><u>Monitoring Indicator:</u> Air (PM10) and noise level measurements ; Dust pollution; or complain of local residents ;</p>	<p>PM10 and noise measurements</p> <p>Observations</p> <p>Public discussions</p>	CC	CSC/ES	Monitoring will be carried out every month during construction.



S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
			<ul style="list-style-type: none"> <li>Separate applications will be prepared by the Contractor for establishment and operation of Quarries.</li> <li>Limit working hours from 8.00am-5.00pm</li> <li>Controlled blasting will be applied</li> <li>Water spraying carried out twice a day</li> </ul>						
3	Cement mixing, hot mix asphalt blending, asphalt curing and rock crushings	Noise pollution  Air pollution through release of noxious odours and fumes affecting communities, and forest and wildlife	<ul style="list-style-type: none"> <li>Facilities will be located at least 500m away from settlements and the wildlife habitat</li> <li>Machines will be operated during daytime between 8am-5pm only</li> <li>Reduce dust level by spraying water at least 2 times a day</li> <li>Noise levels within permissible limits</li> </ul>	Construction Sites	<u>Monitoring Indicator:</u> Air (PM10) and noise level measurements ; Dust pollution; or complain of local residents	PM10 and noise level measurements  Observations  Public discussions	CC	CSC/ES	Monitoring will be carried out every month during construction.
4	Blasting of Rock (Handling & Usage of Blasting Materials)	Loud blasting noise and subsequent vibration will affect human health, community structures and also cause wildlife disturbance	<ul style="list-style-type: none"> <li>Total controlled blasting with limited charges will be carried out in all sensitive locations including wildlife habitat area</li> <li>Only trained or certified blasters will be allowed to carry out blasting activities</li> <li>Blasting will be carried out strictly during daytime only between 8.00am to 4.00pm.</li> <li>Dzongkhag/District and Geog authorities; and communities nearby will be notified of blasting Schedules</li> </ul>	<p>Blasting will be required tentatively at following locations:</p> <p>Between Chainage Km19 to Km 24. Km31 to Km 40 Km51 to Km59</p> <p>Exact locations of blasting sites will be further updated by ES/CSC prior to the construction</p>	<u>Monitoring Indicator:</u> Amount of Blasting Material used, Blasting Schedules; deployment of certified & experienced blasters;	Review of Contractors blasting usage records.  Consultation with local authorities and affected communities	CC	CSC/ES	Daily monitoring will be carried out by CSC whenever blasting is required.
5	Operation of Construction equipment, machinery and vehicles	Air pollution from generation of harmful gases	<ul style="list-style-type: none"> <li>Regular maintenance of machineries, equipment and vehicles</li> </ul>	Construction Sites	<u>Monitoring Indicator:</u> Vehicle maintenance records	PM10 and noise Observations Public discussions	CC	CSC/ES & PMU	Weekly monitoring will be carried out by CSC

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
<b>Impacts on Air Quality and Noise During Operations</b>									
6	Vehicular emission and dust generation degraded road surface and material transports	Average Annual Daily Traffic by 2028 on NDH is estimated to be about 2,237 which is lower than rural traffics of most countries. Yet there will some air emissions from vehicles and the dust generated from degraded road surface and material transport can affect air quality	<ul style="list-style-type: none"> <li>Regular and correct maintenance of the road surfaces,</li> <li>Import Euro 3 emission standard vehicles</li> <li>Import of cleaner petrol and diesel</li> <li>Checking of vehicular emission standards and fine those who violate the maximum permissible emissions for different categories of vehicles</li> <li>Covering dusty materials while Transporting.</li> <li>Environmental awareness programmes for road users, and decision makers will be conducted</li> <li>Vehicular emission within Euro 3 standards</li> <li>Construct noise barriers in case the noise levels exceed the standard limits and become intolerable for settlements, hospitals, schools etc.</li> </ul>	Along the NDH or Roadways	<u>Monitoring Indicator:</u> Vehicular emissions level, PM10 levels, noise level, awareness programs implemented	PM10 levels and vehicular emission testing, and visual observation	DOR Field Divisions  Ministry of Economic Affairs  Road Safety and Transport Authority (RSTA)  Royal Bhutan Police (RBP)	DOR  NEC  RSTA  RBP	Every Six Months by DOR  Periodically by NEC  Yearly vehicular emission testing by RSTA  Periodical and random checking of vehicles by RBP
<b>Impacts on Soil Resources during Preconstruction</b>									
6	Finalization of Alignment considering topographical and geological conditions	Seismic events during operation cause damage to the roadway and adjacent property, and loss of life	<ul style="list-style-type: none"> <li>Detailed study of alignment considering environmental, socio-economic, topographical and geological conditions has been carried out.</li> <li>Final alignment has been chosen which avoids sensitive areas such as seismically active or geologically fragile areas (or land slide prone areas such as Regi Landslide); and environmentally sensitive places such as important wildlife habitat (Saltlick at Regi Area) and human settlements</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> Frequency of occurrences of landslides.  Frequency of maintenance, awareness program implemented	Review of documents, records and observations	CSC	PCU	Once prior to start of constructions
7	Identification of Quarries and borrow pits	Noise and air pollution impacts from quarrying and haulage	<ul style="list-style-type: none"> <li>Establishment of quarries will be prohibited within community areas and important wildlife</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> Quarry and borrow	Review of design documents,	CSC	PCU	Once prior to start of constructions

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
	locations	on wildlife and communities  Hazard due to accidents or slope failure due to quarrying operations	habitats (within Biological Corridor and Regi wildlife habitat area) <ul style="list-style-type: none"> <li>Sand quarrying is prohibited from Tsokhiri and Duri Rivers as it forms part of important wildlife habitats of Regi area</li> <li>Rock quarries are identified near Kirungri, Muru ri and Khalatsho area. However, the contractor will carry out separate study and apply for clearance from the Department of Geology &amp; Mines (DGM) and the National Environmental Commission (NEC).</li> </ul>		pit locations	records and site observations			
8	Recommendation of techniques for excavation and earth cutting works	Excess cutting and use of poor construction techniques will result in landslides and slope failures	<ul style="list-style-type: none"> <li>Environmental Friendly Road Construction techniques such as balance cut and fill method combined with civil &amp; bioengineering applications are incorporated into the detailed design</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> EFRC designs	Review of detailed design documents, records and observations	CSC	PCU	Once prior to start of constructions
9	Identification of site specific bioengineering techniques	Slope failures and erosion problems due to excavation of road formation	<ul style="list-style-type: none"> <li>DOR's bioengineering techniques will be used.</li> <li>Only local or native plant species as recommended under this study will be used</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> Recommended Bioengineering methods and plant species	Review of project design documents, records and observations	CSC	PCU	Once prior to start of constructions
10	Recommendation of Drainage Structures for wet and unstable areas	Slope failures during operation due to poor drainage in the road site.  Climate change effect such as extreme precipitations will further increase the rate of slope failures	Climate Change Adaptation recommendations as provided below has been incorporated into the detailed design: <ul style="list-style-type: none"> <li>42000m long Trapezoidal drain has been design and proposed for construction particularly along the road sections with high discharge</li> <li>About 26000m long improved L-drain in a lesser discharge area. Refer Figure VII-7 of the EIA Report.</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> Designs of both Cross and side drains; No of slab/box culverts; Number and size of Hume pipes	Review of detailed design documents and drawings	CSC	PCU	Once prior to start of constructions

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<ul style="list-style-type: none"> <li>58 Nos of Box culverts with diameter 3-5m is incorporated in the detailed design for streams with high discharge</li> <li>288 Nos of Hume pipes with diameter greater than 900mm is incorporated in the detailed design as relief culverts</li> </ul>						
11	Clearing and grubbing before initiating construction works	Degradation of surface water quality Erosion of exposed soil due to rainfall resulting in siltation of downstream water bodies	<ul style="list-style-type: none"> <li>Critical areas where chances of landslides and soil erosion are high have been identified.</li> <li>3 layers of 1m highway and 250m long Gabion Catch wall is incorporated in the detailed design and will be constructed prior to road construction in critical areas above Chokhorling village</li> <li>Similarly, log or boulder barriers are proposed in other less critical areas to prevent landslides and soil erosion.</li> </ul>	PCU/CSC Office	<u>Monitoring Indicator:</u> Types and length of catch walls and other barriers	Review of design documents and drawings	CSC	PCU	Once prior to start of constructions
12	Identification of disposal sites for construction debris	Improper disposal of construction debris will cause scarring of landscape, damage of wildlife habitat, soil erosion and subsequent siltation of downstream water bodies	<ul style="list-style-type: none"> <li>Disposal sites are identified and incorporated in the detailed design</li> <li>Project Management Unit (PMU) will apply for clearance of identified disposal sites from the local communities and Dzongkhag authorities</li> </ul>	PMU/CSC Office	<u>Monitoring Indicator:</u> Approval of disposal sites	Review of design documents and drawings	CSC/PMU	PMU	Once prior to start of constructions
<b>Impacts on Soil Resources during Construction</b>									
13	Earthwork and Excavation	Loss of nutrient rich top soil  Damage to farm land Soil erosion and slope failure  Disruption of the	<ul style="list-style-type: none"> <li>Final alignment proposed in the Detail design that avoids most unstable areas will be followed</li> <li>EFRC technique of balance cut and fill will be applied wherever feasible</li> <li>Detailed design recommended Batter Slopes for different soil</li> </ul>	All along the proposed highway.  Unstable areas to be avoided are at Chainage: Km6 – Km8	<u>Monitoring Indicator:</u> Arrangement for slope stabilization and design using EFRC concept; Type and length of construction	Site visits, review of design and contract documents.  Site observation	CC	CSC/PMU	Daily monitoring by CSC  Monthly monitoring by ES  Periodically by District

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		<p>natural flow of streams and rivers due to indiscriminate dump of construction debris</p> <p>Damage of private and community properties as well as Injuries to people living along the proposed road.</p> <p><b>Chokhorling</b> settlement and its inhabitants will be affected most during the construction due to its location on the downslope of the proposed road.</p> <p>Damage of wildlife habitats</p>	<p>types will be used for slope cutting:  Hard rock – batter slope 1:0.12  Soft rock – batter slope 1:0.25  Hard soil – batter slope 1:0.5  Soft Soil – batter slope 1:1</p> <ul style="list-style-type: none"> <li>• Wherever feasible top soil will be scrapped and stored for reuse for bioengineering application.</li> <li>• Earthwork and excavation will be carried out during dry season from late September till May.</li> <li>• Excavation will be done using Excavator machine. Use of bulldozers will prohibited to minimize environmental damages</li> <li>• Construction spoil from all feasible construction sites will be disposed in pre-identified dumpsites.</li> <li>• Construction debris from the first cut along the road sections where slopes are more than 60% may fall downhill due to difficulties in retrieving the excavated material. However, the spoil from the second cut will be transported to designated dumpsites.</li> <li>• To protect or avoid damages to the community properties and injuries to the residents of Chokhorling village, 3layers of 1m high and 200m long Gabion catchwall is proposed and incorporated into the detailed design. it will be constructed prior to the start of roadway excavation.</li> <li>• Similarly, in other less critical areas, log or boulder barriers will be constructed to prevent downhill settlements and wildlife habitats.</li> <li>• Construction waste disposed at</li> </ul>	<p>Km49 – Km50</p> <p>Important wildlife Habitat where log or boulder barriers to be erected: Km9-Km15 Km43-Km59</p> <p>Other Important settlements where log or boulder barriers to be erected are Drangnalashing, Dezama, Shuguri, Yargaywoong, Khalatsho, Rishore, Chenari and Dewathang.</p> <p>At Chokhorling village roughly between chainage Km26.5-Km28.5</p> <p>Road stretches where slopes are greater than 60% are Km19-Km23, Km26-Km28, Km31-Km38, Km50-Km60</p>	<p>barriers (log, boulder and gabion walls);  Application of bioengineering.  Number of disposal sites;  Scarring of landscapes;  Construction schedules; and  Use of EFRC recommended construction equipment</p> <p>;</p>	<p>s,  Interaction with local communities</p>			<p>Environment Officer  (Representing NEC )</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			approved site						
14	Blasting of Rock (Handling & Usage of Blasting Materials)	<p>Blasting will weaken geology and lead to slope instability and failures. This may cause injuries to human and animals; and also cause damage to community and private properties.</p> <p>Unstable slope and failure may also damage wildlife habitats</p> <p>Risk of accidents and injuries to construction workers</p> <p>Pollution of ground and surface water due to leakage of toxic materials and wastes</p> <p>Risk of theft and misuse of explosive by unauthorized persons or miscreants</p>	<ul style="list-style-type: none"> <li>Transportation, handling and storage of explosive will be carried out as per prescribed rules – “Explosive rules of the Ministry of Home &amp; Cultural Affairs)</li> <li>Store explosives gelatin and detonators separately in steel containers under lock and key</li> <li>Dispose explosive waste safely by burying them in 5-8 feet deep pits</li> <li>Total controlled blasting with limited charges will be carried out at all sensitive locations including wildlife habitat area</li> <li>Only trained and certified blasters will be allowed to carry out blasting activities</li> <li>Blasting will be carried out strictly during daytime only between 8.00am to 4.00pm.</li> <li>Dzongkhag/District and Geog authorities; and communities nearby will be notified of blasting Schedules to prevent people and the animals from straying into blasting zone in order to prevent accidents and injuries</li> <li>Appropriate warning /Cautionary signs such as hoisting of red flags, signage, whistles, megaphones will be used</li> <li>Occupational health and Safety gadgets such as first aid kits, helmets, boots, gloves, gas masks, goggles etc. will be provided to the workers</li> <li>To reduce the risk of slope failure and thereby accidents, the contractor will ensure the slopes are properly excavated and dressed.</li> <li>Contractor will ensure the</li> </ul>	<p>Blasting will be required tentatively at following locations:</p> <p>Between Chainage Km19 to Km 24. Km31 to Km 40 Km51 to Km59</p> <p>Exact locations of blasting sites will be further updated by ES/CSC prior to construction or even during construction stages.</p>	<p><u>Monitoring Indicator:</u> Amount of Blasting Material used, handling process, storage&amp; record keeping, incidences of accidents, and other types of damages</p>	<p>Review of Contractors blasting storage, handling, and usage records.</p> <p>Consultation with local authorities and affected communities</p>	CC	CSC/ES & PMU	<p>Daily monitoring by CSC</p> <p>Monthly monitoring by ES</p> <p>Periodically by District Environment Officer (Representing NEC )</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<p>availability of appropriate emergency vehicle always at standby to evacuate any injured person to the nearest health center.</p> <ul style="list-style-type: none"> <li>Contractor will be liable for the payment of health and life insurance of workers and others in the event of accidents</li> </ul>						
15	Placement of roads parallel and transverse to rivers.	Damage to roadway due to undercutting of road foundation.	<ul style="list-style-type: none"> <li>Road embankments is placed above highest water level</li> <li>Adequate flood protection structures as given in detailed design will be constructed</li> <li>Embank and flood protection works carried out</li> </ul>	Construction zones but specifically at chainages: Km4.6-Km5 Km 43.7-Km44 Km57-Km58	<u>Monitoring Indicator:</u> Road alignment; Embankment and flood protection works	Review of design and field visit	CC	CSC/ES & PMU	<p>Monthly monitoring by CSC</p> <p>Periodically by District Environment Officer (Representing NEC )</p>
16	Geotechnical Risks to the Roadway Environment due to slope instability and erosion	<p>Soil erosion and landslides due to slope instabilities and thereby damaging or losing entire road</p> <p>Clogging of drains and culverts</p> <p>Loss of fertile top soil</p> <p>Damage to the natural vegetation and the habitat</p> <p>Siltation of streams and rivers thereby impacting aquatic lives</p>	<ul style="list-style-type: none"> <li>Final alignment proposed in the Detail design that avoids most of the unstable areas will be followed</li> <li>EFRC technique of balance cut and fill will be applied wherever feasible</li> <li>Civil slope protections along with bioengineering will be applied</li> <li>In critical areas particularly Shuguri slide area; catch drains (French / horizontal drains); soil nailing as well as use of mesh/shotcrete will be considered.</li> <li>Log or boulder barriers will be constructed to reduce soil erosion and landslides</li> <li>Construction works will be carried out during dry season from late September till May.</li> </ul>	Construction zones  Unstable slopes at Chainage Km6-Km8 Km49-Km50	<u>Monitoring Indicator:</u> No of slope failure and landslides; Slope protection works	Review of design and field visit	CC	CSC/ES & PMU	<p>Monthly monitoring by CSC</p> <p>Periodically by District Environment Officer (Representing NEC )</p>
17	Disposal of construction debris and	loss of topsoil Damage of farmland, Damage to properties	<ul style="list-style-type: none"> <li>using spoils for reclaiming the degraded land in consultation with local community</li> </ul>	Disposal Sites at Chainages: 0+650, 0+850,	<u>Monitoring Indicator:</u> Planning for Spoil	Review of planning and	CC	CSC/ES & PMU	Monthly monitoring by CSC/ES



S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
	spoils.	Disruption of natural drainage, Damages of wildlife habitat, air and water pollution	<ul style="list-style-type: none"> <li>No disposal will allowed in the areas of fragile slopes, floodways, farmland, forest areas, natural drainage path, religious and cultural sites, canal and other infrastructures</li> <li>spoils will be disposed in the designated sites</li> <li>spoil benches to be built for filling disposal area rather than few larger ones to avoid slope overloading</li> <li>Spoil benches will be compacted using rollers</li> <li>Site will be rehabilitated with appropriate bioengineering works and provide proper drainage.</li> <li>Bioengineering using plantation local plants carried out</li> </ul>	4+500, 8+100, 11+250, 12+200, 14+500, 16+250, 20+000, 24+500, 25+250, 27+250, 29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500.	deposition, Current Practices of Spoil disposal,	practice of spoil disposal, site visit and interaction with contractors , site engineers and other stakeholders			Periodically by District Environment Officer (Representing NEC )
18	Operation of equipment storage and repair yards, and fuel depots	Oily waste is improperly disposed off; spilled fuels contaminate soil and pollute water.	<ul style="list-style-type: none"> <li>Secondary containment around fuel tanks and at fueling stations will be placed</li> <li>Oil and fuel spills will be prevented</li> <li>Runoff from contaminated areas will be controlled</li> </ul>	Equipment yards and fueling stations	<u>Monitoring Indicator:</u> Equipment maintenance records, availability of spent oil storage facilities, Oil spillage and runoffs	Review maintenance record Site visit and observation	CC	CSC/ES & PMU	Monthly monitoring by CSC/ES  Periodically by District Environment Officer (Representing NEC )
19	Closure of equipment yards and camps	Failure to render a site clean and safe at the end of use poses both a sanitary and safety hazard.	<ul style="list-style-type: none"> <li>Equipment yards and camp sites will be cleaned; pit toilets will be refilled; regarded; and the area will be revegetated using the local plant species.</li> </ul>	Construction and labor camps	<u>Monitoring Indicator:</u> Status of closed equipment yards	Review document and site observation	CC	CSC/ES & PMU	After shifting or closure of camps or equipment yards  Periodically by District Environment Officer (Representing NEC )
<b>Impacts on Soil Resources during Operations</b>									
20	Operation of roadways	Landslides and other erosion issues.	<ul style="list-style-type: none"> <li>Appropriate engineering structures and bioengineering techniques will be adopted</li> </ul>	Along the roadways	<u>Monitoring Indicator:</u> Landslides and	site observation and review	DOR Field Divisions	DOR	Every Six Months

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
			<ul style="list-style-type: none"> <li>Regular inspection and maintenance will be carried out</li> </ul>		erosions	of documents and records			
21	Operation of Roadways: Impacts due to Location	Seismic events cause damage to the roadway and adjacent property, and loss of life	<ul style="list-style-type: none"> <li>Earthquake risk incorporation in the design and subsequent construction will minimize the effects of seismicity</li> <li>During operations, appropriate engineering measures will be further applied to fix road damages</li> <li>Regular maintenance will be carried out</li> </ul>	Specific road section	<u>Monitoring Indicator:</u> Road conditions such sinking and deformation due to seismic events	site observation and review of documents and records	DOR Field Divisions	DOR	Every Six Months
<b>Impacts on Water Resources and Water Quality during Detailed Design</b>									
22	Planning location, designs, sizes of road side drains, culverts and bridges	<p>NDH falls within sub-tropical zone with high rainfall particularly during monsoons. Therefore, proper sizing and location of cross drains, side drains and bridges are critical as the project is likely to experience effects of extreme climates.</p> <p>Climate change is expected to bring about extreme and intense rainfall within short intervals leading to flooding which will cause damages to bridges and culverts. Road pavements will also be damaged from storm water overflow due to inability of side drains to cope with excessive rainfalls.</p>	<p>Climate Change Adaptation measures listed below will be applied:</p> <ul style="list-style-type: none"> <li>42000m of Trapezoidal drains have been proposed in all high storm water discharge areas.</li> <li>26000m L-Drains have proposed in lesser discharge areas such as ridge tops and along alignments on higher elevations. The current proposed L-drain is designed with 20% slope as compared to the 15% slope of the existing L-drain designs. Refer Figure VII-7 for Trapezoidal and L-drain designs. These designs are part of the detailed design of NDH.</li> <li>58 Nos of Box or Slab culverts of 3-5m widths are proposed and incorporated into the detail design as part of climate change adaptations</li> <li>Similarly, 288 Nos of Hume pipes with diameter greater 900mm have been proposed and incorporated in the design. Wider Hume pipes as relief crossings will be able to cope with increasing/intense rainfalls</li> <li>Cross drains particularly Slab or</li> </ul>	CSC office; along the road corridor; bridge locations	<u>Monitoring Indicator:</u> Incorporation of Trapezoidal and improved L-drain design; sizes and lengths of trapezoidal and L-drains; placement and Nos of slab/Box and Hume pipe crossings; and bridge height and locations	Review of design documents, technical specifications and bid documents  Site observations  Discussion with site engineers	CSC	PMU	Prior to construction works

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<p>Hume pipe crossings will be placed along the naturally gullies to avoid landslides and erosion downstream.</p> <ul style="list-style-type: none"> <li>Using existing Kirungri bailey bridge which is adequately placed above highest flood level</li> <li>Tsokhiri and Duiri Bridges has been relocated downstream from their earlier feasibility study locations.</li> </ul>						
23	Design of road sections running near river or streams	Scouring of roadway embankments parallel to rivers undermines roadway, releases sediment, and affects water quality.	<ul style="list-style-type: none"> <li>Road is adequately placed above the maximum high flood level with embankment protection.</li> </ul>	CSC office; along the road sections at Kirungri, Menchudrangri, Tsokhiri and Duiri rivers	<u>Monitoring Indicator:</u> Incorporation of EA recommendation in design and bid documents	Review of design documents, technical specifications and bid documents	CSC	PMU	Prior to construction works
24	Recommendation of river training and protection structures.	Disturbances in natural flow of river/stream and damage to road structures during operation.	<ul style="list-style-type: none"> <li>Gabion retaining walls are proposed and incorporated in the detailed design to protect road and river embankments.</li> </ul>	CSC office; along the road sections at Kirungri, Menchudrangri, Tsokhiri and Duiri rivers	<u>Monitoring Indicator:</u> Incorporation of EA recommendation in design and bid documents	Review of design documents, technical specifications and bid documents	CSC	PMU	Prior to construction works
<b>Impacts on Water Resources and Water Quality during Construction</b>									
25	Earthworks and excavations	Disposal of excavated materials on hillside and nearby streams and rivers will cause excess sedimentation, creation of temporary dams which may burst and cause disturbances to aquatic ecology.	<ul style="list-style-type: none"> <li>Log or boulder barriers will be constructed on the valley side to control spillage of any excavated material.</li> <li>Indiscriminate dumping of excavated material or construction debris into streams and rivers will be prohibited until and unless it is totally unavoidable due to the steepness of the construction terrains</li> <li>Excavated material will be disposed as far as possible in a pre-identified disposal sites.</li> <li>spoil benches to be built for filling disposal area rather than few</li> </ul>	<p>Construction zones where dumping of spoil is prohibited are along settlements, biological corridors and important wildlife habitat of Regi area.</p> <p>Disposal Sites at Chainages: 0+650, 0+850, 4+500, 8+100,</p>	<u>Monitoring Indicator:</u> Planning for spoil disposal, current practices of spoil disposal, landscape scarring; Water quality tests (turbidity, pH; conductivity) of major water rivers ;	Review of planning and practice of spoil disposal, water quality monitoring; site visit and interaction with contractors , site engineers	CC	CSC/PMU	<p>Daily monitoring by CSC,</p> <p>Monthly monitoring by ES</p> <p>Periodically by District Environment Officer (Representing NEC )</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			larger ones to avoid slope overloading <ul style="list-style-type: none"> <li>Spoil benches will be compacted using rollers</li> <li>Site will be rehabilitated with appropriate bioengineering works and provide proper drainage.</li> <li>Disposal area benched and drainages provided</li> <li>Bioengineering using plantation local plants carried out</li> </ul>	11+250, 12+200, 14+500, 16+250, 20+000, 24+500, 25+250, 27+250, 29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500.		and other stakeholders			
26	Operation of equipment storage and repair yards, and fuel depots	Oily waste is improperly disposed-off as well as fuel spillage will contaminate soil and pollute water.	<ul style="list-style-type: none"> <li>Secondary containment around fuel tanks and at fueling stations will be built</li> <li>Oil and fuel spills, and other runoff from contaminated areas will be controlled.</li> <li>Equipment and fuel depots will be placed in safe zones away from drinking water sources and along river banks</li> </ul>	Equipment yards and fueling stations	<u>Monitoring Indicator:</u> Equipment maintenance records, availability of spent oil storage facilities, Oil spillage and runoffs	Review maintenance record Site visit and observation	CC	CSC/ES & PMU	Daily monitoring by CSC,  Monthly monitoring by ES  Periodically by District Environment Officer (Representing NEC )
27	Construction of road side drains, culverts and bridges	Insufficient and improper side and cross drainages coupled with climate change triggered extreme and intense rainfall within short intervals leading to flooding, which will cause damages to bridges and culverts.  Road pavements will also be damaged from storm water overflow and runoff due to inability of side drains to cope with the excessive rainfalls.	<ul style="list-style-type: none"> <li>42000m of Trapezoidal drains will be constructed in all high storm water discharge areas as per the CCA designs</li> <li>And remaining section in a lesser discharge area; 26000m of improved L-drain.</li> <li>58 Nos of Box or Slab culverts of 3-5m will be constructed in all high discharge streams</li> <li>Similarly, 288 Nos of Hume pipes with diameter greater 900mm will be constructed as a relief culverts to cope with changing rainfall intensity</li> <li>Cross drains or culverts will be placed along the natural gullies to avoid landslides and erosion downstream.</li> <li>Existing Bailey bridge over Kirungri River will be used.</li> </ul>	Along the NDH;  Bridge locations at  Menchudrangri Bridge at Chainage Km 42.3  Tsokhiri Bridge at Km 43.8  Duri Bridge at Km 57.3	<u>Monitoring Indicator:</u> Incorporation of Trapezoidal and improved L-drain design; sizes and lengths of trapezoidal and L-drains; placement and Nos of slab/Box and Hume pipe crossings; and bridge height and locations	Review of design documents, technical specifications and bid documents  Site visit and observation	CSC	PMU	Daily monitoring by CSC,  Monthly monitoring by ES  Periodically by District Environment Officer (Representing NEC )

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<ul style="list-style-type: none"> <li>Bridges over Tsokhiri and Duri rivers will be constructed over design recommended locations</li> </ul>						
<b>Impacts on Water Resources and Water Quality during Operations</b>									
28	Slope Instability and erosion during road operation	Landslide and erosion due to heavy rainfall will cause excess sedimentation thereby degrading downstream water quality which will damage the aquatic ecology.	<ul style="list-style-type: none"> <li>Regular and correct maintenance of the slope protection measures and drainage works will be adopted,</li> <li>Minor landslides, erosion, and mass wasting will be immediately cleared and slope restored with appropriate technology (preferably bioengineering),</li> <li>Soil conservation activities within the ROW and beyond will be carried out in coordination with the relevant organizations,</li> <li>Environmental awareness programmes for local communities, road users, and decision makers will be conducted</li> <li>Bioengineering carried out</li> </ul>	Landslide prone area	<u>Monitoring Indicator:</u> Frequency of occurrence of slide, Frequency of maintenance, awareness programs implemented	Review of document, records and site observations	DOR Field Divisions	DOR	Every Six Months
<b>Impacts on Forests during Pre-construction</b>									
29	Site clearance or Removal of vegetation for roadways	<p>About 167 acres of forest land will be cleared and converted into roadways. Approximately 9700 trees will be removed.</p> <p>Vegetation clearance and tree felling will result in damage of natural wildlife habitat. Damage and destruction of rare and threatened; and endangered plant species as listed under Schedule I of FNCA 1995 and red list plants under CITES</p>	<ul style="list-style-type: none"> <li>Nganglam-Dewathang Highway (NDH) or road has adopted 7.5m formation width which is in the between the Primary (10.5m) and Secondary National Highway (7.5m). The reduced formation width substantially limits the need for vegetation removal</li> <li>Vegetation clearance and tree cutting will be carried out as per the Forestry Rules and Regulations (FNCR) of 2006</li> <li>Road construction zone requiring tree felling will be clearly marked.</li> <li>Tree inventory and marking will be carried out along the road corridor</li> <li>Unnecessary tree felling will be avoided at all cost</li> <li>Economically valuable timbers</li> </ul>	<p>Construction zones where dumping of spoil is prohibited are along the settlements, biological corridors and important wildlife habitat of Regi area.</p> <p>Disposal Sites are at Chainages: 0+650, 0+850, 4+500, 8+100, 11+250, 12+200, 14+500, 16+250, 20+000, 24+500, 25+250, 27+250,</p>	<u>Monitoring Indicator:</u> Road corridor and Road formation width; No of tree felled and handed over to NRDCL; Compensatory plantation site identified.	Review of document, records and site observations	PCU ES	DOR CSC	Prior to the start of road construction work

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
		<p>Appendix II.</p> <p>Schedule I plant: Eagle wood/Indian Aloe Wood (<i>Aquilaria malaccensis</i>)</p> <p>CITES Appendix II (<i>Alsophila spinulosa</i> syn. <i>Cyathia spinulosa</i>, <i>Alsophila brunoniana</i> syn. <i>Cyathia</i> and <i>Dioscorea deltoidea</i>).</p>	<p>will be handed over to Natural Resources Development Corporation Limited (NRDCL)</p> <ul style="list-style-type: none"> <li>Unmarketable trees and logs will be collected, stored and used for constructing log barriers for slope protection and erosion control.</li> <li>Environmental Specialist (ES) under Construction Supervision Consultant (CSC) will be trained to identify the threatened, endangered and protected plant species</li> <li>ES will carry out the ground survey to verify the existence of important plant species that needs protection, rescuing and relocation or rehabilitation.</li> <li>In event, the existences of rare and threatened; endangered and protected plants are confirmed; ES will notify the PMU and the DFO; and accordingly the plant (/s) will be rescued and relocated to a remote natural habitat with the technical assistance of the local forestry experts.</li> <li>ES in consultation with Local Forest Office; geog administration and the communities will identify the suitable for compensatory plantation sites.</li> <li>Depending on the availability of vacant barren land, a compensatory plantation of 1:1 will be carried out.</li> </ul>	29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500.					
<b>Impacts on Forests during Construction</b>									
30	Right of Way/land clearing; earthwork and Excavation	Road formation cutting and excavation combined with improper disposal of construction debris will damage downhill forest cover and the	<ul style="list-style-type: none"> <li>Clearing of ROW will be limited to the minimum required.</li> <li>Wherever feasible road formation cutting will be limited to 7.5m to minimize the damage on forest cover</li> <li>At all feasible sites or locations;</li> </ul>	<p>Construction ROW</p> <p>Divisional Forest Office</p>	<p><u>Monitoring Indicator:</u></p> <p>Width of ROW, Road formation width; and forest areas scarred by falling construction</p>	Review of document, records and site observations	CC	ES/CSC	<p>Daily monitoring by CSC,</p> <p>Monthly monitoring by ES</p> <p>Periodically by</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		natural habitats	<p>the boulder or log barriers will be erected to avoid the construction debris from rolling downhill and damaging forest cover.</p> <ul style="list-style-type: none"> <li>Construction spoil from all feasible construction sites will be disposed in pre-identified dumpsites.</li> <li>In difficult construction terrains where slopes are more than 60%, the construction debris from the first cut may fall downhill due to difficulties in retrieving the excavated material. However, all spoil generated from the second cut will be transported to designated dumpsites.</li> <li>Spoil disposed of in the approved sites</li> </ul>	Road stretches where slopes are greater than 60% are Km19-Km23, Km26-Km28, Km31-Km38, Km50-Km60	debris				District Environment Officer (Representing NEC )
31	Activities of Construction Workers; placing of construction, operation and shifting of camps	Illegal firewood and timber extraction by construction workers may result in deforestation.	<p>Briefing laborers/construction workers Forestry rules and regulations on illegal activities such as felling of trees, fishing and hunting.</p> <p>Camps to be placed in secure location away from sensitive forest area</p> <p>Providing cooking gas or kerosene to discourage use of firewood</p> <p>Firefighting equipment to be provided</p>	Labour camps	<u>Monitoring Indicator:</u> Status of Camp site, availability of cooking gas or kerosene, firefighting equipment, illegal hunting and felling of trees	Field observation of campsite, interaction with workers, local community and other stakeholders	CC	CSC/ES	<p>Daily monitoring by CSC,</p> <p>Monthly monitoring by ES</p> <p>Periodically by District Environment Officer (Representing NEC )</p>
32	Burning plant matter in construction zone.	Dry subtropical forests are susceptible to forest fires. Uncontrolled fire may damage forest resources.	Burning plant residue will be strictly prohibited to avoid forest fires and air pollution	Construction zones	<u>Monitoring Indicator:</u> No of forest fires	Field observation	CC	CSC/ES	Monthly monitoring by ES
33	Blasting of Rock (Handling & Usage of Blasting Materials)	<p>Blasting will weaken geology and lead to slope instability and failures.</p> <p>Slope failure/landslide</p>	<ul style="list-style-type: none"> <li>Transportation, handling and storage of explosive will be carried out as per prescribed rules – “Explosive rules of the Ministry of Home &amp; Cultural Affairs)</li> </ul>	Blasting will be required tentatively at following locations:	<u>Monitoring Indicator:</u> Amount of Blasting Material used, handling process, storage& record	Blasting records, Field observation	CC	CSC/ES	<p>Daily by CSC</p> <p>Monthly monitoring by ES</p> <p>Periodically by</p>



S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		will damage forest covers downhill.	<ul style="list-style-type: none"> <li>• Store explosives gelatin and detonators separately in steel containers under lock and key</li> <li>• Dispose explosive waste safely by burying them in 5-8 feet deep pits</li> <li>• Total controlled blasting with limited charges will be carried out at all sensitive locations including wildlife habitat area</li> <li>• Only trained and certified blasters will be allowed to carry out blasting activities</li> <li>• Blasting will be carried out strictly during daytime only between 8.00am to 4.00pm.</li> <li>• Dzongkhag/District and Geog authorities; and communities nearby will be notified of blasting Schedules to prevent people and the animals from straying into blasting zone in order to prevent accidents and injuries</li> <li>• Appropriate warning /Cautionary signs such as hoisting of red flags, signage, whistles, megaphones will be used</li> <li>• Occupational health and Safety gadgets such as first aid kits, helmets, boots, gloves, gas masks, goggles etc. will be provided to the workers</li> <li>• To reduce the risk of slope failure and thereby accidents, the contractor will ensure the slopes are properly excavated and dressed.</li> <li>• Contractor will ensure the availability of appropriate emergency vehicle always at standby to evacuate any injured person to the nearest health center.</li> <li>• Contractor will be liable for the payment of health and life</li> </ul>	<p>Between Chainage Km19 to Km 24. Km31 to Km 40 Km51 to Km59</p> <p>Exact locations of blasting sites will be further updated by ES/CSC prior to construction or even during construction stages.</p>	keeping, incidences of accidents, and other types of damages				District Environment Officer (Representing NEC )

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			insurance of workers and others in the event of accidents						
34	Operation of Stone crusher plant	Dust generated from the stone crushing operation will cover vegetation with fine layer of dust that will have impact on plant life	<ul style="list-style-type: none"> <li>Water spraying at least thrice a day will be carried out to subdue to the dust generated</li> </ul>	All forested areas along the roadways	<u>Monitoring Indicator:</u> PM10 level, and dust covers of over surrounding vegetation;	Review documents, Field observation and dust measurements	CC	ES	Monthly monitoring by ES  Periodically by District Environment Officer (Representing NEC)
<b>Impacts on Forests during Operation</b>									
35	Operation of roads	Failure in bioengineering structures installed during construction. Poor seedling survival; rate or regeneration of compensatory tree plantation activities carried out in construction stage.	<ul style="list-style-type: none"> <li>Alternative bioengineering or engineering measures will be adopted for slope stabilization</li> <li>Regular watering and monitoring of seedling survival and re-vegetation</li> <li>Appropriate protection measures such as fencing to preventing cattle from eating and trampling freshly planted seedlings.</li> </ul>	Along the NDH or Roadways	<u>Monitoring Indicator:</u> Success of bioengineering, slope failures, Rate vegetation regenerations, Success of compensatory plantation	Review of documents, field observations	DOR Field Divisions	DOR	Every Six Months
<b>Impacts on Wildlife during Construction</b>									
36	Right of Way/ land clearing; earthwork and Excavation	<p>Road formation cutting and excavation combined with indiscriminate dumping of construction debris will damage downhill wildlife habitats.</p> <p>Road excavation on hill side will damage the migratory path and block the movement of Asian elephant (a flagship species which is found in the project area). The impact can occur in the habitat</p>	<ul style="list-style-type: none"> <li>Prior to start of road construction, ES &amp; WS along with Forest &amp; Wildlife expert of Divisional Forest Office (DFO) will survey and determine all possible elephant migratory routes.</li> <li>WS &amp; ES will also determine and restrict felling of tall and matured trees including the Ficus trees which are the sources of food and nesting place for the hornbills.</li> <li>Clearing of ROW will be limited to the minimum required.</li> <li>Wherever feasible road formation cutting will be limited to 7.5m to minimize the damage on forest cover</li> <li>At all feasible sites or locations;</li> </ul>	<p>Construction ROW</p> <p>Specifically at chainages:</p> <p>Biological Corridor: Km9-Km15</p> <p>Regi area: Km43-Km51</p> <p>Disposal Sites are at Chainages: 0+650, 0+850,</p>	<u>Monitoring Indicator:</u> Width of ROW, Road formation width; No. and type of tree felling; disposal of construction debris; Observance of construction timing; Construction and effectiveness of log and boulder barriers; Allowance of temporary elephant passes; No of permanent	<p>Review of document, records and site observations</p> <p>Consultations with site engineers</p>	CC	<p>WS/ES/CSC</p> <p>Forestry &amp; Wildlife Expert of Divisional Forest Office (DFO)</p>	<p>Daily monitoring by WS/ES/CSC during construction inside critical wildlife habitat</p> <p>Periodically by District Environment Officer (Representing NEC), DFO and NEC</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		<p>area of Regi – between Tsokhiri and Duiiri Rivers.</p> <p>Felling of tall and matured fruiting trees will damage the habitat and food sources of Roufous necked hornbill.</p> <p>Noise from operation of construction equipment will disturb wildlife.</p> <p>Continuous construction activities may deter wildlife from visiting saltlicks</p>	<p>the boulder or log barriers will be erected to avoid the construction debris from rolling downhill and damaging forest cover.</p> <ul style="list-style-type: none"> <li>Construction spoil from all feasible construction sites will be disposed in pre-identified dumpsites.</li> <li>In difficult construction terrains where slopes are more than 60%, the construction debris from the first cut may fall downhill due to difficulties in retrieving the excavated material. However, all spoil generated from the second cut will be transported to designated dumpsites.</li> <li>Construction activities within the important wildlife habitat will be restricted between 8.00am-4.00pm to allow wildlife crossing, foraging and visit saltlick.</li> <li>Temporary passage for elephant movement will be made during construction.</li> <li>Permanent elephant crossings with gentle slope that is deemed suitable by WS and the DFO; will be built at all known crossing points. The elephant crossings will be blended with the natural surroundings.</li> <li>blowing of horns of the vehicles will be totally prohibited</li> <li>Elephant crossing signage will be placed both sides before entrance into an important habitat or elephant migratory paths. Placement of signage will be decided by ES in consultation with wildlife experts of DOFPS.</li> <li>Vehicular speed will be limited to 30km/hr</li> <li>Further as a long term mitigation</li> </ul>	4+500, 8+100, 11+250, 12+200, 14+500, 16+250, 20+000, 24+500, 25+250, 27+250, 29+100, 30+500, 34+500, 35+000, 40+000, 40+500, 44+000, 48+000, 50+000, 52+500, 64+000, and 66+500.	elephant crossings with recommended slopes; Appropriate wildlife corridor and traffic signages				

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			measures, wildlife habitat enrichment activities such as planting of native bamboos, fruiting and fodders trees will be carried out within and outside the critical wildlife habitat zones. WS in collaboration with DFO will determine the suitable plant species for elephant habitat enrichment.						
37	Construction bridges over Tsokhiri and Duiiri Rivers	<p>Tsokhiri and Duiiri Rivers are perennial water bodies and it is part of the important wildlife habitat.</p> <p>Elephants use banks of Menchudrangri and Tsokhiri rivers as their migratory passage while river beds of Duiiri River are used.</p> <p>Construction of bridges over these rivers will permanently alter their traditional migratory routes and disrupt their movements.</p>	<ul style="list-style-type: none"> <li>Bridges over Menchudrangri and Tsokhiri Rivers will be built accommodating only the HFL without elephant underpass since elephants do not use the riverbed to migrate up and downstream.</li> <li>However, the slopes on the bridge embankments on both sides will be kept gentle. Embankments will be blended into natural surrounding by bioengineering applications</li> <li>Elevated bridge at Duiiri River with almost 10m in Height from the riverbed will be built to allow elephant passage through river bed and the banks.</li> <li>Bridge construction works will be carried out from 8.00am-4pm.</li> <li>Temporary passages will be maintained at all times in all bridge locations.</li> <li>No construction camps will be erected at the bridge sites.</li> </ul>	<p>Menchudrangri Bridge at Chainage Km 42.3</p> <p>Tsokhiri Bridge at Km 43.8</p> <p>Duiiri Bridge at Km 57.3</p>	<p><u>Monitoring Indicator:</u> Bridge locations; Maintenance of temporary passages; Side slopes of Mechudrangri and Tsokhiri river bridges; Height and length of Duiiri bridge; Erection of construction camps</p>	<p>Review of document, records and site observations</p> <p>Consultations with site engineers</p>	CC	WS/ES/CSC	<p>Daily monitoring by ES/CSC,</p> <p>Periodically by District Environment Officer (Representing NEC ) and DFO</p>
38	Activities of Construction Workers; placement of construction, operation and shifting of camps	<p>Illegal felling of trees and extraction of non-timber products will lead to damage of wildlife habitat and its inhabitants.</p> <p>Illegal fishing and poaching of wildlife by labourers will impact</p>	<ul style="list-style-type: none"> <li>Briefing laborers/construction workers Forestry rules and regulations on illegal activities such as felling of trees, fishing and hunting.</li> <li>Camps to be placed in secure location away from the wildlife habitat</li> <li>Providing cooking gas or kerosene to discourage use of firewood</li> </ul>	Labour camps at Km0.6; Km7; Km17; Km41; Km63	<p><u>Monitoring Indicator:</u> Status of Camp site, availability of cooking gas or kerosene, firefighting equipment, illegal hunting and felling of trees</p>	Field observation of campsite, interaction with workers, local community and other	CC	CSC	<p>Daily monitoring by CSC,</p> <p>Monthly monitoring by ES</p> <p>Periodically by District Environment Officer</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
		wildlife survivals within the project area.	<ul style="list-style-type: none"> <li>Firefighting equipment to be provided</li> </ul>			stakeholders			(Representing NEC) and DFO
<b>Impacts on Wildlife during Operation</b>									
39	Operation of Roadways: Impacts due to Location	Roadways provide access to forested areas which will accelerate illegal logging and wildlife poaching.	<ul style="list-style-type: none"> <li>Forest officials equipped to perform surveillance of areas affected by wildlife poaching.</li> <li>Regular patrolling to be carried out to monitor the wildlife poaching and curb illegal logging.</li> </ul>	Biological corridors and important wildlife habitat of Regi area.	<u>Monitoring Indicator:</u> Number of illegal fishing, logging and poachings	Field observations and interview of locals	DFO	DOFPS	Every Six Months
40	Operation of vehicles along roadways.	Vehicle collisions with wildlife.	<ul style="list-style-type: none"> <li>WS will carry out monitoring of vehicle-wildlife collision; assess the effectiveness of wildlife crossings; and recommend the changes and further rectification works.</li> <li>Maintain and repair wildlife crossing signages posted during construction.</li> <li>Speed limit to be observed.</li> <li>Honking will be prohibited</li> </ul>	Biological corridors and important wildlife habitat of Regi area	<u>Monitoring Indicator:</u> Number of vehicular collisions with wildlife	Field observations and interview of locals	DOR	WS/DFO	Monthly Monitoring by WS till the end of construction defect liability period.  Periodically monitoring by DFO
<b>Impacts on Socio-economic Environment</b>									
<b>Impact on Land Tenure during Pre-construction</b>									
41	Land and Property Acquisition	<p>Loss of 63 acres of land comprising of: Dryland - 46.03 acre Wetland – 1.16 acres Orchard -15.81 acres</p> <p>Loss of : Fruit trees: 14,727 Nos Fodder tree: 19 Nos Private tree: 106 Nos</p> <p>Acquisition of 56 Nos of temporary and permanent structures</p>	<ul style="list-style-type: none"> <li>Land and property acquisition will be carried out as per the Resettlement Plan prepared separately as part of the project.</li> <li>NDH follows RNPII design with 7.5m formation to minimize the land take and property acquisitions.</li> <li>Land Compensation Rate 2009 will govern the compensation payment</li> <li>Qualified engineer will carry out the valuation of structures that needs to be acquired.</li> <li>As far as possible land substitution will be provided within the same geog</li> <li>Resettlement issues such as land substitutions, property acquisition and compensation</li> </ul>	<p>Along the settlements:</p> <p>Nganglam town, Drangnalashing; Dezama; Shuguri; Yargaywoong; Chokhorling; Khalatsho; Rishore; Chenari; Dewathang town</p>	<u>Monitoring Indicator:</u> Land substitution Cash compensation of properties acquired.	Review records Interview affected persons	PMU	DOR	Prior to the construction

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
			payment will be completed prior to the start road construction works. <ul style="list-style-type: none"> <li>Grievances will be redressed through establish Grievance Redress Mechanism.</li> </ul>						
<b>Impact on Land Tenure during Operation</b>									
42	Operation of roadways	Public lands are encroached upon for private use	<ul style="list-style-type: none"> <li>Public land encroachment will be prohibited</li> </ul>	Construction ROW	<u>Monitoring Indicator:</u> Land encroachment	Field observations	Geog administration	Dzongkhag Administration	Yearly
<b>Impact on Labour Rights during Constructions</b>									
43	Placement, operation and shifting of Labour camps as well as the living conditions	Placement of labour camps in hazardous areas will cause injuries to occupants;  Inadequate or lack of sanitation facilities such as provision for clean drinking water and toilet facilities will lead to spread communicable disease with subsequent health problems;  Labour camps located close to settlements will lead unwanted interaction and may lead to spread of communicable disease such as TB and HIV/AIDS	<ul style="list-style-type: none"> <li>Labour or construction camps will be placed in a safe zone; away from elephant migratory paths and important wildlife habitats; and away from steep landslides and fire prone areas.</li> <li>Construction camps will be placed at sufficient distance (if possible at least 500m) away from the nearest settlement;</li> <li>Labourers will be recruited based on health screening as per current RGOB guidelines</li> <li>HIV/AIDS awareness and protection measures will be carried out for local communities and the labourers by the contractor in consultation with PMU</li> <li>First Aid Kit will be made available for all construction camps</li> <li>Fire and rain proof materials will be used for camp construction</li> <li>Clean piped drinking water supply will be made available for all construction camps</li> <li>Pit toilet will be constructed to curb open defecations</li> <li>Solid waste disposal pit will be dug and operated</li> <li>Contractor will evacuate sick and</li> </ul>	Labour camps at Km0.6, Km7, Km17, Km41, Km63  CSC/ES/PMU will decide further labour camp locations during constructions.	<u>Monitoring Indicator:</u> Placement of labour camps; Availability first aid services; Health awareness campaigns; Provision of clean piped drinking water; Availability of Pit latrines; Solid waste disposal sites; provision for evacuation of injured persons; Provision of health and safety insurances	Review documents, records, Field observations	CC	CSC/PMU	Once prior to start of construction;  Every time when labours camps are shifted.  Periodical monitoring by District Environment Officer (Representing NEC )

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<p>injured to the nearest medical centers.</p> <ul style="list-style-type: none"> <li>Contractor will liable for health and safety insurance for labourers working under hazardous conditions</li> </ul>						
44	Safety of workers at site	Road construction work in a mountainous terrain is risky and hazardous to the workers. Slope failure and falling boulder and stones from the cut slopes will result in injuries and even death to the workers.	<ul style="list-style-type: none"> <li>Occupational health and safety guidelines of RGOB will be strictly followed.</li> <li>Provision of safety gadgets such as helmets, boots, gloves, goggles, and ear plugs etc. will be made available for all construction workers.</li> <li>Contractor will ensure that cut slope are properly dressed by removing loose and hanging boulders.</li> <li>Only authorized personnel with adequate training and experience will be allowed to work in hazardous conditions such as rock drilling and blasting activities.</li> <li>First Aid kit will be made available</li> <li>Contractor will evacuate injured to the nearest medical centers.</li> <li>Contractor will liable for health and safety insurance for labourers working under hazardous conditions</li> </ul>	For all construction sites.	<u>Monitoring Indicator:</u> OHS plans; Availability of safety gears; No of injuries; Availability of first kit; Provision of emergency rescue and evacuation;	Review documents, records, Field observations	CC	CSC/PMU	<p>daily during construction;</p> <p>Periodical monitoring by District Environment Officer (Representing NEC )</p>
<b>Public Liability of Contractor and Damage to Water Supply System during Construction</b>									
45	Right of Way/ land clearing; earthwork and Excavation	Road formation cutting and excavation combined with indiscriminate dumping of construction debris will damage private land, local infrastructures such as watershed; water tanks and water supply lines	<ul style="list-style-type: none"> <li>In consultation with local authorities and communities, road construction and widening within the community areas will be carefully planned and executed.</li> <li>Temporary water supply provisions will be made prior to the start of constructions.</li> <li>Road formation cutting will be limited to 7.5m to minimize the damage on water supply system</li> <li>At all feasible sites or locations;</li> </ul>	<p>Construction ROW</p> <p>Specifically at chainages:</p> <p>Chokhorling watershed area between chainage Km27-Km28</p>	<u>Monitoring Indicator:</u> Width of ROW, Road formation width; No. of water supply system damaged	Review of document, records and site observations	CC	ES/CSC	<p>Daily monitoring by ES/CSC,</p> <p>Periodically by District Environment Officer (Representing NEC )</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		<p>Road construction through Chokhorling watershed will damage water tanks and will result in shortage of water supply for the village</p> <p>Similarly, water tanks and water pipelines for Rishore, Chenari and Dewathang town will be damaged during road excavation and widening.</p>	<p>the boulder or log barriers will be erected to avoid the construction debris from rolling downhill and damaging local infrastructures</p> <ul style="list-style-type: none"> <li>Construction spoil will be disposed in pre-identified dumpsites.</li> <li>To minimize the damage on chokhorling watershed; 2 Nos of Slab/Box culverts 3-5m span with shallow foundations will be built.</li> <li>3 layers of gabion or boulder barriers of 1m high and 300m each will be constructed on downhill side prior to the road excavations works to prevent spoils from falling down and damage the water supply.</li> <li>Similarly, log and boulder barriers will be built for all other critical locations within settlement areas.</li> </ul>	Water supply of Rishore; Chenari and Dewathang;					
<b>Damage of Private Properties and Injuries to local inhabitants during Construction</b>									
46	Right of Way/ land clearing; earthwork and Excavation	Road formation cutting and excavation combined with indiscriminate dumping of construction debris will damage private land and cause injuries to people living on downhill side. The impact will be severe at Chokhorling village as the road passes through the upslope of the village	<ul style="list-style-type: none"> <li>Road construction will be carried out in consultation with the local communities.</li> <li>All necessary safety measures such as restriction of movements; placement of flagmen; and cautionary signages will be put in place in all construction site through settled areas.</li> <li>3 layers of gabion or boulder barriers of 1m high and 250m each will be constructed all along downslope facing the Chokhorling village. The barriers will be built prior to the road excavations works to prevent spoils from falling down and damage the private properties.</li> <li>If the accidents and injuries occur due to construction safety lapses, contractor will take full responsibility of evacuating the</li> </ul>	For all settlements as well as Chokhorling village area between chainage Km26.5-Km27.3	<u>Monitoring Indicator:</u> Boulder barrier dimension; location and effectiveness; No of damaged properties; No of accidents and injuries	Review of document; records and site observation s; consultation with the communities living with ROW	CC	ES/CSC	<p>Daily monitoring by ES/CSC,</p> <p>Periodically by District Environment Officer (Representing NEC )</p>



S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
			<p>injured person to the nearest medical center. Appropriate compensation line with RGOB will be paid to injured person.</p> <ul style="list-style-type: none"> <li>Similarly, in the event of damage of any private or community properties, contractor will take full responsibility rebuild or restore the damaged properties. E.g. if the house is damaged due to falling debris, contractor will ensure to provide temporary shelter till the damaged house is restored and is deemed safe to occupy.</li> </ul>						
<b>Damage of Public utilities during Construction</b>									
48	Rural Electricity Supply Pole and Lines and transformer,	<p>About 22 numbers of electricity supply poles (some with support wires) and 2 transformers are located adjacent and along the project road alignment.</p> <p>Construction work may directly or indirectly damage the electric poles. Damage of electricity poles will result in disruption of local power supply.</p>	<ul style="list-style-type: none"> <li>Prior to the start of construction work, PMU will verify and confirm nos of electricity poles that will inevitably need relocation.</li> <li>PMU in consultation with affected communities, local government and Bhutan Power Corporation (BPC) will come with plans and strategies to carry out the relocation works.</li> <li>Temporary electricity supply will be provided till the permanent supply is restored.</li> <li>Road widening will be limited to 7.5m in all feasible areas to minimize the damage of other electricity poles</li> <li>Indiscriminate dumping of spoil will be prohibited.</li> </ul>	Electricity poles are found at Chainages 0+100, 2+350, 4+100, 29+000, 62+420, 63+290, 63+390, 63+900, 63+950, 64+550, 64+580, 65+060, 65+110, 65+230, 65+280, 65+310, 65+430, 65+440, 65+450, 65+470, 65+500, 65+700 Transformers at Km 65+200	<u>Monitoring Indicator:</u> Nos of electric poles relocated; Temporary power supply	Review of document; records and site observation s; consultation with the affected communities	PMU  CC	DOR  CSC	<p>Prior to start of construction.</p> <p>Daily monitoring during construction</p> <p>Periodically by District Environment Officer (Representing NEC )</p>
49	Telephone poles and lines	<p>About 6 telephone poles and lines are located above and below along the road alignment</p> <p>Road widening will damage telephone</p>	<ul style="list-style-type: none"> <li>Prior to the start of construction work, PMU will verify and confirm nos of telephone poles that will inevitably need relocation.</li> <li>PMU in consultation with local government and Bhutan Telecom (BT) will come with plans and strategies to carry out</li> </ul>	Telephone poles at chainages 65+210, 65+280, 65+400, 65+430, 65+610, 65+640.	<u>Monitoring Indicator:</u> Nos of telephone poles relocated	Review of document; records and site observation s; consultation with the	PMU  CC	DOR  CSC/ES	<p>Prior to start of construction.</p> <p>Daily monitoring during construction</p> <p>Periodically by</p>

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
		poles and lines resulting in communication disruption.	<ul style="list-style-type: none"> <li>the relocation works.</li> <li>Road widening will be limited to 7.5m in all feasible areas to minimize the damage of other electricity poles.</li> </ul>			affected communities			District Environment Officer (Representing NEC)
<b>Impact on Cultural/Religious assets during Construction</b>									
50	Meme Lungkhangma labtsa (Sacred Guru Nye);	Sacred Meme Lungkhangma Latsa is located adjacent to existing farm road on the saddle. Unplanned and haphazard road widening and construction activities will damage sacred site.	<ul style="list-style-type: none"> <li>Road widening will be carried out on the opposite side slope.</li> <li>Widening will be limited to 7.5m only</li> <li>Labour camp construction will be prohibited in the area.</li> <li>Blasting will be avoided</li> <li>Temporary access to the sacred site will be provided</li> <li>Spoil dumping towards sacred site will be prohibited.</li> </ul>	Sacred site at Chainage: Km 11.8	<u>Monitoring Indicator:</u> Damage to sacred site; Spoil disposal; Temporary access provision; Permanent access restored	Site observation ; Consultation with local communities	CC	CSC/ES	Daily monitoring during construction  Periodically by District Environment Officer (Representing NEC)
51	Thujaycholing lhakhang/temple	Thujaycholing temple is located about 30-40m above on the hilltop from the proposed road alignment; road excavation and earthworks may weaken the slope and ultimately the temple foundation. Construction activities will also disrupt temple visitors	<ul style="list-style-type: none"> <li>Construction works will be carried out during dry season.</li> <li>3m high and 200m long gabion retaining/breast wall will be constructed to prevent slope failure.</li> <li>For further slope stabilization Bioengineering works will be carried out</li> <li>Construction works will be carried out during daytime from 8.00am-5.00pm only</li> <li>Temporary access to the temple will be provided.</li> <li>Permanent access will be built once road construction is completed.</li> </ul>	Temple at Km26.6	<u>Monitoring Indicator:</u> Damage to temple foundation; provision for temporary access; restoration of permanent access	Review design documents; site observations and consultation with local communities	CC	CSC/ES	Daily monitoring during construction  Periodically by District Environment Officer (Representing NEC)
52	Luu (Big Boulder considered as abode of snake deity)	Luu is located right at the road adjacent. Road construction activities may damage the Luu.	<ul style="list-style-type: none"> <li>Road alignment will be shift at least 2m away from the Luu (Boulder)</li> <li>No excavation will be carried out in and around the boulder.</li> <li>If necessary, drywall will be built around the boulder to protect it from damage.</li> </ul>	Luu at chainage Km65.5	<u>Monitoring Indicator:</u> Site conditions around Luu; Alignment shift  ; ;	Review design documents; site observation and consultation with local communities	CC	CSC/ES	Daily monitoring during construction  Periodically by District Environment Officer (Representing NEC)

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/Frequency
			<ul style="list-style-type: none"> <li>Road widening limited 7.5m</li> <li>No blasting carried out;</li> <li>Temporary access provided</li> </ul>			es			)
53	Gesar Dala Lhakhang or Temple	Boundary fence of temple is located right at the road adjacent. Road construction activities may damage the fence.	<ul style="list-style-type: none"> <li>Road width will be restricted to 7.5m to avoid the damage of temple fence</li> <li>If damaged, new fence will be erected</li> </ul>	At Dewathang	<u>Monitoring Indicator:</u> Fence damage	Review design documents; site 155bservation and consultation with local communities	CC	CSC/ES	Daily monitoring during construction  Periodically by District Environment Officer (Representing NEC)
54	Dantak Memorial Chorten/Stupa	Boundary wall of stupa is located right at the road adjacent. Road construction activities may damage the wall.	Existing road is wide near the stupa wide enough with only slight adjustment requirement. However, following mitigation measures are still proposed in the event there are damages to the chorten boundary wall: <ul style="list-style-type: none"> <li>Road width will be restricted to 7.5m to avoid the damage of temple fence</li> <li>If widening is required, it will be carried out on the opposite of the stupa;</li> <li>If boundary wall is damaged, new wall will be constructed</li> </ul>	At Dewathang	<u>Monitoring Indicator:</u> Boundary Wall damage	Review design documents; site 155bservation and consultation with local communities	CC	CSC/ES	Daily monitoring during construction  Periodically by District Environment Officer (Representing NEC)
<b>Emergency Response During Construction</b>									
55	Slope failure and landslides, fire and explosion, fuel/hazardous substance spillage, occupational health and safety, vehicular-wildlife collision	Risk of injury and death	Prevention and mitigation to eliminate or reduce the impact of a hazard and increase the resilience of an affected community to recover from the consequences of a hazard as given in chapter VII, section F.	Through out the alignment	<u>Monitoring Indicator.</u>  <u>Availability of emergency response plan;</u> <u>organization of an Emergency Planning Group (EPG) for each sub-project;</u> <u>training on ERP;</u> <u>conduct of field and desk exercises</u>	Accomplishment report	PIU	CSC/ES	Semi-annual
<b>Emergency Response During Operation</b>									
56	Slope failure and landslides,	Risk of injury and death	Prevention and mitigation to eliminate or reduce the impact of a hazard and	Through out the alignment	<u>Availability of emergency</u>	Accomplishment	PIU	CSC/ES	annual

S.No	Activities /Issues	Adverse Impacts	Mitigation Measures	Location	Monitoring Indicators	Monitoring Methods	Responsible Implementing Agency	Responsible Monitoring Agency	Schedule/ Frequency
	fire and explosion, fuel/hazardous substance spillage and vehicular-wildlife collision		increase the resilience of an affected community to recover from the consequences of a hazard as given in chapter VII, section F.		<u>response plan;</u> <u>organization of an Emergency Planning Group (EPG) for each sub-project;</u> <u>training on ERP;</u> <u>conduct of field and desk exercises</u>	report			

Notes: CC-Construction Contractor, CSC - Construction Supervision Consultant, DA- Dzongkhag Administration, DC- Design Consultants, DGM - Department of Geology and Mines, ES-Environment Specialist, DoFPS - Department of Forests and Park Services, DoR-Department of Roads, NEC - National Environmental Commission, PCU - Project Coordination Unit; PMU – Project Management Unit

### **C. Environmental Monitoring and Reporting**

464. Monitoring the implementation of mitigation measures will be the responsibility of various parties over the duration of the Project. These parties will in turn be responsible for reporting the results of their monitoring activities. Reporting is a tiered operation that provides summary information at higher levels of accountability, generally in conjunction with reporting done for the overall progress of the Project. Monitoring and reporting refers to the period of loan implementation. Monitoring activities during operations are also addressed herein; however the accountability for implementation of mitigation measures during the operations phase is the responsibility of the RGoB rather than the contractor.

465. The first tier of monitoring is the responsibility of the Environmental Management Officer(s) (EMO) working for the construction contractor(s), who must assure that construction contract obligations are being carried out. The EMO will prepare monthly report on a simplified checklist to demonstrate compliance with obligations, providing the report to the Environment Specialist (ES) engaged with the CSC.

466. ES as part of the construction supervision consultant (CSC) will work in conjunction with the PCU. The PCU engages, via reports, the Environmental Unit (EMU) of the DoR. It should be noted that the ES staff are working as agents for the PCU and the DoR. ES have no authority outside of that granted by the DoR. Among other duties, ES will be responsible for assuring the accuracy and completeness of reporting by the EMO and compiling monthly reports into quarterly summaries and biannual reports to be forwarded to the PCU. The PCU will then forward the biannual reports to ADB for disclosure on the ADB website.

467. This system refers primarily to the loan implementation period, and within that to construction activities. It also can provide monitoring and reporting during the pre-construction period; however there is no involvement of the EMO under the construction contractor. Post-construction monitoring and reporting requires a different form of accountability.

468. Table 59 provides a summary of mitigation measures, parameters to be monitored in respect to each measure, the location and frequency of monitoring, the primary party responsible for performing the monitoring function, and the monitoring cost. In respect to frequency of monitoring, Table 57 reports 'monthly' for parameters that may be monitored continuously by persons in the field, but is reported monthly. Parameters that are monitored quarterly will be reported during the month that they are monitored. In respect to 'primary party responsible', other parties are required to monitor the parameter and verify that the reporting provided through the tiered system is accurate; however the indicated party is the one directly responsible for performing the monitoring and filing the initial report. In respect to cost, often the expense of hiring a staff is sufficient to cover the cost of monitoring, so the entry is then 'no cost'.

**Table 58: Environmental Monitoring (Inspection, Monitoring and Verification Activities)**

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
<b>Impacts on Air Quality and Noise during Construction</b>					
1.	<p>Reduce ambient dust levels by regular spraying of water on exposed earth in construction zone and haul routes where there is potential for human exposure.</p> <p>Remove construction debris and spoil piles</p> <p>Impose traffic controls to reduce public exposure.</p> <p>Cover transport vehicles</p>	<p>Air quality testing and monitoring</p> <p>Direct observation of work progress at jobsite</p>	Construction zone; particularly in settlement and important habitat area	Monthly during construction	PMU and CSC/ES
2.	Spraying of water in quarrying areas and proper covering of vehicles carrying quarried materials	Direct observation of work progress at jobsite	Quarries and construction sites	Monthly	PMU and CSC/ES
3.	<p>Select haul routes around community areas</p> <p>Operate vehicles during restricted hours in village limits</p> <p>Introduce traffic controls to reduce contact between the public and construction activity.</p> <p>Complete segments passing through populated areas before starting new construction</p>	<p>Review of proposal for haul routes. Inspection at jobsite</p> <p>Discussion with community leaders</p> <p>Inspection of jobsite.</p> <p>Inspection of jobsite</p>	Construction office Construction zone	<p>Before starting work in community area.</p> <p>Monthly</p> <p>Monthly</p> <p>Monthly</p>	PMU and CSC/ES
4.	<p>Locate cement mixing and asphalt blending facilities at a sufficient distance from human receptors to eliminate the impact.</p> <p>Conduct activities during daylight hours if there are communities nearby and inside important habitat.</p> <p>Water areas where dust accumulates regularly.</p> <p>Locations for facilities approved by the PMU.</p>	<p>Review of contractor proposal and direct inspection at jobsite</p> <p>Inspection of jobsites</p> <p>Inspection of jobsites</p> <p>Inspection of jobsites</p>	<p>Construction office</p> <p>Jobsite</p> <p>Jobsite</p> <p>Jobsite</p>	<p>Upon set up of facilities</p> <p>Monthly</p> <p>Monthly</p> <p>Monthly</p>	PMU and CSC/ES
5.	Prepare a blasting procedure requiring area restrictions, prior warning of workers and nearby residents, restrictions on the timing of blasts and worker safety. Utilize control blasting whenever possible. Limit blasting to midday hours in all areas	Review of draft procedure. Inspection at jobsite	Construction zone	Upon preparation of procedure	PMU and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	with wildlife.  Procedure to be approved by the PMU and applied rigorously in the work environment.	Discuss with PMU supervisor	Thimphu	Monthly Upon approval of procedure	
6.	Regular maintenance of all machinery, equipments and vehicles.	Inspection at jobsite	Construction zone	Monthly	PMU and CSC/ES
<b>Impacts on Soil Resources during Pre-construction</b>					
7.	Stop land clearing and excavation in rainy periods. Use Log or boulder barriers at the base of slopes subject to erosion. Seed and stabilize slopes and embankments.  Include costs for erosion control (EFRC cost) in the contract bid proposal	Inspection at jobsite  Review contract bid.	Construction zones  Thimphu	Monthly  Upon preparation of contract bid	PMU and CSC/ES
<b>Impacts on Soil Resources during Construction</b>					
8.	Introduce bioengineering techniques as recommended in detailed design to stabilize soils during construction and for finishing slopes.	Review of bioengineering plan and Inspections at jobsite	Construction office and construction zones	Monthly	PMU
9.	Blasting procedures in effect at quarry and borrow pit. Local government clearance obtained prior to use of the area.	Review of official documents and No objection statements	PMU Office	Before the opening of quarries and before initiation of blasting activities	PMU
10.	Place road embankments above highest water level and use gabions for river training as given in detailed design and to prevent scouring	Review of detailed design document and visual inspection at jobsites.	Construction zones	Monthly (during construction of roads falling near rivers)	PMU
11.	Use appropriate excavation and cutting (EFRC) techniques recommended in detailed design and incorporate sufficient safety factors in the determination of slope stability.  Develop and apply means for predicting slope failures in advance and buttress slopes where necessary.	Review of detailed design document. Visual inspections of jobsites.  Inspection of jobsites.	Construction office and construction zones  Jobsite	Monthly  Monthly	PMU
12.	Prohibition of throwing of construction debris in any sites other than the designated disposal sites identified at the detailed design stage	Inspections at jobsite. Review of disposal site plan and field	Construction zones	Monthly	PMU

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
		inspection of disposal sites.			
13.	Install secondary containment around fuel tanks and at fuelling stations. Prevent oil and fuel spills, control runoff from contaminated areas.	Inspection at jobsite	Equipment yards and fuelling stations	Monthly	PMU and CSC/ES
14.	Remove above-grade structures, clean up construction camp debris and backfill latrines; grade, re-vegetate the area and tree planting under the compensatory forest program.	Inspection at jobsite	Construction and labour camps	Immediately after shifting of a labour camp	PMU and CSC/ES
<b>Impacts on Soil Resources during Operation</b>					
15.	Adoption of appropriate engineering and bioengineering structures and techniques	Site visits	Specific road section	Quarterly after completion of all construction	DoR Field Division
16.	Take appropriate engineering measures to fix damages.	Site visits	Specific road section	Quarterly	DoR Field Division
<b>Impacts on Water Resources and Water Quality during Construction</b>					
17.	Use of log barriers or boulder barriers at the base of slopes to hold any excavated material that may fall. No dumping of excavated material or construction rubble on hill side and into streams and rivers nearby (in accordance with DoR's EFRC guidelines) Reuse of excavated material as far as possible and disposal of unwanted material in proper designated disposal sites	Inspection of jobsites	Construction zone	Monthly	PMU and CSC/ES
18.	Install secondary containment around fuel tanks and at fuelling stations. Prevent oil and fuel spills, control runoff from contaminated areas.	Inspection of jobsites	Equipment yards and fuelling stations	Monthly	PMU and CSC/ES
19.	Develop downstream drainage channels to assure continuity of the drainage system		Jobsite		CSC/ES
<b>Impacts on Forests during Pre-construction</b>					
20.	Prepare an inventory and remove marketable timber under a separate contract before construction begins. Clear only unmarketable trees and brush remaining in the construction right-of-way.  Obtain necessary government permits for cutting trees	Review inventory and contract agreement  Review forestry permit	Construction ROW	Before conduction of clearing works	DoFPS  DoFPS



No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
21.	Demarcate right-of-ways and trees before clearing begins.	Inspection of jobsites.	Construction ROW	Before conduction of clearing works	PMU and ES
<b>Impacts on Forests during Construction</b>					
22.	Provide compensatory planting to replace trees removed along the right-of-way. Barren land and abandoned camp sites could be potential locations for carrying out the plantations  Re-vegetation of slopes above and below road through appropriate bioengineering techniques where necessary.  Re-vegetation of road shoulders to help recover some of the vegetated area lost	Assess area of compensatory plantation; species planted; number of trees planted; and survival rate.  Assess success of bioengineering works for all slope protection sites  Assess success of re-vegetations.	Construction ROW  Construction ROW  Construction ROW	At the end of the construction of each road section.  Monthly  Monthly	CSS/ES/DOFPS
23.	Punish illegal removal of trees from public lands outside construction zone.	Discuss with local forestry officials	Construction ROW	monthly	DoFPS
24.	Maintain minimum construction right-of-way, remove only trees that interfere with construction and limit access to adjacent land.  Widening of the standard width of right-of-way to be approved by the CSC supervisor. Prohibit disposal of spoil materials and any other forms of construction debris over the edge of the hillside.	Measurement of ROW. development unwanted accesses  Discussion with PMU  Inspection of jobsite	Construction zones  Head office DoR  Construction zone	Monthly  Before start of construction work of each road segment  Monthly	PMU and CSC/ES
25.	Prohibit fishing, hunting and gathering of firewood among workers.  Provide construction camps with food supplies from purchased stores.	Review contract signed between contractor and DoR. Discussion with local forestry officials on occurrences of poaching. Inspection of jobsite. Discussion with workers	DoR Head office  Jobsites and labour camps	Before initiation of contract work and monthly.  Monthly.	PMU and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Provide firewood for warmth from legitimate sources or stock piled from materials cleared from the roadway construction zone.	Inspection of jobsite. Discussion with workers	Jobsites and labour camps	Monthly	
26.	Avoid burning plant residue by placement of materials into stockpiles outside the line of construction, preferably in contours along slopes below the roadway grade.	Inspection of jobsites	Construction zones	Monthly	PMU and CSC/ES
27.	Construction of log or boulder barriers on hill side to help catch falling debris if any.  Dispose of all spoil materials in designated disposal sites.	Inspection of jobsites  Inspection of disposal sites	Construction zone  Disposal sites	Monthly  Monthly	NEC PMU and CSC/ES
28.	Regular spraying (twice a day) of water in stone crushing site to minimize dust	Inspections at jobsite	Stone crushing sites	Monthly	PMU and CSC/ES
<b>Impacts on Forests during Operation</b>					
29.	Adoption of alternate bioengineering or engineering measures.  Regular watering and monitoring of seedling survival and re-vegetation and taking of appropriate measures such as fencing, preventing of cattle to eat freshly planted seedlings. Illegal logging and forest resources extraction	Assess the success bioengineering works.  Assess the survival rate of plantations  Interview local community; DFO	Within respective road ROW	Monthly  Monthly	PMU/DoR  DFO/DOFPS
<b>Impacts on Wildlife during Construction</b>					
30.	Limit working time to day light hours (8.00am-4.00pm) only  Provision of temporary passage for elephant movement  Construction of permanent elephant corridor  Wildlife habitat enrichment program	Review construction work timing;  Assess the frequency of elephant movement during construction  Check design and assess suitability of constructed elephant crossings.  Assess the type of plant species used for wildlife	Construction zone and Critical Habitat area	Daily by CSC, Weekly by WS & ES  Daily by CSC, Weekly by WS & ES  Daily by CSC, Weekly by WS & ES	PMU, WCD, DOFPS CSC/ES/WS

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	<p>Siting of construction equipment, batching plant and labour camps away from critical habitat</p> <p>Illegal forest activities; fishing and poaching of wildlife</p>	<p>habitat enrichment and their success rate.</p> <p>Site visit</p> <p>Site visit, local complaints; forestry official records</p>		<p>Daily by CSC, Weekly by WS &amp; ES</p> <p>Monthly</p> <p>Weekly by WS &amp; ES Intermittently by WCD/DOFPS</p>	
<b>Impacts on Wildlife during Operation</b>					
31.	<p>DOFPS rangers equipped to perform surveillance of areas affected by wildlife poaching</p> <p>Wildlife-Vehicle collision during operation</p> <p>Illegal fishing, trapping and poaching of wildlife during operations</p>	<p>Visit DFO and review number of surveillance officers</p> <p>Assess number of road collision</p> <p>Site visit, discussion with locals, review the illegal activities recorded by DOF</p>	<p>DoFPS office</p> <p>Local forestry office and Critical Habitat Area</p> <p>Local forestry office and Critical Habitat Area</p>	<p>At the end of road construction works</p> <p>Monthly during road operation</p> <p>Monthly during road operation</p>	<p>DoFPS, WCD CSC/WS</p>
32.	Monitor the presence of appropriate signboards posted during the construction stage	Site visits	Important wildlife habitat zones	Quarterly	WS and WCD and local forestry or park officials
<b>Impacts on Socioeconomic Environment</b>					
<b>Impacts on Land Tenure during Pre-construction</b>					
33.	Provide grievance mechanism under the environment and resettlement components of the project.	Observation of functioning of mechanism; reporting on outcomes	Dzongkhag administrative centres	Monthly during implementation	DEC/NEC
34.	Review land surveys in the area of roadways to assure completeness. Classify ownership adjacent to roads. Prevent encroachment onto public lands.	Review of land survey data and classification of public/private land	<p>Road locations.</p> <p>Dzongkhag administrative</p>	Monthly during implementation	PMU

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
			centres		
<b>Impacts on Land Tenure during Operation</b>					
35.	Prevent encroachment onto public lands.	Visual observations and discussions with local communities	Areas near the project roads	Yearly after completion of construction works	Local district, geog or village officials
<b>Impacts on Labour Rights during Construction</b>					
36.	Provide labourers and others resident at the site lodging in a camp setting outside of any danger zone, food cooking facilities, safe drinking water, adequate washing and bathing facilities for maintaining personal hygiene, and access to health care.	Inspection of labour camp premises. Discussion with labourers on service adequacy	Labour camp locations	Upon set up of labour camp	PMU and CSC/ES
37.	Establish/maintain a safety and accident prevention program, provide adequate protective gear and clothing, maintain equipment, and train workers to be skilled in their jobs; record accident frequency, apply corrective measures.	Review of proposed programs; work place inspections to assure compliance; accident records	Jobsite locations	Upon contract mobilization (formulation of programs); Monthly during implementation	PMU and CSC/ES
38.	Camp facilities should be located at a (at least 500m) distance from nearby communities. Provide sanitary facilities (dry pit or pour flush latrines) for workers and arrange for disposal of solid waste in accordance with local practice	Visual inspection of premises	Jobsite, location of facilities	Upon setup of facilities; quarterly during use	PMU and CSC/ES
39.	Workers hired by roadway contractors should be screened in advance for HIV/AIDS. Undertake an awareness program among workers.  Prohibit recruitment of women for sex among workers. Awareness-raising campaign in pilot communities based on need.	Review of program with project supervisors;	Jobsite	Upon program setup	PMU and CSC/ES  Dzongkhag Environmental Officer/NEC
		Review of program implementation	Labour camps	Quarterly during implementation	
		Review of campaign implementation	Affected communities	Quarterly during implementation	
<b>Public Liability of Contractors and Damage to Local Infrastructure during Construction</b>					
40.	Assure stable slopes when construction is complete; avoid hazard to workers and adjacent property. Post flagmen to regulate passage of people; restrict access in danger zones.	Inspection of slopes; discussion with construction foreman; visual inspection of jobsite and conduct of work	Jobsite	Monthly	PMU and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Adjudicate and compensate property damage or injury under the grievance procedures provided in the Resettlement Action Plan	Records of grievance procedure mechanism	Dzongkhag administration	Quarterly	Dzongkhag Environmental Officer/NEC
41.	Devise a plan with necessary design features to assure these water sources are maintained during construction and left in as good or better condition after construction is complete	Review of detailed design proposals and contract bid documents Assess the completed works	jobsites	At time of detailed design proposals and contract bid documents	PMU
42.	Electricity poles need to be relocated prior to the commencement of construction in order to avoid impairment of power supply.	Inspection of jobsite	Jobsites	Monthly	CSC/ES
43.	Maintain a safe and accessible pathway for both children and adults that need to pass through the area during the period of construction	Inspection of jobsite	Jobsite	Monthly	CSC/ES
44.	Construction should be undertaken with appropriate safety features to avoid accidents and disturbances.	Inspection of jobsite	Jobsite	Monthly	CSC/ES
45.	Infrastructure will need to be relocated, compensation paid under the resettlement and compensation component of the project, or maintained without damage during construction.	Inspection of jobsite	Jobsites and local communities	Monthly	CSC/ES
<b>Impacts during Long term Operation of roads</b>					
46.	Incorporate safety features into the design of the roadway such as signage related to hazardous driving conditions and pullouts for runaway vehicles.	Review of project documents Review of detailed designs	Thimphu	detailed design period	PMU
47.	Institute an anti-littering campaign in areas affected by the problem. Rubbish bins may be placed at strategic locations in community surroundings to reduce roadway litter.	Inspect roadways commissioned prior to end of loan implementation	Roadway segments	After roadways are commissioned and prior to end of loan implementation	NEC
<b>Impacts on Cultural/Religious assets during Construction</b>					
48.	Road widening will be carried out on the opposite side slope of Lungkhangma Nye Widening will be limited to 7.5m only Labour camp construction will be prohibited in the area. Blasting will be avoided Temporary access to the sacred site will be provided	Review of detailed design and contract bid documents; Site observations	Roadway segments (Km11.8)	daily during construction	CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Spoil dumping towards sacred site will be prohibited.				
49.	Gabion retaining wall of around 3m high and 200m long will be constructed to prevent slope failure below Thujaycholing temple. For further slope stabilization Bioengineering works will be carried out Temporary access to the temple will be provided. Permanent access will be built once road construction is completed.	Review of detailed design and contract bid documents; Site observations	Roadway segments (Km26.6)	daily during construction	CSC/ES
50.	Road alignment will be shift at 2m away from the Luu (Boulder) No excavation will be carried out in and around the boulder. If necessary, drywall will be built around the boulder to protect it from damage.	Review of detailed design and contract bid documents; Site observations	Roadway segments (Km65.5)	daily during construction	CSC/ES
51.	Include environmental clauses in contract tender documents;  Make requirements binding on the contractor.	Review of contract tender documents Review of minutes of negotiations	Thimphu  Thimphu	At time of preparation of bid proposals At time of bid negotiations	PMU and CSC

## D. Implementation

### 1. Periods of Applicability

469. The EIA prepared alongside the feasibility study and updated during the detailed design phase. It has provided environmental criteria while carrying out detailed design of the facility with regard to roadway location and configuration, and enhancements related to adjacent land use. The EMP applies primarily to periods of the project beginning with preparation of the loan package (pre-construction), followed by construction of the roadway segments and their eventual operation.

### 2. Management Framework

470. **Preconstruction and Construction.** The environmental management framework during construction is based on and integral with the overall project management framework. The Project will be implemented by a Project Coordination Unit (PCU) within the Department of Roads (DoR). PCU will be headed by Project Coordinator (PC). Under PCU, there will be two separate Project Management Units (PMU) – one each for Nganglam-Tsokhiri (ND01) and Tsokhiri-Dewathang (ND02) sections. PMU will be headed by the Project Manager (PM), who will be the environmental focal person from the DOR side reporting directly to the PC.

471. The **Construction** Supervision Consultant (CSC), hired under a separate contract, is part of the PCU. The CSC will include one national environment specialist (ES) and wildlife specialist; who will be hired for duration of eighteen and twelve months respectively; over the duration of the loan<sup>24</sup>. In addition, CSC will also include one international climate change adaptation specialist (CCAS) for duration of six months. The resident engineer (RE) of ND01 and ND02 will be the environmental focal persons who will be carrying out daily supervision and monitoring of the implementation of EMP. RE will report to the ES (also part of CSC) who will be carrying out the intermittent environmental works.

472. Government agencies and staff may also be involved in monitoring environmental performance on the Project, including the Environmental Management Unit (EMU) at DoR, the Wildlife Conservation Division (WCD) under DoFPS and the Dzongkhag Environmental officers working for NEC. No funds are proposed to be allocated under the Project to these groups, since these agencies are already mandated to carry out monitoring activities.

473. The construction contractors for ND01 and ND02 contract packages will have an Environmental Management Officer (EMO) under the construction project manager (PM), which will be responsible for implementing mitigation requirements in the construction specifications. Line monitoring functions are also assigned to this position, as well as reporting functions.

474. Dzongkhag administrations (DA) will have the authority to monitor and enforce construction impact mitigation measures alongside other responsible agents, specifically where impacts have a direct effect on the local community.

475. The purpose of the organizational arrangement is to assure there are responsible parties for implementation of mitigation measures, for monitoring and for general oversight during the construction of the project. An organizational chart for environmental management is shown in Figure 43.

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<sup>24</sup> Loan duration is of three and half years;

476. **Reporting:** Environment specialist of the construction supervision consultant will prepare monthly reports summarizing the findings of monitoring during the previous month, which will include any monitoring observations from other responsible parties relevant to the period. These reports will be forwarded to the PCU. The ES will summarize monthly reports biannually as a separate environmental monitoring report to be forwarded to ADB for disclosure on its website.

### 3. Capacity Building

477. While EMU established in DoR needs capacity enhancement and regular refresher course, DoR has environment focal officers experienced in external aided projects such as ADB and World Bank. To the Project, experienced focal officers are assigned before design consultants are engaged. Capacity building in the form of in-country training or on the job training is proposed in the mitigation strategy associated with the EMP. Capacity building measures proposed in the mitigation strategy associated with the EMP is in country or on the job training for project managers, site inspectors, and contractors.

#### E. Summary of Environmental Management Cost

478. Table 60 summarizes costs associated with mitigation measures and provision of environmental specialists for the CSC team during project implementation. No direct costs have been identified associated with monitoring. The majority of mitigation measures are included in the cost for construction contract implementation, in which case no separate environmental mitigation cost has been determined.

**Table 59: Summary of Environmental Impacts Mitigation and Management Costs**

Sl.No.	Item	Costs (Nu.)	Remarks
1	Installation of site camps, stores etc.	1,750,000.00	
2	Provision for water supply, toilets & solid waste disposal	700,000.00	
3	Construction on fill, embankments etc.	21,700,334.54	
4	Disposal of spoil materials	222,946,323.43	
5	Installation of Log and boulder barriers	551,925.00	
6	Bio-engineering & Compensatory Plantation	4,090,920.00	
7	Water management - French drains & catch drains	5,036,630.00	
8	Controlled blasting	0	Not quantifiable
9	Wildlife Protection/Corridor Signage	200,000.00	
11	Environmental Specialist (part of CSC)	7,200,000.00	
12	Wildlife Specialist (part of CSC)	600,000.00	
13	Climate Change Adaptation Specialist (part of CSC)	2,700,000.00	
<b>Total Amount (Nu.)</b>		<b>267,476,133</b>	

Source: Adopted from Detailed Design Costing, December 2013

479. Total estimated civil construction cost of the NDH is Nu. 1,919,616,000/- (Ngultrum One billion nine hundred nineteen million six hundred sixteen thousand) only. This estimate does not include project management and hiring of supervision consultants.

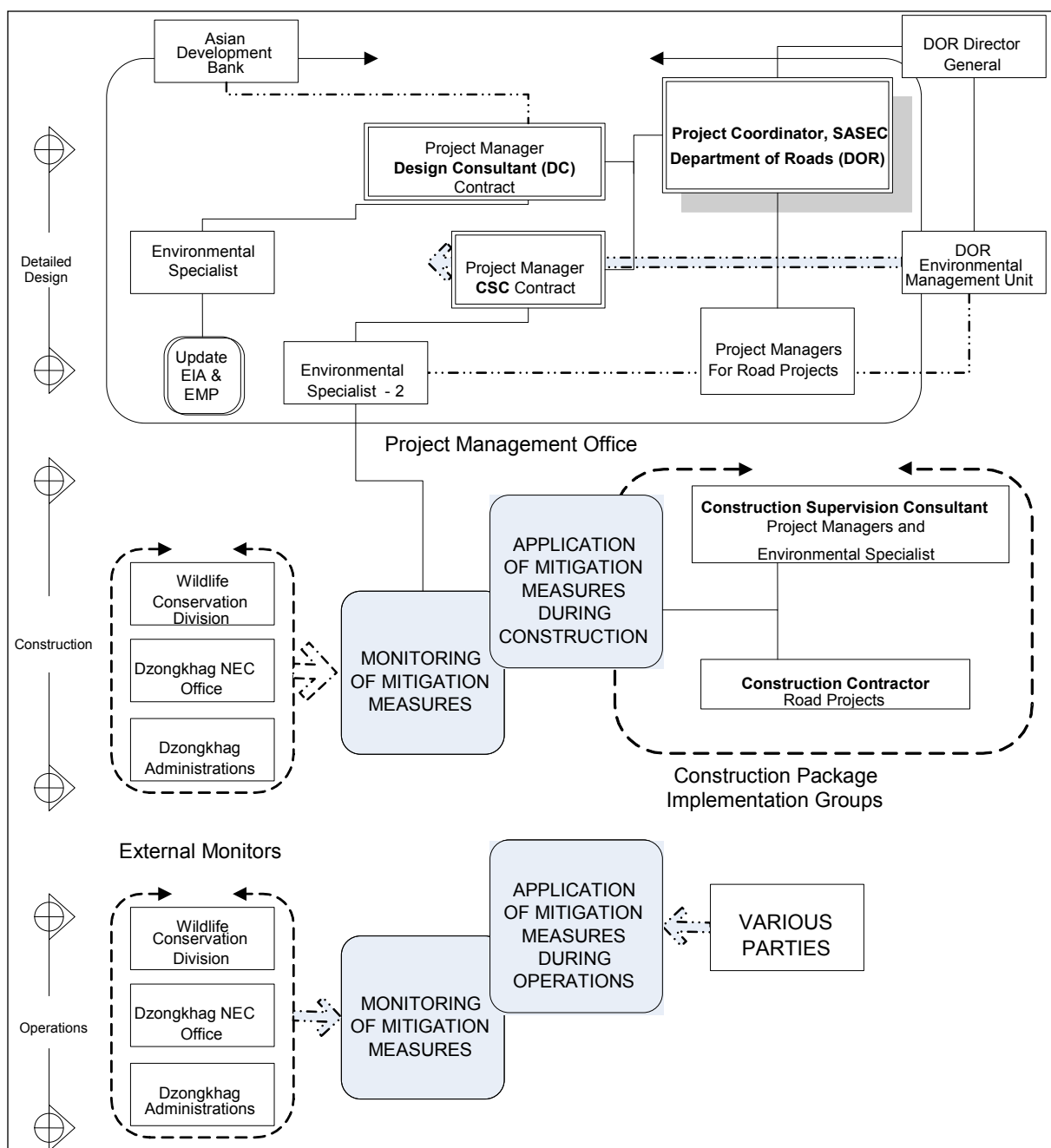


480. As per the detail design costing, the environmental management cost comes to around Nu.267,476,133/- which is about 14% of the total project cost.

481. The climate change adaptation costing comes to around 5.4% (Nu.110,288,935) of the total sub-project cost.

482. There is considerable overlap between climate change adaptations and the environmental mitigation measures in areas such as slope protection and drainage constructions. Therefore, climate change adaptation and environmental mitigation costs cannot be clearly separated from one another.

**Figure 44: Organizational Chart for Environment Management**



## **X. CONCLUSION AND RECOMMENDATION**

### **A. Compliance with Relevant Sector Guidelines of the RGOB**

483. The Project is compliant with RGoB and ADB guidelines concerning environment, social impact, resettlement and compensation, and local administration. Sector guidelines related to the environment, road construction and traffic safety are complied with and incorporated into the project design.

### **B. Gains That Justify Project Implementation**

484. The primary benefits stem from the national road link connecting to isolated communities along the southern stretch of the Country, benefits that include better transport connectivity for movement of people and goods, improved access to social services and to income and livelihood opportunities, a significant infrastructure contribution into the economic and social vitality of the region, and improved security presence for both social and environmental conservation objectives. The latter issue was emphasized during the second public consultation as perhaps of primary importance to the Nation in justifying the presence of the Nganglam – Dewathang Highway.

485. The Nganglam–Dewathang Highway is considered as one of the most critical road sections that will connect east with the west through the ongoing Gomphu–Panbang road funded by the Government of India and Panbang–Nganglam road being constructed under ADB funded RNP II. Without the internal road, the only way to reach the east either is through the Indian State of Assam using National Highway, NH 52 or by using the lateral route from north via Bumthang and Trashigang.

### **C. Adverse Effects**

486. Adverse effects are related to construction and to operational phases of the project and effects are noted on physical, biological and socioeconomic domains of the environment.

#### **1. Adverse Effects Minimized**

487. Adverse effects are related to construction and to operational phases of the project and effects are noted on physical, biological and socioeconomic domains of the environment. The summaries of adverse effects of road development are provided as following:

- Slope instabilities due to weak geology at various locations particularly along Nganglam-Chokhorling road section triggered as a result of road construction will cause landslides and disrupt road use. EFRC slope protection measures are proposed to minimize the impacts.
- From the 68.3km of the proposed road, about 6 km section passes through Biological Corridor. This 6 km section within the biological corridor is part of the farm road connecting Chokhorling to Nganglam. Therefore, no new construction will take place within this stretch except for 3-4m additional widening works.
- Road construction through important wildlife habitat between Tsokhiri and Dui Rivers will damage wildlife habitat (which includes the salt lick site) and disrupt animal (particularly of elephant) migratory path. Specific migratory pathways have been identified and accommodation made in the design for the movements of elephants.

- During road construction at the takeoff, near Nganglam town and through the settlements of Drangnalashingborang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore and Dewathang town would damage and disrupt communities services such as drinking water supply, electricity and impede local traffics. Alternative arrangement during construction and restoration of community infrastructure after construction will reduce the impacts.

488. Further, series of mitigation measures have been proposed that are described in the EIA Report and addressed comprehensively in the environmental measures. These include provision of bioengineering applications for stabilizing slopes, use of spoil disposal areas to minimize destruction of forests down-slope of the alignment, proper sizing of hydraulic structures to assure adequate capacity and prevent destruction of adjacent land, provision of sign boards along migratory paths of animals and other precious ecological zones, provision of bridges and culverts designed especially for facilitating the movement of animals, identification of vulnerable community infrastructure that must be preserved or replaced under construction contracts, limits on location and access of workers and other provisions regarding construction to assure minimum impact, and other basic provisions found in the EMP. All the above observations and mitigation measures will be included in the tender documents for contract works.

489. Application of these measures in parallel with RGoB environmentally friendly road construction guidelines (which mitigation measures reiterate) 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. Short term impacts on communities and households have been minimized by maintaining facilities, such as water supply systems, in service and by reducing construction interference with everyday life.

490. 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, and by accommodating the presence of wildlife in design.

## **2. Adverse Effects Offset**

491. A compensatory tree planting program is proposed and a budget provided for planting trees lost due to the construction of the roadways along the proposed alignments (approximately 167 acres).

## **3. Adverse Effects Compensated**

492. Adverse effects in the social environment, on people's land and properties – are compensated under the terms of the Resettlement Plan.

## **4. Use of Irreplaceable Resources**

493. There is minor use of irreplaceable resources in the form of biological losses, including forests, ecosystems and members of biological species. These losses are minor, since the amount represents only a small fraction of the total range of ecosystem available to a given species. As noted, ecosystem replacement in the form of compensatory planning is proposed under the Project. No other use of irreplaceable resources has been noted by the assessment.

**D. Provisions for Follow-up Surveillance and Monitoring**

494. A systematic approach for surveillance and monitoring is provided by means of a management framework, and monitoring and reporting protocol. Follow-up public consultation is intended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons. The social component of the project has identified the numbers of affected persons and households, the amount and locations requiring total and partial land acquisition, and the amount of damage costs. The EMP has been updated during the detailed design; it is a living document and will be further updated during the construction period. The environmental mitigation measures are itemized and built into the Bill of Quantity (BOQ). The detailed site specific EMP prepared during the detailed design phase will be included in the contract bidding documents.

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## APPROVED TERMS OF REFERENCE



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འཕེལ་ལྔ་ན་འབྲུག་གཞུང་།  
**National Environment Commission**  
Royal Government of Bhutan



NEC/ESD/DOR/2312/2011/ 2292

October 19, 2011

To,

The Director General  
Department of Roads  
MoWHS  
Thimphu

Subject: Endorsed Terms of Reference (TOR)

Sir,

This has reference to the letter No. DoR/RNP-III (01)/2011-2012/2380 dated 4<sup>th</sup> October, 2011 regarding the Terms of Reference (TOR) for conducting the Environmental Impact Assessment (EIA) study for the proposed construction of 60 Km road from Deothang to Nganglam under Samdrup Jongkhar and Pemagatshel Dzongkhags.

Find attached the endorsed terms of reference. Please ensure that the EIA study is conducted as per the endorsed ToR and the reports are submitted accordingly.

Sincerely,

Head  
Environment Services Division

PC RNP III  
for m19  
N

Copy to:

1. The Dzongkhag Environment Officer, Samdrup Jongkhar Dzongkhag for information
2. The Dzongkhag Environment Officer, Pemagatshel Dzongkhag for information
3. OC



**TERMS OF REFERENCE (TOR)  
FOR  
CONDUCTING ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED  
CONSTRUCTION OF 60 KM ROAD DEOTHRANG TO NGANGLAM UNDER SAMDRUP-  
JONGKHAR AND PEMAGATSHEL DZONGKHAGS**

This document outlines the structure of an Environmental Impact Assessment (EIA) report. It provides a framework for applying the methods and approaches in line with the EA process, EA Act 2000 and its Regulation 2002. With this guidance, the EIA practitioner can proceed in a step-by-step fashion to prepare an EIA report.

At a minimum, an EIA report should contain the following:

- i. an introduction;
- ii. a project description;
- iii. a detailed description of the environment;
- iv. an assessment of environmental impacts and mitigation measures;
- v. an environmental management plan; and
- vi. an environmental monitoring plan.

In addition, the EIA report should also contain an evaluation of alternatives, environmental economic analyses including a cost-benefit analysis, and a description of the public participation program.

## **1. Introduction**

The requirements for the preparation of an EIA report is clearly outlined in this term of reference (TOR), which is specifically prepared for the proposed 60 Km road from Deothang to Nganglam. The EIA report should be prepared by the proponent to the requirements of the NEC that will examine the report.

The EIA document/report, prepared based on this TOR, shall be subject to review and evaluation by the National Environment Commission. Thereby, appropriate decisions shall be made viz. a) decide whether the project should be permitted to proceed or not, and b) if it does proceed, set appropriate terms and conditions to ensure an environmentally sound project.

## **2. Scoping**

Scoping is primarily intended to consult with all stakeholders to identify issues and concerns, and it could also serve as a process which could be applied to:

- i. identify concerns of the public and experts or interest about a proposed project or action;
- ii. evaluate these concerns to determine the key issues for the purposes of the EIA (and to eliminate those issues which are not significant); and
- iii. Organize and communicate these to assist in the analysis of issues and the ultimate making of decisions.

This TOR will provide those preparing the EIA report with explicit direction on preparing the EIA report. It should be specific about the information requirements and level of detail to be included in each major section of the report.

### 3. Contents of the EIA Report

This section outlines the basic components or sections that should be included in an EIA report. A recommended table of contents for an EIA report is presented below.

- i. Executive Summary
- ii. Introduction
- iii. Description of the Project
- iv. Description of the Environment
- v. Anticipated Environmental Impacts and Mitigation Measures
- vi. Alternatives
- vii. Environmental Monitoring
- viii. Additional Studies If required
- ix. Environmental Management Plan and Environmental Management Office
- x. Summary and Conclusions
- xi. Annexes

#### 3.1 Executive Summary

An executive summary should be prepared. This critical document summarizes the significant findings of the EIA report. The executive summary must describe each significant environmental issue and its resolution in sufficient detail so that the reader can understand its importance and scope, as well as the appropriateness of the approach taken to resolve it. The executive summary should be a clear presentation of the critical facts that make up each issue, and the resolution of the issues. Whenever possible, the summary should make use of base maps, tables and figures. Information should be condensed into succinct, but meaningful presentations. It must be able to stand alone as a document.

#### 3.2 Introduction

The introduction section of the EIA usually should include the following:

- i. Purpose of the report, including a) identification of the project and project proponent; b) a brief description of the nature, size, and location of the project and its importance to the country; and c) any other pertinent background information.
- ii. Stage of project preparation.
- iii. Extent of the EIA study, including scope of study, magnitude of effort, and agency/firm performing the study.
- iv. Brief outline of the contents of the report, including mention of any special techniques or methods used for identifying issues, assessing impacts, and designing environmental protection measures.
- v. Background references.
- vi. Acknowledgments.

A review of relevant studies and examples of environmental impacts of similar projects should also be presented.

#### 3.3 Description of the Project

The project description should be based on the project feasibility study. Not all the detailed engineering information needs to be included as much of it is unnecessary for the environmental review. The project

description should present a condensed description of those aspects of the project likely to cause environmental and social impacts. The project should be described in terms of its basic activities, location, layout, and schedule (in terms of the project life cycle). This project description section of the report should furnish sufficient details to give a brief but clear picture of the following:

- i. Type of project.
- ii. Need for the project.
- iii. Location (use maps showing general location, specific location, project boundary and project site layout).
- iv. Size or magnitude of operation, including any associated activities required by or for the project.
- v. Proposed schedule for approval and implementation.
- vi. Description of the project, including drawings showing project layout, components of project, etc. Schematic representations of the feasibility drawings which give the information important for EIA purposes should be produced to provide reviewers a clear picture of the project and its operations.
- vii. Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements.

Any new and untested technology should be highlighted and an assessment of the risk of technological failure included.

### 3.4 Description of the Environment

#### a. Study Area

A clear delineation of the study area is important to define the area within which impacts must be considered. The additional description of the study area that will be required for the EIA is dependent on the types of resources located in the area, and upon the magnitude of the anticipated impacts. The area to study must be large enough to include all valued environmental resources that might be significantly affected by the project.

#### b. Establish a Baseline

Once the study area is well defined, studies to gather the baseline conditions for valued environmental components must be developed. In general, it is necessary to provide sufficient information to give a brief but clear picture of the existing environmental components and values. These components and values include, to the extent applicable (but are not necessarily limited to):

- i. **Physical components:** topography, soils, climate, surface water, groundwater, geology/seismology.
- ii. **Ecological components:** aquatic biology, wildlife, forests, rare or endangered species, wilderness or protected areas.
- iii. **Human and economic development:** population and communities (numbers, locations, composition, employment, etc.), industries, infrastructural facilities (including water supply, sewerage, flood control/damage, etc.), institutions, transportation (roads, harbors, airports, navigation), land use planning (including dedicated area uses), power sources and transmission and tourism components.
- iv. **Quality of life values:** socioeconomic values, public health, recreational components and development, aesthetic values, archaeological or historical treasures, and cultural values.



The baseline studies should concentrate on identifying those environmental components that may be significantly impacted by the project.

#### c. Base Maps

Many environmental components can be best represented as spatial data through various types of maps. In addition to the basic physical features and infrastructure of the study area, it is valuable to have maps identifying vegetation types/communities, animal habitat, and major population centers.

### 3.5 Anticipated Environmental Impacts and Mitigation Measures

A thorough treatment of project issues, their impacts on valued components and recommended mitigation measures to minimize impacts are the core of a successful EIA. One approach is to present this information in terms of the various stages of the project: preliminary design, final design, construction and operation. This methodology ties the impacts on the components to the stage(s) of the project during which they are triggered. Addressing impacts through the associated project stage indicates clearly which aspects of the project will require mitigation actions in the form of design changes, and matches the decisions regarding mitigation with the project implementation schedule.

#### a. Item-by-Item Review

This section of the report should evaluate the expected impact (quantified to the degree possible) of the project on each component or value and, in the case of applicable sectoral environmental guidelines, wherever any significant impact is expected (this would include environmental risk assessment, where appropriate). Environmental impacts to be investigated should include those due to project location; those caused by possible accidents; those related to design; and those resulting from construction, regular operations, final decommissioning or rehabilitation of a completed project. Where adverse effects are indicated, discuss measures for minimizing and/or offsetting them. Opportunities for enhancing natural environmental values should be explored. Both direct and indirect effects should be considered, and the region of influence indicated. As required, the impact on the global environment should be described.

It is necessary to present a reasonably complete picture of both the human use and quality of life gains to result from the project due to the utilization, alteration, and impairment of the natural components affected by the project, so that fair evaluation of the net worth of the project can be made.

#### b. Irreversible and Irretrievable Commitments of Components

The EIA report should identify the extent to which the proposed project would irreversibly curtail potential uses of the environment. For example, highways that cut through stream corridors, wetlands, or a natural estuary can result in irreversible damage to these sensitive ecosystems. Other impacts that may be irreversible include alteration of historic sites, habitat loss of endangered species, and expenditure of construction materials and fuels. Projects through sensitive areas like estuaries and marshes may permanently impair the natural ecology of the area, while elimination of recreation areas and parklands can precipitate drastic changes in an area's social and economic character.

#### c. Effects during Project Construction and Operation



v. Mitigated Impact.

e. Mitigation Measures

The EIA report should provide a detailed description of recommended mitigation measures. Where appropriate, an alternative means of mitigating the impacts should be presented. Each mitigation measure should be described in terms of:

- i. the impacts it is designed to mitigate;
- ii. an assessment of its likely effectiveness in terms of reducing or preventing impacts;
- iii. its next best alternative;
- iv. its cost; and
- v. the implementation plan for putting the measure into practice.

### 3.6 Alternatives

If the proposed project is expected to cause serious losses of natural environmental components and/or serious health effects, the EIA report should include consideration of both alternative projects and approaches which could achieve the same or equivalent results and the advantages/disadvantages of the alternatives from the point of view of environmental protection and social safeguards.

In general, the TOR shall require: 1) a summary of adverse impacts of each alternative; 2) the mitigation measures proposed for each alternative; and 3) a discussion with respect to whether the proposed project alternative minimizes the environmental impact and is within acceptable environmental impacts limits.

EIAs address at least two alternatives (with and without the project); they can include multiple alternatives (usually limited to three to five alternatives). A number of factors are usually considered in evaluating alternatives. For example, an assessment of a highway project may include consideration of different routes, different traffic capacities, or various ways of scheduling construction.

In general, alternatives for projects may involve: 1) site selection; 2) design alternatives for a given site; 3) construction, operation, and decommissioning alternatives for a design; 4) project scale; 5) phasing alternatives for large staged projects; and 6) timing alternatives for project construction, operation, and decommissioning. The factors considered and degree of scrutiny depends on the time and budget available.

### 3.7 Environmental Monitoring Program

The technical aspects of monitoring the effectiveness of mitigation measures must be described in the environmental monitoring section of the report. The description of the monitoring program should include:

- i. a technical plan which spells out in detail: 1) the methodologies for measurement, 2) the required frequency of measurements, 3) the planned location of measurements, 4) data storage and analysis, 5) reporting schedules, and 6) emergency procedures; and
- ii. Detailed budgets and procurement schedules for the 1) necessary equipment and supplies, and 2) technical and administrative manpower.

The project usually involves environmental impacts that will occur from construction and operation stages. These impacts and the mitigation measures proposed to reduce or prevent them should be discussed separately in the report.

Generally, EIA analysis has three sequential phases<sup>4</sup> viz. identification, prediction and assessment. Identification involves characterizing the existing baseline environment and components of a development project which are likely to impact the environment. Many of the methods of scoping techniques are well suited for impact identification. During the prediction phase, the project impacts are quantified using standards and by comparison with the findings of other projects. Basically, the predictive function of an EIA is to forecast the nature and extent of the identified environmental impacts, and to estimate the probability that the impacts will occur. During the assessment phase, the importance or significance of impacts is evaluated. The assessment should include consideration of the proposed mitigation measures that have been incorporated into the project design. Overall assessment of significance is based on the net impact assuming the proposed mitigation measures will be effective in minimizing adverse effects.

#### d. Assessment of Significance

The practice of assessing the significance of environmental impacts could be used throughout the different stages in the EIA process, and that an assessment of significance at different stages in the EIA process should be based on clear guidelines and criteria.

Relevant and specific guidance how to assess significance for: 1) air; 2) surface water; 3) soil and groundwater; 4) noise; 5) biological environment; 6) cultural (architectural, historical and archaeological) environment; 7) visual environment; and 8) socioeconomic environment must be prepared.

Determination of the significance of the anticipated impacts of proposed projects is a key component of the EIA process. Some criteria for determining adverse impacts include:

- i. loss of rare or endangered species;
- ii. reductions in species diversity;
- iii. loss of critical/productive habitat;
- iv. transformation of natural landscapes;
- v. toxicity impacts on human health;
- vi. reductions in the capacity of renewable resources to meet the needs of present and future generations;
- vii. loss of current use of lands and resources for traditional purposes by indigenous persons; and
- viii. Foreclosure of future resource use or production.

The significance of adverse impacts depends on magnitude, geographic extent, duration and frequency, irreversibility, ecological context, social context, and economic context. Likelihood is determined by probability of occurrence and scientific uncertainty.

Most EIA reports assign significance to potential impacts. Generally, the potential impacts of projects, and its significance may be classified into one of five possible categories:

- i. No Impact;
- ii. Significant Impact;
- iii. Insignificant Impact;
- iv. Unknown Impact; or



### 3.8 Additional Studies

This section contains a description of other major studies undertaken in support of the preparation of the EIA. If formal studies on public participation, environmental economics, and environmental risk assessment have been undertaken as part of the EIA, these need to be included.

A literature review of all the relevant policies, legislations, guidelines, etc. should also be undertaken as part of the study and included in the report.

#### a. Public Participation

Public participation in our context is very important since most of the projects are funded by international agencies. Public participation in the EIA process is a practice that has been adopted by many national governments and is required by international assistance agencies including the multi-lateral development banks. For these governments and agencies, the completed EIA must include documentation on the affected people's responses to the project. The determination of public response to a project may include an initial educational campaign using mass media or public forums to describe the project, followed by a structured poll or survey of people's attitudes. The extent of public education about the project, and the level of public participation required in the EIA, depends upon the magnitude of the impact, the size of the affected population and the requirements of the approving authority (government and/or lending/donor agency).

This section of the EIA report should include:

- i. summary issues identified by stakeholders;
- ii. evidences of public meetings and participation;
- iii. list of persons receiving this and previous draft reports;
- iv. compliance with coordination and regulatory requirements;
- v. public hearings, press releases, notifications; and
- vi. a summary of the principal community/interest group concerns.

#### b. Environmental Economics

Economic analysis of environmental impacts provides one means of quantifying the severity of the impacts. The net environmental benefit or loss provided by a project can be evaluated if monetary values may be assigned to environmental and social components. Project options may be compared by their net economic impact. Economic analysis may also be used to develop equitable impact mitigation measures. For example, if a project is anticipated to cause negative impacts to a component such as fisheries, resulting in quantifiable loss of income to local fishermen and subsequent losses of income to fish marketers or processors, an appropriate mitigation measure may be the development of aquaculture at a scale that would at least offset the economic losses from the original fishery.

Economic analysis of the projects should include the present value of all benefits and all costs compared in the form of internal rate return on investment, and net present value. Cost-effectiveness of mitigating measures may have to be presented separately.

The net of economic cost and benefit impacts may be totaled by component, by implementation phase of the project, and for the project as a whole. If there are several project alternatives being considered, the net economic cost or benefit may be an important deciding factor in choosing the appropriate alternative.

*[Handwritten signature]*

If there are no means of quantifying the value of a component, the importance of the component must be described in such a way that the severity of impact may be evaluated.

If a cost-benefit analysis has been undertaken, the EIA report should spell out the factors taken into account and define the key assumptions. These assumptions include: 1) setting the discount rate if applicable; and 2) specifying any constraints on costs.

### c. Environmental Risk Assessment

An environmental risk assessment may be a necessary part of the EIA if there is considerable uncertainty about the likelihood or the magnitude of environmental impacts. The data collected during basic EIA studies provides much of the information needed for explicitly dealing with the uncertainties relating to environment impacts. There are two major categories of risk: 1) those to human health, and 2) those to ecosystem integrity. The primary goal of environmental risk assessment is to evaluate risks, their monetary costs, the costs of emergency response and/or avoidance of risk.

Environmental risk assessment studies require a high degree of scientific and mathematical rigor and may be costly if not properly planned.

## 3.9 Environmental Management Plan and Environmental Management Office

The environmental management plan (EMP) is needed to ensure that the mitigation measures specified in the EIA will actually be complied with when the project is approved for implementation. The administration of an EMP may require the establishment of an Environmental Management Office to house monitoring staff after the closure of the EIA office. Funding to cover the costs of establishing and operating an appropriate Environmental Management Office to administer the EMP should be guaranteed in the basic project budget.

The EIA report should include a description of the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored after approval of the EIA. These details are the subject of the environmental management plan. They include the following:

- i. checking the final design documents to ensure they incorporate the management measures;
- ii. monitoring the construction and interacting with the contractor to ensure an understanding of compliance with the constraints involved with the environmental protection or mitigation measures during construction; and
- iii. following construction, continued monitoring during project operations to ensure that the project meets its environmental goals, and to initiate needed modifications to the project design or operations for this purpose.

## 3.10 Summary and Conclusion

The EIA report should present the conclusions of the study, including the following:

- i. the overall net gains which justify implementation of the project;
- ii. explanation of how adverse effects have been mitigated;
- iii. explanation of use or destruction of any irreplaceable components; and
- iv. provisions for follow-up surveillance and monitoring.





Simple visual presentations of the type and magnitude of the impacts may aid the decision-makers.

### 3.11 Annexes

A number of annexes are normally included as part of the EIA report. These annexes provide important detailed information that is not appropriate for presentation in the main body of the EIA report. These annexes may include:

- i. terms of reference for the EIA;
- ii. abstracts or summaries of relevant background documents;
- iii. tabular and graphical summaries of data;
- iv. a list of contacts and meetings; and
- v. a list of data sources.

## 4 Managing the Preparation of the EIA

### 4.1 The EIA Work Plan

The EIA work plan is the management outline of the EIA. It breaks the significant environmental issues into tasks, assigns the tasks to EIA team members, describes the qualifications required of each team member, schedules the completion of tasks, and budgets each task according to its schedule. Each of the functions of the work plan is essential for the proper execution of the EIA process. The work plan is as important as the technical components for the completion of a successful EIA report.

The tasks relate primarily to the performance of items contained in the project description, description of the environment, anticipated environmental impacts and mitigation measures, environmental monitoring plan and environmental management plan of the suggested EIA format. The scheduling of the interim, draft final and final reports also is critical. The preparation of the executive summary must also be planned, ideally as a distinct plan item.

### 4.2 EIA Team Personnel

Since EIA is a multidisciplinary task, EIA reports are prepared by a team of environmental specialists drawn from various disciplines. In general, each team should have at least one qualified environmental engineer, social expert, biologist, environmental economist and a physical scientist. All teams should be directed by an EIA Project Expert/Team Leader who has a good understanding of the administrative, procedural, and technical requirements of Bhutan's EIA process. Experience with the type of development and its associated environmental impacts are also required.

The EIA team must include personnel with the managerial and technical expertise required to perform the work required by the EIA. The management skills are provided by the Project Manager and Assistant Project Manager, with planning and technical assistance provided by the Project Planner or Technical Analyst. Ideally the management team will have an extensive background in EIA work, but if this expertise is lacking in the management staff it can be provided by hiring EIA experts or licensed and certified EIA consultancy companies. The following presents the qualification and experience requirements of the EIA multidisciplinary team.

- i. EIA Expert/Team Leader  
Qualifications:

- Extensive EIA experience
  - Higher educational qualification in EIA
  - Good communication and organization skills
  - Prior EIA project experience
2. Project Manager
- Qualifications
- Project management experience
  - Experience in the local or regional area
  - Familiarity with the local situation
  - Excellent written and oral communication skills
  - EIA experience or knowledge
3. Project Planner / Technical Analyst
- Qualifications
- Knowledge of the project type – design, planning, and operations
  - Understanding of EIA process and objectives
  - Extensive background in project planning
4. Environmental Specialists depending on project type:
- May include the following:
- Physical (Geological) scientists
  - Biological and ecological scientists
  - Social scientists
  - Economists
  - Engineers
  - Other Specialists

Selection of the environmental specialists is based on the natural and human resources in the study area which may be affected by the project. As an example, a dam and flood control project may require the skills of a water resources engineer or hydrologist, an aquatic ecologist or fisheries specialist, an agricultural specialist, a sociologist, economist, and an expert in resettlement. The personnel selection will be different for each project based on the components in the study area and the type and magnitude of project.

#### 4.3 Task Schedule

EIA tasks must be scheduled so the subject items can be completed within the overall time frame of the EIA and feasibility study. For example, to evaluate fisheries impacts in a lake which is enlarged and deepened for water supply purposes, the fisheries specialist will need information regarding water quality impacts, provided by the water resource specialist or hydrologist. If the fisheries specialist cannot begin evaluations until the hydrologist has completed a task, this must be taken into account in overall planning. This interdependency of tasks is a result of the interconnected nature of components and requires careful task planning.

#### 4.4 The EIA and EMP Budget

The EIA budget is a natural outgrowth of the task scheduling and staffing processes. The budget should be tied to the completion of tasks such as submittal and acceptance of interim, draft final and final reports.

For tasks which extend beyond the time frame of the EIA process (for example, the EMP), sufficient budget and payment scheduling must be provided.

**NOTE:**

- *The Environmental Assessment Report is required to be prepared as per the provisions of EA Act 2000, Royal Government of Bhutan*
- *The Consultant should maintain consistency and accuracy in the report and no subjective statements shall be accepted*
- *The Consultant shall render technical assistance to project proponent during Public Consultation as per the provisions of section 31 of the Regulation for the Environmental Clearance of Projects 2002.*
- *The applicant shall be responsible for undertaking any other related study desired by the NEC during the process of environmental clearance*
- *Finally, the EA report should include all other necessary documents such as clearance from respective Dzongkhag Administration, Department of Forest, evidence of public consultation, etc.*
- *A soft copy of the report including all the annexes, maps including Google earth images/maps, GIS data, etc, needs to be submitted along with the hard copy of the report.*

A handwritten signature in black ink, appearing to be 'Himel Kumar', written over a horizontal line.

## ORDER FROM THE DOFPS



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Royal Government of Bhutan  
Ministry of Agriculture and Forests  
Department of Forests and Park Services  
THIMPHU



No.DoFPS/Ka -3-1/2011/ 584

October 26, 2011

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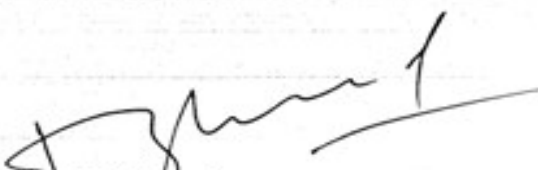
The Chief Forest Officers,  
Sarpang, S/Jongkhar Forest Divisions & RMNP.

**Subject: Feasibility study of Southern East-West Highway.**

The Department is in receipt of letter no. DOR/RNP-III/2011-2012/2443 dated 18/10/2011 regarding the feasibility study of Southern East-West Highway.

In this regard, you are advised to depute the concern staffs and render all possible assistance to the team and accordingly, take necessary action as per the delegation of authority as circulated vide letter No. DF/Ka-3/2008/702 dtd 23/9/08.

The copy of the above referred letter is enclosed herewith.

  
(Phento Tshering)  
Offtg. Director

CC.

1. The Hon'ble Secretary, MoAF for kind information.
2. The Director General, DoR, MoWHS Thimphu for kind information.

## RAPID ENVIRONMENTAL ASSESSMENT CHECKLIST

### Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES), for endorsement by Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

**Country/Project Title:**

Road Network Project II Additional Financing

**Sector Division:**

Transport and Communication Division, South Asia Department

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site	✓		Alignment likely to pass close to a chorten or stupa. During feasibility alignment has been shifted away from the stupa in order to protect it from damages during construction.
▪ Protected Area		✓	Road does not pass through any protected area except for small section touching the biological corridor connecting two protected areas
▪ Wetland		✓	No wetland in the project area.
▪ Mangrove		✓	No mangrove
▪ Estuarine		✓	No estuarine
▪ Buffer zone of protected area		✓	
▪ Special area for protecting biodiversity		✓	
B. Potential Environmental Impacts Will the Project cause...			

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> <li>encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?</li> </ul>	✓		<p>Sacred Holy rock known as Lungkhangma Nye is likely to be damaged during road construction.</p> <p>Similarly, Thujaycholing Temple and Stupa is also likely to be damaged during road construction</p>
<ul style="list-style-type: none"> <li>Encroachment on precious ecology (e.g. sensitive or protected areas)?</li> </ul>	✓		Small section road passes through critical wildlife habitat and migratory area that needs protection...
<ul style="list-style-type: none"> <li>Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?</li> </ul>	✓		Certain section of road alignment crosses streams. There will be of disturbances to surface hydrology and siltation of rivers and stream due to erosion if no proper mitigation measures are carried out. Mitigation measures are proposed to minimize the damages and disturbance to local hydrology.
<ul style="list-style-type: none"> <li>Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?</li> </ul>	✓		Camps will be placed in safe area and will be provided with pit latrine.
<ul style="list-style-type: none"> <li>Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?</li> </ul>		✓	Construction camps as well as the quarries and crushing plants are proposed away from the settlement.
<ul style="list-style-type: none"> <li>Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?</li> </ul>	✓		Occupational health and safety (OHS) risks are associated with construction works. However, risks can be minimized or avoided completely, if OHS rules as provided in the EMP are followed and implemented.
<ul style="list-style-type: none"> <li>Noise and vibration due to blasting and other civil works?</li> </ul>	✓		There will be considerably noise and vibration particularly as a result of blasting along the road alignment. In order to minimize the noise and vibration, a total controlled blasting operation will be employed.

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> <li>Dislocation or involuntary resettlement of people?</li> </ul>	✓		<ul style="list-style-type: none"> <li>140 households will lose around 69.71 acres of land for the road construction.</li> <li>13.56 acres of Orange orchard will be damaged</li> <li>17 nos., Semi-permanent structures: 5 nos., Temporary structures (poultry shed, stores, garage, cowshed, milk collection center, small shop, toilets)</li> <li>22 nos., Others (barbed fence, staircase, gate, retaining wall)</li> <li>14 numbers of water tanks and 8 numbers of water tap outside will be damaged.</li> </ul>
<ul style="list-style-type: none"> <li>Dislocation and compulsory resettlement of people living in right-of-way?</li> </ul>	✓		There will be displacement or compulsory resettlement as a result of road construction.
<ul style="list-style-type: none"> <li>Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?</li> </ul>	✓		27 woman headed households will be affected due to road construction.
<ul style="list-style-type: none"> <li>Other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress?</li> </ul>	✓		
<ul style="list-style-type: none"> <li>Hazardous driving conditions where construction interferes with pre-existing roads?</li> </ul>		✓	There will be traffic interference to the existing roads – on Nganglam-Chokhorling farm road and Rishore-Deothang Coal Mine road.
<ul style="list-style-type: none"> <li>Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?</li> </ul>	✓		There are chances of sanitation and solid waste disposal problem and as well as possibilities of transmission of communicable diseases such as STI/HIV/AIDS etc. The impact has been identified and mitigation measures have been proposed under chapter VII section D of the EIA report.
<ul style="list-style-type: none"> <li>Creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?</li> </ul>		✓	
<ul style="list-style-type: none"> <li>Accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials?</li> </ul>	✓		Road will be designed as such to minimize the accidents and eventual hazards.
<ul style="list-style-type: none"> <li>Increased noise and air pollution resulting from traffic volume?</li> </ul>		✓	Road will not have not very high traffic volume and hence low noise and air pollution.

Screening Questions	Yes	No	Remarks
▪ Increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?		✓	Water pollution due to farm road operation will be of minimum due to low traffic volume.
▪ Social conflicts if workers from other regions or countries are hired?		✓	Social conflicts are not anticipated as the import of foreign labourer will be minimum. Imported labourers will be briefed on local norms and contractor will monitor the situation.
▪ Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		✓	There will be no large scale import of labourer or construction workers as most of works will be carried out using machine. Only about 50 labourers will be imported.
▪ Risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?	✓		Transport, storage and use of blasting materials are of major concern due to its potential hazards. However, EIA has proposed the mitigation measures for safe transport, storage and controlled use of blasting materials to avoid or minimize the impacts.
▪ Community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.	✓		Construction schedule will be made public through local / Geog administration. People will be allowed travel within specified timings so as to avoid injuries and accidents.

Climate Change and Disaster Risk Questions	Yes	No	REMARKS
The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.			
• Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes (see Appendix I)	✓		Project is susceptible to earthquake and heavy storm or monsoon as result of climate change.






<ul style="list-style-type: none"> <li>▪ Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (e.g. increased erosion or landslides could increase maintenance costs, permafrost melting or increased soil moisture content could affect sub0-grade).</li> </ul>	✓		Heavy monsoon will cause or trigger landslides and reduce the overall lifespan of the project.
<ul style="list-style-type: none"> <li>▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g., high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?</li> </ul>	✓		Project area has been facing rural-urban migration due to lack of basic services such as road access. There are no ethnic minorities in the area.
<ul style="list-style-type: none"> <li>▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., by encouraging settlement in areas that will be more affected by floods in the future, or encouraging settlement in earthquake zones)?</li> </ul>		✓	Impact of project on climate change will be insignificant. Bhutanese law discourages the illegal settlers outside the legally identified settlement areas.

Note: Hazards are potentially damaging physical events.

## PUBLIC INVOLVEMENT DOCUMENTATION

## 1. Letter for Public Consultation and Field Survey Works

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 Royal Government of Bhutan  
 Ministry of Works & Human Settlement  
 Department of Roads  
 ROAD NETWORK PROJECT ( SASEC )  
*"Enhancing Productivity & Professionalism"*


DoR/RNP II (SASEC)/10/2012-13/ 4545
Dated: 25<sup>th</sup> March, 2013  


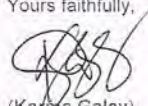
Dasho Dzongdag  
 Dzongkhag Administration  
 Pemagatshel:
 Dasho Dzongdag  
Dzongkhag Administration  
Samdrupjongkhar;
Dasho Dzongdag  
Dzongkhag Administration.  
Chukha.

Sub:- Detailed Design for SASEC Road Connectivity Project under RNP II : Nganglam- Dewathang & Pasakha access project.

Dear Dasho,

The Department of Roads, Ministry of Works & Human Settlement has awarded the contract for detailed design of road from Nganglam to Dewathang viz Choekhorling, Khalasho and Rishore & Pasakha Access Road to M/s Kyingkhor Consultancy Service, Thimphu. The team has been mobilized and is ready to start the survey works. Since the Consultant's assignment involves detailed field survey works, the firm desires to field the technical team at the earliest. We would like to request Dasho to kindly provide necessary support to our consulting team. We look forwards for your continued support & cooperation please.

Yours faithfully,

  
 (Karma Galay)  
 Director, DoR

Cc:-

1. Dasho Dungpa, Nganglam Dungkhag for kind information & with a request to kindly provide necessary support.
2. Dasho Thrompon, Municipality, Phuntsholing for kind information and necessary support.
3. Chairman, M/s kyingkhor Consultancy Services, Thimphu for information and necessary action.

D/L

Filed / date 26/3/13

P.O. Box No. 143, Thimphu: Bhutan. Tele Nos: (+975 2) 326832 Fax.No. (+975 2) 326831  
 Email [address\\_stobgyel58@gmail.com](mailto:address_stobgyel58@gmail.com) Web address: [www.dor.gov.bt](http://www.dor.gov.bt)

## 2. Letters from Samdrup Jongkhar Dzongkhag



བསམ་གྲུབ་ཚུངས་མཁར་ཚུང་ཁག།

DZONGKHAG ADMINISTRATION  
SAMDRUP JONGKHAR



SDA/DES- 10/General/2011-2012/ 2455

Date: 27/10/2011


The Gup  
Geog Administration  
Dewathang

**Subject: Feasibility study of Southern East – West Highway**

Dasho,

Please find enclosed herewith the vide No. DoR/RNP-III/2011-2012/2438 dated 18/10/2011 of Director General, DoR, Thimphu on the above cited subject. Therefore, you are requested to render the necessary services during their visit. We have nominated Mr. Tashi Phuntsho (JE) as a representative from the Dzongkhag during Deothang-Nganglam road survey.

Yours sincerely

  
(Sherab Dorji)  
Offtg. Dzongda

CC.

1. Director General, DoR, Thimphu for kind information
2. Mr. Tashi Phuntsho (JE) for assistance during survey
3. Office copy

### 3. Letters from Samdrup Jongkhar Thromde



ཁྲོམ་དཔོན་ཡིག་ཚང་  
བསམ་གྲུབ་ལྗོངས་མཁའ་ཁྲོམ་སྡེ།  
OFFICE OF THE THROMPON  
SAMDRUP JONGKHAR MUNICIPALITY



SJT / 12 / 2011 – 12 / 688

November 23, 2011

The Project Coordinator  
RNPII –AF  
Department of Roads  
MoWHS, Thimphu

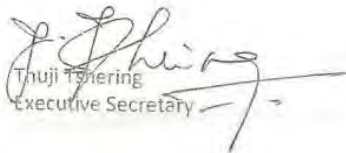
Subject: Road Network Project – II additional financing (AF) feasibility studies

Sir,

With reference to your letter No. DOR/RNP-II(AF)/2011-2012/2589 dated 23/11/11 regarding the above-cited subject, we are pleased to grant the permission for your Social and Environmental Assessment teams to carry out their studies in the municipality area specifically from the junction between road to Jigme Namgyal Polytechnic and coal mine road till highway junction at Rantsham in Deothang.

This is as per the approval of the Dasho Thrompon, S/Jongkhar Thromde.

Yours sincerely,

  
Thujii Tshering  
Executive Secretary

CC:

1. Dasho Thrompon, S/Jongkhar Thromde for kind information.
2. The Director General, Department of Roads, MoWHS, Thimphu for kind information.
3. The Team Leader, TA – 7803, RNP II – AF, Thimphu for kind information.
4. Mr. Chogyel, Environment Specialist (TA – 7803, RNP II – AF).
5. Mr. Rajesh Pradhan, Social & Resettlement Specialist (TA – 7803, RNP II – AF).
6. The Thuemis, Bangtsho / Samdrupgatsel / Kipse, Deothang, Samdrup Jongkhar Thromde with the request to provide any assistance that may be required.

## 4. Project Acceptance Letters from the People of Chokhorling

3

རྒྱ་རྒྱུ་ཀྱི་ཡམ་གྱི་ཕྱི་ཕྱོད་ཀྱི་ཕྱི་ཕྱོད་ཀྱི་  
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 རྒྱུ་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་  
 རྒྱུ་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་  
 རྒྱུ་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་  
 རྒྱུ་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་ཕྱོད་ཀྱི་

1

མཁའ་མཁའ་མཁའ་

མཁའ་མཁའ་མཁའ་

2

མཁའ་མཁའ་













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མཁའ་







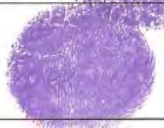





307-17-30/00



## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Zangpo (Tsharpa).		M	Chetkooling	
2,	Zepa Kialy (Chairman)		- 11 -	- do -	
3,	Tashi Zangpo		- 11 -	- 11 -	
4,	Chimi (Tsharpa)		- 11 -	- 11 -	
5,	Lhjay Wangchi		- 11 -	- 11 -	
6,	Singye Wangchi		- 11 -	- 11 -	
7,	Dubala		- 11 -	- 11 -	
8,	Dogji		- 11 -	- 11 -	
9,	Sonam Wangchuk		- 11 -	- 11 -	
10,	Kezang		- 11 -	- 11 -	
11,	Samten		- 11 -	- 11 -	
12,	Singye Chungwa		- 11 -	- 11 -	

## LIST OF PARTICANTS







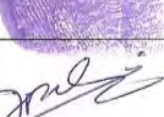
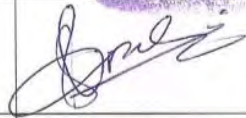
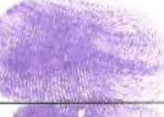

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
13,	Khandu Wangchi		M	Chokkhooking	
14,	Tsheltrim		- 11 -	- 11 -	
15,	Wangchuk		- 11 -	- 11 -	
16,	Layen Zangpo		- 11 -	- 11 -	
17,	Bumzang		F	- 11 -	
18,	Sai Chamo		- 11 -	- 11 -	
19,	Norbu Dema		- 11 -	- 11 -	
20,	Khandu Zangmo		- 11 -	- 11 -	
21,	Bencho Wangmo		- 11 -	- 11 -	
22,	Tshei Chamo		- 11 -	- 11 -	
23,	Rig Zangmo		- 11 -	- 11 -	
24,	Bayza Chamo		- 11 -	- 11 -	

## LIST OF PARTICANTS

[illegible]



## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Duba	Ta-8-213 TNb-540	M	Yargay Noong	
2,	Norbu	TNb-262 Ta-8-222		- 11 -	
3,	Nima Wangdi			- 11 -	
4,	Jangchuk Wangdi			- 11 -	
5,	Namgyal Dangi			- 11 -	
6,	Jangsho			- 11 -	
7,	Pharpa			- 11 -	
8,	Sangay Chopel	Ta-8-225 TNb-600		- 11 -	
9,	Jigme Wangchuk	Ta-8-216 TN-518		- 11 -	
10,	Sonam Rinzin			- 11 -	

## 5. Project Acceptance Letters from the People of Rishore, Chenari, Deothang

Date: 26/11/2011

To whom it may concern

This is to note that on above dated a public meeting was conducted at Gayzer by the visiting consultant (Socio expert & Environmental expert). In the meeting the authority concerned informed the public on the proposed road widening of Resture road that passes through the village which would connect further. For this all the necessary formalities including taking note of the affected areas of the nearby localities were done by the visiting authority. Regarding the proposed road widening the affected public hereby declare no objection to this whatsoever. At the same time the public would also like to inform the authority that all the affected areas like embedded drinking water pipelines also to be included in the note that is being taken by the visiting team. The meeting concluded with thanks from the public on the proposed road widening.

Furthermore, along the proposed road alignment there is no cult cultural & historical monuments like "Chu", the graveyard etc.

1) Pillli  
Tshogpa  
Geog. Adm.  
D/15thang

2) Land Tshogpa  
Chenaree'

3) Land Tshogpa  
Resture.

## LIST OF PARTICIPANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Kuchi		F	Chengjee	
2,	Cezang Tshomo		F	"	
3,	Wangtu		M	"	
4,	Dawa Gyelmo		F	"	
5,	Dawa Dema		F	"	
6,	Tumpey		M	"	
7,	Deki Pema		F	"	
8,	Jigme		M	"	
9,	Carchung		M	"	
10,	Wangjoli Gyelkhen		M	"	
11,	Chakseung		M	"	



## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
12,	Yeshey mo		F	Shengaree <del>Rech</del>	
13,	Cezang		M	"	
14,	Sangay		M	"	
15,	Carma		F	"	
16,	Tenzin		M	"	
17,	Pocko		M	"	
<del>18,</del>	<del>Babjay Tenzin Wangchuk</del>		<del>M</del>	<del>"</del>	
18,	Babjay		M	"	
19,	Laek (Gawa Gyelmo)		M	"	
20,	Lungten Tshering (Tshel mo)		M	"	
21,	Tantsho		M	"	
22,	Carma (Lanel Tshogpa)		M	"	
23,	Tshenchi		F	"	

## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Sonam Dorji		M	Resthore	
2,	Pema Tashi		M	"	
3,	Sangay Wangmo <del>Dechen Chetser</del>		F	"	
4,	Cheki		F	"	
5,	Yanki Chame		F	"	
6,	Zanjay		M	"	
7,	Sangay Wangmo		F	"	
8,	Namgyal Dema		F	"	
9,	Pema Rinzi's (Land Tshogpa)		M	"	
10,	Cheten Zangmo		F	"	
11,	Datta Zangmo		F	"	
12,	Tshering Samchup		M	"	

13, Dechen Chetser

F

"


14, Norbu Zangmo

F

"





## 6. Letter Inviting Stakeholder for National Workshop on RNP II AF



དཔལ་ལྷན་འབྲུག་གཞུང་། འབས་ཏྲོག་ལྷན་ཁག་། ལམ་སེལ་ལས་ཁུངས་།

**ROYAL GOVERNMENT OF BHUTAN**  
**MINISTRY OF WORKS & HUMAN SETTLEMENTS**  
**DEPARTMENT OF ROADS**  
**ROAD NETWORK PROJECT-II (Additional Financing)**  
**THIMPHU: BHUTAN**



**DoR/RNP-II(AF)/2011-2012/307**

**Date: 9/03/2012**

<p>The Director General Department of Geology &amp; Mines Ministry of Economic Thimphu.</p>	<p>The Director General Department of Forest &amp; Park Services Ministry of Agriculture &amp; Forests Thimphu.</p>	<p>The Director Department of Public Accounts Ministry of Finance Thimphu.</p>
<p>The Director Department of Energy Ministry of Economic Affairs Thimphu.</p>	<p>The Dasho Dzongdag Dzongkhag Administration Pemagatshel, Samdrupjongkhar, Sarpang, Dagana &amp; Zhemgang.</p>	<p>The Head Environmental Services Division National Environment Commission Thimphu.</p>

**Sub: Final presentation by PPTA consultants regarding the findings on feasibility studies of roads under TA7803.**

Sir,

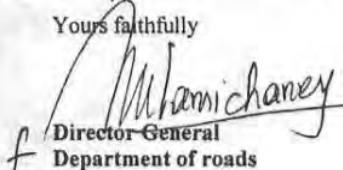
With a support from various agencies the project preparatory technical assistant (PPTA) consultants under TA7803, RNP-II Additional Financing has successfully completed the feasibility study of following roads funded by Asian Development Bank (ADB).

1. Dewathang – Nganglam road under Samdrupjongkhar and Pemagatshel Dzongkhag.
2. Sarpang-Lhamoizingkha road under Sarpang and Dagana Dzongkhag.
3. Samrang-Jomotshangkha road under Samdrupjongkhar Dzongkhag.
4. Gelephu-Panbang road under Sarpang and Zhemgang Dzongkhag.

In this regard, the final presentation regarding the findings of above mentioned roads by PPTA consultant is scheduled on 14<sup>th</sup> March 2012 at 9:30 am in the conference hall of the Ministry of Works & Human Settlements, Thimphu.

Therefore, Department of roads would like to invite your presence during the presentation or nominate relevant officials from your organization. We will be contented to receive comments and suggestion during the presentation from your side for betterment of the project.

Yours faithfully














**Director General**  
**Department of roads**  
**Thimphu.**

Cc:

1. Hon'ble Secretary, MoWHS for kind information with the request to kindly chair the presentation.
2. Hon'ble Secretary, GNHC, Thimphu for kind information and request for Dasho's presence during the presentation.
3. The Dasho Drungpa, Drungkhag Administration, Nganglam, Jomotshangkha, Lhamoizingkha and Panbang with a request of your presence during the presentation.
4. All the Chief Engineer under DoR(Roads, I&DD, S&D and Bridge) are advice to attend the presentation.
5. All PC's under DoR (GoI, ORIO, RAP-II, RNP-I & RNP-II) are advice to attend the presentation.
6. The Chief Planning Officer, PPD, MoWHS for information and kindly attend the presentation.
7. Mr. Janusz, Team Leader, PPTA Consultant, RNP-II (AF) for information and necessary action.














## 7. List of Participants during National Workshop on RNP II AF

## Final Presentation of Feasibility Study Findings

Sl. No.	Name of Participant	Ministry/Department	Email address	Signature
1	Dr. Sonam Tenzin	Hon'ble Secretary, MoRHS	tsongma@yadau.	
2	Dachu Karma Tseten	, , GNHC		
3				
4	Karma Wangdi	Dzongkhag Administration S-sipang	karong_1470@yahoo.com	
5	Kinley	Dzongkhag Admin, Zhangye	kinley@zhu.gov.bt	
6	Namgyal Tshering	MoHHS Def PS, Thimphu	ntshering303@gmail.com	
7	M. B. Morspur	IPDD, DOR	mbsmorspur@yahoo.com	
8	Tenzin Jumbuk	RNP-II, DOR	tenzinj2006@yahoo.com	
9	Jangay Choden	GNHC	schedar@gnhc.gov.bt	
10	Thendup Tharchen	DoFPS, MoAEC	thenduptharchen@gmail.com	
11	T. Wangdi 'A'	DOR		
12	T. Wangdi 'B'	"		
13	C. K. Bradburn	"	ckelooxi@gmail.com	



## Final Presentation of Feasibility Study Findings

Sl. No.	Name of Participant	Ministry/Department	Email address	Signature
14	J. B. Bernet	DEPT. OF HYDROPOWER PROJECTS (DHPS) MOEA	jacob_bernet@yahoo.com	
15	Thuj Tshering	S. Tongkhro Thron-de	thujtshering@gmail.com	
16	KATMA TSHITEEM	CINH COMMISSION	tshteema@yahoo.com	
17	Tsuneyuki SAKAI	ADB	tsakai@adb.org	
18	Sharon ZHAO	ADB	szhao@adb.org	
19	TSHENANG TORGHEL	DUNGHAG, L/Kha	tshenang_torgel@yahoo.com	
20	KARMA YANGZOM	ADB	kyangzom@adb.org	
21	JEMMA T. BADE	ADB	gbade@adb.org	
22	Tshering Dorj	National Environment Commission	clhargyeal@gmail.com	
23	Tshering Dorj	"	tshe.dorj506@yahoo.com	
24	M. N. Lamichaney	Dept. of Roads	cebd2010@gmail.com	
25	UGYEN WANGDA	Dept. of Geology & Min	uwang 2011@gmail.com	
26	Tempa Thinley	Dept. of Roads	ttthinley@yahoo.com	



## Final Presentation of Feasibility Study Findings

Sl. No.	Name of Participant	Ministry/Department	Email address	Signature
27	Ganue Tshering	RNP-II(AF)-IMC/HMEMCO	ganuet1557@yahoo.com	
28	P.L. Sharma	RNP-II(AF)-IMC/HMEMCO	plsharma2008@hotmail.com	
29	Kamal Chhetri	RNP-II(AF)-IMC/HMEMCO	rkchhetri009@gmail.com	
30	Tshering Norbu	DPA, MOF	tnorbu@me.gov.np	
31	Dagi Kuenley	GOI/AF, PDMIS	d.dagi.kuenley@yahoo.com	
32	Pema Rabgyal	MOF, PPA	pemrabgyal@gmail.com	
33	Sorim Tenzin K	RNP II(AF)/EMC/Cygal Shen Consulting	sorimbk@gmail.com	
34	Mahendra Chhetri	HEMCO	hemc2010@gmail.com	
35	Ravi Prasanna	RNP II (AF)-IMC	rn1prasanna@gmail.com	
36	Tim Stiff	IMC worldwide CONSULTANTS	tim.stiff@vicworldwide.co.uk	
37	ROBERT THURLOW	IMC CONSULTANTS	thurlow99@gmail.com	
38	J.P. Sharma	RNP-II(AF) By TL	jpsharma@dnksults.com	
39	Karma Chogyel	Environmental Specialist	chogyelk@yahoo.com	
40	Rajesh Pradhan	Soed / Design Consultant	rajpradhan2008@gmail.com	

**8. Other Key Stakeholders or Officials Consulted**

<b>Sl. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Department/Agency</b>
1	Thinley Dorji	Deputy Chief Environment Officer	National Environment Commission (NEC)
2	Sonam Wangchuk	Chief Forest Officer	Wildlife Conservation Division, DoFPS
3	Sonam Tobgay	Deputy Chief Forest Officer	Wildlife Conservation Division, DoFPS
4	Phub Tshering	Dasho Dzongdag	Samdrup Jongkhar Dzongkhag
5	Sangay Tashi	Cultural Officer	Dzongkhag Administration, Samdrup Jongkhar
6	Karma	DYT Secretary	Dzongkhag Administration, Samdrup Jongkhar
7	Nima Gyeltshen	Dasho Dungpa	Nganglam Dungkhag, Pema Gatshel
8	Tashi Phuntsho	Junior Engineer	Dzongkhag Administration, Samdrup Jongkhar
9	Karma	Dasho Thrompon	Samdrup Jongkhar – Deothang Thromde
10	Rinzin Dorji	Land Record Officer	Nganglam Dungkhag, Pema Gatshel
11	Karma Duptho	Junior Engineer	Nganglam Dungkhag, Pema Gatshel
12	Zangpo	Tshampa	Thujaycholing Temple, Chokhorling
13	Chimi	Tshampa	Thujaycholing Temple, Chokhorling
14	Bumpay	Tshampa	Thujaycholing Temple, Chokhorling
15	Kinzang Wangchuk	RNR Extension Officer	Chokhorling Geog
16	Tshewang Rabgay	Laboratory Technician	RLDC, Khangma, Trashigang
17	Kesang Phuntsho	Chipon	Rishore, Deothang Geog

## 9. Final presentation of revised/updated EIA of Nganglam-Deothang Road



འབྲུག་རྒྱལ་ཁབ་ཀྱི་རྒྱུ་རྩལ་ལྷན་ཁག་།  
**ROYAL GOVERNMENT OF BHUTAN**  
 MINISTRY OF WORKS & HUMAN SETTLEMENT  
 DEPARTMENT OF ROADS  
 SASEC Road Connectivity Project, RNP II (A/F)  
 THIMPHU: BHUTAN



No. DOR/RNP II(SASEC)/2013-2014/07/

5436

08<sup>th</sup> Nov. 2013

The Head  
 Environmental Service Division  
 NECS, Thimphu

The Director General  
 Department of Forestry  
 Ministry of agriculture, Thimphu

Sub : Final draft report on Environment Impact Assessment Report (EIA) of Nganglam-Dewathang Road.

This has reference to our earlier letter no. DoR/RNP II(AF)/07/2012-2013 dated 10<sup>th</sup> Sept. 2012 wherein this office has circulated Environment Impact Assessment (EIA) reports in respect to Nganglam-Dewathang road and IEE for Pasakha link Road prepared as part of the ADB Assisted Project Preparatory Technical Assistant (PPTA).

The EIA report has been further updated by Detail Design Consultant, M/s Kyongkhon Consultancy service as a part of their assignment and copy of the report is attached.

Therefore Department of Roads, Ministry of Works and Human Settlement would like to hold a final consultation meeting with relevant stakeholders on 19<sup>th</sup> October 2013 at 10:00 AM in MoWHS conference hall. Kindly attend in person or depute relevant officials on above mentioned date.

Thanking you for your continued support.

Thanking you

(Karma Galay)

Director

Cc:

1. PPD head, MoWHS with a request to depute one representative for the meeting. *SD*
2. The specialist I&DD to attend the meeting ✓
3. All the Chiefs Engineers, I&DD, Bridge Division, Roads Division and S&DD DoR, to attend the meeting.
4. M/s Kyongkhon Consultancy service for presentation on the above report.
- ✓ 5. Mr. Karma Choyphel, Environment Specialist, ADB Thimphu.

*faxed 21 = 8/11/13*



## 10. List of participants during final stakeholders presentation of revised/updated EIA

ATTENDANCE SHEET					
List of participants during the final stakeholders presentation of revised/updated Environment Impact Assessment Report (EIA) of Nganglam Dewathang Road held at Ministry of Works & Human Settlement, Thimphu (19th Nov. 2013)					
Sl. No.	Name	Designation	Organization	Signature	Email Add.
1	Karma Galay	Director	DOR	[Signature]	karma.galay@com
2	M.N. Lamichaney	Specialist, BD	DOR	[Signature]	cebd2010@gmail.com
3	Karma Chogyel	Staff Consultant	ADB	[Signature]	chogyelk@yash.com
4	Dorji Rinchen	Environment Specialist	KCS	[Signature]	khenrifagpa@com
5	Niralal Rai	Team Leader,	KCS	[Signature]	nkrain2009@gmail.com
6	Namgay Bidha	Forestry Officer	WCD, DoFPS	[Signature]	bidhanamgay@gmail.com
7	Namgay Tshering	— / —	FRED, DoFPS	[Signature]	ntshering303@gmail.com
8	Pema Chenzin	Manager, DOR	Kyapla	[Signature]	Kyapla@com
9	Tshering Wangdi	CE	DOR	[Signature]	tsheringw@yash.com
10	Ugyen Pemo	AE	DOR	[Signature]	ugyensp@project.com
11	Choden	AE	DOR	[Signature]	choged712@gmail.com
12	Sonam Dorji	Sr. En. Off.	PPD, MoWHS	[Signature]	sonamdesai@gmail.com
13	Karma Yangzon	Environment Specialist	ADB	[Signature]	kyangzon@adb.org
14	Sonam Tobgyel	PC	RNP II SASEC	[Signature]	stobgyel58@gmail.com
15	Lela Dorji	Off. CE (IBDD)	IBDD	[Signature]	lece2td@gmail.com
16	P.L. Chenzin	Geotech. Eng.	Kyapla	[Signature]	plshen@com
17	T. Wangdi	CE (SADD)	DOR	[Signature]	twang_yang@yash.com
18	T. Sakai	Transport Specialist	ADB	[Signature]	tsakai@adb.org
19	T. Kawabata	Young Professional	ADB	[Signature]	tkawabata@adb.org

### NATIVE PLANT SPECIES FOR BIOENGINEERING WORKS AND COMPENSATORY PLANTATION

The list of plants species recommended below for bio-engineering works along Nganglam-Deothang Road consists of various methods of planting viz. potted seedlings, stem cutting, rhizome planting and seed broadcasting directly to the site. Planting of wildlings is not recommended as its survival percent is questionable. There is a nursery of forest seedlings and fruits and nuts at Yargaywoong established by a retired Range Officer who is a local in the project area. He could raise both naked roots and polypot seedlings of the species mentioned in the list below and sell to the project for bioengineering plantation.

Sl. No	Botanical name	Family	Local name	Method	Source
1	<i>Morus laevigata</i>	Moraceae	<i>Tshende</i> (Dz.); <i>Kimbu</i> (Lh.)	Potted seedlings	DoFPS/Dz
2	<i>Ficus semicordata</i>	Urticaceae	<i>Barchongma</i> (Sh.); <i>Khaneo</i> (Lh.)	Potted seedlings	DoFPS/Dz
3	<i>Ficus glomerata</i>	Urticaceae		Potted seedlings	DoFPS/Dz
4	<i>Ficus subisinsa</i>	Urticaceae		Potted seedlings	DoFPS/Dz
5	<i>Ficus hookeriana</i>	Urticaceae		Potted seedlings	DoFPS/Dz
6	<i>Ficus racimosus</i>	Urticaceae		Potted seedlings	DoFPS/Dz
7	<i>Ficus sp.</i>	Urticaceae		Potted seedlings	DoFPS/Dz
8	<i>Michelia champaca</i>	Magnoliaceae	<i>Champai-shing</i> (Sh.); <i>Chanp</i> (Lh.)	Potted seedlings	DoFPS/Dz
9	<i>Phoebe golparensis</i>	Lauraceae	<i>Sechanglo-shing</i> (Sh.); <i>Bonsum</i> (Lh.)	Potted seedlings	DoFPS/Dz
10	<i>Schima wallichii</i>	Theaceae	<i>Puyam</i> (Dz.); <i>Slashing</i> (Sh.); <i>Chilaune</i> (Lh.)	Potted seedlings	Locally collected
11	<i>Tetrameles nudiflora</i>	Datisceae	<i>Maina-kath</i> (Lh.)	Seed broadcasting & stem cutting	Locally collected
12	<i>Duabanga grandiflora</i>	Sonneratiaceae	<i>Drangnanglaishing</i> (Sh.); <i>Lampate</i> (Lh.)	Seed broadcasting & potted seedlings	Locally collected & DoFPS/Dz
13	<i>Altingia excelsa</i>	Hamamelideaceae	<i>Jhikri</i> , <i>Seti kath</i> (Lh.); <i>Ding shing</i> (Sh.)	Potted seedlings	DoFPS/Dz
14	<i>Albizia lebbeck</i>	Leguminosae	<i>Khirdang-laishing</i> (Sh.); <i>Laa siris</i> (Lh.)	Potted seedlings	DoFPS/Dz
15	<i>Albizia chinensis</i>	Leguminosae		Potted seedling	DoFPS/Dz
16	<i>Erythrina arborescens</i>	Leguminosae	<i>Kharshing</i> (Sh); <i>Phaledo</i> (Lh.)	Stem cutting	Locally collected
17	<i>Erythrina stricta</i>	Leguminosae	<i>Kharshing</i> (Sh.); <i>Phaledo</i> (Lh.)	Stem cutting	Locally collected
18	<i>Justica adatoda</i>	Acanthaceae	<i>Khatsirim</i> (Sh.); <i>Thro-Bashaka</i> (Med.)	Stem cutting	Locally collected

Sl. No	Botanical name	Family	Local name	Method	Source
19	<i>Salix</i> sp.	Salicaceae		Stem cutting	Locally collected
20	<i>Viburnum erubescens</i>	Caprifoliaceae		Stem cutting	Locally collected
21	<i>Bauhinia purpurea</i>	Leguminosae	<i>Tanki</i> (Lh.); <i>Pekpekpa shing</i> (Sh.)	Potted seedling	Locally collected
22	<i>Bauhinia varigata</i>	Leguminosae	<i>Tanki</i> (Lh.); <i>Pekpekpa shing</i> (Sh.)	Potted seedling	DoFPS/Dz
23	<i>Acrocarpus fraxinifolia</i>	Leguminosae	<i>Mandane</i> (Lh.)	Potted seedling	DoFPS/Dz
24	<i>Melotus philipinensis</i>	Euphorbiaceae	<i>Sindure</i> (Lh.)	Potted seedling	DoFPS/Dz
25	<i>Bridelia retusa</i>	Euphorbiaceae	<i>Gayo</i> (Lh.)	Potted seedling	DoFPS/Dz
26	<i>Bischofia javanica</i>	Euphorbiaceae	<i>Kainjal</i> (Lh.)	Potted seedling	DoFPS/Dz
27	<i>Evodia fraxinifolia</i>	Rutaceae	<i>Khanakpa</i> (Lh.)	Potted seedling	DoFPS/Dz
28	<i>Amoora wallichii</i>	Meliaceae	<i>Lasune</i> (Lh.)	Potted seedling	DoFPS/Dz
29	<i>Amoora rohituca</i>	Meliaceae	<i>Lasune</i> (Lh.)	Potted seedling	DoFPS/Dz
30	<i>Toona ciliata</i>	Meliaceae	<i>Tooni</i> (Lh.)	Potted seedling	DoFPS/Dz
31	<i>Spondias pinnata</i>	Anacardiaceae	<i>Amaro</i> (Lh.); <i>Amarshing</i> (Sh.)	Potted seedling	DoFPS/Dz
32	<i>Lannea coromandelica</i>	Anacardiaceae		Potted seedling	DoFPS/Dz
33	<i>Acer oblongum</i>	Aceraceae	<i>Kapase</i> (Lh.)	Potted seedling	DoFPS/Dz
34	<i>Acer cambellii</i>	Aceraceae	<i>Kapase</i> (Lh.)	Potted seedling	DoFPS/Dz
35	<i>Sapindus rarrak</i>	Sapindaceae	<i>Nakapani</i> (Dz.); <i>Kiling</i> (Sh.); <i>Phirphere</i> (Lh.)	Potted seedling	DoFPS/Dz
36	<i>Hobenia dulchis</i>	Rhamnaceae	<i>Pumoloto</i> (Dz.); <i>Bange</i> (Lh.)	Potted seedling	DoFPS/Dz
37	<i>Kydia calycina</i>	Malvaceae	<i>Kubinde</i> (LH.); <i>Chhambaktang</i> (Sh.)	Potted seedling	DoFPS/Dz
38	<i>Bombax ceiba</i>	Bombacaceae	<i>Simal</i> (Lh.); <i>Pemageser</i> (Sh.)	Potted seedling	DoFPS/Dz
39	<i>Gynocardia odoridisina</i>	Flacourtiaceae	<i>Gante</i> (Lh.); <i>Dorkho</i> (Sh.)	Potted seedling	DoFPS/Dz
40	<i>Legerstromea pervifolia</i>	Lythraceae	<i>Buram shing</i> (Sh.)	Potted seedling	DoFPS/Dz
41	<i>Eugenia jambolana</i>	Myrtaceae	<i>Mauwa</i> (Lh.); <i>Tshos shing</i> (Sh.)	Potted seedling	DoFPS/Dz
42	<i>Terminalia myriocarpa</i>	Combretaceae	<i>Bakhal shing</i> (Sh.); <i>Saj</i> (Lh.)	Potted seedling	DoFPS/Dz
43	<i>Diplocknema butyracea</i>	Sapotaceae	<i>Cheuri</i> (Lh.); <i>Pinse</i> (Sh.)	Potted seedling	DoFPS/Dz

Sl. No	Botanical name	Family	Local name	Method	Source
44	<i>Alstonea scholaris</i>	Apocynaceae	<i>Chatiwan</i> (Lh.); <i>Nimthomo</i> (Sh.)	Potted seedling	DoFPS/Dz
45	<i>Anthocephalus cadamba</i>	Rubiaceae	<i>Kadam</i> (Lh.)	Potted seedling	DoFPS/Dz
46	<i>Cordia obliqua</i>	Boraginaceae	<i>Yangshing</i> (Sh.)	Potted seedling	DoFPS/Dz
47	<i>Callicarpa arborea</i>	Verbenaceae	<i>Khalema</i> (Kh.); <i>Guinle</i> (Lh.); <i>Thulushing</i> (Sh.)	Potted seedling	DoFPS/Dz
48	<i>Dendrocalamus hamiltonii</i>	Bambosae	<i>Bans</i> (Lh.)	Rhizome	Locally collected
49	<i>Thyssonolaena maxima</i>	Graminae	<i>Tsakusha</i> ; <i>Beshawi</i> (Sh.)	Root slip	Locally collected
50	<i>Eupatorium adenophorum</i>	Compositae	<i>Banmara</i> (Lh.); <i>Ngon Changlo</i> (Sh)	Seed broadcasting	Locally collected

### SCREEN III MODEL RUN

02/18/14

14:56:31

\*\*\* SCREEN3 MODEL RUN \*\*\*

\*\*\* VERSION DATED 13043 \*\*\*

PM Bhutan Sasac

#### SIMPLE TERRAIN INPUTS:

SOURCE TYPE = AREA

EMISSION RATE (G/(S-M\*\*2)) = 0.985700E-07

SOURCE HEIGHT (M) = 1.0000

LENGTH OF LARGER SIDE (M) = 70.0000

LENGTH OF SMALLER SIDE (M) = 7.0000

RECEPTOR HEIGHT (M) = 0.0000

URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

BUOY. FLUX = 0.000 M\*\*4/S\*\*3; MOM. FLUX = 0.000 M\*\*4/S\*\*2.

\*\*\* FULL METEOROLOGY \*\*\*

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\*\*\* SCREEN AUTOMATED DISTANCES \*\*\*

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\*\*\* TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES \*\*\*

DIST	CONC	U10M	USTK	MIX HT	PLUME	MAX DIR
(M)	(UG/M**3)	STAB (M/S)	(M/S)	(M)	HT (M)	(DEG)

10.	1.419	5	1.0	1.0	10000.0	1.00 0.
100.	1.390	6	1.0	1.0	10000.0	1.00 0.
200.	0.4661	6	1.0	1.0	10000.0	1.00 0.
300.	0.2379	6	1.0	1.0	10000.0	1.00 0.
400.	0.1468	6	1.0	1.0	10000.0	1.00 0.
500.	0.1010	6	1.0	1.0	10000.0	1.00 0.
600.	0.7414E-01	6	1.0	1.0	10000.0	1.00 0.
700.	0.5718E-01	6	1.0	1.0	10000.0	1.00 0.
800.	0.4617E-01	6	1.0	1.0	10000.0	1.00 0.
900.	0.3828E-01	6	1.0	1.0	10000.0	1.00 0.
1000.	0.3239E-01	6	1.0	1.0	10000.0	1.00 0.
1100.	0.2795E-01	6	1.0	1.0	10000.0	1.00 0.
1200.	0.2444E-01	6	1.0	1.0	10000.0	1.00 0.
1300.	0.2161E-01	6	1.0	1.0	10000.0	1.00 0.
1400.	0.1927E-01	6	1.0	1.0	10000.0	1.00 0.
1500.	0.1733E-01	6	1.0	1.0	10000.0	1.00 0.
1600.	0.1569E-01	6	1.0	1.0	10000.0	1.00 0.
1700.	0.1429E-01	6	1.0	1.0	10000.0	1.00 0.
1800.	0.1309E-01	6	1.0	1.0	10000.0	1.00 0.
1900.	0.1204E-01	6	1.0	1.0	10000.0	1.00 0.

2000.	0.1113E-01	6	1.0	1.0	10000.0	1.00	0.
2100.	0.1037E-01	6	1.0	1.0	10000.0	1.00	0.
2200.	0.9690E-02	6	1.0	1.0	10000.0	1.00	0.
2300.	0.9085E-02	6	1.0	1.0	10000.0	1.00	0.
2400.	0.8541E-02	6	1.0	1.0	10000.0	1.00	0.
2500.	0.8051E-02	6	1.0	1.0	10000.0	1.00	0.
2600.	0.7606E-02	6	1.0	1.0	10000.0	1.00	0.
2700.	0.7201E-02	6	1.0	1.0	10000.0	1.00	0.
2800.	0.6831E-02	6	1.0	1.0	10000.0	1.00	0.
2900.	0.6493E-02	6	1.0	1.0	10000.0	1.00	0.
3000.	0.6183E-02	6	1.0	1.0	10000.0	1.00	0.
3500.	0.5007E-02	6	1.0	1.0	10000.0	1.00	0.
4000.	0.4172E-02	6	1.0	1.0	10000.0	1.00	0.
4500.	0.3552E-02	6	1.0	1.0	10000.0	1.00	0.
5000.	0.3077E-02	6	1.0	1.0	10000.0	1.00	0.
5500.	0.2702E-02	6	1.0	1.0	10000.0	1.00	0.
6000.	0.2400E-02	6	1.0	1.0	10000.0	1.00	0.
6500.	0.2152E-02	6	1.0	1.0	10000.0	1.00	0.
7000.	0.1946E-02	6	1.0	1.0	10000.0	1.00	0.
7500.	0.1778E-02	6	1.0	1.0	10000.0	1.00	0.
8000.	0.1634E-02	6	1.0	1.0	10000.0	1.00	0.
8500.	0.1509E-02	6	1.0	1.0	10000.0	1.00	0.
9000.	0.1400E-02	6	1.0	1.0	10000.0	1.00	0.
9500.	0.1305E-02	6	1.0	1.0	10000.0	1.00	0.
10000.	0.1220E-02	6	1.0	1.0	10000.0	1.00	0.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:

51. 2.544 6 1.0 1.0 10000.0 1.00 0.

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\*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*

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CALCULATION	MAX CONC	DIST TO	TERRAIN
PROCEDURE	(UG/M**3)	MAX (M)	HT (M)

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SIMPLE TERRAIN	2.544	51.	0.
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\*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*

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02/18/14

14:14:32

\*\*\* SCREEN3 MODEL RUN \*\*\*

\*\*\* VERSION DATED 13043 \*\*\*

NOX Bhutan Sasac

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = AREA

EMISSION RATE (G/(S-M\*\*2)) = 0.635000E-07

SOURCE HEIGHT (M) = 1.0000

LENGTH OF LARGER SIDE (M) = 70.0000

LENGTH OF SMALLER SIDE (M) = 7.0000

RECEPTOR HEIGHT (M) = 0.0000

URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

BUOY. FLUX = 0.000 M\*\*4/S\*\*3; MOM. FLUX = 0.000 M\*\*4/S\*\*2.

\*\*\* FULL METEOROLOGY \*\*\*

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## \*\*\* SCREEN AUTOMATED DISTANCES \*\*\*

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\*\*\* TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING  
DISTANCES \*\*\*

DIST	CONC		U10M	USTK	MIX HT	PLUME	MAX DIR
(M)	(UG/M**3)	STAB	(M/S)	(M/S)	(M)	HT (M)	(DEG)

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10.	0.9141	5	1.0	1.0	10000.0	1.00	0.
100.	0.8958	6	1.0	1.0	10000.0	1.00	0.
200.	0.3003	6	1.0	1.0	10000.0	1.00	0.
300.	0.1532	6	1.0	1.0	10000.0	1.00	0.
400.	0.9459E-01	6	1.0	1.0	10000.0	1.00	0.
500.	0.6504E-01	6	1.0	1.0	10000.0	1.00	0.
600.	0.4776E-01	6	1.0	1.0	10000.0	1.00	0.
700.	0.3684E-01	6	1.0	1.0	10000.0	1.00	0.
800.	0.2974E-01	6	1.0	1.0	10000.0	1.00	0.
900.	0.2466E-01	6	1.0	1.0	10000.0	1.00	0.
1000.	0.2087E-01	6	1.0	1.0	10000.0	1.00	0.
1100.	0.1801E-01	6	1.0	1.0	10000.0	1.00	0.
1200.	0.1575E-01	6	1.0	1.0	10000.0	1.00	0.
1300.	0.1392E-01	6	1.0	1.0	10000.0	1.00	0.
1400.	0.1242E-01	6	1.0	1.0	10000.0	1.00	0.
1500.	0.1116E-01	6	1.0	1.0	10000.0	1.00	0.
1600.	0.1011E-01	6	1.0	1.0	10000.0	1.00	0.
1700.	0.9206E-02	6	1.0	1.0	10000.0	1.00	0.

1800.	0.8431E-02	6	1.0	1.0	10000.0	1.00	0.
1900.	0.7758E-02	6	1.0	1.0	10000.0	1.00	0.
2000.	0.7171E-02	6	1.0	1.0	10000.0	1.00	0.
2100.	0.6679E-02	6	1.0	1.0	10000.0	1.00	0.
2200.	0.6243E-02	6	1.0	1.0	10000.0	1.00	0.
2300.	0.5853E-02	6	1.0	1.0	10000.0	1.00	0.
2400.	0.5502E-02	6	1.0	1.0	10000.0	1.00	0.
2500.	0.5186E-02	6	1.0	1.0	10000.0	1.00	0.
2600.	0.4900E-02	6	1.0	1.0	10000.0	1.00	0.
2700.	0.4639E-02	6	1.0	1.0	10000.0	1.00	0.
2800.	0.4401E-02	6	1.0	1.0	10000.0	1.00	0.
2900.	0.4183E-02	6	1.0	1.0	10000.0	1.00	0.
3000.	0.3983E-02	6	1.0	1.0	10000.0	1.00	0.
3500.	0.3225E-02	6	1.0	1.0	10000.0	1.00	0.
4000.	0.2688E-02	6	1.0	1.0	10000.0	1.00	0.
4500.	0.2288E-02	6	1.0	1.0	10000.0	1.00	0.
5000.	0.1982E-02	6	1.0	1.0	10000.0	1.00	0.
5500.	0.1741E-02	6	1.0	1.0	10000.0	1.00	0.
6000.	0.1546E-02	6	1.0	1.0	10000.0	1.00	0.
6500.	0.1387E-02	6	1.0	1.0	10000.0	1.00	0.
7000.	0.1254E-02	6	1.0	1.0	10000.0	1.00	0.
7500.	0.1145E-02	6	1.0	1.0	10000.0	1.00	0.
8000.	0.1052E-02	6	1.0	1.0	10000.0	1.00	0.
8500.	0.9722E-03	6	1.0	1.0	10000.0	1.00	0.
9000.	0.9022E-03	6	1.0	1.0	10000.0	1.00	0.
9500.	0.8407E-03	6	1.0	1.0	10000.0	1.00	0.

10000. 0.7862E-03 6 1.0 1.0 10000.0 1.00 0.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:

51. 1.639 6 1.0 1.0 10000.0 1.00 0.

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\*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*

\*\*\*\*\*

CALCULATION	MAX CONC	DIST TO	TERRAIN
PROCEDURE	(UG/M**3)	MAX (M)	HT (M)

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SIMPLE TERRAIN	1.639	51.	0.
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\*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*

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02/19/14

16:08:09

\*\*\* SCREEN3 MODEL RUN \*\*\*

\*\*\* VERSION DATED 13043 \*\*\*

HC Bhutan Sassec

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = AREA  
EMISSION RATE (G/(S-M\*\*2)) = 0.121100E-07  
SOURCE HEIGHT (M) = 1.0000  
LENGTH OF LARGER SIDE (M) = 70.0000  
LENGTH OF SMALLER SIDE (M) = 7.0000  
RECEPTOR HEIGHT (M) = 0.0000  
URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

BUOY. FLUX = 0.000 M\*\*4/S\*\*3; MOM. FLUX = 0.000 M\*\*4/S\*\*2.

\*\*\* FULL METEOROLOGY \*\*\*

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## \*\*\* SCREEN AUTOMATED DISTANCES \*\*\*

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\*\*\* TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING  
DISTANCES \*\*\*

DIST	CONC		U10M	USTK	MIX HT	PLUME	MAX DIR
(M)	(UG/M**3)	STAB	(M/S)	(M/S)	(M)	HT (M)	(DEG)

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10.	0.1743	5	1.0	1.0	10000.0	1.00	0.
100.	0.1708	6	1.0	1.0	10000.0	1.00	0.
200.	0.5727E-01	6	1.0	1.0	10000.0	1.00	0.
300.	0.2922E-01	6	1.0	1.0	10000.0	1.00	0.
400.	0.1804E-01	6	1.0	1.0	10000.0	1.00	0.
500.	0.1240E-01	6	1.0	1.0	10000.0	1.00	0.
600.	0.9109E-02	6	1.0	1.0	10000.0	1.00	0.
700.	0.7025E-02	6	1.0	1.0	10000.0	1.00	0.
800.	0.5672E-02	6	1.0	1.0	10000.0	1.00	0.
900.	0.4703E-02	6	1.0	1.0	10000.0	1.00	0.
1000.	0.3980E-02	6	1.0	1.0	10000.0	1.00	0.
1100.	0.3434E-02	6	1.0	1.0	10000.0	1.00	0.
1200.	0.3003E-02	6	1.0	1.0	10000.0	1.00	0.
1300.	0.2654E-02	6	1.0	1.0	10000.0	1.00	0.
1400.	0.2368E-02	6	1.0	1.0	10000.0	1.00	0.
1500.	0.2129E-02	6	1.0	1.0	10000.0	1.00	0.
1600.	0.1928E-02	6	1.0	1.0	10000.0	1.00	0.
1700.	0.1756E-02	6	1.0	1.0	10000.0	1.00	0.

1800.	0.1608E-02	6	1.0	1.0	10000.0	1.00	0.
1900.	0.1479E-02	6	1.0	1.0	10000.0	1.00	0.
2000.	0.1368E-02	6	1.0	1.0	10000.0	1.00	0.
2100.	0.1274E-02	6	1.0	1.0	10000.0	1.00	0.
2200.	0.1191E-02	6	1.0	1.0	10000.0	1.00	0.
2300.	0.1116E-02	6	1.0	1.0	10000.0	1.00	0.
2400.	0.1049E-02	6	1.0	1.0	10000.0	1.00	0.
2500.	0.9891E-03	6	1.0	1.0	10000.0	1.00	0.
2600.	0.9344E-03	6	1.0	1.0	10000.0	1.00	0.
2700.	0.8847E-03	6	1.0	1.0	10000.0	1.00	0.
2800.	0.8393E-03	6	1.0	1.0	10000.0	1.00	0.
2900.	0.7977E-03	6	1.0	1.0	10000.0	1.00	0.
3000.	0.7596E-03	6	1.0	1.0	10000.0	1.00	0.
3500.	0.6151E-03	6	1.0	1.0	10000.0	1.00	0.
4000.	0.5125E-03	6	1.0	1.0	10000.0	1.00	0.
4500.	0.4364E-03	6	1.0	1.0	10000.0	1.00	0.
5000.	0.3780E-03	6	1.0	1.0	10000.0	1.00	0.
5500.	0.3320E-03	6	1.0	1.0	10000.0	1.00	0.
6000.	0.2949E-03	6	1.0	1.0	10000.0	1.00	0.
6500.	0.2644E-03	6	1.0	1.0	10000.0	1.00	0.
7000.	0.2391E-03	6	1.0	1.0	10000.0	1.00	0.
7500.	0.2184E-03	6	1.0	1.0	10000.0	1.00	0.
8000.	0.2007E-03	6	1.0	1.0	10000.0	1.00	0.
8500.	0.1854E-03	6	1.0	1.0	10000.0	1.00	0.
9000.	0.1721E-03	6	1.0	1.0	10000.0	1.00	0.
9500.	0.1603E-03	6	1.0	1.0	10000.0	1.00	0.

10000. 0.1499E-03 6 1.0 1.0 10000.0 1.00 0.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:

51. 0.3125 6 1.0 1.0 10000.0 1.00 0.

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\*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*

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CALCULATION	MAX CONC	DIST TO	TERRAIN
PROCEDURE	(UG/M**3)	MAX (M)	HT (M)

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SIMPLE TERRAIN	0.3125	51.	0.
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\*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*

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