Environmental Impact Assessment (Draft)

August 2014

BHU: Green Power Development Project II (Part A: Hydropower Plant Component) Annexes A to I

Prepared by Druk Green Power Corporation Limited and Tangsibji Hydro Energy Limited for the Asian Development Bank

The environmental impact assessment report is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

Annex A: Access Roads Details



DRUK GREEN POWER CORPORATION LIMITED

APPLICATION FOR ENVIRONMENTAL CLEARANCE GUIDELINE FOR HIGHWAYS AND ROADS

PROJECTS DEPARTMENT

MAY, 2014





TABLE OF CONTENTS

2. Project Objectives 4 3. Relevance to Overall Planning 4 4. Funding and Costs 4 5. Project Description 6 5.1 Project Location 6 5.2 Category of Road 7 5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7 Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3.1 Flora 22 9.3.1 Flora 22 9.3.1 Flora 22 24 10. 9.3.2 Fauna 24 10. 10. 10. Project Social Environment	1.	Applicant's Details:	4
3. Relevance to Overall Planning. 4 4. Funding and Costs. 4 5. Project Description. 6 5.1 Project Location 6 5.2 Category of Road. 7 5.3 Road Specifications 8 5.4 Excavated Materials. 8 5.5 Explosives. 9 6. Alternative/s 10 6.1 Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings. 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation. 17 9.2 Protected Areas 21 9.3.1 Flora 22 9.3.2 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Social Environment 24 10. Project Social Environment 24	2.	Project Objectives	4
4. Funding and Costs 4 5. Project Description 6 5.1 Project Location 6 5.2 Category of Road 7 5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7 Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Social Environment 24 10. Project Social Environment 24 10. Project Activities 26 10.4 Project Activities 26	3.	Relevance to Overall Planning	4
5. Project Description 6 5.1 Project Location 6 5.2 Category of Road 7 5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3.1 Flora 22 9.3.2 Fauna 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Social Environment 24 10. Project Social Environment 24 10. Project Activities 26 10.4 Project Activities 26 <	4.	Funding and Costs	4
5.1 Project Location 6 5.2 Category of Road 7 5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3.1 Flora 22 9 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Activities 26 10.4	5.	Project Description	6
5.2 Category of Road 7 5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 9 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Activities 26 10.4 Project Activities 26 10.4 Project Activities 26 11.1 Impacts due to earthworks and excavation 28 11.1 Impacts due to earthworks and excavation 28 11.2 Dust 30	5.1	Project Location	6
5.3 Road Specifications 8 5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6. Alternative/s 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 22 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Activities 26 10.4 Project Mates and Mitigation Measures 28	5.2	Category of Road	7
5.4 Excavated Materials 8 5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 9.3.2 Fauna 9.3.2 Fauna 24 10.1 Population 24 10.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites 25 10.3 Aesthetics 26 11. Project Impacts and Mitigation Measures 28 11.1 Impacts due to earthworks and excavation 28 11.2 Dust 30 11.3 Noise 30 11.4 Biological (vegetation, BC), Fauna 31	5.3	Road Specifications	8
5.5 Explosives 9 6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 9 9.3.2 Fauna 24 10. Project Social Environment 24 10.1 Population 24 10.2 Project Activities 26 10.3 Aesthetics 26 10.4 Project Activities 26 11.1 Impacts due to earthworks and excavation 28 11.1 Impacts due to earthworks and excavation 28 11.2 Mitigation measures 28 11.1 Sioise 30 <	5.4	Excavated Materials	8
6. Alternative/s 10 6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 24 9.3.2 Fauna 24 10.1 Population 24 10.2Loss of Houses, Services, Infrastructure and Cultural Heritage Sites 25 10.3 Aesthetics 26 10.4 Project Activities 26 11.1 Impacts due to earthworks and excavation 28 11.2 Dust 30 11.3 Noise 30 11.4 Biological (vegetation, BC), Fauna 31	5.5	Explosives	9
6.1 Alignment Alternatives: 11 7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 24 9.3.2 Fauna 24 10. Project Social Environment 24 10. Project Social Environment 24 10.2Loss of Houses, Services, Infrastructure and Cultural Heritage Sites 25 10.3 Aesthetics 26 10.4Project Activities 26 11. Project Impacts and Mitigation Measures 28 11.1Impacts due to earthworks and excavation 28 11.2Dust 30 11.3Noise 30 11.4Biological (vegetation, BC), Fauna 31	6.	Alternative/s	10
7. Public Consultation 12 8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 9 9.3.2 Fauna 24 10. Project Social Environment 24 10.1 Population 24 10.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites 25 10.3 Aesthetics 26 10.4 Project Impacts and Mitigation Measures 28 11.1 Impacts due to earthworks and excavation 28 11.2 Dust 30 11.3 Noise 30 11.4 Biological (vegetation, BC), Fauna 31	6.1	Alignment Alternatives:	11
8. Project Site Physical Environmental Details 13 8.1 Topography and Geology 13 8.2 Water Course Crossings 14 9. Project Site Ecological Description 17 9.1 Land Use/Vegetation 17 9.2 Protected Areas 21 9.3 Biological Information 22 9.3.1 Flora 22 9 9.3.2 Fauna 24 10. Project Social Environment 24 10.1 Population 24 10.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites 25 10.3 Aesthetics 26 11. Project Impacts and Mitigation Measures 28 11.1 Impacts due to earthworks and excavation 28 Mitigation measures 28 11.2 Dust 30 11.4 Biological (vegetation, BC), Fauna 31	7.	Public Consultation	12
8.1 Topography and Geology138.2 Water Course Crossings149. Project Site Ecological Description179.1 Land Use/Vegetation179.2 Protected Areas219.3 Biological Information229.3.1 Flora 22249.3.2 Fauna2410. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2611.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.4 Biological (vegetation, BC), Fauna31	8.	Project Site Physical Environmental Details	13
8.2 Water Course Crossings149. Project Site Ecological Description179.1 Land Use/Vegetation179.2 Protected Areas219.3 Biological Information229.3.1 Flora 2299.3.2 Fauna2410. Project Social Environment2410.2Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	8.1	Topography and Geology	13
9.Project Site Ecological Description179.1Land Use/Vegetation179.2Protected Areas219.3Biological Information229.3.1Flora 22249.3.2Fauna2410.Project Social Environment2410.1Population2410.2Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3Aesthetics2610.4Project Impacts and Mitigation Measures2811.1Impacts due to earthworks and excavation28Mitigation measures283011.3Noise3011.4Biological (vegetation, BC), Fauna31	8.2	Water Course Crossings	14
9.1 Land Use/Vegetation179.2 Protected Areas219.3 Biological Information229.3.1 Flora 22239.3.2 Fauna2410. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	9.	Project Site Ecological Description	17
9.2 Protected Areas219.3 Biological Information229.3.1 Flora 229.3.2 Fauna9.3.2 Fauna2410. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	9.1	Land Use/Vegetation	17
9.3 Biological Information229.3.1 Flora 229.3.2 Fauna9.3.2 Fauna2410. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	9.2	Protected Areas	21
9.3.1Flora 229.3.2Fauna2410.Project Social Environment2410.1Population2410.2Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3Aesthetics2610.4Project Activities2611.Project Impacts and Mitigation Measures2811.1Impacts due to earthworks and excavation2811.2Dust3011.3Noise3011.4Biological (vegetation, BC), Fauna31	9.3	Biological Information	22
9.3.2Fauna2410. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	9.3.	1 Flora 22	
10. Project Social Environment2410.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.4 Biological (vegetation, BC), Fauna31	9.3.	2 Fauna	24
10.1 Population2410.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	10.	Project Social Environment	24
10.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites2510.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	10.1	Population	24
10.3 Aesthetics2610.4 Project Activities2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	10.2	Loss of Houses, Services, Infrastructure and Cultural Heritage Sites	25
10.4 Project Activities.2611. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	10.3	Aesthetics	26
11. Project Impacts and Mitigation Measures2811.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	10.4	Project Activities	26
11.1 Impacts due to earthworks and excavation28Mitigation measures2811.2 Dust3011.3 Noise3011.4 Biological (vegetation, BC), Fauna31	11.	Project Impacts and Mitigation Measures	28
Mitigation measures 28 11.2 Dust 30 11.3 Noise 30 11.4 Biological (vegetation, BC), Fauna 31	11.1	Impacts due to earthworks and excavation	28
11.2 Dust 30 11.3 Noise 30 11.4 Biological (vegetation, BC), Fauna 31	Mitig	gation measures	28
11.3Noise3011.4Biological (vegetation, BC), Fauna31	11.2	Pust	30
11.4 Biological (vegetation, BC), Fauna	11.3	Noise	30
	11.4	Biological (vegetation, BC), Fauna	31



NHPP: ENVIRONMENT ASSESSMENT REPORT FOR ROADS

11.4.1 Vegetation	31
11.4.2 Fauna	32
11.5 Blasting, Explosives and Occupational, Health and Safety	33
11.6 Sedimentation of streams	34
12. Monitoring Program	39
13. Declaration of No Objection Certificate 4	14



1. Applicant's Details:

Name of Project: Nikachhu Hydropower Project

Applicant: Druk Green Power Corporation Limited

Mailing Address: Projects Department Druk Green Power Corporation Limited Thimphu Post Box 1351 Tel: +975 2 336413/336414 Fax: +975 2 336342 www.drukgreen.bt

Environment Focal Person: Mr. Pema Dorji

Qualification: B.Sc. Applied Physical Science

Designation: Environment Officer Tel: +975 2 339871

2. Project Objectives

The project is to cconstruct acess roads for 118MW Nikachhu Hydropower Project located at Trongsa. There shall be a total of 8 access roads taking-off from Highway with a total length of 16.488 km. The access roads are to cater to different project components of the Hydropower Project such as to Dam, ADITs, Surge Shaft and Power House during the construction of the project.

3. Relevance to Overall Planning

Nikachhu HPP was identified in the 20 year's Power System Mater Plan and its reconnaissance study completed in 2003. Its Pre-feasibility was carried out in 2010 and Feasibility Study completed in 2012. The Detailed Project Report has been completed in September 2013. The proposed roads are for the Nikachhu Hydropower Project.

4. Funding and Costs

The project shall be developed on 70% debt and 30% equity share by Druk Green. ADB has committed USD 120 million with USD 80 million loan and USD 40 million as the equity share of Druk Green. The total estimated cost of the overall Nikachhu



NHPP: ENVIRONMENT ASSESSMENT REPORT FOR ROADS

Hydropower Project is Nu. 11,964.59 million of which about Nu. 353.760 million alone is for construction of the access roads including the access road to quarry. The detail is as shown below:

Package No	Description	Length in km	Cost in Million Nu
1	Dam Complex	2.100	42.000
1	Adit 1 from NH2	2.278	45.560
	Adit 2 from NH2	1.973	39.460
2	Adit 3 from NH2	1.943	38.860
	Adit 4 from NH2	0.577	11.540
	Adit 5 from NH2	0.417	8.340
3	Adit to BVC and Surge Shaft top from		
	NH2	1.500	30.000
4	Power House Complex	5.700	114.000
5	Stone Quarry site	1.200	24.000
	Grand Total for Roads	17.688	353.760

Table 1: Shows total cost of the Project

The cost for Environment Management Plans (EMP) for roads is included in the overall project cost amounting to Nu.7.885 million out of the total EMP cost of Nu.123 million. The detail of the EMP cost is as given below:

Table 2: Total Cost of Environment Management of the Project

Description	Amount (Nu.)
Land acquisition compensation	7,993,656
Environmental management access roads	7,885,000
Tree planting	8,200,000
Wildlifeconservation	4,300,000
JSWNP engagement in project-related	
activities	8,260,000
Enhancement of staff colony and extra	
waste management	12,152,980
Required National Highway improvements	
and repairs	46,470,000
Specific fish monitoring tasks	1,800,000
Community support	3,100,000



NHPP: ENVIRONMENT ASSESSMENT REPORT FOR ROADS

Description	Amount (Nu.)
Reservoir management	5,070,000
Dam burst safety system	2,500,000
ECDMD operations: pre-construction and construction phases	8,606,000
ECDMD operations: operation phase (2 years)	1,338,000
Audits	2,000,000
Environmental monitoring (6 years)	3,600,000
Total	123,276,521

5. **Project Description**

5.1 **Project Location**

Eight access roads has been identified which takes-off from the Thimphu-Trashigang Highway (NH2). The entire road falls in Tangsibji Geog under Trongsa Dzongkhag. The details of road length and locations of take-off points and termination points is as shown in the table below:

Table 3: Road Length and Locations

CI				Locations		
JI. No	Description	Length	Village		Termination	
NU				Take-off	point	
	Access Road to Dam			90°22'21.644"E	90°22'22.172"E	
1	Complex from NH2	2.100	Lorim	27°27'5.512"N	27°26'55.415"N	
	Access Road to Adit-1			90°23'11.901"E	90°23'26.458"E	
2	from NH2	2.278	Nyla	27°26'56.919"N	27°26'59.718"N	
	Access Road to Adit-2			90°24'52.422"E	90°24'48.676"E	
3	from NH2	1.973	Zapla	27°26'52.865"N	27°26'42.483"N	
	Access Road to Adit-3			90°27'45.973"E	90°27'49.284"E	
4	from NH2	1.943	Tangsibji	27°27'57.731"N	27°27'57.018"N	
	Access Road to Adit-4			90°27'45.88"E	90°27'49.317"E	
5	from NH2	0.577	Tsangkha	27°27'57.703"N	27°27'56.949"N	
	Access Road to Adit-5			90°28'51.5"E	90°28'55.448"E	
6	from NH2	0.417	Norbuodi	27°28'42.224"N	27°28'46.593"N	
	Access Road to Adit					
	to BVC and Surge			90°29'10.644"E	90°28'52.053"E	
7	Shaft top from NH2	1.500	Norbuodi	27°29'25.744"N	27°29'29.576"N	



SI					Locations		
No	Descripti	ion	Length	Village		Termination	
NO					Take-off	point	
	Access	Road to		Norbuodi			
	Power	House		opposite	90°29'8.994"E	90°29'34.417"E	
8	Complex	from NH2	5.700	Chenjapang	27°29'24.413"N	27°29'16.793"N	
TOTAI LENGTH			16.488				

NHPP' ENVIRONMENT ASSESSMENT REPORT FOR BOADS



Project Layout showing all Access Roads

The Layout showing access roads is appended as *Annexure I* of the Report of the Nikachhu Hydropower Project

5.2 *Category of Road*

The road is classified as Access Road as per the road classification in Bhutan. The roads shall serve as access road to the project components like Dam, ADITs, Power House and Surge Shaft of 118MW Nikachhu Hydropower Project.

All the roads shall be temporary except for:

- Access road to Dam;
- Access road to Surge Shaft;
- Access road to Power House;
- Access road to ADIT 3 for Head Race Tunnel (HRT) maintenance during Operation and Maintenance stage.



The temporary roads shall be closed and revegetated once the project construction is completed.

5.3 Road Specifications

The total length of access roads shall be 16.488km with formation width of 6.26m. The roads will have adequate number of cross drainage structures and shall be paved at all locations. The proposed roads shall be constructed following the principle of Environment Friendly Road Construction of Bhutan. The summary of information on the access roads is given below;

Table 4: Road Specification

Item	Unit	DAM	ADIT	ADIT	ADIT	ADIT	ADIT	Surge	Power
			I	П	Ш	IV	V	Shaft	House
Road RoW width	m	Depe	nds on th	ne topog	raphy b	ased on	6.26m f	ormation	width
Formation width	m	6.26	6.26	6.26	6.26	6.26	6.26	6.26	6.26
Pavement width	m								
Pavement material		one laye	er 15cm s	stone an	d anoth	er layer	15cm W	MM (We	t Mix
		Macada	m)						
Volume of	m3								
excavated material	1115	Provide	d in Tab	le 5.4.1	below				
Maximum road	%	6.67	7.14	7.14	5.00	9.09	7.14	8.00	7.40
gradient									
Cross drains	20	0	0	1	4	2	-	-	2
(pipes) -Hume	no	2	2	4	4	3		1	3
nines Rox autorta	20		0	0	- 1	0	4	4	2
Box cuiverts	ΠΟ	I	2	2	I	0	I	I	3
Bridges/Causeways	no	2	3	4	4	0	0	3	8
V-shape side drain									
dimensions	om	60 x	60 x	60 x	60 x	60 x	60 x	60 x	60 x
(horizontal x	CIII	30	30	30	30	30	30	30	30
vertical)									
Total length of V	m	21	2.28	1 9/	1 97	0.57	0.417	15	57
shape drains		۲.۱	2.20	1.54	1.37	0.57	0.417	1.5	5.7

5.4 Excavated Materials

From access road excavation about 413,061 m³ of excavated materials shall be generated. The details on quantity of excavated materials from the access roads to each project components of Nikachhu Hydropower Project are as given below;

Table 5: Quantity of Excavated Materials



NHPP: ENVIRONMENT ASSESSMENT REPORT FOR ROADS

SI.no	Access Roads to;	Excavated material quantity (Cu m)
1	Dam	76,257.80
2	ADIT I	64,994.90
3	ADIT II	41,296.40
4	ADIT III	48,809.10
5	ADIT IV	10,269.00
6	ADIT V	8,487.52
7	Surge Shaft	35,568.66
8	Power House	127,378.22
Total Excavated Material		413,061.60

The excavated materials will mostly be soil as determined by the approximate rock classification carried out by Geologist, Druk Green along the access roads as shown below:

Table 6: Rock Classification

م ou	Approximately classification of the quantity of soil and rock based on rock outcrop along the Access roads to different Project Components of Nikachhu Hydropower Project, Trongsa.						
			% in	% in			
SI #	Name of Access Road	Length (Km)	soil	rock			
1	Access Road to Dam Complex	2.100	70	30			
2	Access Road to Adit-I to HRT	2.278	70	30			
3	Access Road to Adit-II to HRT	1.973	70	30			
4	Access Road to Adit-III to HRT	1.943	70	30			
5	Access Road to Adit-IV to HRT	0.577	60	40			
6	Access Road to Adit-V to HRT	0.417	70	30			
7	Access Road to Surge Shaft and BVC	1.500	70	30			
8	Access Road to Power House Complex	5.700	70	30			

The details of muck management is given in section 11.7.

5.5 Explosives

Blasting shall be done only on rock surface during excavation. For the construction of access roads ordinary gel with NED shall be used. Controlled blasting technique shall be adopted to maintain slope stability, to prevent fly rocks, reduce noise, and to reduce ground vibrations.



6. Alternative/s

The Reconnaissance Study of Nikachhu Hydropower Project was completed in 2003 and the Pre Feasibility Study (PFS) was carried out in 2010. The PFS report came out with six (6) alternative layouts, with three alternative dam axes(D1,D2,D3) and three powerhouse (PH1,PH2,PH3) locations. An updated PFSR was updated in December 2011. It abandoned the first two of the six alternatives and recommended the balance four for further studies. In this process, one of the dam axis, namely D1 and one powerhouse location, namely PH1 were ruled out. Various Alternatives for the project locations have been assessed. The four layouts (D2 PH2, D2PH3, D3PH2, D3 PH3) recommended in the updated PFSR are shown in **Fig. 6.1**. The deatails of the alternatives of the project layout is explained in Section 3: Project Alternatives, of the Environment Impact Assessment (EIA) Report.



Project Alternatives

However during the Feasibility Study further Detailed Study for Alternative 3 with Dam (D2) at Lorim and Power House (PH2) at Norbuodi was recommended and accordingly carried out. Other alternatives were ruled out due to geological, social and Environmental reasons.



6.1 Alignment Alternatives:

Road alignment studies were also carried out wherever possible;

1. Access road to ADIT-1:

Assessment has also been done to construct the access road to ADIT 1 bifurcating from the access road to Dam site instead of accessing from the National Highway. However, this alignment would trespass through the Royal Lamdro. Therefore this alignment has not been considered.

2. Access Road to ADIT-4

Alternative study to access ADIT-4 from the existing Tsangkha Power Tiller track has been carried out and the following drawbacks were noted:

- crematorium needs relocation;
- number of Project Affected People increases:
- impact on community forest;
- alignment crosses two streams;
- steep gradient

Therefore, the alignment taking-off from the NH2 was found suitable.

3. Access Road to Power House

Assessment was carried out to construct the access road to Power House from Mangdechhu HEP Dam site. However, it was ruled out due to the following constraints:

- The Longtoe quarry site identified for project use is located about 50 km from the Power House site considering access from NH2. Had the access road been from the MHEP Dam site, the distance would be more than 90 km which would substantially increase the transportation cost;
- Since the construction of MHEP shall not be completed when Nikachhu HPP construction begins, there will be interferences to MHEP construction activity;
- There will be increased traffic along the access road to MHEP Dam since both the projects shall be using the access road for Dam of MHEP and Power House of NHPP

7. Public Consultation

Majority of the Project Affected People are due to construction of access roads. The Public Consultation Meeting for Nikachhu Hydropower Project was held on January 27, 2014 in presence of the Dzongkhag Administration and geog Administration. During the meeting it was also briefed on the locations, length, impact, EMP and identified the affected people due to the access roads. Issues pertaining to access road have been addressed during the overall Project Public Consultation Meeting. The Minutes of Meeting is attached as part of overall ESIA document.



8. Project Site Physical Environmental Details

8.1 Topography and Geology

Most of the access road alignment of Nikachhu Hydropower Project goes through Colluvium region and Granetic Gnesis. The maps showing Geology at each locations is attached as *Annexure-II.* The Table below shows the details of Geology at each access roads;

Table 7: Topography and Observation along the Roads

Access Road to;	Side Slope in percentage (%) or degrees	Observations on geology	Method of Slope the terrain stabilization Above road Below road
Dam		Colluvium	
		Granetiferous Micaceous Schist	
ADIT I		Colluvium	
	Aug. 45%	Granetic Gnesis	
ADIT II	Avg. 45*	Colluvium	
		Granetic Gnesis	
ADIT III		Colluvium	Refer section
		Granetc Gnesis	11.1
ADIT IV	Avg 55°	Colluvium	
ADIT V		Colluvium	
S/Shaft		Colluvium	
	Avg 45°	Granetic Gnesis	
Power House		Colluvium	

Lansford (1999) described colluviums as the landslide debris which slowly accumulated on long slopes of mountains. Slope failures often occur during peak rainfall. The risk of



slope instability is more at sites characterized by colluviums. However, if appropriately engineered, the presence of colluviums may not preclude development.

However, Granetic Gnesis are strong rocks as classified by Selby (1980) as in the Table below;

Descripton	Example
Vory Wook Pooks	Chalk Book salts Lignita
Very Weak HUCKS	
Weak Rocks	Coal, Siltstone, Schist
Moderate Strong Rocks	Slate, Shale, Sandstone, Ignimbrite
Strong Rocks	Marble, Limestone, Granite, Gnesis
Very Strong Bocks	Quartzite dolerite

Table 8: Classification of the Physical Strength of some rock types

Source: Soils: Gnesis and Geomorphology, Randall Schaetzl & Sharon Andreson

8.2 Water Course Crossings

Although the access roads in total crosses stream at 21 chainages, the streams crossed are only four one stream by access road to ADIT III, one by access road to Surge Shaft, one by the access road to Power House and one stream crossed by the access road to Pressure Shaft.

Along all those crossing, culverts and causeways are proposed so as to allow the natural flow of the stream and also to minimize sedimentation of the streams. The details of the access road where it cross streams are given in the table below;



Table 9: Details of Watercourse Crossing by the Roads

				Remarks			
Access Road to;	Chainage	Name of water course	Type of crossing	Name of User	Households (no) Type of use		
ADIT-III	1+449	Tsheringma Drupchhu	Causeway	Tangsibji Microhydel and Tangsibj village	80	Irrigation and Electricity	Zalamchhu is the main source of water for the 30 kW MicroHydel which is further used for irrigation. Tsheringma Drupchhu is just a tributary of Zalamchhu.
Surge	0+454	Tributary to Mangdechhu	Causeway and Culverts	No Downstream User			It's a tributary to Mangdechhu which joins after the MHEP Dam
Shaft Top	0+321						
	0+35						
	0+317						
	0+800						
Douror	1+364	Tributary to	Coupoway and	No Douroctroom			It's a tributary to Mangdechhu
House	1+714	Mangdechhu	Causeway and	NO DOWNSTREAM			which joins after the MHEP
110030	2+380	(A)	Guivents	0301			Dam
	2+440						
	3+140						
	3+460						
	4+095						



				Downstrear	m water users-	details	Remarks
Access Road to;	Chainage	Name of water course	Type of crossing	Name of User	Households (no)	Type of use	
	4+230						
	4+582						
	4+731						
	4+900						
	5+023						
	5+096	Tributary to					It's a tributary to Manadechbu
	5+301	Mangdechhu	Causeway and	No Downstream			which joins after the MHEP
	5+414	(B)	Cuivens	User			Dam



9. **Project Site Ecological Description**

9.1 Land Use/Vegetation

The roads at most chainages pass through State Reserved Forest Land and only about 14,474.69 m² of private land are affected by road. For all those facilities falling in SRFL, the Forest Clearance have been received and blanket NOC has been obtained for Nikachhu Hydropower Project.

	Chainage from		Land use	Area (m ²)	Tenure	Affected
SI. No.	take	e off				House
	То	From				holds (no)
1	DAM		•			
	0-00	0+021	Natural Pasture	178.50	Government Land	
	0+021	0+097	Kamzhing	433.01	Private Land	
	0+097	0+237	Broadleaved Forest	2,839.00	SRFL	Two
	0+237	0+346	Kamzhing	1,942.49	Private Land	
	0+346	2+100	Broadleaved Forest	12,979.50	SRFL	
2	ADIT-I					
	0-00	2+278	Broadleaved Forest	21,165.10	SRFL	Zero
	ADIT-II					
3	0-00	1+973	Broadleaved Forest	18.008.53	SRFL	Zero
4	ADIT-III					
	0-00	0+174	Kamzhing	1,711.83	Institutional Land	Namgay Choling Community Primary School
	0+174	1+943	Broadleaved Forest	19,169.98	SRFL	Zero
5	ADIT-IV					

Table 10: Land Use along Access Road



SI. No.	Chaina take	ge from e off	Land use Area (m ²)		Tenure	Affected House
	То	From				holds (no)
	0-00	0+577	Broadleaved Forest	6070.29	SRFL	Zero
6	ADIT-V					
	0-00	0+417	Natural Pasture	3,197.02	Government Land	Zero
7	ADIT to	Surge Sha	aft Top			
	0-00	0+246	Broadleaved Forest	2,091.00	SRFL	
	0+246	0+311	Kamzhing	849.84	Private Land	One
	0+311	1+500	Broadleaved Forest	13,772.69	SRFL	
8	Power H	ouse Corr	plex			
	0-00	0+65	Broadleaved Forest	837.20	SRFL	
	0+65	0+136	Kamzhing	975.29	Private Land	
	0+136	0+190	Broadleaved Forest	695.52	SRFL	
	0+190	0+257	Kamzhing	1,133.12	Private Land	
	0+257	0+295	Broadleaved Forest	489.44	SRFL	
	0+295	0+337	Kamzhing	574.65	Private Land	
	0+337	0+553	Broadleaved Forest	2,782.08	SRFL	
	0+553	0+648	Kamzhing	1,408.30	Private Land	
	0+648	0+783	Broadleaved Forest	1,738.80	SRFL	Nine
	0+783	0+894	Kamzhing	472.72	Private Land	
	0+894	1+241	Broadleaved Forest	4,469.36	SRFL	
	1+241	1+356	Kamzhing	534.19	Private Land	
	1+356	2+171	Broadleaved Forest	10,497.20	SRFL	
	2+171	2+285	Kamzhing	1,590.42	Private Land	
	2+285	2+460	Broadleaved Forest	2,254.00	SRFL	
	2+460	2+598	Kamzhing	1,424.50	Private Land	

PROJECTS DEPARTMENT

Page 18



SI. No.	Chaina take	ge from e off	Land use	Area (m ²)	Tenure	Affected House
	То	From				holds (no)
	2+598	3+105	Broadleaved Forest	6,530.16	SRFL	
	3+105	3+115	Kamzhing	667.73	Private Land	
	3+115	5+700	Broadleaved Forest	33,294.80	SRFL	
9	Road to	Pressure	Shaft			
	0+00	0+200	Broadleaved Forest	4,492.01	SRFL	Zero
	Tota	I Area in	m²	181`,553.50		Eleven

The road construction shall be done in 5 packages with Package -1 for Dam complex and ADIT-I, Package-2 for ADIT-II, ADIT-III and ADIT-IV, Package-3 for ADIT-V and ADIT to Surge Shaft top, Packacge -4 for Power House Complex and Package-5 for Quarry site. During roads construction workers, vehicles, machines and equipments shall be deployed for which temporary labour camps, parkings and site offices are required. These areas shall be allocated at the area identified for Contractor's Construction Facility (CCF) for the overall Nikachhu Hydropower Project, since the road construction works shall be executed as pre-construction activity before the start of main project activities. The details of CCF area and initial job facilities area allocated for Nikachhu Hydropower Project is as given below:

Project			
Components	Area (m2)	Tenure	Remarks
Dam	63,940.39	SRFL	
Power House	67,137.41	SRFL	
Surge Shaft	12,140.58	SRFL	The area is for the
ADIT-I	3,642.17	SRFL	Establishment Facliity
ADIT-II	10,117.15	SRFL	Hydropower Project
ADIT-III	26,304.59	SRFL	
ADIT-IV	10,117.15	SRFL	

Table 11: Area allocated for CCF of Nikachhu Hydropower Project



Project Components	Area (m2)	Tenure	Remarks
ADIT-V	10,117.15	SRFL	
TOTAL	203,516.59		

The total area allocated for the CCF is 203,516.59 m² of which only 3,193.90 m² is required for the initial job facilities including the labour camps, site offices and stores during the pre-construction activities with 2113.90 m² and 1080 m² for job facilities for contractor and the client respectively. The details on area of land required during pre-construction activity are as given below:

Table 12: Area for facilities during Road construction

			Pi	roposed	Area in m ²		
Facility	Dam & Adit 1	Adit 2	Adit 3	Adit 4	Adit 5, BVC, SS and PS	Power House and TRT Area	Total
Site Office	275.00	99.00	99.00			275.00	748.00
Transit Camp	200.20					200.20	400.40
Stores	100.00					100.00	200.00
Labour Camp Incl. bathroom and mess	382.75					382.75	765.50
		Тс	otal Area	1,365.90	2,113.90		

a. Initial Job Facilities for Contractor

b. Initial Job Facilities for Client

		Proposed Area in m ²										
Facility	Dam & Adit 1	Adit 2	Adit 3	Adit 4	Adit 5, BVC, SS and PS	Power House and TRT Area	Total					
Site Office incl.												
Store	170.00	-	-	-	-	220.00	390.00					
Transit Camp												
for Site	240.00					240.00	480.00					
Supervisor's						300.00						
camp	240.00		60.00			300.00	600.00					



Total	480.00	-	60.00	-	-	540.00	1 080 00
		Тс	otal Are	a in m	2	1,080.00	1,000.00

All the facilities fall in State Reserve Forest Land constituting Broad-leaved vegetation.

9.2 **Protected Areas**

Only access road to ADIT 2, of the eight access roads to different component, falls in one of the biological corridors connecting Jigme Singye Wangchuk National Park with the Wangchuk Cenntenial Park located in the north. The three corridors that connect JSWNP and Wangchuck Centennial National Park (WCNP) combined represent the largest area (601 km²) compared to all the other biological corridors. The species of interest that may be using these corridors include: Tiger; Red panda; Sambar, Barking Deer, Himalayan Black bear, and musk deer. Tigers have been associated with five other corridors, so are not restricted to just the JSWNP-WCNP corridors; red pandas are associated with two other corridors; musk deer with three other biological corridors as shown in the Table below. The main point here is that the JSWNP-WCNP corridors, especially the eastern one (of three) are not unique in providing safe movement corridors for the species and it is not the main migratory route for the species.

Moreover, the area required for the ADIT-II during its construction including the Access Road, Muck Disposal Site and Contractor Establishment facility is only 0.089 km² of the total 601km² area of the Biological Corridor which is about 0.015%.

Biological Corrido#	Wildlife species of interest (MacKinnon	Area	Length	Bottle- necks	House	eholds in midor	Househ	olds in 500 buffer	Geogs	Dzongkhags	Territorial Divisions	FMUs (as of 2005)
	1999)	(ware)	(see a	wide	N	N/ km²	N	N/km*				
1. TSNR to JDWNP	Takin, blue sheep, musk deer, red panda, snow leopard	149	30	0	40	0.3	239	8.0	Tsento, Bji	Haa, Paro	Paro	None
2. JDWNP to JSWNP	Red panda, musk deer	275	56	2	275	1.0	492	8.8	Kakjisa, Toepisa, Chang, Nahi, GaseWom, Daga	Punakha, Thimphu, Wangdue	Wangdue, Thimphu	Chamgang - Helela
3. Phijesoo WS to JSWNP & RMNP	Tiger, gaur, elephant	376	51	2	311	0.8	1336	26.2	Dunglegang, Beteni, Senge, Hile, Dokhan, Leopani, Bhur, Surey, Serzhong, Dhanabari	Sarpang, Tsirang	Tsirang, Sarpang	None
4. Thrumshingla to RMNP and JSWNP	Tiger	501	40	2	63	0.1	489	12.2	Chumey, Langthel, Nangkhor, Trong, Shingkhar	Trongsa, Zhemgang, Bumthang	Bumthang, Zhemgang	Kikhar Buli
5. RMNP to Khaling WS	Tiger, gaur, elephant, mino	212	49	3	95	0.4	456	9.3	Norbugang, Bakuli, Orong	Samdinap- Jongkhar	Samdrup- Jongkhar	None
6. Khaling WS to Sakteng WS	Tiger, gaur	160	32	0		0.0	1	0.0	Serthi, Shingkarlauri, Kangpara, Martsala, Samrang	Trashigang, Samdrup- Jongkhar	Trashigang, Samdrup- Jongkhar	None
7. Thrumshingla NP to Bomdeling WS	Tiger, red panda, musk deer	79	17	1	188	2.4	327	19.2	Jare, Tsamang, Tsengkhar, Shermuing	Mongar, Lhwentse	Mongar	None
8. JSWNP to WCNP & JDWNP	Tiger, takin, blue sheep, red panda, musk deer	601	55	2	NA	N/A	N/A	NA	N/A	Wangdue, Trongsa	Wangdue, Bumthang	Three FMUs
9. WCNP to Bomdeling WS	N/A	119	17	3	N/A	NA	N/A	NA	NA	Lhuentse	Mongar	None
Total		2472		15	973		3340		> 35	12	10	в

Abbreviations: JDW - Jigme Digye Wangchuck, J5W - Jigme Singye Wangchuck, NP - National Park, RM - Royal Manas, SNR- Strict Nature Reserve, WC - Wangchuck Centennial, WS - wildlife Sanctaary. Housebold deniity in buffer zone - bousebolds/corridor length (+ household per km² because the combined buffers are 1 km wide).



8. JSWNP to WCNP & JDWNP	Tiger, takin, blue sheep, red panda, musk deer	601	55	2	N/A	NA	N/A	N/A	N/A	Wangdue, Trongsa	Wangdue, Bumthang	Three FMUs	
-----------------------------	--	-----	----	---	-----	----	-----	-----	-----	---------------------	----------------------	------------	--

Table 9.2.1 Relative importance of the JSWNP-WCP biological corridors

9.3 Biological Information

9.3.1 Flora

Vegetative cover was sampled at different area as part of overall project sampling. The vegetative cover of the project area is mainly Broad leaved forest.

a. Access road to Dam

The vegetation along the access road to dam area comprises mostly evergreen oak forest, mixed with higher altitude broadleaf species. The main tree species found in this area are *Quercus griffithii*, *Quercus lamellose*, *Quercus lanata*, *Persea clarkeana*, *Acer campbellii*, *Alnus nepalensis*, *Betula alnoides*, *Erythrina arborescens*, *Lyonia ovalifolia*, *Persea bootanica*, and *Juglans regia*. Others, such as *Rhododendron arboreaum*, *Daphne sureil*, *Persea clarkeana*, interspersed with *Pinus wallichiana*, *Castanopsis hystrix*, and smaller oaks are also seen.

b. Access Road to ADIT-1

The vegetation is similar to the dam area, with the top canopy is dominated by *Quercus* griffithii, *Quercus lamellose*, *Quercus lanata*, *Persea clarkeana*, *Alnus nepalensis*, *Betula alnoides*, *Persea species*, *Castanopsis hystrix*, and *Rhododendron arboreaum*. The middle canopy comprises mostly smaller oak trees, *Daphne sureil*, *Persea clarkeana*, *Lyonia ovalifolia*, *Carpinus viminea*, *Viburnum*, *Berberis*, *Rubus*, *Hedysarum*, *Gaultheria*, *Aconogonum mollee*, *Eleocarpus*, *Ilex*, and *Usanus microphylla*. The herb and ground cover comprises mostly ferns, such as *Pteridium*, *Asplenium*, and *Drymaria* spp. *Eupatorium*, *Crassocephalus crepidioides*, *Cynoglossum Hypericum*, *Gnaphalium*, *Potentilla*, *Artemesia*, *Desmodium*, *Arisaema*, *Leucas*, *Campylotropis*, *Galium*, *Anselia*, *Ophiopogon*, and *Geranium* are some of the more common groundcover species. *Primula*, *Viola*, *Oxalis*, *Agepatus* and *Taxas Baccata* are also observed in along the Access road to ADIT-1. *Taxas Baccata* is identified as a protected species in the Schedule-I of Forest and Nature Conservation Rule of Bhutan, however, it is listed as Least Concern by IUCN.

c. Access Road to ADIT-2

The forest comprises mostly broadleaved species, interspersed with Oaks. The dominant species include *Castanopsis hystrix* and *Castanopsis tribuloides, Quercus lamellose, Quercus lanata, Quercus griffithii, Lyonia ovalifolia, Alnus nepalensis,* and



Pinus wallichiana. The shrub layer comprises Berberis aristata, Edgeworthia gardneri, Elsholtzia fruticosa, Eurya serrata, Eurya acuminate, Gaultheria fragrantissima, Viburnum cylindricum, Viburnum cylindricum, Artemesia dubia (Besser), Rubus ellipticus, and Aconogonon molle. The groundcover comprises mostly Anaphalis triplinervis, Ainsliaea aptera, Gentiana pedicellata, Girardiania diversifolia, Eupatorium odoratum, Fragaria nubicola, Persicaria nepalensis, Hedychium ellipticum, Hemiphragma herterophyllum and Pteridium aquilinum.

d. Access Road to ADIT-3

The dominant trees in this area are oaks, such as *Quercus glauca, Quercus griffithii*, and *Quercus lanata*, and *Rhododendron arboreum*, *Erythrina arborescens*, *Castanopsis hystrix*, *Lyonia ovalifolia*, and *Rhus chinensis* interspersed with *Pinus wallichiana*. The understorey and shrub layer is quite sparse and mainly dominated by smaller oak trees and *Lyonia ovalifolia* and *Rhus chinensis*. The dominant shrubs are *Edgeworthia gardneri*, *Elsholtzia fruticosa*, *Eurya serrata*, *Gaultheria fragrantissima*, *Hedychium ellipticum*, *Hedysarum sikkimense*, *Saurauia napaulensis*, *Viburnum cylindricum*, *Viburnum cylindricum*, *Artemesia dubia (Besser)*, *Rubus ellipticus*, *Aconogonon molle*, and *Tetradium daniellii*. The ground cover comprises mostly *Cotoneaster microphylla*, *Anaphalis triplinervis*, *Ainsliaea aptera*, *Gentiana pedicellata*, *Girardiania diversifolia*, *Eupatorium odoratum*, *Fragaria nubicola*, *Persicaria nepalensis*, *Hedychium ellipticum*, *Halenia elliptica*, *Inula cappa*, *Hemiphragma herterophyllum*, and *Pteridium aquilinum*.

e. Access Road to ADIT-4

The dominant tree species are Alnus nepalensis, Quercus griffithii, Betula alnoides, Lyonia ovalifolia, Quercus lanata, Rhododendron, and Benthamedia capitata. The shrub layer comprises species like Rhus chinensis, smaller Quercus, Rhododendrons, and Lyonia and Castanopsis trees. Other shrubs include Eurya serrata, Viburnum cylindricum, Hedysarum sikkimense, Aconogonon molle, Eupatorium odoratum, and Rubus ellipticus. The ground cover is mostly dominated by Eupatorium adenophorum, Hedychium ellipticum, Cautleya gracilis, Cirsium verutum, Bidens pilosa, Carex nubigena, Oxalis corniculata, Anaphalis triplinervis, Desmodium elegans, and Pteridium aquilinium

f. Access Road to ADIT-5

The dominant trees are Alnus nepalensis, Lyonia ovalifolia, Quercus lanata, Quercus griffithii, Erythrina arborescens, Benthamedia capitata, Daphne sureil, Rhus chinensis, Toricellia tiliifolia, and Rhododendrons. The shrub layer comprises smaller trees, such as Alnus, Benthamedia, Rhododendrons, Rhus chinensis, Berberis aristata, Elsholtzia fruticosa, Eurya acuminate, Eurya acuminate, Rosa brunonii, Arundinaria, Viburnum erubescens, and Rubus ellipticus. The ground cover is sparse and comprises mostly Artemesia dubia (Besser), Eupatorium odoratum, Pteridium aquilinum, Anaphalis triplinervis, Carex nubigena, Desmodium elegans, Fragaria nubicola, Hedychium ellipticum, Hedychium spicatum, Rubus ellipticus, Nepeta laevigata, and Ophiopogon intermedius.



g. Access Road to Power house Complex

Here the forest is mostly dominated by broadleaf forest trees and Oaks, such as *Quercus griffithii* and *Quercus lanata*. Other dominant species are *Alnus nepalensis*, *Betula alnoides, Rhododendron spp., Erythrina arborescens, Juglans regia, Persea bootanica, Lyonia ovalifolia, Fraxinus, Albizia* spp., *Magnolia, Ex-bucklandia populnea, Carpinus veminii, Macaranga* spp., and *Pinus wallichiana*. The middle story is dominated by small trees such as *Alnus nepalensis, Quercus griffithii, Quercus lanata, Rhododendrons, Erythrina arborescens, Docynia indica,* and *Lyonia ovalifolia*. The shrub layer is dominated by *Arundinaria* spp., *Eurya acuminate, Daphne sureil, Berberis aristata, Elaegnus parvifolia, Brassaiopsis mitis (Clarke), Aconogonum mollee, Symplocus paniculata, Measa chisia, Viburnum erubescens, Solanum khasianum, Rubus ellipticus, Rosa brunoii, Girardiana diversifolia, and Rhus chinensis. The groundcover comprises mostly Desmodium elegans, Artemesia, Eupatorium odoratum, Hedychium ellipticum, Pilea anisophylla, Poa annua, and Pteridium aquilinium.*

9.3.2 Fauna

Survey of Fauna has been carried out for the overall project. The dropping and fresh hoof marks such as Sambar deer, barking Deer, Horry bellied squirrel, Stripped Squirrel, Himalayan Black Bear and Porcupine have been seen. Assamese macaque, red fox, wild boar and Deer were spotted during the survey. The list of faunal species recorded by Jigme Singye Wangchuk Park is provided as *Annexure-III* of the report.

10. Project Social Environment

10.1 Population

Tangsibji Geog has about 166 households with about 1026 people as informed by the Gup of Tangsibji. It constitutes four Chiwog namely Tsangkha, Tangsibji, Nyala-Drangla and Chendibji. The Access Roads to Dam, ADIT-I and ADIT-II falls under Nyala Chiwog, Access Road to ADIT-III under Tangsibji Chiwog and Accesss roads to ADIT-V,Surge Shaft, Power House and the common muck disposal site under Tsangkha Chiwog. Although there is no house within 50m on the either sides of the Access Roads, there are few households located within 2km from the Access Roads. The number of households (Project beneficiaries) and detail of access roads are as given below:

Table 13:	Households within 2km of Access Road
-----------	--------------------------------------

Dzongkhag	Geog	Access Road To;	Length of Access Road (km)	Households (no)	Distance from Road (Meter)
Trongsa	Tangsibii	Dam	2.100		
0	01	ADIT-I	2.278		



ADIT-II	1.973		
ADIT-III	1.943		
ADIT-IV	0.577		
ADIT-V	0.417		
Surge Shaft	1.500		
Power House	5.700		
Quarry	1.200	25	500
TOTAL	17.688		

Source of information: data collected on ground

The total road length is 17.688km including the access road to Quarry identified at Longtoe. The detail EIA of access road to quarry shall be carried out separately during the preparation of Final Mine Feasibility Report.

10.2 Loss of Houses, Services, Infrastructure and Cultural Heritage Sites

No houses, infrastructures, services and cultural sites are located within the area of proposed Access Roads and therefore do not have any direct impacts (loss) to any existing houses, infrastructure and cultural or heritage sites. However, the access roads to ADIT-III which shall be using the existing farm road to Tangsibji may pose disturbance due to noise and dust to few households and Tsangkha Lhakhang which are located about 100m from the take-off point. As the Access road reaches its termination point on the existing farm road, it approaches Namgaycholing Community Primary School at about 50m. This might disturb the school due to dust and noise. Since the road shall be blacktopped the impact due to dust shall be less, however, appropriate measures like traffic management and dust suppression activities shall be carried out and monitored regularly with these points providing greater importance. The Access road thereinafter goes through SRFL and do not impact any heritage site, house, infrastructure and services. An A3 map showing the Cultural Sites, Infrastructure and houses is attached as **Annexure-IV** of the report. The details of the infrastructure/houses/service/heritage site are given below in the Table:

Type of Loss	(no)	Description of disturbance
Services (list)	None	
Houses	Ten (present at ADIT-III road take-off)	Disturbance due to noise, traffic and dust
Infrastructure	None	
Cultural Sites	One (due Access Road to ADIT-III	Distance is 100m from disturbance due to noise and dust
Heritage Sites	None	

Table 14: Details	of Infrastructure	and Cultural	Sites in Proxim	ity to Access
Roads				



10.3 Aesthetics

All the roads except for the access road to ADIT-IV located between Shauchhu and Gongkhorchhu is visible from the Highway passing-by Tsangkha. Therefore, during construction there might be impact on aesthetics, however, the impact is temporary and shall occur only during the pre-construction stage of the Nikachhu Hydropower Project.

10.4 **Project Activities**

Major project activities involve Formation cutting, Sub-Grade Preparation, Base course and Black topping. The methodology of work execution is as follows;

10.4.1 Setting out of the road alignment

The contractor shall establish working bench marks at suitable locations, with their qualified surveyor, in the area soon after taking possession of the site. The alignment of the road shall be surveyed and pegging done on ground. Fixing of the reference marks along the alignment shall be at 15m apart in straight reaches , 10m apart along curves and near all cross drainage structures, bridges and causeways

10.4.2 Clearing and Grubbing

This shall include cutting, removing and disposing of all materials such as trees, bushes, stumps, roots, grasses, weeds, top organic soil not exceeding 150mm in thickness. All products of clearing and grubbing that cannot be used shall be cleared from roadside and disposed. Trees felt shall be property of the Royal Government.

10.4.3 Excavation of Roadway and Drains

The work shall include excavation of, removal and disposal of materials necessary for construction of roadway, side drains and waterways. It shall include hauling and stacking to the sites of embankment and subgrade construction, disposal of unsuitable cut material in designated sites, trimming and finishing of road.

10.4.4 Rough Excavation and Filling

It includes bringing earth from hillsides cutting, borrow. Hillside sutting shall be done from top to bottom. During excavation the contractor shall maintain the natural/manmade drainage of the area. Earth used for filling shall be free of stone and organic matters and the excavated materials from the same area shall be used for filling.

10.4.5 Preparation of Sub-grade

The surface of the formation of a width of sub-base, which shall be 15cm more on either side of the base course, shall be first cut to a depth equal to the combined depth of sub-base and base course below the finished level. It shall be clear of all foreign substances. The sub-grade shall be consolidated with a power road roller. The roller



shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as elastic mass.

10.4.6 Granular Sub-base

Well graded materials shall be laid and compacted on prepared sub-grade. The materials shall be laid in one or more layers. The sub-base material of grading shall be spread on the prepared sub-grade with the help of motor grader. Thereafter, rolling shall start. Rolling shall be continued till the density achieved is at least 98% of the maximum dry density. The sub-base shall be prepared to receive the Wet Mix Macadam. Any rust and sift yielding plans shall be corrected and rolled until firm surface is obtained.

10.4.7 Compaction

After the Mix has been laid to the required thickness, the grade shall be uniformly compacted to the full depth with roller. Rolling shall be continued till the density achieved is atleast 98%. After final compacting of the wet mix macadam course, the road shall be allowed to dry for 24 hours.

10.4.8 **Protection Works and drainage wotks**

Protection works in the form of breast wall and retaining walls shall be provided at all locations as instructed by the Engineer-In-Charge. The size and height of the walls shall be approved by the EIC.



11 Project Impacts and Mitigation Measures

11.1 Impacts due to earthworks and excavation

Earthwork is the major activity associated with road construction, which involves excavation, cutting of slopes and formation of embankment. Fresh cut invites landslides and erosion which are triggered by rainfall. Slope failure is the mass movement either on mad-made slopes such as road cuts and fill or on natural slopes. The slope failure depends primarily on soil, geology and topography. Since the topography of the project area is steep the risk of slope failure is higher if appropriate measures are not implemented. For all the access roads formation width of 6.6m shall be excavated. During monsoon, the potential for slope failure increases both on the hill side slope as well as the filling area which may impact the road and vegetations respectively. The inappropriate and unstable spoil disposal can cause environmental problem in road construction, particularly in hill ecological regions. About 413,061 m³ of excavated materials shall be generated. The common likely problems from the inappropriate excavation and disposal of spoils are:

- Loss of nutrient rich top soil
- Gullying and erosion of spoil tips, especially when combined with unmanaged surface water runoff,
- Slope overloading and resultant failure and mass wasting,
- Disruption of natural drainage pattern, causing scouring, erosion and landslide,
- Damage and destruction of existing vegetation,
- Water pollution and degradation of water quality;

The above said problems may occur all along the road alignment. The impacts from excavation and spoil disposal during the construction of the proposed road will be significant, if proper mitigation measures are not adopted.

Mitigation measures

- Appropriate road construction technology shall be adopted during formation cutting; since the topography of the overall project area is steep the best method is the Cut and Fill method;
- Retaining walls with gabion boxes shall be provided. The retaining walls with gabion boxes are permeable and are flexible enough to adapt to small slope movement;



- In gullies or depressions the retaining walls with hume pipe culverts shall be laid before filling in the excavated materials to prevent silting of stream by erosion of the excavated materials during monsoon;
- After the completion of formation cutting, bioengineering works shall be carried out in conjunction with the construction of breast walls and retaining, wherever necessary;
- Most of the excavated materials shall be reused in filling. The earth used shall be free from stone, shingles, boulders larger than 75mm, slats, organic or foreign matter. The filling shall be done in layers not exceeding 20cm with each layer rammed with iron rammer where feasible and butt-ends of crowbars where rammers cannot be used. The density of compaction shall not be less than 90% of the maximum dry density as determined by the standard proctor test. Compaction increases the density of material and reduces pore space.
- Adopt bio-engineering technology Bio-engineering is an integral component of Environmental Friendly Road Construction. It is a combination of small-scale civil engineering structures and vegetative systems to enhance the slope stability condition. The major threat to the sustainability of the roads is erosive effect of water, in particular the scourng of side drains, drainage outfalls, roads and embankment edge and exposed slopes in cuts. Innovative work in several countries including in Bhutan has demonstrated that it is possible to select and utilize particular combinations of local plants species to provide sound engineering solutions.

Slope Protection Bio-engineering works

- Jute Geo-textile: open weave jute geo-textile shall be used for slope stabilization to reduce the velocity of surface run-off and to prevent the erosion of topsoil of the slope. Jute being agro-mulching and having high moisture absorption capacity will ensure fast growth of vegetation. Bioengineering shall be done using selected vegetations such as *Lycopodium* and *Alnus nepalensis* found in vicinity of the project area to protect the slope in monsoon;
- Wattling Trenches: Trenches of about 0.3m wide and 1m deep shall be dug upon the counters at spacing of 3 to 5m and filled with brush wood bundles, with approximately 5-6cm in diameter, horizontally to act as permeable barrier entrapping the erodible soil. The trenches will be backfilled with available earth;



• **Plantation:** seeds of plants which can grow on the existing slopes shall be fixed with fertile soil and fertilizer and spread on slopes stabilized by wattling trenches and jute geo-textile in consultation of agronomist of the area;

11.2 Dust

Road construction will involve excavation and movement of heavy vehicles for transportation of construction materials and excavated materials which may cause dust generation. Dust would impact health of the workers and people residing nearby. Dust if not monitored would cause respiratory problems apart from reducing the visibility along the road.

Mitigation Measures:

- Water shall be sprayed regularly along the road construction area to suppress dust generation ;
- Speed limits for vehicles plying on the road shall be enforced to limit dust generation;
- While most of the excavated materials shall be either be reused or filled on the road side-cast, the remaining shall be dumped in the identified Muck Disposal Sites. During transportation, appropriate freeboard shall be maintained in trucks carrying excavated materials. The trucks shall have the loads covered with tarpaulin when it leaves the reserve to avoid dusting of area;
- Workers shall be provided with mouth mask to prevent inhaling dust;

11.3 Noise

During road construction several trucks, excavators and rollers shall be deployed for the construction of work due to which increase in the noise level would occur The Pavement works involve;

- Preparation of subgrade with proper camber by excavating to depth equal to pavement thickness, consolidation with roller;
- Consolidation of subgrade with roller and making good the undulation with earth and rerolling the sub grade;
- Providing and laying Granular Sub-Base material (GSB Grading-II) to required degree of compaction with proper formation of cross fall using mortar garder for laying and compacted;



- Providing and laying wet mix macadam graded aggregate base course to required degree of compaction with proper formation of cross fall using well graded crushed aggregate premixed using suitable mixer and mortar grader;
- Providing and laying Hammber dressed stone edging 150 x 250 mm with stones;

These activities might generate noise, however, since no households are near the access roads except for Access road to ADIT- III, the impact of noise on people is less. While there might be impact on wildlife due to noise the construction work shall not occur at night when major wildlife movement occurs.

11.4 Biological impact

11.4.1 Vegetation

Most of the access roads fall in State Reserved Forest Land. The total land required for access road is **181553.5** m^2 of which only 14,475 m^2 fall in private land and the remaining entirely falls in SRFL. Construction of the work shall require vegetation clearing at all sites.

Common trees that need to be removed are Quercus sp, Rhododendron sp, Alnus nepalensis, and Erythrina species none of which are endangered or protected. One of the species found along the Access road to ADIT I is *Taxus Bacca*ta, commonly called the Himalayan Yew, which is classified as protected under schedule-I of Forest and Nature Conservation Act of Bhutan. However, it is listed as Least Concern in by International Union for Conservation of Nature (IUCN). The work shall consist of cutting, removing and disposing of materials such as trees, bushes, stumps, roots, grass, weeds and top organic soil.

Mitigation Measure:

- Felling of tree shall be restricted to the Right of Way;
- Laborers shall be prohibited from felling the trees for cooking and heating;
- Labours shall be provided with fuels to prevent tree cutting;
- Compensatory afforestation shall be carried out as an overall project activity for Nikachhu Hydropower Project. The detail on Compensatory Afforestation Plan is be as given in Chapter 9 of EMP of the main project report;
- Arboretum shall be developed in consultation with Department of Forest and Park Services to conserve plants with medicinal, economical and ecological value. The detail plan for Biodiversity Conservation is provided in Chapter 3 of EMP in the main project report;



11.4.2 Fauna

Since construction works shall occur mostly in Forest Land the following impact on wildlife are anticipated:

- Disappearance of birds and animals from the construction area due to loss of habitat;
- Fleeing of wildlife due to the disturbance created by increased noise level from operation of heavy machines, blasting and movement of workers;
- Poaching and trapping of wildlife by the labourers during construction. Critically endangered animal like Tiger were spotted at Dam site and ADIT-II sites, they may become victim of the labourers if not monitored properly

ADIT II falls in the Biological Corridor connecting Jigme Singye Wangchuk National Park with the Wangchuk Centennial Park in the north. Construction of road along the route might alter the traditional migratory route of the species.

Mitigation Measures:

- The road construction works are temporary except for access road to Dam, Power House, ADIT-III and Surge Shaft. All other road shall be closed and restored with plantation;
- The road construction works shall be prohibited at night time to minimize disturbance to the animals;
- Poaching or trappings of wildlife will be adequately controlled by taking appropriate measure by the Proponent. In order to avoid such activities, the Proponent will instruct the project officials, labor force, contractors, and other stakeholder not to indulge in illegal activities and abide by the forest act and its regulation. The Proponent will coordinate with Chendibji Forest Management Unit and Tsangkha Forest Beat office to control poaching and trapping by the workers under its authority. Surprise checking will be conducted by Forest Rangers and guards to control illegal hunting or poaching of all wild animals including the protected animals such as Himalayan Black Bear, Leopard, Tigers, and other common wild animals. Bhutan Forest & Nature Conservation Rules 2000 will be strictly implemented to minimize the poaching and trapping of animals. The offender will be penalized as per rules. Poaching shall be monitored at all times;



11.5 Blasting, Explosives and Occupational, Health and Safety

The proposed access roads at few chainages passess through rocky area at as shown in **Table 8.1.1 : Topography and Geology.** The excavation in this stretch is possible only through the use of blasting materials. The common gel with NED shall be used for blasting. The use of blasting materials will have a number of impacts on local environment, if not mitigated properly, which will primarily include the followings:

- Creation of noise and vibration, which may weaken the geology, cause damages to community infrastructures, religious places and monuments;
- Disturb wildlife, ecologically sensitive areas and communities;
- Risk of theft and misuse of explosive by unauthorized person or miscreants;
- Pollution of ground and surface water due to leakage of toxic materials and wastes endangering the health of people as well as aquatic, and wildlife;
- Risk of Injury workers and local people passing by during blasting;
- Misuse of Explosives;
- Contamination of streams and rivers by Explosives if not stored properly

Mitigation Measures:

- The blasting shall be carried out during fixed hours of the day preferably during early morning, mid-day or at the close of works at dusk and the hours shall be be made know to the people in vicinity;
- The contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosive;
- Controlled blasting shall be adopted to maintain slope stability, prevent fly rocks, reduce ground vibrations and to reduce noise;
- Red danger flags shall be displayed prominently in all directions especially on the highways during blasting operation;
- The flags shall be planted 200m from the blasting site;
- People shall be prohibited from entering the area including workman. Workman shall be excluded from the flagged area atleast 10 minutes before the firing;



- A warning siren or whitsle shall be blown 10 minutes before the blast three times to warn the blasting in progress;
- All statutory laws, regulations and rules pertaining to acquisition, transportation, storage, handling and use of explosives shall be strictly adhered;
- The portable magazine for storage of explosives shall be built as per the specifications of the RGoB laws;
- No unauthorized person shall be allowed to enter the premise of portable magazine;
- The blasting operation and handling explosives shall be done by a competent blaster certified by approved authority;
- The portable magazine shall be stored atleast 300m from the road, streams or any structures;
- The blasting powder, explosives, detonators, fuses shall be fresh and damaged shall be immediately removed from the site;
- Monthly explosive account shall be submitted by the contractor to the project authority;
- Provisions of well equipped First Aid Kit, health facilities, and fire fighting equipments on construction sites;
- Contractor shall be responsible for providing the personal protective devices such as helmets, masks, ear muffs and gloves;

11.6 Sedimentation of streams

Removal of vegetation and open cuts with exposed soil to rain and wind erosion cause soil erosion as well as landslide. This can become a major source of silt that the monsoon runoff carries away, increasing suspended and bed load in rivers.

Mitigation measures;

- Culverts and cause ways shall be constructed at stream crossing to prevent siltation and formation of gullies by the vehicles and machines;
- In depressions where filling shall be done shall be provided with hume pipes to prevent sedimentation of the streams during monsoon;


- Proper drainage shall be available right from the beginning of the work construction to avoid erosions and run-offs. During excavation contractors shall be made to maintain the natural drainage or to make temporary ditches that connects the nearest stream;
- Excavated materials shall be compacted well to prevent run-off of the material into the streams and river;

Post Formation Cutting, Construction of V-shaped drains 600X300mm with 50mm thick PCC 1:2:4, 150mm thick soling, RRM in CM 1:5 on sides, finished with 20mm thick 1:4 cement plaster shall be done

11.7 Excavated Materials Management

About 413,061 m³ of excavated materials shall be generated from the excavation of access orads .Soil suitable for filling shall be reused and the surplus shall be disposed off in the designated muck disposal sites.

Although 10 muck disposal sites have been identified for the overall Nikachhu Hydropower Project, 2 of the Muck disposal sites located i) about 20 m below the National Highway which has been identified for ADIT IV and ii) about 100 m from the access road to ADIT V, which has been identified as Muck Disposal Site for ADIT-V, which is located about 10m below the National Hghway, can also be used for disposal of excavated materials from access roads. These areas being just below the highway can be operated from the beginning of road excavation.

The total estimated muck that shall be generated from land development and tunnel works is $1,102,424.91 \text{ m}^3$ and the total capacity of 10 Muck Dumping Sites identified for the overall project is estimated to be $1,531,275.75 \text{ m}^3$, the details of which is given in Chapter Two of the EMP of the main report., with the balance capacity of 428,850.66 m³ i.e it can still accommodated 428,850.66m³ of muck.

The total muck estimated to be generated from the access roads alone is 413,061.60 m³ of which about 18,450 m³ shall be reused for filling and 394,611.60 m³ shall be dumped at designated sites. The detail is as given below;

Access Roads	Estimated Muck Quantity (m ³)	Quantity to be reused in filling (m ³)
Dam Complex	76,257.80	1,980.00
Adit 1	64,994.90	1,980.00
Adit 2	41,296.40	2,820.00
Adit 3	48,809.10	1,860.00
Adit 4	10,269.00	1,170.00

PROJECTS DEPARTMENT



Access Roads	Estimated Muck Quantity (m ³)	Quantity to be reused in filling (m ³)
Adit 5	8,487.52	780.00
BVC and Surge Shaft top	35,568.66	1,920.00
Power House Complex	127,378.22	5,940.00
Total	413,061.60	18,450.00
Total Muck to be Dumped		394,611.60

The above table shows that the Muck Disposal Sites are sufficient to accommodate all the mucks that shall be generated from Tunnel works, Land Development works and Access Road excavation.

Further, the muck generated from the access roads during the initial excavation shall also be used in leveling the Contractor Construction facilities and Residential complex area identified for Dam and Power House, which are just located below the Highway.. However, at the later stage of road excavation all the roads shall reach the Muck Dumping Sites which has been already identified for the Project. During that stage on Muck Dumping Sites identified for individual ADITs shall be used as dump site for roads as well.

Dump Site Reclamation Plan

Terraces will be created and developed by constructing suitable retaining walls (gabion masonry) to support dumping of mud on steep slopes and for optimum space utilization. In-between the terraces, catch water drain will be constructed to provide drainage. The retaining walls (gabion masonary) will be built before muck dumping and each dumping will be followed by compaction, so that it does not enter adjacent watercourses or cause compounding slope failures. The type and height of the retaining wall will be determined by the the Enginner-In-Charge (EIC) and will vary from one site to the other depending on the slope and terrain of each site.

On each terrace, nutrient rich top soil shall be spread and fast growing plant/grass species shall be sown to prevent run-off and slides of the excavated materials on rainfall.

Type of Negative Impact	Possible Mitigation Measure/s	Responsible Agency for implementation	Monitoring Frequency	Responsible Agency for monitoring
Impacts due to earthworks and excavation	 Cut and Fill Retaining walls to be provided 	NHPP/Contractor	Daily	NHPP

Tahla	16. Summary	of Impacts	Mitigation	Moseuroe	and	Monitoring	Dlan
lable	10. Summary	y or impacts	, miligation	measures	anu	monitoring	гап

PROJECTS DEPARTMENT



Type of Negative Impact	Possible Mitigation Measure/s	Aitigation ure/s Responsible Agency for implementation		Responsible Agency for monitoring
	 Culverts with Humes 			
	pipes to be provided in			
	depressions			
	Bioengineering measures			
Noise	•Restriction of work during		Daily	
	night	NHPP/Contractor	Daily	NHPP
	•sprying water	Contractor	Daily	NHPP
	•enforcing speed limit	Contractor	Daily	NHPP
Dust	•covering trucks carrying excavated materials with trapaulin	Contractor	Daily	NHPP
	 provideing fuels to labouresa for cooking and heating 	NHPP/Contractor	Daily	NHPP
	•Felling of tree to be restricted only to the RoW	NHPP/Contractor	Daily	NHPP
			Daily from	
	•Compensatory		the satrt of	
Impact on	Afforestation for trees felt	NHPP/D0FPS	plantation	NHPP/DofPS
Biodiversity			bally from	
			the	
	•Biodiversity		biodiversity	
	Conservations like	NHPP/DoFPS/	conservation	
	development of arboretum	NBC	project	NHPP/DoFPS
	•works to be carried out			
	only during day	Contractor/NUDD		NHPP
	Poaching shall be	Contractor/NHPP	Dally	
	prohbited			NHPP/DoFPS
	Controlled blasting shall			
Impost due to	be adopted	NHPP/Contractor	Daily	NHPP
Riacting	Blasting shall be carried			
Diastilly	out on fixed hours during			
	day	NHPP/Contractor	Daly	NHPP
Impact of Occupational Health and	 notify people near the project area about the use of explosives 	NHPP/Contractor	Daily	NHPP



Type of Negative Impact	Possible Mitigation Measure/s	Responsible Agency for implementation	Monitoring Frequency	Responsible Agency for monitoring
Safety	 Red danger flags to be displayed at each ends at 200m people shall be prohibited from entering the area workers shall be excluded from the area warning signals shall be blown 10 mins before the start of blast Personal Protective Device shall be provided to all workers 			
Impacts due to Explosives	 Exposives shall be handled, stored and used as per the Rules on Explosives,1989 of RGoB only authorized persons shall be allowed to enter the permises of explosive magazine Explosives shall be kept away from any infrastructures and water body 	NHPP/Contractor	Daily	NHPP
 Temporary drainage shall be made right from start of earth works Excavated materials shall be compacted well Construction of V-shaped drains Construction of culverts with hume pipes and causeways at stream crossings 		NHPP/Contractor	Daily	NHPP

Type of Negative Impact	Possible Mitigation Measure/s	Responsible Agency for implementation	Monitoring Frequency	Responsible Agency for monitoring
	 excavated materials shall 			
	be reused and balance			
	shall be dumped in			
	designated area			

All the works related to mitigation measures as suggested by the EA study are incorporated in the bid document. The contract shall be awarded by incorporating all mitigation measures covering physical, social, biological, occupational health and safety, etc. In addition, the specific responsibility of implementation of EMP shall be made mandatory in the bid document as part of technical specification, so that the contractors will be obliged to execute the mitigation measures and EMP during the construction.

12 Monitoring Program

One of the important aspects of Environment Management for any project is Monitoring of project particularly during peak construction. Both compliance Monitoring and impact monitoring shall be carried out for Nikachhu Hydropower Project as a whole and periodic reporting done to Asian Development Bank and National Environment Commission. Compliance monitoring shall be done to evaluate whether the Environment Management Plan is actually implemented on ground and Impact monitoring to record the actual level of impact on ground as compared to the impact predicted in the Environment report. Compliance monitoring is required to be done to enable the contractors and the project proponent to comply with the mitigation measures listed in the document and any other conditions set-forth during the receipt of Environment Clearance.

The monitoring during the construction stage of the project is primarily focused on construction and management practices. This stage of monitoring is to check compliance with the best practices, norms and standards and on implementation of the mitigation measures prescribed by EA vis-a-vis the impact or changes that are occurring on environmental receptors. During this, the following parameters will be mainly focused on:

- disposal of spoil and construction wastes and its consequences;
- disruption of natural water courses, drainage work, and its consequences;
- loss or degradation of forest and vegetation;



- care, sensitivity or disruption of community infrastructures;
- loss or degradation or threat to private properties;
- care sensitivity or disruption to cultural sites;
- slope protection measures;
- Compliance monitoring for mitigation measures listed for impact due to Dust, Noise, Blasting;
- consultation and cooperation with local communities (GYT & DYT) in environmental matters.

However, after construction of the Nikachhu Hydropower Project, all temporary roads shall be closed and permanents roads to Dam, ADIT-III, Surge Shaft and Power House shall be maintained by the Project Authority.

The monitoring during operation shall be done as along with the overall Project activity.

The summary of Mitigation Measures and Monitoring is given below:



Table 17: Matrix of Mitigation Measures and Monitoring

SI.No.	Mitigation measure	Period	Responsibility	Monitoring	Frequency
1	Compensatory afforestation	All phases	Project management and Social Forestry Diviision with local forestry staff	ECDMD	Quarterly
2	Cut off only those trees marked by the Forestry staff	Pre-construction	Contractor and Project management	ECDMD	Quarterly
3	Ensure that area cleared is as per directives/delineation of Forestry staff	Pre-construction	Contractor and Project management	ECDMD	Quarterly
4	Compensation as per Land Act	Pre-construction	Project management	ECDMD	Quarterly
5	Community livelihoods support program	Pre-construction	Project management	ECDMD	Quarterly
6	Mitigation as per 'management of labour camps, water management, waste management, Occupational Health and Safety plan'	Pre-construction	Project management and contractor	ECDMD	Quarterly
7	Mitigation as per "construction equipment management plan'	Pre-construction	Project management and contractor	ECDMD	Quarterly
8	Identify and upgrade parts of the National Highway that will be used by project vehicles, so that narrow sections and blind curves (so-called "chokepoints") do not create a high accident risk.	Pre-construction		ECDMD	Quarterly
9	Creation of a greenbelt along access roads to compensate for the loss of habitat	Construction and Operation	Project management and contractor	ECDMD	Quarterly



SI.No.	Mitigation measure	Period	Responsibility	Monitoring	Frequency
10	Biodiversity Conservation and Wildlife Management Plan	All phases		ECDMD	Quarterly
11	Follow air quality management plan	All phases	Project management and contractor	ECDMD	Quarterly
12	Air Quality and Noise management plan, sprinkling of water to reduce dust	All phases		ECDMD	Quarterly
13	Construction of retaining walls, bioengineering works	All phases	Project management and contractor	ECDMD	Quarterly
14	The Roads will be maintained at least 150 meters from watercourses	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
15	Where roads cross water courses, culverts will be built to minimize impairment of streams	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
16	Follow Occupational health and safety plan	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
17	Fuel storage as per storage plan	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
18	Construction materials will be stored along wider sections of the highway (only at the take off points), and	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
19	Muck disposal management plan	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
20	Use of signage to warn road users of impending construction work, or falling boulders	Preconstruction and construction	Project management and contractor	ECDMD	Quarterly
21	Use flag persons in narrow and accident prone areas congested with material or equipment.	Construction	Project management and contractor	ECDMD	Quarterly
22	Designate hours for peak construction work and 'traffic hours'	Construction	Project management and contractor	ECDMD	Quarterly

PROJECTS DEPARTMENT

Page 42



SI.No.	Mitigation measure	Period	Responsibility	Monitoring	Frequency
23	provision for making repairs to the National Highway (at the end of the construction phase)	Construction	Construction Project management and contractor		Quarterly
24	provision for making repairs to the National Highway and all access roads –	Operation phase Project management		ECDMD	Quarterly
25	Follow air quality management plan	All phases	Project management and contractor	ECDMD	Quarterly
26	Slope stabilization using retaining walls and planting with local species	All phases	Project management and contractor	ECDMD	Quarterly
27	Follow Closure plan	Operation phase	Project management and contractor	ECDMD	Quarterly
28	Remove all machines, equipment, debris from roads	Operation phase	Project management and contractor	ECDMD	Quarterly
29	Hand over road to the Forestry Division for Compensatory Afforestation program to revegetate and restore the area	Operation phase	Project management	ECDMD	Quarterly



13 Declaration of No Objection Certificate

In order to obtain an Environmental Clearance for the project, an NOC must be obtained from all relevant parties. Attach these documents to the Application. Below is a checklist of agencies from whom NOCs is required and their status;

Table 0.1 Cle	arances req	uired and	its Declaration
---------------	-------------	-----------	-----------------

Agency/concerned people to issue NOC	Status/Declaration
Dzongkhag	Blanket Conditional Approval for the project attached
DoF	Forest Clearance attached
Department of Culture	Clearance received for overall project
Nature Conservation Division	Forest Clearance received
Private owner	NOC from project Affected people received and attached
Private property owners	NOc from directly affected people attached
Bhutan Power Corporation	Clearance form BPC attached
Department of Roads	NOC from DoR for road take-offs attached



Royal Government of Bhutan Ministry of Works & Human Settlement Department of Roads Regional Office : Trongsa

Ref. No.RO/DoR(TRONGSA)/2013-2014/PL-10/ 642

Date 19th March, 2014.

The Executive Engineer,

Sub-Division,

DoR: Trongsa.

Sub: DoR Clearance for construction of Approach roads for 118 MW Nikachhu Hydropower Project

from Trongsa - Chuserbu PNH.

With reference to your recommendation letter No.FSDT/DoR/2013-2014/W-09/266 dated 17.03.2014 for the Issuance of DoR clearance for construction of 8 (eight) numbers Approach roads at 326.80 km, 327.50 km, 327.70 km, 329.10 km, 333.40 km, 341.15 km, 347.65 km and 329.20 km leading towards various components of Nikachhu Hydropower Project from Trongsa – Chuserbu Primary National highway is hereby approved with the terms and conditions attached for strict compliance during the time of execution.

Please Submit the Signed Contract Agreement comprising witness signature for our record.

Encl: Terms & Conditions

(Executive Engineer)

Regional Office,

DoR: Trongsa.

CC:

- 1. The Chief Engineer, Maintenance Division, DoR: Thimphu along with a copy of the clearance for kind information.
- 2. Office copy PL-10

R1X - EN

Layout of Nikachhu Hydropower Project





PLANNING & DESIGN DIVISION **PROJECTS DEPARTMENT**

	LEGEND	
	$\begin{array}{c} \sim & \sim \\ \sim & \sim \\ \sim & \sim \\ \sim & \sim \end{array}$	GARNETIFEROUS MICACEOUS SCHIST
		GRANETIC GNEISS
	$\begin{array}{c} \times & \times & \times \\ \times & \times & \times \end{array}$	GRANITE
	~ ~ ~ ~	QUARZITE/SCHIST
20	××××××××××××××××××××××××××××××××××××××	SHEAR
		OUT CROP
	000	ALLUVIUM
		RESIDUEL SOIL
		COLLUVIUM
		CULTIVATED LAND
	$\overline{}$	STREAMS
		RIVER
		HIGHWAY
		INFERRED GEOLOGICAL CONTACT
		STRIKE AND DIP OF FOLIATION
		STRIKE AND DIP OF JOINT
		COMPLETE DRILLED HOLE
	0	DRIFT
		ADITS
		Proposed Road
		Muck Disposal
		Dam Colony



PLANNING & DESIGN DIVISION **PROJECTS DEPARTMENT**

	W K
	GARNETIFEROUS MICACEOUS SCHIST
	GRANETIC GNEISS
	GRANITE
	QUARZITE/SCHIST
	SHEAR
	OUT CROP
	ALLUVIUM
	RESIDUEL SOIL
	COLLUVIUM
	CULTIVATED LAND
$\overline{}$	STREAMS
	RIVER
	HIGHWAY
	INFERRED GEOLOGICAL CONTACT
	STRIKE AND DIP OF FOLIATION
	STRIKE AND DIP OF JOINT
	COMPLETE DRILLED HOLE
0	DRIFT
	ADITS
	Proposed Road
	Muck Disposal

				Sheet Size A	41	Jig
 All dimense Datum WC carry out the Contour are Grid Intervention 	ions are in Metre S84 & Projection ne Survey of Nika e of 1m Interval. val are of 1000m.	es. 1 UTM 46N is follo achhu Hydroproje	wed to ct Project.	Project: Scale :- 1:100	-	NIKac
	Note	e :-		Project:	_	Nikad
						V/
0						
59	Pn	KIC				
						Š5
2401						
		35				
2	450					
		250				
	1. All dimense 0 0 1. All dimense 0 0 1. All dimense 1. Contour are 1. Contour are 1. Contour are 1. Contour are	Examples of the second	Example a series of the ser	Example a series of the ser	<complex-block></complex-block>	<complex-block> U U </complex-block>



			W
$\times \\ \land $			5
< ///////			
	LEGEND		
	~ ~ ~		
	~~~~	GARNETIFEROUS MICACEOUS SCHIST	
	{ , , , , , , , , , , , , , , , , , , ,	GRANETIC GNEISS	
			_
X	$\begin{array}{c} \times & \times & \times \\ \times & \times & \times \end{array}$	GRANITE	
	~~~~	QUARZITE/SCHIST	
	~~~~		_
		SHEAR	
		OUT CROP	
	$\bigcirc \bigcirc \bigcirc$	ALLUVIUM	
	$\bigcirc \bigcirc \bigcirc$		_
		RESIDUEL SOIL	
			_
		CULTIVATED LAND	
	$\sim$	STREAMS	
		RIVER	
×///A			_
		HIGHWAY	
			_
Tring			
		STRIKE AND DIP OF FOLIATION	
			_
		STRIKE AND DIP OF JOINT	
			_
	0	DRIFT	
		ADITS	
		Proposed Road	
		Muck Disposal	



	W W Z S
	GARNETIFEROUS MICACEOUS SCHIST
	GRANETIC GNEISS
$ \begin{array}{c} \times & \times & \times \\ \times & \times & \times \end{array} $	GRANITE
~ ~ ~ ~	QUARZITE/SCHIST
××××××××××××××××××××××××××××××××××××××	SHEAR
	OUT CROP
	ALLUVIUM
	RESIDUEL SOIL
	COLLUVIUM
	CULTIVATED LAND
$\overline{}$	STREAMS
	RIVER
	HIGHWAY
	INFERRED GEOLOGICAL CONTACT
	STRIKE AND DIP OF FOLIATION
	STRIKE AND DIP OF JOINT
	COMPLETE DRILLED HOLE
0	DRIFT
	ADITS
	Approach Road
	Proposed Road
	Muck Disposal
	1]



(Draughtperson)

Yeshi Dorji (GTA/Geologist)

		GARNETIFEROUS MICACEOUS SCHIST
		GRANETIC CNEISS
		GRANITE
		QUARZITE/SCHIST
		SHEAR
S July 10		
1.5 200 10 154000		
		SIREAMS
		STRIKE AND DIP OF FOLIATION
		STRIKE AND DIP OF JOINT
		COMPLETE DRILLED HOLE
	0	DRIFT
		ADITS
		Approach Road
		Proposed Road
		Muck Disposal
R B(		Common Muck Disposal



			W KE
N°			
		GARNETIFEROUS MICACEOUS SCHIST	
		GRANETIC GNEISS	_
		GRANITE	_
		QUARZITE/SCHIST	_
	****	SHEAR	
		OUT CROP	_
dechtu		ALLUVIUM	
		RESIDUEL SOIL	_
		COLLUVIUM	
		CULTIVATED LAND	
	$\overline{\}$	STREAMS	
		RIVER	
		HIGHWAY	
		INFERRED GEOLOGICAL CONTACT	
		STRIKE AND DIP OF FOLIATION	_
		STRIKE AND DIP OF JOINT	
		COMPLETE DRILLED HOLE	
	0	DRIFT	
		ADITS	_
		Proposed Road	
		Muck Disposal	
		Dam Colony	
		Tem Hut	
$ \setminus \setminus \setminus \setminus $			

Annexure III:

Biodiversity Status of Jigme Singye Wangchuck National Park

## Brief Information about Jigme Singye Wangchuck National Park.

Jigme Singye Wangchuck National Park, erstwhile the Black Mountains National Park, was gazetted as a national park in 1995. With an area of 1723 km², this is Bhutan's third largest national park after Wangchuck Centennial Park and Jigme Dorji National Park. It spans five Dzonghags and 10 *geogs*. The park links Jigme Dorji National Park and Wangchuck Centennial Park through biological corridors in the north and it is directly linked with Royal Manas National Park in the south, and thus provides connectivity between the northern and southern protected areas. The National Park represents an important migratory corridor, especially for altitudinal migratory birds.

The park includes important warm and cool broadleaf temperate forests in the middle-Himalayas. These forests are highly threatened elsewhere in the Himalayas. The major habitat types represented in the park ranges from permanent ice cap at the peak of Dorshingla (4925m) to alpine meadows, scrub, and lakes, to subalpine conifer forests, cool and warm broadleaf forests to subtropical broadleaf forests in the south, adjacent to Royal Manas National Park. Over 440 species of vascular plants have been identified/recorded in the park, representing the range of forests types

The park is also rich in wildlife, harbouring important populations of some of Asia's most charismatic species, including the tiger, golden langur, musk deer and red panda. Recent camera trap surveys also show that the park is habitat of rare species such as clouded leopard, black leopard, golden cat, and wild dogs. Overall, 38 species of mammals and over 270 species of birds have been confirmed in the park.

The high mountains in the central regions of the National Park are important source of water stream and rivers, that drain into the Mangde Chuu river in the east and Punatshang Chuu river in the west. The Nika Chhu joins the Mangde Chhu from the north.

The park has relatively few permanent residents. There are a few small farms and settlements scattered along the park boundaries, especially along the Mangde Chhu, in Nabji-Korphu, and along the lower Hara Chhu **Biodiversity Status of Jigme Singye Wangchuck National Park.** 

1. Checklist of Mammals found in Jigme Singye Wangchuck National Park.

Sl. No.	Scientific Name	Common Name	Local Name	FNCA - 1995	IUCN	CITES
CARNIVC	RA					
1	Ailurus fulgens	Red Panda	HaChu Dongka (Dz)	Schedule 1	Vulnerable	Appendix-I
2	Cuon alpinus	Dhole	Phaw (Dz)		Endangered	Appendix-I
3	Canis lupus chanco	Himalayan Wolf/Tibetan Wolf	Aow Changku (Dz)     Least       Concern			
4	Neofelis nebulosa	Clouded Leopard	Gung (Dz)	Schedule 1	Vulnerable	Appendix-I
5	Panthera pardus	Common Leopard	Zee (Dz)	Schedule 1	Near Threatened	Appendix-I
6	Prionailurus bengalensis	Leopard Cat		Schedule 1	Least Concern	Appendix-II
7	Catopuma temmincki	Asiatic Golden cat			Vulnerable	Appendix-II
8	Panthera tigris tigris	Tiger	Taa (Dz) Mam khala (Sh)	Schedule 1	Endangered	Appndix-I
9	Felis chaus	Jungle cat	Ri khai Bjili(Dz)		Least Concern	Appendix-II
10	Martes flavigula	Yellow Throated Marten	Aachu Nyeynyey (Dz) Gawogmu (Sh)		Least Concern	Appendix-III
11	Lutra lutra	Common Otter	Saam(Dz)		Vulnerable	Appendix-I

12	Ursus thibetanus	Himalayan Black Bear	La Dhom (Dz)	Schedule 1	Vulnerable	Appendix-I
13	Prionodon pardiclor	Spotted Linsang	Zig Chu (Dz)		Endangered	
14	Paguma larvata	Himalayan Palm Civet	Bja Zig (Dz) Kasturi Biraloo (Lh)		Least Concern	Appendix-III
15	Verra zibetha	Large Indian Civet	Bja Zig		Near Threatened	
16	Manis pentadactyla	Chinese Pangolin	Mayang Kangyang (Sh)	Schedule 1	Endangered	Appendix-II
17	Talpa micrura	Short-Tailed Mole/Himalayan Mole			N/A	N/A
18	Herpestes urva	Crab-eating Mongoose			Least Concern	N/A
CETARTI	ODACTYLA			·		
19	Bos gaurus	Gaur	Rilang (Dz)	Schedule 1	Vulnerable	Appendix-I
20	Naemorhedus goral	Goral	Bjara (Dz) Basha (Sh)		Near Threatened	Appendix-I
21	Capricornis sumatraensis thar	Serow	Jha (Dz)	Schedule 1	Near Threatened	Appendix-I
22	Muntiacus muntjak	Barking Deer	Ka shaa (Dz)Ga sha (Sh)		Least Concern	
23	Cervus unicolor	Sambar	Shau (Dz)		Vulnerable	
24	Moschus leucogaster	Musk Deer	La chuum (Dz)	Schedule 1	Endangered	Appendix-I
25	Elephas maximus	Asian Elephant	Lamchen (Dz)	Schedule 1	Endangered	Appendix-I
26	Sus scrofa	Wild Boar	Ri Phag (Dz)		Least Concern	

LAGOMO	RPHA						
27	Ochotona himalayana	Common Pika	Gomchen Bjitsi (Dz)		Least Concern		
SORICOM	SORICOMORPHA						
28	Talpa micrura	Himalayan Mole			Least Concern		
PRIMATE	ES						
29	Macaca assamensis	Assamese Macaque	Pcha (Dz) Zala (Sh)		Near Threatened	Appendix-II	
30	Trachypithecus geei	Golden Langur	PchaSer(Dz), Raksha	Schedule 1	Endangered	Appendix-I	
31	Trachypithecus pileatus	Capped langur	Roksha(sh)		Vulnerable	Appendix-I	
32	Semnopithecus entellus	Grey Langur	Pcha Kar (Dz)		Least Concern	Appendix-I	
RODENT	IA						
33	Hystrix bracyhura	Himalayan Crestless porcupine	Bjithu (Dz) Zumphi (Sh)		Least Concern		
34	Ratufa bicolor	Malayan Giant Squirrel	Padala (Kh)		Near Threatened	Appendix-II	
35	Dremomys lokriah	Orange-Bellied Squirrel	Tortoala (Dz)		Least Concern		
36	Petaurista caniceps	Gray-Headed Flying Squirrel	Tortola (Dz)		Least Concern		
37	Tamiops macclellandi	Himalayan Striped Squirrel	Tortola(Dz)		Least Concern		
38	Rattus rattus	Common House Rat	Bjitsi (Dz)		Least Concern		

# 2. Checklist of Birds found in Jigme Singye Wangchuck National Park.

Sl. No.	Family	Scientific Name	Common Name	Ecosystem	Habit	Status
1	Accipitridae	Ictinaetus malayensis	Black Eagle	CP, WB	AM	
2		Spilornis cheela	Crested Serpent Eagle	CP,WB	AM	
3		Accipiter gentilis	Northern Goshawk	CP, WB	AM	
4		Aquila chrysaetos	Golden Eagle	CP, WB	AM	
5		Circus cyaneus	Hen Harrier	ST	AM	
6		Gyps himalayensis	Himalayan Griffon	CP, WB	AM	
7		Haliaeetus leucorphus	Palla's Fish Eagle	CP, WB	AM	VU
8		Accipiter virgatus	Besra	ST	Am	
9		Spizaetus nipalensis	Mountain Hawk Eagle	ST	АМ	
10	Alaudidae	Alauda gulgula	Oriental Skylark	ST	Resident	
11	Aegithalidae	Aegithalos concinnus	Black-throated Tit	CP,WB	AM	
12	Alcedinidae	Alcedo atthis	Common Kingfisher	ST	Resident	
13		Ceryle rudis	Pied Kingfisher	ST	Resident	
14		Halcyon smyrnensis	White-throated Kingfisher	ST, WB	Resident	
15		Megaceryle lugubris	Crested Kingfisher	ST,WB	Resident	
16	Apodidae	Apus pacificus	Forktail Swift	St, WB	Resident	
17		Collocalia brevirostris	Himalayan Swiftlet	ST	Resident	
18	Anatidae	Anas strepera	Gadwall	ST	Migratory	
19	Aroleidae	Ardea insignis	White-bellied Heron	WB	Resident	CR, Sch 1
20	Bucerotidae	Buceros bicornis	Great Hornbill	WB	Resident	NT
21		Aceros unddulatus	Wreathed hornbill	WB	Resident	
22		Aceros nipalensis	Rufous-necked Hornbill	ST,WB	AM	VU , Sch 1
23	Campephagidae	Hemipus picatus	Bar-winged Flycatcher Shrike	CP, WB	AM	
24		Pericrocotus solaris	Grey-chinned Minivet	ST	АМ	
25		Pericrocotus ethologus	Long-tailed Minivet	ST	АМ	

26		Pericrocotus flammeus	Scarlet Minivet	CP,ST,WB	Resident	
27		Pericrocotus brevirostris	Short-billed Minivet	WB	AM	
28	Certhiidae	Certhia familiaris	Eurasian Treecreeper	WB	АМ	
29		Certhia nipalensis	Rusty-flanked Treecreeper	WB	АМ	
30	Caprimulgidae	Caprimulgus indicus	Grey Nightjar	ST,WB	AM	
31	Charadriidae	Vanellus indicus	Red-wattled Lapwing	ST, WB	AM	
32		Vanellus duvaucelii	River Lapwing	WB	АМ	NT
33	Chloropseidae	Chloropsis aurifrons	Golden-fronted Leafbird	WB	АМ	
34		Chloropsis hardwickii	Orange-bellied Leafbird	ST,WB	АМ	
35	Ciconiidae	Cicinia nigra	Black Stork	ST, WB	АМ	
36	Cinclidae	Cinclus pallasii	Brown Dipper	CP,WB	Resident	
37		Cinclus cinclus	White-throated Dipper	СВ	АМ	
38	Cisticolidae	Culicicapa ceylonensis	Grey-headed Canary Flycatcher	ST	AM	
39		Prinia atrogularis	Hill Prinia	ST,WB	АМ	
40		Prinia criniger	Striated Prinia	ST,WB	АМ	
41		Prinia cinereocapilla	Grey-crowned Prinia	ST	АМ	VU
42	Columbidae	Macropygia unchall	Barred Cuckoo Dove	CP, WP	АМ	
43		Chalcophaps indica	Emerald Dove	ST, WB, CB	Resident	
44		Columba leuconota	Snow Pigeon	WB, CB	АМ	
45		Ducula badia	Mountain Imperial Pigeon	ST	АМ	
46		Streptopelia orientalis	Oriental Turtle Dove	ST,WB,CB	Resident	
47		Columba livia	Rock Pigeon	WB,CB	АМ	
48		Columba hodgsonii	Speckled Wood Pigeon	WB	АМ	
49		Streptopelia chinensis	Spotted Dove	CP,ST,WB	Resident	
50		Treron sphenura	Wedge-tailed Green Pigeon	WB	AM	
51	Coraciidae	Eurystomus orientalis	Dollar Bird	WB	АМ	
52	Corvidae	Corvus splendens	House Crow	ST, CP, WB, CB	Resident	

53		Nucifraga caryocatactes	Spotted Nutcracker	ST,CB	Resident	
54		Dendrocitta frontalis	Collared Treepie	WB	AM	
55		Cissa chinensis	Common Green Magpie	ST	АМ	
56		Garrulous glandarius	Eurasian Jay	ST,CB	AM	
57		Dendricitta formosae	Grey Treepie	CP,ST,WB,CB	AM	
58		Corvus macrorhynchos	Large-billed Crow	ST,WB,CB	Resident	
59		Pyrrhocorax pyrrhocorax	Red billed Chough	СВ	Resident	
60		Urocissa flavirostris	Yellow-billed Blue Magpie	СР,СВ	АМ	
61	Cuculidae	Cuculus canorus	Eurasian Cuckoo	WB,CB	Migratory	
62		Centropus sinensis	Greater Coucal	ST	АМ	
63		Phaenicophaeus tristis	Green-billed Malkoha	CP,WB	АМ	
64		Hierococcyx sparverioides	Large Hawk Cuckoo	ST,WB,CB	Migratory	
65		Cuculus poliocephalus	Lesser Cuckoo	ST,WB,CB	АМ	
66		Cuculus saturatus	Oriental Cuckoo	ST,WB,CB	Migratory	
67	Dicaeidae	Dicaeum ignipectus	Fire-breasted Flowerpecker	WB, CB	АМ	
68		Dicaeum concolor	Plain Flowerpecker	WB, CB	АМ	
69	Dicruridae	Dicrurus remifer	Lesser Racket-tailed Drongo	WB	АМ	
70		Dicrurus leucophaeus	Ashy Drongo	CP, WB	АМ	
71		Dicrurus macrocercus	Black Drongo	ST,CP,WB,CB	АМ	
72		Dicrurus hottentottus	Spangled Drongo	WB	АМ	
73	Emberizidae	Melophus lathami	Crested Bunting	ST,WB	АМ	
74	Estrididae	Lonchura striata	White-rumped Munia	WB	АМ	
75	Eurylaimidae	Psarisomus dalhousiae	Long-tailed Broadbill	WB	АМ	
76	Falconidae	Falco tinnunculus	Common Kestrel	ST,WB,CB	АМ	
77	Fringiilidae	Carpodacus erythrinus	Common Rosefinch	ST,WB	AM	
78		Leucosticte nemoricola	Plain Mountain Finch	ST	AM	
79		Carpodacus punicus	Red-fronted Rosefinch	ST, WB	AM	

80		Haematospiza sipahi	Scarlet Finch	WB	АМ	
81		Mycerobas carnipes	White-winged Grosbeak	ST, WB	AM	
82		Pyrrhula nipalensis	Brown Bullfinch	ST	AM	
83		Mycerobas melanozanthos	Spot-winged Grosbeak	ST,WB	AM	
84		Carduelis spinoides	Yellow-breasted Greenfinch	ST,WB	AM	
85	Hirundinidae	Delichon dasypus	Asian House Martin	WB	АМ	
86		Delichon nipalensis	Nepal House Martin	WB	АМ	
87	Ibidorhynchidae	Ibidorhyncha struthersii	Ibisbill	WB	Resident	
88	Indicatoridae	Indicator xanthonotus	Yellow-rumped Honeyguide	WB	Resident	NT
89	Laniidae	Lanius cristatus	Brown Shrike	WB	АМ	
90		Lanius tephronotus	Grey-backed Shrike	СВ	Resident	
91		Lanius schach	Long-tailed Shrike	CP,ST,WB	АМ	
92	Meropidae	Nyctyornis athertoni	Blue-bearded Bee-eater	ST, WB, CB	Resident	
93	Monarchidae	Hypothymis azurea	Black-naped Monarch	ST, WB, CB	Resident	
94	Motacillidae	Anthus hodgsoni	Olive-backed Pipit	WB	АМ	
95		Anthus godlevskii	Blyth's Pipit	WB	АМ	
96		Anthus roseatus	Rosy Pipit	WB,CB	АМ	
97		Anthus rufulus	Paddyfield Pipit	WB	АМ	
98		Motacilla cinerea	Grey Wagtail	WB,CB, ST	АМ	
99		Motacilla alba	White Wagtail	WB	АМ	
100	Muscicapidae	Muscicapa sibirica	Dark-sided Flycatcher	WB	АМ	
101		Ficedula hodgsonii	Slaty-blue Flycatcher	WB	АМ	
102		Ficedula strophiata	Rufous-gorgetted Flycatcher	WB, CB	АМ	
103		Muscicapa ferruginea	Ferruginous Flycatcher	WB, CB	AM	
104		Cyornis unicolor	Pale Blue Flycatcher	WB	АМ	
105		Eumyias thalassina	Verditer Flycatcher	ST,WB,CB	AM	

106		Muscicapella hodgsoni	Pygmy Blue Flycatcher	WB	AM
107		Phoenicurus	White-winged Redstart	ST,CP,CB	AM
		erythrogaster			
108		Phoenicurus schisticeps	White-throated Redstart	ST,CP,CB	AM
109		Rhyacornis fuliginosus	Plumbeous Water Redstart	ST,WB,CB	Resident
110		Chaimarrornis leucocephalus	White-capped Water Redstart	ST,WB,CB	Resident
111		Phoenicurus ochruros	Black Redstart	ST,CP,CB	AM
112		Phoenicurus frontalis	Blue-fronted Redstart	ST,CP,CB	AM
113		Phoenicurus hodgsoni	Hodgson's Redstart	ST	AM
114		Enicurus maculates	Spotted Forktail	ST	AM
115		Enicurus schistaceus	Slaty-backed Forktail	ST,WB	AM
116		Enicurus scouleri	Little Forktail	WB	AM
117		Ficedula westermanni	Little Pied Flycatcher	ST,WB,CB	AM
118		Copsychus saularis	Oriental Magpie Robin	CB,ST,WB	Resident
119		Saxicola ferrea	Gray Bush Chat	CB, ST	Resident
120		Saxicola torquata	Common Stonechat	WB, CB	AM
121		Monticola rufiventris	Chestnut-bellied Rock Thrush	WB, CB	АМ
122		Niltava grandis	Large Niltava	ST,WB	АМ
123		Niltava macgrigoriae	Small Niltava	ST,WB	AM
124		Niltava sandara	Rufous-bellid Niltava	ST,WB	Migratory
125		Niltava macgrigoriae	Small Niltava	ST,WB	AM
126	Nectariniidae	Aethopyga nipalensis	Green-tailed Sunbird	ST, WB	AM
127		Aethopyga ignicauda	Fire-tailed Sunbird	CP, WB	Migratory
128		Aethopyga saturate	Black-throated Sunbird	CP,WB	AM
129		Aethopyga siparaja	Crimson Sunbird	ST,WB	AM
130		Aethopyga gouldiae	Mrs. Gould's Sunbird	СВ	AM
131		Arachnothera magna	Streaked Spiderhunter	CP,ST,WB	AM

132	Orioliidae	Oriolus oriolus	Eurasian Golden Oriole	ST	AM	
133		Oriolus xanthotnus	Black-hooded Oriole	ST	AM	
134		Oriolus traillii	Maroon Oriole	ST,WB	AM	
135		Oriolus tenuirostris	Slender-billed Oriole	ST,WB	AM	
136	Paridae	Parus major	Great Tit	WB	AM	
137		Aegihalos iouchistos	Black-browed tit	WB	AM	
138		Cephalopyrus flammiceps	FIre-capped Tit	WB	АМ	
139		Parus ater	Coal Tit	ST, WB	AM	
140		Parus dichrous	Grey-crested Tit	ST, WB	AM	
141		Parus rubidiventris	Rufous-vented Tit	WB, CB	AM	
142		Sylviparus modestus	Yellow-browed Tit	WB, CB	AM	
143		Parus monticolus	Green-backed Tit	CP,ST,WB,CB	Resident	
144		Melanochlora sultanea	Sultan Tit	WB	AM	
145		Parus spilonotus	Yellow-cheeked Tit	WB	AM	
146	Passeridae	Passer montanus	Eurasian Tree Sparrow	WB	Resident	
147		Passer rutilans	Russet Sparrow	WB	Resident	
148		Passer domesticus	House Sparrow	ST,WB,CB	Resident	
149	Phalacrocoracidae	Phalacrocorax carbo	Great Cormorant	ST,WB	Migratory	
150	Phasianidae	Ithanginis cruentus	Blood pheasant	Alpine	AM	
151		Arborophila torqueola	Hill Partridge	СВ	AM	
152		Arborophila mandellii	Chestnut-breasted Partridge	СВ	AM	
153		Ithaginis cruentus	Blood Pheasant	Alpine	AM	
154		Polyplectron bicalcaratum	Grey Peacock Pheasant	WB	АМ	
155		Lophura leucomelanos	Kalij Pheasant	ST,WB	AM	
156		Gallus gallus	Red Junglefowl	ST,WB	Resident	
157		Arborophila rufogularis	Rufous-throated Partridge	ST,WB	AM	
158		Tragopan satyra	Satyr Tragopan	CB, Alpine	AM	NT, Sch 1

159		Lophophorus impeganus	Himalayan Monal	CB, Alpine	АМ	Sch 1
160	Picidae	Dendrocopos darjellensis	Darjeeling Woodpecker	ST,CB	АМ	
161		Dendrocopos macei	Fulvous-breasted Woodpecker	ST	АМ	
162		Blythipicus pyrrhotis	Bay Woodpecker	ST, CB	АМ	
163		Dendrocopos cathpharius	Crimson-breasted Woodpecker	WB, CB	AM	
164		Gecinulus grantia	Pale-Headed Woodpecker	WB, CB	АМ	
165		Picus chlorolophus	Lesser Yellownaped woodpecker	WB, CB	AM	
166		Dendrocopos canicapillus	Grey-capped Pygmy Woodpecker	ST	AM	
167		Picus flavinucha	Greater Yellownape	CP,ST	АМ	
168		Picus canus	Grey-headed Woodpecker	WB	АМ	
169		Celeus brachyurus	Rufous Woodpecker	ST,WB	АМ	
170		Dendrocopos hyperythrus	Rufous-bellied Woodpecker	ST,WB	AM	
171	Pittidae	Pitta sordida	Hooded Pitta	WB	AM	
172	Prunellidae	Prunella strophiata	Rufous-Breasted Accentor	WB	AM	
173	Pycnonotidae	Hemixos flavala	Ashy Bulbul	СР	АМ	
174		Pycnonotus jocosus	Red-whiskered Bulbul	СР	АМ	
175		Hypsipetes leucocephalus	Black Bulbul	CP, WB, CB	AM	
176		Pycnonotus melanicterus	Black-crested Bulbul	СР	АМ	
177		Hypsipetes mcclellandii	Mountain Bulbul	ST,WB	АМ	
178		Pycnonotus cafer	Red-vented Bulbul	CP,ST,WB	Resident	
179		Alophoixus flaveolus	White-throated Bulbul	ST	AM	
180	Rallidae	Porzana bicolor	Black-tailed Crake	WB	Resident	
181	Ramphastidae	Megalaima asiatica	Blue-throated Barbet	ST,CP,WB	АМ	

182		Megalaima franklinii	Golden-throated Barbet	ST,WB	AM	
183		Megalima australis	Blue-eared Barbet	ST,CP,WB	AM	
184		Megalaima virens	Great Barbet	CP,ST,WB	AM	
185		Megalaima lineate	Lineated Barbet	WB	AM	
186	Rhipiduridae	Rhipidura albicollis	White-throated Fantail	СВ	АМ	
187		Rhipidura hypoxantha	Yellow-bellied Fantail	ST	AM	
188	Regulidae	Regulus regulus	Goldcrist	WB	AM	
189	Scolopacidae	Tringa nebularia	Common Greenshank	ST	AM	
189	Sittidae	Sitta formosa	Beautiful Nuthatch	WB	AM	VU, Sch 1
190		Sitta castanea	Chestnut-bellied Nuthatch	CP,WB	AM	
191		Sitta frontalis	Velvet-fronted Nuthatch	CP, WB	AM	
192		Sitta himalayensis	White-tailed Nuthatch	WB	AM	
193		Tichodroma muraria	Wallcreeper	WB	AM	
194	Strigidae	Glaucidium cuculoides	Asian Barred Owlet	ST, WB	АМ	
195		Glaucidium brodiea	Collared Owlet	ST, WB	AM	
196		Glaucidium radiatum	Jungle Owlet	ST, WB	AM	
197		Ketupa flavipes	Tawny Fish Owl	ST, WB	AM	
198	Sturmidae	Acridotheres tristis	Common Myna	ST,WB	Resident	
199		Saroglossa spiloptera	Spot-winged Starling	ST	AM	
200	Sylviidae	Cettia flavolivacea	Aberrant Bush Warbler	СР	AM	
201		Cettia major	Chestnut-crowned Bush Warbler	CP,ST,WB,CB	AM	
202		Cettia pallidipes	Pale-footed Bush Warbler	WB	AM	
203		Phylloscopus cantator	Yellow-vented Warbler	WB	AM	
204		Phylloscopus reguloides	Blyth's Leaf Warbler	ST,WB,CB	AM	
205		Seicercus burkii	Golden-spectacled Warbler	ST,WB	AM	
206		Seicercus castaniceps	Chesnut-crowned Warbler	CP,ST,WB,CB	AM	
207		Tickellia hodgsoni	Broad-billed Warbler	СР	AM	

208		Cettia brunnifrons	Grey-sided Bush Warbler	CP,WB	AM
209		Phylloscopus maculinennis	Ashy-throated Warbler	WB	AM
210		Acrocephalus dumetorum	Blyth's Reed Warbler	СР	АМ
211		Cettia fortipes	Brownish-flanked Bush Warbler	CP,WB	AM
212		Phylloscopus fuscatus	Dusky Warbler		AM
213		Phylloscopus trochiloides	Greenish Warbler	CP,ST,WB,CB	AM
214		Seicercus poliogenys	Grey-cheeked Warbler	WB	AM
215		Seicercus xanthoschistos	Grey-hooded Warbler	WB	AM
216		Phylloscopus humei	Hume's Warbler	ST,WB,CB	AM
217		Phylloscopus choloronotus	Lemon-rumped Warbler	ST,WB	AM
218		Phylloscopus affinis	Tickell's Leaf Warbler	CP,ST,WB,CB	AM
219		Seicercus whistleri	Whistler's Warbler	ST,WB	AM
220	Timaliidae	Spelaeornis troglodytoides	Bar-winged Wren Babbler	СВ	AM
221		Pnoepyga pusilla	Pygmy Wren Babbler	WB	AM
222		Stachyris ruficeps	Rufous-capped Babbler	WB	AM
223		Stachyris rufifrons	Rufous-fronted Babbler	ST	AM
224		Pomatorhinus schisticeps	White-browed Scimitar Babbler	ST	AM
225		Pteruthius flaviscapis	White-browed Shrike Babbler	ST	AM
226		Pnoepyga albiventer	Scaly-breasted Wren Babbler	WB	AM
227		Pomatorhinus erythrocnemis	Rusty-cheeked Scimitar Babbler	ST,WB	AM
228		Stachyris ruficeps	Rufous-capped Babbler	WB	AM

229	Pomatorhinus ruficollis	Streak-breasted Scimitar Babbler	СВ	AM	
230	Xiphirhynchus superciliaris	Slender-billed Scimitar Babbler	ST,WB	АМ	
231	Stachyris chrysaea	Golden Babbler	WB	AM	
232	Spelaeornis formosus	Spotted Wren Babbler	ST,WB	AM	
233	Spelaeornis caudatus	Rufous-throated Wren Babbler	СВ	АМ	
234	Yuhina bakeri	White-naped Yuhina	СВ	АМ	
235	Yuhina occipitalis	Rufous-vented Yuhina	СВ	AM	
236	Yuhina nigrimenta	Black-chinned Yuhina	СР	АМ	
237	Yuhina gularis	Stripe-throated Yuhina	WB,CB	AM	
238	Yuhina flavicollis	Whiskered Yuhina	ST,WB	AM	
239	Yuhina zantholeuca	White-bellied Yuhina	WB	AM	
240	Garrulax subunicolor	Scaly Laughingthrush	ST, WB	AM	
241	Garrulax ruficollis	Rufous-necked Laughingthrush	ST,WB	АМ	
242	Garrulax monileger	Lesser Necklaced Laughingthrush	СР	АМ	
243	Garrulax affinis	Black-faced Laughingthrush	СВ	AM	
244	Garrulax erythrocephalus	Chestnut-crowned Laughingthrush	СВ	AM	
245	Garrulax lineatus	Streaked Laughingthrush	ST,WB,CB	AM	
246	Garrulux striatus	Striated Laughingthrush	ST,WB	AM	
247	Minla strigula	Chestnut-tailed Minla	ST, WB	AM	
248	Minla ignotincta	Red-tailed Minla	WB	AM	
249	Heterophasia picaoides	Long-tailed Sibia	WB	AM	
250	Heterophasia capistrat	Rufous Sibia	ST,CB	АМ	
251	Alcippe castaneceps	Rufous-winged Fulvetta	WB	AM	

252		Alcippe nipalensis	Nepal Fulvetta	СР	AM	
253		Alcippe cinerea	Yellow-throated Fulvitta	СР	М	
254		Leiothrix argentauris	Silver-eared Mesia	ST	AM	
255		Actinodura nipalensis	Hoary-throated barwing	WB	AM	
256		Gampsorhynchus rufulus	Rusty-fronted Barwing	WB	AM	
257		Garrulax leucolophus	White-crested Laughingthrush	ST,WB	AM	
258		Garrulax albogularis	White-throated Laughingthrush	WB,CB	AM	
259	Troglodytidae	Troglodytes troglodytes	Winter Wren	WB, CB	AM	
260	Trugonidae	Harpactes wardi	Ward's Trogon	WB, CB	AM	
261		Harpactes erythrocephalus	Red-headed Trogon	ST,WB	AM	
262	Turdidae	Myophonus caeruleus	Blue Whistling Thrush	ST,CP,WB,CB	Resident	
263		Zoothera dauma	Scaly Thrush	ST, CP,	Resident	
264		Monticola cinclorhynchus	Blue-capped Rock Thrush	СР	AM	
265		Zoothera citrina	Orange-headed Thrush	ST,WB	AM	
266		Turdus albocinctus	White-collared Blackbird	СВ	АМ	
267	Upupidae	Upupa epops	Common Hoopoe	ST,WB	AM	
268	Certhiidae	Certhia discolor	Brown-throated Treecreeper	CP,ST,WB	AM	
269	Prionopidae	Tephrodornis gularis	Large Woodshrike	ST	АМ	
270	Zosteropidae	Zosterops palpebrosus	Oriental White-eye	ST,WB	AM	

SL. NO.	Species	Common Name	Family
1.	Tirumala limnace	Blue Tiger	Namphalidae
2.	Tirumala septentrionis	Dark Blue Tiger	Namphalidae
3.	Danaus chrysippus	Plain Tiger	Namphalidae
4.	Parantica aglea	Glassy Tiger	Namphalidae
5.	Parantica agleoides	Dark Glassy Tiger	Namphalidae
6.	Parantica sita	Chestnut Tiger	Namphalidae
7.	Euploea mulcibar	Striped Blue Tiger	Namphalidae
8.	Euploea midamus	Blue-Spotted Crow	Namphalidae
9.	Euploea core	Common Crow	Namphalidae
10.	Polyura athamas	Common Nawab	Namphalidae
11.	Polyura doldon	Stately Nawab	Namphalidae
12.	Polyura eudamippus	Great Nawab	Namphalidae
13.	Thaumantis diores	Jungle Glory	Namphalidae
14.	Melanitis leda	Common Evening Brown	Namphalidae
15.	Lethe rohria	Common Treebrown	Namphalidae
16.	Lethe confusa	Banded Treebrown	Namphalidae
17.	Lethe verma	Straight-Banded Treebrown	Namphalidae
18.	Neope bhadra	Tailed Labyrinth	Namphalidae
19.	Orinoma damaris	Tiger Brown	Namphalidae
20.	Callerebia ananda	Ringed Argus	Namphalidae
21.	Ypthima baldus	Common Fivering	Namphalidae
22.	Ypthima huebneri	Common Fourring	Namphalidae
23.	Ypthima nareda	Large Threering	Namphalidae
24.	Ypthima sakra	Himalayan Fivering	Namphalidae
25.	Acraea issoria	Yellow Coster	Namphalidae
26.	Cethosia biblis	Red Lacewing	Namphalidae
27.	Childrena childreni	Large Silverstripe	Namphalidae
28.	Argyreus hyperbius	Indian Fritillary	Namphalidae
29.	Issoria lathonia	Queen of Spain Fritillary	Namphalidae
30.	Vindula erota	Cruiser	Namphalidae
31.	Phalanta phalantha	Common Leopard	Namphalidae
32.	Sumalia daraxa	Green Commodore	Namphalidae
33.	Auzakia danava	Commodore	Namphalidae

# 3. Checklist of Butterflies found in Jigme Singye Wangchuck National Park.

34.	Athyma perius	Common Sergeant	Namphalidae
35.	Athyma ranga	Blackvein Sergeant	Namphalidae
36.	Athyma opalina	Himalayan Sergeant	Namphalidae
37.	Athyma cama	Orange Staff Sergeant	Namphalidae
38.	Neptis miah	Small Yellow Sailer	Namphalidae
39.	Neptis hylas	Common Sailer	Namphalidae
40.	Phaedyma columella	Short-Banded Sailer	Namphalidae
41.	Euthalia monina	Powdered Baron	Namphalidae
42.	Euthalia phemius	White-Edged Blue Baron	Namphalidae
43.	Euthalia duda	Blue Duchess	Namphalidae
44.	Euthalia patala	Grand Duchess	Namphalidae
45.	Neurosigma siva	Panther	Namphalidae
46.	Lexias pardalis	Archduke	Namphalidae
47.	Lexias dirtea khasiana	Dark Archduke	Namphalidae
48.	Cyrestis thyodamas	Common Map	Namphalidae
49.	Chersonesia risa	Common Maplet	Namphalidae
50.	Pseudergolis wedah	Tabby	Namphalidae
51.	Dichorrhagia	Constable	Namphalidae
	nesimachus		
52.	Stibochiona nicea	Popinjay	Namphalidae
53.	Apatura chevana	Indian Purple Emperor	Namphalidae
54.	Rohana parisatis	Black Prince	Namphalidae
55.	Hestina nama	Circe	Namphalidae
56.	Sephisa dichroa	Western Courtier	Namphalidae
57.	Sephisa chandra	Eastern Courtier	Namphalidae
58.	Symbrenthia hypselis	Himalayan Jester	Namphalidae
59.	Symbrenthia hippoclus	Common Jester	Namphalidae
60.	Vanessa indica	Indian Red Admiral	Namphalidae
61.	Vanessa cardui	Painted Lady	Namphalidae
62.	Aglais cashmiriensis	Indian Tortoiseshell	Namphalidae
63.	Polygonia egea	Eastern comma	Namphalidae
64.	Kaniska canace	Blue Admiral	Namphalidae
65.	Junonia orithiya	Blue Pansy	Namphalidae
66.	Junonia hierta	Yellow Pansy	Namphalidae
67.	Junonia iphita	Chocolate Pansy	Namphalidae
68.	Hypolimnas bolina	Great Eggfly	Namphalidae
69.	Hypolimnas misippus	Danaid Eggfly	Namphalidae
70.	Kallima inachus	Orange Oakleaf	Namphalidae
71.	Doleschallia bisaltide	Autumn leaf	Namphalidae
72.	Curetis acuta	Angled Sunbeam	Lycaenidae
73.	Arthopala atrax	Indian Oakblue	Lycaenidae
74.	Heliophorus brahma	Golden Sapphire	Lycaenidae
75.	Heliophorus epicles	Purple Sapphire	Lycaenidae
76.	Heliophorus tamu	Powdery Green Sapphire	Lycaenidae
77.	Anthene emolus	Common Ciliate Blue	Lycaenidae
------	------------------------	------------------------	--------------
78.	Anthene lycaenina	Pointed Ciliated Blue	Lycaenidae
79.	Petrelaea dana	Dingy Lineblue	Lycaenidae
80.	Nacaduba pactolus	Large 4-Lineblue	Lycaenidae
81.	Nacaduba kurava	Transparent 6-Lineblue	Lycaenidae
82.	Prosotas nora	Common Lineblue	Lycaenidae
83.	Lonolyce helicon	Pointed Lineblue	Lycaenidae
84.	Jamides bochus	Dark Cerulean	Lycaenidae
85.	Jamides celeno	Common Cerulean	Lycaenidae
86.	Jamides alecto	Metallic Cerulean	Lycaenidae
87.	Lampides boeticus	Pea Blue	Lycaenidae
88.	Zizeeria karsandra	Dark Grass Blue	Lycaenidae
89.	Celastrina huegelii	Large Hedge Blue	Lycaenidae
90.	Everes argiades	Chapman's Cupid	Lycaenidae
91.	Celastrina huegelii	Large Hedge Blue	Lycaenidae
92.	Acytolepsis puspa	Common Hedge Blue	Lycaenidae
93.	Abisara fylla	Dark Judy	Lycaenidae
94.	Zemeros flegyas	Punchenello	Lycaenidae
95.	Dodona ouida	Mixed Punch	Lycaenidae
96.	Dodona egeon	Orange Punch	Lycaenidae
97.	Dodona eugenes	Tailed Punch	Lycaenidae
98.	Dodona durga	Common Punch	Lycaenidae
99.	Dodona dupoea	Lesser Punch	Lycaenidae
100.	Hasora chromus	Common Banded Awl	Hesperiidae
101.	Capila jayadeva	Striped Dawnfly	Hesperiidae
102.	Celaenorrhinus	Common Spoted Flat	Hesperiidae
	leucocera	_	
103.	Tagiades gana	Suffused Snow Flat	Hesperiidae
104.	Tagiades litigiosa	Water Snow Flat	Hesperiidae
105.	Borbo cinnara	Rice Swift	Hesperiidae
106.	Pseudoborbo bevani	Bevan's Swift	Hesperiidae
107.	Pelopidas mathias	Small Branded Swift	Hesperiidae
108.	Notocrypta paralysos	Common Banded Demon	Hesperiidae
109.	Notocrypta curvifascia	Restricted Demon	Hesperiidae
110.	Graphium cloanthus	Glassy Bluebottle	Papilionidae
111.	Graphium sarpedon	Common Bluebottle	Papilionidae
112.	Graphium Agamemnon	Tailed Jay	Papilionidae
113.	Chilasa clytia	Common Mime	Papilionidae
114.	Papilio polytes	Common Mormon	Papilionidae
115.	Papilio helenus	Red Helen	Papilionidae
116.	Papilio memnon	Great Mormon	Papilionidae
117.	Papilio protenor	Spangle	Papilionidae
118.	Papilio alcmenor	Redbreast	Papilionidae
119.	Papilio paris	Paris Peacock	Papilionidae

120.	Papilio polyctor	Common Peacock	Papilionidae
121.	Papilio polyeuctes	Common Windmill	Papilionidae
122.	Atrophaneura	Common Rose	Papilionidae
	aristolochiae		
123.	Atrophaneura hector	Crimson Rose	Papilionidae
124.	Troides Helena	Common Birdwing	Papilionidae
125.	Eurema brigitta	Common Grass Yellow	Pieridae
126.	Eurema laeta	Spotless Grass Yellow	Pieridae
127.	Eurema sari	Chocolate Grass Yellow	Pieridae
128.	Colias fieldii	Dark Clouded Yellow	Pieridae
129.	Eurema brigitta	Small Grass Yellow	Pieridae
130.	Colotis danae	Crimson Tip	Pieridae
131.	Colotis etrida	Small Orange Tip	Pieridae
132.	Ixias Marianne	White Orange Tip	Pieridae
133.	Ixias pyrene	Yellow Orange Tip	Pieridae
134.	Pieris brassicae	Large Cabbage White	Pieridae
135.	Pieris napi	Green Veined White	Pieridae
136.	Pieris canidia	Indian Cabbage White	Pieridae
137.	Cepora nadina	Lesser Gull	Pieridae
138.	Delias belladonna	Hill Jezebel	Pieridae
139.	Delias pasithoe	Red-Base Jezebel	Pieridae

# 4. Checklist of Plants found in Jigme Singye Wangchuck National Park.

# a. Trees

S.L No.	Family	Botanical Name	Uses	Status
1	Aceraceae	Acer campbellii	Т	Special Class
2	Achariaceae	Gynocardia odorata	OI,FU	
3	Altingiaceae	Altingia excelsa	Т	
4	Anacardiaceae	Choerospondias axillaris	T,FR,MD	
		Mangifera sylvatica	Т	
		Spondias pinnata	GU,FR,FU	
5	Annonaceae	Mitrephora harai	Т	
6	Araliaceae	Schefflera tenuis	FO	
7	Betulaceae	Alnus nepalensis	Т	
		Betula alnoides	Т	"A" Class
		Betula utilis	Т	
8	Bignoniacea	Stereospermum colais	FO,PP,T,FU	
9	Cornaceae	Alangium chinensis	Т	
10	<b>)</b> Cupressaceae	Cupresus corneyana	Т	Special Class
		Juniperus recurva	Т	Special Class
11	Elaeocarpaceae	Elaeocarpus sikkimensis	T,FR	
		Sloanea tomentosa	T,FO	
12	Ericaceae	Enkianthus deflexus	OR,FU	
		Lyonia obvalifolia	T,FU	
		Rhododendron arboreum	OR, CR, FU	
		Rhododendron barbatum	OR, CR, FU	
		Rhododendron grande	OR, CR, FU	
		Rhododendron hodgsonii	OR, CR, FU	
		Rhododendron kesangiae	OR, CR, FU	
13	Euphorbiaceae	Bischofia javanica	Т	
		Bridelia retusa	T,FR	
		Macaranga indica	FU,PP	
		Mallotus philippinensis	FU,PP	
		Ostodes paniculata	FO,FU,T	
		Phyllanthus emblica	MD,FU	
14	Fabaceae	Albizia lebbeck	Т	
		Castanopsis hystrix	T,FR,Fu	
		Castanopsis tribuloides	T,FR,Fu	
		Lithocarpus fenestratus	Т,	
		Quercus griffithii	FU,	

		Quercus lanata	FU. T	
15	Flacourtiaceae	Casearia glomerata	Т	
16	Juglandaceae	Engelhardia spicata	Т	
17	Lauraceae	Actinodephne ovata	Т	
		Beilschmiedia assamica	T,FR	
		Cinnadenia paniculata	Т	
		Cinnamomum glaucescens	T,CU	
		Cinnamomum	Т	
		impressinervium		
		Cryptocarya bhutanica	Т	Endemic
		Litsea albescens	PO,	
		Litsea sericea	FO,	
		Neocinnamomom caudatum	T,FU	
		Neolitsea foliosa	Τ,	
		Persea duthiei	Т	
		Persea fructifera	T,FR	
		Persea odoratissima	Т	
		Phoebe lanceolata	Т	
18	Magnoliaceae	Alcimandra cathcartii	Т	
		Magnolia campbellii	OR,FU	
		Michelia kisopa	Т	
19	Meliaceae	Aphanamixis polystachya	Т	
		Chisocheton cumingianus	Т	
20	Moraceae	Artocarpus chama	T,FR	
		Ficus 2	FO, Fu,	
21	Myrsinaceae	Myrsine semiserrata	T,FU	
22	Myrtaceae	Syzygium cumini	MD,FR,T	
23	Oleaceae	Ligustrum compactum	T,OR	
24	Pinaceae	Abies densa	Т	
		Pinus roxburghii	Т	
		Pinus wallichiana	Т	"A" Class
		Taxus baccata		Schedule I
		Tsuga dumosa	Т	
25	Proteaceae	Helecia niligarica	PO,	
		Helicia eliptica	DY,FU	
26	Rosaceae	Prunus rufa	T,CR	
		Sorbus wallichii	OR, FU	
27	Rubiaceae	Wendlandia coriacea	T,OR	
		Zanthoxylum armatum	CU,MD	
28	Simaroubaceae	Ailanthus integrifolia	Т	
		Picrasma javanica	Т	

29	Sterculiaceae	Ptervaota alata	T.FO
30	Symplocaceae	Symplocos lucida	BI,FU,PO
31	Theaceae	Eurya acuminata	FO, Fu,T
		Schima wallachii	T,PLY.
32	Ulmaceae	Celtis tetrandra	FO

# b. Shrubs

Sl. No.	Species Name	Family.	USE
1	Aechmanthera gossypina	Acanthaceae	OR
2	Oxyphora paniculata		OR
3	Thumbergia coccinea		OR
4	Vibernum erubescens	Adoxaceae	OR
5	Viburnum continifolium		OR
6	Viburnum mullaha		OR
7	Rhus paniculata	Anacardiaceae	MD,FR
8	Centella asiatica	Apiaceae	OR
9	Beaumontia grandiflora	Apocynaceae	OR
10	Rhaphidophora calophylla	Araceae	OR,FO
11	Rhaphidophora glauca		OR,FO
12	Rhaphidophora grandis		OR,FO
13	Rhaphidophora hookeri		OR,FO
14	Brassaiopsis hainla	Araliaceae	OR,FO
15	Brassaiopsis mitis		OR,FO
16	Schefflera bengalensis		OR,FO
17	Schefflera tenuis		OR,FO
18	Calamus erectus	Arecaceae	W,RM,FR
19	Calamus flagellum		W,RM
20	Calamus latifolius		W,RM
21	Caryota urens		OR,FR
22	Wallichia densiflora		FO
23	Wallichia disticha		FO
24	Treutlera insignis	Asclepiadaceae	OR
25	Vernonia volkameriifolia	Asteraceae	OR
26	Berberis aristata	Berberidaceae	DY
27	Berberis cooperi		DY
28	Berberis griffithiana		DY
29	Berberis praecipua		DY
30	Lonicera acuminata	Caprifoliaceae	OR

31	Lonicera macrantha		OR
32	Celastrus stylosus	Celastraceae	OR
33	Meytenus rufa		FE
34	Reissantia arborea		OR
35	Hypericum gramineum	Clusiaceae	OR
36	Hypericum hookerianum		OR
37	Hodgsonia macrocarpa	Cucurbitaceae	OR,MD
38	Trichosanthes lepiniana		OR,
39	Elaeagnus parvifolia	Elaeagnaceae	FR
40	Agapetes auriculata	Ericaceae	OR
41	Agapetes saligna		OR
42	Agapetes serpens		OR
43	Enkianthus deflexus		OR
44	Gaultheria nummularioides		OR
45	Gaultheria semi-infera		OR
46	Rhododendron lepidotum		OR,
47	Vaccinium nummularia		OR
48	Croton coudatus	Euphorbiaceae	OR
49	Croton joufra		OR
50	Phyllanthus reticulatus		MD
51	Phyllanthus emblica		OR,MD
52	Astragalus cytissoides	Fabaceae	OR
53	Crotalaria cytisoides		OR,NF
54	Desmodium gangeticum		OR,NF
55	Desmodium mortonii		NF,OR
56	Desmodium oblongum		NF,OR
57	Euchresta hoesfielddii		OR,NF
58	Flemingia fruticulosa		OR,NF
59	Indegofera decora		OR,NF
60	Indigofera purpurea		OR
61	Indigofera dosua		OR
62	Millettia extensa		OR,MD
63	Mucuna macrocarpa		MD
64	Pueraria edulis		NF,OR
65	Pueraria lobata		NF,OR
66	Aeschynanthus sikkimensis	Gesneriaceae	OR
67	Borinda grossa	Gramineae	FO,FE
68	Drepanostachyum		FO,W
60	Intermedium Dibaa griffithii	Crocculariacoco	ED
09 70	Kibes grijjitnii	Grossulariaceae	rk OD (Endomia)
70	Corylopsis nimalayana	пататендасеае	OK (Endemic)

71	Miquelia assamica	Icacinaceae	OR
72	Holboellia latifolia	Lardizabalaceae	OR,FR
73	Crawfardia speciosa	Lythraceae	OR
74	Woodfordia fruticosa		NF,OR
75	Sida acuta	Malvaceae	BP
76	Sida rhombifolia		BP
77	Stephania glabra	Menispermaceae	OR
78	Stephania glandulifera		MD
79	Ficus pubigera	Moraceae	FD
80	Ardisia macrocarpa	Myrsinaceae	OR
81	Ardisia solanaceae		OR
82	Aristolochia tagala		OR
83	Maesa chisia		OR
84	Myrsine semiserrata		FU
85	Ligustrum confusum	Oleaceae	OR
86	Phoenix acaulis	Palmae	FR,BP
87	Phoenix loureiri		FR,BP
88	Piper betaloides	Piperaceae	CO,MD
89	Piper mullesua		MD
90	Piper pedicellatum		MD
91	Piper suipigua		MD
92	Piper sylvaticum		MD
93	Aconogonum molle	Polygonaceae	OR,
94	Clematis montana	Ranunculaceae	OR
95	Berchemia floribunda	Rhamnaceae	OR
96	Cotoneaster bracillaris	Rosaceae	OR
97	Cotoneaster microphyllus		OR
98	Rosa sericea		OR
99	Rubus alexeterius		OR,FU
100	Rubus calycinus		OR,FU
101	Rubus ellipticus		OR,FU
102	Rubus paniculatus		OR,FU
103	Spiraea bella		OR
104	Hedyotis scandens	Rubiaceae	OR
105	Paederia cruddasiana		OR
106	Psilanthus bengalensis		OR
107	Psychotria calocarpa		OR
108	Psychotria denticulata		UK
109	Leptodermis stafiana		Y,UK
110	Rubia manjit	D	MD
111	Murraya koenigii	Kutaceae	MD

112	Toddalia asiatica		MD
113	Zanthoxylum armatum		CU,MD
114	Zanthoxylum oxyphyllum		CU,MD
115	Osyris lanceolata	Santalaceae	OR
116	Schisandra grandiflora	Schisandraceae	OR,FU
117	Buddleja asiatica	Scrophulariaceae	OR,Y
118	Sellaginella sp.	Selaginellaceae	OR
119	Smilax lanceifolia	Smilacaceae	OR
120	Smilax aspera		OR
121	Smilax aspericaulis		OR
122	Smilax menispermoidea		OR
123	Smilax minutiflora		OR
124	Smilax myrtilus		OR
125	Smilax perfoliata		OR
126	Brugmansia suaveolens	Solanaceae	OR
127	Solanum spirale		OR
128	Solanum torvum		OR
129	Solanum villosum		OR
130	Daphne bholua	Thymelaeaceae	OR,PM
131	Daphne sureil		OR,PM
132	Boehmeria macrophylla	Urticaceae	RM
133	Boehmeria glomerulifera		RM
134	Boehmeria ternifolia		RM
135	Dendrocnide sinuata		РО
136	Pilea hookeriana		V,FO
137	Pilea scripta		WE
138	Clerodendrum hastatum	Verbenaceae	OR
139	Anipelocissus divasicata	Vitaceae	OR
140	Cissus rapanda		OR,FO
141	Leea guineensis		FO
142	Parthenocissus semicordata		OR
143	Tetrastigma bracteolatum		OR,FO
144	Tratastigma rumicispermum		OR,FO
145	Tetrastigma serrulatum		OR,FO
146	Leea asiatica		FO
147	Dohaldia cappa		OR

# c. Herbs

S.L No.	Species Name	Family.	USE	Status

1	Thunbergia grandiflora	Acanthaceae	OR	
2	Thysanolaena maxima		BP,FO	
3	Viburnum erubescens	Adoxaceae	OR	
4	Allium macranthum	Alliaceae	MD,OR	
5	Allium rhabdotum		MD,OR	Endemic
6	Acronema hookeri	Apiaceae	BW	
7	Agelica sikkimensis		WE	
8	Cortia drepressa		OR,MD	
9	Arisaema concinnum	Araceae	OR,FO	
10	Arisaema griffithii		OR,FO	
11	Arisaema tortuosum		OR,FO	
12	Colocasia fallax		FO	
13	Pothos cathcartii		OR	
14	Rhaphidophora grandis		OR,FO	
15	Rhophidophora hookeri		OR,FO	
16	Panax psedo-ginseng	Araliaceae	MD,OR	Schedule I
17	Wallichia densiflora	Arecaceae	FO,Comb	
18	Hoya polyneura	Asclepiadaceae	OR	
19	Persicaria nepalensis		BW,BI	
20	Persicaria runcinata		BW,BI	
21	Polygonatum sibiricum	Asparagaceae	MD,OR	
22	Asplenium gueinzianum	Aspleniaceae	OR	
23	Asplenium macrophyllum		OR	
24	Asplenium nidus		OR	
25	Asplinium macrophyllum		OR	
26	Ageratina adenophora	Asteraceae	WE	
27	Ageratum conyzoides		WE	
28	Ainsliaea aptera		OR	
29	Ainsliaea latfolia		OR	
30	Artemisia austroyunnanensis		MD,MU	
31	Aster albescens		OR	
32	Aster himalaicus		OR,MD	
33	Aster neoelegans		OR	
34	Chromolaena odoratum		BW	
35	Gynura bicolor		OR	
36	Ixeridium beauverdianum		OR,BI	
37	Leibnitzia nepalensis		BI	
38	Leontopodium jacotianum		OR,BI	
39	Ligularia mortonii		BW	
40	Mikania micrantha		BW	
41	Senecio laetus		OR,	

42	Senecio scandens		OR
43	Senecio wallichii		OR
44	Synotis wallichii		OR
45	Dryopteris khasiana	Athyriacea	OR,BI
46	Dryopteris marginata		OR,BI
47	Dryopteris paleaceae		OR,BI
48	Diplazium esculentum		OR,VE
49	Impatience spirifer	Balsaminaceae	OR,BI
50	Impatiens cristata		OR,BI
51	Impatiens florigera		OR,BI
52	Impatiens radiata		OR,BI
53	Impatiens urticifolia		OR,BI
54	Podophyllum hexandrum	Berberidaceae	MD,OR
55	Lobelia pyramidalis	Campanulaceae	OR
56	Gypsophylla cerastioides	Caryophyllaceae	OR
57	Cephalanthera domasonium	Chenopodiaceae	OR
58	Commelina paludosa	Commelinaceae	WE
59	Anaphalis busua	Compositae	OR
60	Anaphalis nepalensis		OR
61	Carpesium nepalense		We
62	Dubyaea hispida		W
63	Senoeio raphanifolius		OR,W
64	Ophiopogon bodinieri	Convallariaceae	OR
65	Ophiopogon clarkei		OR
66	Ophiopogon wallichianus		OR
67	Onychium siliculosom	Cryptogrammataceae	OR
68	Trichosanthes lepiniana	Cucurbitaceae	MD,OR
69	Cyperus cyperoides	Cyperaceae	WE, FO
70	Cyprus cyperinus		WE,FO
71	Scirpus ternatanus		RM,
72	Dennstaedtia scabra	Dennstaedtiaceae	OR
73	Monachosorum henryi		OR,BI
74	Pteridium aquuilinum		CB,BI
75	Dioscorea bulbifera	Dioscoreaceae	MD,VE
76	Dipteris wallichiana	Dipteridaceae	OR
77	Drosera peltata	Droseraceae	OR,MD
78	Dendrobium aphyllum	Epidendroideae	OR
79	Dendrobium chrysanthum		OR
80	Dendrobium densiflorum		OR
81	Dendrobium fimbriatum		OR
82	Gueldenstaedtia himalaica	Fabaceae	MD,OR

83	Spongiocarpella purpurea		MD
84	Trifolium rapens		FO,W
85	Swertia bimaculata	Gentianaceae	OR
86	Crowfurdia speciosa		OR
87	Gentiana capitata		OR
88	Aeschynanthus sikkimensis		OR, GU
89	Aschynanthus skimemsis		OR,GU
90	Arundinella hookeri	Gramineae	FO
91	Cymbopogon flexus		OI
92	Festuca wallichiana		FO
93	Hymenophyllum sp.	Hymenophyllaceae	BI
94	Molineria crassifolia	Hypoxidaceae	FO,BI
95	Juncus brachystigma	Juncaceae	FO
96	Juncus himalensis		FO
97	Scutellaria discolor	Labiatae	OR
98	Stachys melissaefolia		OR
99	Clinopodium umbrosum	Lamiaceae	WE
100	Clintonia udensis		OR
101	Prunella vulgaris		OR
102	Desmodium motorium	Leguminosae	BW
103	Streptopus simplex	Liliaceae	OR
104	Tricyrtis maculata		OR
105	Nephrolepis cordifolia	Lomariopsidaceae	OR,BI,FR
106	Lycopodium clavatum	Lycopodiaceae	OR,
107	Lygodium japonicum	Lygodiaceae	OR
108	Marchantia spp	Marchantiaceae	BI
109	Stephania glabra	Menispermaceae	MD,
110	Usnea longifloum		BI
111	Aletris pauciflora	Nartheciaceae	OR
112	Oleandra nerriformis	Oleandraceae	OR
113	Aerides roseum	Orchidaceae	OR
114	Aorchis spathulata		OR,MD
115	Bulbophyllum affine		OR
116	Bulbophylum gamblei		OR
117	Calanthae brevicornu		OR,VE
118	Calanthe masuca		OR,VE
119	Calanthe plantaginea		OR,VE
120	Cymbidium hookerium		OR,VE
121	Cyprepidium cordigerum		UK
122	Dendrobium nobile		OR
123	Eria ferruginea		OK

124	Listera pinetorum		BI
125	Malaxis muscifera		OR
126	Otochilus albus		OR
127	Pleoine hookeriana		OR,GU
128	Satyrium nepalensis		MD,OR,
129	Oxalis leucolepis	Oxalidaceae	OR,MD
130	Corydalis ecristata	Papaveraceae	MD,OR
131	Lichen sp.	Parmeliaceae	OR,BI
132	Brachypodium sylvaticum	Poaceae	FO
133	Danthonia cumminsii		OR,FO
134	Eragrostis nigra		FO
135	Eragrostis tenella		FO
136	Imperata cylindrica		FO
137	Ione bicolor		OR,BI
138	Muhlenbergia huegelii		FO
139	Poa annua		OR,FO
140	Drepanostachyum khasiaum		W,OR
141	Saccharum spontaneum		OR,SB
142	Yushania microphylla		FO,
143	Aconogonun molle	Polygonaceae	OR,BI
144	Bistorta vivipara		OR
145	Arthromeris wallichiana	Polypodiaceae	OR
146	Drynaria coronans(Big hard)		OR,BI
147	Drynaria mollis		OR,BI
148	Drynaria propinqua		OR,CB,BI
149	Lepisorus loriformis		OR
150	Lipisorus mehrae		OR
151	Microssorium phyllomanes		OR
152	Oleandra pistillaris(Climbing fern)		OR
153	Oleandra wallichii		OR
154	Pyrrosia spp.		OR
155	Primula denticulata	Primulaceae	OR
156	Bryocarpum himalaicum		MD,OR
157	Primula obliqua		OR
158	Cheilanthes rufa	Pteridaceae	OR
159	Pteris biaurita		OR
160	Pteris cretica		OR
161	Pteris wallichiana		OR
162	Actaea acuminata	Ranunculaceae	OR,
163	Anemone rivularis		OR

164	Caltha palustris		OR	
165	Clematis montana		OR,MD	
166	Ranunculus brotherusii		OR,MD	
167	Thalictrum chelidonii		OR	
168	Thalictrum foliolosum		OR	
169	Thalictrum rostellatum		OR	
170	Fragaria nubicola	Rosaceae	FR	
171	Potentilla cuneata		MD,OR	
172	Potentilla griffithii		MD,OR	
173	Potentilla peduncularis		MD,OR	
174	Rubus calycinus		FR,	
175	Rubus fockeanus		FR,	
176	Galium aparene	Rubiaceae	W	
177	Galium sikkimense		W	
178	Rubia hispidicaulis		MD,DY	
179	Rubia manjit		MD,DY	
180	Boenninghausenia abiflora	Rutaceae	WE	
181	Saxifraga strigosa	Saxifragaceae	BI	
182	Tiarella polyphylla		OR	
183	Alectra avensis	Scrophulariaceae	OR	
184	Hemiphragma heterophyllum		OR	
185	Scoparia dulcis		MD, W	
186	Selaginella sp.	Selaginellaceae	OR,BI	
187	Smilax menispermoidea	Smilacaceae	MD	
188	Anisodus luridus	Solanaceae	MD,PO	
189	Solanum americanum		MD	
190	Sphagnum moss	Sphagnaceae	BI	
191	Daphne bholua	Thymelaeaceae	OR,PM	
192	Paris polyphylla	Trilliaceae	MD,OR	
193	Bupleurum dalhousieanum	Umbelliferae	MD	
194	Sanicula elata		BI	
195	Elatostema lieneolatum	Urticaceae	BI	
196	Elatostema ssessile		BI	
197	Gerenium nepalense		OR	
198	Girardinia diversifolia		VE,RM,MD	
199	Pauzolzia hirta		MD,	
200	Periploca callophylla		MD	
201	Pilea glaberrima		W,BI	
202	Pilea hookeriana		W,BI	
203	Pilea scripta	X7' 1	W,BI	
204	Viola bhutanica	Violaceae	OR	Endemic

205	Viola biflora	Violaceae	OR
206	Cautleya gracilis	Zingiberaceae	OR
207	Roscoes alpina		OR
208	Moss		BI,OR



# Annex B: 132 kV Transmission Line for Power Evacuation

#### **APPLICATION FOR ENVIRONMENTAL CLEARANCE**

# CONSTRUCTION OF 132 kV POOWER TRANSMISSION LINE FROM NIKACHHU POT HEAD YARD TO MANDGECHHU POT HEAD YARD

# 1.1 Applicant's Details

Name of Project: Construction of 132 kV Transmission Line for 118 MW Nikachhu Hydropower Project, Trongsa.

Name of Applicant: Druk Green Power Corporation Limited.

Full contact Address of Applicant: Projects Department Druk Green Power Corporation Limited Thimphu

Name of contact person: Mr. Pema Dorji, EO

Telephone no.: (+975)-2-339871 Fax no: (+975)-2-323853

Email address: pema.dqpc@qmail.com

#### **1.2** Describe the objective (s) and purpose of the project

The objective of the proposed project is to construct 18.6 km, 132 kV line from Nikachhu pot head yard to Mangdechhu pot head yard for the evacuation of power from Nikachhu Hydropower Project. 118 MW Nikachhu Hydropower construction activities shall be commenced from third quarter of 2014 and therefore, this 132 kV line shall be constructed to evacuate power till Mangdechhu pot head yard at Yurmo. The power shall be further evacuated through 400 kV line undertaken by Bhutan Power Corporation from Yurmo-Goling-Jigmeling.

Therefore, the proposed project activity shall occur for stretch of only 18.6 km from Nikachhu Pot head yard at under construction Mangdechhu Dam till Yurmo where Mangdechhu pot head yard is housed.

1.3 **Name of the project financier:** Tangsibji Hydro-Energy (ThyE), The Company incorporated to undertake Nikachhu Hydropower Project;

#### 1.4 Project Details

#### 1.4.1 Site Route

The transmission line traverses through the following areas.

#### Table 1: Transmission line route details

From	То	GIS Dist (Crow Fly)	Actual in km (approx)	Place under Trongsa Dzongkhag
TL1	Т6	2.07	2.48	Tashidingkha, Eusa
TL7	TL14	2.02	2.42	Tashidingkha, Eusa, Taktse
				Taktse, Eusa, Bubja,
TL15	TL26	3.15	3.78	Kuengarabten
				Kuengarabten, Samcholing,
TL27	TL42	5.32	6.38	Lhakhang Jab

TL43	TL50	1.70	1.57	Lhakhang Jab, Raphey Top
	TL56 at			
TL51	Yurmo	1.31	1.57	Raphey, Khompey and Yurmo
Tota	I Distance			
	(km)	15.57	18.68	

# 1.4.2 Transmission line Details:

- i. Voltage level: 132kV
- ii. Tapping point: Nikachhu Pot Head Yard
- iii. Termination point: Mangdechhu Pot Head Yard
- iv. Length of line: **18.6 km** (Maximum)
- v. Right of Way (ROW) width: 27 m

# 1.4.3 Project Cost

The total estimated cost of the Project: **Nu. 143 million.** The only impact on land due to construction of the 132 kV transmission line would be due to vegetation clearing in the 27 km RoW as required by the National Transmission Grid Master Plan (NTGMP) of Bhutan Power Corporation. The private lands of 6 households shall be affected by 6 towers footing located in their land. The compensation mechanism and cost is included the overall Resettlement Plan (Volume 3 of the ESIA Report). Moreover, compensatory afforestation shall be covered in the overall project cost of Nikachhu Hydropower Project.

# 1.4.4 Towers/Poles

Provide total number of towers/poles:

#### 61 number of towers

How many towers/poles will be located in private land: The alignment of the transmission line mostly falls in SRF Land. Only about 0.24 acres of private land belonging to 6 private land holders will be affected by 6 tower footings. The NOC from the Affected Persons has been accorded and therefore attached with the report.

# 1.4.5 Excavated Material

An estimated amount of about 24,583 m³ shall be generated from excavation works of 61 towers along teh 18.6 km stretch. The volume of excavated material is at dispersed locations and is low. Therefore, the excavated material shall be reused to fill the holes of tower foots and shall be used to stabalize it.

# 1.4.6 Implementation Schedule

1. How long will the project take to construct?

The transmission line and power evacuation system for Nikachhu Project shall be awarded to Bhutan Power Corporation (BPC) as a deposit work. The detailed survey and investigation related to the transmission line will be carried out by BPC. So far, BPC has carried out walk on survey for the transmission line from Nikachhu power house to the Mangdechhu pot head yard. Tentatively, the survey and engineering design of the transmission lines and implementation shall be carried out by **2015-2018** before completion of Nikachhu Hydropower Project.

# 1.4.7 Environmental Unit

(Section 22 of The Regulation for the Environmental Clearance of Projects, 2002, requires that depending on the size of the project, the project either establishes an Environmental Unit or under Section 23 delegates a focal person who will be in charge of Environmental Compliance).

Tangsibji Hydro Energy (THyE) will have a dedicated Environment & CDM Unit to look after all matters related to environmental aspects. The Unit shall closely work with the Contractor during the execution and ensure Environment Compliance. The Unit shall strictly adhere to the Terms and Conditions of the Environment Clearance and ensure proper reporting and record keeping.

# 1.5 Alternative (s) Transmission Route

Transmission line route survey (walk on survey) for 132 kV line was carried from Nikachhu Pot Head yard to Mangdechhu Pot Head yard from 24th September to 14th October, 2013. During the survey, two alternative routes were explored. Based on the walk on survey, the the survey team recommended the first alternative route (Port head yard-- Mangdechu River crossing- parallel to Mangdechu Dam axis road-TL1 – Alternative-TL 56, Taktse-Tashidingka-Euse-Bubja- Kuengarabten- Samchholing-Lhakhang jap-Raphey- Kompey-Yurmoo with 18.6Km owing to the reasons listed below:

- i. The total line length compared to the other route is shorter by about 1km and the line encroaches less private land, especially wet land at Yurmoo.
- ii. Construction would be a difficult task owing to limited space at Yurmoo, as approximately 1km stretch of the total line length at Yurmoo is spotted parallel to 400kV D/C transmission line and also 66 kV Yurmoo-Trongsa line is also traversing through the same area making it more difficult to spot the tower foundation resulting in clearance issues.
- iii. The terrain along the proposed route was found comparatively moderate.

Therefore, Option-1 with line length of 18.6 km has been chosen as the best alternative.

# 1.6 The Project Environment

#### 1.6.1 Topography

The Tansmission line extending from Nikachu Pothead to Yurmo begins with slopes of approximately 35% mostly extending along undulating terrain with from elevation of beginning at 2,040m, falling to 1,140m at the end.



# 1.6.2 Land Use/Vegetation

i. <u>Transmission Line</u>

Table 2: Area of land use along transmission line ROV
-------------------------------------------------------

Facility	Chu- zhing	Kam - zhin g	Broadleaf forest	Co nife r for est	Scrub- land	Orcha rds	Expos ed/Roc ky	Total (km/k m²)
Transmissio n line length (km)	0	0	15	0	3.6	0	0	18.6
Actual Corridor length clearance required (km ² )	0	0	15km* 0.027 km =0.045 km ²	0	3.6km *0.027km =0.0972 km ²	0	0	0.1422
Total area requ	uiring clea	arance (	(km ² ): 0.1422					

Note: Chuzhing: wet land, paddy field, marsh Kamzhing: rain-fed dry land Scrubland also includes disturbed areas of Broadleaf and Coniferous forest that have been logged and are now regenerating.

# ii. <u>Sub-station/s</u>

# Table 3: Area of land required for sub-stations (m²)

Facility	Chu- zhing	Kam- zhing	Broadle af forest	Conif er forest	Scrub- land	Orchar ds	Expo sed/R ocky	Total (m ² )			
Sub-	There is	s no requi	rement for a	any subs [.]	tation for thi	is project.	This line				
Station	is solely	is solely for the purpose of power evacuation.									
Total Area requiring clearance	Not rele	evant									

Note: Chuzhing: wet land, paddy field, marsh Kamzhing: rain-fed dry land Scrubland also includes disturbed areas of Broadleaf and Coniferous forest that have been logged and are now regenerating.

# iii. Land Tenure

For those areas in Table 2 and 3, show the tenure ship of these areas as being either (a) "private" or (b) "public". For private land show the number of households affected. Enter these details in Table 4. This data will be used to work out resettlement requirements and compensation payable.

# Table 4: Land ownership and affected household details

Facility	Chւ ց	Chuzhin Kamzhi g ng		Broadlea Conif f forest forest		ifer st	Scrubl and		Orchar ds		Exposed / Rocky		Total		
raciity	Tn	нн	Tn	ΗH	Tn	нн	Tn	нн	Tn	HH	Tn	ΗH	Tn	HH	
Sub- Station (Nos)	It is not relevant as no substation is planned for this project.														
Total Family (Nos.)	Not relevant, the proposed transmission line will not involve issues of resettlement and displacement of houses or families or any other private infrastructures														

Source of this information: Site Survey Note:1.HH: household (s)

2. "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 landowner.

# 1.6.3 Houses and Infrastructure

The project will not cause loss of any house or any other infrastructure, no substation is planned.

# Table 5: Losses of houses and other infrastructure

Facility	Houses (Nos.)	Other infrastructures (Nos.)
Sub-station	Not relevant, this project will not ca	use loss of any house or any other
Transmission	infrastructure, no substation is planne	d.
line		
Total (no)		

Note: Other infrastructures losses could include shops, hotels, offices, health posts, schools, etc

# 1.6.4 Protected Areas

a) Will the transmission line cross a Protected Area (PA)?

No.

b) If yes, provide the information in the following table.

# Table 6: Protected area details for transmission lines

Name of protected area	Length within t	Length of transmission line through different zones within the protected area (km)								
	Encla ve zone	Buffer zone	Core zone	Seasonab le grazing zone	Administr ative zone	Multiple Use zone	length (km)			
NIL				N.A.						

- c) Will any of the sub-stations be located in a Protected Area? "No"
- d) If yes, provide the information in the following table.

# Table 7: Protected area details for sub-stations

Name of protected area	Area of transmission line through different zones within the protected area (m2)			Total		
	Encla ve zone	Buffer zone	Core zone	Seasonab le grazing zone	Administr ative zone	Multiple Use zone
	Not relevant. No substation is planned.					

# 1.6.5 Access Roads

Will the access road be constructed? "No"

The existing road and footpaths will be used for the transportation of poles and equipments.

If yes, is it temporary or permanent? NA

If temporary, did you seek alternative means of transportation, such as cableway? NA

# 1.6.6 Aesthetics

Will the location of the transmission line significantly impair visual aesthetics? "Yes" or "No". Explain your answer.

# "No significant impact"

However, the overall aesthetic effect of a transmission line is likely to be negative to most people, especially where proposed lines would cross natural landscapes and be close to tourist destinations. But the structure to be established by the project may seem out of proportion and not compatible with agricultural landscapes because scenery points do not exist near to the project site. Besides, electric transmission lines can be routed to avoid areas considered scenic.

# a. Biodiversity report for Transmission Line

**Background:** The proposed 132kV transmission line with 18.6Km and 19.2Km respectively is aligned mostly in the State Reserved Land/forest with few numbers of towers falling under private land and community forest. The first and the preferred route with 18.6 km is diverted via Raphey top crossing the existing 66kV line at Tower No.7 & T8.

¹³² kV Construction Power 132 kV Transmission Line Application_NEC.doc

Along the alignment for the Transmission line a total of 74 plots were randomly selected at intervals of approximately 250m each. Within these plots, data was collected on vegetation, wildlife; birds as well as additional information on signs of disturbance were noted. 80% of the alignment fell under broadleaf forest, while 15% was in Scrub forest and the remaining 3% in agricultural land or community forest or crossing footpath or road.

Along most of the transmission alignment, disturbance was quite high as this area is close to the cleared Right of Way for the 66 kV transmission line. There are also some marshy and rocky areas. Also, the project site can be easily accessed from the Mangdechu Dam Axis, the Trongsa-Zhemgang Highway and some footpaths. It also crosses the river and there are community plantations of cypress and the Taktse community forest as well as Eusa-Barpo community forest

# b. Forest type

Moving along the transmission line the forest is mostly cool broadleaf forests and eventually as the elevation drops and climate is warmer, the vegetation becomes more sub-tropical with species like *Duabanga grandiflora, Alnus nepalensis, Bischofia javanica, Rhus chinensis, Pinus roxburghii, Ficus roxburghii, Ficus semicordata*, and *Quercus lanata* in Langthel and Yurmo. Tree density is not very high with a maximum of **14 trees in 100m²**. Broadleaf forest is interspersed at intervals with scrub forest that comprises mostly of Artemesia, Rubus, Berberis and Eupatorium species.

Species recorded within and outside the transmission line are listed. The Top canopy comprises mostly of *Quercus griffithii*, *Quercus lanata*, *Quercus lamellosa*, *Alnus nepalensis*, *Lyonia ovalifolia*, Daphniphyllum species, *Docynia indica*, *Juglans regia*, *Symplocus ramosissima*, *Ex-bucklandia populnea*, *Toricellia tiliifolia*, *Castanopsis Hystrix*, *Persea bootanica*, *Michelia doltsopa*, *Quercus semicarpifolia*, *Rhododendron arboreum*, *Prunus cerasoides*, and Bamboo. As the elevations decreased, other species such as *Castanopsis hystrix*, *Rhus wallichii*, *Rhus chinensis*, *Cinnamomum bejolghota Quercus lanata*, *Schima wallichii*, *Saurauia napaulensis*, *Erythrina arborescens* and in drier areas *Pinus roxburghii* are present.

Shrubs include Berberis aristata, Ardisia macrocarpa, Edgeworthia gardneri, Dichroa fibrifuga, Viburnum erubescens, Mahonia nepalensis, Brassaiopsis mitis, Daphne bholua, Viburnum cylindricum, Maesa chisia, Eurya acuminatum, Rhododendron arboreum, Symplocos glomerata, Viburnum cylindricum, Ilex species, Cotoneaster microphylla, Elaeagnus parvifolia, Rubus ellipticus, Eupatorium adenophorum, Zanthoxylum species,. Vaccinium myrtillus, Rhododendron vaccinoides, Indigofera dosua, Aconogonum molle, Datura suaveolens, Adhatoda vasica and Arundinaria species

Herbs include Artemisia vulgaris, Artemisia indica, Leucas ciliata, Inula cappa, Leucosceptrum species, Eupatorium adenophorum, Urtica parviflora, Anaphalis triplinervis, Cirsium falconeri, Solanum virginianum, Smilax ovalifolia, Swertia chirata, Pilea umbrosa, Ainsliaea aptera, Elatostema platyphyllum, Hedychium ellipticum, Elshotzia fruticosa, Osbeckia stellata, Oxalis corniculata, Pilea anisophylla, Colocasia esculenta and Pilea umbrosa.

Ground cover include *Polygonum runcinatum*, *Hydrocotlye javanica*, *Fragaria nubicola*, *lycopodium clavatum* (moss), *Poa annua* (turfgrass), *Hemiphragma heterophyllum* (creeping plant), *Potentilla fruticosa*, *Potentilla microphylla*, *Tupistra chinensis*, *Osbeckia stellata*, *selaginella sp* (spikemoss),

¹³² kV Construction Power 132 kV Transmission Line Application_NEC.doc

Climbers include Raphidophora species, *Hedera nepalensis* and *Agapetes serpens*. Ferns include *Diplazium esculentum*, *Pteris wallichiana*, *Oleandra pistillaris*, *Gleichenia gigantean*, *Pteridium aquilinum* and *Drynaria propinqua*, *Adiantum caudatum*, Asplenium sp.

Orchids include *Calanthe* sp, *Eria coronaria*, *Phalaenopsis* sp. *Vanda cristata*, Cymbidium cyperifolium, *Gastrochilus* sp., and *Dendrobium candidum*, Coelogyene corymbosa and Bulbophyllum sp.,

Mushrooms that can be found there include Amanita sp., *Lactarius piperatus, Laetiporus* sp.,*Lycoperdon* sp., *Trichaptum abietinum, Boletus sp., Laccaria sp., Ramaria sp., Fomes sp., Xeromphalina campanella.* 

SI. No.	Scientific Name	Family	Habit
1	Aconogonon molle	Polygonaceae	Shrub
2	Adhatoda vasica	Acanthaceae	Shrub
3	Agapetes serpens	Ericaceae	semiclimbing shrub
4	Ainsliaea aptera	Compositae	Herb
5	Alnus nepalensis	Betulaceae	Tree
6	Anaphalis busua	Compositae	Herb
7	Anaphalis triplinervis	Compositae	Herb
8	Ardisia macrocarpa	Myrisinaceae	Shrub
9	Artemesia vulgaris	Asteraceae	herb
10	Artemisia indica	Asteraceae	Herb
11	Arundinaria sp.	Poaceae	Cane
12	Asplenium sp.	Aspleniaceae	fern
13	Berberis aristata	Berberidaceae	Shrub
14	Berberis praecipua	Berberidaceae	Shrub
15	Bischofia javanica	Bischofiaceae	Tree
16	Brassaiopsis mitis	Araliaceae	Shrub
17	Bulbophyllum affine	Orchidaceae	Orchid
18	Calanthe sp.	Orchidaceae	Orchid

# Table: List of Plant species recorded from Project site

SI. No.	Scientific Name	Family	Habit
19	Castanopsis hystrix	Fagaceae	Tree
20	Cautleya gracilis	Zingiberaceae	Herb
21	Cinnamomumm bejolghota	Lauraceae	Tree
22	Cirsium falconeri	Asteraceae	Herb
23	Cirsium verutum	Asteraceae	Herb
24	Coelogyene corymbosa	Orchidaceae	Orchid
25	Cotoneaster microphyllus	Rosaceae	Shrub
26	Cymbidium cyperifolium	Orchidaceae	Orchid
27	Cyperus Cyperoides	Cyperaceae	Grass
28	Daphne bholua	Thymelaeaceae	Shrub
29	Daphniphylluim calycinum	Daphniphyllaceae	Shrub
30	Daphniphyllum sp.	Daphniphyllaceae	Tree
31	Datura suaveolens	Solanaceae	Shrub
32	Dendrobium candidum	Orchidaceae	Orchid
33	Dichroa febrifuga	Hydrangeacea	shrub
34	Diplazium esculentum	Athyriacea	fern
35	Docynia indica	Rosaceae	Tree
36	Duabanga grandiflora	Sonneratiaceae	Tree
37	Edgeworthia gardneri	Thymelaeaceae	Shrub
38	Eleagnus parvifolia	Elaeagnaceae	Shrub
39	Eria coronaria	Orchidaceae	Orchid
40	Erythrina arborescens	Leguminaceae	Tree
41	Eupatorium	Asteraceae	Herb

SI. No.	Scientific Name	Family	Habit
	adenophorum		
42	Eupatorium odoratum	Asteraceae	Shrub
43	Eurya acuminata	Theaceae	T/S
44	Eurya acuminata	Theaceae	Shrub
45	Exbucklandia populnea	Hamamelidaceae	Tree
46	Ficus roxburghii	Moraceae	Tree
47	Ficus semicordata	Moraceae	Tree
48	Fragaria nubicola	Rosaceae	Herb
49	Gastrochilus	Orchidaceae	Orchid
50	Gleichenia gigantea	Glienchianaceae	Fern
51	Hedera nepalensis	Araliaceae	Climber
52	Hemiphragma heterophyllum	Scrophulariaceae	creeping plant
53	Hydrocotlye javanica	Apiaceae	Herb
54	llex aquifolium	Aquifoliaceae	Shrub
55	Indigofera dosua	Leguminosaceae	Shrub
56	Inula cappa	Asteraceae	Herb
57	Juglans regia	Juglandaceae	Tree
58	Leucas ciliata	Lamiaceae	Herb
59	Lindera pulcherrima	Lauraceae	Tree/Shrub
60	Lindera pulcherrima	Lauraceae	Tree/Shrub
61	Lycopodium clavatum	Lycopodiaceae	club Moss
62	Lycopodium clavatum	Lycopodiaceae	Moss
63	Lyonia ovalifolia	Ericaceae	Tree
64	Measa chisia	Myrinsinaceae	Shrub
65	Michelia doltsopa	Magnoliaceae	Tree

SI. No.	Scientific Name	Family	Habit
66	Mikania micrantha	Asteraceae	vine
67	Neillia rubiflora	Rosaceae	Shrub
68	Oleandra pistillaris	Oleandraceae	Fern
69	Ophiopogon wallichianus	Convallariaceae	herb
70	Osbeckia stellata	Melastomataceae	Herb
71	Persea bootanica	Lauraceae	Tree
72	Persea clarkeana	Lauraceae	Tree
73	Phalaenopsis sp.	Orchidaceae	Orchid
74	Pilea umbrosa	Urticaceae	Herb
75	Pinus roxburghii	Pinaceae	Tree
76	Poa annua	Poaceae	grass
77	Polygonum runcinatum	Polygonaceae	Herb
78	Potentilla indica	Rosaceae	weedy plant
79	Potentilla microphylla	Rosaceae	Herb
80	Prunus cerasoides	Rosaceae	Tree
81	Pteridium aquilinum	Dennstaedtiaceae	Fern
82	Pteris wallichiana	Pteridaceae	Fern
83	Quercus glauca	Fagaceae	Tree
84	Quercus griffithii	Fagaceae	Tree
85	Quercus lamellosa	Fagaceae	Tree
86	Quercus lanata	Fagaceae	Tree
87	Quercus semicarpifolia	Fagaceae	Tree
88	Rhododendron arboreum	Ericaceae	tree
89	Rhus chinensis	Anacardiaceae	Tree

SI. No.	Scientific Name	Family	Habit
90	Rhus wallichii	Anacardiaceae	Tree
91	Rubus ellipticus	Rosaceae	Shrub
92	Sauraria nepalensis	Saurariceae	Tree
93	Schima wallichii	Theaceae	Tree
94	Selginella	Selaginellaceae	Spikemoss
95	Senecio scandens	Asteraceae	Climber
96	Smilax myrtilus	Smilacaceae	Climber
97	Solanum khasianum	Solanaceae	Herb
98	Sorbus microphylla	Rosaceae	Shrub
99	Swertia chirata	Gentianaceae	Herb
100	Symplocos glomerata	Symplocaceae	Tree/Shrub
101	Symplocos paniculata	Symplocaceae	Shrub
102	Symplocos ramosissima	Symplocaceae	tree/shrub
103	Toricellia tiliifolia	Torricelliaceae	Tree
104	Tupistra sp.	Convallariaceae	Herb
105	Urtica dioica	Urticaceae	Herb
106	Urtica parviflora	Urticaceae	Heb
107	Vaccinium myrtillus	Ericaceae	Shrub
108	Vanda cristata	Orchidaceae	Orchid
109	Viburnum cylindricum	Axodaceae	Shrub
110	Viburnum erubescens	Axodaceae	Shrub
111	Yushinia microphylla	Poaceae	Bamboo
112	Zanthoxylum armatum	Rubiaceae	Tree
113	Zanthoxylum oxyphyllum	Rutaceae	Shrub

# c. Wildlife

In the areas within and adjacent to the Transmission line alignment, signs of wildlife was recorded within the plots. Out of 74 plots, there were signs of wildlife, through their scat, rooting, scratching, wallowing, footprints, or nesting places, or through direct sighting in 23 plots resulting in 31% of plots. Assamese macaque and Barking deer were sighted during the field visit.

Plot No.	Wildlife species	Sign type	No. of signs
1	Wild pig	resting pl.	1
2	Barking deer	dung	1 clump
7	Barking deer	dung	1 clump
7	Wild pig	rooting	1
8	Wild pig	rooting	1
9	Barking deer	footprint	3
12	Barking deer	dung	1
19	Barking deer	footprint	3
25	Wild pig	rooting	1
30	Wild pig	rooting	1
32	Jungle fowl	scratching	many
33	Sambar	footprint	4
34	Barking deer	spotted	1
37	Wild pig	resting place	1
38	Wild pig	rooting	1
39	Barking deer	footprint	1
44	Wild pig	Rooting	1
45	Wild pig	wallowing	1
46	Wild pig	rooting	1
49	Wild pig	wallowing	1
52	Wild pig	nesting	1

Plot No.	Wildlife species	Sign type	No. of signs
55	Wild pig	rooting	1
60	Wild pig	footprint	1
65	Wild pig	rooting	1
	Total Plots	U	23

However, given the Forest types and Vegetation, we can expect other wildlife species such as Tigers, Common leopard, Leopard Cat, Himalayan Black Bear, Porcupine, Serow.

iner species of wildlife expected to be found in the Project Area					
Common Name	Scientific Name	Expected in project area	Status in Bhutan		
Leopard	Panthera pardus	Yes	Schedule-I		
Clouded		Yes			
Leopard	Neofelis nebulosa		Schedule		
Leopard		Yes			
Cat	Prionailurus bengalensis		Schedule		
Himalayan		Yes	Schedule-I		
Black Bear	Ursus thibetanus	X			
Wild pig	Sus scrofa	Yes			
Wild dog	Cuon alpinus	Yes			
Barking		Yes			
deer	Muntiacus muntjak				
Sambar	Cervus unicolor	Yes			
Indian		Yes			
porcupine	hysterix indica				
Common		Yes			
langur	Semnopithecus entellus	X			
Tiger	Panthera tigris tigris	Yes	Schedule-I		
Goral	<u>Naemorhedus goral</u>	Yes			
Indian		Yes			
porcupine	Hysterix indica				
Common		Yes			
mongoose	Herpestes edwardsii				
Bengal fox	Vulpes bengalensis	Yes			
Assamese		Yes			
macaque	Macaca assamensis				
Capped		Yes			
Langur	Trachypithecus pileatus				
Himalayan		Yes			
Serow	Capricornis thar				
Jungle cat	Felis chaus	Yes			
Red Panda	Ailurus fulgens	Yes	Schedule-I		
Yellow		Yes			
throated					
Marten	Martes flavigula				

#### £ \\/:|__|:£ Oth . . . . ما 4 مر: ام - D . . . .

Common	Scientific Name	Expected in	Status in
Name		project area	Bhutan
Gaur	Bos gaurus	Yes	Schedule-I

# d. Birds

At total of 123 species of birds were recorded in and around the Project site. These are presented in the table.From these the Rufous-necked Hornbill (Aceros nipalensis) is listed as Vulnerable in IUCN and a totally protected species listed in Schedule-I of the Forest and Nature Conservation Act, 1995.

SI. No	Common Name	Scientific Name	Status in Bhutan	IUCN status
1	Aberrant Bush Warbler	Cettia flavolivacea		LC
2	Ashy Wood Pigeon	Columba pulchricollis		LC
3	Ashy-throated Warbler	Phylloscopus maculipennis		LC
4	Asian Brown Flycatcher	Muscicapa dauurica		LC
5	Barred Cuckoo-dove	Macropygia unchall		LC
6	Black Bulbul	Hypsipetes leucocephalus		LC
7	Black Redstart	Phoenicurus ochruros		LC
8	Black-faced Laughingthrush	Garrulax affinis		LC
9	Black-tailed Crake	Amaurorius bicolor		LC
10	Black-throated Tit	Aegithalos concinnus		LC
11	Blue Whistling Thrush	Myophonus caeruleus		LC
12	Blue-fronted Redstart	Phoenicurus frontalis		LC
13	Blue-throated Barbet	Magalaima asiatica		LC
14	Blyth's Leaf Warbler	Phylloscopus reguloides		LC
15	Brownish-flanked Bush Warbler	Cettia fortipes		LC
16	Chestnut-bellied Rock- thrush	Monticola rufiventris		LC

17	Chestnut-crowned laughingthrush	Garrulax erythrocephalus	LC
18	Chestnut-crowned Warbler	Seicercus castaniceps	LC
19	Chestnut-tailed Minla	Minla strigula	LC
20	Chestnut-tailed Starling	Strunus malabaricus	LC
21	Collared Owlet	Glaucidium brodiei	LC
22	Oriental Scops Owlet	Otus sunia	LC
23	Common Buzzard	Buteo buteo	LC
24	Common Hoopoe	Upupa epops	LC
25	Common Kestrel	Falco tinnunculus	LC
26	Common Myna	Acridotheres tristis	LC
27	Common Quail	Conturnix conturnix	LC
28	Common Tailorbird	Orthotomus sutorius	LC
29	Coral-billed Scimitar- babbler	Pomatorhinus ferruginosus	LC
30	Himalayan cutia	Cutia nipalensis	LC
31	Darjeeling Woodpecker	Dendrocopos darjellensis	LC
32	Dark-throated Thrush	Turdus ruficollis	LC
33	Eurasian Jay	Garrulus glandarius	LC
34	Eurasian Tree Sparrow	Passer montanus	LC
35	Eurasian Treecreeper	Certhia familiaris	LC
36	Eurasian Woodcock	Scolopax rusticola	LC
37	Golden-throated Barbet	Magalaima franklinii	LC
38	Great Barbet	Magalaima virens	LC
39	Greater Necklaced Laughingthrush	Garrulax pectoralis	LC
40	Green-backed Tit	Parus monticolus	LC
41	Green-tailed Sunbird	Aethopyga nipalensis	LC

42	Grey Bushchat	Saxicola ferreus	LC
43	Grey Treepie	Dendrocitta formosae	LC
44	Grey Wagtail	Motacilla cinerea	LC
45	Grey-backed Shrike	Lanius tephronotus	LC
46	Grey-headed Canary Flycatcher	Culicicapa ceylonensis	LC
47	Grey-hooded Warbler	Phylloscopus xanthoschistos	LC
48	Grey-winged Blackbird	Turdus boulboul	LC
49	Hill Partridge	Arborophila torqueola	LC
50	Hill Prinia	Prinia atrogularis	LC
51	Hoary-throated Barwing	Actinodura nipalensis	LC
52	Hodgson's Redstart	Phoenicurus hodgsoni	LC
53	Kalij Pheasant	Lophura luecomelanos	LC
54	Large Niltava	Niltava grandis	LC
55	Large-billed Crow	Corvus macrorhynchos	LC
56	Lemon-rumped Warbler	Phylloscopus proregulus	LC
57	Lesser necklaced Laughingthrush	Garrulax monileger	LC
58	Little Bunting	Emberiza pusilla	LC
59	Little Forktail	Enicurus scouleri	LC
60	Little-pied Flycatcher	Ficedula westermanni	LC
61	Long-tailed Minivet	Pericrocotus ethologus	LC
62	Long-tailed Shrike	Lanius schach	LC
63	Long-tailed Thrush	Zoothera dixoni	LC
64	Maroon-backed Accentor	Prunella immaculata	LC
65	Mountain Bulbul	Hypsipetes mcclellandii	LC

66	Mountain Hawk-eagle	Nisaetus nipalensis		LC
67	Olive-backed Pipit	Anthus hodgsoni		LC
68	Orange-flanked Bush Robin	Tarsiger cyanurus		LC
69	Oriental Magpie-robin	Copsychus saularis		LC
70	Oriental Turtle Dove	Streptopelia orientalis		LC
71	Plain-backed Thrush	Zoothera mollissima		LC
72	Plumbeous Water Redstart	Rhyacornis fuliginosa		LC
73	Pygmy Wren Babbler	Pnoepyga pusilla		LC
74	Red-billed Chough	Pyrrhocorax pyrrhocorax		LC
75	Red-headed Bullfinch	Pyrrhula erythrocephala		LC
76	Red-vented Bulbul	Pycnonotus cafer		LC
77	Rock Pigeon	Columbia livia		LC
78	Rufous-bellied Niltava	Niltava sundara		LC
79	Rufous-breasted Accentor	Prunella strophiata		LC
80	Rufous-capped Babbler	Stachyris ruficeps		LC
81	Rufous-gorgeted Flycatcher	Ficedula strophiata		LC
82	Rufous-necked Hornbill	Aceros nipalensis	Sch-I	V
83	Rufous sibia	Heterophasia capistrata		LC
84	Rufous-vented Yuhina	Yuhina occipitalis		LC
85	Rufous-winged Fulvetta	Alcippe castaneceps		LC
86	Russet Sparrow	Passer rutilans		LC
87	Rusty-cheeked Scimitar - babbler	Pomatorhinus erythrogenys		LC
88	Rusty-flanked Treecreeper	Certhia nipalensis		LC

89	Satyr Tragopan	Tragopan satyra	near Threatened
90	Scaly Thrush	Zoothera dauma	LC
91	Scaly-breasted Munia	Lonchura punctulata	LC
92	Scarlet Minivet	Pericrocotus flammeus	LC
93	Slaty-backed Forktail	Enicurus schistaceus	LC
94	Slender-billed Scimitar Babbler	Xiphirhynchus superciliaris	LC
95	Small Niltava	Nitava macgrigoriae	LC
96	Solitary Snipe	Gallinago solitaria	Lc
97	Speckled Wood Pigeon	Columba hodgsonii	Lc
98	Spotted Forktail	Enicurus maculatus	LC
99	Streak-breasted Scimitar Babbler	Pomatorhinus ruficollis	LC
100	Striated Bulbul	Pycnonotus striatus	LC
101	Striated Laughingthrush	Garrulax striatus	LC
102	Striated Prinia	Prinia crinigera	LC
103	Stripe-throated Yuhina	Yuhina gularis	LC
104	Ultramarine Flycatcher	Ficedula superciliaris	LC
105	Verdicter Flycatcher	Eumyias thalassinus	LC
106	Wallcreeper	Tichodroma muraria	LC
107	Wedge-tailed Green Pigeon	Treron sphenurus	LC
108	Whiskered Yuhina	Yuhina flavicollis	LC
109	Whistler's Warbler	Scicercus whistleri	LC
110	White Wagtail	Motacilla alba	LC
111	White-browed Bush Robin	Tarsiger indicus	LC
112	white-browed fulvetta	Alcippe vinipectus	LC
113	White-capped Water	Chaimarrornis leucoceph	alus LC

	Redstart		
114	White-collared Blackbird	Turdus albocinctus	LC
115	White-throated Fantail	Rhipidura albicollis	LC
116	White-throated Laughingthrush	Garrulax albogularis	LC
117	Yellow-bellied Fantail	Rhipidura hypoxantha	LC
118	Yellow-billed Blue Magpie	Urocissa flavirostris	LC
119	Yellow-rumped Honeyguide	Indicator xanthonotus	near threatened
120	Orange bellied leafbird	Chloropsis hardwickii	LC
121	Nepal Fulvetta	Alcippee nipalensis	LC
122	Orange bellied leafbird	Chloropsis hardwickii	LC
124	Nepal Fulvetta	Alcippee nipalensis	LC

The Satyr Tragopan and the Yellow-rumped Honeyguide are both listed as 'Near threatened' in the IUCN Red List

Table showing frequency of sightings of birds during survey


# 1.6.7 Cultural and Heritage Sites

Table 8 shows any cultural or heritage sites that will be directly affected by the transmission or distribution line and sub-stations.

Table 8: Cultural and heritage site details	Table	8:	Cultural	and	heritage	site	details
---------------------------------------------	-------	----	----------	-----	----------	------	---------

Name	of	Cultural/Heritage	Location Co	oordinates	Circuitionnes of the site				
Site		C C	Easting	Northing	Significance of the site				
Not rele	Not relevant the project site does not encroach any cultural/beritage sites								

# 1.7 Public Consultation

The overall Public Consultation Meeting for Nikachhu Hydropower Project was held on 27th January, 2014 to discuss issues and concerns related to proposed project. Separate Consultations were held with Affected People (affected by private land) to draw agreement regarding acquisition of land for the project in presence of Gup and Gewog official. Based on agreed terms, No Objection Certificate (Attached) was obtained for Transmission Line Component along with other Project Components.

# **1.8 Project Impacts and Mitigation Measures**

There will always be both positive and negative impacts from a power line transmission project. Using the information provided in the earlier sections, list down both positive and negative impacts. Against each negative impact provide mitigation measures and estimated costs required to implement the measure.

#### Impacts

Although there is no significant direct positive impact due to the transmission line, Nikachhu Hydropower Project shall have greater national social and environmental benefits after commissioning. The details on the impact (positive) are given in the ESIA of Detailed Project Report.

The only negative impact envisaged due to the construction of the 132 kV transmission line is on the vegetation since it requires vegetation clearing along the RoW, 27 m. However, it shall be compensated as a part of the whole project management plan. The details of impacts and management plan for transmission line is addressed in EMP (Volume 2) of the report.

#### 1.9 Monitoring Program

The monitoring is important for the following reasons:

- To observe if mitigation measures are implemented;
- To ensure that the proposed mitigation measures are practical or effective and accordingly consider other measures to minimize impacts;
- To ensure timely implementation of the project; and
- To change environmental terms and conditions, if necessary.

Item	Method	Responsibility		
Construction phase				
Soil erosion and	Monitor ground cover clearing to ensure not to cause	DGPC	site	
slope stability	erosion or land slide	engineer		
	Monitor rain season construction to check the	DGPC	site	
	stability of land	engineer	a:ta	
Landuas	Monitor location of poles specified in clauses	DGPC	site	
Land use	included in design and bid documents.	contractor		
	Monitor tree clearing based on the design	DGPC/DoFP	s	
Forestry	Monitor clearing for construction camp and vehicle storage	DGPC	0	
	<u> </u>	DGPC	site	
Wildlife	Monitor burning activity by workers on site.	engineer,		
		contractor		
		BPC	site	
	Monitor illegal firearms/trapping	engineer,		
	contractor			
Disposal of waste	contamination of sites.	Contractor		
Public health	Check workers health (if applicable)	Contractor		
	Check construction camp sanitation	Contractor		
Worker conflict with local communities	Meeting needs and managing behavior of workforce to minimize undesirable impacts on local community from unwanted behaviors from workers on and off site.	Contractor		
Cultural/heritage		DGPC	site	
sites	Monitor archaeological sites/artifact discovery	engineer,		
Operation phase		Contractor		
Soil erosion and		DGPC	site	
slope stability	Monitor stable condition of land and structure	engineer	0.00	
Forestry	Monitor the vegetation of ROW	DGPC, DOF		
	Manitar area of ROW algorance not to avoin ROW	DGPC	site	
	Monitor area of ROW clearance not to expand ROW	engineer		
Wildlife	Monitor illegal firearms/trapping	DGPC	site	
VIIdine		engineer		
	Hearing to local people to obtain information of wildlife	DGPC		
All phase				
Environmental monitoring audits	Undertake third party environmental monitoring audits	NEC		
Compliance of	Observe compliance of EC by Contractor during	DGPC and N	NEC	
EC by Contractor	execution of works.	EA Officer.		

Table 9: Environmental monitoring program

Note: Submission of monitoring reports to NECS will be specified in the conditions attached to the clearance.

# 1.10 Checklist for No Objection Certificate

The following list shows NOCs accorded and therefore enclosed with this application:

Agency/concerned people	Why/when	Check				
Dzongkhag	Always required	Enclosed				
Department of Forest	The transmission line passes through forest area	No, To be obtained during implementation.				
Public		Enclosed				

Note:x: required N/A: Not applicable

The GIS Map of the line route is attached with the report and the following figure shows the google earth representation of the line.







May 27, 2014

NECS/ESD/DGPC/ToR/2014/5710

To,

The Director Druk Green Power Corporation Limited **Thimphu** 

# Subject: Terms of Reference (ToR) for carrying out EIA study for transmission line

Sir,

This has reference to the letter No. DGPC/PD/P&DD/20(f) 2014/484 dated May 27, 2014 regarding the terms of reference (TOR) for carrying out Environmental Impact Assessment (EIA) studies for the proposed 132KV transmission line from Nikachhu Pot Head Yard to Mangdechhu Pot Head Yard under Trongsa Dzongkhag.

In this regard, the National Environment Commission Secretariat (NECS) is pleased to endorse the TOR as attached herewith. Please ensure that the EIA study is conducted as per the approved TOR and the EIA report is submitted accordingly to NECS.

Further, please note that the submission of EIA report doesn't guarantee the issuance of environmental clearance.

If you have any queries, please contact the Environment Services Division of NECS @ 02323384 during office hours.

Thanking you,

Yours sincerely,

Chief Environment Officer Environment Services Division

Copy to:

1. Guard File (Terms of Reference), ESD for record.

Fax: (975.2) 323385

# TERMS OF REFERENCE (TOR) FOR CONDUCTING ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE CONSTRUCTION OF 132KV TRANSMISSION LINE FROM NIKACHHU POT HEAD YARD TO MANGDECHHU POT HEAD YARD

These terms of reference (ToR) provides a framework for conducting environmental impact assessment for the construction of 132KV transmission line from Nikachhu Pot Head Yard to Mangdechhu Pot Head Yard under Trongsa Dzongkhag in line with the environmental assessment procedure under the Environmental Assessment Act 2000 and its Regulation 2002. The level of detail and analysis in the report should reflect the potential environmental, economical and social impacts of the proposed project and recommend mitigation and management plan for the likely adverse environmental impacts. The ToR provides the scope of studies for the environmental impact assessment (EIA). The report prepared as per this ToR should be submitted to the National Environment Commission Secretariat along with other perquisite clearances and approvals from relevant stakeholder agencies for granting environmental clearance for the proposed project.

- 1. Title page: the title page should contain the following:
  - a) The name and location of the project.
  - b) Name and Address of the proponent.
  - Name, qualification and address of the EIA consulting firm;
- 2. Table of Contents: The title and page number of all sections, maps, plans, tables, figures, and appendices of the environmental assessment reports;
- 3. Executive Summary: A brief description of the proposed project in clear and nontechnical language including:
- Summary of key findings and recommendations of the assessment, including the main environmental and social issues, economic benefits, significant environmental challenges and impacts covering cumulative impacts and proposed mitigation measures.
- The objective and need for the project, alternative alignment studies and justification for chosen alignment considering technical, environmental and social concerns.
- Make use of the base maps, tables and figures wherever possible to make the report clear and understandable to the reader/reviewer. Highlight the technical and procedural aspects that need to be addressed so that they do not hamper the work progress during implementation, and the recommended strategies to circumvent such risks.
- Project financial statement and the project activity schedule.
- A declaration stating that the information disclosed in the EIA report is correct.



# 4. Essential maps for EIA of transmission line projects:

- A map with appropriate scale showing the proposed transmission line along with alternative alignments, the location of towers, sub-stations, project access (road/rope ways), water supply, muck disposal site, site offices, labour camps and other existing infrastructure along the length of new route/ alignment. This should also be plotted in the Google Earth and soft copy needs to be submitted to NECS.
- A map specifying the existing land use patterns of the proposed transmission line RoW.
- A map specifying the forest cover along the right of way (RoW) of the transmission line, showing, if applicable, zonation of biological corridors, national parks, and sanctuaries and occurrence of any endangered/threatened flora and fauna species and/or plants and animals of economic/ecological, importance.
- A contour map (with appropriate scale) of the proposed transmission line RoW.
- **Topography** Plot the transmission line layout on an appropriate scale; topographical map with a map scale and geographical North. Geology, seismicity and stability characteristics at all project facility locations and in the area of influence should also be incorporated.

# Note: Depending on the type, size and location sensitivity, NEC/Competent Authorities can decide the study area and recommend appropriate scale for Environmental Assessment.

#### 5. Policy and Legal Frameworks

Provide descriptions on the review of existing legislations and policies governing the implementation of the proposed activity and environmental assessment requirements.

#### 6. Project Description

- Information about the project proponent and his/her experience in transmission sector with following details (a) Name of the project (b) Name of the applicant (c) Present mailing address including telephone number, fax, and email (if any) (d) Name of the environmental focal person (e) Telephone number of environmental focal person.
- Name of organization/consultant preparing the EIA report, qualifications and experience of experts involved in report preparation.
- Type and nature of the project:
  - a) Source(s) and destination(s) of power.
  - b) Capacity, Voltage level.
  - c) Number of substation and capacity.
  - d) Project duration.

e) Total environmental management cost.

AWAY Page 2 of 13

• Describe the route details of proposed alignment including administrative location as mentioned in *Table 1: Transmission line route details*.

# Table 1. Transmission line route details

Dzongkhag	Geog	Village	Distance (Km)		

# Design and Engineering features, such as:

- a) Voltage level.....KV.
- b) Tapping Point.....
- c) Termination Point.....
- d) Length of line.....km.
- e) Right of Way (RoW) width.....m.
- f) Conductors: Number of lines and circuits, composition and diameter, minimum height over ground level for overhead lines, depth and trench and fill specifications for underground lines.
- g) Number, type and composition of towers (number of towers on private land), manholes (if any).
- h) Number and designs of substations to be constructed or modified or operated in conjunction with the transmission lines.
- i) Points of interconnection with the existing grid,
- j) Load Flow Analysis.
- Design drawings for towers, manholes, trenches, substation and other facilities.
- Access roads for transmission lines, sub-stations and other facilities:
  - a) Means of access for each stretch of the route.
  - b) Detailed information on any roads to be constructed. If roads are being constructed mention whether they are 'Temporary' or 'Permanent.' Description on the consideration of alternative means of transportation such as 'cableway' were considered or not. (Note: All information required for applications for environmental clearances for the construction of road/cableways should be included).

# • Construction phase:

- (a) Identify and provide schedule for each phase of construction and operation for all project and ancillary facilities including the environmental issues associated with each ancillary activity, wherever possible:
  - i. Mobilization of work including resources and labours
  - ii. Road construction and improvements.

Page 3 of 13

- iii. Land clearing.
- iv. Blasting, if required.
- v. Borrow and spoil disposal.
- vi. Excavation and sub-grade preparation.
- vii. Foundation preparation.
- viii, Concrete work.
- ix. Stockyard for construction materials.
- x. Construction and installation of each project facility.
- xi. Stabilization of disturbed areas.
- (b) Construction camps (if applicable):
  - i. Location of the camp. Land acquisition and compensation and study on the existing environment.
  - ii. Water supply and distribution.
  - iii. Waste generation, handling and disposal.
  - iv. Fuel supply.
- (c) Handling and disposal of mucks: Provide the total quantity of excavated material likely to be generated during construction period (in m³), along with a management and disposal plan including identification of dump sites, dumping methods and restoration/reclamation plan.

# Requirement of Resources

- Land: Provide details of the land requirements for different project activities such as transmission line RoW, substations, roads, labour camps, stock yards and offices.
- Raw materials : A complete list of the raw material requirements for the construction and erection of transmission line with quantities, sources, an inventory of chemical, toxic or hazardous substances and storage means etc., in case of sub-stations.
- Details of workforce to be employed -skilled, semi-skilled and unskilled labour both during construction and operational phases of the project with specific attention to employment opportunities for local population with assessment of skills available and training needs to make them employable for such project.
- Equipment : equipment and machineries required for the proposed project along with type and quantity of fuels required for their operations.
- The project should also explore the availability of environment friendly technologies for the type of project proposed and the feasibility of adopting such technologies in the Country.

# 7. Description of Existing Environment of the Project Area (Baseline Data)

#### A. Land Environment

- Provide details of topography, geology, stability and type of soil in the project area;
- Provide information on the existence of any transmission lines ( of different voltage levels) in the proposed area and the status of their environmental impacts such as visual aesthetics due to such infrastructures;

Page 4 of 13



- Describe land use types of all lands required by the project such as transmission line alignment, substations, labour camps, stock yards, offices, etc.
- Discuss the characteristics of topsoil, its thickness and estimate the total quantity of topsoil to be generated during clearance of land along the RoW, construction of the transmission towers, sub-stations, access roads, labour camps, site offices, etc.

# B. Air Environment

- Provide data on ambient air quality including parameters such as PM₁₀, gaseous pollutants, and information on existing meteorological conditions such as temperature, humidity, rainfall and wind speed and direction, wherever applicable.
- Describe the sources of the emissions.

# C. Water Environment

Provide:

- Data on surface and sub-surface water characteristics including inventory of rivers, streams, springs, water crossings falling along the RoW of the transmission line.
- Information on the existence of any water sources along the line route should be spelled out in report
- Detailed information on existing natural drainage/run-off patterns along the length of the proposed alignment.
- If any changes are likely in the drainage pattern due to the proposed activity, provide details of such changes including the identification of areas vulnerable to erosion and landslide.

# **D.** Biodiversity

- Obtain a list on the type of vegetation and wildlife including birds along the RoW of transmission line and approach roads/cableways and proposed substation location from the nearest forest office;
- Collect primary data through biodiversity survey on the occurrence of forest type and wildlife including avi-fauna in the project area and document the findings.
- Conduct public interviews to collect information on biodiversity.
- Compare the findings of the survey and interview with the list provided by forest office.
- Existence of any restricted areas from a biodiversity perspective, if applicable.
- Give details on the type of forest being diverted for non-forest use and status of forest cover in the length of new alignment proposed.
- Inventorise species of trees and plants along the RoW and 200 metres on both sides of the RoW of the alternative as well as the final proposed alignment of the transmission route in every 10KM stretch, access road/cableways and other project infrastructures locations which will be permanently affected.
- Provide information on the existence of any unique, endemic, threatened or declining species, or species of high economic and cultural value to society or ecosystem in providing important services.
- Obtain authentication and verification of the wildlife corridor by the competent authority.
- Provide information on the existence of any community forests and their significance;

Page 5 of 13



- Provide information on the existence of biological corridors, national parks, sanctuaries and their significance in terms of occurrence of any endangered/threatened flora and fauna species and their habitats. In case of biological corridors, state the type/species of fauna which uses it.
- In case of transmission passing through Protected Areas, provide the following.

Name of protected area	Length of	f transmissi	on line in (	different zones	within the protecte	d area (km)	Total (km)	Length
	Enclave zone	Buffer zone	Core zone	Seasonal grazing zone	Administrative zone	Multiple use zone		

# Table 4. Protected area details for transmission line

If Sub-stations fall fall in the Protected Area, provide the following information.

# Table 5. Protected area details for sub-stations

Name protected area	of	Area occu (km)	pied by Sul	b-stations	in different a	cones within the p	rotected area	Total (km)	Length
		Enclave zone	Buffer zone	Core zone	Seasonal grazing zone	Administrative zone	Multiple use zone		
									_

Provide the zonation map of the protected areas through which the transmission line passes.

# E. Socio-economic and Cultural Aspect

• Cultural and heritage sites – Existence of any significant cultural, historical, archaeological or environmentally sensitive sites along and 10KM on both sides of the RoW of the transmission line, access road/cableways alignment and other project infrastructures. List these sites as per *Table 6 below*.

# Table 6. Cultural and heritage site details

Name of cultural heritage	Location Easting	Coordinates Northing	Describe the significance of site. Is the sit listed with Department of Culture			



- Describe with the help of maps the number of villages likely to be affected by the proposed project. Provide details of the land use type likely to be affected in the villages.
- Study the socio-economic and livelihood benefits obtained by local communities from the forests likely to be affected by the transmission project and its ancillary facilities.
- 8. Public Consultation: Public consultation is mandatory as per Article 16 of the EA Act 2000, and Section 31 of the Regulation for the Environmental Clearance of Projects 2002.

The proponent must explain the expected impacts of the proposed project to the public and surrounding environment indicating where they will occur, level and extent of impacts and how they will be mitigated. Concerned public should be made aware of both positive and adverse impacts likely from the proposed project, listen to the concerns raised, provide clarifications and maintain record as follows:

- Description of issues raised and resolved during the consultation. List out pending issues and the proponent's views on the pending issues.
- Provide evidences of public meetings and participations duly approved by the Local Government and Dzongkhag;

# 9. Assessment of Potential Environmental Impacts

This section should provide the prediction, assessment and description of environmental impacts likely to be caused by the proposed project.

### A. Land Environment

Provide the assessment of the following:

- Impact due to land acquisition for the proposed project and corresponding land use changes the project would cause.
- Provide detailed assessment of the area of land required for the transmission line RoW. In areas of steep topography not all the forest within the RoW needs to be cleared. For a particular transmission line project, the total area of forest to be cleared should be calculated based on the length of transmission line and RoW for corresponding voltage level. However, the areas which are not required to be cleared should be estimated depending on the topography, type of land, and ground clearance requirement and should be subtracted from the total area to obtain the actual forest area to be cleared.

Refer Table 2: Areas of landuse along transmission line RoW.

# Table 2. Areas of land use along transmission line RoW

Facility	Chushing (km ² )	Kamshing (km ² )	Tseri (km²)	Tsamdo (km²)	Sokshing (km ² )	Broadleaf (km ² )	Conifer forest (km ² )	Scrub land (km ² )	Total (km²)
Transmission									
line RoW									
Actual Corridor clearing required									



• Substations – Detailed information on the land use required for the substation and type of vegetation existing in the proposed area should be provided as per *Table 3*.

Facility	Chushing (km ² )	Kamshing (km ² )	Tseri (km ² )	Tsamdo (km²)	Sokshing (km ² )	Broadleaf (km ² )	Conifer forest (km ² )	Scrub land (km ² )	Total (km ² )
Substation 1					-			()	
Substation 1		-							
Total area requiring clearance (m ² )									

# Table 3. Areas of land use required for sub stations (m²)

Note: Scrubland also includes disturbed areas of Broad Leaf and Coniferous forest that have been logged and are now regenerating

- Impact to the surrounding environment due waste generation from labour camps and site offices.
- Impacts due to earth excavations. Provide the quantity of mucks likely to be generated surplus mucks likely to be generated from the proposed project.
- Impacts from extraction and production of construction materials such as aggregates, if applicable;
- Impact of project on the hilly terrain due to slope destabilization caused by site preparation, civil works, construction of access roads and other activities, if applicable such as landslides, soil erosions and sedimentations due to surface run-offs;
- Aesthetics Mention whether the location of transmission line will significantly impair visual aesthetics. Explain in detail.
- Details of the quantity and characteristic of solid/hazardous wastes likely to be generated including from utilities, if applicable.
- Complete information on the use of hazardous materials such as insulating oils/gases (e.g. Polychlorinated Biphenyls [PCB] and Sulphur Hexafluoride [SF₆]) used in transformers used during the construction and vegetation maintenance of RoW should be enumerated in the EIA, if any.

# B. Air Environment

- Details about the potential sources of fugitive emissions and list of activities that may generate fugitive dust.
- Impact of fugitive emissions on ambient air quality and on workers during the construction phase of project.
- Details about the potential sources of noise generating equipments and activities that may cause noise pollution. Level of noise likely to be generated from such sources.

# C. Water Environment

- List of potential project activities which can cause contamination of water resources.
- Impacts of the project on local hydrology along the length of the new alignment including impact on surface and groundwater resources.
- Impact of project and its auxiliary activities on land and water contamination.
- Impacts on water bodies due to discharge of effluents from labour camps, colonies and offices.



# **D.** Biodiversity

Describe and provide assessment of:

- Impact of transmission line project on biodiversity.
- Likely illegal hunting and poaching.
- Impact on wildlife habitats.
- Loss of species; Address the concern of possible extinction of such species.

# E. Socio-economic and Cultural Aspect

Provide assessment of:

- Socio-economic impact of the project.
- Scope of land acquisition and its impact on the social environment.
- Employment opportunities for Bhutanese.
- If land acquisition is involved, the report should give the extent of land to be acquired for the project along with name of affected people village wise with followings information:
  - (a) Village-wise list of the affected persons or family-wise along the RoW.
  - (b) The extent and nature of land and immovable property to be acquired from affected persons; including list of public utilities and government buildings which are affected or likely to be affected, details of public and community properties, assets and infrastructure, likely to be affected. For providing information refer Table 2.8: Losses of houses and other infrastructures.
  - (c) A list of agricultural labourers in such area and the names of such persons whose livelihood depends on agricultural activities; if applicable.
  - (d) A list of persons likely to lose their employment or livelihood or likely to be alienated wholly or substantially from their main sources of trade, business, occupation due to acquisition, if applicable.
  - (e) Non-agricultural labourers, including artisans in such area, if applicable.
  - (f) Land ownership of the acquired land; provide information as described in Table 7.

Facility	Chu-shing		Ka sh	атт- ing	Ts	eri	Ts o	amd	So shi	k- .ng	Forest	Serub land	Wetlan d	Total
	Ownership (O) / Households (HH)	Total Area Affected (TAA)	0 / H H	T A A	0 / H H	T A A	0 / H H	T A A	0 / H	T A A	TAA	ΤΛΑ	TAA	TAA
Sub-Station 1					1		<u> </u>		1		-			-
Sub-Station 2														
Transmission Line		<u></u>												
Total affected households (no.)														

 Table 7. Land ownership and affected household details (m² or acres or decimal)

 Where HH= Households, O=Owner, Total Affected Area=TAA



# Table 8. Losses of houses and other infrastructure

Facility	Houses (no.)	Other infrastructure, describe
Sub-station 1		
Sub-station 2		
Sub-station 3		
Transmission Line		
Total (no)		

Note: Other infrastructure losses could include shops, hotels, offices, health posts, schools, etc.

- Provide assessment of displacement of communities/people, if required.
- Describe the possibility of human-wildlife conflict due to the proposed project.
- Provide assessments of risk and hazard associated with transmission line, substation and other allied activities both during construction and operation.
  - (a) Electromagnetic Field (EMF): If EMF levels are confirmed or expected to be above the recommended exposure limits then:
    - Evaluate potential exposure on workers, people living in existing residences, schools, other occupied buildings, and populated areas along the transmission corridor.
    - Evaluate effects of EMF on wildlife and vegetation (if applicable).
  - (b) Landslides, earthquakes and snow avalanches Based on the soil conditions, topography and geological features along each of the sections of the transmission corridor, evaluate areas of potential slope instability, potential seismic risk, debris flows, and rock fall hazards.
  - (c) Substation failure: Identify potential effects due to accidents and malfunctions associated with mechanical failures of project-related substation and capacitor station equipment.
  - (d) Occupational health and safety: Assess the potential occupational health and safety issues that may arise out of:
    - Live power lines (Electrical hazards)
    - Electric and magnetic fields
    - Working at height
    - Fire/explosions from transformers
    - Exposure to chemicals

#### 10. Assessment of Alternatives

A description and analysis of alternatives to the project and its alignment including:

- a) all feasible alternatives for both the project and its alignments;
- b) the alternative of not undertaking the project (i.e., the no-build alternative) for the purpose of establishing a future baseline in relation to which the project



and its alternatives can be described and analyzed and its potential environmental impacts and mitigation measures can be assessed;

- c) an analysis of the feasible alternatives for both project and alignments in light of the objectives of the proponent;
- d) an analysis of the principal differences among the feasible alternatives under consideration, particularly regarding potential environmental impacts;
- e) a brief discussion of any alternatives no longer under consideration including the reasons for no longer considering these alternatives;

# 11. Mitigation and Environment Management Plan (EMP)

The EMP should discuss the mitigation measures to be taken against every impact on Land, Air, Water, Biodiversity, and Socio-economic and cultural aspects and the timeline for completion, the responsible agencies for implementation, and the budget for the EMP, post-monitoring provisions and reporting to the concerned regulatory authority. EMP should include:

- Resettlement and Rehabilitation plan (R&R) if displacement is involved. The plan should include details of the compensation provided/to be provided, including landfor-land compensation, employment or money; provisions at the resettlement colony (such as basic amenities including housing, educational facilities, infrastructure and alternate livelihood potential); a clear timeline for implementation, responsibility, budgets, grievance mechanism, etc.
- Detailed management plan to reduce landslides and ensure slope stabilization during transmission line construction, wherever applicable.
- Options for alternative or any substitute to avoid or minimize land acquisition with appropriate justification.
- Detail waste management plan; waste generated from the worksite, site offices, labour camps and stockyard if any must be managed and must prevent open dumping in the surrounding environment.
- Public safety strategy and plan; risk of circuit failure and electric shock must be addressed in the EIA report. Proper awareness program and plan must be adopted for general public awareness;
- Mitigation measures for control of erosion and run-off from the area where construction is to take place, especially if there is a river or agricultural land adjoining the project site.
- If the transmission line project passes through sensitive areas, Biodiversity Action Plan must be prepared. Detailed mitigation and management measures must be planed for protecting endangered species.
- Mitigation measures for noise abatement and control, wherever applicable.
- Management plan for topsoil utilization and conservation.
- Management plan to reduce fugitive emissions during land-clearing, civil works, handling/transporting of construction material, construction of access roads, quarry operations, etc., *if applicable*.

- Mitigation plan to reduce, avoid or minimize spills and leaks from transformers, sub stations etc.
- Restoration and reclamation plan for all debris/spoil/ muck disposal sites and other project affected areas.
- Management plan to minimize or avoid electrocution of raptors and other large birds.
- Mitigation plan to minimize or avoid EMF exposure, if applicable.
- Mitigation measures against extreme weather events and natural catastrophes such as landslides, earthquakes and avalanches.
- Afforestation and reforestation plan.
- Mitigation plan to minimize or avoid hazardous materials spills and leakages.
- A management plan for occupational health and safety of the workers and local community in the proposed transmission line RoW.
- A detailed mitigation plan and EMP for improving and enhancing socio-economic condition.
- **Decommissioning Plan:** Provide detailed plan to be implemented during decommissioning of the project.
- Rescue plan for flora and fauna species and habitats.
- Measures to manage and combat Human-wildlife conflict, if caused by the proposed project.
- Slope stabilization plan.

#### 12. Environment Monitoring Plan

Provide a comprehensive and detailed plan covering the environmental and social parameters/variables to be monitored. Clearly state the agencies responsible for the monitoring plan during construction and operation.

#### 13. Environmental Budget Outlay

Provide the activity breakdown and budget for the implementation of EMP and environmental monitoring both during construction and operation.

14. Response to Comments: A response to each comment received on environmental report unless the NEC Secretariat or Competent Authority, has indicated otherwise, the environment assessment report shall contain a copy of each comment either in this section or in a separate appendix, provided that this section clearly explains the location of each comment and the response to each comment.

# 15. Annexures:

ENVIR

Provide the following annexures.

- A presentation of detailed technical data to the extent necessary to keep the main text of the environmental assessment report clear and readable. The main text of the environmental impact assessment shall refer to and summarize any information contained in any annexure.
- A copy of the terms of reference duly approved by NEC Secretariat.
- Curriculum Vitae of the EIA Team members.

Page 12 of 13

- List of all regulatory approvals, clearances and No Objection Certificates (NOC) required for the project and their status.
- All stakeholder clearances and approvals.
- Copy of Minutes of all consultation meetings.

• Copy of Minutes of the EIA presentation (for final EIA reports). *NOTE:* 

The Proponent should maintain consistence in

- The Proponent should maintain consistency and accuracy in the report and no subjective statements shall be accepted.
- The Proponent shall be responsible for undertaking any other related study desired by the NEC during the process of environmental clearance.
- Consistency and accuracy of information should be ensured in the report and no subjective statements shall be accepted.
- The EIA report shall 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.



Annex C: Muck Disposal Sites (Maps)

# Muck Disposal Sits for Nikachhu HPP



# **Project Components** Dam and Adit-I



# **Project Components** Adit-II, III and IV

Ν



# Annex D: Construction Power for Project (5 km, 33 kV line)

#### APPLICATION FOR ENVIRONMENTAL CLEARANCE

#### CONSTRUCTION OF 33 KV CONSTRUCTION POWER FOR 118 MW NIKACHHU HYDROPOWER PROJECT

#### 1.1 Applicant's Details

Name of Project: Construction of 33 kV construction power line for 118 MW Nikachhu Hydropower Project, Trongsa.

Name of Applicant: Druk Green Power Corporation Limited.

Full contact Address of Applicant: Projects Department Druk Green Power Corporation Limited Thimphu

Name of contact person: Mr. Pema Dorji, EO

Telephone no.: (+975)-2-339871 Fax no: (+975)-2-323853

Email address: pema.dgpc@gmail.com

#### **1.2** Describe the objective (s) and purpose of the project

Druk Green has awarded the work for carrying out exploratory drift, a small tunnelling work of 1.8m x 2.1m sized drift of 300m length to establish geological condition at the underground Desilting Chamber at the project site of Nikachhu Hydropower Project, for which construction power supply has been required to provide till the contractor work site. It requires extension of 5km, 33 kV Transmission Line from Banglapokto till the work site and stepping it down from 33kV to 0.415kV supply source to for construction of Nikachhu Hydropower Project at Dam and ADIT-I& II.

There is also feasibility of providing power supply to the community of Nyela and Dangla (our dam location) under Tangsibji Gewog as suggested by the Gewog and Trongsa Dzongkhag officials during the site visit.

#### **1.3** Name of the project financier: Druk Green Power Corporation Limited

#### 1.4 Project Details

#### 1.4.1 Site Route

The transmission line traverses through the following areas.

#### Table 1: Transmission line route details

Dzongkhag	Geog	Location	Distar	ice (km)
			HT	LT
Trongsa	Tangsibji	Banglapokto	2.50	
		Lorim	2.50	
Total distance	. (km)		5.00	
Total distance				

# Transmission line Details:

- i. Voltage level: 33kV
- ii. Tapping point: Banglapokto-1km
- iii. Termination point: Dam site, Nikachhu HPP, Lorim
- iv. Length of line: 5.0 km (Maximum)
- v. Right of Way (ROW) width: 12 m

#### 1.4.2 Project Cost

The total estimated cost of the Project: **Nu. 1.0455 million.** The only impact on land due to construction of the 33 kV transmission line would be due to vegetation clearing in the 12 km RoW as required by the National Transmission Grid Master Plan (NTGMP) of Bhutan Power Corporation. The compensatory afforestation shall be covered in the overall project cost of Nikachhu Hydropower Project which is expected to be started by this year.

#### 1.4.3 Towers/Poles

Provide total number of towers/poles:

#### 100 number of poles

How many towers/poles will be located in private land: The alignment of the transmission line entirely falls in SRF Land and no private land will be encroached. This was further verified during the joint site visit with Gewog and Dzongkhag Officials on January 22, 2014.

#### 1.4.4 Excavated Material

Since the proposed transmission line will not involve construction of towers which will result in excavation of tonnes of earth. The volume of excavated materials will be significantly low. Morevoer, the excavated material shall be reused to fill the holes of pole foot and to satbilize it.

#### 1.4.5 Implementation Schedule

1. How long will the project take to construct?

The work for alignment of transmission line has been awarded to M/s Tsasum Yangphel Construction, Trashigang on 24th December, 2013 for a duration of 2 months. It is proposed to complete the works within (2) two months.

#### 1.4.6 Environmental Unit

(Section 22 of The Regulation for the Environmental Clearance of Projects, 2002, requires that depending on the size of the project, the project either establishes an Environmental Unit or under Section 23 delegates a focal person who will be in charge of Environmental Compliance).

DGPC already have an established Environment and CDM Unit, under the Planning and Design Division of Projects Department. The Unit shall closely work with the Contractor during the execution and ensure Environment Compliance. The Unit shall strictly adhere

to the Terms and Conditions of the Environment Clearance and ensure proper reporting and record keeping.

# 1.5 Alternative (s) Transmission Route

Transmission line route survey (walk on survey) for the extension of 33 kV line from Bangla Pokto, Chendebji till the dam site of Nikachhu HPP, Chendebji was carried out on 17/08/2013 and 18/08/2013 along with officials of Bhutan Power Corporation. Different route options were explored and they are as follows:

# Option I

The line length of about a kilometer will first be routed along the road (the poles will be fixed above the road taking into consideration the likely areas to be stripped if the expansion of road takes place in the future) which is common for both Option I and Option II. For Option I, beyond this point, it will then be taken below the road till a point (L8 in Annexure I) where the old foot path (Old Zhung Iam) stands just about 20 meters below it. The slope gradient varies from about 30 to 45 degrees. From here, the line will directly be extended to the next point (L9 in Annexure I) over/across the gorge of Khang Khangmey chhu. The distance between these two points seems much longer and probably four (4) poles have to be set up on both the ends. Similarly at some other points also, four (4) poles may have to be set up. The line will finally reach the dam site after crossing few more of such gorges and streams. In between, the line will also pass through the identified area of ADIT I, through which its construction power could directly be drawn. The existence of private lands or buffer zones along the route was not known but from the way the old foot path was found blocked at certain points/locations, it was able to make out that some of the areas along the line route could possibly be pasture lands. There are no such steep slopes or high cliffs to pose risk or give tough time while carrying out the works.

The approximated line length from Bangla Pokto till dam site is of about 5 kilometers. The standard number of poles per kilometer as per Bhutan Power Corporation (BPC) for 33 kV Transmission line is twenty (20). Therefore, the total number of poles calculated for 5 kilometers of line is one hundred (100). The standard width of Right Of Way for 33 kV transmission line is 12 meters and in this option, quite a number of trees have to be cleared for achieving a good line clearance.

# Option II

For this option, the transmission line will continuously be routed along the road until about 0.6 kilometers before Sephuchen. From here it will then be taken below the road where the slope gradient is of about 25 to 35 degrees. The dam site from this slope/point will approximately be of about 0.8 kilometers. As mentioned above, the poles will be fixed above the road taking into consideration the likely areas to be stripped if the expansion of road takes place in the future. However, followings observations were made in this option i.e. beyond the point where transmission line in option I take its route below the road;

- a. Most of the areas below the road are either of a very steep slopes or rocky cliffs and taking the transmission line through is almost or not at all possible.
- b. The areas above the road are also mostly of rocky cliffs with little flat areas over the cliff tops. These little flat areas are the proposed areas for locating the poles. Since it's over the rocky cliff tops, it will be difficult to get good foundations for the poles.
- c. To take the lines further up means that the line length will substantially be increased which in turn will give rise to the cost and completion time. Since the work areas are along the

cliffy and difficult terrains, the work time taken to set up the poles, laying the cables and carry out stringing will be much longer and the risk factor involved while carrying out the work is also high.

The line length, if taken through the cliff tops will almost be equal or little longer than the one in Option I. With the Right Of Way width of 12 meters, the number of trees to be cleared seems almost equal to that of Option I.

Comparatively, taking into consideration the difficult terrains which would result in longer completion time, additional cost development and risk factors involved while carrying out the works, Option I seems more feasible than Option II. Moreover, with Option I, since the line passes through the identified area of ADIT I, construction power for it can also be drawn easily without requiring installing additional poles and cables.

#### 1.6 **The Project Environment**

#### 1.6.1 Topography

The elevation along the transmission line ranges from 2,240 m at Banglapokto to 2,350 m at Lorim.

# 1.6.2 Land Use/Vegetation

i. Transmission Line

Facility	Chu- zhing	Kam- zhing	Broadleaf forest	Conif er fores t	Scrub- land	Orchar ds	Expos ed/Roc ky	Total (km²)
Transmissio	0	0	4.0	0	0.0	0	0	0.00
(km)	0	0	4.8	0	0.2	0	0	0.96
Actual Corridor length clearance required (km ² )	0	0	4.8*0.012 =0.058	0	0.2*0.0 12=0.0 02	0	0	0.06
Total area regu	iiring clos	aranco (l	$(m^2) \cdot 0.06$					

#### Table 2: Area of land use along transmission line ROW

otal area requiring clearance (Km⁻): 0.06

Note: Chuzhing: wet land, paddy field, marsh Kamzhing: rain-fed dry land Scrubland also includes disturbed areas of Broadleaf and Coniferous forest that have been logged and are now regenerating.

#### ii. Sub-station/s

#### Table 3: Area of land required for sub-stations (m²)

Facility	Chu- zhing	Kam- zhing	Broadlea f forest	Conife r forest	Scrub- land	Orchard s	Expos ed/Ro cky	Total (m ² )
Sub- Station	No subs this proj	No substation is planned for this project; There is no substation for this project.						
Total Area requiring	Not rele	evant						

Note: Chuzhing: wet land, paddy field, marsh Kamzhing: rain-fed dry land Scrubland also includes disturbed areas of Broadleaf and Coniferous forest that have been logged and are now regenerating.

#### iii. Land Tenure

For those areas in Table 2 and 3, show the tenure ship of these areas as being either (a) "private" or (b) "public". For private land show the number of households affected. Enter these details in Table 4. This data will be used to work out resettlement requirements and compensation payable.

# Table 4: Land ownership and affected household details

Facility	Chuz	hing	Kam g	zhin	Broa fores	ndleaf st	Coni fores	ifer st	Scru d	blan	Orch s	ard	Expe Roci	osed/ ky	Total
	Tn.	HH	Tn.	HH	Tn.	HH	Tn.	НН	Tn.	HH	Tn.	HH	Tn.	HH	
Sub-Station (Nos)	It is trans	t is not relevant as no substation is planned for this project. The existing ransformer at Banglapokto shall be used.													
Total Family (Nos.)	Not reset infras	transformer at Banglapokto shall be used. Not relevant, the proposed transmission line will not involve issues of resettlement and displacement of houses or families or any other private infrastructures. It entirely falls in SRFL													

Source of this information: site survey Note:1.HH: household (s)

- 2. "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 landowner.
- 3.

# 1.6.3 Houses and Infrastructure

The project will not cause loss of any house or any other infrastructure, no substation is planned. The existing transformer at Banglapokto shall be used. The line falls entirely in SRFL

#### Table 5: Losses of houses and other infrastructure

Facility	Houses (Nos.)	Other infrastructures (Nos.)					
Sub-station	Not relevant, this project will not ca	use loss of any house or any other					
Transmission line	infrastructure, no substation is planne	d.					
Total (no)							

Note: Other infrastructures losses could include shops, hotels, offices, health posts, schools, etc

# 1.6.4 Protected Areas

a) Will the transmission line cross a Protected Area (PA)?

Of the total 5 km transmission line length, about 2 km falls in one of the Biological Corridors connecting Jigme Singye Wangchuk National Park and Wangchuk Cetennial Park in the north. However, this has been assessed by the concerned forest in charge and accordingly the Forest Clearance has already accorded vide no. ZFD/TECH/22-2/2013-14/906 dated 4th February, 2014 which is enclosed with this application.

b) If yes, provide the information in the following table.

# Table 6: Protected area details for transmission lines

Nomo of	Length within t	of tra	nsmiss	ion line tł ea (km)	nrough diff	erent zones	Total	
protected area	Encla ve zone	Buffer zone	Core zone	Seasonab le grazing zone	Administr ative zone	Multiple Use zone	length (km)	
Biological Corridor Connecting JSWNP and WCP	The tran National with WC	nsmissior I Park exe NP to the	n line d cept the e North.	loes not fall Biological C	in any of th orridor conne	e zones of a ecting JSWNP		

- c) Will any of the sub-stations be located in a Protected Area? "No"
- d) If yes, provide the information in the following table.

# Table 7: Protected area details for sub-stations

Name of protected area	Area o within t	Total							
	Encla ve zone	Buffer zone	Core zone	Seasonab le grazing zone	Administr ative zone	Multiple Use zone	area (m2)		
	Not rele	Not relevant. No substation is planned.							

# 1.6.5 Access Roads

Will the access road be constructed? <u>"No"</u> The existing road and footpaths will be used for the transportation of poles and equipments.

If yes, is it temporary or permanent? NA

If temporary, did you seek alternative means of transportation, such as cableway? NA

# 1.6.6 Aesthetics

Will the location of the transmission line significantly impair visual aesthetics? "Yes" or "No". Explain your answer. <u>"No significant impact"</u>

However, the overall aesthetic effect of a transmission line is likely to be negative to most people, especially where proposed lines would cross natural landscapes and be close to tourist destinations. But the structure to be established by the project may seem out of proportion and not compatible with agricultural landscapes because scenery points do not exist near to the project site. Besides, electric transmission lines can be routed to avoid areas considered scenic. Since road clearance shall be secured when the lines will be along with road, the lines would be out of view.

# 1.6.7 Wildlife

### a. Flora from the project site

The dominant trees include the evergreen Oaks (*Quercus glauca, Quercus serrata, Quercus lanata*), mixed with Birches (*Betula* spp.), Maples (*Acer* spp.), and evergreens, such as *Castanopsis* and *Persea*, as well as some magnolias. Some of the coniferous trees, such as Pines (*Pinus* spp.) and Spruce (*Picea* spp.) are found here as well. Maple and *Castonopsis* spp. predominate at lower altitudes, while oak predominates higher up; alders are also common; *Carpinus veminii* (ash) is also evident throughout the top canopy.

The middle canopy comprises Rhododendrons, *Rhus* species, *Sorbus*, *Symplocus*, *Persea clarkeana* (a type of avocado), and *Fraxinus* species. The shrub layer comprises of species such as *Berberis aristata*, *Daphne sureil*, *Eurya serrata*, *Sorbus*, *Lyonia ovalifolia*, *Aconogonum mollee*, *Edgeworthia gardenia*, *Zanthozxylum oxyphyllum*, *Viburnum*, *Smilax* spp., *Rubus paniculata*, and Rhododendrons. None of these species are considered to be endangered, protected, or endemic.

# b. Fauna

Species that were sighted during mammals surveys conducted at the project site include Sambar Deer (fresh hoof marks and dung), Barking Deer (sighted, as well as fresh hoof marks and dung), Hory-bellied Squirrel (sighted), Stripped Squirrel (sighted), and Assamese Macaque (sighted). Other "status" wildlife species that are known to occur in the project area include the Capped Langur, Wild Dog, Goral, Gray Langur, Himalayan Black Bear, Indian Porcupine, Little Himalayan Rat, Jungle Cat, Leopard, Leopard Cat, and Wild Pig; this information is based on anecdotal evidence provided by Park staff and local communities.

# c. Birds

Common birds that were observed were Bulbuls, Barbets, Sparrows, Warblers, Babblers, Cuckoos, Pigeons, Doves, Nightjars, Thrushes, Forktails, Redstarts, Wagtails, Choughs, Flycatchers, and Swifts.

Note: Detailed assessment has been done as a part of EIA of Nikachhu Hydropower Project, Trongsa.

# 1.6.8 Cultural and Heritage Sites

Table 8 shows any cultural or heritage sites that will be directly affected by the transmission or distribution line and sub-stations.

Table 8: Cultural and heritage site details
---------------------------------------------

Name of Cultural/Heritage	Location C	oordinates	Circuiting and a fithe site				
Site	Easting	Northing	Significance of the site				
Not relevant, the project site does not encroach any cultural/heritage sites.							

# 1.7 Public Consultation

Transmission line does not affect any of the household or fall on any private land. During the Pubic Consultation Meeting carried out with the public of Tangsibji Gewog on 27th January, 2014, the people showed their support for the project. The Public Clearance for the same is also

enclosed herewith. Moreover, the Dzongkhag Environment Committee has also accorded Dzongkhag Approval as enclosed.

# **1.8 Project Impacts and Mitigation Measures**

There will always be both positive and negative impacts from a power line transmission project. Using the information provided in the earlier sections, list down both positive and negative impacts. Against each negative impact provide mitigation measures and estimated costs required to implement the measure.

#### Impacts

Although there is no significant direct positive impact due to the transmission line, the project, Nikachhu Hydropower Project, for which the transmission line shall be used to fetch construction power, shall have social benefits and environmental benefits during operation generating green energy. The details on the impact (positive) is given in the ESIA of Detailed Project Report.

Since, the community, at the moment, is facing electricity shortage they may tap the electricity from the 33 kV transmission thereby increasing the electricity reliability. This concern has been raised by the Tsogpa of Nyla Chiwog, Tangsibji Gewog, Trongsa. Moreover, The expectation during the Public Consultation Meeting from the Public was reliable electricity supply to community of Nyala and Dangla villages since the current electricity supply from 70 kW Chendebji Micro-hydel does not provide reliable supply. The Dzongkhag also supported and was considered while issuing the administrative approval.

The only negative impact envisaged due to the construction of the 33kV transmission line is on the vegetation since it requires vegetation clearing along the RoW, 12m. However, those fallen trees shall be compensated as a part of the whole project and not as the transmission line alone.

The depth of the foundation shall be only 1900mm for 10m (33kV) poles while the area of foundation will be 600x700 sq.mm. once the pole has been erected inside the pit, the pit shall be backfilled and compacted with the materials generated while excavation. Therefore, resulting into no excavated materials.

# 1.9 Monitoring Program

The monitoring is important for the following reasons:

- To observe if mitigation measures are implemented;
- To ensure that the proposed mitigation measures are practical or effective and accordingly consider other measures to minimize impacts;
- To ensure timely implementation of the project; and
- To change environmental terms and conditions, if necessary.

Item	Method	Responsibility	
Construction phase			
Soil erosion and	Monitor ground cover clearing to ensure not to cause	DGPC site	
slope stability	erosion or land slide	engineer	
	Monitor rain season construction to check the	DGPC site	
	stability of land	engineer	
Land use	Monitor location of poles specified in clauses	DGPC site	

#### Table 9: Environmental monitoring program

Item	Method	Responsibi	lity
	included in design and bid documents.	engineer,	-
		contractor	
	Monitor tree clearing based on the design	DGPC/DOF	
Forestry	Monitor clearing for construction camp and vehicle storage	DGPC	
		DGPC	site
Wildlife	Monitor burning activity by workers on site.	engineer,	
		contractor	
		BPC	site
	Monitor illegal firearms/trapping	engineer,	
		contractor	
Disposal of waste	Monitor proper disposal of waste so as to avoid contamination of sites.	Contractor	
Public health	Check workers health (if applicable)	Contractor	
	Check construction camp sanitation	Contractor	
Worker conflict with local communities	Meeting needs and managing behavior of workforce to minimize undesirable impacts on local community from unwanted behaviors from workers on and off site.	Contractor	
		DGPC	site
	Monitor archaeological sites/artifact discovery	engineer,	
Siles		contractor	
Operation phase			
Soil erosion and	Monitor stable condition of land and structure	DGPC	site
slope stability		engineer	
Forestry	Monitor the vegetation of ROW	DGPC, DOF	
	Monitor area of BOW clearance not to expand BOW	DGPC	site
		engineer	
Wildlife	Monitor illegal firearms/trapping	DGPC	site
		engineer	
	Hearing to local people to obtain information of wildlife	DGPC	
All phase			
Environmental	Undertake third party environmental monitoring	NEC	
monitoring audits	audits		
Compliance of EC by Contractor	Observe compliance of EC by Contractor during execution of works.	DGPC and EA Officer.	NEC

Note: Submission of monitoring reports to NECS will be specified in the conditions attached to the clearance.

# 1.10 Checklist for No Objection Certificate

The following list shows NOCs accorded and therefore enclosed with this application:

Agency/concerned people	Why/when	Check
Dzongkhag	Always required	Enclosed
Department of Forest	The transmission line passes through forest area	Enclosed
Public		Enclosed

Note:x: required N/A: Not applicable

# Transmission line route survey (walk on survey) on the extension of 33 kV line from Bangla Pokto till Nikachhu HPP Dam Site - Line Photographs

Pole Locations	Pictures	Remark
L0		33 kV line at Bangla Pokto, from where the Line will be extended.
L1		

L2	
L3	
L4	

L5	Till this point the line will be along the road and from here, it will be taken below the road.
L6	
L7	

L8	From this point, the old foot path (old Zhung lam) is just about 20 meters below.
L9	This point is on the left hand side of Khang Khangmey Chhu.
L10	
-----	--
L11	

L12	
L13	

L14	
L15	

L16	
L17	
L18	

L20	L19

L22	
L23	

L24	
L25	
L26	

L27	L27	
L28		
L29		



### Proposed 33 kV line alignment from Banglapokto to Lorim







DZONGKHAG ADMINISTRATIVE APPROVAL

In exercise of the powers delegated under the National Environment Protection Act 2007, of the National Environment Commission Secretariat, Section 47, which mandates the Dzongkhag Environment Committee (DEC) as one of the Competent Authorities in Making recommendations to the concerned Ministries, Local Governments, and /or to the Secretariat concerning any measures that need to be taken to protect the quality of the Environment. Also, Dzongkhag Administration is mandated to issue the Dzongkhag Administrative Approval as per the Section 3.10 of Application for Environmental Clearance Guideline; the **Dzongkhag Administrative Administrative Approval is hereby accorded in favor of Nikachhu Hydropower Project as** per the 5th **Dzongkhag Environment Committee meeting** held on January 23, 2014 for Construction of 5 km, 33kV Transmission line for 118MW Nikachhu Hydropower Project with following terms and conditions:

- 1. Applicant to execute the wok as per The Land Act 2007.
- 2. Applicant to execute the work as per Waste Prevention and Management Regulation 2012.
- Applicant to carry out the transmission line construction along the National Highway RoW, along the edges of the Royal Tsamdro as recommended by the DEC during the field visit.
- The Applicant to maintain the Zhunglam (Footpath) and maintain Smeters RoW for the Existing Zhunglam (footpath) for the construction of the transmission line.
- 5. Applicant to ensure that restoration works are carried out after the completion of the construction.
- 6. The said transmission line construction to benefit the community of Sephuchen (Ngala and Dangla)
- The Dzongkhag Administrative Approval is accorded only for obtaining Environmental Clearance and does not include Social Clearance, Forestry Clearance, if required thereof;
- The Dzongkhag Administrative Approval for the said activity is within the jurisdiction of Trongsa Dzongkhag.

Further, this Dzongkhag Administrative Approval will stand valid till obtaining the Environment Clearance from the Competent Authority.

mum

(Tshewang Rinzin) Chairman

Dzongkhag Environment Committee Copy to:

- 1. The Director (Projects), Druk Green Power Corporation Limited, Thimphu for kind perusal.
- 2. The Chief Environment Officer, ESD, NECS, Thimphu for kind information.
- 3. The Range Officer, Range Office, Tshangkha for kind information.
- 4. The Gup, Tangsibji gewog Administration for kind information.
- The Environment Officer, Nikachhu Hydropower Project, Trongsa for kind information and necessary action please.
- 6. Office Copy.

พาสสาฐาสราญาณีามากาน สีสาญาสานที่มีญามากามกามกามกามกามกามสารกายเกินกามการสารกายเกินการการกายการกายกายกายกายกายกา กัญานรุญารัฐราพิญาสราสุณ อากัญาญาริณาภายนามาลาร์ ภัณามาลาร์ ภัณามาลายเล่าเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่องเรื่ สุขายเข ส์ขามการ์ข้าขามาร์ขางการ์ขางการของเมากราชิงเมาลางระยาบาร์รานายารายเกลายรงานเกายรงานกายเรายางกากกายกายกา

צביותאיתקאיאלבישאיאבי אביאאגן

R5 :

รุมณาวิจารสีมามียีะ... אַז׳יֹגאישישלאיישישישלבין אַריאישי אַז׳יֹגאין באייצאי אַבישאאן GEOG ADMINISTRATION OFFICE, TANGSIBI GEOG TRONGSA, DZONGKHAG. -gran 20/2/2020 3 र्मेश्रम्दरम्महमायद्वमाणा

สาของส์ขางกายากายสารรับกายายาลายาลายาลายาลายาลายาลายาลา นี้เหลาระเสราของเราส์รามีสาย ของเราร์รามีรายง ของเราร์ราสายราสายเราร์รายงอาร์รายงอาร์รายงอาร์รายงอาร์รายงอาร์รา いかっちいかし



קאגעיאצאילאלאלאיני וואישליגניוואיפגאימקאיוואישאנישיועלאליגניוויזעלאניוויזעלאליניווי אישליאלישאיאלישאנישיצניומשישנשיי יהבלקיחיאיואירים וויוייבי אילילאיני אירים יישיא איליאין אילי אירים ישליאי אילישיאליש איאלים איאלי ישארי אילי ישאי אילי ישאי אילי אירים אירים איאלי אירים אירים אירים אילי אילי אירים אי สูเรมนามาสาสสายสายสายสายสายสายสายสาย 20/2/2020 33'าบายการเลา

แสพระพระเพรามีพราแพลามิรุมเริ่าขุมามรายอุรามารัฐรายที่เมณ์ผู้เรารับรา สุราณีขายรูโราพิมาส์ราสุมา ผู้อามนิย์ผู้อาเมาใน้อาเมา

2 ogneinstaverigeriggigeringinssoners/asimi allark Willing wight Grs. 28:29rm. nyum, mjizi o a zg. Z' ~ Graniza 2 4313512011. Ezgini - -_____ Qet, 2 4 grunzmi --11-NER asal genne 215' ginn 20 GRIBIAN クセ REAN つつ ar à His うろ ANSIA つか Tangsibi Chewog Tangsibi Geog



3 gning av Zuiggigeningingonstingiet 24~1 017:27 orgen 201 mi Grg, (39' a 215's) a 21' 37 31m- Hg 2 ~ 2 いちいらく3つの~. 3 えんころ 14, 123, 320 ad to on al The graves



gnigowin Ku Bound In might astrongiest GNI åstignen. man. my Et Again gh GIR' MANINT クニ 22. Cargar moderal 12naginamiania = 12a. ani sigi gona E-Dri Rigondi 4-5 4 AT 5 Wing an Blight 6-Acrif -(2921 Mbar P-HAN ZE SE × -NGAI Emityzi n -¢ 2011 5 11 15 ASI 20-Rimisona 77 -- The gar クユー 22 APAN MADI 7m-23 5 いいううう 25 -之前日日かり 74-Du AI BIEMINI 25 75--Znizigumizg' 7P-



dit i egenni * Knymi myici Marinal the gnidor Zai -7-32-(391 mgnippina) 22-(291天かいこう) nm -之日 2 gi agi goud -NE-24 Grain 124--25 ALMIZING MIDI an 26-Znigoringar no-24 -L'ingrightin Eni 124 -20 Marysi Zimidu nn--441 50112 20-30 Marig variage -127-しているがで、 mnmm -3ginner sourd mmme neeringarasia me--Zowing Smini myan gangvini Eq. ---mu--311 国山るない」 mi mo--33129101 加入-34.11.



Li yours

Gig = au à

RVINIBOUTS WINI

En Smi

GAI Smidel

EE-

2-

En-

En-

Em-

E4-

25-

àg sy MALIZAVI

89110334

gavin. ezern chi

-----

------

-

Real I

my GI

E?

EE

-6-

RE4

422

大いうのいたい ER-えない あるいはいい 注意い -ER-Mar way Ly 24-Zhu Ar ginggo. En-(10) 的日子四日 40-47 1 nah, ar zy 42-र्क्ता द्राग्रेग yn-42 AL BUDY AN AN Same and um-----Eq non uy ME-And 42 ____ L'UNI ZILL 44-



of ejouni Shi Rider gun, 60-Man margi Gi fai 619 -「ふうう」 62-れを行うう ののかう うれ, 63nini nienj GE-Frin winter Gu-Legiton your 66-

man . ogin Dryhi

mg, EI

denf.

GE

K111 di GP-GP ... Elsizen ymin G2-Gn-21301 80112 po-27 20 Ard minggi gosidi 27zinger Mader pn-Gigigvmind pm-Funder de NIFAI RE-State Pu man (なす:ヨリタリのとり) Ru-





#### শ্বন্থরশ্বধুন্য

OFFICE OF THE CHIEF FORESTRY OFFICER ZHEMGANG FOREST DIVISION DEPARTMENT OF FORESTS AND PARK SERVICES

#### ZFD/TECH/22-2/2013-14/906

#### Date: 04/02/2014

#### FORESTRY CLEARANCE

The Zhemgang Division, Department of Forests & Park services, Ministry of Agriculture & Forests is pleased to issue Forest Clearance for Construction of Transmission Line measuring 5km length and 12m wide from Banglapokto to Dam site of NHPP via biological corridor of JSWNP & JSWNP in favor of Nikachu Hydro Power Project, Trongsa

This elegrance is issued as per the approval from the Department vide letter no.DoFPS/ka-3-2/2014/1038 dated 9th January 2014.

This clearance is limited to forestry perspective as per the detail field report;

- 1. This clearance id not transferable;
- 2. The validation of this clearance shall subject to obtaining other clearances;
- 3. Additional clearances should be sought prior to any deviation of the activity area;
- This clearance shall not be liable for any dispute arising during the implementation of activity;
- 5. This clearance is limited within the proposed area for specific one time activity;
- 6. Any damage caused to public /Private property shall be borne by the holder of this clearance;
- Any waste generated from the activity should be properly dispose as per the Waste Preventation and Management regulation.2012;
- 8. The existing Forest produce shall be disposed as per the existing rules and regulation:
- 9 Upon approval of GRF land on lease, the proponent and concerned authority should execute lease agreement for the intended activity. A copy of leased agreement should be forwarded to concerned Forest Division;
- The legal status of the land on lease shall remain unchanged and shall not be converted to private ownership mortgaged sub-lease (sold;
- 11. This clearance shall not restrict easement:
- 12. Upon expiry/annulment of the GRF land on lease, the GRF land should be restored to original and handover to DoFPS as per F&NCR;
- 13. The renewal of the clearance is subject to performance of the activity;
- 14. The GRF land shall be released only after the proper handing taking note signed by the both the parties.
- 15. This clearance shall be revoke without any liability on part of Government if the holder of this clearance violates any of the above terms & conditions;
- 16. This shall valid till one year from the date of issue and subject to the periodic review and changes.

Zheingang, Post Box 394; Tele No. 00 975 - 03 -741205 - 741323 Fax No. 741224/ e-mail dfozhem@moaf.gov.bt

*********



#### OFFICE OF THE CHIEF FORESTRY OFFICER ZHEMGANG FOREST DIVISION DEPARTMENT OF FORESTS AND PARK SERVICES

Non-compliance of any of the above mentioned conditions is a violation of the Forest and Nature Conservation Act 1995 and its Rules 2006 and amended Rules 2008 and any other relevant laws. This shall result in revocation/suspension of the Forestry Clearance, in part or in whole and the penalties enforced as per the Act without any liability on the part of the government;

This is issued as per field inspection report submitted by Unit In charge, CFMU vide no.CFMU/DoF/22/2013-14/37 dated 25/12/2013.

(Ugyen Tenzin Chief Forestry Officer

Copy to:

- 1. The Dasho Dzongdhag, Dzongkhag Administration, Trongsa for kind information.
- 2. The Gup, Geog Administration, Tangsibgi Gewog for kind information,
- 3. The Project Manager, NHPP, Trongsa for information.
- 4. The Unit In charge, CFMU for information.
- 5. Office copy,

Zhemgang, Post Box 394; Tele No. 00 975 - 03 -741205 / 741323 Fax No. 741221/ e-mail dfozhem@moaf.gov.bt



Royal Government of Bhutan Ministry of Agriculture and Forests Department of Forests and Park Services THIMPHU



No. DoFPS/Ka-3-2/2014/ /038

The Chief Forest Officer Zhemgang Forests Division.

#### Sub: Approval for issuance of Forestry Clearance

January 9, 2014 2404 ceived No. 90

As recommended by your office letter no. 727 dated 31/12/2013, the approval is hereby accorded as per the annexure 18(d),(6)for issuance of Forest Clearance for proposed re-alignment of 33kv transmission line passing through the SRF land measuring **5km length & 12metres** wide, from Banglapokto to Damsite of NHPP via biological corridor of JSWNP & JDWNP in favour of NHPP, Trongsa.

Therefore, you are asked to issue the forest clearance for above activity from your end as per the existing guidelines. The trees and poles within the transmission alignment should be handed over to NRDCL for extraction &disposal as per the F&NCAR, 2008.

(Chencho Norbu **Director** General

Copy to:

1. The CFO, WCD information.

2. PA to Director General, DoFPS for record.

for ha

# Annex E: ToR for Environment Wing of THyE

#### Terms of Reference for the Environment Unit.

The Environment Unit under Tangsibji Hydro Energy Ltd (THyE) shall be established during the execution of Nikachhu Hydropower Project, Trongsa to fulfill the Terms and Conditions laid by National Environment Commission, Thimphu. The Division shall serve as the principal Social, Environment and CDM advisor to Project Authority in general and Engineer-In-Charge in particular. The Unit shall serve as the primary source of social, environment and CDM policy expertise, guidance, direction and support Management.

An Environmental Focal Person shall be appointed with the following Terms of Reference to help and oversee the Environmental issues related to the Project development works. The Environment Focal Person shall ensure that:-

- 1. Any modification of the proposal/application shall take place only with prior approval from National Environment Commission as per Section 28.3 of the Regulation of the Environmental Clearance of Projects 2002,;
- 2. The contractor shall comply with the Environment Management Plans including the EMPs of Roads ,which shall be provided as part of the Contract Document;
- 3. All project activities including quarry shall comply with the national standards for Ambient Air Quality, Industrial Emission, Workplace Emission and Noise levels for Bhutan, NEC 2007 and Environmental Discharge Standard 2004;
- 4. Renew Environment Clearance on its expiry;
- 5. Process any other Ad-hoc clearances on requirement;
- 6. Ensure that the quarry is operated only for the purpose of meeting materials requirement for Project construction activities;
- 7. Ensure that the quarry is operation of quarry is limited or confined strictly within the demarcated boundary;
- 8. The impact on local residents/households/communities/public, private parties and any other religious/historic sites are minimized at the extent possible, at all time.
- 9. Project authority tie up with other agencies like DoFPS, NBC, GNHC, and WWF for Biodiversity Conservation Projects and Compensatory Afforestation Projects;
- 10. The project area is free of waste maintaining proper House- keeping;
- 11. The contractor abide by the Rules on Occupational Health and Safety issued by Ministry of Labour and Human Settlement;
- 12. Any issues on Social and Environment with the community be resolved;
- 13. Monitoring report with the Detailed Implementation Plan be submitted to NEC as required;
- 14. Public and workers be provided awareness on waste and importance of waste segregation;
- 15. Workers be provide awareness on the rules and regulations of Bhutan related to Forest and Nature Conservation, Waste Management, Code of Conduct;

- 16. Communities, employees, student be involved in waste management activities such Cleaning campaign;
- 17. Awareness on STD diseases be provided to the communities in collaboration with the Department of Public Health, Ministry of Health;
- 18. The project authority abide by the Environmental Terms and Conditions set-forth in the Environment Clearance;
- 19. The contractor and project authority abide by the Terms and conditions set-forth in the Undertaking of Forest Clearance;
- 20. Any other work assigned by the management be done

## Annex F: Sedimentation Data for Nikachhu

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Bridan

Chendebji Bridge

278

Latittude: 27:30:29 N Longitude: 90:16:35 E

Elevation m): 2660

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/Rainy)		Colour)			
11/Sep/09	900				22.59	272.20	
19/Sep/09	1500				22.59	57.00	
8/Oct/09	900				42.48	1539.27	
31/Jan/10	900				3.19	7.78	
2/Feb/10	1500				2.86	8.98	
3/Feb/10	900				2.83	105.79	
4/Feb/10	1500				2.83	79.46	
6/Feb/10	1500				2.83	42.25	
12/Feb/10	900				3.13	23.01	
16/Feb/10	1500				2.92	9212.71	abnormally high PPM
18/Feb/10	900				3.04	20.20	
20/Feb/10	900				2.85	67.92	
25/Feb/10	1500				2.75	10.04	
3/May/10	900		0.91		5.60	5.47	
4/May/10	1500		0.91		5.31	8.81	
6/May/10	900		0.94		5.88	13.72	
7/May/10	900		0.94		6.27	19.84	
10/May/10	900		0.92		6.21	7.56	
11/May/10	1500		0.94		7.14	11.79	
11/May/10	900		0.94		7.14	300.08	
12/May/10	900		0.92		7.09	2.25	
13/May/10	900		0.92		6.64	20.51	

Logation :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude:	27:30:29 N
Longitude:	90:16:35 E

Longitude: Elevation m): 2660

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/Rainy)		Colour)			
15/May/10	900		0.90		6.14	13.44	
19/May/10	900		0.94		7.11	5.80	
19/May/10	900		0.94		7.11	18.56	
24/May/10	1500		0.97		6.45	12.30	
6/Oct/10	900		0.21		20.13	3.2	
7/Oct/10	900		0.21		16.09	8.3	
12/Oct/10	900		0.17		14.62	78.7	
13/Oct/10	900		0.17		14.26	8.6	
14/Oct/10	900		0.17		13.60	8.7	
15/Oct/10	900		0.16		15.94	6.9	
18/Oct/10	900		0.21		16.70	10.2	
19/Oct/10	900		0.2		15.45	9.3	
21/Oct/10	900		0.19		15.59	23.9	
22/Oct/10	1500		0.2		15.87	2.4	
25/Oct/10	900		0.17		14.26	11.7	
26/Oct/10	915		0.16		13.45	6.4	
27/Oct/10	900		0.13		13.19	1.3	
2/Nov/10	1500		0.10		10.18	1.7	
4/Nov/10	900		0.10		4.73	17.4	
5/Nov/10	920		0.09		4.48	32	
8/Nov/10	905		0.08		4.31	73	
15/Nov/10	905		0.06		3.69	11.5	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Bridan

Chendebji Bridge

Latittude: 27:30:29 N 90:16:35 E

Longitude: Elevation m):

2660

278

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/Rainy)		Colour)			
17/Nov/10	900		0.06		3.70	3	
18/Nov/10	900		0.05		3.57	3	
19/Nov/10	1500		0.05		3.69	12.2	
22/Nov/10	900		0.04		3.68	83.1	
23/Nov/10	900		0.03		3.34	18.6	
24/Nov/10	900		0.07		3.29	9.7	
6/Dec/10	900		0.02		4.69	19.7	
21/Dec/10	900		-0.85		4.26	10.7	
27/Dec/10	900		-0.84		4.29	11.4	
28/Dec/10	1500		-0.84		4.26	13.5	
29/Dec/10	900		-0.85		4.11	10.8	
30/Dec/10	900		-0.83		4.27	11.2	
31/Dec/10	900		-0.83		4.48	7.6	
7/Jan/11	900		-0.83		3.71	6.6	
10/Jan/11	900		-0.85		3.66	7.9	
11/Jan/11	900		-0.84		3.75	4.6	
12/Jan/11	900		-0.84		3.97	3.7	
21/Mar/11	1500				3.52	0.76	
22/Mar/11	900				3.65	0.76	
25/Mar/11	930				3.27	0.76	
29/Mar/11	900				3.35	-0.79	
7/Apr/11	900		-0.77		0.00	8.21	
11/Apr/11	900		-0.77		3.39	1.89	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude: 27:30:29 N 90:16:35 E

Longitude: Elevation m): 2660

Date of	Time (Hrs)	Weather	Gauge	Water Colour	Discharge	PPM reading	Remarks
Sampling		(Sunny/cloudy	Height (m)	(Muddy/Clear/			
		/nanry)					
14/Apr/11	930		-0.80		0.00	3.23	
26/Apr/11	1500		-0.80		3.57	10.96	
28/Apr/11	Not provided		-0.82		0.00	8.15	
29/Apr/11	Not provided	Rainfall	-0.85	Brown	4.11	1.19	
30/Apr/11	Not provided		-0.82		3.95	1.39	
4/May/11	Not provided		0.01			3.20	
17/May/11	930		0.02		7.07	1.50	
19/May/11	930		0.04		0.00	2.48	
20/May/11	Not provided		0.05		7.30	1.20	
23/May/11	900		0.10		7.75	3.75	
24/May/11	Not provided		0.12		7.69	31.26	
25/May/11	900		0.16		6.80	3.18	
27/May/11	Not provided		0.08		8.23	11.05	
30/May/11	Not provided		0.12		8.80	7.91	
6/Jun/11	900		0.20		12.35	12.32	
9/Jun/11	900		0.10		0.00	9.76	
11/Jun/11	900		0.24		13.17	26.02	
13/Jun/11	1500		0.15		11.59	337.65	
16/Jun/11	Not provided		0.18		0.00	9.24	
17/Jun/11	915		0.22		14.33	3233.51	
29/Jun/11	Not provided		0.32		17.07	43.24	
2/Feb/12	Not provided		0.11		0.00	205.12	
9/Feb/12	Not provided		0.11		3.53	1208.08	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude:	27:30:29 N
Longitude:	90:16:35 E

2660

Elevation m):

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy /Rainy)	Gauge Height (m)	Water Colour (Muddy/Clear/ Colour)	Discharge	PPM reading	Remarks
18/Feb/12	Not provided		0.13		0.00	57.51	
20/Feb/12	Not provided		0.12		4.13	36.93	
25/Feb/12	Not provided		0.13		9.53	1389.51	
29/Feb/12	Not provided		0.13		3.44	1637.07	
3/Mar/12	Not provided		0.13		3.39	22.94	
5/Mar/12	Not provided		0.12		3.91	3.89	
10/Mar/12	Not provided		0.13		2.86	14.50	
13/Mar/12	Not provided		0.13		3.16	4.81	
16/Mar/12	Not provided		0.14		0.00	4.78	
20/Mar/12	Not provided		0.14		0.00	2.90	
23/Mar/12	Not provided		0.13		3.10	3.00	
26/Mar/12	Not provided		0.12		3.31	12.23	
30/Mar/12	Not provided		0.12		12.00	88.67	
2/Apr/12	Not provided		0.13		0.00	14.22	
5/Apr/12	Not provided		0.12		3.52	4.91	
9/Apr/12	Not provided		0.10		0.00	16.26	
13/Apr/12	Not provided		0.08		3.99	5.88	
16/Apr/12	Not provided		0.09		0.00	44.99	
18/Apr/12	Not provided		0.08		4.31	2.93	
20/Apr/12	Not provided		0.03		3.80	10.51	
23/Apr/12	Not provided		0.02		0.00	6.58	
4/May/12	Not provided		0.02		3.37	5.48	
7/May/12	Not provided		0.04		0.00	3.60	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude:	27:30:29 N
Longitude:	90:16:35 E

Longitude: 2660

Elevation m):

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/Rainy)		Colour)			
14/May/12	Not provided		0.00		0.00	9.40	
15/May/12	Not provided		0.01		3.65	13.86	
17/May/12	Not provided		0.01		3.51	5.28	
23/May/12	Not provided		0.00		4.65	5.46	
24/May/12	Not provided		0.00		4.95	6.85	
26/May/12	Not provided		0.06		5.39	51.54	
28/May/12	Not provided		0.05		0.00	41.58	
30/May/12	Not provided		0.10		0.00	55.94	
1/Jun/12	Not provided		0.10		4.52	66.83	
5/Jun/12	Not provided		0.11		3.72	47.99	
7/Jun/12	Not provided		0.07		4.02	171.56	
11/Jun/12	Not provided		0.04		0.00	34.50	
14/Jun/12	Not provided		0.02		4.99	29.42	
16/Jun/12	Not provided		0.03		5.71	139.39	
18/Jun/12	Not provided		0.30		0.00	110.37	
20/Jun/12	Not provided		0.15		5.11	39.09	
22/Jun/12	Not provided		0.19		5.89	47.09	
26/Jun/12	Not provided		0.30		7.01	51.80	
5/Jul/12	Not provided		0.30		10.98	121.29	
7/Jul/12	Not provided		0.23		11.02	36.80	
9/Jul/12	Not provided		0.30		0.00	56.44	
11/Jul/12	Not provided		0.28		9.59	35.56	
12/Jul/12	Not provided		0.39		9.14	101.76	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

Latittude:	27:30:29 N
Longitude:	90:16:35 E

2660

Elevation m): 278

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy /Bainy)	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/naiiy)					
13/Jul/12	Not provided		0.00		8.47	59.78	
18/Jul/12	Not provided		0.31		13.37	347.97	
20/Jul/12	Not provided		0.37		15.68	247.56	
24/Jul/12	Not provided		0.00		15.83	1978.50	
1/Sep/12	Not provided		0.32		36.86	0.17	
3/Sep/12	Not provided		0.29		0.00	0.18	
5/Sep/12	Not provided		0.28		29.27	0.09	
7/Sep/12	Not provided		0.27		27.89	0.13	
10/Sep/12	Not provided		0.26		0.00	0.09	
14/Sep/12	Not provided		0.42		31.04	0.06	
17/Sep/12	Not provided		0.39		0.00	0.03	
19/Sep/12	Not provided		0.37		25.32	0.03	
21/Sep/12	Not provided		0.35		24.87	0.01	
25/Sep/12	Not provided		0.26		25.64	0.00	
27/Sep/12	Not provided		0.23		25.64	-0.09	
29/Sep/12	Not provided		0.20		25.64	-0.04	
7/Nov/12	Not provided		0.00			2.01	
10/Nov/12	Not provided		0.00			3.57	
16/Nov/12	Not provided		-0.10			5.82	
21/Nov/12	Not provided		-0.12			228.60	
24/Nov/12	Not provided		-0.13			10.86	
26/Nov/12	Not provided		0.13			2.58	
30/Nov/12	Not provided		-0.14			3.35	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude: 27:30:29 N Longitude: 90:16:35 E

Elevation m): 2660

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/Rainy)		Colour)			
1/Dec/12	Not provided		-0.15			17.55	
2/Dec/12	Not provided		-0.16			65.47	
3/Jan/13	Not provided	sunny	-0.20	Clear	29.31	11.26	
4/Jan/13	Not provided	sunny	-0.11	Clear	26.11	0.79	
8/Jan/13	Not provided	sunny	-0.21	Clear	23.68	1.36	
14/Jan/13	Not provided	sunny	-0.23	Clear	36.70	0.60	
16/Jan/13	Not provided	sunny	-0.23	Clear	0.00	5.75	
17/Jan/13	Not provided	Rainfall	-0.23	Clear	28.89	1.79	
19/Jan/13	Not provided	sunny	-0.22	Clear	28.49	0.41	
21/Jan/13	Not provided	sunny	-0.22	Clear	27.34	0.40	
23/Jan/13	Not provided	sunny	-0.25	Clear	0.00	1.30	
28/Jan/13	Not provided	sunny	-0.26	clear	24.25	79.99	
1/Feb/13	Not provided	sunny	-0.25	Clear	5.51	1.47	
4/Feb/13	Not provided	sunny	-0.25	Clear	0.00	1.46	
8/Feb/13	Not provided	sunny	-0.24	Clear	5.75	8.31	
13/Feb/13	Not provided	sunny	-0.25	Clear	4.90	2.84	
16/Feb/13	Not provided	sunny	-0.24	Clear	5.50	2.94	
18/Feb/13	Not provided	Rainfall	-0.17	colour	0.00	52.93	
26/Feb/13	Not provided	sunny	-0.23	Clear	4.97	21.64	
4/Mar/13	Not provided	-	-0.24			5.13	
8/Mar/13	Not provided		-0.23			3.72	
11/Mar/13	Not provided		0.23			3.5	
13/Mar/13	Not provided		-0.24			4.39	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude:	27:30:29 N
Longitude:	90:16:35 E

Elevation m): 2660

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy	Gauge Height (m)	Water Colour (Muddy/Clear/	Discharge	PPM reading	Remarks
		/nainy)		Colour)			
16/Mar/13	Not provided		0.23			6.31	
22/Mar/13	Not provided		-0.22			9.4	
25/Mar/13	Not provided		0.22			2.6	
1/Apr/13	Not provided	sunny	-0.21	Clear	4.60	10.14	
4/Apr/13	Not provided	sunny	-0.22	Clear	0.00	10.42	
9/Apr/13	Not provided	sunny	-0.21	Clear	4.75	14.77	
12/Apr/13	Not provided	sunny	-0.19	Clear	4.50	12.41	
13/Apr/13	Not provided	sunny	-0.19	Clear	4.53	10.19	
15/Apr/13	Not provided	sunny	-0.17	Clear	5.02	9.45	
17/Apr/13	Not provided	sunny	-0.18	Clear	4.83	15.94	
22/Apr/13	Not provided	Rainfall	-0.10	Brown	4.53	216.56	
29/Apr/13	Not provided	sunny	0.10	Brown	0.00	270.60	
1/May/13			0.05			151.7	
19/May/13						5.5	
22/May/13	1500	Rainy	0.2	Brown		180.49	
24/May/13	1500	Cloudy	0.24	Clear		211.25	
27/May/13	1500	Sunny	0.16	Clear		140.43	
29/May/13	1500	Rainy	0.46	muddy		696.5	
31/May/13	1500	Rainy	0.42	muddy		151.91	
3/Jun/13	900	sunny	0.22	Clear		130.89	
5/Jun/13	900	sunny	0.25	Clear		108.1	
10/Jun/13	900	Cloudy	0.18	Clear		262.39	
12/Jun/13	900	sunny	0.11	Clear		30.14	

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude: 27:30:29 N 90:16:35 E

Longitude:

Elevation m): 2660

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy /Rainy)	Gauge Height (m)	Water Colour (Muddy/Clear/ Colour)	Discharge	PPM reading	Remarks
		, , <b>,</b> ,		,			
14/Jun/13	900	sunny	0.07	Clear		133.77	
17/Jun/13	900	sunny	0.07	Clear		43.36	
19/Jun/13	900	sunny	0.09	Clear		201.53	
22/Jun/13	900	Rainy	0.15	Clear		40.23	
27/Jun/13	900	Rainy	0.29	Clear		22.22	
29/Jun/13	900	Rainy	0.29	Clear		8.58	
4/Jul/13			0.38			10.52	
6/Jul/13			0.35	Clear		89	
8/Jul/13			0.36	Clear		206	
10/Jul/13			0.34	Clear		161	
12/Jul/13			0.29	Clear		69	
15/Jul/13			0.27	Clear		113	
18/Jul/13			0.4	Clear		584	
19/Jul/13			-	Clear		238	
22/Jul/13			0.37	Clear		487	
26/Jul/13			0.4	Clear		119	
29/Jul/13			0.36	Clear		466	
4/Aug/13			0.29			41	
12/Aug/13			0.33			46	
15/Aug/13			0.29			57	
16/Aug/13			0.3			67	
19/Aug/13			0.26			42	
21/Aug/13			0.3			65	
# Nikachhhu Hydropower Project

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of
LUCATION.	Chandahii Dridaa

Chendebji Bridge

278

Latittude: 27:30:29 N Longitude: 90:16:35 E

Elevation m): 2660

Catchment area (km²):

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy /Rainy)	Gauge Height (m)	Water Colour (Muddy/Clear/ Colour)	Discharge	PPM reading	Remarks
26/Aug/13			0.29			43	
29/Aug/13			0.26			60	
31/Aug/13			0.24			36	
30/Sep/13			0.1	Clear		44	
1/Oct/13			0.08	Clear		41	
2/Oct/13			0.06	Clear		37	
3/Oct/13			0.06	Clear		54	
5/Oct/13			0.18	muddy		107	
7/Oct/13			0.15	Clear		53	
9/Oct/13			0.09	Clear		72	
10/Oct/13			0.05	Clear		53	
11/Oct/13			0.05	Clear		100	
16/Oct/13			0.06	Clear		90	
19/Oct/13			0.06	Clear		186	
22/Oct/13			0.05	Clear		192	
28/Oct/13			0.03	Clear		63	
3/Nov/13			0.01	Clear		89	
5/Nov/13			0.02	Clear		114	
6/Nov/13			-0.03	Clear		118	
7/Nov/13			-0.04	Clear		79	
9/Nov/13			0.03	Clear		99	
13/Nov/13			0.07	Clear		65	
16/Nov/13			-0.08	Clear		68	

# Nikachhhu Hydropower Project

Location :	2 km Upstream of Chendebji Chorten and 500 m downstream of Chendebji Bridge
Latittude:	27:30:29 N

Longitude: 90:16:35 E

Elevation m): 2660

Catchment area (km²): 278

Date of Sampling	Time (Hrs)	Weather (Sunny/cloudy /Rainy)	Gauge Height (m)	Water Colour (Muddy/Clear/ Colour)	Discharge	PPM reading	Remarks
17/Nov/13			-0.08	Clear		54	
20/Nov/13			-0.1	Clear		63	
21/Nov/13			-0.1	Clear		84	
26/Nov/13			-0.13	Clear		130	
28/Nov/13			-0.13	Clear		145	

# **Annex G: Hydrological Report**

#### HYDROLOGICAL REPORT

#### 1. Introduction

The main feature of the physical environment that the project is most dependent on and which the project, in turn, is likely to impact most significantly (especially during operation) is the hydrology of the Nikachhu, and, less directly, the Nikachhu river profile (this means the elevation changes over distance, including abrupt changes which would be evident as cascades or waterfalls; this has implications for fish migration). The details presented in this section are mainly based on discharge data for the Nikachhu and the Mangdechhu. Calculation of flows was based on catchment area data and flow data recorded at Bjizam (1995-2008) and the Chendebji Gauging Station (2009-2011), and then using deductive analysis for accumulated discharge to isolate the flow specific to the Nikachhu. The most salient points, relevant to the environmental and social impact assessment, are presented and discussed below, after an overview of the river systems in Bhutan.

There are four major rivers in Bhutan. The Drangmechhu, the largest river system, flows southwesterly from India's Arunachal Pradesh State, and has three major branches: the Drangmechhu, Mangdechhu, and Chamkharchhu. These branches from the Drangmechhu Basin, which spreads over most of eastern Bhutan and drains the Trongsa and Bumthang valleys. In the southern plains, where eight tributaries joins, the Drangmechhu is called the Manas. The Punatsangchhu rises in northwestern Bhutan as the Mochhu and the Phochhu, both fed by the snow-covered Himalayas. These two join to from the Punatsangchhu in Punakha, which flows southerly into West Bengal, India. The smallest river system, the Amochhu flows out of Tibet into the Chumbi Valley, and swiftly through western Bhutan before broadening near Phuentsholing and then flowing into India.

In the project area, the Mangdechhu and Nikachhu dominate. The Mangdechhu flows through the heart of the dzongkhag, dividing the dzongkhag almost in half. The Mangdechhu rises in northern Bhutan near Kula Kangri Peak. At Tongsa Dzong, the bed of the river is about 1,666 m above sea level and its flow is very swift. The Chamkharchhujoins Mangdechhu,near Gomphu under Zhemgang Dzongkhagbefore it joins Manas. The Nikachhu is a tributary of Mangdechhu, with its catchment north and south of the road running from Pele La to Tangsibji. The size of the catchment that "feeds" the Nikachhu (the watershed above the proposed dam at Lorim) measures 373 km². There are no glacial lakes in the catchment and therefore the project area is free from the risk of Glacial Lake Outburst Flood (GLOF). The catchment is supplied

with snow-melt water and rainfall, most of which is channeled through many smaller tributaries that join the Nikachhu, and most of which discharges in the monsoon (June-September, as noted previously).

The river profile of the Nikachhu is significant for the project. The riverbed drops from about 2,400 masl about 6 km upstream of the proposed dam site to 2,262 m asl at the dam site (at Lorim), and then to about 1,400 m asl at the confluence with the Mangdechhu, dropping 860 m over about 10 km. There are indications that somewhere between the dam site and the confluence with the Mangdechhu, most likely just after Bangla Pokto (where there is a steep drop in elevation evident in the topographic chart), there is an abrupt drop in the riverbed of about 30 m (a very significant waterfall).¹ Wherever this site is, it was not accessible to the current team; however, there is evidence of waterfalls along the Nikachhu. And an area several kilometers below the proposed dam site has a series of cascades; with heights up to 3.2 m (this is significant for migrating fish, as it is higher than the jumping capability of migratory fish in Bhutan. The waterfalls are clearly associated with the northwest-southeast traverses that the Nikachhu makes across the prevailing northeast-southwest ridges that connect the mountain systems on either side of the Nikachhu. In this manner, the Nikachhu riverbed drops about 1,000 meters over 12-13 km.

The mean monthly discharges at the Nikachhu dam site are shown in Table 1. Based on the Chendebji gauging station data, it is clear that the maximum monthly discharges at the dam site are strongly correlated with the monsoon rain and also reflecting a one-month lag (in October), with June to October monthly discharges up to 8 times greater than the lean months flows (December-March). Table 2 show the Nikachhu discharge data combined with the Mangdechhu discharge data, reflecting the Nikachhu tailrace discharge to the water above the Mangdechhu dam.

The average monthly flow derived from long term flow series (1991-2012) at Bjizam and Dam site of Nikachhu is given in Table 1.

¹ Recorded by a BHUCORE consultant in July 2010, and also noted by local people and the previous fishing warden, Mr. Phuntsho.

Month	Bjizam Flow m ³ /s	Nikachhu Flow m ³ /s
Jan	15.79	5.11
Feb	14.57	4.84
Mar	17.80	5.51
Apr	29.99	7.90
Мау	53.55	13.00
Jun	94.81	22.27
Jul	164.90	37.86
Aug	164.80	39.74
Sep	118.12	29.27
Oct	59.95	15.37
Nov	30.04	8.42
Dec	20.04	6.01
Average flow	65.36	16.27
Minimum flow	14.57	4.84
Maximum flow	164.90	39.74
Average lean flow ( Dec- March)	17.05	5.37

Table 1: Average Monthly Flow at Bjizam and Nikachhu dam site

At Nikachhu Dam site, it is seen that minimum flow is 4.84 m3/s and average lean flow (Dec-Mar) is  $5.37 \text{ m}^3$ /s. The average flow is 16.27 m3/s and the maximum flow is 39.74 m3/s.

The catchment area of Mangdechhu at the dam site is 1,506 km2. The maximum design discharge of Nikachhu with 10% overloading is 28 m3/s. The combined mean monthly flow of Nikachhu and Mangdechhu at the Mangdechhu dam site is shown in Table 2.

Months	Mangdechhu (m ³ /s)	Nikachhu (m ³ /s)	Combined flow at Mangdechhu dam site (m ³ /s)
lon	17.6	5 1 1	22.16
	17.0	5.11	
Feb	16.72	4.84	21.01
March	20.13	5.51	25.09
April	32	7.90	39.35
may	58.02	13.00	70.47
June	103.71	22.27	125.43
July	174.61	37.86	202.38
Aug	185.77	39.74	213.55
Sept	131.23	29.27	159.01
Oct	63.91	15.37	78.73
Nov	32.43	8.42	40.30
Dec	21.83	6.01	27.29

Table 2: Mean monthly flows at Nikachhu and Mangdechhu Dam Site.

#### 2. Impact Assessment

Nikachhu HEP involves the inter basin transfer of water from Nikachhu to Mangdechhu river. Hence the impact assessment is carried out as pre and post-project scenarios at the following four affected locations of the river system:

- a) Nikachhu immediately downstream of the dam;
- b) Nikachhu immediately upstream of Mangdechhu confluence;
- c) Mangdechhu immediately upstream of Nikachhu Confluence;
- d) Mangdechhu between downstream of Nikachhu-Mangdechhu confluence and Mangdechhu HPP Tailrace outlet.

#### 2.1. Nikachhu immediately downstream of the dam

The design flow for the project is 25.45 m³/s and with the overload of of 10%, the flow works out to be 28 m³/s. The pre and post project flows are given in Table 3.

Month	Flow (m ³ /s)			
	Pre- project	Post- project		
Jan	5.11	0.554		
Feb	4.84	0.554		
Mar	5.51	0.554		
Apr	7.90	0.554		
May	13.00	0.554		
Jun	22.27	0.554		
Jul	37.86	10.636		
Aug	39.74	12.523		
Sep	29.27	2.045		
Oct	15.37	0.554		
Nov	8.42	0.554		
Dec	6.01	0.554		

Table 3: Pre and post flows immediately downstream of dam

#### 2.2. Nikachhu immediately upstream of Mangdechhu confluence

There are numerous tributaries contributing to Nikachhu downstream of the dam. The first stream joins Nikachhu at the distance of about 800 m downstream of the dam. Of the numerous streams, there are six major streams between dam site and confluence of Nikachhu and Mangdechhu as shown in the Figure 1 below;



# Figure 1: Streams between dam and confluence of Nikachhu and Mangdechhu

The details of six major streams are given in Table 4 below;

Table 4: Six ma	jor tributaries	between dam	and confluence
-----------------	-----------------	-------------	----------------

Name of tributary	Bank	Distance from Dam (Km)	Catchment area (km ² )
Tshonamchhu	Right	6.33	21.09
Kenulachhu	Right	2.7	9.88
Zalamchhu	Left	8.05	9.33
Nyalalamchhu	Left	2.44	5.66
Bangla Chhupa	Left	4.36	5.12
Dangtsigang	Right	9.74	3.74
	Total catchr	nent area (km²)	54.82

The catchment area upto the dam site is 373 km² and upto the confluence is 453 km²; therefore the catchment area between the dam site and confluence of Nikachhu and Mangdechhu is 80.5

 $km^2$ . By the method of catchment area ratio, the minimum contribution at the confluence from the tributaries is 0.86 m³/s and after adding E- flow of 0.554 m3/s, the minimum contribution is 1.41 m³/s as give in Table 5 and represented in Figure 2.

Month	pre- project flow at dam site	Contribution from tributaries	Contribution from Tributaries + E- flow	Flow pattern after the project
	m³/s	m³/s	m³/s	m³/s
Jan	5.11	0.91	1.46	1.46
Feb	4.84	0.86	1.41	1.41
Mar	5.51	0.98	1.53	1.53
Apr	7.90	1.40	1.96	1.96
May	13.00	2.31	2.86	2.86
Jun	22.27	3.95	4.51	4.51
Jul	37.86	6.72	7.27	17.36
Aug	39.74	7.05	7.61	19.58
Sep	29.27	5.19	5.75	7.24
Oct	15.37	2.73	3.28	3.28
Nov	8.42	1.49	2.05	2.05
Dec	6.01	1.07	1.62	1.62

Table 5: Pre and post project flows at Confluence of Nikachhu and Mangdechhu



Figure 1: Flow pattern of Nikachhu

By the same catchment area ration method, the contribution from each of six major streams are given in Table .

	Avera	Contribution from major Tributaries						
Mont h	ge Iong term flow	Tshonamch hu	Kenulach hu	Zalamch hu	Nyalalamch hu	Bangl a Chhup a	Dangtsiga ng	
	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	
Jan	5.11	0.29	0.14	0.13	0.08	0.07	0.05	
Feb	4.84	0.27	0.13	0.12	0.07	0.07	0.05	
Mar	5.51	0.31	0.15	0.14	0.08	0.08	0.06	
Apr	7.90	0.45	0.21	0.20	0.12	0.11	0.08	
May	13.00	0.73	0.34	0.33	0.20	0.18	0.13	
Jun	22.27	1.26	0.59	0.56	0.34	0.31	0.22	
Jul	37.86	2.14	1.00	0.95	0.57	0.52	0.38	
Aug	39.74	2.25	1.05	0.99	0.60	0.55	0.40	
Sep	29.27	1.65	0.78	0.73	0.44	0.40	0.29	
Oct	15.37	0.87	0.41	0.38	0.23	0.21	0.15	
Nov	8.42	0.48	0.22	0.21	0.13	0.12	0.08	
Dec	6.01	0.34	0.16	0.15	0.09	0.08	0.06	

 Table 6: Flow contribution from each of six major streams

Department of Hydro Met Services has been collecting spot data once in a year during the leanest seasons at Zalamchhu as given in Table 6. As seen from Table, the average leanest flow over the years works out to  $0.12 \text{ m}^3$ /s and from Table , the flow from Zalamchhu during the leanest seasons is also  $0.12 \text{ m}^3$ /s which validates the data calculated by catchment area ratio method.

Date of Measurement	Year	Discharge (m ³ /s)
25.01.94	1994	0.149
02.01.95	1995	0.127
22.01.96	1996	0.167
21.02.97	1997	0.124
23.01.98	1998	0.123
29.01.99	1999	0.11
11.01.00	2000	0.119
06.02.01	2001	0.098
23.02.02	2002	0.102
07.02.03	2003	0.142
11.02.04	2004	0.119
19.02.05	2005	0.161

Table 7: Spot data collected by DHMS at Zalamchhu

13.02.06

12.03.07

17.02.08

19.02.09

22.02.10

27.03.11

#### 2.3. Mangdechhu immediately upstream of Nikachhu Confluence

Average Flow

The dewatered stretch between Mangdechhu dam and the confluence of Mangdechhu-Nikachhu is 7.5 km. This stretch will be impacted by Mangdechhu HPP which is covered in Mangdechhu ESIA Study. The design discharge of Nikachhu project that will be drained into Mangdechhu reservoir is 25.45 m³/s and 28 m³/s with 10% overload. The design discharge of Mangdechhu is 118 m³/s and 129.8 m³/s with 10% overloading. The e-flow adopted for Mangdechhu Project is 1.5 m³/s. The table below shows the flow downstream of Mangdechhu dam before and after Nikachhu Project.

2006

2007

2008

2009

2010

2011

0.113

0.109

0.111

0.099

0.082

0.089

0.12

Month	Mangdechhu (m ³ /s)	Nikachhu (m³/s)	Pre- Nikachhu (m ³ /s)	Post Nikachhu (m³/s)
Jan	17.6	5.11	1.5	1.5
Feb	16.72	4.84	1.5	1.5
Mar	20.13	5.51	1.5	1.5
Apr	32	7.90	1.5	1.5
May	58.02	13.00	1.5	1.5
Jun	103.71	22.27	1.5	1.5
Jul	174.61	37.86	44.81	72.81
Aug	185.77	39.74	55.97	83.97
Sept	131.23	29.27	1.50	29.43
Oct	63.91	15.37	1.5	1.5
Nov	32.43	8.42	1.5	1.5
Dec	21.83	6.01	1.5	1.5

Table 7: Downstream of Mangdechhu dam before and after Nikachhu Project

In the pre-Nikachhu scenario, the discharge downstream of Mangdechhu dam in lean season is the e-flow and contribution from additional downstream catchment. As seen from above table, the flow downstream of Mangdechhu dam increases slightly due to additional flow from Nikachhu particularly in monsoon season.

# 2.4. Mangdechhu between downstream of Nikachhu-Mangdechhu confluence and Mangdechhu HPP Tailrace outlet.

The pre and post project flows at this location are presented in the table below:

Months	Pre- Nikachhu (m ³ /s)	Post- Nikachhu (m ³ /s)
Jan	6.61	2.96
Feb	6.34	2.91
Mar	7.01	3.03
Apr	9.40	3.46
May	14.50	4.36
Jun	23.77	6.01
Jul	82.67	90.17
Aug	95.71	103.55
Sept	30.70	36.67
Oct	16.87	4.78
Nov	9.92	3.55
Dec	7.51	3.12