

# Environmental Impact Assessment (Draft)

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November 2013

## BHU: SASEC Road Connectivity Project Nganglam – Deothang Road

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

## CURRENCY EQUIVALENTS

(as of 31 October 2013)

Currency unit	–	Ngultrum (Nu)
Nu1.00	=	\$0.011606
\$1.00	=	62.25 Nu

## ABBREVIATIONS

ADB	-	Asian Development Bank
AIDS	-	Acquired Immunodeficiency Syndrome
Aps	-	Affected Persons
BC	-	Biological Corridor
BHUs	-	Basic Health Units
BDBL	-	Bhutan Development Bank Limited
BOBL	-	Bank of Bhutan Limited
BOQ	-	Bill of Quantity
BPCL	-	Bhutan Power Corporation Limited
CA	-	Competent Authority
CC	-	Construction Contractor
CSC	-	Construction Supervision Consultant
CGI	-	Corrugated Galvanized Iron
CPS	-	Community Primary School
DA	-	Dzongkhag Administration
DC	-	Design Consultant
DGM	-	Department of Geology and Mines
DoFPS	-	Department of Forests and Park Services
DoR	-	Department of Roads
DT	-	Dzongkhag Tshogdu
EC	-	Environmental Clearance
EFRC	-	Environmental Friendly Road Construction
EIA	-	Environmental Impact Assessment
EIAG	-	Environmental Impact Assessment Guidelines
EMO	-	Environmental Management Officer
EMP	-	Environmental Management Plan
EMU	-	Environmental Management Unit
ES	-	Environment Specialist
FHWA	-	US Federal Highway Administration
FMUs	-	Forest Management Units
FNCA	-	Forest and Nature Conservation Act
GNHC	-	Gross National Happiness Commission
GT	-	Geog Tshogchung
HC	-	Hydrocarbons
HD	-	Heavy Duty
HHs	-	Households
HIV	-	Human Immunodeficiency Virus
HSS	-	Higher Secondary School
IPCC	-	Intergovernmental Panel on Climate Change
IRC	-	Indian Roads Congress
LSS	-	Lower Secondary School
MoHCA	-	Ministry of Home and Cultural Affairs

MoWHS	-	Ministry of Works and Human Settlement
MSTF	-	Multi Sectoral Task Force
NEC	-	National Environmental Commission
NFEC	-	Non-Formal Education Centre
NRDCL	-	Natural Resources Development Corporation Limited
NSB	-	National Statistical Bureau
PC	-	Project Coordinator
PHCB	-	Population and Housing Census of Bhutan
PIA	-	Project Influence Area
PM	-	Particulate Matter
PM	-	Project Manager
PMO	-	Project Management Office
PPTA	-	Project Preparatory Technical Assistance
REA	-	Rapid Environmental Assessment
RGoB	-	Royal Government of Bhutan
RICBL	-	Royal Insurance Corporation of Bhutan Limited
RSMP	-	Road Sector Master Plan
RNP II	-	Road Network Project II
ROW	-	Right of Way
SASEC	-	South Asia Subregional Economic Cooperation
SPS	-	Safeguard Policy Statement
STDs	-	Sexually Transmitted Diseases
UN	-	United Nations
WCD	-	Wildlife Conservation Division
ToR	-	Terms of Reference

### **WEIGHTS AND MEASURES**

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

### **NOTE**

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## EXECUTIVE SUMMARY

### A. Introduction

1. This report summarizes the findings and results of the Environmental Impact Assessment (EIA) for the Nganglam-Deothang highway, a component of the SASEC Road Connectivity Project, briefly describing the Project, existing environmental conditions in the project area, anticipated environmental impacts and corresponding mitigation measures, public consultation process, the environmental management plan (EMP) and its monitoring plan. Other components under the SASEC Road Connectivity Project include: i) Pasakha Access Road (1.6km) including a Land Customs Station, ii) Phuentsholing Bypass road (about 2.9km), and iii) Phuentsholing Mini Dry Port.

2. The Project develops public sector roadway infrastructure and auxiliary drainage features for interconnecting national highways for the Department of Roads, Royal Government of Bhutan (RGoB). The project is located in Pema Gatshel and Samdrup Jongkhar dzongkhags<sup>1</sup>, in the southern region of the Country with the total road length of 74.5 km. The project objective is to improve the socioeconomic environment through provision of roads. Environmental and social benefits stem from roadway uses: i) access to health, education and other forms of community infrastructure, ii) indirect benefits from improved incomes that derive from better access to markets and jobs, iii) direct benefits for biodiversity stemming from better field management of protected areas to limit poaching of wildlife and forest products, and iv) improved safety in traveling along the southern boundary of Bhutan.

3. The EIA was updated during the detailed design of the project from April 2013 to October 2013 on behalf of the Department of Roads of RGoB. Field data were collected by the Environmental Specialist of the detailed design team. The environmental assessment process was incorporated in project design and contributed to improving project construction and operation.

4. The EIA was prepared in accordance with ToR endorsed by NEC and relevant laws and regulations of RGoB, including the Environmental Assessment Act (2000), the Regulation for the Environmental Clearance of Projects (2001) and the Guideline for Application for Environmental Clearance for Highways and Roads (2004); and Environmental Impact Assessment Guidelines, 2003; and the Safeguard Policy Statement 2009.

5. After completing the detailed design of the project road, the DoR will seek environmental clearance from National Environmental Commission (NEC) by submitting EIA report. The civil works will begin only after receiving the environmental clearance from the NEC.

### B. Description of the Project

6. The proposed 74.5 km Nganglam-Deothang road sub-project lies in the South-east part of the country falling under the Dzongkhags of Pema Gatshel and Samdrup Jongkhar. The proposed road starts from industrial town of Nganglam of Pema Gatshel Dzongkhag and ends at Deothang of Samdrup Jongkhar/Deothang Municipality. Major settlements along the road alignment are Nganglam town, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang town.

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<sup>1</sup> Dzongkhag - District

7. From Nganglam (takeoff point) till chainage Km 15.00 near Yargaywoong will more or less follow the existing farm road (Nganglam-Chokhorling Geog Centre farm road) with minor readjustment. The middle section from chainage Km 15.00 to Rishore under Deothang Geog<sup>2</sup> 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 74.5 will follow existing coal mine and Deothang Municipal roads.

8. This road is one of the important missing link roads of Bhutan which is aimed at linking east to the west through Panbang and Tingtibi. Considering the importance, this roadway is accorded highest priority by the RGoB for implementation under SASEC Road Connectivity Project.

9. Roadways of national roads will be constructed to a standard section consisting of a 5.5 m carriageway width with 7.5 m formation width and longitudinal drainage structures. The design of the roadway cross-section will still depend on conditions at a given location, which differ somewhat in that ground slopes are greater in some areas, some alignments traverse catchments, others follow the alignment of rivers and still others maintain grade along the slope of an escarpment.

10. Hydraulic structures will constitute substantial part of project cost. The project will require at least 3 bridges and over 300 slyabs culverts. Longitudinal drains are placed on upslope of roadways and, in some locations, curb and pipe drains may be installed in areas where the roadway width is confined by the slope of the mountain side.

11. Associated facilities consist of quarries, construction and worker camps, equipment and material storage areas, fuel depots and work staging areas. Quarries are expected to be small, localized operations since there are good quarry materials available from excavation of the roadways. Proper spoil disposal sites will be needed for most segments where side hill materials have been removed and require disposal. Construction camps to house 50-100 workers will be needed on each roadway segment. These camps will consist of sleeping quarters, washing and bathing facilities, latrines and waste disposal facilities, canteen or cooking in groups, and other auxiliary features. Aggregate crushing and grading plants, concrete batch plants and other associated facilities are also required on each contract. Locations for these facilities will be determined by the construction contractor in accordance with the stipulations of the EMP and other imposed constraints.

12. The road pavement structure is designed for 10-year life. The EIA was undertaken during the detailed design stage. Preparation of the detailed design and survey was undertaken in 2013, which will be followed by procurement of construction contractor and supervision consultants. Construction is expected to commence during the last quarter of 2014, targeting completion by 2018.

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

### **1. Stakeholder Analysis**

13. Stakeholders include institutions and cohorts of individuals affected either beneficially or adversely, directly or indirectly, by the Project. Those adversely affected by environmental impact include those directly exposed to construction impacts due to their proximity to the

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<sup>2</sup> Geog – Block (comprising of a group of villages)



roadway, those entitled to compensation for structures and land for widening of the right-of-way, 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 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 administrators benefit through closer ties with parent national agencies. Regional and national stakeholders include groups making up the citizenry of the Nation and the various groups within RGoB. International stakeholder groups are found in the tourism and conservation sectors.

## **2. Process for Involvement of Public**

14. To initiate the first stage of public consultation, the DoR on behalf of the Consultant wrote official letters to the dzongkhag (district) and dungkhag (sub-district) administrations instructing them to inform the public living in the study area of the proposed road development projects, working through geog administrations. Affected dzongkhags of Pema Gatshel and Samdrup Jongkhar as well as Nganglam Dungkhag was informed of the impending road detailed design studies through this process. The detailed design team inclusive of consultants of the environmental and social components conducted field surveys of the alignments to obtain primary data, and visited each affected village along the proposed routes. Environmental and social consultants conducted public consultation according to a prescribed format and in accordance with specific objectives.

15. Participants were specifically asked their views on issues related to the road condition, beneficiary and affected groups, impacts of the road due to existing conditions and expected impacts from proposed rehabilitation measures, priorities for transport, environmental issues, community participation and women's issues. Attendance and Acceptance and letter of concerns for the first stage public consultation have been well recorded in the course of carrying out the EIA.

16. 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, Ministry of Economic Affairs, and the Local governments (representatives from 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 consultants responded to some of these directly, while others were noted and considered in the final reassessment of the EA report covering its contents, and the comprehensiveness of the assessment process that contributed to that. The comments, coming as they did from official representatives of government agencies and other stakeholders, have all been incorporated into the findings and recommendations of the EIA and EMP.

17. The final stakeholder presentation of revised/updated Environmental Impact Assessment Report was held on 19 November 2013 for one-half day at the conference hall of the Ministry of Works and Human Settlement in Thimphu. The presentation was attended by representatives

from ADB, DoR, PPD, MoWHS, DoFPS/Wildlife Conservation Division and Detailed Design Team, Kyingkhor Consultancy Service. The consultant presented a brief overview EIA study of the project road, updated environmental impact assessment, anticipated potential environmental impacts and proposed mitigation measures and general and site specific environmental management plans for potential environmental impacts and proposed mitigation measures that were identified in the environmental assessment process. Questions and comments were taken from the participants. The consultants responded to some of these directly and some comments coming from official representatives of government agencies and other stakeholders have all been incorporated into the findings and recommendations of the final EIA and EMP.

### **3. Further Milestones in Public Involvement and Grievance Mechanism**

18. Public consultation is to be carried forward through implementation by both environmental and social components of the project. Event milestones include formal public consultation over environmental issues at local level prior to start of construction contracts and continue informal discussions during construction stage. Further grievance redress mechanism will be in place to receive and address complaints or concerns of affected individuals if any. This mechanism will be functional during pre-construction, construction and immediately after construction stage.

### **4. Compliance with Regulatory Requirements**

19. The RGoB requires that the public be heard at all levels concerning environmental and social impacts of projects: the issuance and enforcement of environmental clearances is meant “to provide meaningful opportunities for public review of potential environmental impacts of projects” (Environmental Assessment Act, 2000) and that the environmental report shall contain “public comments received by the Competent Authority for each project.” Section 31 of the Law clearly states the minimum procedures that apply to significant projects, which have been met by the public consultation effort of social and environmental components of the project.

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

20. Most comments concerned social issues, compensation and status of land claims. Some comments related to environmental impact, specifically location of cross drainage to avoid damage to fields, maintaining an acceptable distance from villages and homes, adjusting the alignment to avoid taking storefront property, avoiding damage to homes and land from debris generated during construction, and maintaining and preserving small water supplies, irrigation canals, orchards, religious and private properties.

21. Placement of road alignment was the major concern of the people of Norbugang, Chokhorling and Deothang. The use of existing farm road from Nganglam–Chokhorling, the coal mine road from Rishore to Chenari and the municipal road under Deothang town to upgrade to a highway standard has been proposed by the people to minimize the property damages (private structures and land). Further, the concerns on damage of community infrastructures such as water tank, water supply pipeline and electricity supply poles which will lead to shortage of water and electricity were expressed during the road constructions. However, people in general, welcomed the development of new highway, as it would bring business opportunities as well as safe transport network within Bhutan.

## D. Description of the Environment

### 1. Physical Resources

22. **Rainfall, Temperature and Climate Change:** Information on rainfall and temperature has been taken from the Deothang, Samdrup Jongkhar weather station (800 meters above sea level). Average total annual rainfall in the area varies, but can reach 3740 mm. Maximum rainfall occurs in the months of June – August, which are also the warmest months when temperatures touch 28.9°C. The coldest months are from November to February when the temperatures are as low as 10.7°C.

23. The analysis of surface air temperature data in Bhutan from 1985 to 2002 has shown a warming trend of about 0.5°C, mainly during the non-monsoon season (Tse-ring et al, 2010). Analysis of data from 2000 to 2009 from meteorological stations of the four representative eco-floristic zones of Bhutan also shows a trend of rising mean summer and winter temperature. However, due to the short time-series data on temperature, it is difficult to quantify the annual rise in temperature.

24. Unlike temperature, no consistent spatial trends have been observed in precipitation throughout the Eastern Himalayan region. The changes in annual precipitation are quite variable, decreasing at one site and increasing at a nearby site (Tse-ring et al, 2010). In Bhutan, no comprehensive precipitation observations are available to conclude any trends. However, rainfall fluctuations are largely random with no systematic change detectable on either annual or monthly scale (Tse-ring 2003). A recent analysis of rainfall data from 2000 to 2009 across four eco-floristic zones of Bhutan shows annual fluctuations within regions without any detectable trend.

25. **Geology and Seismology:** The project area is characterized by four distinct geological formations such as Manas, Duiiri, Shetikhola and I-III formations. Formations making up the Lower Himalayan Belt are most prominent in the project area. Manas formation comprised of dolomite, limestone, quartzite and conglomerates; Duiiri formation is mainly characterized by hard phyllite with quartzite, Siltstone and Diamicitte; Shetikhola formation is comprised of feldspathic sandstone, sand stone, siltstone, shale, carbonaceous shale and coal; and I-III formation which is dominant in the lower latitude is comprised of sandstone, siltstone, shale and clay.

26. **Hydrology:** 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 system within the project area except for the three minor rivers–Kirungri, Tshokhiri and Duiiri.

### 2. Biological Resources

27. **Protected Areas:** Nganglam–Deothang road does not fall inside any of the protected areas of Bhutan. The road alignment falls mostly to the north of the biological corridor connecting Royal Manas National Park and the Khaling Wildlife Sanctuary. For about 2 km stretch from chainage km 13-5 passes through the biological corridor. This 2 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 widening works.

28. However, the area between Tsokhiri (Chowkiri) and Duri Rivers has been identified as critical wildlife habitat due to presence of saltlick (at the base of Regi landslide), mud pools, relatively undisturbed forests and perennial river systems.

29. **Forests:** As per NSB's Statistical Yearbook of Bhutan, 2011, about 87.7% of the Pema Gatshel and 86.9% of Samdrup Jongkhar Dzongkhag are under true forest cover. Pema Gatshel 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 Dzongkhag.

30. Forests are managed according to four types: government owned national forest, community forest, sokshing (Government forest registered in individual name or household, used basically for collection of leaf litters and fire woods for domestic consumption) and private tree plantations. Government forests are managed by the Department of Forests and Park Services while community forest is managed by the village or a community. The sokshing (woodlots) and private forests are owned and managed by individuals, households and local communities. No forest management units (FMUs) are within the project's area of influence.

31. **Wildlife:** Given that most of the project roads fall inside important wildlife habitat which also serves as a continuum for animal movement from the Indian plains, wildlife forms an important environmental feature of this project.

32. The roads fall passes through important wildlife habitat areas between Tshokhiri and Duri. The important wildlife species that are found through these road segments are Elephant (*Elephus maximus*), Gaur (*Bos gaurus*), Tiger (*Panthera tigris tigris*), Himalayan Black Bear (*Selenarctos thibetanus*) and Leopard (*Panthera pardus*).

33. Subtropical broad-leaved forests are rich habitats of bird species among all the forest types. Hence, all the project roads comprise many bird species including the globally endangered Rufous necked Hornbill (*Aceros nipalensis*).

### 3. Socio-economic Resources

34. The proposed road falls under Pema Gatshel and Samdrup Jongkhar Districts or Dzongkhags. There are three geogs or blocks namely Norbugang, Chokhorling and Deothang. As per Dzongkhag Statistics 2010 of Pema Gatshel and Samdrup Jongkhar, the combined population of the affected dzongkhags is 61,083 persons. While the population of affected geogs/blocks of Norbugang, Chokhorling, and Deothang is 11,323 persons. However, there are 12 main settlements including Nganglam and Deothang urban areas that are directly along the 3 km Project Influenced Area (PIA) with the total population of 6,162 persons (1037 households) and average family size of 5.9 in table V.9. Sharchokpa or Tshangla speaking people inhabit the PIA.

35. As per the PHCB 2005, about 5.8% and 2.9% of the total population of Samdrup Jongkhar and Pema Gatshel Districts 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 Pema Gatshel 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 the outside world, which led to inbreeding and thus high incidences of disabilities amongst their

offspring. The proposed road construction from Nganglam to Deothang does not directly affect any of the disabled households.

36. The principal crops grown in the project area include paddy, maize, millet, pulses, oranges, areca nut and cardamom. Delivering products to markets is difficult due to the lack of roads. The sale of livestock and livestock products is another important source of income for farmers who rear all types of domestic animals available in Bhutan.

37. Community and rural infrastructure constructed by RGoB include community schools, primary schools, basic health units, outreach clinics, renewable natural resources extension offices and irrigation and rural water supply schemes. Almost all the villages inside the project area are now electrified through the Rural Electrification Project supported by ADB and other donors. Only irrigation scheme seen at Khalatsho is defunct due to damages caused by erosion and landslide. There is farm road from Nganglam to Chokhorling, the coal mine road Rishore to Chenari, and the municipal road inside Deothang town.

38. The Population and Housing Census of Bhutan 2005 shows that around 8,129 and 12,467 people out migrated from Pema Gatshel and Samdrup Jongkhar districts. Within the Project area, Khalatsho village has high out migration. As per geog census record, there are total of 117 registered landholders at Khalatsho. However, there are only 7 households actually living there. The main reason for out migration is due to human-wildlife conflict (wildlife encroachment and destruction agriculture of fields) and the inaccessibility of the area.

#### **4. Physical Cultural Resources**

39. There are few religious, historical and cultural sites in the project area such as Zangtopelri at Nganglam; Lungkhangma Nye (Sacred Rock) near Yargaywoong; and Lhakhangs at Chokhorling and Deothang. These religious sites will be avoided. There are no known archeological sites in the project affected area. The area contains visual and aesthetic resources that are typical of the lower Himalayan foothills, but recreational opportunities are limited due to lack of access.

### **E. Analysis of Alternatives**

#### **1. The No-Project Alternative**

40. The Project provides benefits that 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 123,254 persons inhabit the dzongkhag served by the Project, which is 17% 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.

41. 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 as an alternative and safer passage for Bhutanese travelers.

42. 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 such as direct forest loss and poaching. 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.

## **2. Location and Alignment Alternatives**

43. The three alternative alignments were assessed as part of the Nganglam-Deothang highway feasibility studies. Two of the alignments—80 km top route and 88 km border route were DoR's alignments from the Road Sector Master Plan. Under the PPTA, the new alignment of 74.5 km from Nganglam to Deothang was proposed under SASEC Road Connectivity project and studied in relation to the two alignments from the road sector master plan. The road alignment of 74.5 km from Nganglam to Deothang was recommended and detailed design study carried out for being shortest route; follows 15 km existing farm road (from Nganglam to Yargaywoong farm road and 4.5 km coal mine road and Municipal at Deothang); requires shorter bridge spans; connects all major settlements; avoids critical wildlife habitats; and will have minimum environmental impact.

## **3. Technology and Roadway Standards**

44. National road standards are set by the DoR but will be modified in some cases. For Nganglam to Deothang road construction, the RNP II design standards have been adopted.

45. In general the EIA recommends the adoption of practices set out in the DoR guidelines for environmentally sound roadway construction, but with a degree of flexibility that insures that costs are not compounded excessively. In short, guidelines should be applied with an attitude towards practicality that allows the Project to be implemented efficiently yet with minimal environmental impact. Application of bioengineering has been proposed at various locations as part of the detailed design works.

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

### **1. Physical Environment**

#### **a. Air Quality**

46. ***During Construction:*** Air emissions during construction arise from the operation of construction machinery, 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.

47. To minimize issues of dust the contractor will be required to regularly water roadway surfaces particularly where there are communities (homes, businesses, schools) nearby. Spraying may be done twice daily or at such frequency as is needed to minimize impacts. Since the actual lengths involved are relatively short, the contractor should be able to provide near

complete coverage of critical sections. All vehicles transporting materials should be covered properly.

48. Rock crushing, cement preparation, aggregate drying and surface treatment preparation operations (whether bituminous asphalt or spray seal mixes) should be removed a sufficient distance (500m) from habitations and community environments to assure there are no community impacts.

49. 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.

50. ***During 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.

#### **b. Noise**

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

52. ***During Construction:*** Noise impacts originate from the operation of construction equipment in the vicinity of homes, institutional buildings, stores and wildlife habitat areas, and from rock blasting to clear roadbed in hillside areas. This is an unavoidable consequence of construction that should be mitigated by limiting the times of construction to daylight hours in the vicinity of sensitive receptors.

53. The contractor will prepare a blasting procedure requiring area restrictions; prior warning of workers, nearby residents and those passing through the area; restrictions on the timing of blasts; and worker safety procedures. Controlled blasting should be carried out during the daytime to prevent disturbance to wildlife during the night, dawn and dusk.

54. Nganglam-Deothang segments are the principal areas where construction will be conducted in the near vicinity of communities; however all routes will enter settled areas either at their starting points or termini; and noise will result in some exposure along short stretches on these routes.

55. ***Operations:*** During operations, noise emissions disturb community life and the living environment. Noise impacts from vehicles traveling along these roadways are not expected to be significant due to the light traffic loads and low density of settlements.

#### **c. Geology, Soils and Tectonics**

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

57. ***During Detailed Design:*** The project road fall inside high rainfall and weak soil and geology zones. As a result the likelihood of landslides and erosion are high both during construction and operation stages. Hence, appropriate methods of excavation or cutting to minimize landslides and enable slope stability have been adopted during the detailed design stage.

58. In accordance with Environmental Friendly Road Construction (EFRC) guidelines, the cut and fill method requiring balanced cut and fill have been recommended as far as it is feasible at site.

59. The application of bioengineering has been proposed at various locations based on current practices within the region and in reference to the Field Handbook of Bioengineering developed.

60. **During Construction:** The road will mostly be cut into the side slopes of mountains ranging from 45° 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. Though erosion, rock falls, are unavoidable during cutting works, appropriate methods of excavation and benching recommended during the detailed design must be followed to minimize these impacts. All borrow areas must be properly restored after use.

61. Use of borrow areas where necessary will result in formation of open pits. This can lead to issues of erosion. Hence, after use all borrow areas must 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.

62. The need for quarries should be minimized by use of materials cut from the roadway alignment. In the event that quarries are required in a particular area, the detailed design consultant should identify locations in advance and confirm those locations with the selected construction contractor. 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. A development plan should be prepared by the contractor that estimates approximate quantities and final contours. Blasting procedures should be put into place for the development of quarries. Necessary government clearances for land and resource use should be obtained by the contractor prior to commencement of work in the area.

63. **During Operations:** Though recommendations have been provided in the detailed design and construction stage for adoption of proper methods and techniques for excavation and earth works and provision of adequate support and drainage structures, there may still be problems of erosion and landslides during operation. This is often unavoidable due to the steep slopes and unstable soils. Under such circumstances, necessary engineering and bioengineering measures will need to be taken to help stabilize slopes. In addition maintenance engineers should develop and apply means for predicting slope failures in advance and buttress slopes where necessary.

64. 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.

65. 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. There is a high but uneven seismic risk related to the location of the roads. Any east-west trending road system in the south part of the Country is exposed to this risk to a greater extent than would be a road system running from north to south, because longer sections of roadway are in close proximity to major faults.

66. Earthquake risk is incorporated into the preliminary 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.

#### **d. Water Resources and Water Quality**

67. Effects on local drainage, river flow and water quality can occur during detailed design, construction and during the operation of roadways. 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.

68. ***During Detailed Design:*** Roadside drainage have been located in such a way that the roadway surface does not concentrate rainfall and cause damage to local properties such as agricultural fields and irrigation channels.

69. Engineering and hydrological criteria have been applied to the design of drainage structures. Specific attention has been given to longitudinal road side drains, culverts and bridges.

70. Roadway embankments that run parallel to rivers have been placed at an adequate elevation above maximum high water level and embankments protected with gabions. Gabions needed for river training have already been identified.

71. Extreme meteorological conditions and other environmental factors as a result of climate change can exceed the capacity of drainage structures, erode slopes and destroy pavement structures. The design of road structures and bridges have taken into account climate change induced extreme weather conditions (such as temperature and precipitation) in determining the preliminary sizing of structures, stability of slopes and height of roadway embankments along rivers and streams.

72. Further detailed site visits was carried out by the Environmental Specialist with the engineering members of the detailed design team to verify the appropriateness of all drainage structures recommended by the engineering team.

73. ***During Construction:*** Recommended designs and structures proposed by the detailed design consultant must be implemented during the construction stage to mitigate potential impacts on water resources during construction.

74. 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 should be stopped in rainy periods.

75. Temporary measures to reduce erosion involve placement of log barriers or stone barriers at the base of slopes in accordance with recommended EFRC construction methods provided by DoR. Long term mitigation involves application of bioengineering techniques such as seeding and stabilizing slopes, in order to reduce sediment loss.

76. By no means must any of the construction rubble be thrown on the hill side and into the streams or rivers below. 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. Proper housekeeping in equipment and supply yards must be maintained to avoid soil and water pollution.

77. **Operations:** It is imperative to implement the mitigation measures proposed during the detailed design stage while constructing the respective road segments. This will help to minimize negative impacts on the water resources during operation of the road segments.

78. However, given the high rainfall, existence of innumerable streams in the project area as well as existence of local water supply facilities, problems may arise during operation of the road. Necessary mitigation measures will need to be taken by the respective DoR field staff.

79. Upstream check dams may be installed to arrest the flow of debris down the channel. Also, maintenance of culverts over the operating life of the roadway is important. DoR should remove debris that interferes with the flow in culverts.

## 2. Biological Environment

### a. Forests

80. The dzongkhags encompassing the roadway alignments 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.

81. **During Detailed Design and Pre-Construction:** Specific forestry rules exist for removal of trees. Hence, all necessary paperwork and tree marking procedures must be followed in accordance with the requirements of the Forest and Nature Conservation Rules. It must be ensured that all paperwork and approvals are obtained well ahead in time to prevent delays in construction.

82. To prevent disposal of spoil materials on the lower slope below the roadway grade and hence destruction of forests and vegetation, locations for deposit of spoil materials were identified at 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, 67+500 and 69+000.

83. **During Construction:** As per field survey December 2011 and subsequent analysis, it is estimated that around 88.96 acre of agriculture land and 174.2 acres of forest land could directly or indirectly be lost to the proposed road development.

84. A total of about 174.2 acres of forest will be displaced for the project roads out of a total land area of about 276.16 acres of cleared area (see Table V-5). Land Cover and Area Statistics, MoA (1997) indicates forest coverage (dense and open forest combined) averages

87% across two affected dzongkhags. Placement of the roadways results in an average of 0.03% reduction in existing forest cover.

85. 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 has been allocated in the project. Also, the official procedure for assuring that the Government obtains economic value from the timber and other usable wood products should be enforced.

86. 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. Hence, only necessary vegetation and trees falling with the ROW must be removed through clear markings. Appropriate re-vegetation of the fresh cut slopes and road shoulders must be carried out immediately after construction works in each road segment. In addition compensatory tree plantations will be carried out in suitable spaces to improve and restore wildlife habitats. Any organized removal of trees from public lands outside the boundary of the construction area should be punishable as a criminal offense.

87. Disposal of spoil materials and any other forms of construction debris over the edge of the hillside is prohibited excepting in unavoidable areas. However maximum effort must be made to avoid such disposal to the extent possible. The spoil materials should be disposed off at designated locations.

88. During construction, workers can cause further destruction of forests for collecting fuel wood. The construction contractor will prohibit firewood gathering among the worker population, and is required to provide construction camps with canteen or cooking in groups, providing cooking gas, electricity and fuel to minimize firewood use and housing facilities.

89. 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 in and around the stone crushing machinery will be necessary.

90. ***During Operation:*** Since the traffic volumes anticipated in the project road segments, impacts of pollution on the forests will be negligible.

91. Bioengineering and re-vegetation activities carried out during construction may result in problems such as poor regeneration and survival. Necessary replantation and other remedial actions will need to be taken by the respective field DoR staff responsible for maintenance of the roads. The estimates for bioengineering applications have been included in the cost estimate of detailed design.

#### **b. Wildlife**

92. ***Detailed Design and Pre-construction:*** Roadway may form a barrier that blocks the daily and seasonal movement of wildlife during the operational life of the project. The main animal species that migrate extensively within the project areas and so are potentially affected by the presence of roadways are the Asian Elephant and Gaur.

93. The Detailed Design team has proposed measures for the roadway segments those impacts on the movement of wildlife. Specific migratory pathways have been identified and

accommodation made for the movements of elephants and gaurs in the detailed design. The design consultant has incorporated measures into the design that facilitate these movements. A number of measures such as mild slope conditions, drainage structures, culverts enabling wildlife movement and postage of signboards have been considered during the detailed design.

94. Movements may be along river and stream channels, in which case the bridges should be high enough to allow for the passage of animals beneath the bridge structure.

95. In addition, studies have been conducted for the proposed road in collaboration with relevant technical experts from Department of Forests and Park Services before construction.

96. Recommendations are made on the appropriate timing for the conduction of construction activities in order not to disturb seasonal migration activities of wildlife.

97. Special measures such as limited pull out spaces are recommended to prevent unnecessary disturbances within the wildlife habitat areas but at the same time facilitate patrolling activities by forestry officials.

98. **Construction:** The project road falls inside the habitat of important wildlife species. Hence, it is imperative that the construction contractor follow the recommendations provided in the detailed design for various structures and measures to facilitate animal movement and conservation.

99. Conduction of construction activities during early morning or late evening hours will result in disturbances to wildlife. Working time must be limited to day light hours only. Special precautions must be taken during conduction of noisy activities such as blasting, drilling and operation of stone crushing machinery. Controlled blasting must be carried out as far as possible if blasting works are necessary.

100. Construction workers may hunt, fish or carry out other activities that will negatively impact wildlife. All activities of such kind must clearly be prohibited by the contractor. To remove all possible reasons that may encourage workers to take up these activities, the contractor must ensure that necessary food items, cooking fuel and proper housing is provided. Siting of construction camps within critical habitat is prohibited.

101. **Operation:** Access to conservation areas could lead to increased poaching of wildlife and illegal harvesting of forest products on one hand and facilitate monitoring activities for forestry officials on the other hand.

102. Benefits from the roads for conservation should outweigh impacts so long as the roads are integrated into the management plans for the respective areas.

103. 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 this is not high speed road; drivers are generally intent on observing road conditions, vehicle traffic volumes are not high and appropriate signs indicating wildlife presence will be posted.

### 3. Socioeconomic Environment

104. The employment of labor and importation of workers into an area may have adverse effects on the socioeconomic environment. Contractors are required to provide adequate living

and working conditions for workers, including lodging in a camp setting outside of any danger zone, canteen or kitchen for cooking, safe drinking water, adequate washing and bathing facilities for maintaining personal hygiene, and access to health care. The contractor should 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 record keeping related to accident frequency combined with measures to correct deficiencies that have shown to be the cause of accidents. The contractor should 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 should provide for collection, burning and burial of rubbish at controlled sites away from human habitation. Workers hired by roadway contractors should be screened in advance for HIV/AIDS. The Multi Sector Task Force (MSTF) in dzongkhags undertakes periodic HIV/AIDS and human trafficking awareness programs.

105. 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. Flagmen should be posted to regulate passage of people where slopes are temporarily unstable as a result of blasting and excavation, and the movement of people restricted in those areas until they are rendered safe. Property damage or injury should be adjudicated and compensated under the resettlement plan.

106. The specific locations where these impacts have been noted during the field reconnaissance, along with proposed mitigation measures, are tabulated in the EMP. In the event any archeological remains are uncovered, the contractor should halt construction upon their discovery and notify the PMO, who will contact the relevant government authority to investigate and undertake recovery.

## **G. Economic Assessment**

107. 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.

108. Major quantifiable impacts estimated in monetary from those from air pollution (dust and fumes) and interruption of portable or irrigation supply, and carbon fixation value, is negligible compared with the project cost. While the loss of trees could also be quantifiable in monetary terms, the value will not be a loss to the economy as felled trees have to be handed over to local forestry officials who will then pass them to the Natural Resource Development Corporation Ltd for auction. The total estimated economic value of impacts on physical, biological and socio-economic environment is Nu.31, 250,446.25 (Refer Table VIII.2 for details).

## **H. Environmental Management Plan**

### **1. Environmental Management Plan and Responsible Authorities**

109. The Environmental Management Plan (EMP) will serve as a guideline for incorporating environmental measures to be carried out by DoR, the project manager, contractors and other

parties to mitigate possible impacts of the Project. The EMP needs to be updated at the beginning of implementation, especially once the detailed design is completed so that details of locations and the frequency of monitoring can be defined in a more practical way.

110. DoR through the project manager is responsible for ensuring that (i) all required mitigation measures that need to be incorporated into the project design are passed onto the engineering consultants, (ii) the bidding document for contractor contains all required mitigation measures to be implemented during the construction period and contractors' obligations to implement the EMP during construction, (iii) the environmental clearance is obtained before commencement of civil work in the relevant section of project roads, (iv) implementation of EMP is monitored regularly as required and the annual report on implementation of the EMP is well documented, (v) other parties and government agencies implement the EMP at all stages of the Project, (vi) remedial actions are undertaken in response to unpredicted environmental impacts, and (vii) additional environmental assessment is undertaken if any change in alignment or project design takes place.

111. To ensure that contractors comply with the provisions of the EMP, the following specifications should be incorporated in all construction bidding documents: (i) the environmental mitigation measures and environmental monitoring works that need to be implemented by the contractor; (ii) environmental clauses for contract conditions and specifications; and (iii) the EIA reports.

## **2. Environmental Monitoring and Reporting, and Institutional Capacity**

112. The Environmental Monitoring Plan is provided in Table IX.3. PMO will have a focal officer to facilitate interdepartmental coordination and ensure EMP implementation. The contractor will have an environmental management officer (EMO) who will be responsible for implementing mitigation measures in the construction specification. One environment specialist will be engaged as a member of the CSC team, respectively, who work with PMO. The environment specialist will also be responsible for assuring the accuracy and completeness of reporting by the contractor and compiling monthly reports into quarterly summaries to be forwarded to the PMO and to the ADB. Quarterly reports are also sent to the DoR's Environment Management Unit (EMU).

113. 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 administrations 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.

114. DoR has established EMU. While EMU capacity needs enhancement, DoR has environment focal officers experienced in external aided projects such as World Bank. To the Project, experienced focal officers will be 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.

### **I. Conclusions and Recommendations**

#### **1. Minimized Adverse Effects**

115. 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. Slope protection measures are proposed to minimize the impacts.

116. From the 74.5 km of the proposed road, about 2.0 km section passes through Biological Corridor. This 2.0 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 widening works.

117. Road construction through critical wildlife habitat between Khalatsho (Chowkiri) and Duri area will damage wildlife habitat (which includes the saltlick site) and disrupt animal (particularly of elephant) migratory path. However, the detailed design team has prepared routing for the roadway segments that limit impacts on the movement of wildlife. Specific migratory pathways shall be constructed for the movements of elephants and gaur.

118. During road construction at the take off near Nganglam town and through the settlements of Drangnalashing Borang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore and Deothang town would damage and disrupt communities services such as drinking water supply, electricity and impede local traffics.

119. The identified potential adverse effects from construction in all three domains of the environment and have been minimized by prevention and mitigation measures, as well as by a monitoring presence during the construction activity. These have been set out in the EMP.

120. EMP implementation especially with the use of EFRC 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.

121. Potential adverse effects during operations of the roadways have been minimized through the process of preliminary design that fixes the alignments 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. Use of Irreplaceable Resources**

122. 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, and represent only a small fraction of the total range of ecosystem available to a given species. As noted, ecosystem replacement in the form of compensatory planting is proposed under the Project. The cost of compensatory plantation is included in the cost of bioengineering. The proposed scope of bioengineering has been included in the Bill of Quantity (BOQ). No other use of irreplaceable resources has been noted by the assessment.

### **3. Provisions for Follow-Up Surveillance and Monitoring**

123. 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 will be reviewed during the early stage of loan implementation, at which time environmental impacts and mitigation measures will be reassessed, specific mitigation measures incorporated into detailed design, and a revision prepared of associated costs.



## I. INTRODUCTION

### A. Project Background

124. 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.

125. 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 sections of the second east-west highway; (i) Manitar-Raidak, (ii) Raidak-Lhamoizingkha, (iii) Panbang-Nganglam, (iv) Samdrupcholing-Samrang and (v) Tsebar-Mikuri-Durungri roads have been completed. All five road sections are at varying stages of construction.

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

**Table I.1: Candidate Road Sections**

Sl. No.	Road Name	Length	Coverage
1	Lhamoizingkha-Sarpang Road	115 km	Dagana and Sarpang
2	Gelephu-Panbang	87 km	Sarpang and Zhemgang
3	Nganglam – Deothang	74.5 km	Pema Gatshel & Samdrup Jongkhar
4	Samrang-Jomotsangkha	84 km	Samdrup Jongkhar

127. Except for Gelephu-Panbang road section, the feasibility studies inclusive of Environmental Impact Assessment (EIA) studies of three other road sections have been carried out. Of the three road sections the Nganglam – Deothang road was found to be most economically viable, hence this road was selected for financing under the SASEC Road Connectivity Project. Accordingly, the detailed design study for Nganglam-Deothang road section started from April 2013 and is planned for completion by December 2013. This report presents the findings of updated EIA study on the Nganglam – Deothang highway based on the detailed design.

128. In addition to this highway, there are three other components under the SASEC Road Connectivity Project: i) Pasakha Access Road (1.6km) including a Land Customs Station, ii) Phuentsholing Bypass road (about 2.9km), and iii) Phuentsholing Mini Dry Port.

### B. Purpose of the Report

129. This report presents the findings and results of the Environmental Impact Assessment (EIA) for the Nganglam-Deothang road sub-project under the SASEC Road Connectivity 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 Project in respect to the roadway segment being proposed, the various phases of 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 B contains the terms of reference for the EIA which was approved by the National Environmental Commission (NEC).

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

130. 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.

131. 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 Project:

132. 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 74.5 km Nganglam–Deothang road construction. In some cases, it may extend up to hundreds of meters especially downhill when the road construction take place along the steep terrain.

**Figure I-1: Location of Nganglam – Deothang Road**



133. 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 sensitive habitat areas that are found along the road section. Therefore, 3.0 km Project Influence Area (PIA) which is 1.5 km on either side of the road centerline has been considered for comprehensive impact assessments.

134. Therefore, the boundaries of the study area will vary according to the impacts expected at different phases of the Project.

#### **D. Data Sources**

135. Primary observation from site surveys and published information are the two main types of source material. Field data were obtained jointly with the PPTA team for the preparation of the preliminary design, the EIA and Social Impact Assessment studies. Mapping information was shared and field trips were conducted jointly. For the purpose of updating, field data were also collected by the Environmental Specialist of the detailed design team for the EIA and Social Impact Assessment studies. A reference list of published information and web sources used in the EIA is provided in Appendix A.

#### **E. Status of EIA and Further Additions**

136. The EIA was prepared during the Project Preparation Technical Assistance (PPTA) over a 4 months period from October 2011–March 2012, by a national environmental consultant engaged directly by the ADB to work with the PPTA team. Updating of the EIA was conducted from April - October 2013 and the following team members of the detailed design team were involved:

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

<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, Deothang Beat	Forest and Wildlife Management

137. The environmental assessment process was used to influence changes in project design, and can be further applied in an adaptive management sense to improve project construction and operation based on results of monitoring undertaken during implementation. The EIA was updated by the environmental specialist<sup>3</sup> of the detailed design team from April 2013-November 2013. Mitigation measures, monitoring requirements and costs contained in the EMP have been reviewed and adjusted based on updated information. Also, public consultation on social and environmental issues, and enactment of a grievance procedure for those affected by degradation of the living environment, resettlement and loss of assets, should be undertaken during project execution.

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<sup>3</sup> Dorji Rinchen, environmental specialist of detailed design team updated the EIA.

## **II. ENVIRONMENTAL POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK**

### **A. International Environmental Policy**

138. 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:

#### **1. UN Framework Convention on Climate Change signed on 11 June 1992 and ratified on 25 August 1995**

139. 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.

140. 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.

#### **2. UN Convention on Biological Diversity signed 11 June 1992 and ratified 25 August 1995**

141. 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**

142. 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 Environmental Impact Assessment guideline 2003, 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**

143. 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.

144. 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.

145. 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>4</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.

146. A further guideline document has been promulgated by the NEC, called the Guideline for Application for Environmental Clearance for Highways and Roads<sup>5</sup>. 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 EA 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 II.1.

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<sup>4</sup> The Unit was established in 2007 during implementation of the Rural Access Project funded by World Bank.

<sup>5</sup> National Environment Commission, Royal Government of Bhutan, August 2004.

**Table II.1: 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
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.

### **1. Nature Conservation Legislation**

147. 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.

148. 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.

149. 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.

## 2. Land Acquisition Regulations

150. 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:

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

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

153. 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.

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

### Conclusion

155. The sub-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 Environmental Impact Assessment Guidelines (2002) 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.

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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



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

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

156. 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.

157. Local stakeholders are cohorts of individuals inhabiting the directly linked or affected geogs of Norbugang and Chokhorling of Pema Gatshel, Rishore and Chenari of Samdrup Jongkhar and Deothang 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.

158. 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 air 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.

159. 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**

160. 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

161. 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 Pema Gatshel and Samdrup Jongkhar were informed of the impending detailed design 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:

- 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
- 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

162. 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 III.1: 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
Deothang, Samdrup Jongkhar	Chenari	Male=20 Female=17 Total =37	4.30Pm; 26/11/2011

## 3. Second Stage of Public Consultation

163. 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<sup>10</sup> 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.

164. 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 will be incorporated into the findings and recommendations of the EIA and EMP. List of participants can be found in Appendix J.

**Figure III-1: Public Consultation at Chokhorling**



**Figure III-2: Public Consultation at Rishore**



**Figure III-3: National Consultation Workshop**



**Figure III-4: Protected Area Zoning Workshop**



<sup>10</sup> The project title was earlier RNP II Additional Financing. The project title was later changed to the SASEC Road Connectivity Project under which only the Nganglam – Deothang road section was selected.

**Figure III-5: Consultation with Chokhorling Geog**



**Figure III-6: Chokhorling Public Consultation**



**Figure III-7: Consultation with Samdrup Jongkhar Dzongkhag**



**Figure III-8: Consultation with Deothang Geog**



**Figure III-9: Consultation with Samdrup Jongkhar CFO**



**Figure III-10: Final Stakeholder Presentation Workshop**



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

165. 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 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. The 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 Presentation of updated EIA findings

166. The final stakeholder presentation of revised/updated Environmental Impact Assessment Report was held on 19 November 2013 for one-half day at the conference hall of the Ministry of Works and Human Settlement in Thimphu. The presentation was attended by representatives from ADB, DoR, PPD, MoWHS, DoFPS/Wildlife Conservation Division and Detailed Design Team, Kyingkhor Consultancy Service. *List of participants is attached in the appendix E Section 9.* The consultant presented a brief overview EIA study of the project road, updated environmental impact assessment, anticipated potential environmental impacts and proposed mitigation measures and general and site specific environmental management plans. Questions and comments were taken from the participants. The consultants responded to some of these directly and some comments coming from official representatives of government agencies and other stakeholders have all been incorporated into the findings and recommendations of the final EIA and EMP. Key discussion points entailed identification of new issues in comparison to the earlier EIA; clarification of procedures for removal of protected plant species and compensatory afforestation; clarification of budget requirements for the EMP; and the findings of the climate change study.

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

167. 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 project influenced area welcomed the prospect of building new highway from Nganglam to Deothang 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 J Section 3.* However, the following issues were raised by people that are relevant to the proposed road development project:

168. **Water Supply:** People of PIA (Nganglam, Drangnalashing Borang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang) 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.

169. **Religious and Cultural Assets:** People of Yargaywoong, Chokhorling and Deothang 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 14+000), Thujaycholing Lhakhang or temple located at chainage km 28+000, Big Boulder (Lu- Snake Goddess) at Chenari karphu at chainage Km 71+500, Chenari Phodrang (Nyepo-Sacred Rock) at chainage Km 72+500 and Gesar Dala Lhakhang at chainage km 73+000. Protection/mitigation measures have been included in the detailed design.

170. **Private Properties:** People of Rishore, Chenari and Deothang 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 Deothang 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.

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

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

172. 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 road construction project is expected to 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.

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

174. 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**

175. 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 project implementation, there will be

<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.

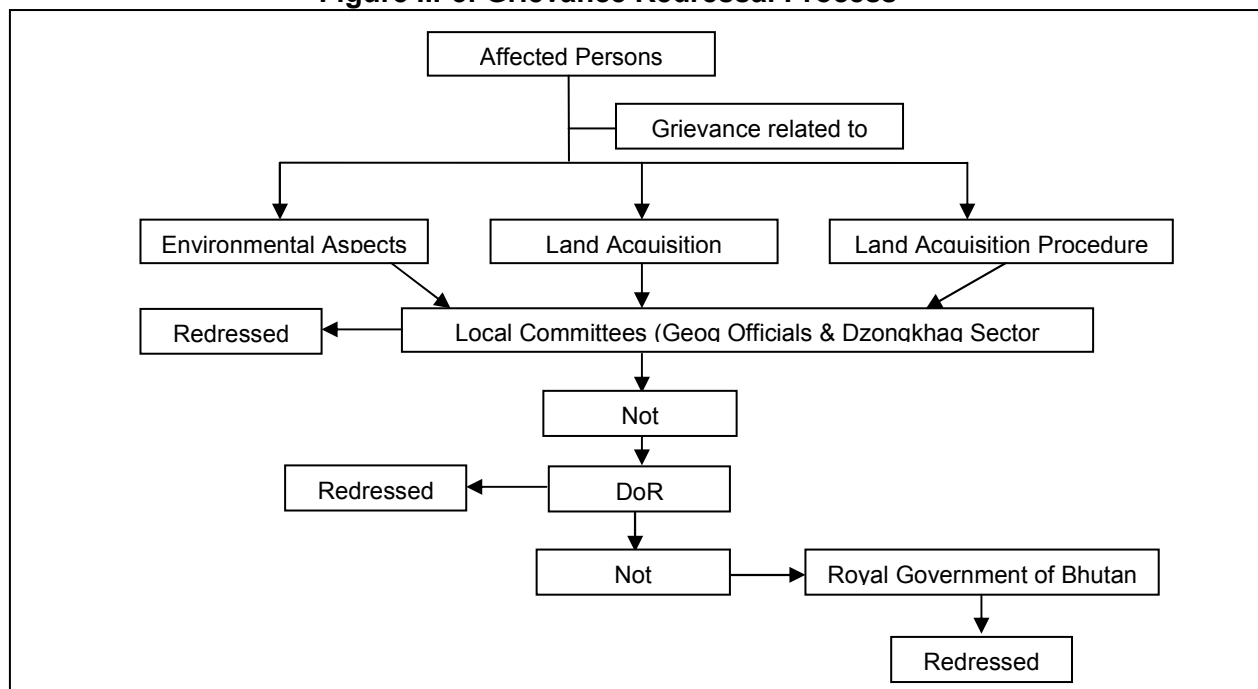
issues that individuals or groups who feel that they are not given adequate attention, or the issues are not properly addressed. Therefore, in this light, project will establish a Grievance Redress process in the existing mechanism of local committees (Geog Tshogchung, Dzongkhag Tshogdu), and the Dzongkhag/Dungkhag 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

176. The detailed procedures for redressing grievances will be established for the project in order to create avenues for APs to express their grievances related to environment, land acquisitions and resettlements. Figure III-3 shows the grievance redressal procedures:

- **Step 1:** If any aspects of the grievances related to environment, land acquisition and resettlements that aggrieve any AP, he/she can approach the contractor, construction supervision consultants or DoR site staff.
- **Step 2:** However, if grievances are not addressed at the site level, the AP can lodge a written grievance to the grievance redress committee comprising of Sector Heads of Dzongkhag Administration as well as Geog Officials. In the case of land acquisition related grievances the written grievance should be forwarded to the grievance redress committee within 15 days from the date of receiving the notification of compensation and rehabilitation. The committee must respond within 15 days.
- **Step 3:** If the person making the complaint 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.

**Figure III-5: Grievance Redressal Process**



## IV. DESCRIPTION OF PROJECT

### A. Development Context

177. 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 roads). 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-Deothang and Samrang-Jomotsangkha) of the second east-west highway that were not included under RNP II. Of these four road sections, the Nganglam – Deothang road 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.

178. Segments of roadway (inclusive of Nganglam-Deothang road 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.

179. 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 Road Alignment

180. The proposed Nganglam-Deothang road sub-project lies in the South-East part of the country falling under the Dzongkhags of Pema Gatshel and Samdrup Jongkhar. The proposed road starts from industrial town of Nganglam of Pema Gatshel Dzongkhag and ends at Deothang of Samdrup Jongkhar/Deothang Municipality. Major settlements along the road alignment are Nganglam town, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang town.

181. From Nganglam till Km 15.5 near Yargaywoong will more or less follow the existing farm road (Nganglam-Chokhorling Geog Centre farm road) with minor readjustment. The middle section from Km 15.5 to Rishore under Deothang Geog<sup>12</sup> 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 74.5 will follow existing coal mine and Deothang Municipal roads.

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<sup>12</sup> Geog – Sub District (Administrative unit under District, there are 205 Geogs in Bhutan).



182. This road is one of the important missing link roads of Bhutan which is aimed at linking east to the west through Panbang and Tingtibi. Considering the importance, this roadway is accorded highest priority by the RGoB for implementation under RNP II AF.

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

183. The total project cost for all project components is estimated to be about \$ 50 million, including design and construction supervision. Detailed estimates for individual subproject components are still being finalized at the time of writing this report.

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

184. 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 30 months starting last quarter of 2014. The Construction Supervision Consultant (CSC) will be procured later under a separate contract. The road segment will be constructed under two separate contracts including the bridges.

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

185. The contract will be awarded generally to local contractors, since these have proven competent under the first RNP II. 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. Access roads may be cut to some locations, but generally construction will proceed from an existing point of access at the head of the roadway. Some roads may be constructed from two points of access if conditions permit, and hence under two separate contracts, which would speed up progress of the work.

186. 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 15.0 km stretches in which a progressive sequence of activities takes place, depending on location and terrain, roughly as follows:

187. 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.

### **F. Construction Materials**

188. Construction materials particularly the stones shall be quarried along the roadside. These quarries are expected to be small, localized operations. There are good quarry materials along the Nganglam-Deothang 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. Sand can be quarried from the riverbeds of Tshokhiri and Duri. Cement will be

procured from Dungsam Cement Plant as the plant will start manufacturing cement by late 2013 or early 2014 or if not, procure from Pugli, Gomtu under Samtse Dzongkhag via India through a border of Phuentsholing. Rest of the construction materials will be imported mainly from India.

#### **G. Construction Equipment**

189. The environmental friendly road construction technology and equipments 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 THE ENVIRONMENT

190. 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.

191. 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

192. 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 subproject.

### A. Physical Environment

#### 3. Geology, Soils and Seismology

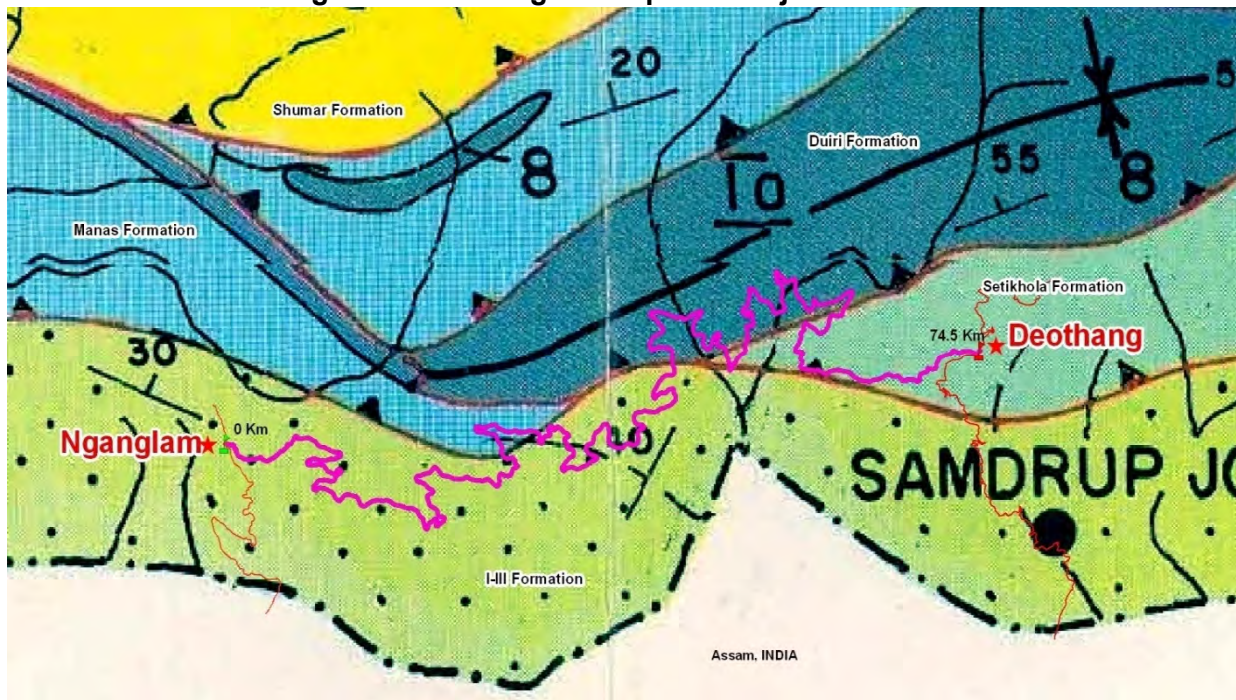
193. The project area is characterized by four distinct geological formations such as Manas, Duri, Shetikhola and I-III formations (Refer Figure V-1). Formations making up the Lower Himalayan Belt are most prominent in the project area.

- Manas formation comprised of dolomite, limestone, quarts and conglomerates,
- Duri 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,

194. 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

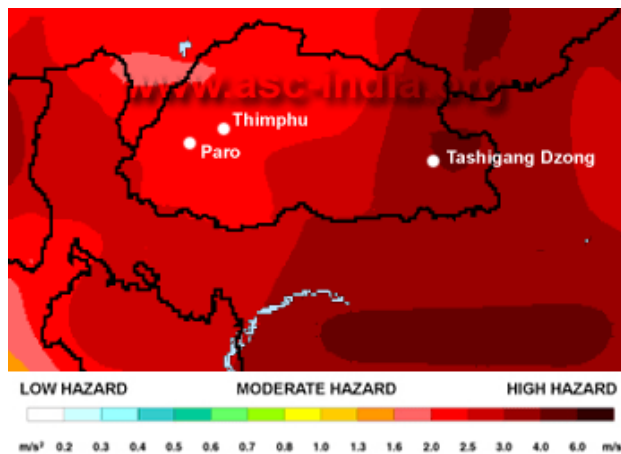
experienced and at least one magnitude 7.0 event is thought to have occurred in the 1700's in eastern Bhutan and adjoining parts of India (ASC 2009). However there is an absence of other large magnitude seismic events in Bhutan noted in the historical records (Drukpa, et. al., undated) and a 'seismic 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 V-1: Geological Map and Project Location**



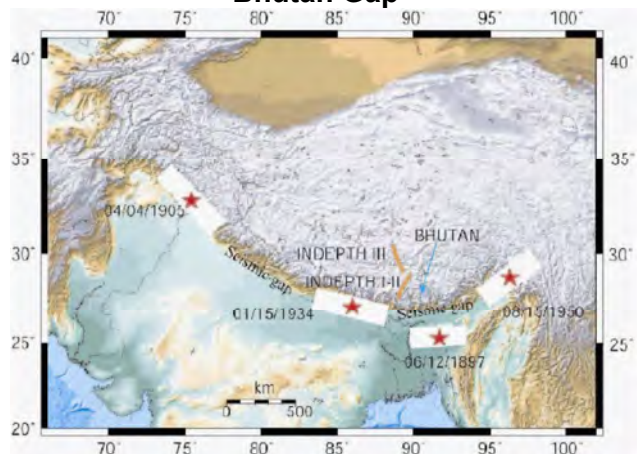
(Ref: Geological Map of Bhutan)

**Figure V-2: Seismic Hazard Map of Bhutan**



Source: ASC 2009

**Figure V-3: Major Seismic Events and Bhutan Gap**



Source: Tobgay, Undated

195. 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 V.1: 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 28+000 – Km 29+000	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	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. (Note: The exposed rocks containing natural minerals near the base of Regi slide is being actively used as Salt lick area by wildlife). This is the main salt lick site in the vicinity.	<ul style="list-style-type: none"> <li>• Road alignment has been shifted on the saddle above the Regi slide to avoid this slide altogether if possible in order avoid triggering of further landslides by way of construction of tunnel</li> <li>• If road is constructed through the top of the slide than it would require expensive mitigation measures such as construction of toe walls, benching etc.</li> <li>• Compensatory plantation for protection of slope</li> </ul>
7	Km 70+000 – Km 72+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, 2013

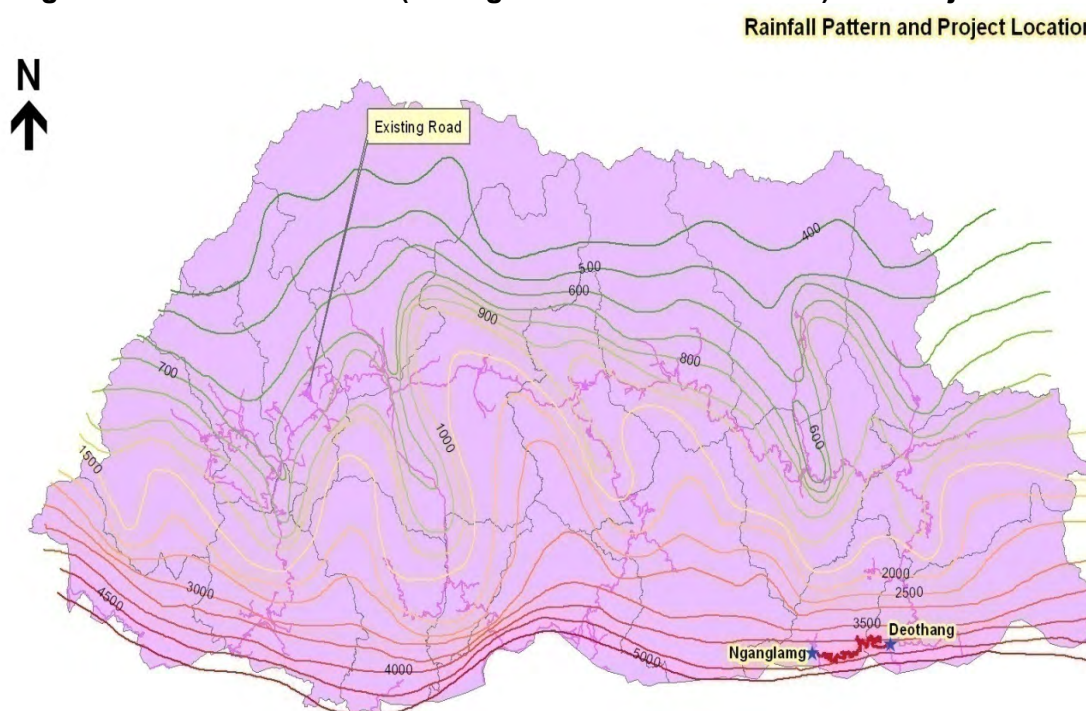
#### 4. Meteorology and Climate

196. 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.

197. 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. Nganglam-Deothang Road falls under the humid and subtropical southern region of Bhutan.

198. 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 V-4: Rainfall Pattern (average annual rainfall in mm) and Project Location**



**Table V.2: Average Temperature and Rainfall (from year 2005-2011) of Deothang, Samdrup Jongkhar Dzongkhag**

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>

Month	Mean max. temp (°C)	Mean min. temp (°C)	Average temp (°C)	Total rainfall (mm)
March	25.02	15.66	20.24	91.82
April	25.94	17.28	21.72	363.37
May	27.24	19.66	23.44	402.87
June	28.14	21.36	24.64	696.45
July	28.56	22.08	25.3	935.82
August	28.92	21.94	25.52	537.52
September	28.08	21.1	24.54	456.63
October	27.54	17.9	22.6	196.75
November	24.6	15.06	19.72	8.57
December	22.02	12	12.9	6.08
<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

199. 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 within project area.

200. 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.

201. 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.

## 5. Climate Change Trends

202. Climate change experts (Hydrologist and Environment Engineer) recruited by ADB have adequately highlighted in their report that climate change is for real and that mean temperatures and precipitation levels will increase over time. This will adversely impact the road infrastructures and that the bridges and culverts, surface drainages and hillside slope stability will be most vulnerable due to increased mean annual rainfall and increased intensity of rainfall events, increased runoff and sediment load transport. They have emphasized the need to address the climate change-induced risks through proper sizing of structures based on future predicted hydraulic data and computations. In brief, the following suggestions have been provided:

- To adopt the appropriate design frequency criteria depending upon whether the highway is major or minor and whether it is located in rural or urban areas;
- To adopt the correct methods for estimating peak discharge based on size of discharge basin;
- To apply percentage adjustments to extreme rainfall per 1° C of warming, for a range of average recurrence intervals (ARIs.);

- To design the pavements following standard pavement design practices so that pavement failures due to the effects of extreme temperatures, precipitation and flooding are prevented;
- Maximize the application of EFRC techniques and bio-engineering for slope stabilization and slope failures;
- To design proper drain profile that provides maximum discharge and adopt steeper cross fall for the pavement structure and side drains to cater to the increased precipitation and flooding;
- To design bridges by keeping allowance for the thermal expansion and contraction of the bridge decks due to extreme temperatures;
- Adequate span and height must be considered during bridge design to account for the increased magnitude of flooding and scouring.
- Geotechnical study must highlight the unstable areas and implement the mitigation measures.

203. The recommendations of the climate change experts must be incorporated during the detailed design. The details of the recommended climate change adaptation measures are available in the report "Climate Change Vulnerability Assessment and Adaptations", July 2013 prepared for SASEC Road Connectivity Project, DoR.

204. The Climate Change study from National Action Plan for Biodiversity Persistence and Climate Change, Bhutan 2011 (prepared for Climate Summit for Living Himalayas 2011) has been used as a basis to understand the change in climate in Bhutan. The changes in surface temperature, rain and snowfall patterns are described in the report as following:

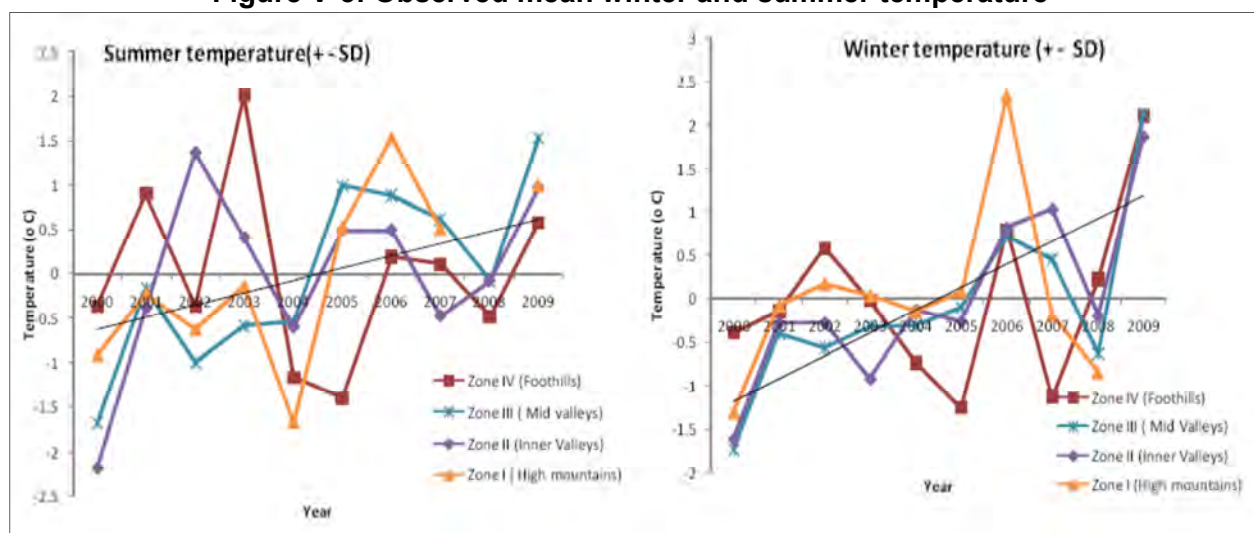
**a. Surface Air Temperature**

205. The global mean surface temperature has increased by 0.6°C (0.4-0.8°C) over the last 100 years (Gitay et al, 2002). The analysis of climate parameters of the Eastern Himalayas have shown that the Eastern Himalayan region's mean annual temperature is increasing at the rate of 0.01°C/year or more (Chettri et al, 2010). Further, warming is observed and predicted to be more rapid in the high mountain areas than at lower elevations, with areas greater than 4000 m experiencing the highest warming rates (Shrestha & Devkota, 2010).

206. The analysis of surface air temperature data in Bhutan from 1985 to 2002 has shown a warming trend of about 0.5°C, mainly during the non-monsoon season (Tse-ring et al, 2010). Analysis of data from 2000 to 2009 from meteorological stations of the four representative eco-floristic zones of Bhutan also shows a trend of rising mean summer and winter temperature (Figure V-5). However, due to the short time-series data on temperature, it is difficult to quantify the annual rise in temperature.



**Figure V-5: Observed mean winter and summer temperature**

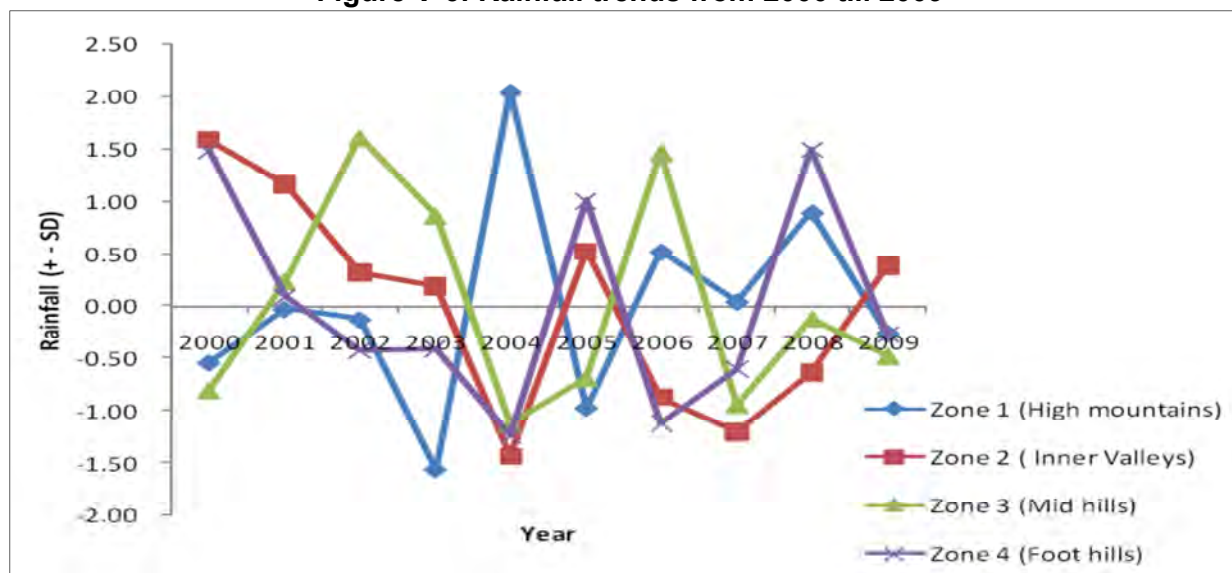


Source: National Action Plan, Biodiversity Persistence and Climate Change Bhutan 2011

### b. Rainfall

207. Unlike temperature, no consistent spatial trends have been observed in precipitation throughout the Eastern Himalayan region. The changes in annual precipitation are quite variable, decreasing at one site and increasing at a nearby site (Tse-ring et al, 2010). In Bhutan, no comprehensive precipitation observations are available to conclude any trends. However, rainfall fluctuations are largely random with no systematic change detectable on either annual or monthly scale (Tse-ring 2003). A recent analysis of rainfall data from 2000 to 2009 across four eco-floristic zones of Bhutan shows annual fluctuations within regions without any detectable trend (Figure V-6).

**Figure V-6: Rainfall trends from 2000 till 2009**



Source: National Action Plan, Biodiversity Persistence and Climate Change Bhutan 2011

### c. Snow cover, Snow Fall pattern and Frost.

208. The extent of snow cover has decreased by about 10 percent on average in the Northern Hemisphere since the late 1960s (Gitay et al, 2002). Analysis of snow cover from Landsat MSS images taken from 1973 to 1979 and Landsat ETM+ images from 1999 to 2000 indicates a decrease in snow cover in the eastern Himalayas by 24.6 percent (Chettri et al, 2010).

209. There is no systematic record of data and observation on snow cover and snowfall to analyze and conclude any trends in Bhutan. However, people's observations on snowfall are discussed under community observation and perception on climate change.

## B. Air Environment

210. 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. Primary data was collected for pre monsoon season to understand the air quality in the region and to assess the impacts on air environment.

211. Air pollution studies carried out by Dungsam Cement Project Authority in 2000 in Nganglam area reveals that SPM levels was within the National limit of 300 – 400  $\mu\text{g}/\text{m}^3$  set by NEC. The level of SO<sub>2</sub> and NO<sub>x</sub> was below detection level. However, due to recent upsurge of construction activities of various farm roads around Nganglam and Dungsam Cement Industry has led to increase dust pollution particularly during dry season. Similarly, Rishore, Chenari and part of Deothang Municipal area is also affected by dust pollution due to haulage of coal from coal mine in Rishore to a depot in Samdrup Jongkhar. Coal mining activities is carried out during dry season, normally from October to March every year. As mitigation measures to reduce dust pollution along the haulage route, the regular water sprinklings are done by the coal mine operator. The dust pollution has been significantly reduced.

## C. Noise Environment

212. 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).

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

214. There are no industries and commercial activities and hence no noise pollutions in the area such as Dezama, Yargaywoong, Chokhorling and Khalatsho.

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

215. 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 Duri.

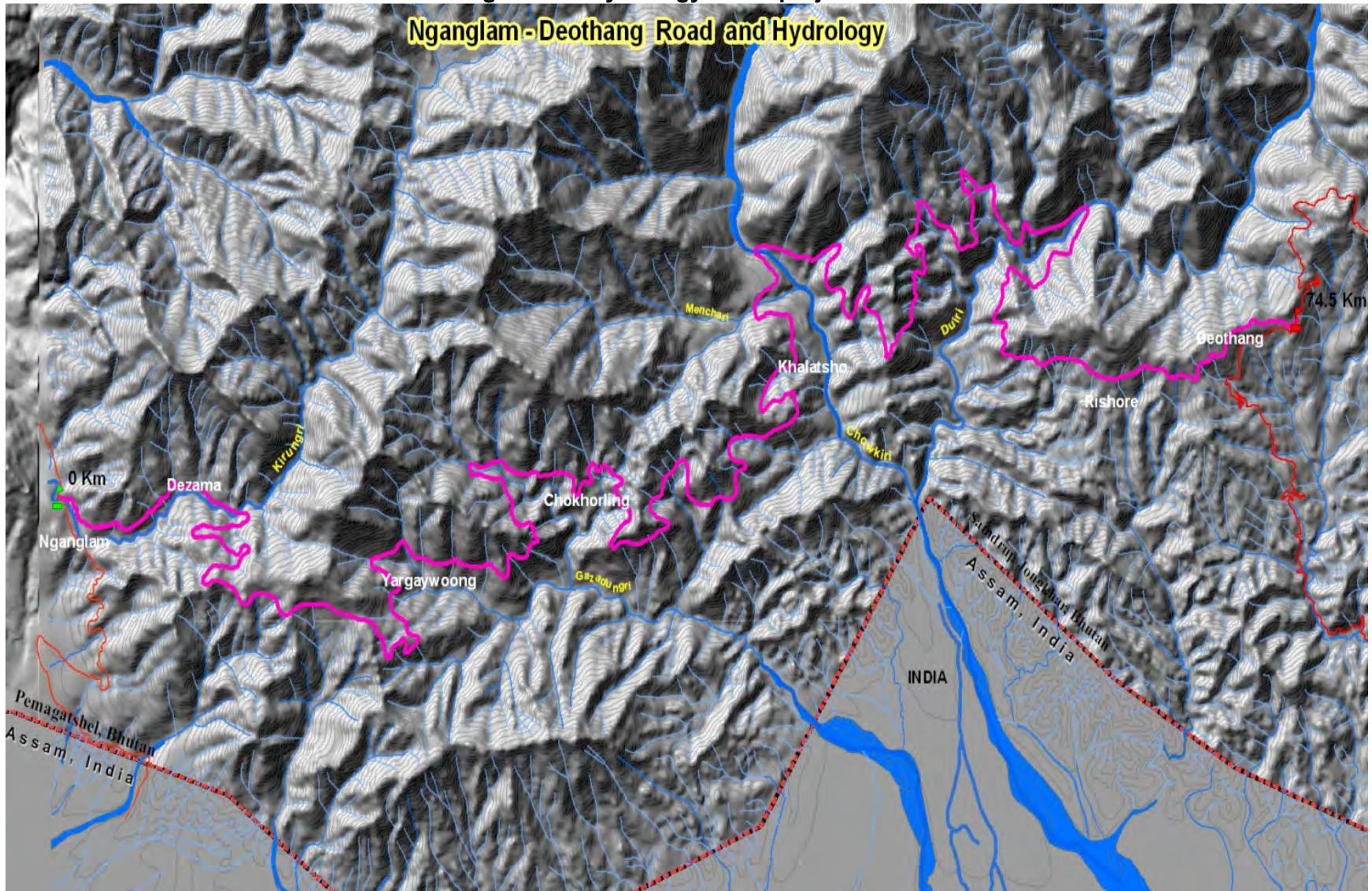
216. Kirungri flows southwest and runs for about 5 km parallel to the proposed road alignment before joining the Manas. The Kirungri River covers a total length of 32.0 km with the watershed area of 32.4 sq km from the bridge point (chainage 5.0 km). The river originates from the inner Himalayan Mountains and passes through settlements of Dezama and Nganglam before joining Manas. It is joined by other small tributaries along its path to Manas.

217. The Chowkiri River covers a total length of 21 km with the watershed area of 68.7sq km from the bridge point (chainage 44.0 km). The river originates from the inner Himalayan Mountains and passes through settlements of Khalatsho before joining Duri and flow towards Indian Plain. It is joined by four other major streams along its path to Indian Plain.

218. Similarly, the Duri River covers a total length of 29 km with the watershed area of 146 sq km from the bridge point (chainage 62.5km). The river originates from the inner Himalayan Mountains and passes through steep valleys of Orong and Deothang before being joined by Chowkiri and flow towards Indian Plain. It is joined by seven other major streams along its path to Indian Plain.

Figure V-7: Hydrology of the project area

**Nganglam-Deothang Road and Hydrology**



219. 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%.

220. After approximately 5.5 km from the take off point in Nganglam the route crosses a major river, the Kirungri. Towards the eastern side nearing Deothang, the alignment crosses two more rivers the Chowkiri and Duri. Over all on this alignment, there are four major bridges and 293 culverts will be required. The major hydrology along this road segment has been presented in Figure V-7.

**Table V.3: Major River crossing along the Roadway**

Sl. No.		River	Bridges Span (m)	Downstream Water Users		
				Downstream Community	No. of HHs	Type of Use
1	Km 5+500	Kirungri	40	-	-	-
2	Km 44+000	Chowkiri	25	-	-	-
3	Km 61+000	Menchudrangri	25	-	-	-
4	Km 62+500	Duri	40	-	-	-
Total			130			

Source: Detailed Design Study, 2013

### 1. Surface Water Quality

221. 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.

222. 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 and industrial establishment. The quality of Kirungri River water is equally until it passes through Nganglam Township from where the effluents such as domestic and industrial wastes start seeping into this pristine water body.

## E. Biological Environment

### 1. Protected Areas

223. Nganglam–Deothang road does not fall inside any of the protected areas of Bhutan (Refer Figure V-8). The road alignment falls mostly to the north of the biological corridor connecting Royal Manas National Park and the Khaling Wildlife Sanctuary. For about 2.0 km stretch from chainage km 13 -15 passes through the biological corridor (Refer Figure V-9).

Figure V-8: Bhutan Conservation Areas and Nganglam-Deothang Road Segment

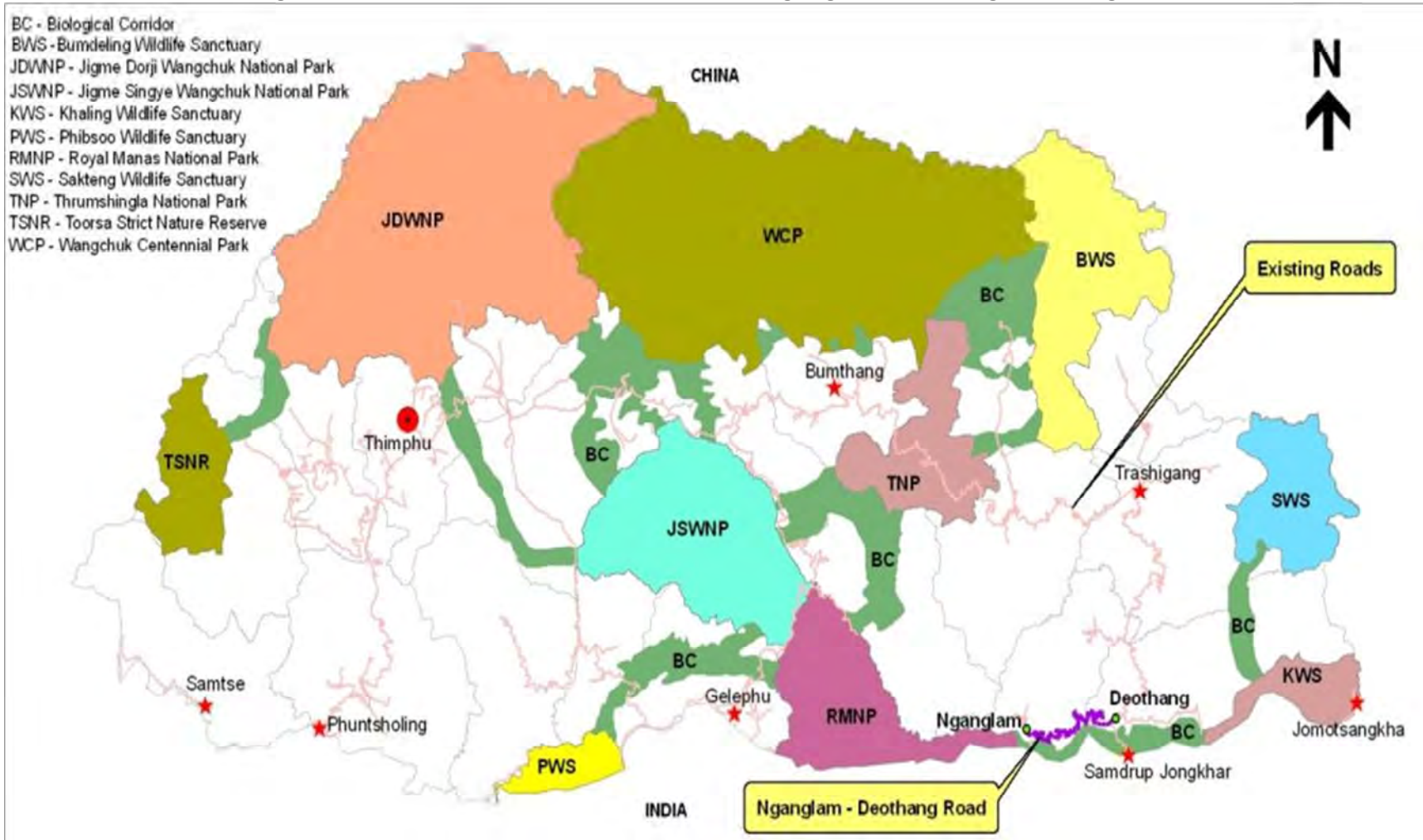
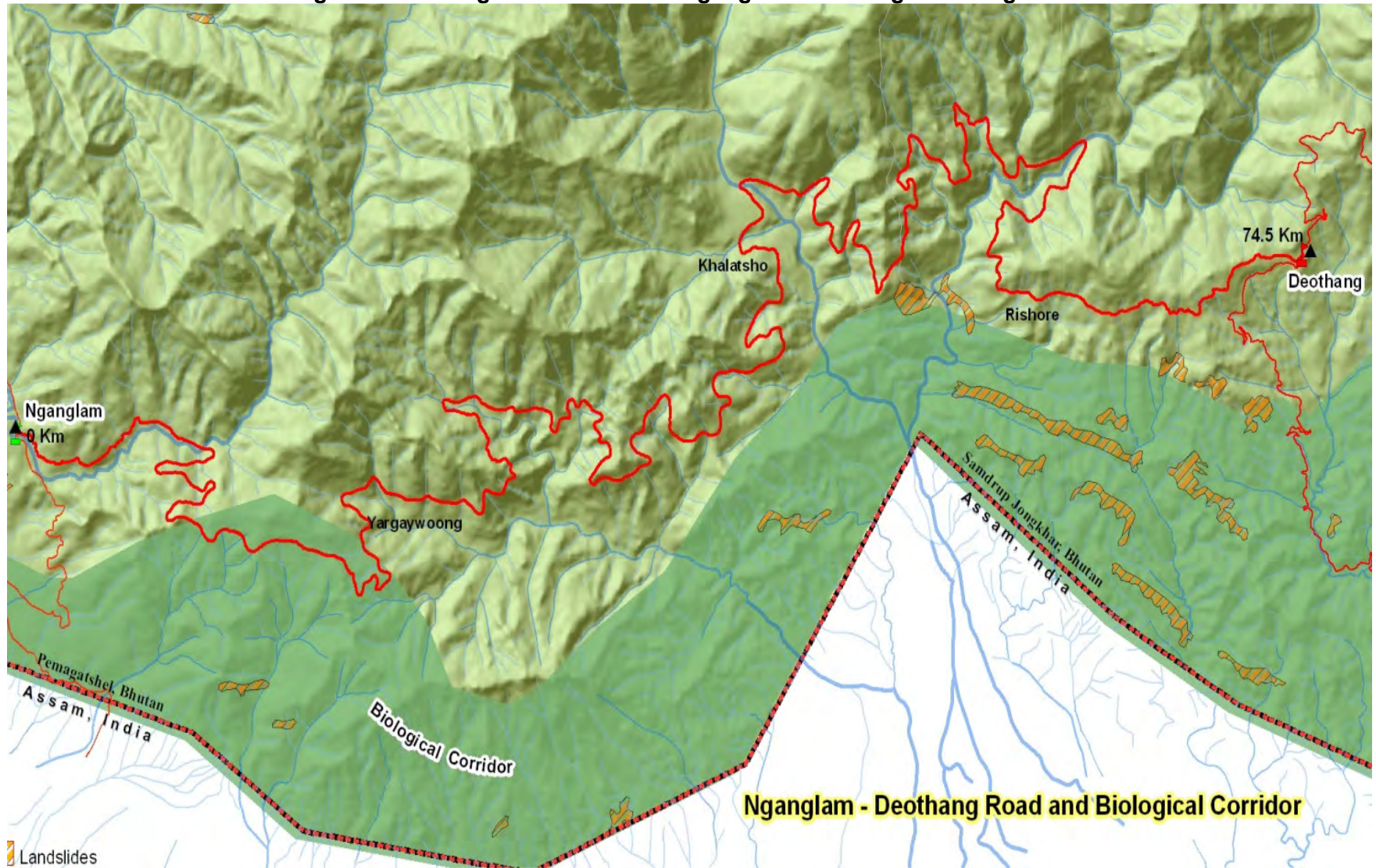


Figure V-9: Biological Corridor and Nganglam-Deothang Road Segment



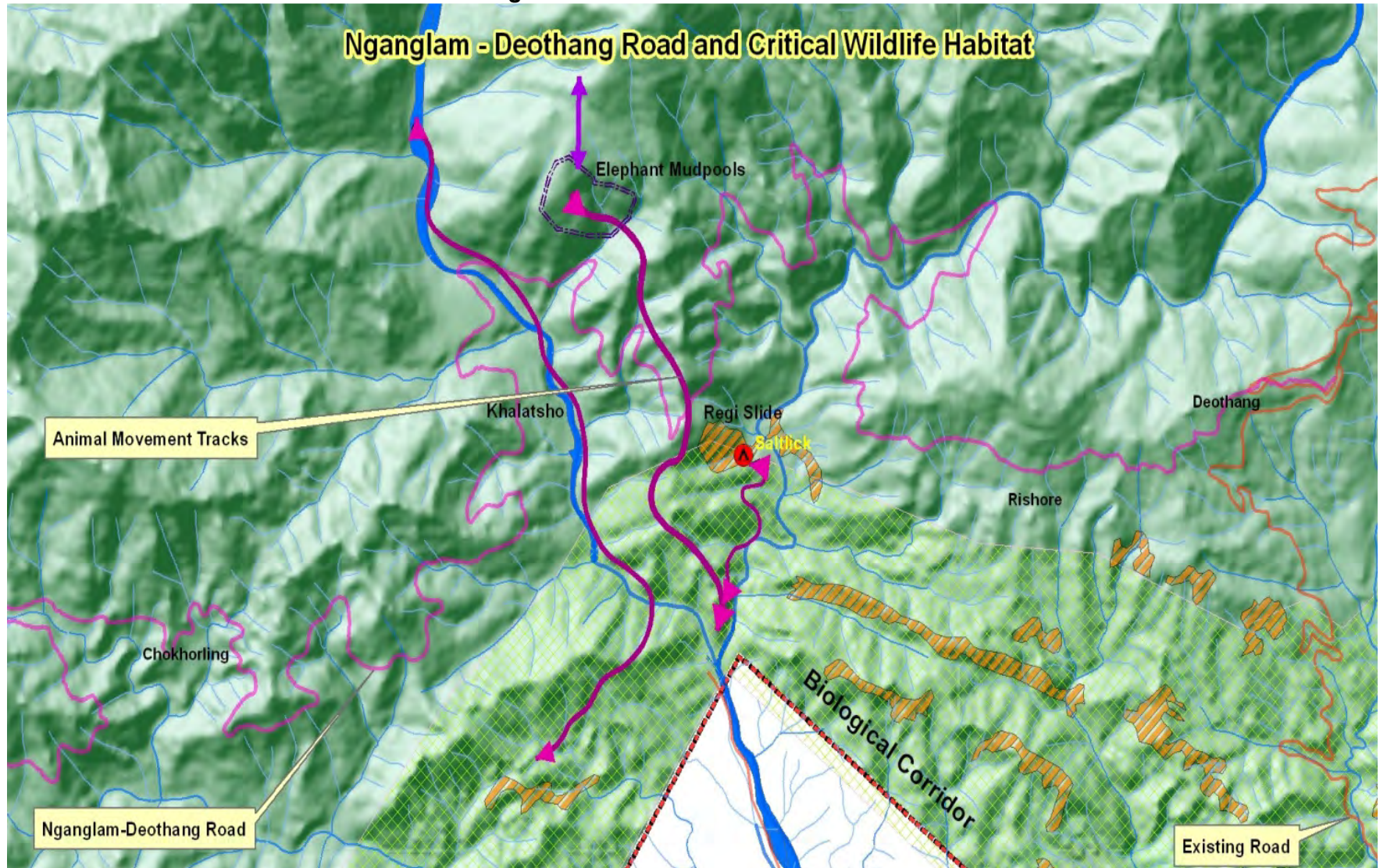
## **2. Critical Wildlife Habitat**

224. The area between Tsokhiri (Chowkiri) and Duri Rivers has been identified as critical wildlife habitat due to presence of salt lick (at the base of Regi landslide), mud pools, relatively undisturbed forests and perennial river systems. However, Tshokhi including Khalatsho areas were widely settled area in the past (i.e. till 1990s). The people from Khar, Tsebar and Yurung geogs of Pema Gatschel used to migrate to Tshokhiri during winters with their livestock stay till the winter is over. This practice was put to end when the Royal Government has asked people to discontinue the practice due to the potential threat from militancy movement of northeast India.

225. Owing to the problems of militancy and ever-increasing wildlife encroachment into human settlements, the most of people of Khalatsho area started out migrating. 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 critical wildlife habitat. The wildlife particularly Elephant, Gaur and Tiger are known to migrate through this forests and riverine systems. The figure V-10 represents the critical wildlife habitat within the project area.



Figure V-10: Critical Wildlife Habitat



### 3. Forest Resources and Land Cover

#### a. General

226. As per NSB's Statistical Yearbook of Bhutan, 2011, about 87.7% of the Pema Gatshel and 86.9% of Samdrup Jongkhar Dzongkhag are under true forest cover. Pema Gatshel 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 V-4.

**Table V.4: Land Cover figures of Pema Gatshel 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: Adapted from Statistical Yearbook of Bhutan, 2011, NSB, RGOB

#### b. Land Use Change and Forest Loss

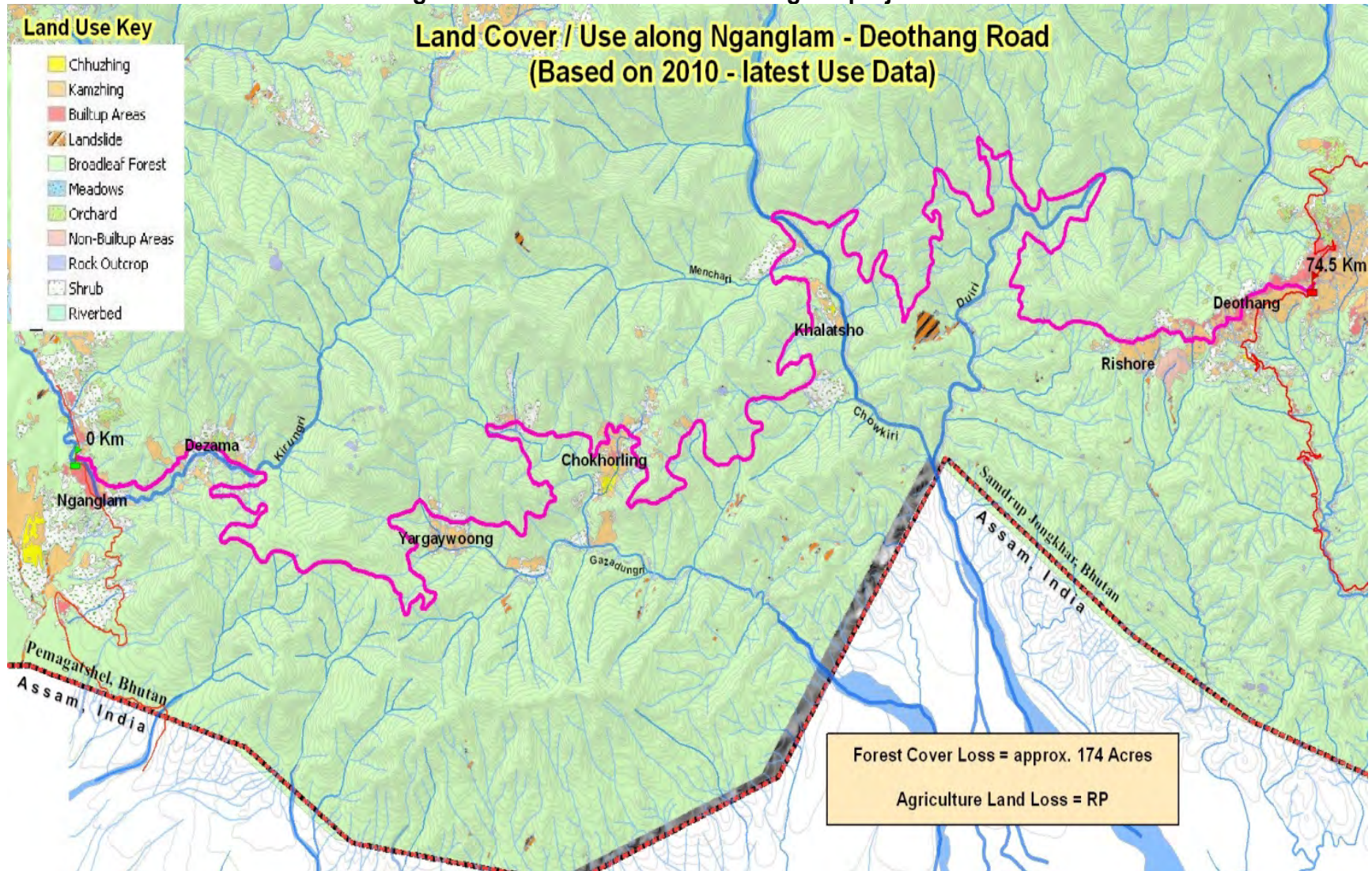
227. As per Land Cover and Area Statistic 1997 of MoAF, Pema Gatshel Dzongkhag had only about 53% of its land area (518km<sup>2</sup>) under forest cover. However, the recent statistics (NSB's Statistical Yearbook of Bhutan 2011) show the mark increase of forest area from 53% to 87.7% over the period of 15 years. Similarly, Samdrup Jongkhar had only about 76% of its area (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.

**Table V.5: Land Use or cover along the Road Section**

(Km)		Length (m)	Change in Land Use or Cover (in Acre)	Existing Land Cover or Land Use Type
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	10+000	4,000.00	14.83	Agriculture and Fallow Land
10+000	14+000	4,000.00	14.83	Scrub Forest (Fallow land)
14+000	20+000	6,000.00	22.24	Forest
20+000	21+000	1,000.00	3.71	Agriculture and Fallow Land of Yargaywoong
21+000	25+000	4,000.00	14.83	Forest and Steep Rocky Area
25+000	27+000	2,000.00	7.41	Agriculture and Fallow Land of Chokhorling
27+000	31+000	4,000.00	14.83	Agriculture and Fallow Land
31+000	37+000	6,000.00	22.24	Regenerated Forest (Old Tseri area)
37+000	42+000	5,000.00	18.53	Agriculture and Fallow Land of Khalatsho
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	64+000	4,000.00	14.83	Riparian Forest
64+000	68+000	4,000.00	14.83	Forest
68+000	71+000	3,000.00	11.12	Agriculture area through the Settlement Rishore and Chenari
71+000	74+500	3,500.00	12.97	Through Municipal Areas of Deothang
<b>Total</b>		<b>74,500</b>	<b>276.16</b>	

Source: Field Survey, November 2011

Figure V-11: Land use or cover along the project road



228. As per field survey December 2011 and subsequent analysis, it is estimated that around 88.96 acre of agriculture land, 174.2 acres of forest land and 12.97 acres of municipal areas could directly or indirectly be lost to the proposed road development.

### c. Forest Types within the Project Sites

229. Nganglam-Deothang Road falls within an altitude of 300-1100 m above sea level. This road 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 orchard. The road passes through a broad-leaved forest in most sections of the road from Shuguri to Deothang except passing small stretch in farmland at Yargaywoong, Chokhorling, Khalatsho and Rishore to Chenari and urban area from Chenari to Deothang. Bamboo and banana forests are common in the area. 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 Nganglam-Deothang road alignment (table V.6.1-V.6.10). 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 sylvesteris*, *Careya arborea*, *Diplocknema butyraceae*, *Vitex heterophylla*, *Phoenix humilis*, *Trachycarpus martianus* and *Caryota urens*. 7 rare shrubs are *Piper mulesua*, *Crotolaria sp.* *Flemingia sp.*, *Todalial 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 species is found very remotely in the wild. It is therefore required to protect *acquilaria* tree before it is virtually exhausted in the wild state.

230. The forest area all the way from Nganglam till Khalatsho village and nearing Rishore, Deothang 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 Duri is pristine and undisturbed. This forest is the habitat to Asian Elephant, Tiger, Gaur, Wild Pig, Sambar, Leopard, Wild Dog/Dhole, etc.

**Table V.6.1: Tree species recorded along Nganglam-Deothang Road Alignment**

Sl. No.	Botanical Name	Family	Local Name	Availability
1	<i>Engelhardia spicata</i>	10. Juglandaceae	Mauwa (Lh.); Mur shing, Tshos shing (Sh.)	LC
2	<i>Castanopsis indica</i>	13. Fagaceae	Aule katus (Lh.); Tsai shing (Sh.)	A
3	<i>Castanopsis clarkei</i>	13. Fagaceae	Tsai shing (Sh.)	LC

Sl. No.	Botanical Name	Family	Local Name	Availability
4	<i>Lithocarpus elegans</i>	13. Fagaceae	Arcaula (Lh.)	C
5	<i>Lithocarpus fenestrata</i>	13. Fagaceae	Arcaula (Lh.)	C
6	<i>Lithocarpus pachyphylla</i>	13. Fagaceae	Patptate (Lh.)	LC
7	<i>Celtis tetrandia</i>	14. Ulmaceae	Khari (Lh.); Phantang shing (Sh.)	C
8	<i>Trema orientalis</i>	14. Ulmaceae	Chhib shing (Sh.)	C
9	<i>Ficus semicordata</i>	15. Moraceae	Barchongma (Sh.),	C
10	<i>Ficus oligodon</i>	15. Moraceae	Chongma (Sh.); Fig	C
11	<i>Ficus subisinsa</i>	15. Moraceae	Eng. Fig; Gugai chongma (Sh.)	C
12	<i>Ficus glomerata</i>	15. Moraceae	Eng. Fig; Dumri (Lh)	C
13	<i>Ficus hookeriana</i>	15. Moraceae		
14	<i>Ficus virens</i>	15. Moraceae	Phi shing (Sh.); Kabra, Pakkar, Dumri (Lh.)	C
15	<i>Ficus elastic</i>	15. Moraceae	Brong shing (Sh.)	R
16	<i>Ficus spp.</i>	15. Moraceae		C
17	<i>Morus macroura</i>	15. Moraceae	Kimbu (Lh.); Tshende (Dz.), Sengdeng (Sh.)	LC
18	<i>Artocarpus chama</i> ; A chaplasha	15. Moraceae	Lathar (Lh.); Yetsushing (Sh.); Hindi Chaplash	LC
19	<i>Artocarpus lacucha</i> ; A.lakoocha	15. Moraceae	Borhar, Dewa (Lh.); Hindi: Lakooch	LC
20	<i>Boehmeria rugolosa</i>	16. Ueticaceae	Dar (Lh.); Dongtsong shing (Sh.)	LC
21	<i>Talauma hodgsoni</i>	34. Magnoliaceae	Balukath (Lh.); Kadering shing (Sh.)	LC
22	<i>Michelia champaca</i>	34. Magnoliaceae	Champai shing (Sh.); Aule champ (Lh.)	R
23	<i>Polyalthia semiarum</i>	35. Annonaceae	Runchi (Lh.)	LC
24	<i>Knema tenuinervia</i>	36. Myristaceae	Rate balayo (Lh.); Duruka (Med.)	LC
25	<i>Phoebe golparaensis</i>	39. Lauraceae	Bonsum (Lh.); Seychanglu shing (Sh.)	R
26	<i>Phoebe hainesiana</i>	39. Lauraceae	Angare (Lh.)	LC
27	<i>Phoebe lanceolata</i>	39. Lauraceae	Jhangri-khat (Lh.)	LC
28	<i>Cinnamomum tamala</i>	39. Lauraceae	Tespar shing (Sh.); Tespatta (Lh.)	LC
29	<i>Cinnamomum ciccidodaphne</i>	39. Lauraceae	Malagiri (Lh.)	LC
30	<i>Cinnamomum impressinervium</i>	39. Lauraceae		LC
31	<i>Litsea sebifera</i>	39. Lauraceae	Nengshing (Sh.)	LC
32	<i>Saurauia napaulensis</i>	49. Sauraraceae	Gogun (Lh.)	LC
33	<i>Dillenia pentagyna</i>	53. Dilleniaceae	Tatari (Lh.)	R
34	<i>Dillenia indica</i>	53. Dilleniaceae	Panchphale (Lh.)	R
35	<i>Actinodaphne obovata</i>	54. Actinidaceae	Runchipat (Lh.)	C
36	<i>Schima wallichii</i>	56. Theaceae	Puyam (Dz.); Zala shing (Sh.); Chilaune (Lh.)	A
37	<i>Garcinia sopsopia</i>	57. Guttiferae	Khomang shing (Sh.); Kusum (Lh.)	R
38	<i>Altingia excelsa</i>	65. Hamamelidaceae	Dhing shing (Sh.); Sheti-kath, Jhigkri (Lh.)	LC
39	<i>Darris sp.</i>	76. Leguminosae		LC
40	<i>Erythrina arborescens</i>	76. Leguminosae	Khar shing (Sh.); Chhase (Dz.)	C

Sl. No.	Botanical Name	Family	Local Name	Availability
41	<i>Albizia lebbeck</i>	76. Leguminosae	Khirdang laishing (Sh.); La-siris (Lh.)	C
42	<i>Albizia chinensis</i>	76. Leguminosae	Sershing (Sh.); Siris (Lh.)	C
43	<i>Albizia procera</i>	76. Leguminosae	Sershing (Sh.); Siris (Lh.)	C
44	<i>Acrocarpus fraxianifolius</i>	76. Leguminosae	Mandane (Lh.)	LC
45	<i>Cassia fistula</i>	76. Leguminosae	Donga (Med.); Dongka shing (Sh.); Rajbriksh (Lh.)	C
46	<i>Sapium baccatum</i>	84. Euphorbiaceae	Ankhataruwa (Lh.)	R
47	<i>Mallotus philippinensis</i>	84. Euphorbiaceae	Sindure (Lh.)	C
48	<i>Macaranga pustulata</i>	84. Euphorbiaceae	Malata (Lh.)	C
49	<i>Macaranga denticulata</i>	84. Euphorbiaceae	Malata (Lh.)	C
50	<i>Macaranga peltata</i>	84. Euphorbiaceae	Malata (Lh.)	
51	<i>Ostodes paniculata</i>	84. Euphorbiaceae	Bepari (Lh.)	A
52	<i>Bridelia retusa</i>	84. Euphorbiaceae	Gayo (Lh.)	C
53	<i>Baccaurea sapinda</i>	84. Euphorbiaceae	Gothampaise (Sh.); Kusum (Lh.)	LC
54	<i>Putranjiva assamica</i> ; <i>P. roxburghii</i> Willd. F.B.I v. 336; E. D. P 1433 <i>Nageia putranjiva</i> F. I. III. 766.	84. Euphorbiaceae	Thongpa shing (Sh.); Hind. & Beng. Jia-putta, Putranjiva; Santal. Pitoj	R
55	<i>Zanthoxylum budrunga</i>	86. Rutaceae	Hougi shing (Sh.)	LC
56	<i>Evodia fraxinifolia</i>	86. Rutaceae	Khanakpa (Lh.)	C
57	<i>Micromelum integerrimum</i>	86. Rutaceae		R
58	<i>Ailanthus grandis</i>	87. Simaroubaceae	Gokul (Lh.); Somo shing (Sh.)	LC
59	<i>Garuga pinnata</i>	88. Burseraceae	Aule dabdabe (Lh.); Warong shing (Sh.)	LC
60	<i>Cannarium sikkimensis</i>	88. Burseraceae	Poikar (Dz.); Poskar (Sh.)	R
61	<i>Amoora wallichii</i>	89. Meliaceae	Lasune (Lh.); Wagore dore sey (Sh.)	LC
62	<i>Amoora rohituca</i>	89. Meliaceae	Lasune (Lh.); Wagore dore sey (Sh.)	LC
63	<i>Heyna trijuga</i>	89. Meliaceae	Ankhataruwa (Lh.)	LC
64	<i>Cedrela toona</i>	89. Meliaceae	Tooni (Lh.)	LC
65	<i>Mangifera sylvestris</i>	92. Anacardiaceae	Borang-am (Sh.); Amp (Lh.); Mango (Eng.)	R
66	<i>Leana coromandalica</i>	92. Anacardiaceae		C
67	<i>Spondias pinnata</i>	93. Anacardiaceae	Amaru (Lh.); Amar shing (Sh.)	A
68	<i>Rhus griffithii</i>	93. Anacardiaceae	Balayo (Lh.)	C
69	<i>Rhus chinensis</i>	93. Anacardiaceae	Robtang shing (Sh.); Datrid (Med.)	C
70	<i>Acer obolongon</i>	94. Aceraceae	Phirpiri (Lh.)	LC
71	<i>Acer thomsonii</i>	94. Aceraceae		LC
72	<i>Sapindus rarak</i>	95. Sapindaceae	Nakapani (Dz.); Kiling (Sh.), Ritha (Lh.)	LC

Sl. No.	Botanical Name	Family	Local Name	Availability
73	<i>Bischofia javanica</i>	104. Bischofiaceae	Kainjal (Lh.); Goile (Dz.)	LC
74	<i>Hovenia acerba</i> syn. <i>Dulcis</i>	108. Rhamnaceae	Pumoloto (Dz.); Bange (Lh.)	LC
75	<i>Zizyphus mauritiana</i>	108. Rhamnaceae	Baer (Lh.); Khangkhaling (Sh.)	LC
76	<i>Zizyphus recurba</i>	108. Rhamnaceae	Baer (Lh.); Khangkhaling (Sh.)	
77	<i>Eleocarpus veruna</i>	111. Eleocarpaceae	Badrase (Lh.); Gasha thungshing (Sh.)	C
78	<i>Kydia calycina</i>	113. Malvaceae	Kubinde (Lh.); Chambagtang shing (Sh.)	C
79	<i>Bombax ceiba</i>	114. Bombacaceae	Simal (Lh.); Pemageser (Sh.)	C
80	<i>Sterculia villosa</i>	115. Sterculiaceae	Phrang shing (Sh.); Odal (Lh.)	C
81	<i>Pterospermum acerifolium</i>	115. Sterculiaceae	Hatipaile (Lh.); Mongnang laga (Sh)	C
82	<i>Pterogota alata</i>	115. Sterculiaceae	Badam shing (Sh.); Hathipaile (Lh.)	C
83	<i>Gynocardia odorata</i>	118. Flacourtiaceae	Gante (Lh.); Dorkho shing (Sh.)	LC
84	<i>Casaeria glomerata</i>	118. Flacourtiaceae	Lathikath (Lh.)	C
85	<i>Tertrameles nudiflora</i>	126. Datisceae	Maina-kath (Lh.)	LC
86	<i>Lagerstroemia parviflora</i>	129. Lythraceae	Sidha (Lh.); Buram shing (Sh.)	C
87	<i>Duabanga grandiflora</i>	131. Sonneratiaceae	Lampate (Lh.); Khirdanglai shing (Sh.)	C
88	<i>Careya arborea</i>	133. Lacethidaceae	Kubinde (Lh.)	R
89	<i>Terminalia myriocarpa</i>	136. Combretaceae	Panisaj (Lh.); Bakhhal shing (Sh.)	C
90	<i>Terminalia belerica</i>	136. Combretaceae	Barra (Lh.); Baru (Med.; Sh. & Dz.)	
91	<i>Alangium chinense</i>	141. Alangiaceae	Benthong or Shoskum shing (Sh.)	C
92	<i>Pentapanax</i> sp	143. Araliaceae	Gu shing (Sh.); Chinde (Lh.)	
93	<i>Heteropanax fragrans</i>	143. Araliaceae	Bale totola, Gykure (Lh.); Baha-bu-toh or Kekchi shing (Sh.)	C
94	<i>Trevesia palmata</i>	143. Araliaceae	Tokpulu shing (Sh.); Phutta h.	C
95	<i>Diplocknema butyraceae</i>	153. Sapotaceae	Yika (Dz.); Pinse (Sh.); Chewri (Lh.)	R
96	<i>Alstonea scholaris</i>	162. Apocynaceae	Chatiwan; Nimthomo shing	C
97	<i>Holarrhena antidysenterica</i>	162. Apocynaceae	Khirra (Lh.)	LC
98	<i>Plumeria rubra</i>	162. Apocynaceae	Pagoda tree (Eng.)	LC
99	<i>Wrightia tomentosa</i>	162. Apocynaceae	Khirra (Lh.)	C
100	<i>Adina cordifolia</i>	164. Rubiaceae	Karam (Lh.)	LC
101	<i>Neolamrackia cadamba</i>	164. Rubiaceae	Kadam (Lh.)	C
102	<i>Cordia oblique</i>	167. Boraginaceae	Yam shing (Sh.)	LC
103	<i>Callicarpa arborea</i>	168. Verbenaceae	Thulu shing (Sh.); Khalema (Kh.); Guinli (Lh.)	A
104	<i>Premna bengalensis</i>	168. Verbenaceae	Gineri (Lh.)	LC
105	<i>Gmenila arborea</i>	168. Verbenaceae	Kholom shing(Sh.);Gamari (Lh.)	LC
106	<i>Vitex heterophylla</i>	168. Verbenaceae	Panch pate (Lh.)	R
107	<i>Sterospermum colais</i>	174. Bignoniaceae	Aba shing (Sh.); Parari (Lh.)	LC
108	<i>Sterospermum chilonoides</i>	174. Bignoniaceae	Parari (Lh.)	C
109	<i>Oroxylum indicum</i>	174. Bignoniaceae	Namkaling or Tsampaka (Lh.);	C

Sl. No.	Botanical Name	Family	Local Name	Availability
			Totola (Lh.)	
110	<i>Viburnum cylindricum</i>	182. Caprifoliaceae	Yumeling shing (Sh.); Ghora-kahri (Lh.)	C
111	<i>Vernonia</i> sp	187. Compositae		C
112	<i>Phoenix sylvestris</i>	234. Areaceae (Palmae)		LC
113	<i>Phoenix humilis</i>	234. Areaceae		R
114	<i>Phoenix</i> sp.	234. Areaceae	Thakal (Lh.)	
115	<i>Trachycarpus martianus</i>	234. Areaceae	Lari (Sh.)	R
116	<i>Caryota urens</i>	234. Areaceae	Brungshing or Thakchung (Sh.); Rangbhang (Lh.)	R
117	<i>Calamus</i> spp.	234. Areaceae	Phekre Bet (Lh.)	LC
118	<i>Plectocomia himalayana</i>		Tokri Bet (Lh.); Tikir (Sh.)	R
119	<i>Pandanus furcatus</i> ; <i>P. nepalensis</i>	235. Pandanaceae	Tarica (Lh.); Perumnang shing or Gelpotashor (Sh.)	LC
120	<i>Pandanus unguifer</i> ; <i>P. minor</i>	235. Pandanaceae	Perumnang shing or Gelpotashor (Sh.)	LC

Field survey, November 2011 and June/September 2013 Note: A-Abundance, C-Common; LC-Less Common; R-Rare

**Table V.6.2: Different species of shrub recorded along Nganglam-Deothang Road Alignment**

Sl. No.	Botanical name	Family	Local name	Availability
1	<i>Boehmeria macrophylla</i>	16. Urticaceae		A
2	<i>Boehmeria penduliflora</i>	16. Urticaceae		C
3	<i>Pauzolia sanguine</i>	16. Urticaceae	Yongiba (Sh.); Chiple (Lh.)	A
4	<i>Debregaesia velutina</i>	16. Urticaceae	Tusare (Lh.)	C
5	<i>Dendroconide sinuate</i>	16. Urticaceae	Phronglo (Sh.); Jangorba	C
6	<i>Cannabis sativa</i>	17. Cannabaceae	Phagpa nam (Sh.)	C
7	<i>Aconopogon molle</i>	24. Polygonaceae	Kochoma (Sh.)	C
8	<i>Piper mullesua</i>	50. Piperaceae	Peepla (Sh.); Pipiling (Med.)	R
9	<i>Piper pedicellatum</i>	50. Piperaceae		C
10	<i>Rubus</i> sp.	74. Rosaceae		C
11	<i>Desmodium</i> sp.	76. Leguminosae		C
12	<i>Cassia tora</i>	76. Leguminosae	Theka dorji (Med.); Keker dorji (Sh.),	VC
13	<i>Cassia occidentalis</i>	76. Leguminosae		C
14	<i>Cassia floribunda</i>	76. Leguminosae		C
15	<i>Cesalpinia cucullata</i>	76. Leguminosae	Bokshi kangra (Lh.)	C
16	<i>Mimosa pudica</i>	76. Leguminosae	Boari jhar (Lh.)	C
17	<i>Tephrosia candida</i>	76. Leguminosae	Kumchimo shing (Sh.),	C
18	<i>Crotolaria</i> sp.	76. Leguminosae		R
19	<i>Crotolaria cytisoides</i>	76. Leguminosae	Bainang lebi (Sh.),	VC
20	<i>Dalbergia pinnata</i>	76. Leguminosae		C
21	<i>Flemingia</i> sp.	76. Leguminosae		R
22	<i>Desmodium gyriodes</i>	76. Leguminosae	Mardum kumchimo shing (Sh.),	C
23	<i>Croton cordatus</i>	84. Euphorbiaceae	Phikhiru (Sh.); Supari or	C



Sl. No.	Botanical name	Family	Local name	Availability
			<i>Halaunre</i> (Lh.)	
24	<i>Gauania leptostrachya</i>	84. Euphorbiaceae		C
25	<i>Fleuggea virosa</i>	84. Euphorbiaceae	<i>Goikhang shing</i> (Sh.)	C
26	<i>Recinus communis</i>	84. Euphorbiaceae	<i>Chamaling</i> (Sh.)	C
27	<i>Todalia asiatica</i>	86. Rutaceae	<i>Khaitorzu, Kapur</i> (Sh.)	R
28	<i>Citrus limon</i>	86. Rutaceae	<i>Numpang</i> (Sh.)	R
29	<i>Cipadessa baccifera</i>	89. Meliaceae		R
30	<i>Rhamnus nepalensis</i>	108. Rhamnaceae		C
31	<i>Leea asiatica</i>	110. leeaceae	<i>Boram shing</i> (Sh.)	C
32	<i>Abroma angustifolia</i>	113. Malvaceae	<i>Ulat cambal</i> (Beng.)	C
33	<i>Abelmoschus</i> sp.	113. Malvaceae		LC
34	<i>Melastroma nepalensis</i>	134. Melastromaceae		LC
35	<i>Maesa chisia</i>	150. Myrsinaceae	<i>Khuberbu</i> (Sh.)	A
36	<i>Maesa macrophylla</i>	150. Myrsinaceae	<i>Khuberbu</i> (Sh.)	A
37	<i>Jusminum</i> sp.	158. Oleaceae		C
38	<i>Buddleja asiatica</i>	159. Loganiaceae	<i>Binsenpate</i> (Lh.)	C
39	<i>Tabernaemontanum divaricata</i>	162. Apocynaceae	<i>Baramase</i> (Lh.); <i>Waatokase</i> (Sh.)	C
40	<i>Uncaria scandens</i>	164. Rubiaceae	<i>Gogthur Zu</i> (Sh.)	LC
41	<i>Musaenda roxburghii</i>	164. Rubiaceae		C
42	<i>Coffea bengalensis</i>	164. Rubiaceae		C
43	<i>Cephalanthus</i> sp.	164. Rubiaceae		C
44	<i>Clerodendrum viscosum</i>	168. Verbanaceae	<i>Mokomo</i> (Lh.)	C
45	<i>Holmskioldia sanguine</i>	168. Verbanaceae		C
46	<i>Eisholtzia</i> sp	170. Labiatae		LC
47	<i>Solanum verbascifolium</i>	171. Solanaceae		C
48	<i>Brugmansia suaveolens</i>	171. Solanaceae	<i>Dung momnang</i> (Sh.)	LC
49	<i>Solanum torvum</i>	171. Solanaceae		C
50	<i>Strobilanthus</i> sp.	175. Acanthaceae		C
51	<i>Justice adhatoda</i>	175. Acanthaceae	<i>Khatsarim</i> (Sh.)	C
52	<i>Phlogacanthus thyrsofolia</i>	175. Acanthaceae	<i>Bashakha</i> (Sh.)	C
53	<i>Sambucus adnata</i>	182. Caprifoliaceae		LC
54	<i>Chromolaena odorata</i>	187. Compositae	<i>Banmara</i> (Lh.); <i>Ambertala</i> (Sh.)	VC
55	<i>Artimesia</i> sp.	187. Compositae	<i>Meringma</i> (Sh.)	C
56	<i>Xanthium indicum</i>	187. Compositae		C
57	<i>Tithonia diversifolia</i>	187. Compositae		R
58	<i>Pterocanthus</i> sp.	175. Acanthaceae		LC
59	<i>Phlogacanthus thyrsoformis</i>	175. Acanthaceae	<i>Bashakha, Chuwa</i> (Lh.)	C
60	<i>Justica adhatoda</i>	175. Acanthaceae	<i>Asuro</i> (Lh.); <i>Khatsirin</i> (Sh.)	C
61	<i>Dendrocalamus hamiltonii</i>	233. Graminae	<i>Choya bans</i> (Lh.); <i>So</i> (Sh.), <i>Baa</i> (Dz.)	C
62	<i>Thysanolaena maxima</i>	233. Graminae	<i>Tsakusha, Beshawee</i> (Sh.)	C
63	<i>Wallichia densiflora</i>	234. Areaceae (Palmae)	<i>Saitsam</i> (Sh.); <i>Thakal</i> (Lh.)	LC
64	<i>Wallichia disticha</i>	234. Areaceae	<i>Saitsam</i> (Sh.); <i>Thakal</i> (Lh.)	LC

Field survey, November 2011 and June/September 2013

**Table V.6.3: Different species of herbs recorded along Nganglam-Deothang Road Alignment**

Sl. No.	Botanical name	Family	Local name	Availability
1	<i>Elatostema</i> sp	16. Urticaceae	<i>Gogleto</i> (Lh.)	VC
2	<i>Pilea</i> sp.	16. Urticaceae		C
3	<i>Girardinia diversifolia</i>	16. Urticaceae	<i>Gom jazu</i> (Sh.)	C
4	<i>Urtica ardens</i>	16. Urticaceae	<i>Sisnu</i> (Lh.); <i>Zocha</i> (Dz.); <i>Jazu</i> (Sh.)	C
5	<i>Laportia terminates</i>	16. Urticaceae	<i>Sisnu</i> (Lh.)	C
6	<i>Chenopodium</i> sp.	31. Chenopodiaceae	<i>Bethu</i> (Lh.)	C
7	<i>Alternanthera pungens</i>	32. Amaranthaceae		VC
8	<i>Amaranthus</i> sp.	32. Amaranthaceae		C
9	<i>Oxalis</i> sp.	78. Oxalidaceae		C
10	<i>Bistorta</i> sp.	91. Polygalaceae		C
11	<i>Aconopogon molle</i>	91. Polygalaceae		C
12	<i>Persicaria</i> sp.	91. Polygalaceae		
13	<i>Impatiens</i> sp	99. Balsaminaceae		C
14	<i>Triumfetta pilosa</i>	112. Tiliaceae		C
15	<i>Urena lobata</i>	113. Malvaceae	<i>Brengpa shing</i> (Sh.)	C
16	<i>Sida acuta</i>	113. Malvaceae	<i>Lishong rogpu</i> (Sh.)	C
17	<i>Abelmoschua</i> sp.	133. Malvaceae		C
18	<i>Hydrocotyle asiatica</i>	143. Araliaceae		C
19	<i>Solanum nigrum</i>	171. Solanaceae		C
20	<i>Solanum khasianum</i>	171. Solanaceae	<i>Banthozu</i>	C
21	<i>Physalis divaricata</i> var. <i>microcarpa</i>	171. Solanaceae	<i>Pokpokpa</i> (Sh.)	C
22	<i>Datura stramonium</i>	171. Solanaceae		C
23	<i>Scoparia dulcis</i>	173. Scrophulariaceae	<i>Chini jhar</i> (Lh.)	C
24	<i>Lindenbergia perviflora</i>	173. Scrophulariaceae		R
25	<i>Plantago</i> sp.	181. Plantaginaceae	<i>Tsashoma</i> (Sh.)	C
26	<i>Bidens pilosa</i>	187. Compositae	<i>Zumphi robu</i> (Sh.)	VC
27	<i>Bidens bipinnata</i>	187. Compositae		VC
28	<i>Ageratum conyzoides</i>	187. Compositae		VC
29	<i>Acmela clava</i>	187. Compositae		VC
30	<i>Crassocephalum crepidiodes</i>	187. Compositae	<i>Ngangkunchi</i> (Sh.)	VC
31	<i>Eclipta prostate</i>	187. Compositae		C
32	<i>Galingsoga perviflora</i>	187. Compositae		C
33	<i>Galingsoga pedicellatum</i>	187. Compositae		C
34	<i>Xanthium indicum</i>	187. Compositae		C
35	<i>Segesbeckia orientalis</i>	187. Compositae	<i>Woongchilo rokpu</i> (Sh.)	C
36	<i>Arisaema</i> sp.	210. Araceae	<i>Buchilato</i> (Sh.); <i>Cobra plant</i>	R
37	<i>Colocasia</i> sp.	210. Araceae	<i>Sokpa</i> (Sh.)	C
38	<i>Hedychium</i> sp.	224. Zingibericeae		C
39	<i>Commelina difusa</i>	228. Commelinaceae		A
40	<i>Carex</i> sp.	232.. Cyperaceae		C

Field survey, November 2011 and June/September 2013

**Table V.6.4: Different species of Climbers recorded along Nganglam-Deothang Road Alignment**

Sl. No	Botanical name	Family	Habit	Availability
1	<i>Tinospora cordifolia</i>	47. Menispermaceae	Climber	LC
2	<i>Stephania glabra</i>	47. Menispermaceae	Twiners	C
3	<i>Cissumpelos</i> sp	47. Menispermaceae	Climbers	C
4	<i>Piper bedloides</i>	50. Piperaceae	Climbing shrub	C
5	<i>Piper longum</i>	50. Piperaceae	Climbing shrub	C
6	<i>Derris acuminata</i>	76. Leguminosae	Large woody climbers	C
7	<i>Derris</i> sp	76. Leguminosae	Large climbers	C
8	<i>Millittia pachycarpa</i>	76. Leguminosae	Large woody climbers	C
9	<i>Mucuna macrocarpa</i>	76. Leguminosae	Woody climbers	LC
10	<i>Mucuna pruriens</i>	76. Leguminosae	Twiners	C
11	<i>Entada reedhii</i> subsp. <i>Sinohimalaica</i>	76. Leguminosae	Large climbers	C
12	<i>Pueraria phaseoloides</i>	76. Leguminosae	Woody twiners	C
13	<i>Shuteria involucrate</i>	76. Leguminosae	Climbers	C
14	<i>Cissus repens</i>	109. Vitaceae	Climbers	A
15	<i>Tetrastigma</i> sp.	109. Vitaceae	Climbers	A
16	<i>Adena trilobata</i>	121. Passifloraceae	Woody climbers	R
17	<i>Adena cardiophylla</i>	121. Passifloraceae	Woody climbers	R
18	<i>Hodgsonia macrocarpa</i>	128. Cucurbitaceae	Climbers	LC
19	<i>Tricosanthes</i> sp.	128. Cucurbitaceae	Climbers	A
20	<i>Solena amplexicaulis</i>	128. Cucurbitaceae	Climbers	C
21	<i>Clematis</i> sp.	152. Ranunculaceae	Climbers	LC
22	<i>Beaumontia grandiflora</i>	162. Apocynaceae	Large woody climbers	C
23	<i>Cryptolepis buchmanii</i>	163. Asclipidaceae	Climbers	C
24	<i>Paederia foetida</i>	164. Rubiaceae	Climbers	A
25	<i>Hedyotis scandens</i>	164. Rubiaceae	Large climbing shrub	C
26	<i>Uncaria scandens</i>	164. Rubiaceae	Woody climbers	LC
27	<i>Argyria venusta</i>	165. Convolvulaceae	Large twiners	A
28	<i>Thunbergia coccinea</i>	175. Acanthaceae	Climber shrub	A
29	<i>Thunbergia grandiflora</i>	175. Acanthaceae	Climbing shrub	A
30	<i>Plumbago zylanicum</i>	181. Plumbaginaceae	12.	LC
31	<i>Mikania macrantha</i>	187. Compositae	Twining perennial herb	VC
32	<i>Dioscorea deltoidea</i>	188. Dioscoreaceae	Twining perennials	R
33	<i>Dioscorea bulbiflora</i>	188. Dioscoreaceae	Twining perennials	VC
34	<i>Dioscorea</i> sp.	188. Dioscoreaceae	Twining perennials	C

Field survey, November 2011 and June/September 2013

**Table V.6.5: Different species of Epiphytes recorded along Nganglam-Deothang Road Alignment**

Sl. No	Botanical name	Family	Local name	Availability
1	<i>Sheffleria venulosa</i>	143. Araliaceae		C
2	<i>Agapetes serpens</i>	149. Ericaceae		LC
3	<i>Aeschynanthus</i> sp.	177. Gesneraceae		LC
4	<i>Hoya</i> sp.	177. Gesneriaceae		LC
5	<i>Aeschynanthus sikkimnesis</i>	177. Gesneriaceae		LC
6	<i>Oberonia falconeri</i>	209. Orchidaceae		C
7	<i>Dendrobium chrysanthum</i>	209. Orchidaceae	Chang (Sh.)	LC
8	<i>Symbidium aloifolium</i>	209. Orchidaceae	Chang (Sh.)	LC

Sl. No	Botanical name	Family	Local name	Availability
9	<i>Symbidium</i> sp.	209. Orchidaceae		LC
10	<i>Dendrobium</i> sp	209. Orchidaceae		LC
11	<i>Ceologyne</i> sp.	209. Orchidaceae	Chang (Sh.)	LC
12	<i>Pothos catcartii</i>	210. Araceae	Sanu kanchirna (Lh.)	C
13	<i>Raphidophora grandis</i>	210. Araceae	Kanchirna (Lh.); Brensla (Sh.)	C
14	<i>Colocasia</i> sp.	210. Araceae	Sogpa (Lh.)	C
15	<i>Cutleya</i> sp.	224. Zingeraceae		LC

Field survey, November 2011 and June/September 2013

**Table V.6.6: Diverse habit of underground rhizome, sucker and rhizomatous herbs recorded along Nganglam-Deothang Road Alignment**

Sl. No	Botanical name	Family	Local name	Availability
1	<i>Colocasia</i> sp.	210. Araceae	Sokpa (Sh.); Dowa (Dz.); Eng. Taro; Mane (Lh.); Kutchu (Bengali.)	C
2	<i>Amorphophallus bulbifer</i>	210. Araceae	Olo-bantho (Sh.)	LC
3	<i>Arisaema</i> sp.	210. Araceae	Ruginang asham (Sh.)	C
4	<i>Acorus calamus</i>	210. Araceae	Bartsi (Sh.)	LC
5	<i>Amorphophallus nepalensis</i>	210. Araceae	Ruginang asham (Sh.)	C
6	<i>Musa griersonii</i>	223. Musaceae	Shinang laishing (Sh.)	LC
7	<i>Musa</i> sp.	223. Musaceae	Laishing (Sh.); Kola (Lh.)	C
8	<i>Zingiber</i> sp.	224. Zingiberaceae	Borang saga (Sh.)	C
9	<i>Curcuma aronitica</i>	224. Zingiberaceae	Jung (Sh.); Doim (Dz.)	C
10	<i>Kaempferia rotunda</i>	224. Zingiberaceae	Buin champa (Sh.)	LC
11	<i>Hedychium ellipticum</i>	224. Zingiberaceae	Khui-see (Sh.)	LC
12	<i>Hedychium</i> sp.	224. Zingiberaceae	Khi saga (Sh.)	LC
13	<i>Cosctus lucerus</i>	225. Costaceae	Beth laure (Lh.)	LC
14	<i>Phrynium puvenerve</i>	227. Marantaceae	Laburlaga (Sh.); kopat, Kufyer, Kawaipat (Lh.)	C
15	<i>Phrynium placentarium</i>	227. Marantaceae	Laburlaga (Sh.); kopat, Kufyer, Kawaipat (Lh.)	C

Field survey, November 2011 and June/September 2013

**Table V.6.7: Endemic species recorded along Nanglam-Deothang Road Alignment**

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

Field survey, November 2011 and June/September 2013

**Table V.6.8: Plant species with medicinal value recorded along Nanglam-Deothang Road Alignment**

Sl. No.	Botanical name	Family	Local/medicinal	Habit	Part used
1	<i>Knema tenuinervia</i>	36. Myristicaceae	<i>Duruka</i> (Med.); <i>Rate Balayo</i> (Lh.)		
2	<i>Tinospora cordifolia</i>	47. Menispermaceae	<i>Gurjo</i> (Lh.); <i>Geloi</i> (Hind.); <i>Letey</i> (Med.)	Climber	Stem
3	<i>Cassia tora</i>	76. Leguminosae	<i>Theka dorji</i> (Med.)	Shrub	Seed
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
5	<i>Erythrina arborescens</i>	76. Leguminosae	<i>Khelmaz shosha</i> (Med.); <i>Kharshing</i> (Sh.)	Tree	Seed
6	<i>Piper mullesua</i>	50. Piperaceae	<i>Pipiling</i> (Med.)	Shrub	Seed
7	<i>Piper longum</i>	50. Piperaceae	<i>Pipiling</i> (Med.)	Climbing shrub	Seed
8	<i>Recinus communis</i>	84. Euphorbiaceae	Chamiling	Shrub	Seed
9	<i>Phyllanthus Eemblica</i>	84. Euphorbiaceae	<i>Churu</i> (Med.)	Tree	Seed
10	<i>Canarium strictum</i>	88. Burseraceae	<i>Poikar</i> (Med.); <i>Poskar</i> (Sh.)	Tree	Fresh resin
11	<i>Rhus chinensis</i>	93. Anacardiaceae	<i>Datrid</i> (Med.); <i>Robtang shing</i> (Sh.)	Tree	Fruit
12	<i>Abroma angustifolia</i>	113. Malvaceae	<i>Ulat cambal</i> (Beng.)	Shrub	Root
13	<i>Adena trilobata</i>	121. Passifloraceae	<i>Dakor meji</i> (Sh.)	Climber	Root
14	<i>Adena cardyophylla</i>	121. Passifloraceae	<i>Dakor laji</i> (Sh.)	Climber	Root
15	<i>Beaumontia grandiflora</i>	162. Apocynaceae	<i>Dukmo-nyung</i> (Med.); <i>Gothale phul</i> (Lh.)	Large climber	Stem
16	<i>Scoparia dulcis</i>	173. Scrophulariaceae	<i>Chini jhar</i> (Lh.)	Herb	Entire plant
17	<i>Justicia adhatoda</i>	175. Acanthaceae		Shrub	Flowers

Field survey, November 2011 and June/September 2013

**Table V.6.9: Recognized Threatened Plants recorded along Nanglam-Deothang Road Alignment**

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

Source: The Red Data List of Bhutan

**Table V.6.10: CITES Plants recorded along Nanglam-Deothang Road Alignment**

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

Field survey, November 2011 and June/September 2013

#### d. Forest Management

231. There are basically three types of forest—government owned national forest including Forest Management Units<sup>13</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 mould, and private tree plantation and the private forests are owned and managed by an individual or the household.

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

#### e. Endangered and Protected Flora

233. 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. However, there is possibility of occurring Eagle wood/Indian Aloe wood (*Aquilaria malaccensis*), the totally protected plant species under Schedule I of Forest and Nature Conservation Act 1995 in the project road area.

### 4. Mammals and Birdlife

#### a. Mammals

234. There are about 31 species of wild animals inhabiting the study area particularly the subtropical broad-leaved forest. The Asian elephant (*Elephus maximus*), Gaur (*Bos gaurus*), Himalayan Black Bear (*Selenarctos thibetanus laniger*), Tiger (*Panthera tigris tigris*) and 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 (*Elephus maximus*), Malayan Giant Squirrel (*Ratufa bicolor*), Himalayan Yellow-throated Marten (*Martes flavigula*), Pallas Squirrel (*Callosciurus erythraeus*), Wild Pig (*Sus scrofra*) and Capped langur (*Trachypithecus pileatus*). Fresh foot prints and fresh dungs of Asian Elephant (*Elephus 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.

<sup>13</sup> FMUs are geographic areas of government reserved forests that are scientifically managed for purposes of logging and conservation.

235. 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*).

**Photo V-1: Skeleton Sambar Deer, Duri River**



Field Photo, November 2011

**Photo V-2: Main Salt Lick area at the base of Regi slide**



Field Photo, November 2011

236. 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 V.7.

**Table V.7: 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
1	<i>Elephas maximus</i>	Asian Elephant	Endangered	Totally Protected
2	<i>Bos gaurus</i>	Gaur	Vulnerable	Totally Protected
3	<i>Panthera tigris tigris</i>	Tiger	Endangered	Totally Protected
4	<i>Selenarctos thibetanus laniger</i>	Himalayan Black Bear	Threatened to Endangered	Totally Protected
5	<i>Melursus ursinus</i>	Sloth Bear	Threatened	Protected
6	<i>Panthera pardus</i>	Leopard	Lower Risk	Totally Protected
7	<i>Panthera pardus</i>	Black Panther	Lower Risk	Totally Protected
8	<i>Macaca assamensis</i>	Assamese Macaque	Vulnerable	Common
9	<i>Muntiacus muntjak</i>	Barking Deer	Lower Risk	Common
10	<i>Sus scrofa</i>	Wild Pig	Lower Risk	Common

11	<i>Hystrix indica</i>	Indian Porcupine	Lower Risk	Common
12	<i>Trachypithecus pileatus</i>	Capped Langur	Endangered	Uncommon
13	<i>Cuon alpinus primaevus</i>	Wild Dog/Dhole	Endangered	Uncommon-
14	<i>Vulpes bengalensis</i>	Bengal Fox	Lower Risk	Common
15	<i>Martes flavigula</i>	Himalayan Yellow-Throated Marten	Lower Risk	Common
16	<i>Callosciurus erythraeus</i>	Pallas Squirrel/ Red-bellied Squirrel	Lower Risk	Common
17	<i>Ratufa bicolor</i>	Malayan Giant Squirrel/Black Giant Squirrel	Lower Risk	Common
18	<i>Hystrix brachyura</i>	Himalayan Crestless Porcupine	Lower Risk	Common
19	<i>Manis pentadactyla</i>	Chinese Pangolin	Lower Risk	Totally Protected
20	<i>Cervus unicolor</i>	Sambar	Lower Risk	Common
21	<i>Nemorhaedus goral hodgsonii</i>	Goral	Lower Risk	Common
22	<i>Felis chaus</i>	Jungle Cat	Lower Risk	Common
23	<i>Prionailurus bengalensis/Felis bengalensis</i>	Leopard Cat	Lower Risk	Totally Protected
24	<i>Lepus nigricollis</i>	Blacknaped Hare	Lower Risk	Common
25	<i>Dremomys lokriah</i>	Orange-bellied Squirrel	Lower Risk	Common
26	<i>Callosciurus pygerythrus</i>	Hoary-bellied Squirrel	Lower Risk	Common
27	<i>Paradoxurus hermaphrodites</i>	Common Palm Civet/Toddy Cat	Lower Risk	Common
28	<i>Viverricula indica</i>	Small Indian Civet	Vulnerable	Common -
29	<i>Viverra zibetha</i>	Large Indian Civet	Vulnerable	Common
30	<i>Lutra lutra</i>	Common Otter	Vulnerable	Common
31	<i>Capricornis sumatraensis</i>	Himalayan Serow	Vulnerable	Totally Protected

Source: Field Survey, November 2011 and June/September, 2013

## b. Birdlife

237. 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 V-8 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 V.8: Avifauna in Project Area

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
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</i>	Blue-capped Redstart	Least concern	Rare

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
	<i>coeruleocephalus</i>			
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
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 ruficolis</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 superciliaris</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 flavolivace</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 traillii</i>	Maroon Oriole	Least concern	Common
71	<i>Hierococcyx sparverioides</i>	Large Hawk Cuckoo	Least concern	Common
72	<i>Lophura leucomelanos</i>	Kalij Pheasant	Least concern	Common
73	<i>Gallus gallus</i>	Rred 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 erythrogeus</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 superciliaris</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

Sl. No.	Scientific name	Common Name	IUCN Status	FCNA Status
89	<i>Sturnus contra</i>	Asian Pied Starling	Least concern	Common
90	<i>Cephalopyrus flammiceps</i>	Fire-capped Tit	Least concern	Common

Source: Field Survey, November 2011 and June/September 2013

### c. Aquatic Life

238. 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 (Tort tor) is a totally protected species under schedule I of Forest and Nature Conservation Act of Bhutan, 1995.

239. No past surveys of fish species has been noted for Kirungri, Chowkiri and Duri Rivers. According to local fishermen, there are around 15 different known fish species in the rivers within the project area. The fish species found in the rivers are Schizothorax progastus (Snow trout/Asala/Menjai), Schizothorax spp., Glyptothorax trilineatus (Bayna/Kabre), Labeo spp. (Gardi), Macrornathus aculeatum (Spiny eel), Acrossocheilus hexagonalepsis (Katley), Bagarius bagarius (Cat fish/Gonch), Channa maurilus (Snakehead), Barilins spp. (Fageta), Garra Gotyla gotyla (Buduna/Chinya). Amongst three rivers, Chowkiri River and Duri River are known to harbour most of the fish species, and also locally known as khey-nga, Mong-nga, Bobinang, Merangma-nga, Olongi-nga, Lysae-nga, Roinang-nga, Borka, Tektokpa-nga, Brung-nga, Gongdo-nga, Tshaphalakpa, Bathpala and Phektala nga. Fish population of Duri River and Chowkiri River are almost depleted at the international border due to widespread illegal fishing. There are crabs (Kangkara) and prawns (Chitongompa) in these rivers.

## F. Socio-Economic Environment

### 1. Population, Households and Ethnicity

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

241. The total population of the affected Dzongkhags/districts of Pema Gatshel and Samdrup Jongkhar is 61,083. While the population of affected Geogs/blocks of Norbugang, Chokhorling, Deothang and the municipality of Deothang is 11,323 persons.

242. However, there are 12 main settlements including Nganglam and Deothang 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.9. Sharchhokpa or Tshangla speaking people inhabit the PIA.

**Table V.9: 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>	<i>621</i>	<i>397</i>	<i>1018</i>	<i>179</i>
<b>Chokhorling Geog</b>	<b>1423</b>	<b>957</b>	<b>2380</b>	<b>256</b>

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>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>Deothang 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>Deothang Throm/Town</i>	1377	1267	2644	557

Source: EIA Field Survey, November 2011 and PHCB 2005

## 2. Main Occupation

243. The main occupation of all people residing within the PIA of the proposed road alignment is agriculture and livestock. Most of people within the PIA are involved in agriculture and livestock along with other occupation (Labour and porter, business and commerce). However, agriculture farming is not enough for subsistence level due to small landholding size, limited transportation facilities and difficult access to modern farm inputs, etc. people are carrying out other economic activities like labour and porters, working in government and non government organizations and business.

## 3. Market Centres and Business Facilities

244. Nganglam (takeoff point) and Deothang (termination point) are two main market centres within the PIA having number shops, hotels and even bars. There are very few shops (one in Dezama, two in Chokhorling and three in Chenari) along the proposed alignment. The details of business establishment within the PIA are provided in the table V.10.

**Table V.10: Type and number of business establishment within PIA**

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
Deothang Throm/Town	1	16	25

Source: EIA Field Survey, November 2011

## 4. Local Economy

245. Apart two urban areas of Nganglam and Deothang, the economy of the area are predominantly agriculture (horticulture) based. Local people have been entirely dependent on selling of oranges or mandarins. In the past, people made substantial income through orange export to India and Bangladesh. However, in recent years, orange business fell sharply due to decreasing yields. Orchards have been affected by a plant disease called citrus greening known

to be caused by virus. There are no known effective remedies against such infections except for cutting and burning the infected orange trees. In order to restore the cash income for locals, the government has encouraged people to diversify the farming activities such as high value vegetable cultivations.

246. Due to decreased cash income, local people are forced to increasingly engage in business activities in Nganglam and Deothang area. Permanent to seasonal migration to various parts of Bhutan to earn some money for their livelihood has been reported.

## **5. Farming Pattern and Livestock**

247. The dominant crops in the project area are maize and millet. Major crops that are cultivated in the project area are maize, millet, potato, beans etc. Orange is the major cash crop that is grown in the project area.

248. Due to availability good number of fodder trees, the project area has also good potentiality of jersey farming for dairy production. Poultry farming can also be encouraged due to easy market access.

## **6. Health and Sanitation**

249. Major health problems associated with local people are gastric, water borne diseases, gynaeo 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.

250. As per the PHCB 2005, about 5.8% and 2.9% of the total population of Samdrup Jongkhar and Pema Gatshel 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 Pema Gatshel 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 Deothang does not directly affect any of the disabled households.

## **7. Public Services and Infrastructures**

### **a. Education**

251. The proposed project area consists of a total of 11 educational institutions ranging from primary level to Secondary level. Primary and Community Primary schools are found in all major settlements. In addition, there are 2 higher secondary schools in Nganglam and Deothang settlement. Apart from formal schools, Non-Formal Education Centres (NFEC) is found in all three geogs. Deothang has a tertiary learning institute, the Jigme Namgyal Polytechnic which offers Civil, Electrical and Mechanical engineering courses. Local people have realized the importance of education in their life and most of them send their children to school. However, female enrollment in schools is still lower than that of male students. Literacy rate in the project area has been estimated below 60 percent.

**Table V.11: Educational Facilities**

Sl. No	Institution Type	Norbugang	Chokhorling	Deothang	Total No	Remarks
1	CPS	1	1	-	2	II.
2	PS	-	-	-	-	III.VII.
3	LSS	1	-	1	2	IV.VIII.
4	MSS	-	-	1	1	V.IX.
5	HSS	1	-	1	2	VI.X.
6	NFEC	1	1	1	3	VII.XI.
7	Others	-	-	1	1	Jigme Namgyal Polytechnic, Deothang

Source: EIA Field Survey, November 2011

### b. Health Facility

252. Within the PIA, there is one Hospital (Royal Bhutan Army hospital) at Deothang and 2 Basic Health Units (BHUs) at Nganglam and Chokhorling. The remote areas are served through Out Reach Clinics. There are 4 such clinics in the PIA.

**Table V.12: Health Facilities**

Sl. No	Education Type	Norbugang	Chokhorling	Deothang	Total No	Remarks
1	Hospital	-	-	1	1	Military Hospital
2	Basic Health Unit (BHU)	1	1	-	2	VIII.XII.
3	Out Reach Clinic	1	-	3	4	IX.XIII.

Source: EIA Field Survey, November 2011

### c. Communication

253. 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. There are two post offices (one each in Nganglam and Deothang) and have been serving the local people.

### d. Electricity

254. Almost all settlements within PIA are either electrified or are under process of electrification through national grid transmission line. Solar lighting facilities are widely used in Chokhorling, Yargaywoong and Khalatsho before electricity reached these villages. However, the electricity has been connected to these villages in 2012. The proposed road construction is likely to damage rural electricity supply lines and poles particularly between Nganglam–Yargaywoong.

### e. Water Supply

255. 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.

**f. Irrigation**

256. Irrigation facility is not common within PIA. The only irrigation channel that is found within PIA is in Khalatsho area once used to irrigate paddy fields is now defunct due to damage caused by erosion and landslides. The agriculture activities in the project area hence depend on the rainfall for cropping.

**g. Industries**

257. Apart from Mega Dungsam Cement Project in Nganglam and Bhutan Polymers Limited at Nganglam and Coal Mining at Rishore, Deothang, there are no cottage and 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.

**h. Financial Institution**

258. The branch offices of Bank of Bhutan (BoBL), Royal Insurance Corporation of Bhutan Limited (RICBL), and Bhutan Development Bank Limited (BDBL) are located at Nganglam. Similarly, Deothang has a 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 Deothang.

**i. Land Holding Pattern**

259. The details of land holdings of the affected persons within the PIA shows that about 46% of the population has 1-5 acres of land while 40% falls under 5-10 acres land holding category. Few HHs (13.6%) have less than one acre land. The average land holding for the project area is 5.7 acres.

**j. Settlement, Poverty and Migration**

260. Most of the settlements within PIA of the project are of clustered type due to lack proper inhabitable areas. Housing pattern of these settlements are mostly one or two storied, corrugated galvanized iron (CGI) sheet roofed buildings. Some of them are also thatch roofed buildings. RCC buildings can be found in market centres at Nganglam and Deothang.

**Figure V-12: Bamboo Thatched House at Chokhorling**



**Figure V-13: Two storied House at Chokhorling**



261. The small area estimation of poverty in rural Bhutan, 2010 carried out jointly by World Bank and National Statistical Bureau (NSB) shows high prevalence of poverty (with poverty rate of 20-30%) within the PIA. Amongst the three geogs within the PIA, Deothang geog has the highest rate of 30%. However, in the near future, the poverty incidences may increase amongst the people of Chokhorling Geog due to dying orange orchards and reduced yield. The orange is the main cash crop in the area which is exported to India and Bangladesh earning much needed cash income for the rural households.

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

263. Within the PIA, 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. However, there are only 7 households actually living there. The main reason for out migration is due to human-wildlife conflict (wildlife encroachment and destruction agriculture of fields) and the inaccessibility of the area.

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

264. The following historical and religious sites are within PIA of the proposed project area (within Row and outside the road alignment) as given in Table V.13.



Figure V-14: Meme Lungkhangma Labtsha



Figure V-15: Thujaycholing Lhakhang at Chokhorling



Table V.13: 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	"
Community Lhakhang / Temple	4+000 km	Dezama	No	500 m	"
Lungkhangma Nye	15+800 km	Lungkhangma Labtsha, Yargaywoong	Yes	2m	Lungkhangma literally mean split rock which is considered sacred by locals. People claim to see imprint of Guru Padma Sambhava inside the split rock. No impact is expected.
Thujaycholing Lhakhang/ Temple and Stupa	29+000 km	Chokhorling	Yes	15m	Road construction may affect the foundation of the temple with risk of landslide and slope failure. So need to provide retaining wall and proper drainage to avoid impact on Lhakhang.
Tshampa Chorten (Small stone stupas)	29+200 km	Chokhorling	Yes	10m	No impact to Chortens or stupas
Gyesar Dala Lhakhang	73+000 km	Deothang Town	X-XIV.	3-4m	The boundary of temple is about 3-4 m from the existing road that will

Name		Location	Impact (Yes or No)	Distance from road	Remarks
					upgrade to national highway. Road widening will encroach the temple compound boundary. So need to adjust road alignment to avoid damage
Dantak Memorial Stupa	73+170 km	Deothang Town	Yes	0m	Road construction may damage this memorial stupa. So need to adjust road alignment to avoid damage to stupa.
Gortap Dungkhor Mani (Prayer Wheel)	74+500 km	At the Junction of Samdrup Jongkhar – Trashigang National Highway, Deothang	No	14 m	No impact is expected.

Source: Field Survey, November 2011

#### H. Potential Development Area

265. 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 V.14.

**Table V.14: Development Potential Area**

Sl. No.	Development potential area	Description of potential development
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 – Duiri	Eco-tourism (bird watching, botanical tour)
5	Rishore	Increased Coal Mining Opportunities
6	Deothang	Business Center

Source: Field Survey, November 2011

## VI. ANALYSIS OF ALTERNATIVES

### A. No-Project Alternatives

266. 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.

267. 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.

268. 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.

269. 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.

270. 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

271. 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

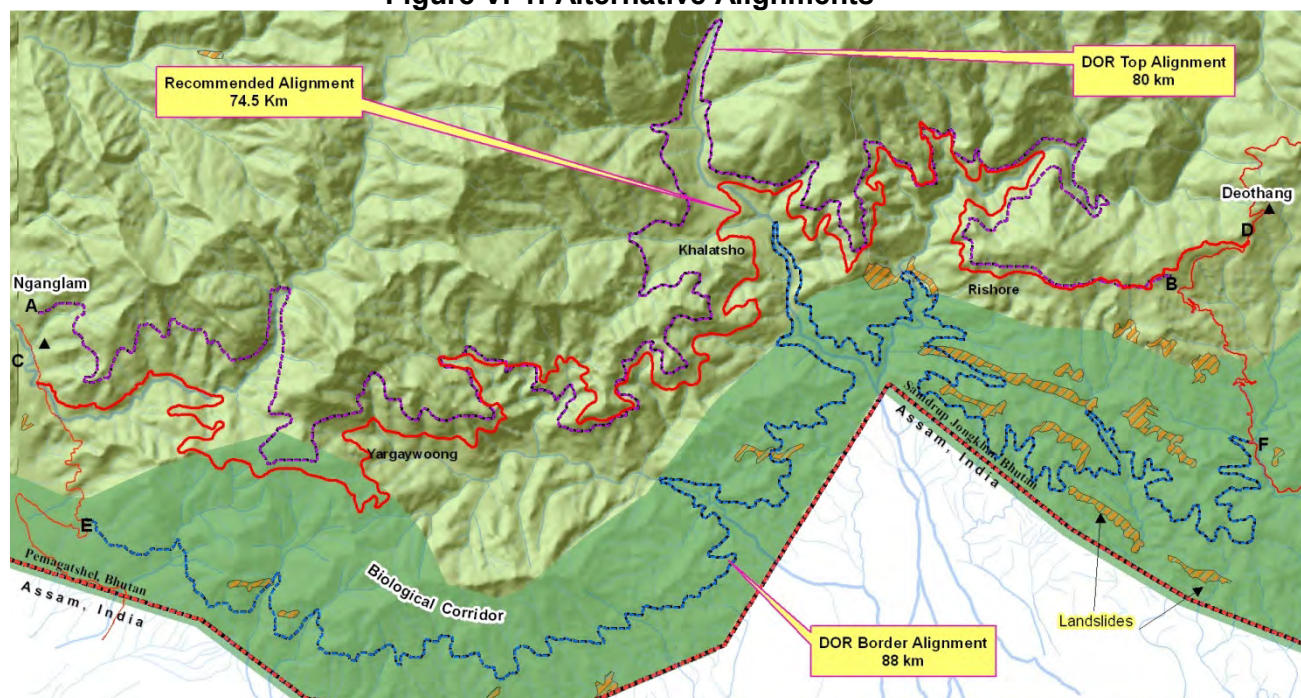
proposed national highway alignment location was found to be practical for contributing to an east-west corridor along the southern boundary of the Country.

### C. Alignment Alternatives

272. 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.

273. The three alternative alignments were assessed as part of the Nganglam-Deothang 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.

**Figure VI-1: Alternative Alignments**



274. On comparison, the alignment CD was found to be best possible alternative alignment option and detailed design carried out due to following reasons:

- It is shortest amongst three proposed alignments.
- Almost 15.0 km existing farm road is to be upgraded with some modification from Nganglam to Yargaywoong. Similarly, almost 5 km of existing road from Rishore to termination point at Deothang will be used and upgraded to national highway.
- Shorter bridge spans are required for this alignment
- Alignment passes through relatively more stable than other two alignments.
- It connects all the major settlements namely; Nganglam, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang.

- Being shortest route, there will be less forest clearance requirement and hence will have least environmental impacts.

275. Hence the alignment CD has been designed for construction and highway development.

#### **D. Technology and Roadway Standards**

276. National road standards set by the DoR will be followed to the maximum possible extent and also modify it in some cases.

277. 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. Application of occupational health and safety guidelines among workers is also a matter of technological choice for which there are associated costs. In general the EIA recommends the adoption of these (and other) principles for environmentally sound roadway construction, but with a degree of flexibility that insures that costs are not compounded excessively. In short, guidelines should be applied with an attitude toward practicality that allows the Project to be implemented efficiently yet with minimal environmental impact. This proposal is similar to cost-effective analysis, in which benefits gained need to be proportional to cost, and where the cost becomes disproportional (e.g. little benefit is gained in the escalation of costs expended); some flexibility in the application of guidelines is allowed. Practical implementation of this provision is the responsibility of the DoR PMO accompanied by the design and construction supervision consultant.

#### **E. Design**

278. 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 made in the engineering interim progress report for installation of safety features. 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.

279. Observations and expert advice indicate that migrating animals, mainly Elephants and Gaurs, travel along ridge tops and also along drainage pathways in search of water and forage. The high bridges and mild slopes proposed in the design are expected to facilitate the passage of animals along the drainage channels.

#### **F. Operation**

280. 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.

281. Access along the Nganglam-Deothang segment 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.

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

282. 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.

283. 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, NOx 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.

### **H. Conclusion**

284. 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 preliminary engineering proposal. Alternatives have been selected that represent environmentally sound engineering judgment in cases where the timing is appropriate to best determine the most appropriate outcome, and in a few instances the selection of an alternative has been postponed until detailed engineering and further public consultation on the issue. 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 proposals, 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.

## VII. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

### A. Introduction

285. This section provides an assessment of the positive negative impacts on the physical 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. The environmental quality of the project site could be affected from project activities during each phase of project development, if environmental management measures are not properly followed.

286. This section discusses the potential environmental impacts of the proposed road construction and identifies mitigation measures to minimize the impacts in the design or pre-construction, construction and operational phases.

287. 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 solid wastes generated during construction and operations; iv) impacts associated with increased road traffic, v) air pollution from dust and emission from equipments and vehicles and vi) Occupational Health and Safety.

### B. Physical Environment

#### 2. Greenhouse Gas Contribution

288. **Construction.** Carbon dioxide emissions stemming from the project originate from a one-time-only contribution from the release of carbon currently sequestered in the forests that are removed to make way for the roadways (approximately 174 acres or about 70 ha) and continuous contributions from the increase in fuel use along roadways. In the latter case, it is difficult to say whether there is an increase since these roads may only be providing alternative routes for vehicles that would be travelling similar, if not longer, routes through India. Some additional contributions come from the operation of equipment during the construction of the roadway.

289. Forests that experience a net loss of biomass volume through mortality due to cutting, disease or fire become net emitters of CO<sub>2</sub>. According to Brown (1988), dry tropical forest averages 27 Mt C/ha in Latin America and Asia and 63 Mt C/ha in Africa. Assuming a figure of 50 Mt C/ha as an average value for the mixed deciduous forests of Bhutan, the amount of CO<sub>2</sub> released 3,500 Mt for the 70 ha of forest lost due to the Project over a three year implementation period, or about 1,166.6Mt/yr. By comparison, the annual emissions of CO<sub>2</sub> for Bhutan (2001) were about 400,000 Mt (Earth Trends), so the project will increase Bhutan's CO<sub>2</sub> contribution by about 0.7% over the three years of implementation. Some re-vegetation is likely following construction, with a positive contribution to carbon sequestration. Historically, Bhutan's CO<sub>2</sub> emissions have been declining, with a 3.5% decline in 2003 over the previous year (Index Mundi).

290. **Operation.** Contributions to greenhouse gases due to the increase in vehicle traffic are not assessed, as there are no firm estimates of future roadway traffic, and in any case, the traffic loads expected on these roadways is small.

### 3. Air Quality

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

292. **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.

293. 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 Deothang settlements will need spraying of water to lessen the dust pollution during construction. Spraying may be done twice daily or at such frequency as is needed to minimize impacts. The contractor should provide near complete coverage of these critical sections. The water can be collected from the nearby streams using tanker.

294. 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.

295. 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 (500 m) from habitations and community environments to assure there are no community impacts. Particularly noisy activities should be conducted during daylight hours if there are communities nearby. Areas where dust accumulates should be watered regularly. Locations for these facilities must be approved by the PMO.

296. 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.

297. **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.

298. Emissions of concern are oxides of nitrogen (NO<sub>x</sub>), particulate matter (PM) and hydrocarbons (HC). Two alternative methods are used for evaluating effects on air quality: a simple box model with an assumed mixing height, and a Gaussian analytical model for an infinite line source.

299. The traffic projections of 10 year intervals have been prepared for the project as part of the PPTA engineering studies which is shown in Table VII-1 along with emission factors



resulting source strength for the target emissions. Emission factors are taken from various sources reflecting a variety of light and heavy duty petrol and diesel vehicles. These emission factors are equal to or more than the Euro 2 automotive emission standards currently in effect in Bhutan for light duty vehicles (CO: 1 gm/km, HC+NO<sub>x</sub>: 0.7 gm/km and PM: 0.08 gm/km) and for heavy duty (HD) diesel engines. The latter values are given in gm/kWh (HC: 1.1, NO<sub>x</sub>: 7.0 and PM: 0.15) and direct conversion is based on the motor efficiency of the vehicle; nevertheless conservative values are used for the emissions from buses and trucks in the table.

**Table VII.1: Traffic Loads, Emission Factors and Source Strength**

	Emission Factors			Vehicle units (8 hr interval)
	NO <sub>x</sub>	PM	HC	
	gm/km			XI.XV.
Cars	2.00	0.08	0.75	299
Buses	25.00	12.00	2.25	215
Trucks	25.00	12.00	3.19	220
Source Strength	428	189	61	(gm/km-hr)

300. For the box model and assuming stable meteorological conditions, wind speed of two m/s and mixing height of 400 m, dispersion downwind of the source reduces ambient concentrations, so that the ambient concentration is assumed to be the source strength completely mixed in a volume of air represented by the mixing height and the wind speed.

301. Estimated ambient concentrations of the project area are given in Table VII-2 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 box-model estimate shows that ambient concentrations of air pollutants are less than ambient criteria set by WHO and NEC.

**Table VII.2: Estimated Ambient Concentrations and Standards (µg/m<sup>3</sup>)**

	NO <sub>x</sub>	PM	HC
Ambient Concentrations	149	66	21
WHO criteria	200-400	150-250	None
NEC criteria (Industrial)	470	300-400	None

302. The Gaussian plume model for an infinite line source emitting at ground level may be used as a check to determine if a different combination of wind speed and mixing height might yield a higher downwind concentration due to vertical mixing. This analytical approach is described by Turner (1970). The combined effects of wind speed and stability may produce maximum concentrations that are not necessarily defined by the stable conditions (E and F types) represented by the box model. The critical wind speed is taken as 4 m/sec under type D overcast skies, at a downwind distance of 300 m. Based on nomographs found in the reference,  $\sigma_z$  (the vertical dispersion factor) is 12 m. Then the values for  $\chi$  (downwind concentration in gm/m<sup>3</sup>) at 300 m downwind distance for the reference pollutants are shown in Table VII-3.

**Table VII.3: Source Strengths and Ambient Concentrations Based on Gaussian Plume Model for a Line Source**

Class D atmospheric condition, 300 m downwind concentration			
	NO <sub>x</sub>	PM	HC
Source Strength (gm/m-sec)	1.19E-04	5.25E-05	1.69E-05
Ambient Concentrations (µg/m <sup>3</sup> )	1.98	0.87	0.28
WHO criteria (µg/m <sup>3</sup> )	200-400	150-250	None
EPA criteria (µg/m <sup>3</sup> )	100	150	None

303. These values likewise 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

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

305. **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.

306. The Road segments through Nganglam (takeoff), Drangnalashing Borang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang settlements are the main areas where construction will be conducted in the near vicinity of communities which will result in some exposure to noise pollutions.

307. 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 VII.5. 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. Noise impacts are an unavoidable consequence of construction that should be mitigated by limiting the times of construction to daylight hours in the vicinity of sensitive receptors.

**Table VII.4: 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)

308. Rock blasting to clear right-of-way is also a noise and safety hazard. Rock blasting will be required for road segments near takeoff (Nganglam town), Yargaywoong Ri, between Yargaywoong and Chokhorling; between Chokhorling and 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 should be carried out during the daytime to prevent disturbance to wildlife during the night, dawn and dusk. The contractor shall employ blasters experienced in controlled blasting recognized by MoAF. 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).

309. **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. Noise levels can be evaluated using a FHWA (US Federal Highway Administration) highway traffic noise prediction nomograph. Because the volume of traffic per hour is minimal, some assumptions must be made to produce a result by this method. The traffic volume shown in the table VII.6 is used for purposes of noise prediction:

**Table VII.5: Traffic Volume Estimation**

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

310. From the FHWA Noise Prediction Nomograph:

Automobiles:	30 dBA
Medium trucks:	25 dBA
Heavy trucks:	20 dBA

311. Computing the total equivalent noise level ( $L_{eq}$ ) for the three vehicle classes using decibel addition and the following equation:

$$L_{eq} = 10 \log (30 + 25 + 20) = 18.7 \text{ dBA}$$

Round off to 19 dBA

312. This level of noise intensity is an insignificant impact even in extraordinarily quiet areas and institutional surroundings.

#### 4. Soils and Tectonics

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

314. **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, EFRC methods to minimize landslides and enable slope stability have been built into the design.

315. In accordance with Environmental Friendly Road Construction (EFRC) guidelines, the cut and fill method requiring balancing of mass must be adopted as far as feasible during the conduction of detailed design works. However, the road construction in the mountainous terrain is highly challenging particularly the safe disposal of construction spoils.

316. 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 may be referred to while proposing bioengineering methods for specific road segments.

317. For areas that are particularly wet or marshy increasing the likelihood of erosion and problems of slope failure both during construction and operation, appropriate drainage structures and mechanisms such as horizontal drains taking into of extreme rainfalls must be recommended during the detailed design works.

318. During the site visits of detailed design consultants (Environment specialist), the sites for carrying out bioengineering and engineering structure have been assessed. The bioengineering methods 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 following locations:

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, 67+500, 69+000, 71+250,	Planting of wildings	<i>Morus laevigata</i>	<i>Tshende</i> (Dz.); <i>Kimbu</i> (Lh.)
		<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.); <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, 71+250, 73+000	Turfing
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, 67+500, 69+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,	Palisades	<i>Justicia adatoda</i>	<i>Khatsirim</i> (Sh.); <i>Thro-Bashaka</i> (Med.)
		<i>Salix sp.</i>	
		<i>Viburnum erubascens</i>	

Chainage	Bioengineering method	Botanical name	Local name
34+000, 60+100, 64+000, 67+500,		<i>Bridelia retusa</i>	Gayo (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, 67+500, 69+000	Seed broadcasting	<i>Eupatorium adenophorum</i> <i>Duabanga grandiflora</i> <i>Artemisia</i>	Banmara (Lh.); Ngon Changlo(Sh) Drangnanglaishing (Sh.); Lampate (Lh.) Titepati (Lh.) Khempa shing (Dz.)
0+850, 12+000, 15+500, 17+500, 28+200, 34+000, 55+250, 64+000,	Brush Layering	<i>Callicarpa arborea</i>	Khalema (Kh.); Guinle (Lh.); Thulushing (Sh.)
12+000, 28+100, 71+250, 73+000	Turfing	<i>Dendrocalamus hamiltonii</i>	Bans (Lh.)
25+000, 28+120, 29+200, 73+000	Planting of slip	<i>Thyssonolaena maxima</i>	Tsakusha; Beshawi (Sh.)

319. **Construction.** The roads will mostly be cut into the side slopes of mountains ranging from 35°C to 80°C; 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 must 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 should 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, 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, 67+500 and 69+000. Down slopes must also be stabilized but to a lesser extent; here the greater problem is with rubble loosed from above that is lost down the mountainside and may be mobilized by rainfall or from earth movements.

320. Though erosion, rock falls, are unavoidable during cutting works, and would fall downstream and forests and damage vegetation, harm wild animals and aquatic fauna and cause siltation to rivers and small streams. It would also fall to the settlements of Drangnalashing Borang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari villages below and damage the houses, farmlands and risk to the local communities. So appropriate methods of excavation and benching, i.e. log barrier, boulder barrier, etc, should be recommended during the detailed design and must be followed to minimize these impacts on flora, fauna and water bodies and to lives and properties of communities.

321. Use of borrow areas where necessary will result in formation of open pits. This can lead to issues of erosion. Hence, after use all borrow areas must 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.

322. Quarries located at too great a distance from the work zone involve hauling that creates air pollution impacts and degrades existing roadway surfaces. 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.

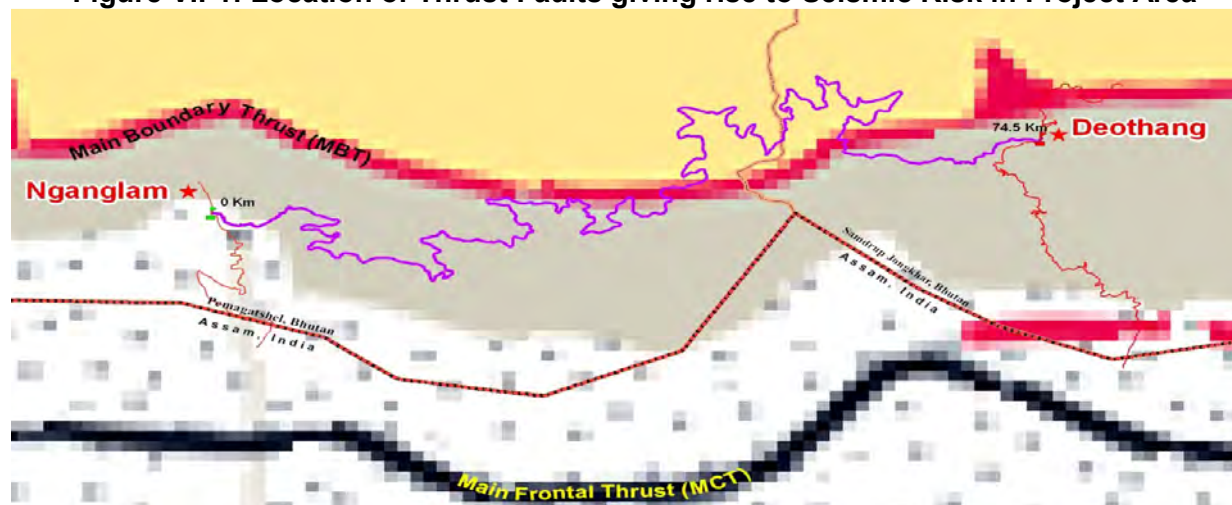
323. The need for quarries should be minimized by use of materials cut from the roadway alignment. In the event that quarries are required in a particular area, the detailed design consultant should identify locations in advance and confirm those locations with the selected construction contractor. A development plan should be prepared by the contractor that estimates approximate quantities and final contours. Blasting procedures should be put into place for the development of quarries. Necessary government clearances for land and resource use should be obtained by the contractor prior to commencement of work in the area.

324. **Operations.** Instabilities and landslides will be major concern along the proposed road, therefore, the detailed design and subsequent construction will adopt of proper methods and techniques for excavation and earth works with provision of adequate support and drainage structures, as there may be problems of erosion and landslides during operation. Under such circumstances, necessary engineering and bioengineering measures will need to be taken to help stabilize slopes. In addition maintenance engineers should develop and apply means for predicting slope failures in advance and buttress slopes where necessary.

325. Soils also affect roadway durability and life. Slumping of the roadbed is known to occur in locations throughout the Country, a problem that can be relieved to some extent with horizontal drains across the sub-grade to relieve pore water and increase soil stability. This is an engineering solution that may be applicable where there is excessive soil moisture and underground seeps. It is applied experimentally and can be attempted provisionally in some locations along all roads.

326. 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.

**Figure VII-1: Location of Thrust Faults giving rise to Seismic Risk in Project Area**

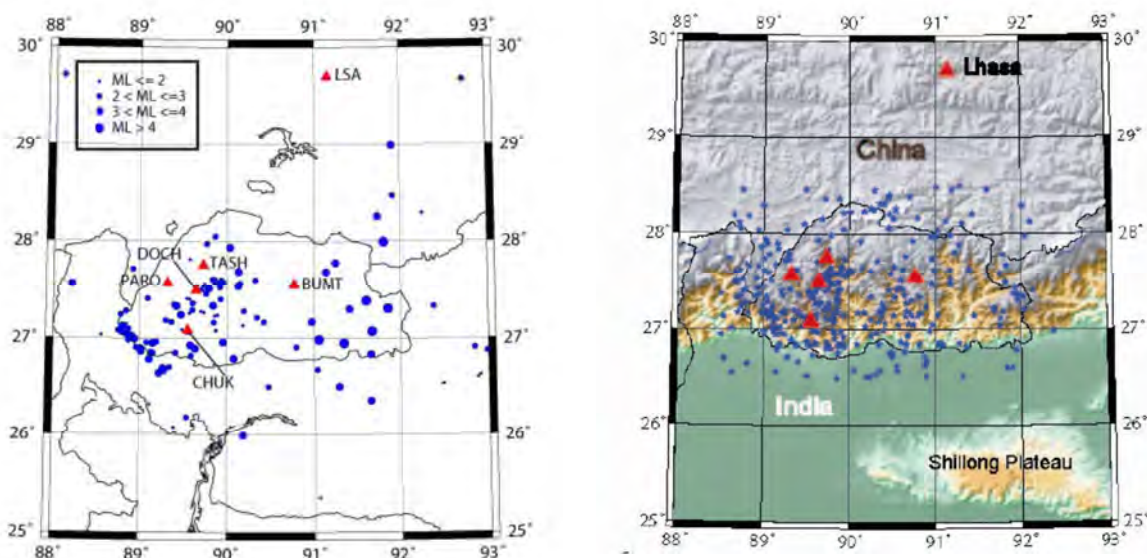


327. Over the long term, seismic events may cause damage to the roadway and adjacent property, and result in loss of life. The risk of earthquake is ever-present in Bhutan and criteria must be applied to determine whether a given location is acceptable. The road segment is located close to major fault zone, a main boundary thrust fault as shown figure VII-1.

328. Seismic risk is said to be greater in the eastern side of the Country, and perhaps greater toward the south, even though actual recorded events are more populated toward the west (though still to the south, see Figure VII-2).

329. In summary there is a high but uneven seismic risk related to the location of the roads. Any east-west trending road system in the south part of the Country is exposed to this risk to a greater extent than would be a road system running from north to south, because longer sections of roadway are in close proximity to major faults.

**Figure VII-2: Seismic Event Record for Bhutan**  
(left: Gee, 2004; right: Univ. of Texas El Paso) from Tobgay, undated



330. Seismic 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).

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

332. Earthquake risk is incorporated into the preliminary 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 Mizoram State Roads project a location with similar geotechnical conditions.

## 5. Water Resources and Water Quality

333. 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. In turn, construction activities may interfere with access to water supplies and roadway hydraulic structures may be inadequate to assure serviceability and supply of water for household and irrigation. Flow of water mobilizes sediment that can degrade water quality and potentially damage adjacent land. 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.

334. **Detailed Design.** Roadside drainage in community areas should receive particular attention by the detailed design team to assure that the roadway surface does not concentrate rainfall and cause damage to local properties. Engineering and hydrological criteria have been applied in the design of drainage structures.

335. Where longitudinal roadside drainage is undersized, water is diverted insufficiently, and flooding undercuts the roadway surface over time, causing breakup of the pavement and edge fraying, a safety hazard and eventual failure of the road surface. In order to avoid this condition, the roadway design engineer has designed roadside drainage structures with sufficient discharge capacity.

336. Insufficient roadside drainage, particularly along the settlements of Nganglam, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang may lead to flooding and damage to adjacent properties and to road itself. Fully lined drains (V-shaped drain is found not suitable in high rainfall) with intermittent relief humepipe cross drains have been proposed (cross drains will be terminated to the natural gullies or streams) for the road sections.

337. Extreme meteorological conditions and other environmental factors as result of climate change can exceed the capacity of drainage structures, erode slopes and destroy pavement structures. The detailed design engineers have incorporated the following climate change adaptation measures:

- Nganglam-Deothang road falls under hot subtropical Southern Bhutan where annual maximum summer temperature can go above 30°C for altitudes between 500-1000m and above 40°C for altitude less than 500m with climate change. High temperatures are likely to cause bleeding, rutting and segregation leading to pavement failure. Pavement Design Manual of June 2005 has stringent requirements for pavement design and construction which if followed will be able to address most of the concerns of impacts of extreme temperature rise. Therefore, the SASEC Design Team in consultation with the DoR pavement experts shall strictly follow the Design Manual for SASEC road pavement design. Grade(s) of asphalt cement mix used in hot-mix paving should be selected based on climatic conditions and past performances, i.e. 80/100 Bitumen type used for hotter areas so that mix should not or be displaced when subject to traffic loads more so at high temperature.



- Nganglam-Deothang 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 lead to blockage of surface drains and damage the pavement surfaces. To prevent water logging and damage of pavement surfaces, the Detailed Design team shall design proper cross-fall as per the Standard Road Survey and Design Manual for subsequent implementation by the contractors. The Detailed Design team shall use sheet flow or discharge estimation methods provided in the hydrological study to calculate the flow required for designing the side drain. U-drain shall be considered in critical sections along Nganglam-Deothang road between Km 3-13, where the road passes Dezama and winds on the slopes of Shuguri on the left bank of Kirungri river.
- Regular thermal expansion and contraction has significant impact on bridge structure along Nganglam-Deothang road. The increase in frequency, intensity and duration of heat waves brought about by climate change will have further impact on bridge structures. Detailed design team shall look into the all bridge construction materials and propose the suitable ones for SASEC bridges design and construction. Since the bridge span for Nganglam-Deothang road is between 40-50m, the detailed design team proposes concrete bridges. However, the design engineer shall employ suitable bridge design model which takes into account of future extreme temperature rises. The detailed design team shall refer the future extreme temperature data provided in section 4.4.1 of Climate Change Adaptation report or the hydrological study report for more details. Frequencies of bridge inspection and maintenance shall be increased in anticipation of severity of the impacts of extreme temperatures on the bridges.
- Hydrological study reveals that major bridges of Nganglam-Deothang road over Kirungri, Tshokhiri/Chowkiri and Duri Rivers will be less likely to be affected by climate change triggered extreme flooding due to geomorphological advantages of bridge locations. Only smaller stream with flatter stream beds are likely to be affected of flashfloods. Therefore, the detailed design team shall use 50 Year ARI (storm return period) as recommended by the hydrological study for bridge designing. Locations of bridges (over Kirungri and Duri Rivers) under Nganglam-Deothang road are supposedly located above High Flood Level (HFL). The detailed design team shall ensure that any changes in bridge locations during the course of detailed design phase are located safely above the HFL. For long term, the DoR will have to institute and build GIS capabilities for mapping flood prone areas which is critical for study of bridge locations. Frequencies of bridge inspection and maintenance shall be increased in anticipation of severity of the impacts of extreme flooding on the bridge structures.
- Road damage by surface water is expected to increase in the future as consequences of predicted increase in general rainfall, and more frequent heavy storm events. RNP II PPTA study has found out that L-drain (most commonly constructed drain) and Humepipe crossings are inadequate to meet the extreme weather conditions of Southern Bhutan which applies for Nganglam-Deothang road. The Detailed Design team shall use sheet flow or discharge estimation methods provided in the hydrological study to calculate the flow required for designing the side drain. U-drain shall be considered in critical sections along Nganglam-Deothang road between Km 3-13, where the road passes Dezama and winds on the slopes of Shuguri on the left bank of Kirungri river. The detailed design team shall review the existing cross drainage design pattern using

Hume pipe in relation to extreme precipitation leading flooding. The 50 Year ARI (storm return period) as recommended by the hydrological study for bridge and culvert design has to be used. Wherever necessary the design and construction of Box culverts has to be initiated in anticipation of future extreme weather conditions. Frequencies of drainage inspection and maintenance shall be increased in anticipation of severity of the impacts due to extreme precipitation on the road infrastructures.

- 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 field verification shows the presence of number of landslide or slope failure vulnerable areas which could be triggered by extreme precipitations as result of climate change. Although RNP II AF PPTA feasibility maps indicate the vulnerable areas, the detailed design team should carry detailed study and mapping of the vulnerable areas. Regi slide between Km 49-50 needs to be avoided to maximum and the detailed design team shall study thoroughly for possibility of having alternative route. EFRC structures such as gabion walls, pineapple walls, check dams, etc. along with bioengineering which could be adopted as climate change adaptation measures with little or no additional costs for slope protections. Application or right EFRC structures at right place which are specific to site conditions are utmost importance for effective slope protection.

338. **Construction.** Recommended designs and structures proposed by the detailed design consultant must be implemented during the construction stage to mitigate potential impacts on water resources during construction. Specifically, the contractor should implement water and slope management (construction of lined U-Drain and laying of Hume pipes to prevent flooding and erosion) particularly for the road section that passes through the settlements of Nganglam, Drangnalashingborang, Dezama, Shuguri, Yargaywoong, Chokhorling, Khalatsho, Rishore, Chenari and Deothang.

339. 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 should be stopped in rainy days.

340. Temporary measures to reduce erosion involve placement of log barriers 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.

341. Long term mitigation involves application of bioengineering techniques such as seeding and stabilizing slopes, in order to reduce sediment loss. Costs for sediment control during construction should be incorporated into the preliminary budget estimate and incorporated into the contract bid.

342. 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.

343. **Operations.** It is imperative to implement the mitigation measures proposed during the detailed design stage while constructing the respective road segments. This will help to minimize negative impacts on the water resources during operation of the road segments.

344. However, given the high rainfall, existence of number streams in the project area as well as existence of local water supply facilities, problems may arise during operation of the road. Necessary mitigation measures will need to be taken by the beneficiary.

345. Also, plugging of culverts can occur due to debris swept down from mountain side during heavy downpours, resulting in unwanted canalization and damage to the roadway. Wherever critical, upstream check dams may be installed to arrest the flow of debris down the channel. Also, maintenance of culverts over the operating life of the roadway is important. Beneficiaries should remove debris that interferes with the flow in culverts.

346. Scouring of roadway embankments that run parallel to rivers and streams can undermine and destroy sections of the roadway, and release of sediment from scouring affects water quality.

## **C. Biological Environment**

### **1. Forests**

347. 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 Figures V-II.

348. **Detailed Design and Pre-Construction.** Necessary actions such as tree marking must be carried out in accordance with the forestry rules before felling of trees for the project roads. All paperwork and approvals must be obtained well ahead in time to prevent delays in construction.

349. Clearing marketable timber prior to construction should 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 should 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 (DoFPS 2006). In locations where there is financial justification, the marketable timber should be handed over to Natural Resources Development Corporation Limited (NRDCL), the authorized Government Agency, prior to mobilizing construction in a given area.

350. Right-of-ways should be clearly marked to avoid removal of vegetation unnecessarily.

351. To prevent disposal of spoil materials on the lower slope below the roadway grade and hence destruction of forests and vegetation preliminary locations for deposit of spoil materials must be identified by the detailed design team to be confirmed by the construction supervision consultant.

352. Construction. A total of about 174 acres of forest will be displaced for the project roads out of a total land area of about 276 acres of cleared area (see Table V-5). As per Land Cover and Area Statistic 1997 of MoAF, Pema Gatsel 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.

353. 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 should be 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 should be handed over to Natural Resources Development Corporation Limited for extracting prime logs and disposal of logs in local markets through auction.

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

355. 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 should be demarcated before clearing begins, and the DoFPS should clearly mark and delineate trees requiring removal, as is their current practice. Re-vegetation (using species mentioned in the appendix F) of the fresh cut slopes and road shoulders must 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 can be carried out in suitable spaces particularly at Drangnalashing Borang and Chokhorling watershed areas. Any organized removal of trees from public lands outside the boundary of the construction area should be punishable as a criminal offense.

356. 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 PMO supervisor. Disposal of spoil materials and any other forms of construction debris over the edge of the hillside is prohibited, and spoil materials are to be disposed off at designated locations, which will be 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.

357. 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, plants listed in Schedule I of FNCA 1995 (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*). 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 PMO will instruct contractors to prohibit workers from destruction of rare, threatened and endangered floral species. The PMO will inform the concerned agencies to rescue plants listed in Schedule I of FNCA 1995 (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*) if found on the Right of way during road construction. The protected plant species should be rescued and relocated in compensatory plantation in barren forestland since it may not survive in Royal Botanical garden located at high altitude in Thimphu and technical advice may be sought from local forestry officials. 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 should be made aware to the worker population. The contractor should provide construction camps with food supplies from purchased stores, and to maintain a canteen for workers or cooking in groups. The contractor should supply cooking fuels/gas to construction workers to refrain them from using fuel wood for cooking and warming purposes. However if 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.

358. 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 should 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.

359. 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 should dispose of all spoil materials in designated spoil disposal locations identified by the detail design consultant and verified by the PMO.

360. 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 in and around the stone crushing machinery will be necessary.

361. **Operation.** Since the traffic volumes anticipated in the project road segments, impacts of pollution on the forests will be negligible.

362. Bioengineering and re-vegetation activities 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.

## 2. Wildlife

363. **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. Alignments for new roadways 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.

364. The main wildlife species that migrate extensively and so are potentially affected by the presence of roadways are the Asian Elephant, Gaur and Tiger. The proposed road segment is populated with Elephants that migrate between the wildlife reserve across the Indian border, a few km south of the proposed roadway, and catchments at higher elevations to the north. The joint field survey with the representative of DoFPS has revealed that the forest between Khalatsho settlement (or Chowkiri River) and Duri River is widely used by elephant for seasonal migration to north. The Regi landslide which is located within this forest area has the salt lick site which attracts variety of animals in regularly for mineral intake. The road alignment during the detailed design bypassed the Regi landslide by taking the road alignment from the saddle located at the top of the Regi landslide which has avoided the disturbance and permanent damage to the salt lick area located at the base of the landslide. The appropriate mitigation measures such as overpass or underpass for wild animals to safely move, mild roadside slopes and corridor wide enough for wild animals to easily move and proper signages to avoid road accidents and vehicle-animal collision and fences, etc shall be incorporated into the road design. The terrain through this area is easily traversed by Elephants and Gaurs. Movements may be along river and stream channels, in which case road crossings have been designed over high bridges to allow for the passage of animals beneath the bridge structure.

365. The road alignment falls north of biological corridor and passing through 2 Km biological corridor between 13-15 Km. The road passes through existing farm road for 2.0 Km stretch, so no new roadway cutting except widening of existing farm road. DoR should mention 2 Km road passing from chainage Km 13-15 through biological corridor in existing farm road while processing for forestry clearance from DoFPS. DoFPS shall prescribe guidelines with specific terms and conditions for biological corridor to protect biological corridor in forestry clearance.

366. Specific migratory pathways have been proposed to facilitate the movements of elephants and gaur. Some of these measures considered during the design include:

- Variable terrain conditions: to the extent possible, the road corridor have been widened and slopes made milder in order to provide opportunities for passage that wildlife can take advantage of in their movements.
- Minimize obstructions: Use of guardrails have been minimized in areas where animal movements are vital.
- During the construction phase approaches to the road from existing wildlife migratory route should be provided through smooth slope. This will facilitate movement of Elephant and Gaur from hillside and valley side properly.
- The unearthed soil shall not block the migratory routes of wild animals and clear the route and build steps on roadside slopes and maintain it natural to allow easy wildlife movement. Appropriate barriers such as fences should be built in steep road cutting to prevent wild animals to pass through such terrain/slope to avoid falling and death and prevent vehicle-animal collusion.
- Sign boards: Signages such as indicating "Wild Animal Crossing-2 Km Ahead" and that the particular road segment is a high animal population zone and/or migratory path of respective wildlife species must be posted at appropriate locations. They must also indicate regulatory signboards such as "No Horn for next 5 Km", "Low Beam for next 5 Km" and "Strictly no Feeding of Wild Animals" that vehicles must slow down, not honk or carry out any activities that will disturb

wildlife. It is also recommended to place signboard in Elephant and Gaur corridor “Drive Slow, Elephants and Gaurs Have Right of Way and Do Not Obstruct” to allow them to pass through the road. Even, measures such as “Speed Limit 10 Km per hour” and speed breakers shall be placed to slow down high speed vehicles for safe passage of wildlife and to avoid accidents on the road crossing wildlife migratory paths.

367. The environment specialist carried out detailed alignment inspection to identify specific locations of migratory paths and local diurnal access to feeding/grazing and watering. The detailed design environment specialist also consulted a wildlife specialist from the Department of Forest and Park Services, who is capable of identifying these key areas where movement of animals across the roadway can and should be facilitated. The specialist advised on practical means for diminishing the impact in sensitive areas, to include where signboards should best be posted to notify travelers to avoid disturbance of wildlife.

368. It is recommended to restrict construction activities from 8.00 a.m. to 5.00 p.m. upon consultation with the PMO in order not to disturb seasonal migration activities of wildlife.

369. Roads inside important wildlife habitat should be constructed with kerbs on both sides of the paved width to prevent vehicle parking except for areas where village communities are located. Placement of pull-outs should be limited to those areas where pull-outs are needed for reasons of driving safety.

370. **Construction.** Part of the project road fall inside the habitat of important wildlife species. The proposed road alignment has bypassed the Regi landslide by passing through the saddle at the top of the Regi landslide to reduce disturbance and permanently damaging salt lick area located at the base of the landslide. The various appropriate mitigation measures such as underpass or overpass (create vegetative covers to mimic natural environment for use by wild animals) for wild animals to safely move, make wide corridor, slopes wider and gentle and steps on roadside slopes for wild animals to easily climb up and fences on kerbs and steep slopes to minimize animal death by fall and vehicle-wildlife collision, incorporated in the design should be implemented.

371. Construction activities during early morning or late evening hours will result in disturbances to wildlife. So the construction working time must be limited to day light hours only preferably between 8.00 a.m to 5.00 p.m. Special precautions must be taken during conduction of noisy activities such as blasting, drilling and operation of stone crushing machinery. Controlled silent blasting must be carried out as far as possible if blasting works are necessary.

372. Construction workers may hunt, fish or carry out other activities that will negatively impact wildlife. The contractor should clearly brief the construction workers on strict forestry rules on illegal harvesting of forest products, poaching of wildlife and illegal fishing. To remove all possible reasons that may encourage workers to take up these activities, the contractor must ensure that necessary food items, cooking fuel and proper housing is provided.

373. **Operation.** Access to conservation areas or critical 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 should be facilitated.

374. However, in longer run it is expected that benefits from the roads for conservation will outweigh impacts so long as the roads are integrated into the Forest Management Plans. In forest areas under supervision by the Department of Forests and Park services, the same mitigation measures should apply to limit access to the forest and reduce the potential for wildlife poaching.

375. 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, there should be signages warning motorists in areas where there is wildlife crossing the roadways and even place vehicle slowing measures.

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

376. 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 174 acres, or about 0.027 of the forested area in the project area. 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 quarry locations are potentially-forested areas, as the mitigation measures prohibit use of forested areas for other construction-related purposes. 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 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.
- Roads interfere with animal movements and vehicle collisions with animals increase mortality. These impacts have been assessed elsewhere and are judged to be significant but of a minor order of magnitude in respect to the amount of resource being affected. Vehicle collision with wild animals is judged to be insignificant overall. Interference with animal movements, while significant, is judged to be minor, given mitigation measures that have been proposed and in respect to the absolute amount of the resource affected.



- 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
Accelerated land use changes near roadways:	minor
Overall impact:	minor

## D. Socioeconomic Environment

### 1. Land Tenure

377. **Pre-construction.** Due to outmigration, ban of shifting cultivation (Tseri) and lack of accessibility, much of the land in the project area has gone fallow. Clearing of land for new right-of-ways improves access, increases value of land, and leads to conflicting land claims amongst the kin and the kiths. Land titles and boundaries may be challenged within local power hierarchies, with particular impacts on vulnerable groups and livelihoods. A significant impact can result from the placement of the roadway that requires specific mitigation actions.

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

379. Land surveys in the area of roadways should be reviewed to assure they are complete. Types of land ownership adjacent to or accessible from roadways should be loosely classified as public or private before or during initial ROW surveys.

380. **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.

### 2. Labour Rights during Construction

381. **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.

382. The contractor should provide labourers and others resident at the site lodging in a camp setting outside of any danger zone, canteen or group cooking, safe drinking water, adequate washing and bathing facilities for maintaining personal hygiene, 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.

383. 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 should 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. Guidance for the program can be found in the previously referenced Government Rules and Regulations.

384. The location and maintenance of construction camps may interfere with the normal life of nearby communities. 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 should be used for locations of construction and worker camps. The contractor should 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 should provide for collection, burning and burial of rubbish at controlled sites away from human habitation.

385. Construction workers may introduce the threat of HIV/AIDS and other sexually transmitted diseases (STDs) and other diseases. The contractor and PMO should 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**

386. 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. Flagmen should be posted to regulate passage of people where slopes are temporarily unstable as a result of blasting and excavation, and the movement of people restricted in those areas until they are rendered safe.

387. Construction activity where it occurs near businesses and in community areas blocks access, disturbs the daily life of the community and produces noise, dust and congestion. The contractor should select haul routes for materials and equipment to bypass community areas, and regularly water construction zones and haul roads where these pass through or are located in communities, or are in use by the public. The contractor should operate vehicles during restricted hours in village limits, and rapidly clean up roadway debris during construction.

Segments passing through populated areas should be completed over short stretches before opening up new lengths to construction. Contractor will be responsible to rectify any damages including to road and other infrastructures along the haulage routes as a result of movement of haulage vehicles.

388. Various types of private property infrastructure have been noted in the field surveys that are in the alignment of roadway. This infrastructure will need to be relocated and compensated as per ADB's safeguard policy if damaged, or maintained without damage during construction. There are other locations where similar impacts may occur, and the mitigation measures proposed there should be applied universally. Descriptions of the types of impact are provided in the subsequent paragraphs.

389. Community water supply systems at locations along specific roadways can be put out of commission during construction, disadvantaging local people. There are no irrigation schemes within the PIA except for defunct irrigation canal at Khalatsho area. There will be no impact on the irrigation scheme. Damages will occur to water intake and pipelines of drinking water supply of Drangnalashingborang, Dezama, Shuguri, Chokhorling, Khalatsho, Rishore and Deothang communities. Road construction upstream will cut off the seepage of water downstream that Chokhorling communities drink during dry season. Small diameter pipelines and spring water from takeoff till termination point that are used for local water supply may be disabled or disturbed during construction leaving households with no alternative water supply and any damages to the water source and other infrastructures can lead to shortages of water. Siltation of the stream may occur from spillage of debris and spoils from construction. Water supplies need to be maintained during the rehabilitation of roadways. Prior to start of works, the project must discuss with the local administration and the affected people on its relocation of the reservoirs, tanks above the road and pipelines. A plan with necessary design features should be devised to assure these water sources are maintained during construction and left in as good or better condition after construction is complete. Remove all the excavated debris from and near water source and dump in pre-identified dumpsites to avoid siltation and damage to community drinking water source. Construct stone and log barriers to stop spillage of excavated spoils downstream to prevent siltation and carry out bioengineering plantation to conserve water source and prevent from drying. The design consultant should include necessary protection measures and the supervision consultant should ensure that the water sources are maintained. The details of water supply infrastructures are provided in table VII.7.

**Table VII.6: 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

Sl. No	(Km)	Water Infrastructures	Impact
6	28+500 – 29+500	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 collection tanks	Road through Khalatsho area may damage water source and collection tanks during road construction.
8	70+000 – 72+200	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 Deothang Polytechnic Water supply is shared with the community.
9	72+500 – 73+500	Water supply pipelines	There are number of water supply pipelines that run parallel to existing road. Important water supply lines are that of Deothang 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 Deothang Primary, Polytechnic and the hospital.
10	73+700 – 74+000	Water supply pipelines	Water supply pipeline for Deothang

Source: Field Survey, November 2011

390. 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 adjacent and along the project road alignment at various locations in the Right of Way along the Dezama and Rishore - Deothang road section at chainages 0+100, 2+350, 4+100, 29+000, 70+420, 71+290, 71+390, 71+900, 71+950, 72+550, 72+580, 73+060, 73+110, 73+230, 73+280, 73+310, 73+430, 73+440, 73+450, 73+470, 73+500, 73+700,. Road widening and construction works must be carried out with utmost care to avoid the damage of electric poles and its support wires. Avoid excessive excavation uphill side to avoid damages to some of the electricity poles located on the uphill side of the road. Avoid dumping spoil towards electric pole location (downhill side). If damages are unavoidable, then the poles have to be relocated to safer place in coordination with BPCL with prior information to the affected people. Some poles will require support walls to protect from damage. There is likely chance of damage of 2 electricity transformers at chainage km 73+200. 2 transformers will require construction walls to support from damage and shift road alignment towards Forest Beat office to avoid damage to transformers. If relocations are required, it has to be carried out done in consultation with Bhutan Power Corporation Limited (BPCL) and the affected communities. Telephone poles and lines that are close to road alignment may be disrupted.

391. 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. If relocations and protection are required, it has to be carried out in consultation with Bhutan Telecom Limited (BTL).

392. The road alignment crosses a number of existing footpath or mule tracks at Shuguri, Lungkhangma Labtsha, Chokhorling, Khalatsho and Rishore. Passage (foot and mule trails) may be impaired for people with no alternative path of access to homes, schools and public facilities. Along road sections at Shuguri, Lungkhangma Labtsha, Khalatsho and Rishore area will occupy existing footpaths and foot/mule trails that are the only access available for local people currently. During road construction and widening works, there are likely chances of damaging or blocking of the footpath or mule tracks. The proposed road cross footpath or mule tracks at Chainages Km12+000, 16+000, 28+750, 40+000 and 70+000. During the construction, project should make arrangement for temporary access/passage for travelers in consultation with Geog officials and local people. Upon the completion of works, the project shall fully reinstate the footpath or mule tracks.

#### 4. Spiritual and Religious Sites and Archeological Remains

393. **Construction.** In the process of construction, damage can occur to religious monuments and archaeological monuments and unearthed evidence. There has been no indication that any archaeological remains exist in the project area, still, in the event any are uncovered, the contractor should halt construction upon their discovery and notify the PMO 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.

394. However, there are few Spiritual 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 fall within right of ways.

395. During excavation, there is risk of slides and slope failures which can undermine the stability of the Chokhorling Lhakhang. The access to the Lhakhang by the community will be hindered during construction as the road formation cutting will block the footpath from village to Lhakhang. The excavation works of road construction should be carried out in a controlled manner and the slopes must be protected by constructing masonry retaining walls at right side and left side and proper drainage. All the spoils must be transported to the pre-identified disposal sites and carry out bioengineering plantation above the walls to protect from landslide. Temporary access to the Lhakhang must be provided during construction while permanent access should be provided before handing over of works by contractor.

396. The road cutting that will be carried out below the Lungkhangma Labtsha and will need to be protected during the construction. The retaining wall may need to be constructed uphill to protect the Nye. All the spoils must be transported to the pre-identified disposal sites and carry out bioengineering plantation below the wall to protect from landslide.

397. Road construction may damage Big Boulder believed to possess Lu (Snake Goddess) by local people and dry up the water source below the road at Chenari Karphu. Destruction of big Rock will annoy Lu and bring disease to the local people. Big Boulder needs to be protected and carry out road construction on both sides of the road to save the Big Boulder and do not blast the Big Boulder. All the spoils must be transported to the pre-identified disposal sites and carry out bioengineering plantation below the wall to protect from landslide.

398. Road construction may damage Chenari Phodrang (Nyepo) who is believed to protect people of Chenari from natural calamities, disease and famine and. Stream is water source of Chenari people. Chenari Phodrang (Nyepo) needs to be protected by constructing wall above the road and do not blast the Rock. All the spoils must be transported to the pre-identified disposal sites and carry out bioengineering plantation above the road to protect it from landslide.

## 5. Long Term Use of Roadway

399. **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.

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

401. There is a possibility that agricultural land will be converted to other land uses. But this is unlikely to occur. As mentioned earlier much agricultural land has been allowed to go fallow in areas along the proposed road. Horticultural cropping thrives in other areas but with severe market impediments due to lack of access. Finally the government has a policy that limits the development of settlements in areas with agricultural potential. The likely scenario in the wake of roadway development through agricultural areas is for fallow lands to be brought back into cultivation, followed by crop intensification. Conversion of agricultural land to different land uses is unlikely because there is little economic incentive for it and because there is government restrictions prohibiting land conversion. Agriculture will remain the most viable form of income earning activity in the area, and the presence of roads will support the activity.

402. 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.

## VIII. ECONOMIC ASSESSMENT

403. 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 there, 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.

404. 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.

405. 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.

406. 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

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

408. 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.

409. 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.

410. 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.

411. 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.

412. 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.

413. 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**

414. 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.



415. 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.

416. The estimated economic value due to loss of forest cover during the construction phase is nil. Even though 174 acres or 70 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 70 ha of forest lost due to the project of Nu 443,520. If \$3/Mt-C is used, the value is Nu 742,000.

417. 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.

418. 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**

419. 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). Tables VIII.1 summarize information gained during the field assessment of social impacts regarding resettlement/relocation, land acquisition and damage compensation. The table 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 VIII.1: Summary of Resettlement, Relocation and Compensation**

Lands	Affected land (acres)	Dry land (acres)	Cash crop land (acres)	Affected household	Displaced person	Options	Total cost estimates (Nu)	Impact
	69.71	56.15	13.56	140	700	87% land for land, 13 % cash for land	396,619.65	Significant as 200 or more people will experience major impacts
Structures	Permanent structures: 17 nos., Semi-permanent structures: 5 nos., Temporary structures (poultry shed, stores, garage, cowshed, milk collection center, small shop, toilets): 22 nos., Others (barbed fence, staircase, gate, retaining wall): 25 numbers						20,382,815.72	
	Water tanks: 14 nos. ,Water taps: 8 nos.						274,689.25	
Fruit trees	Oranges: 1770 trees, Areca nut: 112 trees, Banana: 224 nos., Bamboo: 3137 trees, Others (fodder trees, pomelo, mango, peach, guava, coconut and litchi).						5,456,537.00	
Vulnerable group	Women headed households: 27 HHs. <b>Assistance recommended:</b> proposed Nu. 150/day/household for 3 months.						364,500.00	
Total cost estimates							29,514,92625	

Source: Resettlement Census Survey, November 2011

#### D. Physical Cultural Resources

420. 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.

421. 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 VIII.2: 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 (174 acres or 70ha)	443,520.00	
	Loss of Carbon fixation value	742,000.00	
Socio-Economic	Loss of private properties such as land, structures and private plantations	29,514,926.25	Adapted from Resettlement Planning document
<b>Total Economic Impact value (Nu.)</b>		<b>31,250,446.25</b>	

## IX. ENVIRONMENTAL MANAGEMENT PLAN

422. 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.

423. 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 preparation of loan project implementation according to preferred practice by the Asian Development Bank.

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

424. Table IX-1 summarizes the status of clearances and no-objection certificates that are already obtained or are likely necessary for implementation of the construction works.

**Table IX.1: 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: Application needs to be prepared during pre-construction stage.</b>	DoR	Prior to construction
Dzongkhag	Administrative approval <b>Status: Administrative approvals need to be obtained</b>	DoR	Prior to construction
DoFPS	Removal of trees in road construction <b>Status: Clearance is obtained for preliminary study but further forestry clearance will be required for detailed design and construction</b>	DoR	Prior to construction
Department of Culture	Location near cultural and religious sites <b>Status: locations identified in detailed design</b>	DoR	Prior to construction
Private property or land owners	Written clearances obtained and private land donated by the communities	DoR GA & DA	Prior to construction
Department of Health	Within 50m of hospital <b>Status: locations to be identified in detailed design</b>	DoR	Prior to construction
Department of Education	Within 50m of school <b>Status: locations to be identified in detailed design</b>	DoR	Prior to construction
BPCL	Relocation of power transmission line <b>Status: exact locations identified in detailed design</b>	DoR	Prior to construction
Department of Roads	Access from highways and feeder roads <b>Status: exact locations identified in detailed design</b>	DoR	Prior to construction

## **B. Mitigation Measures**

425. Table X.2 summarizes the environmental impacts and proposed mitigation measures and Table X.3 summarizes the site specific environmental impacts and proposed mitigation measures, along with their locations, that were identified in Chapter VII. The table also prescribes implementation and monitoring responsibilities for the following groups: the design consultant (DC) or construction supervision consultant (CSC) and the environment specialist (ES) working with these groups; the construction contractor (CC); the Department of Roads Project Management Office (PMO) , which may include a representative of the Environmental Management Unit of DoR (see later in this section); other national institutional authorities (identified by their common acronyms); and local authorities, or Dzongkhag administrations (DA). Some construction monitoring may be provided by the Wildlife Conservation Division (WCD) of the Department of Forests and Park Services where there are protected areas and important wildlife habitat. Implementation and monitoring responsibilities for a particular mitigation may be shared among these units.

426. Costs have also been estimated for the various mitigation actions and included in Table 8-2. These costs cannot be wholly attributed to environmental requirements in all cases, as many of the actions are necessary according to good engineering or management practice. Some of the mitigation actions under the responsibility of the DC and CSC incur no extraordinary cost as the action is part of the schedule of work for these groups. Costs associated with mitigation actions under the responsibility of the CC in most cases are not separable, since these costs are part of the normal cost of construction contracting. Some items are clearly related to environmental protection measures, for which estimates have been provided. Cost estimates are preliminary and should be updated during detailed project design.

**Table IX.2: General Environmental Management Plan for Predicted Environmental Impacts and Proposed Mitigation Measures**

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
<b>Impacts on Air Quality and Noise during Construction</b>							
1.	Excavating, grading, finishing	Dust, fumes and noise in the vicinity of the worksite. Temporary damage to adjacent land use and exposure to air and noise pollutants.	Reduce ambient dust levels by regular spraying of water on exposed earth in construction areas and haulage routes where there is potential for human exposure. Remove construction debris and spoils promptly. Impose traffic controls to reduce public exposure. Materials transported should be properly covered while in transit.	Settlement Areas	CC	PMO and CSC/ES	Inform public through the Geog administration about the timing of road construction activities and anticipated hazards.
2.	Operation of quarries and borrow pits	Air and noise pollution. Location of quarries and borrow pits in unstable areas or close to habitations will induce landslides and harm health of people.	Spraying of water in quarrying areas and proper covering of vehicles carrying quarried materials. Quarry sites shall be identified before start of construction works.	Quarries and construction sites	CC	PMO and CSC/ES	Seek clearance for quarry sites from DoFPS and approval from DGM. Inform public through the Geog administration about the location and operation of quarries and anticipated hazards.
3.	Construction activity near business and community areas	Blocks access, disturbs daily life of community and produces noise, dust and congestion	Select haul routes around community areas. Operate vehicles during restricted hours in village limits. Introduce traffic controls to reduce contact between the public and construction activity.	Business and community areas.	CC	PMO and CSC/ES	Inform public through the Geog administration about the timing of road construction works.
4.	Cement mixing, hot mix asphalt blending, rock crushing and asphalt curing.	Noxious odours and fumes.	Locate facilities at a sufficient distance from human receptors to eliminate the impact. Conduct activities during daylight hours if there are communities nearby. Water areas where dust accumulates regularly.	Construction sites	CC	PMO and CSC/ES	Discussion with local Geog authorities and people living nearby on the location of crushing plant and Asphalt mixing plant
5.	Blasting of rock	Noise and safety hazard	Follow the Explosive rules, RGoB. Prepare a blasting procedure requiring area restrictions, prior warning of workers and nearby residents, restrictions on the timing of blasts and worker safety. Adopt controlled blasting. Limit blasting to midday hours in all areas with wildlife. Procedure to be approved by the PMO for	Rocky stretches	CC	PMO and CSC/ES	Discussion with local Geog or Dungkhag authorities on the blasting schedules. Geog or Dungkhag authorities shall inform the general public of the agreed blasting schedules.

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
			strict compliance in the work environment.				
6.	Operation of construction equipment, machinery and vehicles	Air pollution from generation of harmful gases.	Regular maintenance of all machinery, equipments and vehicles.	Construction sites	CC	PMO and CSC/ES	
<b>Impacts on Soil Resources during Detailed Design and Pre-construction</b>							
7.	Finalization of alignment considering topographical and geological conditions.	Seismic events during operation cause damage to the roadway and adjacent property, and loss of life.	Conduct topographical and geological studies; propose alignments to avoid landslide prone areas where possible; assess feasibility of alternative designs and alignments; and recommend preferred alignments based on due consideration of seismic risk.	DDC office	DC	PMO	
8.	Identification of quarries and borrow pit locations	Impacts from hauling and degraded roadway surfaces during construction Hazard due to accident or slope failure during construction	Identify quarry locations, or consider other options, in conjunction with the selected construction contractor.	DDC office	DC CC	NEC  PMO and CSC/ES	
9.	Recommendation of techniques for excavation and earth cutting works.	Excess cutting and use of poor techniques resulting in landslides and slope failures.	Incorporate EFRC construction techniques in the detailed design such as use of cut and fill method instead of complete cut or box cut.	DDC office	CC	PMO	
10.	Identification of site specific bioengineering techniques	Slope failures and erosion problems due to excavation of road formation	Apply recommend Bio-engineering techniques for specific sites based on existing practices within the region and the DoR's Manual on Bioengineering.	DDC office	CC	PMO	
11.	Recommendation of drainage structures for wet and unstable areas.	Slope failures during operation due to poor drainage in the road site.	Identification of appropriate drainage structures such as horizontal drains suitable for specific site conditions particularly for road section passing through fields of villages.	DDC office	CC	PMO	
12.	Clearing and grubbing before initiating construction	Degradation of surface water quality. Soil loss from exposure to rain and flowing water, and increased sediment in rivers	Use log or boulder barriers at the base of slopes subject to erosion. Seed and stabilize slopes and embankments.	Construction zones	CC	PMO and CSC/ES	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
	works.	and streams.					
13.	Identification of disposal sites for construction debris	Improper disposal of construction debris resulting in scarred landscape.	Identify suitably located disposal sites for construction debris.	Along ROW	CC	PMO and CSC/ES	
<b>Impacts on Soil Resources during Construction</b>							
14.	Cutting and excavation of the roadbed.	Unstable slopes lead to soil loss.	Use balanced cut and fill method to minimize cut volume. Construction of log barriers on valley side of slope to control any falling debris and spoils. Proper disposal of excavated materials and spoils to pre-identified disposal sites. Apply bioengineering techniques to stabilize soils. Construct retaining structures/walls wherever required.	Construction zones	CC	PMO/CSC	
15.	Blasting of rocky areas and slopes	Hazard due to accident or slope failure.	Adopt standard blasting procedures in force for road construction, Operation of quarry and borrow pits. Clearance be obtained for quarry and borrow pits prior to operation from concerned agencies.	Construction areas.	CC	PMO/CSC	Discussion with local Geog or Dungkhag authorities on the blasting schedules. Geog or Dungkhag authorities shall inform the general public of the agreed blasting schedules
16.	Placement of roads parallel and transverse to rivers.	Damage to roadway due to undercutting of road foundation.	Place road embankments above highest water level and provide adequate flood protection structures as given in detailed design	Construction zones	CC	PMO/CSC	
17.	Geotechnical Risks to the Roadway Environment	Slope failure and landslides affect operation of roadway, require further reconstruction, and cause the loss of life and property.	Use balanced cut and fill method to minimize cut volume. Construction of log barriers on valley side of slope to control any falling debris and spoils. Proper disposal of excavated materials and spoils to pre-identified disposal sites. Apply bioengineering techniques to stabilize soils. Construct retaining structures/walls wherever required.	Construction zones	DC	PMO/CSC	
18.	Disposal of construction	Improper disposal of construction debris over	Prohibit indiscriminate throwing of construction debris but in the designated disposal sites.	Construction zones	DC	PMO/CSC/ES/NEC	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
	debris and spoils.	hillside resulting in scarring of landscape and loss of aesthetic.	Proper restoration of waste disposal area with top soil and carrying out appropriate bioengineering works.				
19.	Operation of equipment storage and repair yards, and fuel depots	Oily waste is improperly disposed off; spilled fuels contaminate soil and pollute water.	Install secondary containment around fuel tanks and at fueling stations. Prevent oil and fuel spills, control runoff from contaminated areas.	Equipment yards and fueling stations	CC	PMO and CSC/ES	
20.	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.	Remove /dismantle structures, clean up construction camp debris and backfill latrines; grade, re-vegetate the area and carry out tree planting.	Construction and labor camps	CC	PMO and CSC/ES	
<b>Impacts on Soil Resources during Operation</b>							
21.	Operation of roadways	Landslides and other erosion issues.	Adoption of appropriate engineering structures and bioengineering techniques.	Specific road section	DoR	DoR	
22.	Operation of Roadways: Impacts due to Location	Seismic events cause damage to the roadway and adjacent property, and loss of life	Apply appropriate engineering measures to fix damages.	Specific road section	DoR	Dzongkhag / DoR	
<b>Impacts on Water Resources and Water Quality during Detailed Design</b>							
23.	Planning location and size of culverts and bridges	Backwater conditions at undersized culverts and bridges cause flooding of areas upstream of the roadway and overtopping of the road surface	Culvert and bridges have to be designed with adequate discharging capacities and located in an appropriate site to avoid flooding as well as downstream erosion.	DDC office	DC	PMO	
24.	Design of road sections running near river or streams	Scouring of roadway embankments parallel to rivers undermines roadway, releases sediment, and affects water quality.	Design to assure adequate elevation above maximum high water level; include embankment protection in design of roads.	DDC office	DC	PMO	
25.	Recommendation of river training and protection structures.	Disturbances in natural flow of river/stream and damage to road structures during operation.	Identification of appropriate structures suited to specific locations alongside rivers.	DDC office	DC	PMO	



Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
26.	Recommendation and design of structures for enabling proper drainage under all weather conditions.	<p><b>Climate change induced -</b> Extreme meteorological conditions exceed capacity of structures, erode slopes and destroy pavement structures. High temperatures are likely to cause bleeding, rutting and segregation leading to pavement failure.</p> <p>The climate change is expected to bring about extreme precipitation and flooding which lead to blockage of surface drains and damage the pavement surfaces.</p> <p>Regular thermal expansion and contraction has significant impact on bridge structure along Nganglam-Deothang road. The increase in frequency, intensity and duration of heat waves brought about by climate change will have further impact on bridge structures.</p> <p>Road damage by surface water is expected to increase in the future as consequences of predicted increase in general rainfall, and more frequent heavy storm events.</p>	<p><b>Climate Change Adaptations:</b> Grade(s) of asphalt cement mix used in hot-mix paving should be selected based on climatic conditions and past performances, i.e. 80/100 Bitumen type used for hotter areas so that mix should not or be displaced when subject to traffic loads more so at high temperature.</p> <p>Use sheet flow or discharge estimation methods provided in the hydrological study to calculate the flow required for designing the side drain. U-drain shall be considered in critical sections along Nganglam-Deothang road between Km 3-13, Since the bridge span for Nganglam-Deothang road is between 40-50m, the concrete bridges are proposed. However, the design engineer shall employ suitable bridge design model which takes into account of future extreme temperature rises.</p> <p>L-drain (most commonly constructed drain) and Hume pipe crossings are inadequate to meet the extreme weather conditions of Southern Bhutan which applies for Nganglam-Deothang road. Use sheet flow or discharge estimation methods provided in the hydrological study to calculate the flow required for designing the side drain. U-drain shall be considered in critical sections along Nganglam-Deothang road between Km 3-13. Review the existing cross drainage design pattern using Hume pipe in relation to extreme precipitation leading flooding. The 50 Year ARI (storm return period) as recommended by the hydrological study for bridge and culvert design has to be used. Wherever necessary the design and construction of Box culverts has to be initiated in anticipation of future extreme weather conditions. Frequencies of</p>	DDC office	DC	PMO	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
		High intensity or continuous precipitation over a period has potential to trigger material slides.	drainage inspection and maintenance shall be increased in anticipation of severity of the impacts due to extreme precipitation on the road infrastructures. EFRC structures such as gabion walls, pineapple walls, check dams, etc. along with bioengineering which could be adopted as climate change adaptation measures with little or no additional costs for slope protections. Application of right EFRC structures at right place which are specific to site conditions are utmost importance for effective slope protection.				
27.	Design of roadside drainage	Insufficient roadside drainage in community and paddy field leads to flooding of adjacent properties.	Pay particular attention to roadside drainage in community to assure roadway surface does not concentrate rainfall and cause damage to local properties.	DDC office	DC	PMO	
28.	Design of longitudinal drainage structures.	Longitudinal roadside drainage is undersized, causing breakup of pavement and a safety hazard.	Design appropriate roadside drainage structures and include in project cost estimate.	DDC office	DC	PMO	
<b>Impacts on Water Resources and Water Quality during Construction</b>							
29.	Excavation works	Disposal of excavated materials on hillside and nearby streams and rivers causing excess sedimentation, creation of temporary dams which may burst and cause disturbances to aquatic ecology.	Use of log barriers or boulder barriers in the valley side to control spillage of any excavated material. Prohibit indiscriminate dumping of excavated material or construction debris into streams and rivers. Reuse of excavated material as far as possible and disposal of unwanted material in pre-identified disposal sites.	Construction zone	CC	PMO and CSC / ES	
30.	Operation of equipment, storage and repair yards, and fuel	Oily waste is improperly disposed off; spilled fuels contaminate soil and water.	Install secondary containment around fuel tanks and at fueling stations. Prevent oil and fuel spills, control run off from contaminated areas.	Equipment yards and fueling stations.	CC	PMO and CSC/ES	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
	depots.						
31.	Construction of road side drainage structures.	Insufficient roadside drainage in community areas leads to flooding of adjacent property and buildings.	Construct adequate drainage facilities which continue sufficiently downstream into natural drainage system as far as possible.	Construction sites	CC	CSC/ES	
<b>Impacts on Water Resources and Water Quality during Operation</b>							
32.	Operation of roads	Plugging of culverts from debris during heavy downpours; channelization and damage to the roadway.	Maintain culverts and remove debris that interferes with the flow in culverts.	Roadway locations	DoR Dzongkhag maintenance units	DoR	
<b>Impacts on Forests during Pre-construction</b>							
33.	Land clearing for roadways.	Displacement of forest and destruction of natural habitat.	Prepare an inventory and remove marketable timber prior to construction. Clear only unmarketable trees and brush remaining in the road corridor. All valuable timber shall be handed over to NRDC. Obtain necessary government permits for cutting trees	Construction ROW Construction ROW  Divisional Forest Office	PMO/DoR PMO/DoR  CC	DoFPS DoFPS  DoFPS	
34.	Land clearing for roadways.	Clearing extends into adjacent forests: loss of habitat.	Demarcate right-of-ways and trees before clearing begins.	Construction ROW	CC	PMO and DC/ ES	
<b>Impacts on Forests during Construction</b>							
35.	Land clearing for roadways.	Displacement of forest and destruction of natural habitat. Destroy rare and threatened and endangered plants, herbs and medicinal plants, endemic plants, plants listed in Schedule I of FNCA 1995 (Eagle wood/Indian Aloe wood ( <i>Aquilaria malaccensis</i> ) and red list plants under CITES Appendix II ( <i>Alsophila spinulosa</i> syn. <i>Cyathia spinulosa</i> , <i>Alsophila brunoniana</i> syn. <i>Cyathia</i> and	Provide compensatory plantation to replace trees removed along the ROW. Re-vegetation of slopes above and below road through appropriate bioengineering techniques where necessary. The PMO will instruct contractors to prohibit workers from destruction of rare, threatened and endangered floral species. The PMO will inform the concerned agencies to rescue plants listed in Schedule I of FNCA 1995 (Eagle wood/Indian Aloe wood ( <i>Aquilaria malaccensis</i> ) and red list plants under 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> ) if found on the Right of way during road construction.	Construction ROW	PMO/DoR	DoFPS/PMO/ CSC	Discussion with forestry officials for jungle clearing and tree felling.

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
		<i>Dioscorea deltoidea</i> ).					
36.	Land clearing for roadways	Clearing extends into adjacent forests resulting in loss of habitat.	Prohibit removal of trees from public lands outside ROW/construction zone.	Construction on ROW	Local Administration	DoFPS	
37.	Clearing right-of-way	Excessive road width causes unnecessary damage to hillside, increases need for rehabilitation and leads to unstable slopes.	Maintain minimum required width for construction, remove trees that interfere with construction and limit access to adjacent land. Prohibit excessive disposal of spoil materials and any other forms of construction debris over the edge of the hillside.	Construction zones	CC	PMO and CSC/ES	
38.	Activities of Workers.	Workers fish, hunt and gather firewood; destruction of biological resources.	Make aware of the strict forestry rules and regulations prohibiting hunting, fishing and firewood gathering to the worker population. Prohibit fishing, hunting and gathering of firewood without permits. Provide construction camps with food supplies from purchased stores and to maintain a canteen for workers or cooking in groups. The contractor should supply cooking fuels/gas to construction workers to refrain them from using fuel wood for cooking and warming purposes. However, if necessary provide firewood for warmth from legitimate sources or stockpiled from materials cleared from the roadway construction zone according to other rules set out in the contract specifications	Construction sites and labor camps	CC	PMO and CSC/ES/DoFPS	Discussion with local forestry officials on issue of illegal hunting, fishing and firewood collection.
39.	Burning plant matter in construction zone.	Conflagrations, habitat destruction and regional air pollution.	Avoid burning plant residue by placement of materials into stockpiles outside the line of construction.	Construction zones	CC	PMO and CSC/ES	Included in cost of construction contract implementation
40.	Blasting of rocks and excavation works.	Disposal of spoil materials on downhill slopes destroys forests and contributes to sediment loss.	Construct log or boulder barriers on hillside to help catch falling debris if any.  Dispose of all spoil materials in designated disposal sites.	Construction zone  Construction zone	DC  CC	NEC  PMO and CSC/ES	Discussion with local or geog administration and communities on blasting schedules.
41.	Stone crushing operations.	Covering of surrounding areas and vegetation in a white layer of dust causing resultant impacts on the	Regular spraying of water in stone crushing site to minimize dust.	Stone crushing sites.	CC	PMO and CSC/ES	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
		plant life.					
<b>Impacts on Forests during Operation</b>							
42.	Operation of roads	Failure in bioengineering structures installed during construction. Poor seedling survival rate or regeneration rate under compensatory tree plantation and re-vegetation activities carried out in construction stage.	Adoption of alternate bioengineering or engineering measures.  Regular watering and monitoring of seedling survival and re-vegetation and apply appropriate measures such as fencing, preventing cattle from eating and trampling freshly planted seedlings.	Road ROW	DoR Field Office.	PMO/DoR	
<b>Impacts on Wildlife during Construction</b>							
43.	Construction activities.	Generation of noise and disturbances to wildlife.	Limit working time to day light hours only.	Construction zone	CC	PMO, WCD, CSC/ES	
44.	Activities of Workers	Hunting, fishing and other activities with negative impacts on wildlife.	Prohibition of workers from hunting, fishing and carrying out other activities that will disturb wildlife. Contractor must provide workers with adequate food, clothing, shelter, fuel to discourage the activities mentioned above.	Construction zone	CC	PMO, WCD, CSC/ES	
45.	Building structures and signages to facilitate wildlife movements	Minimize wildlife casualties from fall from steep slope, vehicle-wildlife collision	Build wider and gentle slopes, wider corridor and steps on roadside slopes and maintain it natural to allow easy wildlife movement and fences should be built in steep road cutting to prevent wild animals to pass through such terrain/slope to avoid falling and death and prevent vehicle-animal collusion. Signages such as indicating "Wild Animal Crossing-2 Km Ahead" and that the particular road segment is a high animal population zone and/or migratory path of respective wildlife species must be posted at appropriate locations. Indicate regulatory signboards such as "No Horn for next 5 Km", "Low Beam for next 5 Km" and "Strictly no Feeding of Wild Animals" that vehicles must slow down, not honk or carry out any activities that will disturb wildlife. It is also recommended to place signboard in Elephant and Gaur corridor "Drive Slow, Elephants and Gaurs Have Right of Way				

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
			and Do Not Obstruct” to allow them to pass through the road. Even, measures such as “Speed Limit 10 Km per hour” and speed breakers shall be placed to slow down high speed vehicles for safe passage of wildlife and to avoid accidents on the road crossing wildlife migratory paths.				
<b>Impacts on Wildlife during Operation</b>							
46.	Operation of Roadways: Impacts due to Location	Roadways provide access to forested areas and accelerate wildlife poaching.	Forest officials equipped to perform surveillance of areas affected by wildlife poaching. Provide salaries and operating expenses to forest officials for performance of duties.	DoFPS office	DoFPS  RGoB/DoFPS	DoFPS, NEC	
47.	Operation of vehicles along roadways.	Vehicle collisions with wildlife.	Monitor the presence of appropriate sign boards posted during the construction stage	Important wildlife habitat zones	Range Office, DoFPS	DoFPS	
<b>Impacts on Socioeconomic Environment</b>							
<b>Impacts on Land Tenure during Pre-construction</b>							
48.	Land clearing for roadways	Improved access leads to conflicting land claims	Provide grievance mechanisms under the EIA components of the Project.	DA office	PMO	NEC	
49.	Land clearing for roadways	Public lands are encroached upon for private use	Review land surveys in the area of roadways to assure completeness. Classify ownership adjacent to roads. Prevent encroachment onto public lands.	Construction ROW	DA	PMO	
<b>Impacts on Land Tenure during Operation</b>							
50.	Operation of roadways	Public lands are encroached upon for private use	Prevent encroachment onto public lands.	Construction ROW	DA	PMO	
<b>Impacts on Labour Rights during Construction</b>							
51.	Living conditions of labour	Unhealthy living and working conditions affect workers' health.	Construct camps outside of any danger zone; ensure food service facilities, safe drinking water, adequate washing and bathing facilities for maintaining personal hygiene, and access to health care.	Labour camps	CC	PMO/CSC/ES	
52.	Safety of workers at site	Accident and injury to workers.	Establish and 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.	Job sites	CC	PMO/CSC? ES	
53.	Set up of	Sanitary waste and litter	Camp facilities should be located at a distance	Construction	CC	PMO/CSC/	

Sl. No.	Action	Resource Impact	Mitigation	Location	Responsibility		Public Participation and Coordination
					Implementation	Monitoring	
	construction camps	degrade local environment around construction camps.	from nearby communities. Provide sanitary facilities (dry pit or pour flush latrines) for workers and arrange for disposal of solid waste.	on and labour camps		ES	
54.	Transmission of HIV/AIDS and other STDs by labors	Threat of HIV/AIDS and other STDs	Workers hired by contractors should be screened for HIV/AIDS and other STDs in advance. Conduct HIV/AIDS awareness-raising campaign among the construction workers and nearby communities.	Construction and labour camps Local communities	CC PMO	PMO and CSC/ES NEC	
<b>Public Liability of Contractors and Damage to Local Infrastructure during Construction</b>							
55.	Cutting slopes	Unstable slopes cause hazard for workers and nearby people.	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. Adjudicate and compensate property damage or injury under the grievance procedures provided in the Resettlement Action Plan.	Construction zones  DA office	CC  PMO	PMO and CSC/ES  NEC	
56.	Targeted impacts during construction	Private and public property and infrastructures have been affected by the road alignment	Infrastructure need to be relocated, compensated under resettlement action plan, or maintained without damage during construction.	Construction site and local communities.	PMO, CC	CSC/ES/NEC	
<b>Impacts on Archaeological Remains during Construction</b>							
57.	Construction excavation: archaeology	Damage to archaeological monuments and unearthed evidence.	Immediately halt nearby work upon discovery of archeological relics. Notify the PMO to contact relevant government authority to investigate and undertake recovery. Work to remain halted at the specific location until recovery is complete.	Construction zone	CC	PMO, CSC/ES	Included in cost of construction contract implementation

Notes: CC-Construction Contractor, CSC - Construction Supervision Consultant, DA- Dzongkhag Administration, DDC-Detailed Design Consultants, DC-Design Consultant, DGM - Department of Geology and Mines, ES-Environment Specialist, DoFPS - Department of Forests and Park Services, DoR-Department of Roads, NEC - National Environmental Commission, PMO - Project Management Office

**Table IX.3: Site Specific Environmental Management Plan for Predicted Environmental Impacts and Proposed Mitigation Measures**

Sl. No.	Resources	Impact	Mitigation	Location	Monitoring		Public Participation and Coordination
<b>Impacts on Rural Electricity distribution Poles and lines and Telephone Poles</b>							
1.	Rural Electricity Supply Pole and Lines and transformer,	About 22 numbers of electricity supply poles (some with support wires) and 2 transformers are located adjacent and along the project road alignment. About 50% of the electricity poles located adjacent to the road alignment are likely to be affected during the road widening and construction. About 10% of the poles located along the road alignment will have to be relocated.	Road widening and construction works must be carried out with utmost care to avoid the damage of electric poles and its support wires Avoid excessive excavation uphill side to avoid damages to some of the electricity poles located on the uphill side of the road Avoid dumping spoil towards electric pole location (downhill side) If damages are unavoidable, then the poles have to be relocated to safer place in coordination with BPCL with prior information to the affected people. Some poles will require support walls to protect from damage. 2 transformers will require construction walls to support from damage and shift road alignment towards Forest Beat office to avoid damage to transformers.	Electricity poles are found at Chainages 0+100, 2+350, 4+100, 29+000, 70+420, 71+290, 71+390, 71+900, 71+950, 72+550, 72+580, 73+060, 73+110, 73+230, 73+280, 73+310, 73+430, 73+440, 73+450, 73+470, 73+500, 73+700 Transformers at Km 73+200	DC, CC and BPCL and BTL	CSC	Discussion with concerned Gups and the nearby communities regarding the possible disruption of power supply.
2.	Telephone poles and lines	Damage of electricity poles will result in disruption of local power supply. About 6 Telephone poles and lines are located above and below along the road alignment	4 telephone poles and lines have to be relocated and 2 telephone poles will require support walls to protect from damage.	Telephone poles and lines at chainages 73+210, 73+280, 73+400, 73+430, 73+610, 73+640.			Discussion with Bhutan Telecom Limited regarding of disruption of telephone lines and relocation and construction of walls to support from damage of telephone poles and lines.



<i>Sl. No.</i>	<i>Resources</i>	<i>Impact</i>	<i>Mitigation</i>	<i>Location</i>	<i>Monitoring</i>		<i>Public Participation and Coordination</i>
<b>Impacts on Water Supply</b>							
1.	Chokhorling Community Water Supply	<p>The road alignment passes through at about 200 m upstream of one of the water intake of Chokhorling community.</p> <p>Construction work will have following impacts:</p> <p>Damages to water intake and pipelines.</p> <p>Any damages to the water source and other infrastructures can lead to shortages of water.</p> <p>Siltation of the stream from spillage of debris and spoils from construction.</p> <p>Road construction upstream will cut off the seepage of water downstream that Chokhorling communities drink during dry season.</p>	<p>Prior to start of works, the project must discuss with the local administration and the affected people on its relocation of the reservoirs, tanks above the road and pipelines.</p> <p>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.</p> <p>Provide prior notice of at least two weeks to the communities regarding possible disturbance and have measure to provide alternative supply such as via mobile tank during temporary disruption.</p> <p>In the event of unavoidable damages, the water supply has to be immediately reinstated through alternatively arrangement.</p> <p>Water supply crossings along the road have to be reinstated immediately.</p> <p>Remove all the excavated debris from and near water source and dump in pre-identified dumpsites to avoid siltation and damage to community drinking water source.</p> <p>Construct stone and log barriers to stop spillage of excavated spoils downstream to prevent siltation and carry out bioengineering plantation to conserve water source and prevent from drying.</p>	Water intake at Chainages 28+500 to 29+000	DC, CC, and Geog administration	CSC	Discussion with Chokhorling Geog Administration and the communities regarding the possible drying up of water source and damage of water source supply pipelines by the road construction works.
2.	Water supply disruption(Ng anglam (takeoff), Drangnalashi ngborang, Dezama, Shuguri and Kalatsho)	<p>Damages to water intake and pipelines of drinking water supply of Drangnalashingborang, Dezama, Shuguri and Khalatsho communities.</p> <p>Any damages to the</p>	<p>Prior to start of works, the project must discuss with the local administration and the affected people on its relocation of the reservoirs, tanks above the road and pipelines.</p> <p>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.</p>	Construction site Chainages 1+600, 1+000-4+000, 7+500, and 40+250.	DC, CC, and Geog administration	CSC	Discussion with Norbugang and Chokhorling Geog Administrations and the affected communities regarding the possible drying up of water source and damage of water source supply pipelines by the road construction works.

Si. No.	Resources	Impact	Mitigation	Location	Monitoring		Public Participation and Coordination
3.	Water supply disruption (Rishore, Chenari and Deothang)	<p>water source and other infrastructures can lead to shortages of water.</p> <p>Damages to water intake, tank and pipelines of drinking water supply of Rishore, Chenari and Deothang communities. Any damages to the water source and other infrastructures can lead to shortages of water.</p>	<p>Provide prior notice of at least two weeks to the communities regarding possible disturbance and have measure to provide alternative supply such as via mobile tank during temporary disruption. In the event of unavoidable damages, the water supply has to be immediately reinstated through alternatively arrangement. Water supply crossings along the road have to be reinstated immediately. Remove all the excavated debris from and near water source and dump in pre-identified dumpsites to avoid siltation and damage to community drinking water source. Construct stone and log barriers to stop spillage of excavated spoils downstream to prevent siltation and carry out bioengineering plantation to conserve water source and prevent from drying.</p> <p>Prior to start of works, the project must discuss with the local administration and the affected people on its relocation of the reservoirs, tanks above the road and pipelines. 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. Provide prior notice of at least two weeks to the communities regarding possible disturbance and have measure to provide alternative supply such as via mobile tank during temporary disruption. In the event of unavoidable damages, the water supply has to be immediately reinstated through alternatively arrangement. Water supply crossings along the road between Km 70+000-72+200 of Rishore and Chenari communities and Km 72+500 –</p>	Construction site at Chainages 70+000-72+200, 72+500 – 73+500	DC, CC, and Geog administration and Deothang Thromde.	CSC	Discussion with Deothang Geog Administration and the affected communities, and Deothang Thromde and affected communities regarding the possible drying up of water source and damage of water source, water tank and supply pipelines by the road construction works.

Sl. No.	Resources	Impact	Mitigation	Location		Public Participation and Coordination
					Monitoring	
			<p>73+500 of Deothang Thromde and communities has to be reinstated immediately.</p> <p>Remove all the excavated debris from and near water source and dump in pre-identified dumpsites to avoid siltation and damage to community drinking water source(spring) of Rishore village, relocate and construct new water tank.</p> <p>Construct stone and log barriers to stop spillage of excavated spoils downstream to prevent siltation and carry out bioengineering plantation to conserve water source and prevent from drying.</p>			
<b>Impacts on Religious Monuments</b>						
1.	Thujaycholing Lhakhang above Chokhorling village	<p>During excavation, there is risk of slides and slope failures which can undermine the stability of the Lhakhang.</p> <p>The access to the Lhakhang by the community will be hindered during construction as the road formation cutting will block the footpath from village to Lhakhang.</p>	<p>The excavation works of road construction should be carried out in a controlled manner and the slopes must be protected by constructing masonry retaining walls at right side and left side and proper drainage. Carry out bioengineering plantation above the walls to protect from landslide.</p> <p>Blasting is strictly prohibited. Carry out bioengineering plantation above the walls to protect from landslide. All the spoils must be transported to the pre-identified disposal sites. Temporary access to the Lhakhang must be provided during construction while permanent access should be provided before handing over of works by contractor.</p>	<p>Construction sites 28+000</p> <p>Construction site 14+000</p>	<p>DC, CC, and Chokhorling Geog administration</p> <p>CSC</p>	<p>Discussion with Chokhorling Geog Administration and the communities for the provision of temporary access to the Lhakhang.</p>
2.	Meme Lungkhangma a Labtsha (Sacred Holy stone)		<p>Lungkhangma Labtsha below the road will need to be protected during the construction. Road cutting will carried out on uphill side and retaining wall may need to be constructed downhill side to protect the Nye. All the spoils must be transported to the pre-identified disposal sites. Carry out bioengineering plantation below the wall to protect from landslide.</p>	<p>Construction site 71+500</p> <p>Construction site 72+500</p>	<p>DC, CC, and Geog administration</p> <p>CSC</p>	<p>Discussion with Chokhorling Geog Administration and the communities for the provision of temporary access to the Labtsha.</p>

<i>Sl. No.</i>	<i>Resources</i>	<i>Impact</i>	<i>Mitigation</i>	<i>Location</i>	<i>Monitoring</i>		<i>Public Participation and Coordination</i>
3.	Big Boulder(Lu-Snake Goddess) above road at Chenari Karphu	Road construction may damage Meme Lungkhangma Labtsha (Sacred Holy stone)	Big Boulder needs to be protected and carry out road construction on both sides of the road to save the Big Boulder. Do not blast the Big Boulder. All the spoils must be transported to the pre-identified disposal sites. Carry out bioengineering plantation below the wall to protect from landslide.		DC, CC, and Geog administration	CSC	Discussion with Deothang Geog Administration and the communities for protection of big Big Boulder above road at Chenari Karphu.
4.	Targeted Impacts during construction on Spiritual and Religious Sites (Chenari Phodrang-Nyepo) and water source above the road at Chenari	Road construction may damage Big Boulder believed to possess Lu (Snake Goddess) by local people and dry up the water source below the road at Chenari Karphu. Destruction of big Rock will annoy Lu and bring disease to the local people.  Road construction may damage Chenari Phodrang (Nyepo) who is believed to protect people of Chenari from natural calamities, disease and famine and. Stream is Water source of Chenari people.	Chenari Phodrang (Nyepo) needs to be protected by constructing wall above the road. Do not blast the Rock. All the spoils must be transported to the pre-identified disposal sites. Carry out bioengineering plantation above the road to protect it from landslide.		DC, CC, and Geog administration	CSC	Discussion with Deothang Geog Administration and the communities for protection of big Rock above road at Chenari.
<b>Impacts on Footpath or Mule Tracks</b>							
1.	Footpath or Mule Track	The road alignment crosses a number of existing footpath or mule tracks at Shuguri, Lungkhangma	During the construction, project should make arrangement for temporary access/passage for travelers. Upon the completion of works, the project shall fully reinstate the footpath or mule tracks if required.	The proposed road cross footpath or mule tracks at Chainages: 12+000,	DC, CC, and Geog administration	CSC	Discussion with the concerned Geog Administration and the nearby communities regarding the possible damage of footpath by the road construction.

Sl. No.	Resources	Impact	Mitigation	Location	Monitoring		Public Participation and Coordination
		Labtsha, Chokhorling, Khalatsho and Rishore. During road construction and widening works, there are likely chances of damaging or blocking of the footpath or mule tracks.		16+000, 28+750, 40+000, 70+000.			
<b>Impacts on Access Road</b>							
2.	Access roads	The Kerung farm road takes off at Km 5+000 of the proposed road and Chokhorling farm road continues to the Geog office at Km 15.5. The Rishore coalmine access road continues to the coal mine at km 70+000 from the project road.  During road construction and widening works, there are likely chances of damaging or blocking the access roads.	During road construction, project should make arrangement for temporary access/passage for vehicles travelling through the access or farm roads. Upon the completion of road works, the project shall fully reinstate the access or farm road	Chainages: Km 5+000, 15+500, 70+000.	DC, CC, and Geog administration	CSC	Discussion with the concerned Geog Administration and the nearby communities and Eastern Bhutan Coal Company Limited regarding the possible damage and blockage of access road by the road works
<b>Impacts by Cross Drainages (Culverts that discharge directly into private land)</b>							
3.	Culvert	The existing culverts directly discharge into private agriculture land. Storm water discharge from the cross drains damage the private land causing soil erosion and landslide. Damage of	Proper design and sitting of cross drainage systems so that they do not discharge into private agriculture land. Side drain water should discharge to the natural drainage. Existing cross drainages that empty into private land need to be restudied and designed and relocated to the safer place.	Culverts are located at chainages: 2+100 to 3+000, 28+000 to 28+750, 70+000 to 73+000	DC, CC, and Community	CSC and Geog administration	Discussion with concerned Geog Administrations and the communities regarding the sitting of culverts

Sl. No.	Resources	Impact	Mitigation	Location	Monitoring		Public Participation and Coordination
		agriculture land which reduces the crop productivity.					
<b>Impacts on Forest Resources</b>							
4.	Site Clearance/ removal of vegetation / Tree felling	<ul style="list-style-type: none"> <li>Loss of trees and vegetation cover.</li> <li>Loss of micro level ecosystem</li> <li>Loss of habitat for Elephant, Gaur and other animals</li> <li>Soil erosion</li> <li>Scarring of Landscape</li> </ul>	<ul style="list-style-type: none"> <li>As far as possible the removal of trees and vegetation shall be limited to the required width to obtain 7.5 m road formation.</li> <li>Tree felling shall be done parallel to road alignment</li> <li>Felled trees shall be handed over to NRDCL who will commercially sell them to generate revenue.</li> <li>Compensatory plantation within road corridors to restore lost habitat</li> <li>Log barrier/Check dams to be installed to prevent debris from rolling down and damaging the vegetation cover</li> <li>Bioengineering with native plants species.</li> </ul>	<ul style="list-style-type: none"> <li>In general removal of vegetation cover or tree felling will be throughout the road length. However, dense trees and vegetation are observed between chainages: Km12+000 to 26+000, 30+000 to 35+000, 46+000 to 62+000, 62+000 to 68+000.</li> </ul>	DC, CC, DoFPS and NRDCL	SC and DoFPS	Discussion with Nganglam Forest Range Office and NRDCL regarding the felling of trees
<b>Impacts on wildlife habitat and migratory routes</b>							
5.	Wildlife habitat and their migratory routes	<p>The road alignment at Khalatsho, Chowkiri, Regi slide and Diuri pass through the migratory routes of Elephants and Gaur.</p> <p>Road construction and blasting activities in the steep and rocky stretches at Chowkiri and Diuri can disturb and damage the routes.</p> <p>Indiscriminate dumping of spoils</p>	<p>In order to offset or minimize the negative impacts of the road constructions through the wildlife habitat the following mitigation measures need to be implemented:</p> <p>Road design shall accommodate all the requirements to avoid conflict of wild animals and vehicles and to facilitate movement of animals.</p> <p>Maintain adequate road corridor in excess of 7.5 m in order to facilitate uninterrupted movement of animals.</p> <p>Provide adequate sight distances to allow enough stopping time for vehicles and to avoid collision with animals.</p> <p>Provide signages "Elephant and Gaur</p>	Chainages: 25+000, 41+000, 44+000, 50+000, 62+000, 65+000.	DC, CC	SC, ES and WCD/DoF PS	Discuss with local forestry officials while implementing mitigation measures for wildlife conservation and protection.

<b>Sl. No.</b>	<b>Resources</b>	<b>Impact</b>	<b>Mitigation</b>	<b>Location</b>			<b>Public Participation and Coordination</b>
						<b>Monitoring</b>	
		along the road construction can damage vegetation.	<p>Corridor- Drive Slow, Elephant and Gaur have the Right of Way, Do not Obstruct". Slope shall be cut in benches and flatten to allow easy movement/ crossing by animals. As far as possible, road formation cutting should be carried out during dry season for there are considerably less wild animals during this time.</p> <p>Installation of strong log barrier/check dams to prevent debris from rolling downhill and damaging the vegetation cover.</p> <p>Tree felling, collection of firewood or disturbance of vegetation shall not be allowed outside road reserve</p> <p>Contractor/Construction Supervisor will ensure the minimum level of noise to reduce disturbances to wildlife</p> <p>Contractor/Construction Supervisor will be responsible for controlling illegal activities by the construction workers.</p> <p>Formation cutting at steep slopes and unstable slope should be done with utmost care. All construction debris should be carried to the pre-identified dumpsites to avoid damaging the downhill vegetation.</p> <p>Create awareness on forest rules and regulations for laborers and project officials in coordination with Samdrup Forest Division, Samdrup Jongkhar Range office and Nganglam Range office to discourage &amp; prevent unlawful act.</p>				
6.	Biological corridor connecting RMNP and KWS	Road passing through 2 Km biological corridor between 13-15 Km	<p>Road alignment falls north of biological corridor,</p> <p>Road passes through existing farm road for 2.0 Km stretch, so no new roadway cutting except widening of existing farm road.</p> <p>DoR should mention 2 Km road passing from chainage Km 13-15 through biological corridor in existing farm road while processing for forestry clearance from DoFPS.</p> <p>DoFPS shall prescribe guidelines with</p>	Chainages: Km13+000-15+000.	DC, CC	SC, ES and WCD/DoF PS	Discuss with local forestry officials Nganglam Forest Range Office while implementing guidelines with specific terms and conditions for protecting biological corridor.

<b>Sl. No.</b>	<b><u>Resources</u></b>	<b><u>Impact</u></b>	<b><u>Mitigation</u></b>	<b><u>Location</u></b>	<b><u>Monitoring</u></b>		<b><i>Public Participation and Coordination</i></b>
			specific terms and conditions for biological corridor to protect biological corridor in forestry clearance.				
7.	Regi Landslide	Regi landslide is sensitive for conservation and preservation due to presence of salt lick. Road alignment through the Regi landslide cause disturbance and permanent damage to the salt lick area located at the base of the landslide.	Presence of salt lick at base of Regi landslide which attracts variety of animals in regularly for mineral intake. The road alignment during the detailed design bypassed the Regi landslide by taking the road alignment from the saddle located at the top of the Regi landslide which has avoided the disturbance and permanent damage to the salt lick area located at the base of the landslide.	Chainages: Km 58+000-59+000	DC, CC	SC, ES and WCD/DoF PS	Discuss with local forestry officials while implementing mitigation measures for preservation and conservation of salt lick at base of Regi landslide



### C. Environmental Monitoring and Reporting

427. 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 ADB.

428. 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 reports on a simplified checklist to demonstrate compliance with obligations, providing the report to the Environment Specialist (ES) engaged with the CSC.

429. There are two ES staffs working as members of the design consultant (DC) and construction supervision consultant (CSC) teams<sup>14</sup>, who work in conjunction with the PMO. The PMO engages, via reports, the Environmental Management Unit (EMU) of the DoR. It should be noted that the ES staffs (and the DC and CSC generally) are working as agents for the PMO and the DoR. ES staffs have no authority outside of that granted by the DoR. Among other duties of ES these persons will be responsible for assuring the accuracy and completeness of reporting by the EMO and compiling monthly reports into quarterly summaries to be forwarded to the PMO and to the ADB. Quarterly reports are also sent to the EMU on an informational basis.

430. 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.

431. Table IX.4 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 IX.3 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'.

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<sup>14</sup> Note that these two contracts will be recruited and hired separately

**Table IX.4: 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.	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. Remove construction debris and spoil piles Impose traffic controls to reduce public exposure. Cover transport vehicles	Direct observation of work progress at jobsite	Construction zone	Monthly during construction	PMO 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	PMO and CSC/ES
3.	Select haul routes around community areas Operate vehicles during restricted hours in village limits Introduce traffic controls to reduce contact between the public and construction activity. Complete segments passing through populated areas before starting new construction	Review of proposal for haul routes. Inspection at jobsite Discussion with community leaders Inspection of jobsite.  Inspection of jobsite	Construction office Construction zone	Before starting work in community area. Monthly Monthly  Monthly	PMO and CSC/ES
4.	Locate cement mixing and asphalt blending facilities at a sufficient distance from human receptors to eliminate the impact.  Conduct activities during daylight hours if there are communities nearby.  Water areas where dust accumulates regularly.  Locations for facilities approved by the PMO.	Review of contractor proposal and direct inspection at jobsite  Inspection of jobsites  Inspection of jobsites  Inspection of jobsites	Construction office  Jobsite  Jobsite  Jobsite	Upon set up of facilities  Monthly  Monthly  Monthly	PMO 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.	Review of draft procedure. Inspection at jobsite	Construction zone	Upon preparation of procedure	PMO and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Limit blasting to midday hours in all areas with wildlife.  Procedure to be approved by the PMO and applied rigorously in the work environment.	Discuss with PMO supervisor	Thimphu	Monthly  Upon approval of procedure	
6.	Regular maintenance of all machinery, equipments and vehicles.	Inspection at jobsite	Construction zone	Monthly	PMO 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 sediment control in the contract bid proposal	Inspection at jobsite  Review contract bid.	Construction zones  Thimphu	Monthly  Upon preparation of contract bid	PMO 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	PMO
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	DoR office	Before the opening of quarries and before initiation of blasting activities	PMO
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)	PMO
11.	Use appropriate excavation and cutting 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	PMO
12.	Prohibition of throwing of construction debris in any sites other than the designated disposal sites identified at the detailed design	Inspections at jobsite. Review of disposal site	Construction zones	Monthly	PMO

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	stage	plan and field 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	PMO 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	PMO 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	PMO 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	PMO 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.	Review inventory and contract agreement	Construction ROW	Before conduction of clearing works	DoFPS

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Obtain necessary government permits for cutting trees	Review forestry permit			DoFPS
21.	Demarcate right-of-ways and trees before clearing begins.	Inspection of jobsites.	Construction ROW	Before conduction of clearing works	PMO and DC/ES
<b>Impacts on Forests during Construction</b>					
22.	Provide compensatory planting to replace trees removed along the right-of-way. 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	Inspection of jobsites and abandoned camp sites.  Inspection of jobsites  Inspection of jobsites	Construction ROW  Construction ROW  Construction ROW	At the end of the construction of each road section.  Monthly  Monthly	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 PMO supervisor.  Prohibit disposal of spoil materials and any other forms of construction debris over the edge of the hillside.	Inspection of jobsite  Discussion with PMO  Inspection of jobsite	Construction zones  Head office DoR  Construction zone	Monthly  Before start of construction work of each road segment  Monthly	PMO and CSC/ES
25.	Prohibit fishing, hunting and gathering of firewood among workers.  Provide construction camps with food supplies from purchased stores.  Provide firewood for warmth from legitimate sources or stock piled from materials cleared from the	Review contract signed between contractor and DoR. Discussion with local forestry officials on occurrences of poaching. Inspection of jobsite. Discussion	DoR Head office  Jobsites and labour camps  Jobsites and labour camps	Before initiation of contract work and monthly.  Monthly.  Monthly	PMO and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	roadway construction zone.	with workers  Inspection of jobsite. Discussion with workers			
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	PMO 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 PMO and CSC/ES
28.	Regular spraying of water in stone crushing site to minimize dust	Inspections at jobsite	Stone crushing sites	Monthly	PMO 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.	Site inspections  Site inspections	Within respective road ROW	Monthly	PMO/DoR
<b>Impacts on Wildlife during Construction</b>					
30.	Limit working time to day light hours only	Discussion with nearby communities inspection of jobsites	Construction zone	Monthly	PMO, WCD, CSC/ES
<b>Impacts on Wildlife during Operation</b>					
31.	Staff WCD with rangers equipped to perform surveillance of areas affected by wildlife poaching  Provide salaries and operating expenses to rangers for performance of duties	Visit WCD office and review number of surveillance officers  Receipt of salaries paid	DoFPS office  Local forestry or park office	At the end of road construction works  Monthly during road operation	DoFPS, WCD
32.	Monitor the presence of appropriate signboards posted during the construction stage	Site visits	Important wildlife habitat zones	Quarterly	WCD and local forestry or park officials
<b>Impacts on Socioeconomic Environment</b>					

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
<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	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	Road locations.  Dzongkhag administrative centres	Monthly during implementation	PMO
<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	PMO 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	PMO and CSC/ES
38.	Camp facilities should be located at a 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	PMO and CSC/ES
39.	Workers hired by roadway contractors should be screened in advance for HIV/AIDS. Undertake an awareness program among workers.	Review of program with project supervisors;	Jobsite	Upon program setup	PMO and CSC/ES

No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	Prohibit recruitment of women for sex among workers. Awareness-raising campaign in pilot communities based on need.	Review of program implementation  Review of campaign implementation	Labour camps  Affected communities	Quarterly during implementation  Quarterly during implementation	NEC
<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.  Adjudicate and compensate property damage or injury under the grievance procedures provided in the Resettlement Action Plan	Inspection of slopes; discussion with construction foreman; visual inspection of jobsite and conduct of work Records of grievance procedure mechanism	Jobsite  Dzongkhag Administrations	Monthly  Quarterly	PMO and CSC/ES  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	Thimphu and jobsites	At time of detailed design proposals and contract bid documents	PMO
42.	Electricity poles need to be relocated prior to the commencement of construction in order to avoid impairment of 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.	Assure irrigation systems are recorded on surveys and means provided for passage of water beneath the roadway, to the extent necessary to maintain systems in as good or better condition	Review of detailed design proposal Inspection of jobsite	Thimphu Jobsite	At time of detailed design At time road is constructed through the area	CSC/ES
45.	Construction should be undertaken with appropriate safety features to avoid accidents and disturbances.	Inspection of jobsite	Jobsite	Monthly	CSC/ES
46.	Infrastructure will need to be relocated, compensation paid under	Inspection of jobsite	Jobsites and local	Monthly	CSC/ES



No.	Mitigation Measure	Method of Monitoring	Location	Frequency	Responsible Party
	the resettlement and compensation component of the project, or maintained without damage during construction.		communities		
<b>Impacts during Long term Operation of roads</b>					
47.	Incorporate safety features into the design of the roadway such as signage related to hazardous driving conditions and pullouts for runaway vehicles.	Review of draft project documents Review of detailed designs	Thimphu	At time of preparation of detailed designs	PMO
48.	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 Archaeological Remains during Construction</b>					
49.	Halt nearby work upon discovery of archaeological relics.  Notify the PMO to contact relevant government authority to investigate and undertake recovery.  Work to remain halted at the specific location until recovery is complete.	Discussions with contractor and work foreman  Discussion with PMO  Onsite observation	Jobsite  Thimphu  Jobsite	Quarterly  Quarterly  At event frequency	PMO and CSC/ES
50.	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	PMO and CSC

## D. Implementation

### 1. Periods of Applicability

432. The EIA prepared alongside the feasibility study and updated during the detailed design has provided environmental criteria during the 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

433. **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 Coordinator (PC) within the Department of Roads (DoR). The PC oversees Project Managers (also within DoR) for each separate construction contract. The PC and Project Managers, along with supervisors, inspectors and other support staff, make up the Project Management Office (PMO). The Construction Supervision Consultant (CSC), hired under a separate contract, are part of the PMO.. The CSC will include national environment specialist (ES) staffed at approximately ten months per year, over the duration of the loan<sup>15</sup>.

434. 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.

435. The construction contractor will establish 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.

436. 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.

437. 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 IX-I.

438. **Reporting.** Environment specialists 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 PMO. 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

439. While EMU established in DoR needs capacity enhancement and regular refresher course, DoR has environment focal officers experienced in external aided projects such as World Bank. To the Project, experienced focal officers will be 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.

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<sup>15</sup> This assumes duration of three years; if increased or extended, the allowed person-months should be increased proportionally.

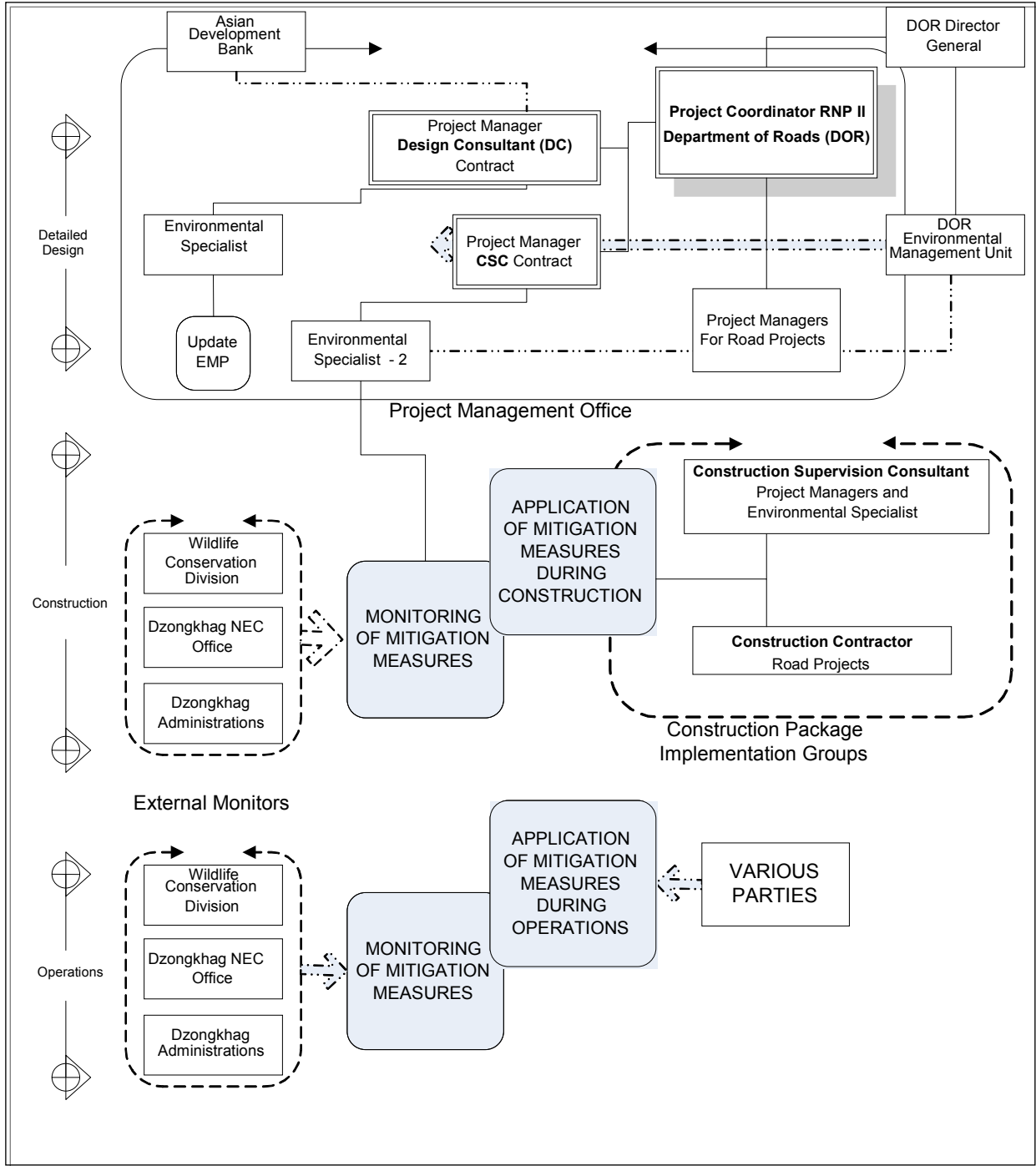
## E. Summary of Environmental Management Cost

440. Table IX-5 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. Costs associated with resettlement, land acquisition and damage compensation are summarized elsewhere.

**Table IX.5: Summary of Environmental Management Costs**

<b>Item</b>	<b>Cost</b>	<b>Cost Center</b>
<i>Mitigation measures</i>		
Secondary containment around fuel tanks and at fuelling stations	\$3,400	Construction
Compensatory planting to replace trees removed along the right-of-way	\$15,000	Construction Supervision
<i>Monitoring</i>		
National Environmental consultant on Construction Supervision Consultant Team	\$5,000 X 30 months = \$150,000	Construction Supervision

**Figure IX-61: Organizational Chart for Environment Management**



## **X. CONCLUSION AND RECOMMENDATION**

### **A. Compliance with Relevant Sector Guidelines of the RGoB**

441. 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 by the project feasibility study and the detailed design study and, the project overall.

### **B. Gains That Justify Project Implementation**

442. 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 – Deothang Road.

443. The Nganglam–Deothang road is considered as one of the most critical 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 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**

444. 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.

#### **4. Adverse Effects Minimized**

445. 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. Slope protection measures are proposed to minimize the impacts.
- From the 74.5km of the proposed road, about 2 km section passes through Biological Corridor. This 2 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 widening works.
- Road construction through critical wildlife habitat between Khalatsho (Chowkiri) and Duiiri area 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 and gaur.

- During road construction at the takeoff near Nganglam town and through the settlements of Drangnalashingborang, Dezama, Yargaywoong, Chokhorling, Khalatsho, Rishore and Deothang 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.

446. 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.

447. 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.

448. 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.

#### **5. Adverse Effects Offset**

449. 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 174 acres).

#### **6. Adverse Effects Compensated**

450. Adverse effects in the social environment—on people's land and real property—are compensated under the terms of the Resettlement Plan.

### **D. Use of Irreplaceable Resources**

451. 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.

**E. Provisions for Follow-Up Surveillance and Monitoring**

452. 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 will be reviewed during the early stage of loan implementation, at which time the EMP will be revised if necessary, and included in the contract bidding documents.

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**NEC APPROVED TERMS OF REFERENCES**



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དཔལ་ལྷན་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 19  
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 DEOTIANG 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 Deotiang 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 inter 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 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 environments 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 qualifying 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.

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-maker.

### 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.

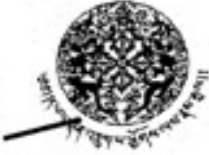
For tasks which extend beyond the time frame of the EIA process (for example, the EMP), sufficient budget and payment scheduling must be provided.

**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 'Himalay', written over a horizontal line.

OFFICE ORDER FROM THE DEPARTMENT OF FOREST & PARK SERVICES



འབྲུག་རྒྱལ་ཁབ་རྒྱལ་ཁབ་ལྷན་ཁག་། རྒྱལ་ཁབ་དང་རྒྱལ་ཁབ་ལྷན་ཁག་། རྒྱལ་ཁབ་དང་རྒྱལ་ཁབ་ལྷན་ཁག་།

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  
27

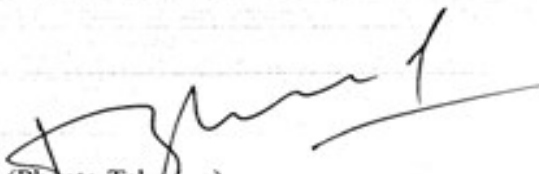
The Chief Forest Officers,  
Sarpang,S/Jongkhar Forest Divisions & RMNP.

**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
<b>A. Project Siting</b> 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>B. Potential Environmental Impacts</b> Will the Project cause...			
▪ encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?	✓		<ul style="list-style-type: none"> <li>• Sacred Holy rock known as Lungkhangma Nye is likely to be damaged during road construction.</li> <li>• Similarly, Thujaycholing Temple and Stupa is also likely to be damaged during road construction</li> </ul>
▪ Encroachment on precious ecology (e.g. sensitive or protected areas)?	✓		Small section road passes through critical wildlife habitat and migratory area that needs protection...



Screening Questions	Yes	No	Remarks
<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.
<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
<ul style="list-style-type: none"> <li>▪ Increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?</li> </ul>		✓	Water pollution due to farm road operation will be of minimum due to low traffic volume.
<ul style="list-style-type: none"> <li>▪ Social conflicts if workers from other regions or countries are hired?</li> </ul>		✓	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.
<ul style="list-style-type: none"> <li>▪ Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?</li> </ul>		✓	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.
<ul style="list-style-type: none"> <li>▪ 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?</li> </ul>	✓		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.
<ul style="list-style-type: none"> <li>▪ 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.</li> </ul>	✓		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 The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.	Yes	No	REMARKS
<ul style="list-style-type: none"> <li>• 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)</li> </ul>	✓		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. Letters from Samdrup Jongkhar Dzongkhag



བསམ་གྲུབ་རྫོང་ས་མཁའ་རྫོང་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

## 2. Letters from Samdrup Jongkhar Thromde



འབྲུག་རྒྱལ་ཡོན་ལྷན་ཚོང་

བསམ་གྲུབ་ལྗོངས་མཁའ་འབྲུག་སྡེ།

OFFICE OF THE THROMPON  
SAMDRUP JONGKHAR MUNICIPALITY



SJT / 12 / 2011 - 12 / 888

November 23, 2011

The Project Coordinator  
RNP II - AF  
Department of Roads  
MoWHS, Thimphu

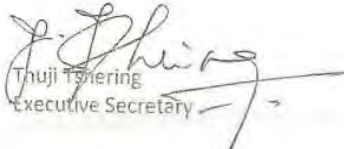
Subject: Road Network Project - II additional financing (AF) feasibility studies

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,





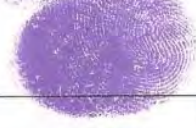



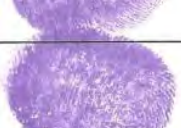
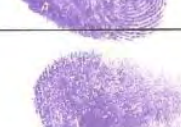


  
Thuji Tshering  
Executive Secretary

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.



## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Zangpo (Tshampa).		M	Chokkooling	
2,	Zopa Kirby (Chairman)		-11-	-do-	
3,	Tadi Zangpo		-11-	-11-	
4,	Chimi (Tshampa)		-11-	-11-	
5,	Hajay Wangchi		-11-	-11-	
6,	Singye Wangchi		-11-	-11-	
7,	Dubala		-11-	-11-	
8,	Dozji		-11-	-11-	
9,	Sonam Wangchuk		-11-	-11-	
10,	Kezang		-11-	-11-	
11,	Sansten		-11-	-11-	
12,	Singye Chungwa		-11-	-11-	






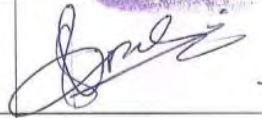


## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
13,	Khandu Wangdi		M	Chokkoting	
14,	Tsheltrim		-"-	-"-	
15,	Wangchuk		-"-	-"-	
16,	Ugyen Zangpo		-"-	-"-	
17,	Bumzang		F	-"-	
18,	Sai Chamo		-"-	-"-	
19,	Norbu Dema		-"-	-"-	
20,	Khandu Zangmo		-"-	-"-	
21,	Keneho Wangmo		-"-	-"-	
22,	Tshei Chamo		-"-	-"-	
23,	Rig Zangmo		-"-	-"-	
24,	Boyta Chamo		-"-	-"-	





## LIST OF PARTICANTS

SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Daba	Ta-8-213 TNo-540	M	Yargang Noongy	
2,	Norbu	TNo-262 Ta-8-222		- 11 -	
3,	Nima Wangdi			- 11 -	
4,	Jangchuk Wangdi			- 11 -	
5,	Nangay Doji			- 11 -	
6,	Janksho			- 11 -	
7,	Pharpa.			- 11 -	
8,	Sangay Chopel	Ta-8-225 TNo-600		- 11 -	
9,	Jigme Wangchuk	Ta-8-216 TNo-518		- 11 -	
10,	Sonam Rinzin			- 11 -	

**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 Grayzer 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 such cultural & historical monuments like "Chu", etc graveyard etc.

1) Billi  
Tshogpa  
Crsg. Adm.  
D/16thang

Billi  
2) Land Tshogpa  
Chenaree'

3) Land Tshogpa  
Resture.

## LIST OF PARTICANTS

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,	Enchung		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	Chengree <del>Reeth</del>	
13,	Kezang		M	"	
14,	Sangay		M	"	
15,	Karma		F	"	
16,	Tenzin		M	"	
17,	Poko		M	"	
<del>18,</del>	<del>Babjay Tenzin Wangchuk</del>		<del>M</del>	<del>"</del>	<del></del>
18,	Babjay		M	"	
19,	Loeb (Gawa Gyemo)		M	"	
20,	Lungten, Isherig (Tsho mo)		M	"	
21,	Jamtsho		M	"	
22,	Karma (Land Tshogpa)		M	"	
23,	Tshenchi		F	"	

## LIST OF PARTICANTS


SNo	Name	House / Tharm No	Gender	Village	Signature or Thumb Impression
1,	Senam Dorji		M	Reshore	
2,	Pema Tashi		M	"	
3,	Sangay Wangmo <del>Dechen Chosten</del>		F	"	
4,	Cheki		F	"	
5,	Yaski 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,	Dawa Zangmo		F	"	
12,	Tshering Samdup		M	"	
13,	Dechen Chosten		F	"	
14,	Norbu Zangmo		F	"	

#### 4. Letter Inviting Stakeholder for National Workshop on RNP II AF



དཔལ་ལྷན་འབྲུག་གཞུང་། འབས་ཏྲིག་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**



Date: 9/03/2012

DoR/RNP-II(AF)/2011-2012/3077

<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 Dzungdag 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

*M. Hamichaney*

**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.

## 5. 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
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12	T. Wangdi 'B'	"		
13	C. K. Bradban	"	cledossip@gmail.com	

## Final Presentation of Feasibility Study Findings

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## Final Presentation of Feasibility Study Findings



Sl. No.	Name of Participant	Ministry/Department	Email address	Signature
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### 6. Other Key Stakeholders or Officials Consulted

Sl. No.	Name	Designation	Department/Agency
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

## 7. Letter for Public Consultation and Field Survey Works

དཔལ་ལྷན་འབྲུག་གཞུང་། འབྲུག་རྒྱལ་ཁབ་ལྷན་ཁག་། ལམ་སྟེང་ལས་ཁུངས།  
 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  
*26*

Dasho Dzongdag  
 Dzongkhag Administration  
 Pemagatshel:

Dasho Dzongdag  
 Dzongkhag Administration  
 Samdrupjongkhar:

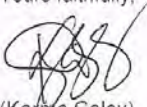
Dasho Dzongdag  
 Dzongkhag Administration.  
 Chukha.

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.

*DL*


*Forwarded / date 26/3/13*

**8. Letter Inviting Stakeholders for final presentation of revised/updated EIA of Nganglam-Deothang Road**



དཔལ་ལྷན་འགྲུབ་ལྷན་ཁྲུང་། རབ་ས་རྒྱལ་ལྷན་ཁྲུང་།

**ROYAL GOVERNMENT OF BHUTAN**  
**MINISTRY OF WORKS & HUMAN SETTLEMENT**  
**DEPARTMENT OF ROADS**  
 SASEC Road Connectivity Project, RNPII (A/F)  
 THIMPHU: BHUTAN



No. DOR/RNPII(SASEC)/2013-2014/07/ 5436 08<sup>th</sup> Nov. 2013

<p>The Head Environmental Service Division NECS, Thimphu</p>	<p>The Director General Department of Forestry Ministry of agriculture, Thimphu</p>
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Sub : Final draft report on Environment Impact Assessment Report (EIA) of Nganglam-Dewathang Road.

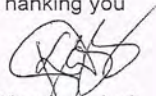
This has reference to our earlier letter no. DoR/RNPII/(AF)/07/2012-2013 dated 10<sup>th</sup> Sept. 2012 wherein this office has circulated Environment Impact Assessment (EIA) reports in respect to Nganglam-Dewathang road and IEE for Pasakha link Road prepared as part of the ADB Assisted Project Preparatory Technical Assistant (PPTA).

The EIA report has been further updated by Detail Design Consultant, M/s Kyingkhor 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~~ <sup>October</sup> 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 Kyingkhor Consultancy service for presentation on the above report.
- ✓ 5. Mr. Karma Choyphel, Environment Specialist, ADB Thimphu.

*fayed af = 8/11/13*

9. List of participants during final stakeholders presentation of revised/updated EIA of  
Nganglam-Deothang Road

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 Adds.
1	Karma Galay	Director	DOR		Karma.galay@gnm.gov.np
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3	Karma Chogyel	Staff Consultant	ADB		chogyelk@adb.org
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11	Choden	AE	DOR		chogyel712@gmail.com
12	Sonam Jang	Sr. En. Off.	PPD, MoWHS		sonamdesai@gmail.com
13	Karma Yangzom	Environment Specialist	ADB		kyangzom@adb.org
14	Sonam Tshering	PC	RMP II SASEC		stshering303@gmail.com
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18	T. Sakai	Transport Specialist	ADB		tsakai@adb.org
19	T. Kawabata	Young Professional	ADB		tkawabata@adb.org
20					

### BIOENGINEERING PLANTATION WORKS

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>	Hamamelideceae	<i>Jhikri, 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 arborens</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
19	<i>Salix sp.</i>	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

Sl. No	Botanical name	Family	Local name	Method	Source
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
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>	Boraginoceae	<i>Yangshing</i> (Sh.)	Potted seedling	DoFPS/Dz
47	<i>Callicarpa arborea</i>	Varbenaceae	<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>Thysonolaena 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