AMADABLAM MINI HYDRO SUBPROJECT (911 kW)

2.1 General information on the Subproject

The Amadablam Mini Hydro Subproject is a Greenfield subproject and is a run-of -river scheme, which will use water from Cholunche Khola. The subproject plans to provide electricity to 451 households in Chukhung, Debuche, Dingboche, Dole, Mongla, Lawi-Schyasa, Mongla, Lobuche, Luza, Milingo, Mingbo, Mochhermo, Pangboche, Pheriche, Phortse, PhortseTenga, FhungiTenga, Shomare, Thukla, Tyangboche and Worshyo villages of Ward No. 4.

The subproject is planned to develop 911 kW capacity releasing 50% of minimum monthly flow as per "**Directive on Physical Infrastructure Construction and Operation in Conservation Areas, 2065"**[4].

2.2 Location and Accessibility

2.1.1 Description of Location

The subproject is proposed to be implemented in Pangboche, Khumbu Pasang Lhamu Rural Municipality, Ward No.4, Solukhumbu district. Geographically, the proposed subproject lies between 27°50'50"N to 27°51'40"N latitude and 86°47'49"E to 86°49'19"E longitude. The elevation within the subproject area varies from 3951.18 m to 4422 m above mean sea level (amsl).

Major subproject components such as headworks (including intake, desanding basin), penstock pipe, powerhouse, switchyard and tailrace are proposed to be located on the left bank of the Cholunche Khola, which is a tributary of Imja Khola.

2.2.12 Accessibility

The subproject site can be reached via airplane up to Lukla and then by foot or by helicopter from Kathmandu. Flight from Kathmandu to Lukla takes 30 minutes. Travel from Lukla to Pangboche via Monjo - Namche Bazaar requires three days for a trekker. Construction materials and electromechanical equipment can be transported to the subproject site either by helicopter or mules. Alternatively, the subproject site can be accessible by a blacktopped motorable road up to Salleri bazzar, headquarter of Solukhumbu district. From Salleri bazzar, there is a seasonal road up to Buksa which is 48 km and from Buksa the subproject site is accessible either by helicopter or by foot. Travel distance from road head from Buksa via Lukla to subproject site is approx. 65 km and requires 6 days for a loaded porter. From Lukla to Pangboche, it is approximately 35 km foot trail.

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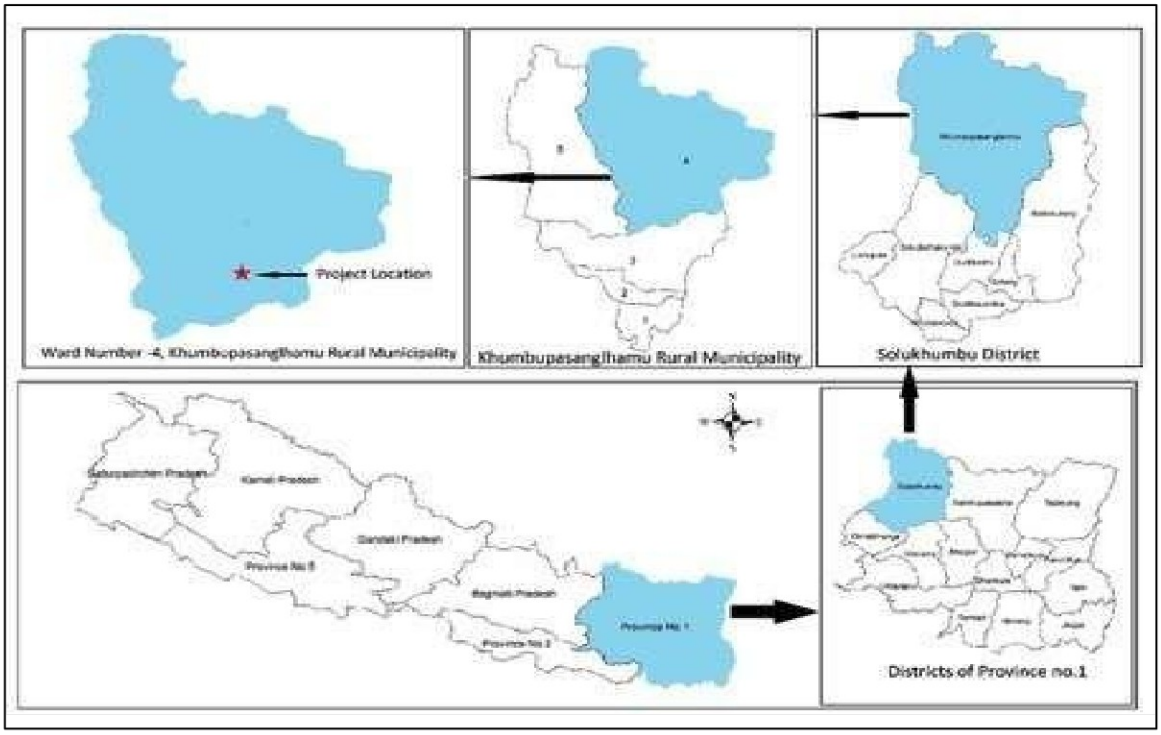
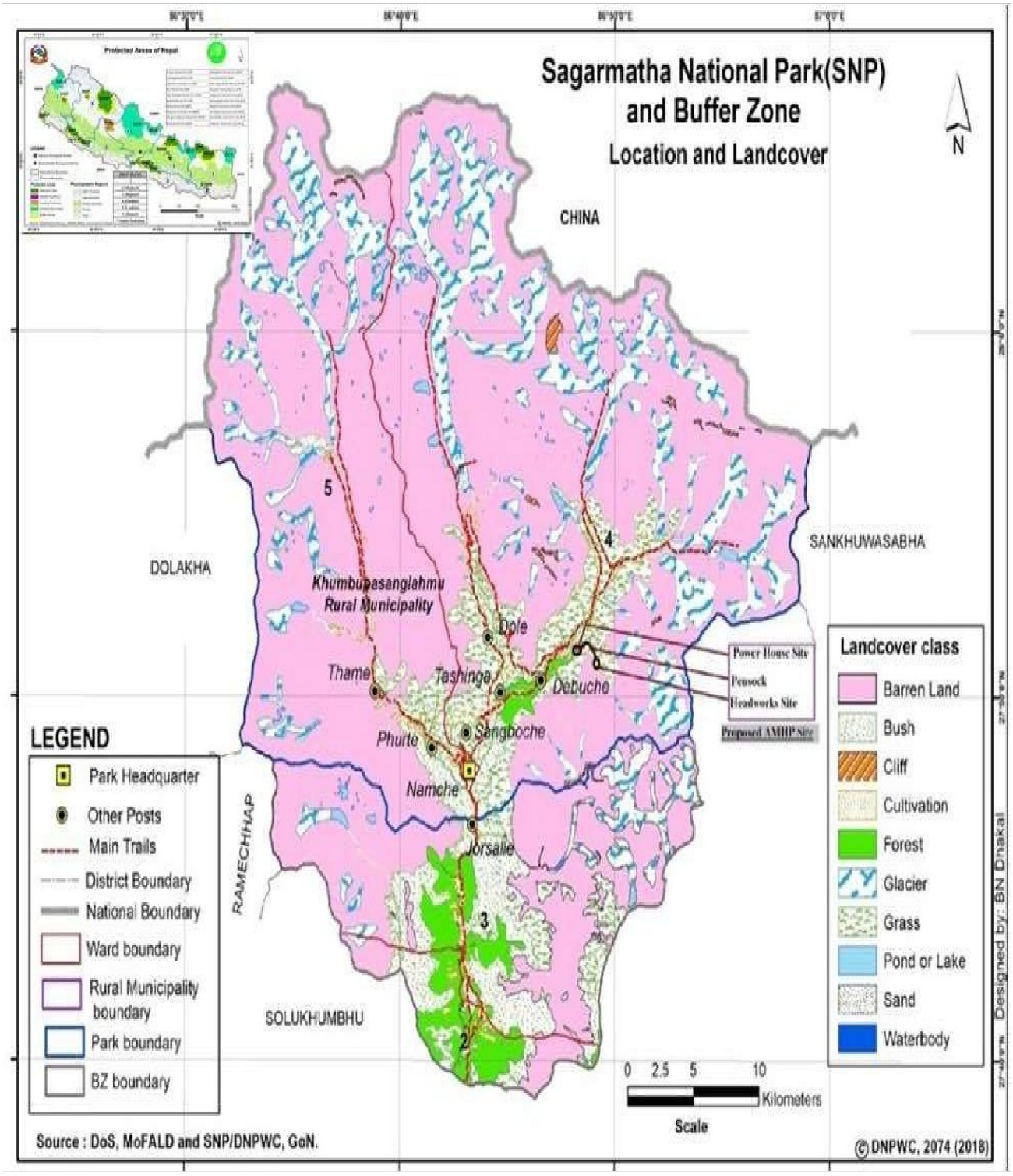
[4] *At least 50% of the available monthly discharge should be released to river/stream in order to generate electricity using river/stream in National Parks and Conservation area,*

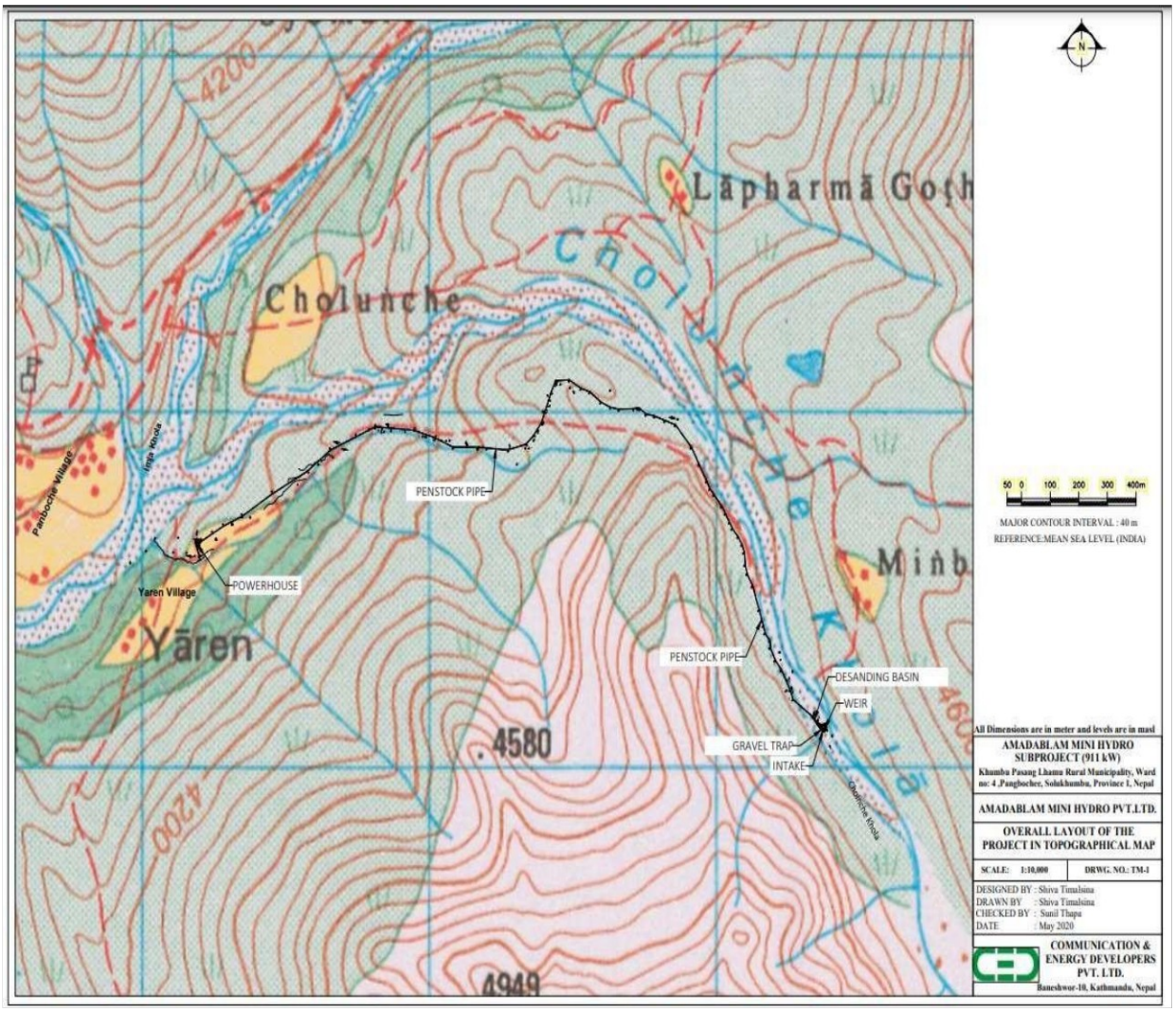


Map 1: Subproject Location in District Map (Shape file modified by CED)

Map 2: Subproject Location on Google Earth Map

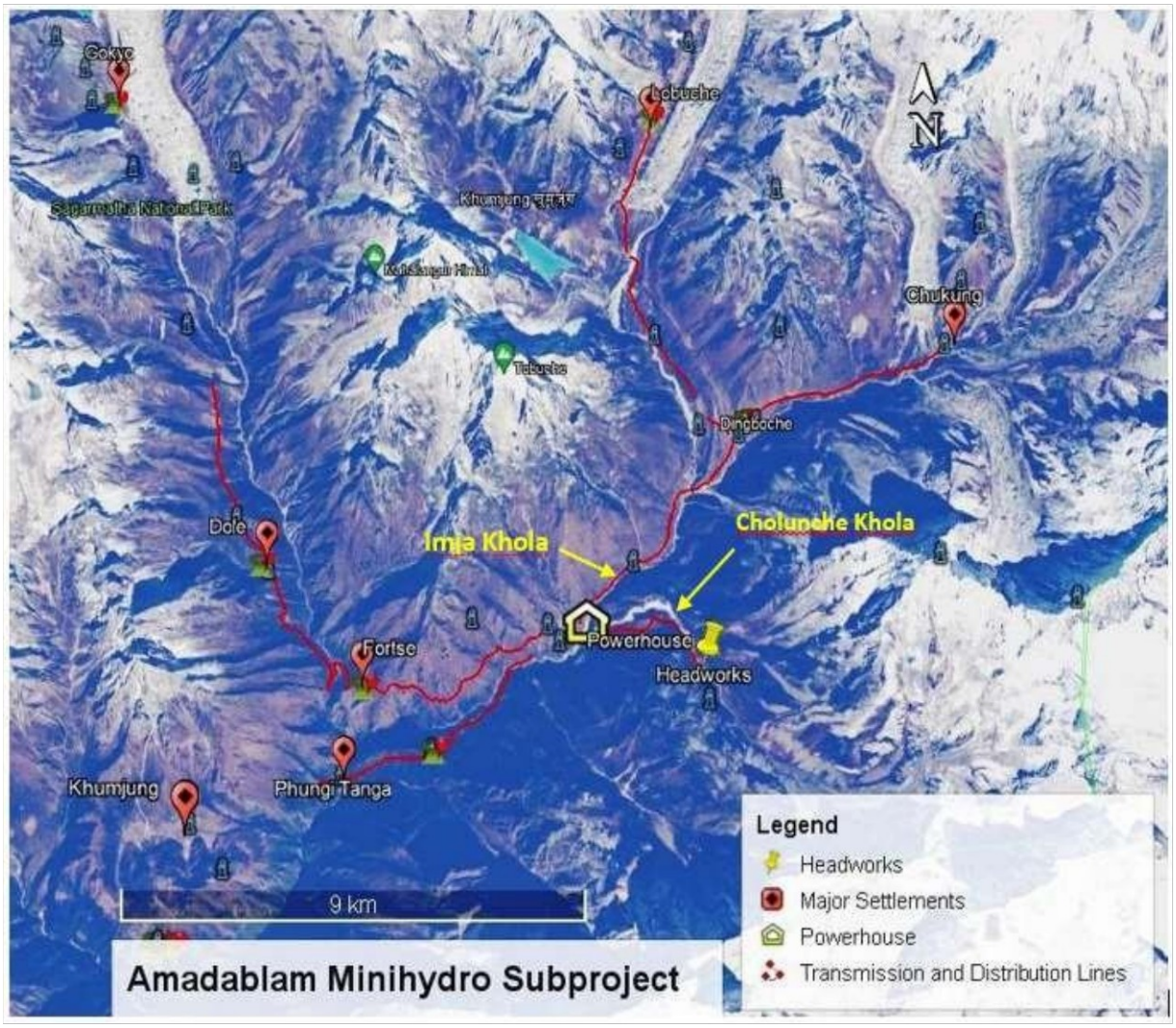


Map 3: Subproject Location within Sagarmatha National Park Boundary



Map 4: Subproject Location in Topographic Map

Map 5: Major Settlements in Ward No. 4 of Khumbu Pasanglhamu RM



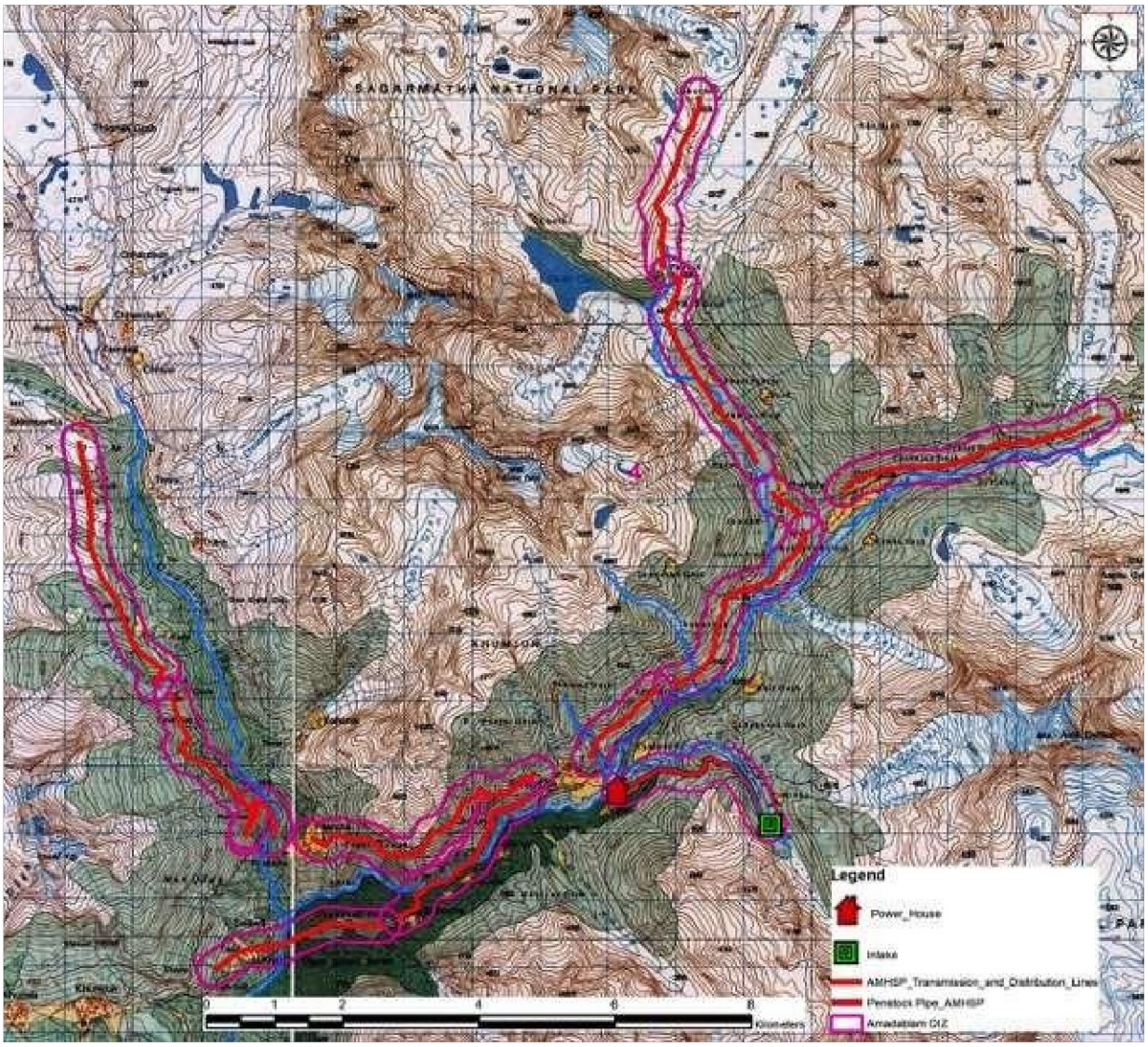
Map 6: Subproject Structure, Transmission and Distribution Lines

2.2.3 Subproject Area of Influence

The subproject area consisting of the subproject site and the area that will be impacted due to the construction and operation activities of the proposed subproject is defined as the Area of Influence (AoI). The AoI is classified into two areas - Direct Impact Zone (DIZ) and Indirect Impact Zone (IIZ) - based on the nature and the extent of the impact of construction and operation of subproject components.

2.2.3.1 Direct Impact Zone (DIZ) Construction & Operation

The DIZ of the Amadablam Mini Hydro Subproject area consists of the subproject structures and facilities that will be directly impacted due to the construction and operation of the subproject such as headworks, reservoir, powerhouse, penstock and T&D line. In terms of headworks and powerhouse, 100 m around the structure and in terms of penstock and T&D line 10 m around the structure will be taken as the Direct Impact Zone, all of which are in Ward No. 4, Map 7. The term "Core Subproject Area" is also used to imply the area fenced off for safeguarding of various structures and facilities as well as the area permanently acquired by the subproject. There is not any settlements and private properties in DIZ area of headworks, powerhouse and Pestock.



Map 7: DIZ of AMHSP

2.2.3.2 Indirect Impact Zone (IIZ)

The Indirect Impact Zone (IIZ) of Amadablam Mini hydro is the surrounding area around the DIZ, up to 10 m beyond the DIZ, where the indirect impact of the construction and operation activities occurs due to the movement of the workers, transportation of construction materials etc. These areas lie within the Ward No. 4 of Khumbu Pasanglhamu RM.

2.2.4 Nearby Communities and Forests, Environmentally Sensitive Areas, and Heritage Sites

The nearest settlement from powerhouse is Pangboche, which is approx.1.5 km away and mostly resided by Sherpa people. The presence of other caste/ethnic groups is negligible. Other settlements where power will be distributed are Chukhung, Debuche, Dingboche, Dole, Lawi-Schyasa, Mongla, Lobuche, Luza, Milingo, Mingbo, Mochhermo, Pangboche, Pheriche, Phortse, PhortseTenga, Mongla, Fhungi Tenga, Shomare, Thukla, Tyangboche and Worshyo. All the settlements lie in Ward No. 4 of Khumbu Pasanglhamu RM. All the areas within the Sagarmatha National Park (SNP), except private registered land, belong to the SNP, which is listed as the World Heritage Site under criteria (vii). There are 9 buffer zone user groups under Khumbihulya Buffer Zone User Committee in the subproject area. The

subproject might have direct impacts on the grassland as all the infrastructures lie in grassland area. The transmission and distribution lines will be underground along the foot trails, except in river crossing areas.

2.3 Salient Features

The salient feature of the proposed subproject is given in **Table 4.**

Table 4: Salient Feature of the Subproject

1	**Location**		
	Province	:	1
	District	:	Solukhumbu
	Rural Municipality	:	Khumbu Pasanglhamu Rural Municipality Ward No. 4
	Geographical Coordinates Latitude Longitude	:	27°50'50"N to 27°51'40"N latitude and 86°47'49"E to 86°49'19"E longitude
	Intake	:	27°50'56.52"N and 86°49'6.15"E, elevation 4422 masl
	Power House	:	27°51'12.98"N, 86°47'49.21"E, elevation 3951.18 masl
	Total Households to be Electrified		451
2	**General**		
	Name of River	:	Cholunche Khola
	Nearest Town	:	Namche Bazaar (13 Km)
	Type of Scheme	:	Run of River
	Gross Head	:	471.87 m
	Net Head		448.86 m

	Installed Capacity	:	911 KW
	Average Annual Energy	:	7,225,781.76 kWh
3	**Hydrology**		
	Catchment Area at Headworks Site	:	28 km^2 (Total), 21 km^2 (>5000 m) 7 km^2(5000 m< A> 4000 m)
	Design Discharge ($Q_{80\%}$)	:	0.25 m^3/s
	Design Flood (1 in 100 year)	:	15 m^3/s
	Compensation flow	:	50% of discharge at river every month*
4	**Diversion Weir**		
	Type	:	Concrete gravity type weir
	Length	:	12 m
	Height	:	2.57 m
	Crest level	:	El. 4423.57 m
5	**Reservoir (due to Diversion Weir)**		
	Surface Area	:	360 m^2
	Volume	:	493.2 m^3
	Average depth	:	1.37 m
	Average Width	:	12 m
	Average Length	:	30 m
6	**Undersluice**		
	Type	:	Rectangular Flat Gate
	Size	:	1.0 m x 1.3m
	Invert level	:	El. 4421.08 m
7	**Intake**		
	Type	:	Orifice type side intake
	No of Orifice	:	1 No.
	Size of Opening	:	1.5 m (B) x 0.3 m (H)
	Intake Invert Level	:	El. 4422.00 m
	Coarse Trashrack (1.4 m x 1.5 m)	:	0.7 m x 0.37 m (6 Pcs)
8	**Gravel Trap**		
	Size (L x B x H)		8 m x 1.5 m x 1.3 m
	Bed load size to trap		2 mm
	Fine Trashrack (2m x 1.5 m)	:	1m x 0.37 m (6 Pcs)
9	**Headrace Pipe**		
	Type	:	Pressurized pipe flow, MS
	Length	:	10 m
	Diameter	:	450 mm
	Thickness	:	6 mm
	Shape	:	Circular
	Type	:	Pressurized pipe flow
10	**Desanding Basin cum forebay**		

	Type	:	Conventional with head pond
	Size (L x B x H)	:	26.50 m x 2.65 m x 2.30 m
	Number of Bay	:	1 No.
	Nominal size of trapped particle	:	0.15 mm
	Fine Trashrack (2.65 m x 1.6 m)		0.82 m x 0.41m (10 Pcs)
11	**Trashrack heating system**	:	Heater 1 at desilting basin 4.5 kW Heater 2 at desilting basin 1.5 kW Heater 3 at gravel trap 3.0 kW
12	**Penstock Pipe**		
	Type	:	Mild Steel Pipe (Buried)
	Internal Diameter	:	400 mm dia
	Thickness	:	6 mm to16 mm
	Branch Pipe	:	MS 200 mm dia, 16 mm thick 16 m long
	Total Length of the pipe	:	2930 m length
	No of Anchor Block	:	58 Nos
12	**Powerhouse**		
	Type of powerhouse	:	Surface Type

	Size (L x B x H)	:	19.95 m x 7.0 m x 5.8 m
13	**Tailrace Conduit**		
	Type	:	Pipe and Canal
	Size (L x B x H)	:	18 m x 0.5 m x 0.68 m
	Pipe	:	MS 400 mm dia, 6 mm thick, 21 m long
	Turbine Axis Level	:	El. 3951.50 m
14	**Turbines**		
	Type	:	Horizontal Shaft Pelton Turbine Single Jet
	Number of Units	:	2
	Discharge per unit	:	0.125 m^3/sec
	Rated Output (Mechanical)	:	485 kW X 2 units
	Synchronous Speed	:	1500 rpm
	Rated Net Head	:	448.86 m
	Rated Efficiency at 100% Discharge	:	88%
15	**Generators**		
	Type	:	3-Phase, Synchronous, Brushless
	Rated Output Capacity per Unit	:	650 kVA
	Rated Efficiency	:	96%
	Frequency	:	50 Hz
	Rated Voltage	:	0.4 kV
	Number of Poles	:	4
	Speed	:	1500 rpm
	No of units	:	2 Nos.
16	**Governor**		
	Type	:	Electronic, PID Oil-hydraulic, self-closing without electric power
	No of units	:	2 Nos.
17	**Transformer**		
	i. Power Transformer		
	Type	:	ONAN Cooling, YNyn0, 3 phase
	Rated capacity	:	630 kVA
	Voltage ratio	:	0.4/11 kV
	Efficiency	:	98%
	No of units	:	2 Nos.
	ii. Distribution Transformer		
	Type		11/0.4 kV, 3-phase, oil immersed, copper owned AVR with parallel operation
	Rated Capacity	:	150 kVA- 2 Nos
			125 kVA- 2 Nos
			100 kVA- 4 Nos
			65 kVA-5 Nos

			50 KVA-1 No.
			Total 14 Nos.
18	**Transmission & Distribution line**		
	A. Single Line Distribution		64.45 km
	Total Length of 11 kV underground line (underground XLPE armored 3 core 35 sq. mm aluminum)	:	40.00 km
	Total length of 11 kV overhead line during river crossings (squirrel ACSR)	:	1.0 km
	1.1 kV 95 sq.mm. 4 Core XLPE Insulated Unarmoured Aluminium Cable	:	12.45 km
	1.1 kV 35 sq.mm. 4 Core XLPE Insulated Unarmoured Aluminium Cable	:	9.50 km
	1.1 kV 25 sq.mm. 2 Core XLPE Insulated Unarmoured Aluminum Cable	:	1.50 km
	B. Distribution Transformer		
	Type	:	Outdoor installation type
	Quantity required	:	Fifteen (15)
	Type of cooling	:	ONAN
	Number of phases	:	Three phase
	Frequency	:	50 Hz
	Rated voltage	:	
	1) Primary	:	11 kV
	2) Secondary	:	0.4 kV.
	Vector group symbol (by IEC designation)	:	Dyn11
	C. Major River Crossings		930 m
	Chukung	:	70 m
	Dingboche	:	50 m
	Thukla	:	170 m
	Power House	:	120 m
	Phortse	:	100 m
	Dole	:	70 m
	Luza	:	70 m
	Machhermo	:	80 m
	Milingo	:	100 m
	Fungi Tenga	:	100 m

	D. Poles for Overhead Transmission During Crossings		
	Type	:	Galvanized Mild Steel Tubular poles
	Total Length	:	9 m
	Bottom Section	:	5m long, outer diameter 165.1 mm, thickness 4.5 mm
	Middle section	:	2m long, outer diameter 139.7 mm, thickness 4.5 mm
	Top section	:	2m long, outer diameter 114.3 mm, thickness 3.65 mm
	Minimum weight	:	120 kg
	E. Sub-Station		
	Type	:	Pole mounted
	Total Sets	:	14
	Pole Type	:	Galvanized steel tubular poles
	Length of Poles	:	9 m
	F. Conductors		
	Type	:	ACSR Conductor (Weasel)
	Code Name	:	Weasel
	Nominal Aluminum Area, mm^2	:	30
	Specific Weight, kg/km	:	128
	Resistance, ohm/km	:	95 A
	Inductive Reactance	:	0.345
	G. Underground Cables	:	Poly Vinyl Chloride (PVC) insulated armored aluminum cable
	H. Distribution Box		
	Total Number	:	80
	Coordinate of DB (Lobuche)	:	X: 86.813247 °E;Y:27.957777 °N [North most]
	Coordinate of DB (Chukung)	:	X: 86.871694°E;Y: 27.904166°N [North-East Most]
	Coordinate of DB (Machhermo)	:	X: 86.715327°E;Y: 27.902013°N[North-West Most]
	Coordinate of DB (Lawi Schyasa)	:	X: 86.739166°E;Y: 27.830000°N [South Most]
	System	:	Double Door
	Size	:	L X B X H = 45 cm X 30 cm X 60 cm
19	**Switchyard**		
	Type	:	Indoor, Single Bus Configuration, 11 kV
	Dimension	:	3.55 m X 6.32 m
	Location	:	Inside Powerhouse
20	**Load Center**	:	Number of Consumers (HHs) (451 Beneficiary Households)
1	Chukung	:	12
2	Debuche	:	6
3	Dingboche	:	86
4	Dole	:	14
5	Fungi Tenga	:	11
6	LawiSchyasa	:	12

7	Lobuche	:	3
8	Luza	:	3
9	Mingbo	:	13
10	Machhermo	:	102
11	Pangboche	:	35
12	Pheriche	:	106
13	Phortse	:	3
14	PhortseTenga	:	9
15	Shomare	:	19
16	Thukla	:	2
17	Tyangboche	:	7
18	Worshyo	:	1
19	Mongla	:	7
21	**Power and Energy**		
	Type of Power Plant	:	Run-of-river
	Design Discharge	:	0.25 m^3/s
	Total Gross Head	:	471.87 m
	Rated Net Head	:	448.86 m
	Installed Capacity	:	911 kW
	Total Annual Energy	:	7,225,781.76 kWh
22	**Subproject Cost Estimate**		
	Total Subproject Cost with VAT and Provisional Sums and IDC	:	NRs. 618,901,638.89
	Subsidy (GoN/AEPC/MGEAP)		NRs. 128,307,000.00 (20.73%)
	Loan (WB/AEPC/MGEAP)		NRs. 366,814,311.11 (59.27%)
	Equity (ESCO)		NRs. 123,780,327.78 (20.00%)
	Cost Per kW	:	NRs. 679,365.14
	Net Present Value (@ 6% discount factor)	:	NRs. 245,613,643.75
	Subproject rate of return	:	11.21 %
	Payback	:	7.68 years
	BC Ratio	:	1.35