

**SUPPLEMENTARY  
ENVIRONMENTAL IMPACT ASSESSMENT (SEIA)  
OF  
UPPER MARSYANGDI-1 HYDROPOWER  
PROJECT (102 MW)**

**Submitted to  
Ministry of Forest and Environment  
Singhdurbar, Kathmandu**

**Through  
Ministry of Energy, Water Resources and  
Irrigation  
Singhdurbar, Kathmandu  
&  
Department of Electricity Development  
Sanogaucharan, Gyaneshwor, Kathmandu**

**Submitted by  
Upper Marsyangdi Hydropower Company Pvt. Ltd.  
Lalitpur Metropolitan City-3, Sanepa, Lalitpur**

**June 11, 2022**

**ABBREVIATION**

°C	Degree centigrade	ESU	Environmental and Social Unit
ACA	Annapurna Conservation Area	FM	Frequency Modulation
ACSR	Aluminum Conductors Steel Reinforced	GIS	Geographic Information System
AGTB	Above ground Tree Biomass	GLOF	Glacial Lake Outburst Flood
AGTC	Above ground Tree Carbon	GoN	Government of Nepal
B	Breadth	GWh	Gigawatt-hour
BA	Basal Area	H	Height
BOD	Biological Oxygen Demand	Ha	Hectare
BS	Bikram Sambat	HFT	Himalayan Frontal Thrust
CAMC	Conservation Area Management Committee	HH	Household
CBS	Central Bureau of Statistics	HPP	Hydropower Project
CF	Community Forest	Hz	Hertz
CFUG	Community Forest User Group	IDC	Interest During Construction
CITES	Convention on International Trade of Endangered Species of Wild Flora and Fauna	IUCN	International Union for Conservation of Nature
CR	Critically Endangered	IVI	Importance Value Index
CSP	Corporate Social Performance	KII	Key Informant's Interview
CSR	Corporate Social Responsibility	Km	Kilometer
D	Diameter	Kv	Kilovolt
DBH	Diameter at Breast Height	Kw	Kilowatt
DHM	Department of Hydrology and Meteorology	L	Length
DIA	Direct Impact Area	LPG	Liquefied Petroleum Gas
DNPWC	Department of National Parks and Wildlife Conservation	M	Meter
DoED	Department of Electricity Development	Masl	Meters above sea level
DPR	Detailed Project Report	MBT	Main Boundary Thrust
EHS	Environmental Health & Safety	MCT	Main Central Thrust
EIA	Environmental Impact Assessment	Mg/l	Milligrams per liter
EMP	Environment Management Plan	MHT	Main Himalayan Thrust
EMU	Environmental Monitoring Unit	Mm	Millimeters
EPA	Environment Protection Act	MoFE	Ministry of Forest and Environment
EPR	Environment Protection Regulation	MS-excel	Microsoft-excel
ESISU	Environmental and Social Implementation Sub-Unit	MW	Megawatt
ESMSU	Environmental and Social Monitoring Sub-Unit	N	North
		N/A	Not Applicable
		NBS	Nepal Biodiversity Strategy
		NEA	Nepal Electricity Authority
		NGO	Non-Governmental Organization
		NPHC	National Population and Housing Census
		NPR	Nepalese Rupee
		NTC	Nepal Telecommunication

NTFPs	Non-Timber Forest Products
NTNC	National Trust for Nature Conservation
ONAF	Oil Natural Air Forced
PAFs	Project Affected Families
PM	Particulate Matter
RCC	Reinforced Cement Concrete
RM	Rural Municipality
RMP	Resource Management Plan
RoR	Run of River
SCM	Supply Chain Management
SEIA	Supplementary Environmental Impact Assessment

Sp.	Species
STD	Sexually Transmitted Disease
TDS	Tax Deducted at Source
ToR	Terms of Reference
TSS	Total Suspended Solid
UM-1HPP	Upper Marshyangdi -1 Hydropower Project
UMPCPL	Upper Marshyangdi Power Company Private Limited
USD	United States Dollar
VAT	Value Added Tax
VDC	Village Development Committee
VU	Vulnerable

## कार्यकारी सारांश

### १. पृष्ठभूमि

अपर मर्स्याङ्दी -१ जलविद्युत आयोजना गण्डकी प्रदेशको लमजुङ्ग जिल्ला भएर बग्ने मर्स्याङ्दी नदीमा प्रस्तावित आयोजना हो। प्रस्तावक अपर मर्स्याङ्दी पावर कम्पनी प्रा.लि. ले विद्युत विकास विभागबाट २०६५/०४/१५ मा सर्वेक्षण अनुमति प्राप्त गरेपश्चात गरिएको सम्भाव्यता अध्ययनले १३८ मेगावाट क्षमता प्राप्त गर्न सकिने निकर्षण गरेकाले सोही अनुरूप यस आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनसमेत स्वीकृत भइसकेको थियो। अनुमतिपत्रमा उल्लेख भए अनुरूप सम्पूर्ण प्रक्रिया सम्पन्न गरी आयोजना सुरु गर्ने क्रममा प्रस्तावित आयोजनाको विद्युतगृहभन्दा तल अर्को प्रस्तावित अपर मर्स्याङ्दी ए जलविद्युत आयोजनाको बाँधक्षेत्रले प्रभाव पार्ने देखियो। यसकारण अपर मर्स्याङ्दी पावर कम्पनी प्रा.लि.ले विद्युतगृहलाई पहिलेको आयोजनाको सीमाभन्दा करिब १.२ किलोमिटर माथि सार्ने निर्णय गरियो र सोही अनुरूप पुनः विस्तृत अध्ययन गरियो। तर, यस अध्ययनले स्थापित क्षमता १०२ मेगावाटमात्र प्राप्त गर्न सकिने निकर्षण गरेकाले यसका आकार, संरचनाका प्रकार र स्थानमा परिवर्तन आएको छ। यसै परिवर्तनका कारण आयोजनास्थलका विद्यमान वातावरणको जानकारी संकलन गर्न, स्वीकृत वातावरणीय प्रभाव मूल्याङ्कनमा प्रस्तावित प्रभाव र हालको प्रभावलाई दाँज्न र उपयुक्त न्यूनीकरणका उपायहरू पहिचान गर्न यस पूरक वातावरणीय प्रभाव मूल्याङ्कन गरिएको छ। यसको लागि वन तथा वातावरण मन्त्रालयबाट मिति २०७७/१२/१३ मा अध्ययन अनुमति प्राप्त भएको थियो।

### २. प्रस्तावको परिचय

अपर मर्स्याङ्दी १ जलविद्युत आयोजना रन अफ रिभर (ROR) प्रकारको आयोजना हो जसको संरचनाहरू मर्स्याङ्दी गाउँपालिका वडा नं. ३ र ४ मा पर्दछ भने सुक्खाक्षेत्र सोही गाउँपालिकाको वडा नं. ५ र ६ मा पर्दछ। आयोजनाको सम्पूर्ण संरचनाहरू मर्स्याङ्दी नदीको दायाँ किनारामा अवस्थित रहने छन् जसमध्ये हेडवर्क्स क्षेत्र रामबजारमा रहने छ भने विद्युतगृह सिउरुडबेसीस्थित सिउरुडखोला र मर्स्याङ्दी नदीको सङ्गमस्थलमा रहने छ। आयोजनास्थल लमजुङ्गको बेसीसहरबाट खुदी, डादी हुँदै करिब २५ किलोमिटर कच्ची मोटरबाटो पार गरेपश्चात पुग्न सकिन्छ।

मर्स्याङ्दी नदीमा बाँध बाँधेर उक्त पानीलाई डिसिल्टिङ्ग बेसिनमा थिन्ग्राएर ५१४२.२८ मिटर लामो हेडरेस सुरुङ्गमार्फत सर्ज ट्याङ्कमा पुर्याई ४२६.८६ मिटर लामो पेनस्टक पाइपको सहायतामा विद्युतगृहमा झारी १०२ मेगावाट विद्युत उत्पादन गरिने छ र उक्त पानीलाई १९८ मिटर लामो टेलरेसद्वारा पुनः मर्स्याङ्दी नदीमा खसालिने छ। आयोजनाको निर्माण अवधि ४० महिना रहने छ र उक्त अवधिमा विद्युत उत्पादनसम्मका कार्यहरू गरिने छन्। यस कार्यपश्चात भने उत्पादित विद्युतलाई २२० के.भी. ट्रान्समिसन लाइनमार्फत करिब ६.५ किलोमिटर टाढा रहेको खुदी (तादी कुना) सबस्टेसनमा लगी जडान गरिने छ, जसका लागि छुट्टै वातावरणीय अध्ययन गरिने छ।

बाँध, हेडरेस सुरुङ्ग, सर्ज ट्याङ्क, पेनस्टक, विद्युतगृह, पहुँचमार्ग आदि संरचनाहरू नदीको दायाँ किनारामा अवस्थित रहने छ भने ठेकेदार र कामदारका लागि शिविरक्षेत्र र निर्माण सामग्री उत्खनन् का लागि प्रस्तावित खानीक्षेत्र नदीको बायाँ किनारामा रहने छ। आयोजना निर्माणका लागि दक्ष, अर्धदक्ष र अदक्ष गरी करिब १५०० कामदारहरूको आवश्यकता पर्दछ भने सन्चालन चरणमा करिब ५० कामदार आवश्यक पर्ने अनुमान छ। आयोजनाको लागत भने करिब ३३,३१४,९२८,११२.०० नेपाली रुपैयाँ अनुमान गरिएको छ।

### ३. अध्ययन विधि

यस वातावरणीय अध्ययनको क्रममा आयोजनास्थल रहने अन्नपूर्ण संरक्षण क्षेत्र र मर्स्याङ्दी गाउँपालिकाको भौतिक, जैविक, सामाजिक, आर्थिक तथा साँस्कृतिक तथ्यांकहरू संकलन गरिएको थियो। अध्ययनका लागि विभिन्न प्रकाशित र अप्रकाशित सन्दर्भसामग्री, चेकलिस्ट र प्रश्नावली आदिको सहायता लिइएको थियो भने विज्ञद्वारा अध्ययनस्थलको बृहत भ्रमण गरी जानकारी संकलन गरिएको थियो। भौतिक तथ्याङ्क पूर्व स्वीकृत वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन, सम्भाव्यता अध्ययन प्रतिवेदन र अनुकूलन अध्ययन प्रतिवेदन (२०२०) को बृहत अध्ययन गरी विज्ञद्वारा प्रत्यक्ष अवलोकनसमेतबाट संकलन गरिएको थियो। यसका साथै भू-गर्भ अध्ययनका लागि जियोलेजी अफ नेपाल हिमालय ( धिताल, २०१५) को सहायतामा विज्ञविमर्श लिइएको थियो भने उपयुक्त विधिका माध्यमबाट भू-उपयोग, हावापानी, ध्वनि आदि सम्बन्धी तथ्यांक संकलन गरिएको थियो। पानीसम्बन्धी अध्ययनका लागि ल्याबमा अनालाइटिकल टेस्टको सहायता लिएर अर्गानिक, ठोस र खनिज टेस्ट गरिएको थियो। उक्त क्षेत्रको ध्वनिको अवस्था थाहा पाउनका लागि भने मोबाइल डेसिमिटरको प्रयोग गरिएको थियो।

जैविक वातावरण अध्ययनका लागि आयोजनास्थलका वन्यजन्तु, वनस्पति र संरक्षण क्षेत्रसँग सम्बन्धित जानकारी संकलन गरिएको थियो। वन्यजन्तुको अध्ययन गर्दा तिनीहरूको बासस्थान, हिडडुलको अवस्था आदिका बारेमा प्रभावित क्षेत्रका व्यक्तिहरूसँग छलफल गरी जानकारी संकलन गरिएको थियो। आयोजनास्थल वरपर प्राकृतिक जंगल भएको कारणले सर्वेक्षण म्यानुअल (२०१९) का आधारमा स्याम्पल साइटहरूको पहिचान गरिएको थियो। उक्त क्षेत्रहरूमा १०० मिटर×१०० मिटरको ग्रिड बनाई प्रत्येक १०० मिटरमा १० मिटर× १० मिटर, ५ मिटर× ५ मिटर र १ मिटर×१ मिटरको वर्गाकार स्याम्पल प्लटहरू स्थापना गरिएको थियो। सो पश्चात वनस्पतिको हकमा उक्त प्लटहरूमा क्रमशः ठूला रुख, झाडीदार बुट्यान र झारपातको अध्ययन गरिएको थियो भने वन्यजन्तुको हकमा क्रमशः स्तनधारी र पंक्षी, सरीसृप र उभयचरहरू, र कीटपतङ्गका प्राचुर्यताको तथ्यांकहरू संकलन गरिएको थियो। अध्ययनका क्रममा वन्यजन्तुका दिसा, आखेटोपहर आदिको पनि जानकारी संकलन गरिएको थियो। यसका साथै जनावरको उपलब्धता, बासस्थानका द्वितीय जानकारी भने चराहरूका लागि इन्सकिप र इन्सकिपद्वारा सन् २०१६ मा लिखित नेपालका चराहरू, बराल र अन्यद्वारा सन् २०१९ मा लिखित अन्नपूर्ण संरक्षण क्षेत्रका स्तनधारी वन्यजन्तु, शाहद्वारा सन् २००४ मा लिखित नेपालका सरीसृप, विश्व

प्रकृति संरक्षण संघ र साइटिसद्वारा प्रकाशित अन्य सामग्रीको अध्ययन गरिएको थियो । वनस्पतिको अध्ययनका क्रममा भने आयोजनाका लागि हटाइनुपर्ने सम्पूर्ण रुखहरू संरक्षण क्षेत्र अधिकारी र स्थानीय सहायकको रोहवरमा प्रजाति पहिचान गरी संख्या गर्ने, गोलाई र उचाई नाप्ने आदि कार्यहरू गरिएको थियो। साथै, वनस्पतिको बासस्थानको अवस्था, संरक्षण अवस्था, उपलब्धता, प्रयोग आदिको बारेमा जानकारी संकलन गर्ने कार्यहरू गरिएको थियो।

सामाजिक, आर्थिक र सांस्कृतिक वातावरणको अध्ययनका लागि भने उक्त क्षेत्रको जनसंख्या, धार्मिक, सांस्कृतिक पूर्वाधार आदिको जानकारी संकलन गरिएको थियो। मुख्यतया प्रभावित क्षेत्रका बासिन्दाहरूसँग विविध प्रश्नावली प्रस्तुत गरी सो को आधारमा छलफलपश्चात मस्यौदा प्रतिवेदनको तयारी गरियो भने सो प्रतिवेदनलाई प्रभावित क्षेत्रको प्रतिनिधित्व गर्ने संघीय सांसद, प्रादेशिक सांसद सहितका विविध जनप्रतिनिधि, स्थानीय निकायका प्रतिनिधि एवं स्थानीय बासिन्दा तथा अन्य सरोकारवालाहरूको उपस्थितिमा मिति २०७८/०७/१२ गते सार्वजनिक सुनुवाई गरिएको थियो। सो सुनुवाईमा प्राप्त भएका सुझावहरूलाई समावेश गरी अन्तिम वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन तयार गरिएको थियो।

#### ४. प्रस्तावसँग सम्बन्धित नीति, कानून तथा मापदण्डहरू

यस आयोजनाको निर्माण र संचालन हुने क्रममा सम्बन्धित रहने विद्यमान ऐन, कानून, नीति, निर्देशिका आदिको अध्ययन गरी आवश्यक जानकारीहरूलाई यस परिच्छेदमा संलग्न गरिएको छ । विशेष गरी जलस्रोतको प्रयोग हुँदा सम्बन्धित रहने जलविद्युत विकास नीति २०५८, वातावरण संरक्षण नियमावली २०७७, वातावरण संरक्षण ऐन, २०७६, राष्ट्रिय निकुन्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ मा हालसम्म भएका संसोधनहरू र अन्नपूर्ण संरक्षण क्षेत्र व्यवस्थापन नियमावली, २०५३ का अतिरिक्त प्रस्तावसँग सम्बन्धित अन्य कानूनी सामग्रीको बृहत अध्ययन गरी आयोजनासँग सम्बन्धित प्रत्येक ऐन, नियमावली, कार्यनीति तथा रणनीति, मापदण्ड, अन्तराष्ट्रिय सन्धीहरूलाई संलग्न गरिएको छ ।

#### ५. विद्यमान वातावरणीय अवस्था

##### क. भौतिक वातावरण

अपर मस्यौडी १ जलविद्युत आयोजना गण्डकी प्रदेशको तल्लो हिमाली भेगमा रहेको छ जहाँ आउगन नेइस, ब्यान्डेड नेइस, सिष्ट, स्लेटजस्ता चट्टानका विभिन्न एकाईहरू पाइन्छन्। यी क्षेत्रमा परिवर्तित र पत्रे चट्टानहरूपनि रहेको पाइन्छ । प्रस्तावित हेडवर्क्स क्षेत्र माथिल्लो हिमालय टेक्टोनिक क्षेत्रमा पर्दछ भने विद्युतगृह तल्लो हिमालय टेक्टोनिक क्षेत्रमा पर्दछ । स्ट्राटम ५ किमी भन्दा मोटो रहेको हेडवर्क्स क्षेत्रमा आउगन गनेइस र क्वार्जको मात्रा बाक्लो रूपमा रहेको पाइएको छ भने विद्युतगृह क्षेत्रमा सिस्ट, स्लेट, फ्राइलाइट जस्ता चट्टान पाइन्छन् ।

प्रस्तावित आयोजना त्यस भेगको उचाईको आधारमा उपोष्ण देखि समशीतोष्ण जलवायु क्षेत्रमा पर्दछ । तिलिचो, ग्यान्गपू, थुलागी, पाँगो र पांगेरी, सुती, भिम्दाङ्ग, पुर्दी आदिजस्ता हिमतालबाट पग्लिएर आउने पानी नै मस्यौडी नदीको स्रोत हो । आयोजनास्थलमा मनसुनी समयमा औसत ६०० मिमि. र अन्य

समयमा औसत २७३ मिमि. वर्षा हुने गरेको पाइएको छ भने आयोजनास्थलबाट नजिक रहेको चामेस्थित जलवायु मापन केन्द्रको अभिलेख अनुसार उक्त क्षेत्रको उच्चतम तापक्रम २२.६ डिग्री सेन्टिग्रेड र न्यूनतम तापक्रम -५.३ डिग्री सेन्टिग्रेड रहेको पाइयो ।

यस क्षेत्रमा भूमिगत पानीलाई प्रदूषण गर्ने खालका उद्योगहरू नभएको कारण भूमिगत पानी प्रदूषण छैन र वायु प्रदूषण गर्ने खालका उद्योगहरू तथा उल्लेख्य मात्रामा ढुवानी तथा यातायातका साधन नभएकाले ध्वनिमा पर्ने प्रतिकूल असरहरू निकै कम देखिएको छ। जमिन प्रयोगको दृष्टिकोणले हेर्दा भने यस क्षेत्रमा मुख्यतया खोला किनार, जङ्गल, खेतीयोग्य जमिन र आवास क्षेत्र आदि रहेको पाइन्छ।

### ख. जैविक वातावरण

आयोजनाको सम्पूर्ण भू-भाग अन्नपूर्ण संरक्षण क्षेत्रमा पर्दछ भने यस क्षेत्रमा उपोष्ण र समशीतोष्ण हावापानीको बाहुल्यता रहेकै कारण मुख्यतया चिलाउने-कटुस प्रजातिको बाहुल्यता रहेको स्टेनटन (१९७२) को वर्गीकरण अनुसार देखिन्छ। यी प्रजातिका साथै अन्य प्रजातिमा भने उत्तिस, सिमल, शिरीष आदि पर्दछन्। यस क्षेत्रमा पाइने प्रजातिहरूमध्ये सुक्खा क्षेत्र र बाँधभन्दा माथिका केही क्षेत्रमा लोपोन्मुख रुख उनीउ पाइन्छन्। यद्यपी, कटान गर्ने क्रममा भने रुख प्रजाति मात्र नभएर त्यसमा आश्रित सुनाखरी, झ्याउ र लहरा प्रजातिहरू पनि प्रभावित हुने देखिन्छ।

अन्नपूर्ण संरक्षण क्षेत्र जैविक विविधताले निकै भरिपूर्ण रहेको छ। जैविक विविधताको सन्दर्भमा कुरा गर्दा बराल (२०७५) का आधारमा संरक्षण क्षेत्रभित्र १,३५२ प्रजातिका वनस्पति, १२८ प्रजातिका स्तनधारी, ५१४ प्रजातिका चराचुरुङ्गी, ३४८ प्रजातिका पुतली, ४० सरीसृप र २३ प्रजातिका उभयचरहरू पाइन्छन्। यीमध्ये आयोजनास्थलमा भने सर्वेक्षणका आधारमा १७ प्रकारका माछा, २० प्रकारका स्तनधारी, १९ प्रकारका चराचुरुङ्गी र ७ प्रकारका सरीसृप पाइएका छन्। यीमध्ये केही प्रजातिहरू नेपाल सरकार र विश्व प्रकृति संरक्षण संघको संरक्षण सूची र CITES को अनुसूचीमा समेत पर्दछन्। यी प्रजातिहरूलाई यिनै सूचीहरूमा संरक्षण अवस्थासहित प्रस्तुत गरिएको छ। वातावरण संरक्षणमा खेप्नुपर्ने चुनौतीहरूका सन्दर्भमा जङ्गल क्षेत्र अतिक्रमण, जंगली जनावरहरूको वासस्थानको क्षति, वन विनाश, जैविक विविधतामा असर, वन पैदावर वस्तुहरूको अधिक प्रयोगका साथै डढेलो आदिजस्ता जानकारी प्रस्तुत गरिएका छन्।

### ग) सामाजिक तथा आर्थिक वातावरण

यस आयोजनाको कार्यान्वयनबाट मर्स्याङ्दी गाउँपालिकाको वडा नं. ३, ४, ५ र ६ प्रभावित हुनेछन्। यस आयोजनाबाट मुख्य प्रभावित क्षेत्रहरूमा रामबजार, घेर्मु, मिप्रा, सिउरुडबेसी, अर्खलेबेसी, ठूलीबेसी, थाकन र थाकनबेसी रहेका छन्। आयोजना निर्माणका क्रममा निजी घरजग्गा अधिग्रहण गर्नुपर्ने भू-भाग प्राय उपरोक्त वडाहरूकै बासिन्दाका पर्दछन्। उल्लिखित प्रभावित घरधुरीको संख्या ९० रहेको छ भने विस्थापित हुने घरहरू १४ वटा रहेका छन्। वि. सं. २०६८ को जनगणना अनुसार गाउँपालिको प्रभावित ४ वडाहरूमा बसोबास गर्ने कूल जनसंख्या ९,५९० रहेको छ जसमा पुरुष ४,४५५ र महिला ५,१३५

रहेका छन्। यस क्षेत्रमा मुख्यतया गुरुङ्ग जातिका मानिसहरूको बसोबास रहेको छ भने यसका अलावा तामाङ्ग, क्षेत्री, ब्राह्मण आदि जातका मानिसहरू पनि बाक्लै रूपमा रहेका छन्। बौद्ध धर्मावलम्बीहरूको बाक्लो बासस्थान रहेको यहाँको समुदायमा हिन्दु धर्म मान्नेहरूको पनि बसोबास रहेको पाइन्छ। यस क्षेत्रमा बसोबास गर्ने समुदायहरू मुख्य गरी वैदेशिक रोजगारी, पर्यटन, खेती, व्यापार तथा पशुपालनमा संलग्न रहेका छन्। प्रख्यात क्षेत्र चामे र मनाङ्ग जाने पर्यटकहरू यही क्षेत्र हुँदै प्रस्थान गर्ने भएकाले होटेल सञ्चालक, गाइड र सहयोगीका पेशा धेरैले अँगालेको पाइन्छ। यस क्षेत्रमा लगाइने प्रमुख बालीनालीहरूमा धान, मकै, गहुँ अन्न बालीको रूपमा तथा आलु, तोरी, सिमी र अन्य फलफूलहरू नगदे बालीको रूपमा लगाइने गरेको छ। साधारणतया, कृषिजन्य क्रियाकलाप तथा घरपालुवा चौपाया पालनहरू नै प्रायः परिवारहरूको प्रमुख आयको श्रोत रहेको छ। सूचना आदानप्रदानको लागि यस ठाउँमा नेपाल दूरसंचार कम्पनी र एनसेलले संचार सुविधा उपलब्ध गराएको छ।

आयोजनाको सीमाभित्र मर्स्याङ्दी पानीलाई उपयोग गरी कुनैपनि सिंचाई तथा आयोजनाहरू सञ्चालन गरिएको पाइएन। साथै आयोजना क्षेत्रभित्र पानीको प्रयोग गरी व्यवसायिक रूपमा मनोरन्जन प्रयोजन छैनन् र माछा मारेर मात्रै जिविकोपार्जन गर्ने परिवारहरू पनि यस क्षेत्रमा रहेको पाइएन। आयोजनाभन्दा माथि रहने स्याङ्गे क्षेत्रमा बायाँ किनारमा अन्त्येष्टी घाट रहेको छ भने बाँकी रहने सुक्खा क्षेत्रमा पनि बौद्ध धर्मावलम्बीहरूको अन्त्येष्टी गर्ने गरेको पाइन्छ।

#### ६. प्रस्तावको विकल्प विश्लेषण

यस आयोजनाका प्रस्तावित विकल्पहरू आयोजनाको सम्भाव्यता, कार्य सञ्चालन, आर्थिक पक्ष, निर्माण र वातावरणीय दृष्टिको आधारमा मूल्याङ्कन गरिएको थियो। विकल्पहरूको विश्लेषण गर्दा मुख्यतया आयोजना निर्माणको स्थल, डिजाइन, प्रविधि, कार्यविधि, प्रक्रिया, समय तथा अन्य ऊर्जासँगको तुलनात्मक अध्ययन गरिएको थियो। देशमा विद्यमान रहेको ऊर्जा संकट न्यूनीकरण र स्थानीय बासिन्दाको विकासको उत्कृष्ट अभिलाषा पूर्तिमा आयोजनाले प्रत्यक्ष फाइदा पुर्याउने भएकाले आयोजना नबनाउने विकल्पमा प्रवेश गरिएन। साथै स्थानीयले दक्षताका आधारमा निर्माण र सञ्चालन चरणमा विभिन्न कार्यमा संलग्न हुने अवसर प्राप्त गर्ने भएकाले यस आयोजनाका कारण सामाजिक, आर्थिक अवस्था सुदृढ हुने सम्भाव्यता समेत प्रबल पाइयो।

#### ७. प्रस्तावको कार्यान्वयन गर्दा वातावरणमा पर्ने प्रभाव

##### क) सकारात्मक प्रभावहरू

आयोजनाको कार्यान्वयनबाट स्वच्छ ऊर्जा उत्पादन भई जैविक वातावरणको संरक्षणमा टेवा पुर्याउंछ भने सामाजिक र आर्थिक वातावरणमा पनि भौतिक पूर्वाधार र आयआर्जनमा वृद्धि हुन गई उल्लेख्य रूपमा सकारात्मक प्रभाव पर्ने देखिन्छ। यस आयोजना निर्माण, सञ्चालन तथा मर्मत संभारको क्रममा उपलब्ध भएसम्म आवश्यक पर्ने दक्ष, अर्धदक्ष तथा अदक्ष जनशक्ति स्थानीय र प्रादेशिक क्षेत्रबाट नै परिपूर्ति भई सो क्षेत्रको बासिन्दाको आर्थिक स्थितिमा सुधार हुने देखिन्छ। यस आयोजना अवधिभर



कार्यरत रहने कामदारहरूको माग बमोजिम खाजा घर, चिया पसल आदिको सन्चालनले स्थानीय उत्पादनले बजार पाउनुका साथै स्थानीय समुदायमा आय आर्जन वृद्धि हुने देखिन्छ। यसले स्थानीय बासिन्दाहरू रोजगारीका लागि गाउँघरबाट टाढा धाउनुपर्ने अवस्थाको अन्त्य गर्न सहयोगी भूमिका निर्वाह गर्नेछ। यस आयोजनाको निर्माणले आयोजना क्षेत्रमा घरेलु तथा साना उद्योग स्थापना तथा सञ्चालनको सम्भावना बढाउनुको साथै उक्त विकासबाट स्थानीय स्तरको राजश्व पनि वृद्धि हुन सक्ने देखिन्छ। यसै गरी यस आयोजनाले राष्ट्रिय राजश्व र स्थानीय आयमा समेत योगदान पुऱ्याउने छ। स्थानीय कामदारहरूको सीप विकास भई नागरिक सीप प्रवर्द्धनमा मद्दत पुग्नेछ।

## ख) नकरात्मक प्रभावहरू

### भौतिक तथा रासायनिक वातावरण

अपर मस्यार्ङ्दी १ जलविद्युत आयोजना निर्माण तथा सञ्चालनका समयमा स्थायी र अस्थायी रूपमा जमिनको आवश्यकता पर्दछ। आयोजना निर्माणको लागि खन्ने, भिरालो भाग काट्ने र मिलाउने काम गर्दा आयोजना स्थलको भू-बनोटमा साथै प्रयोगमा पनि केही परिवर्तन हुन सक्नेछ। आयोजनाको लागि आवश्यक पर्ने निर्माण सामग्री ढुवानीका लागि प्रयोग गरिने सवारी साधनका कारण वायु प्रदूषण, ध्वनि प्रदूषणका सम्भावना रहने देखिन्छ।

बाँध बाँधेर जमाएको पानी विद्युत उत्पादनमा प्रयोग हुने हुँदा बाँधस्थल देखि विद्युतगृहसम्मको खोलाको संरचनामा परिवर्तन हुने देखिन्छ। निर्माणको चरणमा विभिन्न क्षेत्रबाट उत्पादन हुनसक्ने ठोस, तरल एवं रासायनिक फोहोर व्यवस्थापनमा ध्यान नदिइएको खण्डमा उक्त फोहोरले त्यस क्षेत्रको वातावरणमा नकरात्मक असर पार्न सक्दछ। सन् २०१४ मा स्वीकृत भएको वातावरणीय प्रभाव मूल्याङ्कनमा पहिचान गरिएका असरबाहेक केही क्षेत्रहरूमा भू-क्षय र पहिरोका सम्भावना पनि रहेको देखिन्छ।

### जैविक वातावरण

आयोजनाका लागि प्रयोग हुने ३.४९ हेक्टर स्थायी र १२ हेक्टर अस्थायी जङ्गल, १६.४८ हेक्टर खोला तथा किनारा क्षेत्रका कारण उक्त क्षेत्रको भू-उपयोगमा परिवर्तन हुने देखिन्छ। आयोजना क्षेत्रभित्र रहेको विभिन्न प्रजातिको करिब ३४७ रुख, ३८१ बल्लाबल्ली तथा ७८ साना रुखहरू काट्नुपर्ने देखिन्छ। निर्माण कार्यले गर्दा खोलाको पानी फोहोर हुनसक्ने र सञ्चालनको बेलामा बाँध देखि विद्युतगृहसम्मको क्षेत्रमा पानी कम हुने हुँदा जलचरहरूको बासस्थानमा केहि प्रतिकूल प्रभाव पर्न सक्ने देखिन्छ। कामदारहरूबाट पनि जङ्गल क्षेत्रमा काठ दाउरा संकलन तथा खोलामा माछा मार्ने कार्यहरू हुन गई जैविक वातावरण क्षेत्रमा नकरात्मक प्रभाव पर्ने सम्भावना पनि रहन्छ।

### सामाजिक तथा आर्थिक वातावरण

यस आयोजनाको लागि केही निजी जमिन समेत अधिकरण गर्नुपर्ने हुन्छ। यसमध्ये ८.३७ हेक्टर खेतीयोग्य जमिन, १.७२ हेक्टर घर घडेरी र ०.४६ हेक्टर बाँझो जमिन अस्थायी रूपमा आवश्यक पर्दछ भने २.७१ हेक्टर खेतीयोग्य जमिन, ०.२१ हेक्टर घर घडेरी र ०.५३ हेक्टर बाँझो जमिन

स्थायी रूपमा प्रयोग हुने देखिन्छ। यसरी आयोजनाका लागि जमिन अधिग्रहण गर्दा ९० जना जग्गाधनीहरूको जग्गा प्रयोग हुँदा १४ घर टहरा हटाउनुपर्ने देखिन्छ। आयोजना निर्माणका लागि आवश्यक जनशक्तिको व्यवस्थापन गर्दा केही बाह्य कामदारहरूपनि सो क्षेत्रमा प्रवेश गर्ने भएकाले तिनीहरूबाट जाँड-रक्सी सेवन हुँदा झै-झगडा एवं होहल्लाका घटना हुनगई सामाजिक तथा साँस्कृतिक वातावरणमा असर पर्ने देखिन्छ। आयोजना क्षेत्र आर्थिक दृष्टिकोणले त्यति सम्पन्न नरहेको अवस्थालाई मध्यनजर राख्दा निर्माणको अवधिमा बालश्रमको दुरुपयोग समेत हुनेसक्ने सम्भावना देखिन्छ।

#### ८. प्रभाव न्यूनीकरणका उपायहरू

यस आयोजना निर्माण, सञ्चालन तथा मर्मतसंभार गर्दा जलविद्युत तथा वातावरणसम्बन्धी राष्ट्रिय नीति, नियम, निर्देशिका अनुसार गरिने छ। यस वातावरणीय अध्ययन प्रतिवेदनले प्रस्तावित आयोजना कार्यान्वयन गर्दा उत्पन्न हुने वातावरणीय प्रभावहरूको पहिचान गरी विभिन्न नकरात्मक प्रभाव न्यूनीकरण तथा सकारात्मक प्रभाव बढोत्तरीका उपायहरू प्रस्ताव गरेको छ। भौतिक वातावरणमा आयोजनाका मुख्य स्थानहरूमा नदीको तट संरक्षणका लागि ग्याबियन वाल निर्माण गर्ने, निर्माणका समयमा निस्कने फोहोर (muck) उचित स्थानमा व्यवस्थापन गर्ने, बाँधको तल्लो तटीय क्षेत्रमा प्राकृतिक बहाव कायम गर्ने, सवारीसाधनको प्रदूषण परीक्षण र मर्मतसंभार गर्न आदिजस्ता उपायहरू प्रस्ताव गरिएका छन्। जैविक वातावरणमा पर्ने प्रतिकूल असर न्यूनीकरणका लागि १ रुख काटे बराबर २५ रुख रोपी हुर्काई पाँच वर्षपछि सम्बन्धित निकायलाई हस्तान्तरण गर्ने तथा विभिन्न जनचेतना सम्बन्धी कार्यक्रम कार्यान्वयन गर्ने लगायतका उपायहरू प्रस्ताव गरिएका छन्। सामाजिक, आर्थिक र साँस्कृतिक वातावरणमा पर्ने असरहरूको न्यूनीकरणका लागि प्रभावित स्थानीयलाई आर्थिक सुदृढीकरणका उपाय अपनाउने, क्षतिपूर्ति दिने, स्वास्थ्य तथा सुरक्षाबारे जनचेतना बढाउने, पूर्वाधार निर्माणमा सहयोग गर्ने, सामाजिक सुरक्षाको प्रत्याभूति दिलाउन सहयोग गर्ने आदि कार्यहरू प्रस्ताव गरिएका छन्। जमिन बापत क्षतिपूर्ति, नकरात्मक प्रभाव न्यूनीकरणका उपायहरू, सामाजिक उत्तरदायित्व, वातावरण अनुगमन तथा परीक्षण लगायत सम्पूर्ण वातावरणीय प्रभावहरूको न्यूनीकरण तथा अभिवृद्धिका लागि ने. रु. ८१६,७१८,४६२.४ प्रस्ताव गरिएको छ जुन आयोजनाको कूल लागतको २.५१ प्रतिशत रहेको छ।

#### ९. वातावरणीय व्यवस्थापन योजना

भौतिक, जैविक, सामाजिक, आर्थिक तथा साँस्कृतिक वातावरणमा पर्ने प्रभावको न्यूनीकरणका उपायहरू कार्यान्वयन गराउनका लागि वातावरणीय व्यवस्थापन योजना तर्जुमा गरिएको छ। यस योजनामा आयोजना व्यवस्थापनका लागि आवश्यक संरचना, अनुगमन योजना र असर न्यूनीकरणसम्बन्धी अन्य कार्यक्रमहरू रहेका छन्। आयोजना प्रवर्द्धकनै वातावरणीय व्यवस्थापन योजना कार्यान्वयन गर्ने निकाय भएकाले यसले दैनिक कार्यहरूको व्यवस्थापन गर्ने, वातावरणीय समस्याको अन्तिम निर्णय गर्ने, स्थानीयको समस्या सम्बोधन गर्ने आदि कार्य गर्नुपर्ने हुँदा सो को लागि ठोस वातावरणीय व्यवस्थापन योजना बनाई

कार्यान्वयनका लागि संयन्त्रसमेत प्रस्ताव गरिएको छ। यी कार्यहरू व्यवस्थापन गर्नाका लागि बनाइने वातावरण तथा सामाजिक व्यवस्थापन इकाई, निर्माण चरणमा गरिनुपर्ने व्यवस्थापन योजना, सम्बन्धित निकायहरूको दायित्व र कार्यसमयसम्बन्धी विस्तृत जानकारी यस वातावरणीय व्यवस्थापन योजनामा समावेश गरिएको छ।

#### १०. वातावरणीय परीक्षण

वातावरणीय परीक्षण गर्नुको मुख्य उद्देश्य भनेको यस अध्ययन प्रतिवेदनले पहिचान गरेका विभिन्न असर वा जोखिमहरूको उचित न्यूनीकरण भए नभएको एकिन गर्नु र वातावरणीय व्यवस्थापन योजना अनुरूप कार्य भए नभएको परीक्षण गर्नु हो। यसमा प्रारम्भिक अवस्थाको अनुगमन, प्रभाव अनुगमन र नियमपालन अनुगमनका बारेमा जानकारीहरू दिइएको छ। साथै, अनुगमनका प्रकार, क्षेत्र, विधि, सूचक र जिम्मेवार निकाय समावेश गरिएको अनुगमन संयन्त्र प्रस्तुत गरिएको छ। यस अनुगमन संयन्त्रले भौतिक, जैविक, सामाजिक, आर्थिक र सांस्कृतिक वातावरणमा पार्ने असरहरूलाई कुन समयमा कसले कसरी परीक्षण गर्ने कुरालाई प्रष्ट पार्छ।

#### ११. निष्कर्ष

यस आयोजनाको मुख्य उद्देश्य प्राकृतिक स्रोतको दिगो प्रयोग गरेर जलविद्युत उत्पादन गरी देशको अर्थतन्त्रमा टेवा पुऱ्याउनु नै हो। आयोजना कार्यान्वयन गर्दा आयोजनाको सकारात्मक पक्षका साथै प्रतिकूल वातावरणीय असरहरू पनि पर्ने भएकाले उक्त असरहरूको पहिचान, विश्लेषण गरी न्यूनीकरणका उपायहरू यस प्रतिवेदनमा प्रस्तुत गरिएको छ। यस अध्ययन अनुसार आयोजनाले पार्ने नकारात्मक प्रभावहरू सकारात्मकका तुलनामा न्यून रहेका छन् र ती प्रभावहरू न्यूनीकरण गर्न सकिने नै हुँदा अपर मर्स्याङ्दी १ जलविद्युत आयोजना कार्यान्वयन गरिनु उपयुक्त देखिएको छ। यसका साथै आयोजना प्रस्तावक पूरक वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा उल्लेख गरिएका न्यूनीकरणका सम्पूर्ण उपायहरूलाई अपनाएर आयोजना सम्पन्न गर्न प्रतिबद्ध छ।

## Executive Summary

### 1. Background

Upper Marshyangdi -1 Hydropower Project (henceforth referred as UM-1 HPP) is proposed in Marshyangdi River flowing through Lamjung District in Gandaki Province of Nepal. The proponent Upper Marshyangdi Power Company P. Ltd. obtained the survey license from Department of Electricity Development (DoED) on April 16, 2010 and the feasibility study was conducted accordingly which confirmed the project to be of 138 MW installed capacity. Environmental Impact Assessment (EIA) carried out on the basis of feasibility study was already approved from the Ministry of Forests and environment. After fulfilling the requirements of the survey license within the stipulated period, Upper Marshyangdi Power Company Pvt. Ltd. initiated further steps for developing the project. The project was stalled due to the overlap between UM-1HPP's licensed powerhouse with the reservoir of the Upper Marshyangdi A hydropower Project lying downstream of the proposed project. To separate the licensed survey area of the both projects, proponent re-developed the project and shift powerhouse location 1.2 km upwards than the previous project boundary. Based upon the updated feasibility study report prepared, the capacity of the project has been reduced to 102 MW from 138 MW. Not only the capacity, project boundary, locations of the project structures and other project designs has been changed. So, to integrate baseline environmental conditions, compare the impacts between approved EIA and recent Supplementary EIA, and to propose adequate mitigation measures to those impacts, this study has been carried out. The license to undergo Supplementary EIA was issued by Ministry of Forests and Soil Conservation on 13<sup>th</sup> Chaitra 2077 (26<sup>th</sup> March, 2021).

### 2. Introduction of Proposal

Upper Marshyangdi -1 Hydropower Project is a Run of River (ROR) typed with its major project components lying in ward 3 and 4 and dewatered zone lying in ward 5 and 6 of Marshyangdi Rural Municipality (RM). All the structures of the project are proposed on the right bank of Marshyangdi river, where headworks lies in Rambazar and powerhouse will be located at the assemblage of Siurung Khola and Marshyangdi river in Siurungbesi. The project site lies at a distance of 25 km from Besisahar of Lamjung via Khudi and Nyadi.

A diversion weir is proposed in Marshyangdi River which will divert the water into 5142.28 m long headrace tunnel reaching to the Surge Chamber. A Penstock pipe of length 426.86 m will descend the water from Surge Chamber reaching to the Powerhouse, which will generate an electricity of 102MW and after the generation, the water will re-discharge to Marshyangdi River with the help of a 198 m long tailrace. The project construction period is expected to be 40 months and the electricity generated there forth is transmitted to Khudi (Tadi Kuna) substation with the help of a 6.5 km long 220 KV transmission line. A separate environmental study will be conducted for the transmission line.

Intake, Desilting basin, tunnel, is situated in the right bank of the Marshyangdi river. The main components of the project are diversion structures, powerhouse, tunnel, and approaching motorable road. Apart from that, storage area for construction materials, staff residential area, muck disposal areas are also the project components. Other project infrastructures include internal access road to project components, contractors and labor colonies, muck area, construction materials (crushers, collection area, area for cement mixing equipment) will be located around the headworks and powerhouse area. During project construction, it has been estimated that about 1500 skilled, semiskilled and unskilled labor force will be required daily and during operation maximum 50 workers will be required for the project. The total project cost is estimated to be NRs. 33,314,928,112.00

### **3. Study Methodology**

The baseline information related to the physical, biological, socio-economic and cultural environment of the project area were collected during this environmental study. Various published literatures related to hydropower projects and project area were reviewed along with the unpublished design reports, municipality and RM profile, map and photographs etc. The relevant legal provisions, EIA Guidelines and manuals, approved ToR, feasibility study reports and previously prepared EIA report of Upper Marshyangdi -1 Hydropower Project were thoroughly reviewed. The secondary information regarding geology were obtained from Geology of Nepal Himalayas (Dhital, 2015) and primary information regarding land-use, climate, sound, water, etc. were collected applying suitable methodologies. Analytical tests were performed for the presence and identification of organic, solid and mineral tests in water. Mobile decimeter was used for the collection of information on noise within the project area.

For the study of biological environment of the project area, suitable methodologies were adopted and information on Annapurna Conservation Area, wild flora and fauna, their presence, distribution and habitat were collected and analysed. A Field Manual published by the Forest Research and Training Centre in 2019 was followed for the sampling methodologies and scientific study of the vegetation within the study area and accordingly, stratified systematic cluster sampling design was applied for the vegetation study. A total of 6 sample plots were identified in the project area. A 100 m × 100m grid was applied at an interval of 100 meter. Within the grid, a 10m×10m square sample plot was deployed and the tree species lying inside the plot was listed and inventoried. Within the same square plot, the mammalian presence was studied with the help of their scars on trees, furs and pellets inside the plot. A 5m×5m square plot was deployed for the shrub species and 1m×1m square plot was deployed for the herbs. They were inventoried and along with this, the study of droopings, pellets, nails, faeces, etc of reptiles and amphibians were carried out within those square sample plots. Herpetofauna of Nepal (Shah & Tiwari, 2004), Birds of Annapurna Conservation Area (Baral, 2018), Birds of Nepal (Inskipp and Inskipp, 2016), etc. were consulted for the identification of faunal species and Flowering Plants of Nepal (RajBhandari et.al.,2019) was consulted for the identification of plant species. Along with this, the enumeration of plants to be felled down were carried out in presence of Conservation Area officials and a local guide. The information regarding their habitat, conservation status, abundance and ethno-medicinal uses were noted down.

The study of socio-economic and cultural environment was carried out to collect information on population, religion, cultural practices, economic status and other aspects of the society. The project affected families were identified and interviewed and along with this, a draft SEIA report was prepared. A Public hearing was conducted on 29<sup>th</sup> October, 2021 in the presence of representatives from central government, provincial government, schools, hospitals and other stakeholders like representatives of affected municipality, wards, project affected families, etc. and the comments and suggestions were collected from each of them. The comments and suggestions obtained were incorporated in the report and a finalized SEIA report has been prepared.

### **4. Review of Plan/Policies, Legislations, Standards and Guidelines**

Relevant Acts, Policies, Guides and Guidelines that guides the project during the construction and operation are studied and related information are briefly described in this section. The Constitution of Nepal, Hydropower Development Policy, 2001, Environment Protection Rules, 2020, Environment Protection Act,

2019, etc. were thoroughly reviewed and consulted and different other related documents were reviewed and included.

## **5. The current Environmental situation of project area**

### **5.1 Physical Environment**

Upper Marshyangdi -1 Hydropower Project is located in Lower Himalayan belt of Gandaki Province in Western Nepal where exposed rocks constitute of Augen Gneiss, Banded Gneiss, Schist, Slate, etc. are found. Along with this, the area consists of metamorphic and sedimentary rocks, sediment deposits consisting of alluvial and colluvial sediments. Geologically, the project area lies partly in the Formation of the Higher Himalaya and partly in the Lesser Himalaya. Here mainly gneiss, banded gneiss, Schist and slate are main rock types.

The proposed project lies in the tropical and sub-tropical regions and Marshyangdi River river in the river originates from Tilicho, Gyangpu, Thulagi, Paango, Pangeri, Sutee, Bhimdang, Purdee glaciers and lakes. During the monsoon, the area receives a rainfall of 600 mm and during other times of the year, it receives an average of 273 mm rainfall, and the data is obtained from the archive of nearby hydrological station at Chame. The annual lowest temperature of the project area is recorded up to -5.3 degree Centigrade and the annual highest temperature of the region is 22.6 degree centigrade.

The noise and water quality of project area is in natural condition and is free from drainage, water pollutants, vehicular and industrial noises. Air quality of that area is free from pollution and air quality is assured to be within the National Ambient Air Quality Standards. The water quality of the river is of better standard. Majorly, the land use pattern comprises of river bank followed by cultivating land, forests and settlements.

### **5.2 Biological Environment**

The project area lies inside the Annapurna Conservation Area where tropical and sub-tropical bioclimatic zonation occur. The forest type of the area is classified as *Schima-Castanopsis* by Stainton in 1972. Along with these species, other tree species like *Alnus*, *Bombax*, *Albizzia*, etc. are found growing within and around the area. A species of tree fern, *Cyathea spinulosa*, listed in Appendix II of CITES is found to be distributed in the dewatered stretch and in the upstream of headworks area. The clearing of the area is accompanied by felling off the trees which harbors some species of orchids, lichens and medicinally important climber species.

Annapurna Conservation Area is enriched with the biodiversity due to wider range of climatic conditions and supports diverse array of ecosystems with 1,352 species of plants, 128 wild mammals, 514 bird species, 348 butterfly species, 40 reptiles and 23 amphibians (Baral, 2075). A detail survey of the project area suggests that there are at least 17 species of fishes, 20 species of mammals, 19 species of birds and 7 species of reptiles. Some of these species are even listed by the CITES and IUCN and these species are presented in table with their conservation status in the area. The impacts of project on biological environment are identified as encroachment of the forest area, conversion of forest area into agricultural land, destruction of habitat, pressure on non-timber forest products etc.

### **5.3 Socio-Economic and Cultural Environment**

Although the project will directly and indirectly affect four wards viz. 3,4,5 and 6 of Marshyangdi Rural Municipality, the direct impact will be in and around main project structure site mainly Raidu khola-Marshyangdi confluence and around powerhouse site near Arkhalebeshi. The major impact areas nearby project components are: Rambazaar, Ghermu, Mipra, Arkhalebesi, Siurungbesi, Thakan and Thakanbesi.

During the project construction phase, the land or property within the proposed project area has to be acquired and the landowners belong from the nearby project areas or are outsiders. The project affected household counts to 90 and houses to be displaced counts to 14.

According to the CBS, 2011, the total population of the project affected wards is 9,590 with male population of 4,455 and female of 5,135. The majority is of Gurungs followed by Tamang, Brahmin, Chhetri, Magar, Newar, Kami and other casts. Majority of people follow Buddhism; however, the people of the project area follow Hinduism. Majority of the communities involved in tourism, agriculture and husbandry. Most of the people here work as guides, porters, helpers and runs hotel as internal and international tourists frequently travel to Chame and Manang via this route. Local farmers normally cultivate their crops in irrigated land as well as dry land. They cultivate rice, maize, millet, wheat, barley, fagopyrum and beans. Additionally, different kind of beans, seasonal and non-seasonal vegetables, potatoes, green vegetables, spices and roots are cultivated. Two leading communication companies, Nepal Telecom and Ncell has provided the telecommunication services within the project area, which has made the lives of inhabitants here much easier.

There are no any projects utilizing the water of Marshyangdi river within the project area. Water is not utilized for irrigation purposes, fish farming, recreational activities, etc. and there are no any families who depend on the fishing activities in Marshyangdi. However, there lies a grave used for the burial purpose by Buddhist communities and along with this, Baur Ghat and Gelphe Ghat lies in the dewatered stretches of the project area.

## **6. Analysis of Alternatives**

Different alternatives were considered for the project depending on feasibility, financial and environmental aspects of the project area. During the analysis of the project, project site alternatives, their design, access to the project sites, construction technology to be adopted and operational procedure, adverse impacts of project implementation, consequences of non-implementation of the project etc. have been taken into consideration. This analysis results in a fact that the proposed area is most suitable for the project development and implementation. "No Action" option with the implementation of proposed action option. During the construction and operation phase, locals are expected to be involved in different activities which will provide economic opportunity and support local economy.

## **7. Major environmental impacts**

### **7.1. Positive Impacts**

Though the project will not impart positive impacts on physical and biological environment, it has beneficial impacts on socio-economic environment. The skilled, semi-skilled and unskilled manpower required for the construction, operation and maintenance of the project will be employed locally as far as available so there will be increase in employment opportunity and economic activities which will help in the betterment of the economic condition of the locals. During the project construction and operation phase the people employed needs food and snacks daily which will increase the shops and markets in the area that avail opportunities locally and can stop people from migrating to other places for job and their economic status will also increase. Development of the project will avail electricity in the area which will help the local people to run small scaled industries and such development will also increase the local revenue. The people employed in project will acquire skills and in future they will have further chances of employment in other similar projects.

### **7.2. Negative Impacts**

#### **Physical and Chemical Environment**

The construction of Upper Marshyangdi -1 Hydropower Project requires 44.6 hectares of land that should be acquired temporarily and permanently. For the construction of the project digging and slope cutting will change the land structure of the area to some extent. Project requires heavy vehicles and equipment due to which there may be the chances of air, noise pollution within the project area.

Since the project will construct dam to discharge water to the headrace tunnel and finally to the powerhouse, there will be change in the river morphology. The waste generated during the construction phase may have negative impacts in the nearby surroundings. The SEIA includes some of the effects that are not addressed in the previously approved EIA in 2014. In addition, there are some of the regions prone to soil erosion, sedimentation and landslides.

### **Biological Environment**

The project requires 3.49 ha permanent and 12 ha of temporary forest area and 16.48 ha river/river flood plain due to which the land use pattern changes. During project construction phase, all together 347 trees, 381 poles and 78 saplings of different species will be felled down. The construction works from intake to powerhouse area will heavily impact the water quality of the area, biological status of the dewatered stretch which will directly impact the aquatic lives and fishes. The collection of fuel wood by the work force from the forest and possibility of fishing and poaching will have negative impacts in the biological environment. During the project operation period, the obstacles to the migratory fish species, will have some impact. Similarly, diversion of river water is also concern with the river ecosystem, because it reduces the water between dam and powerhouse. Also, it prohibits migration of fish species. Due to this breeding ground for fish will be synchronized.

### **Socio-economic and Cultural Environment**

The project requires 8.37 ha cultivable land, 1.72 ha settlement area and 0.46 ha barren land temporarily and 2.71 ha cultivable land, 0.21 ha settlement area and 0.53 ha barren land permanently. Along with this, the acquisition of private land will affect 90 household and 14 household needs to be relocated by the project. The construction of the project requires huge number outsider workforces may create chaos in the project areas. The consumption of liquor and other anti-social activities may increase due to their influx and it may affect the social and communal harmony. Along with this, there may be the chances of gender dominance and child labor as the people living in the area are under basic financial margin.

## **8. Mitigation Measures**

The construction, operation and maintenance activities of the project will be guided by different policies and documents related to the hydropower and environment. This SEIA has proposed various approaches to mitigate the environmental impacts based on number of studies and expertise. To reduce the physical impacts to acceptable levels river bank protection measures such as gabion walls will be constructed at strategic locations in the project area, including at the weir site and immediately downstream. A reasonable compensation will be given to the private land acquired by the project. Controlled excavation will be applied. Bioengineering will be adopted to minimize soil loss and mitigate landslides. Physical infrastructures that will have impact due to project activities will be compensated. To mitigate and minimize the impacts on biological environment, project will afforest the seedlings in the ratio of 1:25, i.e., cutting of one tree will be accompanied by compensatory plantation of 25 trees, maintaining the e-flow in the dewatered stretch in the dewatered section during every month and conservation education will be provided to the people nearby project areas. To minimize the impact due to forest loss, the community will be provided technical and financial to enhance the conditions of their degraded forests. The project will work together with the



authorities of Annapurna conservation area to conserve biodiversity of the area. The project will provide skill enhancement trainings vocational education, income generating trainings, which will provide extra income opportunity for the concern stakeholders. To mitigate the impacts on socio-economic and cultural environment, different approaches will be adopted including compensatory measures. The project will provide skill enhancement trainings vocational education, income generating trainings, which will provide extra income opportunity for the concern stakeholders. The project will provide employment opportunity to the locals on a priority basis. Along with this, the project will help in educating communities, assisting infrastructure development and development of the area. The project has allocated a total sum of NRs. 816,718,462.4 for mitigation and enhancement of environmental impacts including CSP cost, which is 2.51 % of the total project cost.

## **9. Environmental Management Plan**

Environmental Management Plan is basically prepared to implement the proposed mitigation and enhancement measures suggested by the environmental study. This section explains the objectives and rationale of what the proposed project refers to as the Management Plan in relation to project activities, organization and approach to environmental, social, health and safety mitigation. Further, it includes the procedural frameworks to make sure that all mitigation measures and monitoring requirements specified in the EIA study report will actually be carried out. Environmental Management Plan (EMP) has been prepared as an essential part of the EIA report to set out the procedural framework to ensure the implementation of mitigation measures, monitoring and auditing requirements carried out in consecutive stages of project construction and operation phase.

## **10. Environmental Audit**

The objectives of the environmental audit are to evaluate whether the identified risks in SEIA report are effectively mitigated and comply with the requirements of the Environmental Management Plan. This section deals with the compliance monitoring, baseline monitoring and impact monitoring. Along with this, the mitigation approach to be adopted for impacts on physical, biological, socio-economic and cultural environment will be monitored and the types of monitoring, area, methodology, parameters, and agency responsible for conducting the monitoring are clearly presented in a tabulated form.

## **11. Conclusion**

The major objective of the project is to sustainably utilize the natural resources and aid the economy of country. The implementation of project comes up with both positive and negative impacts to physical, biological, socio-economic and cultural environment. This SEIA report explores those impacts and also suggests practical mitigation measures. The benefits that the project generates to the people and economy is significantly greater than its negative impacts. Also, most of the negative impacts can be mitigated adopting different measures. Considering this, UM-1 HPP is recommended for development and operation with effectively implementing the SEIA. Further, the proponent is committed to adopt all the proposed mitigation and enhancement measures, and take responsibility to complete the project.

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## **1. INTRODUCTION**

### **1.1. Name and address of proponent**

The proponent of the Upper Marshyangdi -1 Hydropower Project (UM-1HPP) is Upper Marshyangdi Hydropower Company Pvt. Ltd, a Private Limited Company registered under the Company Act, 2053 of Government of Nepal (GoN). The address of the proponent is as under:

#### **Upper Marshyangdi Hydropower Company Pvt. Ltd**

Lalitpur Metropolitan City-03, Sanepa, Lalitpur

Phone: +977-1-5439586

Email: umhydropower@gmail.com

### **1.2. Name and address of consultant**

Resources Lab Pvt. Ltd, an environmental consulting firm registered with the GoN, has prepared this document. The company is located in Kathmandu on the following address:

#### **Resources Lab Pvt. Ltd.**

Bhakti Thapa Sadak,

Thapagaun, Kathmandu, Nepal

Tel: 977-1-5244333

Email: info@resourceslab.org

### **1.3. Rationale for capacity change**

The proposed project was stalled due to the overlap between UM-1HPP's licensed powerhouse and tailrace areas and the reservoir of the Upper Marshyangdi A hydropower Project built by Sino hydro-Sagarmatha Power Company Pvt. Ltd. To separate the licensed survey area of the both projects, Upper Marshyangdi Hydropower Company Pvt. Ltd. (UMPCPL) re-developed the project and shifted powerhouse 1.2 km upstream of the previously proposed project boundary in recent design. Based upon the updated feasibility study report prepared by UMPCPL, the capacity of the project has been reduced to 102 MW from 138 MW. Besides, the design discharge is also decreased by 20.3 m<sup>3</sup>/s. As per the electricity generation license, the installed capacity of UM-1 HPP is 138 MW with the design discharge of 106 m<sup>3</sup>/s. However, according to relevant requirements of Nepal Electricity Authority (NEA), in general, design discharge shall meet Q40 probability of exceedance criteria, i.e., the runoff frequency at the dam site corresponding to the design discharge shall exceed 40%. The design discharge is 85.7 m<sup>3</sup>/s(Q40). The calculation of hydraulic energy shows that the installed capacity of UM-1 HPP is 102MW. Also, the project boundary, locations of the project structures and other project designs has been changed which is given in **Table 2 of Chapter 2**.

### **1.4. Rationale of the SEIA study**

At the time when the UM-1 HP was initiated for study, the then Environment Protection Rule (EPR) 1997, schedules mandated EIA study for the project for the subsequent generation licensing because the capacity of the project has been reduced from 138 MW to 102 MW, the extension of the physical infrastructures and relocation of the structures lie inside the impact area defined in the approved EIA, the land requirement has gone to 44.58 ha from 42.385 ha and the project does not displace or relocate more than 100 number of people than the approved EIA and the development site lies inside the Annapurna Conservation Area. This SEIA for 102 MW is exclusively for the hydropower component and does not include the transmission line component of the project. Rationality for conducting the SEIA is further enhanced by following guidelines as adapted from the National Environmental Impact Assessment Guidelines 1993 AD (2049/50 BS) and as per the Clause

11, Sub-Clause (3) of the Environmental Protection Regulation (2077). The first phase of SEIA study was to obtain the consent from the MoFE. The SEIA study consent was obtained on 2077/12/13.

Also, as per the Annex 12 related to Section 7 of Sub-rule 5 of Rule 7 of Environmental Protection Rule, the report can be written in English Language if the project is proposed by the foreign investor. This Upper Marshyangdi-1 Hydropower Project is also proposed by the foreign investor company and received permission from Nepal government for investment. So, the development of this SEIA report is done in English language.

### 1.5. Objectives of the study

The principal objective of SEIA is to assess and address the additional or changed dimension of environmental impacts that have occurred due to partial alteration of design and relocation of the project components. It primarily focuses on the additional environmental and social impacts both beneficial and adverse that may occur on due to the changes. Its specific objectives are to:

- Document change in baseline status of physical, biological and socio-economic and cultural environments in the project affected area;
- Identify and predict new adverse and beneficial physical, biological and socioeconomic and cultural environmental impacts due to current project layout;
- Formulate mitigation measures for avoiding/reducing/compensating newly identified adverse effects and maximizing beneficial effects with compatible monitoring and environmental management plans and environmental costs involved, suggest mitigation measures for adverse impacts;
- Revise environmental management, monitoring and auditing plans if so triggered;
- Involve public in the decision-making process related to environment; and
- Advise decision makers on the additional implications of the implementation of the project.

### 1.6. Scope of the study

The scope of work area for SEIA study of UM-1HPP is the assessment of the baseline condition of the proposed project based on new changes (i.e., the previous location of the headworks shifted downstream from the previous site and powerhouse has been shifted 1.2 km upstream from the previous project boundary) by comparing with previously approved EIA (138 MW) of UM-1HPP, 2014. The study aims to identify the relevant impact and propose mitigation measures, and implementation of the mitigation measures through cost effective environmental management plan.

### 1.7. Time Schedule

The major activities for undertaking SEIA are shown in the **Table 1-1**.

**Table 1-1: SEIA Schedule for UM-1HPP**

Activities	Months								
	1	2	3	4	5	6	7	8	9
Obtain consent for SEIA Study	*								
Study of the Approved EIA report	*								
Acquisition of secondary information		*							
Field investigations and surveys		*	*						

Activities	Months								
	1	2	3	4	5	6	7	8	9
Consultation				*					
Comparative study of the approved EIA and SEIA				*					
Draft Report				*	*				
Public Hearing					*				
Collection of Recommendations and suggestions (Local Level)					*				
Finalizing SEIA Report						*			
SEIA presentation, comments incorporation and approval-DoED							*		
SEIA presentation, comments incorporation and approval-MoFE								*	*

### 1.8. Formation of Study Team

A multidisciplinary team of experts with expertise and experience in their respective fields were involved in the supplementary EIA study. The study team **Table 1-2** comprised of following key professionals:

**Table 1-2: List of study team with their qualification**

Capacity	Name	Qualification	Contact	Experience
Team Leader	Fanindra Raj Kharel	Masters in Protected Area Management	9843002277	40 years of work experience, involved in 15+ EIA & IEE projects.
Environmental Expert	Ashmita Shrestha	Masters in Environmental Science	9849618585	4 years of work experience, involved in 5+ EIA & IEE projects.
Biological Expert	Prakash Poudel	Bachelors in Botany	9803564518	3 years of work experience, involved in 5+ EIA & IEE projects.
Social Expert	Suwash Chandra Dahal	Masters in Sociology	9849498931	4 years of work experience, involved in 5+ EIA & IEE projects.
Energy Resources Expert	Gyanendra Acharya	Masters in Renewal Energy	9841032927	8 years of work experience, involved in 10+ EIA & IEE projects.

Apart from the above key experts, other consultants of different background were involved during the SEIA preparation.

## 2. PROJECT DESCRIPTION

### 2.1. The Project

The Upper Marshyangdi -1 Hydropower Project (henceforth referred as UM-1HPP) of installed capacity 102 MW is situated in Lamjung District of Gandaki Province of Federal Republic of Nepal. Upper Marshyangdi Power Company Pvt. Ltd. (UMPCPL) is developing the project under a survey license issued by Department of Electricity Development (DoED), Government of Nepal (GoN).

In accordance with the requirements of the survey license, Upper Marshyangdi Power Company Pvt. Ltd. completed the feasibility study and Environmental Impact Assessment (EIA) of UM-1HPP in 2014. Both studies confirmed the technical soundness, financial viability and environmental sustainability of the UM-1HPP as a 138 MW run-of-river (RoR) project. After fulfilling the requirements of the survey license within the stipulated period, Upper Marshyangdi Power Company Pvt. Ltd. initiated further steps for developing the project. The proposed project was stalled due to the overlap between UM-1HPP's licensed powerhouse and tailrace areas and the reservoir of the Upper Marshyangdi A hydropower Project built by Sinohydro-Sagarmatha Power Company Pvt. Ltd. To separate the licensed survey area of the both projects, UMPCPL re-developed the project and shifted the powerhouse and entire project components upstream. Based upon the updated feasibility study report prepared by UMPCPL, the capacity of the project has been reduced to 102 MW from 138 MW. Not only the capacity, project boundary, locations of the project structures and other project designs has been changed.

So, as per the Environmental Protection Regulations, 2020 (2077 B.S.), the SEIA for UM-1HPP has been carried out as per the consent provided by the Ministry of Forest and Environment.

### 2.2. Project location

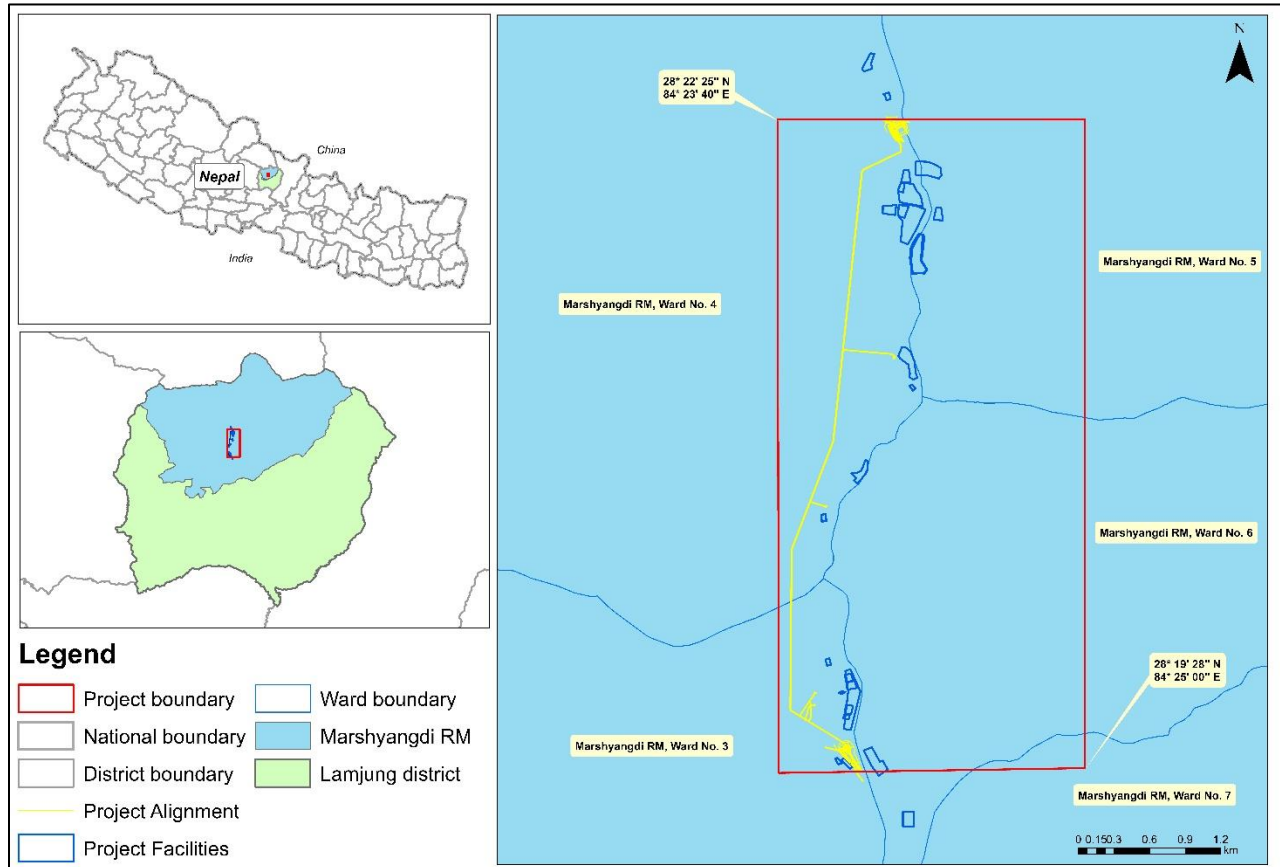
The project area of UM-1HPP is about 25 km from the nearest city Besisahar and about 200 km from capital city Kathmandu. The project lies between the project boundary of latitude 28°19'28" N to 28°22'25" N and longitude 84°23'40" E to 84°25'00" E. The project components of UM-1HPP are located in Marshyangdi Municipality of Lamjung district, encompassing the villages Rambazaar, Ghermu, Arkhalebesi, Siurungbesi, and Thakanbesi. The headworks components of the project are proposed near Rambazaar lying in ward 4 of Marshyangdi Rural Municipality, about 450 m downstream of the confluence of Raidu Khola and Marshyangdi River. The surface powerhouse is proposed at the left-bank terrace of the Marshyangdi River, at the confluence of Siurung Khola and Marshyangdi River in Siurungbesi, Marshyangdi RM-4. Some supporting project components like quarry site, spoil area and campsites are proposed in Ghermu and Bahundanda villages of Marshyangdi RM-5 & 6.

**Table 2-1: The description of the project location along with the comparative changes**

Description	Approved EIA, 2014	Present SEIA
Province	Gandaki	Gandaki
District	Lamjung	Lamjung
Local body	Taghring, Khudi, Ghermu, Bahundanda (VDCs)	Marshyangdi RM (3,4,5 & 6)
Geographical location	Lon: 84°23'51" E to 84°25'00" E Lat: 28°18'50" N to 28°22'25" N	Lon: 84°23'40" E to 84°25'00" E Lat: 28°19'28" N to 28°22'25" N

*Source: Approved EIA, 2014 and UFSR, 2021*

The comparative changes of the project physical location are shown in above **Table 2.1**. Major project components are proposed in the right bank of the Marshyangdi River which lie inside Annapurna Conservation Area while some of the supporting components like camp sites, spoil areas, quarry sites are lies on the left bank and it is outside of the conservation area. Also, the map showing the project location is given in **Figure 2-1** below.

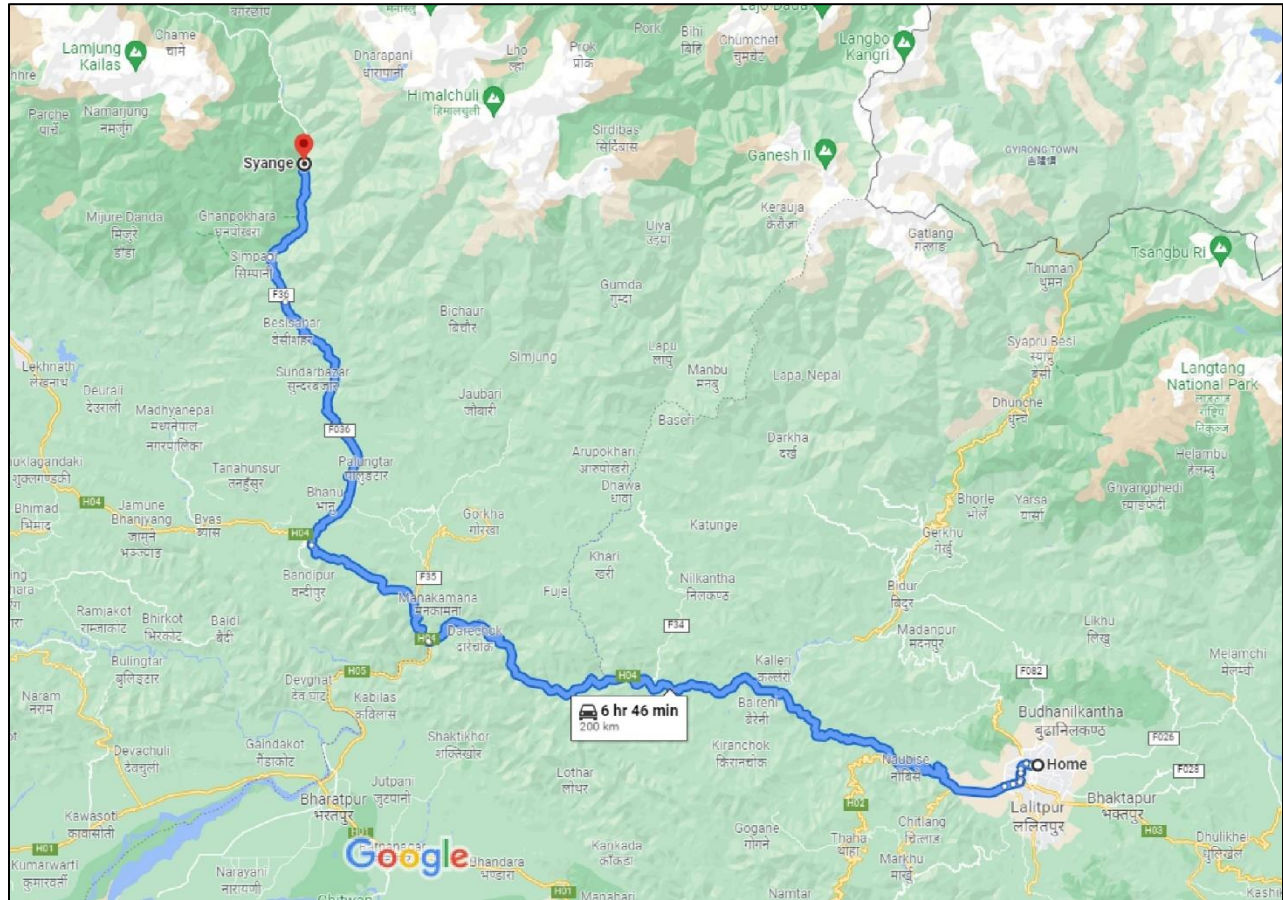


**Figure 2-1: Project location map showing the project boundary, alignment and facilities**

### 2.3. Accessibility

The project area is connected to Kathmandu and Terai via Prithvi Highway at Dumre. The hill road from Dumre to Besisahar is also black topped. The road section from Besisahar to Khudi Khola is all weather graveled road. The Khudi Khola is crossed by a Bailey bridge. After Khudi Khola, the road/track is rough and narrow throughout the project site. 4xW drive jeeps are plying on this road. This section of road requires extensive rehabilitation to accommodate the construction traffic and transportation of electromechanical /electrical equipment. Department of Road is now improving the road which follows the right bank of Marshyangdi River. The nearest airfield is located in Bharatpur of Chitwan district which is approx. 100 kms in the south and at Pisang in the Manang District, about 65 km to the north. The details of the accessibility of the project site and road type are shown in **Table 2-2** below.

The road track from Besisahar to headwork area is already in operation but needs maintenance at many places. The cost of road is considerably low to justify the attractiveness of the project from accessibility point of view.



**Figure 2-2: Map showing the roadway from Kathmandu to Project Site**

**Table 2-2: Accessibility to Project Site and Road Type**

S.N.	From-To	Distance	Road Type	Remarks
1	Kathmandu-Dumre	133 km	Black topped	National highway
2	Dumre-Besishahar	42 km	Black topped	District feeder road
3	Besishahar-Rambazar (HW site)	25 km	Earthen road	Gravel road partly with earthen track
	Total	200 km		

## 2.4. Project components

### 2.4.1. Principal features

The UM-1HPP is a RoR type project with the headworks just 450 m downstream of the confluence of the Raidu Khola and the Marshyangdi River. The dam site of UM-1HPP is located in the middle and lower reaches of the Marshyangdi River having installed capacity of 102 MW with the design discharge of 85.7 m<sup>3</sup>/s (Q40) and net head of 137.45 m. Three 35.05 MW Francis type units are equipped to generate 586.69 GWh of energy annually. The total reservoir storage of Upper Marshyangdi-1 hydropower station is 394 thousand m<sup>3</sup> with submergence area 9.47 ha. Considering the operation type of the downstream hydropower station, i.e., Upper Marshyangdi A hydropower station (RoR project), RoR is selected for this project too.

The main structures of the project include flood discharge sluice, flushing sluice, intake, desilting basin, headrace tunnel, upstream surge chamber, penstock, surface powerhouse, tailrace structures and switchyard, etc. It is proposed to interconnect to NEA Grid at switchyard of proposed 220kV Khudi (Tadi Kuna) substation. The 220kV line is about 6.5km in length. The brief description of the project components are given in **Annex 3.2**.

#### 2.4.2. Project's comparative salient features

**Table 2-3** highlights the changes or “additionally” between the approved EIA 2014 and DPR, 2021. This comparison will assess the “additionally” which will ease to identify additional impacts, predication of impacts and to propose subsequent mitigation measures.

**Table 2-3: Comparison of the project components as per DPR 2021 and EIA 2014**

Feature	EIA (with installed capacity 138 MW)	SEIA (Changed after detailed design with 102 MW)	Remarks
<b>PROJECT LOCATION</b>			
Province	Gandaki	Gandaki	Same
District	Lamjung	Lamjung	Same
Local body	Taghring, Khudi, Ghermu, Bahundanda (VDCs)	Marshyangdi RM	Same
Headworks' site	Taghring, Ghermu (VDCs)	Marshyangdi RM-3	Same
Powerhouse site	Khudi, Bahundanda (VDCs)	Marshyangdi RM-4	Same
Geographical coordinates	Lon: 84°23'51" E to 84°25'00" E Lat: 28°18'50" N to 28°22'25" N	Lon: 84°23'40" E to 84°25'00" E Lat: 28°19'28" N to 28°22'25" N	Changed
Protected area (if any)	Annapurna Conservation Area	Annapurna Conservation Area	Same
<b>GENERAL</b>			
Name of the River	Marshyangdi	Marshyangdi	Same
Type of scheme	Run of River (RoR)	Run of River (RoR)	Same
Gross Head	155.50 m	152 m	Changed
Net rated head	N/A	137.45 m	-
Installed capacity	138 MW	102 MW	Changed
Total Annual Energy	681.79 GWh	586.692 GWh	Changed
<b>HYDROLOGY</b>			
Catchment area	2501 km <sup>2</sup>	2501 km <sup>2</sup>	Same
Mean annual discharge	N/A	110 m <sup>3</sup> /s	-
Design discharge	106.00 m <sup>3</sup> /s (Q35)	85.7 m <sup>3</sup> /s (at 40% PoE)	Changed
Riparian release	2.71 m <sup>3</sup> /s	10% of monthly flow	Same

Feature	EIA (with installed capacity 138 MW)	SEIA (Changed after detailed design with 102 MW)	Remarks
Design flood discharge	2840 m <sup>3</sup> /s (1 in 2000 years)	2500 m <sup>3</sup> /s (1 in 500 years)	Changed
Probable maximum flood	6405 m <sup>3</sup> /s	4380 m <sup>3</sup> /s	Changed
Average annual precipitation		873 mm	-
<b>DIVERSION WEIR</b>			
Type of Weir	Spillway with breast wall	Concrete dam	Changed
Length of Weir	N/A	3m ×10 m	-
Crest elevation	EL. 1040.00 m	EL 1040.00 m	Same
Spillway type	N/A	Spillway with breast wall	-
Undersluice opening (W×H)	15×14 m	7.0×7.0 m	Changed
Undersluice crest level	N/A	EL 1040.00 m	-
<b>INTAKE STRUCTURE CUM GRAVEL TRAP</b>			
Type of Intake	N/A	Side Intake	-
Nos of opening	N/A	2	-
Size of intake	4× 8.50 m (width) × 7 m (height)	6.0×8.0 m	Changed
Intake sill level	EL. 1047.00 m	EL. 1046.00 m	Changed
<b>APPROACH CANAL</b>			
Type	N/A	Rectangular RCC	-
No. of canal	N/A	2	-
Length	N/A	19.6 m / 45.3 m	-
Size (W×H)	N/A	6.0×13.5-14.5 m	-
<b>DESANDING BASIN</b>			
Type	Underground desander	Surface continuous flushing with 2 chambers	Changed
Dimension (L×B×H)	170×16.50×22.50 m	80.0×15.0×15.68-16.88 m	Changed
Inlet transition length	N/A	10.0 m	-
Particle size to be settled	>0.2 mm	0.35 mm	Changed
Trapping efficiency	N/A	80%	-
<b>HEADRACE TUNNEL</b>			
Type	N/A	Horse-shoe	-
Internal diameter	N/A	6.0 m (after concrete lining)	-
Length	6251.20 m	5142.28 m	Changed
Steel thickness/type of lining	N/A	40 cm / R.C.C	-
Nos of Anchor blocks	N/A	N/A	-



Feature	EIA (with installed capacity 138 MW)	SEIA (Changed after detailed design with 102 MW)	Remarks
<b>SURGE TANK</b>			
Type	Underground vertical shaft with restricted orifice	Underground restricted orifice type	Same
Effective depth	N/A	58.5 m	-
Diameter (or size)	18 m	11.0 m	Changed
Up surge level	EL. 1080.40 m	EL. 1083.03 m	Changed
Down surge level	EL. 1027.20 m	EL. 1028.32 m	Changed
Normal operation level	N/A	EL. 1049.14 m	-
<b>STEEL PENSTOCK PIPE</b>			
Type	Horseshoe shaped tunnel	Steel (Burried)	Changed
Internal diameter	7 m	4.8 m	Changed
Length	40 m	426.86 m	Changed
Steel thickness	N/A	12 mm-28 mm	-
<b>POWERHOUSE</b>			
Type	Underground powerhouse	Surface powerhouse	Changed
Size	85.60×15.00 m	73.5×19.0 m	Changed
Height	36.90 m	43 m	Changed
Turbine axis level	EL. 902 m	EL. 901.40 m	Changed
<b>TAILRACE</b>			
Type	Inverted D-shaped	Tunnel rectangle	Changed
Tailrace length	Tailrace-1: 27.55 m; Main tailrace: 207.00 m	198 m	Changed
Size (W×D)	Tailrace-1: Diameter 4.25 m; Main tailrace: Diameter 6.80 m	4.0×5.0 m (single unit)	Changed
Tailrace water level	N/A	EL.907.50	-
<b>TURBINE</b>			
Type	Francis turbine	Francis turbine	Same
Number	3	3	Same
Rated output capacity per unit	46.00 MW each	35.05 MW each	Changed
Turbine axis level	EL. 902.00 m	EL. 901.40 m	Changed
Net head	N/A	137.45 m	-
Discharge per unit	N/A	28.57 m <sup>3</sup> /s	-
Rated efficiency	N/A	91 %	-
<b>GOVERNOR</b>			

Feature	EIA (with installed capacity 138 MW)	SEIA (Changed after detailed design with 102 MW)	Remarks
Type	N/A	PID programmable micro-computer	-
Adjustment for speed drop	N/A	±0.25%	-
<b>GENERATOR</b>			
Type	N/A	Synchronous 3 phase	-
Rated output capacity per unit	N/A	40 MVA	-
Power factor	N/A	0.85	-
Generation voltage	N/A	10.5 kV	-
Frequency	N/A	50 Hz	-
No. of units	N/A	3	-
Excitation system	N/A	A self-shunt excitation thyristor static	-
Efficiency	N/A	97%	-
<b>TRANSFORMER</b>			
Type	N/A	Three phase ONAF	-
Rated capacity	N/A	42 MVA	-
Voltage ratio	N/A	242:10.5	-
No. of units	N/A	3	-
Vector group	N/A	YNd11	-
Frequency	N/A	50 Hz	-
Efficiency	N/A	99%	-
<b>TRANSMISSION LINE</b>			
Voltage level	132 kV (Double circuit)	220 kV	Changed
Length	5 km	6.5 km	Changed
Conductor type	N/A	2×ACSR Bison	-
From	Powerhouse	Powerhouse	Same
To	Khudi Hub	Khudi (Tadi Kuna) substation	Changed
<b>PROJECT COST ESTIMATE</b>			
Total cost of the project	NRs. 32,909,501,067.66	NRs. 32,498,209,650.00	Changed as per exchange rate (1\$= NRs. 120.67)
<b>CONSTRUCTION PERIOD</b>	N/A	40 months	-

*Source: DPR, 2021 & EIA, 2014*

## 2.5. Brief description of the project components

The UM-1HPP is a weir & long water way type hydropower station. The Project structures consist of dam, intake, desilting basin, headrace tunnel, surge chamber, penstock and surface powerhouse. The headworks

structures are located about 450 m downstream from the mouth of the Raidu Khola; from left to right, there are left-bank connecting dam, 3 flood discharge sluices, 1 flushing sluice, water intake, power intake in dry season and right-bank connecting dam respectively. The headrace tunnel is arranged along the right bank of the Marshyangdi River. The surge chamber is arranged in the mountain behind the powerhouse and is of restricted orifice type. The penstock supplies water to the three units by a main penstock through a trifurcate penstock. The surface powerhouse is arranged on the accumulation fan at the mouth of the Siurung Khola. The general layout of the Project is given in **Figure 2-5**. The component wise description of the project is described below:

### **2.5.1. Headworks**

The headworks consist of structures like flood discharge sluice, flushing sluice, left- and right-bank connecting dam, water intake and desilting basin. The sluice crest elevation is 1040.00 m, and the maximum dam height is 24.0m high. The 3-flood discharge sluice is arranged in the main river channel, and the water intake of the desilting basin is arranged on the right bank. The flushing sluice is arranged between the water intake and the flood discharge sluice to form a layout of water intake and sediment control.

### **2.5.2. Water intake and sediment control structure**

In order to facilitate water intake and sediment control, the layout type of “sideward water intake and forward flushing” will be adopted by the Project. The water intake is arranged on the downstream of the concave bank of the river bend at the dam site. The fore edge of the water intake is at an angle of 105° to the dam axis, and is arranged close to the flushing sluice.

In order to prevent the bed load sediment from entering the water intake, a sand guide sill is proposed and placed in front of the water intake. The sill top elevation is 1048 m, which is 8 m higher than the floor slab of the flushing sluice and 2.0m higher than the floor slab of the water intake.

In order to improve the effect of flushing, a waterway contraction wall shall be arranged between the flushing sluice and the flood discharge sluice, with an along flow-direction-length of 40.0m and wall top elevation of 1050.00m. The sand flushing channel formed among the bottom sill of water intake, sand-guide sill and waterway contraction all can improve the capacity of waterway contraction and flushing, so as to achieve the purpose of “free of Sediments before the water intake”.

### **2.5.3. Fish Pass**

A pool type fish pass is set on the downstream face of the left non-overflow block of the diversion wear for migration of the fishes. The width of the fish ladder is 2.0m. The maximum length of the fish pass is 342m, and the maximum bottom slope is 8%. Three level outlets are provided to facilitate migration of the fishes at different reservoir operating levels, and the bottom levels of the outlets are 1054.00m, 1055.00m and 1056.00m respectively. The dimensions of the outlet openings are 2.0m(width) × 1.5m(height).

### **2.5.4. Headrace Tunnel**

The total length of the tunnel is 5142.28 m (including headrace culvert), elevation of the tunnel inlet floor slab is 1042.00m, the elevation to the surge chamber floor slab is 1019.00 m, and the base slope is 4.47%. In order to facilitate the construction, the tunnel is designed to have flat horseshoe-shaped excavated section with an internal diameter of 6 m and central angle of 212.52°.

### **2.5.5. Surge Tank**

The surge tank is arranged in the bank slope rock mass of the upstream side of the powerhouse area. The surge tank is an underground restricted orifice surge tank, with a bottom elevation of 1028.32m, a top

elevation of 1083.03m and a maximum height of 58.5m. The shaft section is circular-shaped, with a section diameter of 11.00m and a restricted orifice diameter of 3.30m. The consolidation grouting is applied for shaft surrounding rock, with the grouting hole penetrating into the bedrock for 3.0m, 14 holes per row, 3.0m of row spacing, and in quincunx arrangement. The access tunnel (used as ventilation tunnel also) at the top of the surge chamber is about 155m long. A circular-arch straight-wall section is applied, with a section size of 5.4m × 6.5m (width × height).

#### **2.5.6. Penstock**

The surge chamber is connected with the penstock. According to the location of the powerhouse and surge chamber, as well as the topographical and geological conditions of the penstock, the underground buried penstock is adopted. It supplies water to the three units by a main penstock through a trifurcate penstock, wherein the main penstock is composed of upper flat section, upper bend section, inclined shaft, lower bend section and lower flat section. The upper flat section (including concrete transition section) is 42.53m long, the upper and lower bend sections are about 15.71m long, the inclined shaft section with dip angle 60° is about 121.24m long, the lower flat section is about 231.67m, the main penstock inner diameter is 4.80m, the turning radius is 15.0m, and the total length of main penstock is about 426.86m. The diameter of the branch penstock is 2.4m, and the total length of the branch penstock is about 85.0m

#### **2.5.7. Powerhouse**

The powerhouse is a riverside surface powerhouse. The powerhouse is composed of the main powerhouse, auxiliary powerhouse, GSU transformer GIS building, tailrace channel, Access Road and turnaround. The GSU transformer GIS building and the auxiliary powerhouse are located in the upstream of the main powerhouse and are arranged parallel to the main powerhouse. The auxiliary powerhouse is located at the right end of the GSU transformer GIS building.

The main powerhouse is composed of the generator hall and the erection bay. The generator hall is equipped with 3 Francis turbine generator units, each with a capacity of 35.05 MW and a total installed capacity of 102MW. The unit has a setting elevation of 901.40m, each with a quotative discharge of 28.57 m<sup>3</sup>/s. The generator hall is 52 m long; the upper structure is 19m wide, the lower structure is 25 m wide and height is 42.95 m.

#### **2.5.8. Tailrace**

The draft tube is connected to the tailrace culvert. According to the location of the powerhouse and the topographic and geological conditions of the tailrace culvert, a single-unit single-tube tailrace culvert is adopted. The tailrace culvert is a cast-in-place concrete structure with a length of about 198m. It is divided into reverse slope section, flat slope section and outlet section along the flow direction, and the length is about 28.65m, 150m and 20m respectively.

The exit section is an open channel section, which is connected with the natural river bed. When the unit is running, the normal tail water level is 907.50m, and the minimum tail water is 906.10m.

#### **2.5.9. Turbine**

In the UM-1HPP, the minimum water head is 131.0m and the maximum water head is 152m, showing no great variation. Vertical-shaft Francis turbine is adopted in this head section. The rated output of the proposed turbine is 35.05 MW while the rated head is 137.45 m. The runner diameter of the turbine is 2.1 m and the rated discharge per unit is 28.57 m<sup>3</sup>/s. The rated efficiency of the turbine is 91% with the rated speed of 375r/min. The single turbine weight is 110 t.

### 2.5.10. Generator

According to the number of circuits of incoming and outgoing lines and the specific situation of the project, the recommended electrical single line scheme at this stage is as following: unit wiring is adopted for the generator transformer combination, and double -bus wiring is adopted for the high voltage 220kV side. The vertical shaft suspension type generators have rated power 40 MVA and generation voltage 10.5kV. The runaway speed of the generator is 723r/min with 97% efficiency.

## 2.6. Project ancillary facilities and requirements

### 2.6.1. Land requirement

Approved EIA, 2014 envisaged the land use of 42.385 ha for the project development. The new land acquisition report prepared in 2021 suggests that a total of 45.97 ha of land is required for the project that is highlighted in **Table 2.4**. Also, the comparative land requirement details between this SEIA and approved EIA are given in **Table 2.5**.

**Table 2-4: The detail component wise land requirement for the UM-1 HPP**

Project Components	Government			Private				Total (Pvt. + Gov.)
	Forest Land	River	Total	Cultivation Land	Settlement Area	Barren Land	Total	
<b>Permanent Land Requirement</b>								
Submerge Area	0.71	7.71	8.42	0.65	0.00	0.41	1.06	<b>9.47</b>
Headworks	1.54	2.78	4.32	0.04	0.00	0.13	0.17	<b>4.48</b>
Audit and Access Tunnel	0.35	0.00	0.35	0.00	0.00	0.00	0.00	<b>0.35</b>
Powerhouse	0.24	1.00	1.24	0.67	0.21	0.00	0.88	<b>2.12</b>
Owners Camp	0.00	0.00	0.00	0.97	0.00	0.00	0.97	<b>0.97</b>
Access Road	0.66	0.00	0.66	0.38	0.00	0.00	0.38	<b>1.03</b>
<b>Sub-Total (A)</b>	<b>3.49</b>	<b>11.48</b>	<b>14.98</b>	<b>2.71</b>	<b>0.21</b>	<b>0.53</b>	<b>3.45</b>	<b>18.42</b>
<b>Temporary Land Requirement</b>								
Camp	0.59	0.00	0.59	1.78	0.00	0.00	1.78	<b>2.38</b>
Army Camp and Bunker House	0.00	0.00	0.00	0.50	0.00	0.00	0.50	<b>0.50</b>
Access Road	0.81	0.00	0.81	0.21	0.00	0.00	0.21	<b>1.02</b>
Bridge	0.00	0.05	0.05	0.00	0.00	0.00	0.00	<b>0.05</b>
Fuel Station	0.00	0.00	0.00	0.18	0.00	0.00	0.18	<b>0.18</b>
Concrete batching plant	0.69	0.07	0.76	0.30	0.00	0.09	0.39	<b>1.15</b>
Aggregate processing system	0.75	0.40	1.15	0.64	0.00	0.00	0.64	<b>1.79</b>
Warehouse	0.00	0.27	0.27	0.00	0.00	0.34	0.34	<b>0.61</b>
Repair workshop	0.20	0.04	0.24	0.23	0.00	0.03	0.26	<b>0.50</b>
Spoil Area	7.56	3.10	10.66	2.70	1.51	0.00	4.20	<b>14.86</b>
Quarry Site	0.60	0.59	1.19	0.63	0.00	0.00	0.63	<b>1.82</b>
Diesel generator	0.22	0.00	0.22	0.14	0.17	0.00	0.31	<b>0.53</b>

Project Components	Government			Private				Total (Pvt. + Gov.)
	Forest Land	River	Total	Cultivation Land	Settlement Area	Barren Land	Total	
Rebar and Carpenter Yard	0.15	0.21	0.36	0.56	0.00	0.00	0.56	<b>0.92</b>
Mechanical and Penstock Yard	0.43	0.28	0.70	0.49	0.05	0.00	0.54	<b>1.25</b>
<b>Sub-Total (B)</b>	<b>12.00</b>	<b>4.99</b>	<b>17.00</b>	<b>8.37</b>	<b>1.72</b>	<b>0.46</b>	<b>10.55</b>	<b>27.54</b>
<b>Total (A+B)</b>	<b>15.50</b>	<b>16.48</b>	<b>31.97</b>	<b>11.07</b>	<b>1.93</b>	<b>0.99</b>	<b>13.99</b>	<b>45.97</b>

Source: LAP of UM1HP, 2021

**Table 2-5: Comparative Land Requirement of the Project**

SN	Land Type	Approved EIA	SEIA	Remarks
<b>Permanent</b>				
1	Forest (Gov.)	13 ha	3.49	Decreased
2	Cultivation Land	4.54 ha	2.71	Decreased
3	River and Flood Plains	0.055 ha	11.48	Increased
4	Settlement Area	-	0.21	Added
5	Barren Land (Pvt.)	-	0.53	Added
	<b>Sub-Total (A)</b>	<b>17.595 ha</b>	<b>18.42</b>	<b>Increased</b>
<b>Temporary</b>				
1	Forest (Gov.)	16.21 ha	12.00	Decreased
2	Cultivation Land	6.58 ha	8.37	Increased
3	River and Flood Plains	2 ha	4.99	Increased
4	Settlement Area	-	1.72	Added
5	Barren Land	-	0.46	Added
	<b>Sub-Total (B)</b>	<b>24.79 ha</b>	<b>27.54</b>	<b>Increased</b>
	<b>Grand Total (A+B)</b>	<b>42.385 ha</b>	<b>45.97</b>	<b>Increased</b>

Source: Approved EIA, 2014 and LAP of UM1HP, 2021

### 2.6.2. Construction materials

The sand and aggregates are prepared locally at the project site by installing crusher. The cement will be purchased from local manufacturers in Nepal. The reinforcement steel will be purchased from the nearest market, Pokhara, approximately 150 km to the site. A fuel station will be installed in the project site for the diesel and other petroleum products. Coordination with Nepal Oil Corporation and local supplier will be done. The blasting materials i.e., emulsion will be supplied through local explosive suppliers on the guidance of Nepal Army as per their Standard Operating Procedure for the purpose on the designated area shared by the UM-1HPP project. All kinds of building materials are transported by road to the site warehouse. The details of the construction materials required for the projects are shown in **Table 2-6** below.

**Table 2-6: Construction materials required for the project**

SN	Materials	Units	Year 1	Year 2	Year 3	Year 4	Total
1.	Cement	t	0	20,850	54,622	41,443	116,915
2.	Timber	m <sup>3</sup>	0	285	747	566	1598
3.	Steel	t	0	482	1262	958	2702
4.	Reinforcement	t	0	2,534	6,638	5,037	14,209
5.	Explosive (Emulsion)	t	18	329	71	0	418
6.	Fuel	t	86	1595	1666	284	3631

Source: DPR, 2021

### 2.6.3. Internal Access Road and bridge

The project will require different sections of road to access various project structures and facilities. The earth road from powerhouse to headworks site will be reconstructed and expanded to serve as the artery of on-site access connecting headworks, powerhouse works; besides, multiple branch lines leading to construction working faces, contractor's camp, temporary construction facilities, waste disposal area, etc. need be newly built for construction.

On-site access roads have a total length of about 11.7 km, including 9.8 km long permanent road and 1.9 km temporary road; all of them have clay bound macadam pavement. A 60.0m long temporary bridge will be newly built at the position about 500m downstream from dam site; it will have a load class of Automobile-40 and a deck width of 4.5m. The construction of access road will require 2.05 ha of land. The project will not acquire land for the existing 8 km highway that lies between powerhouse and headworks site of the project. For the proposed bridge the project will acquire 0.05 ha land. The details of access roads are tabulated in **Table 2-7** below.

**Table 2-7: Details of the internal access road of the UM1HP**

S/N	Description	Length (km)	Width of pavement (m)	Remarks
<b>I. Road</b>				
1# road	Highway to powerhouse and dam on right bank	8	6.5	Reconstruction and expansion of existing single lane, permanent road
2# road	From 1# road to right bank of 1# temporary bridge	0.4	6.5	Newly-built, temporary road
3# road	From left bank of 1# temporary bridge to the left abutment	0.8	4.5	Newly-built, temporary road
4# road	From 1# road to 1# adit	0.4	6.5	Newly-built, temporary road
5# road	From 1# road to 3# adit	1.1	6.5	Newly-built, permanent road
6# road	From 5# road to the access tunnel to surge chamber	0.7	4.5	Newly-built, permanent road

S/N	Description	Length (km)	Width of pavement (m)	Remarks
7# road	To powerhouse camp	0.3	4.5	Newly-built, temporary road
Total		11.7		
<b>II. Bridge</b>				
1# bridge	About 500m downstream from dam site	0.06	4.5	Newly-built, temporary bridge

Source: DPR, 2021

#### 2.6.4. Quarry and burrow areas (Aggregate, sand, clay)

Only one quarry site is proposed for planned exploitation of the quarry. Based on the quarrying and transportation conditions, bench blasting method is adopted for exploitation of quarry. The obtained materials will be collected with the assistance of 180 hp bulldozer and loaded by 1.6 cubic meter hydraulic backhoe onto 15t dump trucks, which transport them to the aggregate processing system.

The total quantity of quarry from the proposed quarry site is 342,000 m<sup>3</sup>. The total area required will be about 1.82 ha. The area is heavily degraded river bank with no trees or shrubs.

#### 2.6.5. Spoil/Muck disposal areas

Excavated material from the head works, adit, pressure shaft and other project locations have to be safely disposed in identified disposal sites. The total quantity of spoil to be disposed is around 0.51 million cubic meters. 14.86 ha of land is identified in five different locations as mentioned in **Table 2-8** below.

**Table 2-8: Spoil or Muck disposal sites identified for the UM1HP**

S.N.	Description	Area (ha)	Capacity (m <sup>3</sup> )	Quantity of waste stacked (10 <sup>4</sup> m <sup>3</sup> )	Location	Source of waste
1.	Disposal site 1	1.2	14.2	124,000	Left bank of headworks	Headworks
2.	Disposal site 2	1.5	30.0	186,000	Downstream from desilting basin	Headworks, desilting basin and powerhouse
3.	Disposal site 3	0.9	12.0	94,000	Nearby Audit 1	Headrace tunnel
4.	Disposal site 4	0.7	8.6	74,000	Nearby Audit 2	Headrace tunnel
5.	Disposal site 5	4.5	70.0	542,000	Right bank upstream from powerhouse	Powerhouse and penstock

Source: DPR, 2021

The spoil areas after completion of the project construction will be managed properly (merging into landscapes and covered by top soil as far as possible) for use as lay down areas, storages, camp facilities etc.



### 2.6.6. Camps

Permanent residential, office and other facilities need to be established at key project locations, both for project staffs and labor force. The permanent accommodation for the staff of the project and also for the contractor has to be built near the construction sites. During peak construction period, the work force at the powerhouse and the head works sites could be approximately 1500 persons. Three potential sites with an approx. area of 3.35 ha have been identified for project site office/colonies, labor camps and other facilities, at dam site, surge tank area and powerhouse area to accommodate the permanent and temporary quarters.

The contractor has to construct camps for its work force comprising of skilled, semi-skilled and unskilled labors. The camp will be well managed to avoid hazards to maintain environmental integrity. It is envisaged that the civil contractor will have to construct two such camps - one near powerhouse site and another near the headwork site. Other contractors will also have to construct their camps in designated area between powerhouse and headwork. The employer will also construct separate camp for his/her employees and Engineer's staff. The employer's camp will be subsequently converted to the camp required for the operation and maintenance of the power plant. If properly coordinated and provisions are made some of the camp facilities constructed by the contractor also may be used for operation and maintenance of power plant as required.

The area required for the construction facilities will also comprise space for permanent camps for construction management staff, temporary camps for contractors' staff and labors, contractors' offices, yards for construction materials processing and stock piling, workshops, equipment storage, medical facilities etc. It is estimated that an approximate area of 27,500 m<sup>2</sup> will be required for the construction facilities.

### 2.6.7. Construction power

The construction power will be required at the powerhouse location, head works location, adit tunnels, batching plant, crushing plant, camp area and etc. of UM-1HPP for the operation of the machinery and equipment. The peak construction power required during the construction phase of the project shall be around 4,000 kW. There are villages and towns adjacent to the project area; besides, the downstream UM-1HPP has been put into operation for power generation. So, it is possible to connect wires from the locality to project area, which shall be implemented in the next phase. In the current phase, consideration is given to 50% diesel power generation; five 500kW diesel generators are provided in headworks (two generator) and powerhouse areas (three generator).

### 2.6.8. Construction equipment

The key construction equipment required during the project construction period for the construction of the different key project components is presented in **Table 2-9** below.

**Table 2-9: Key construction equipment required for the construction of UM1HP**

S.N.	Equipment Name	Model	Units	Qty.				Total
				Year 1	Year 2	Year 3	Year 4	
1.	Excavator	1.6m <sup>3</sup>	Set	2	8	4	4	8
2.	Bulldozer	88kw	Set	2	4	4	3	4
3.	Loader	2.0m <sup>3</sup>	Set	2	10	10	6	10
4.	Air-leg pneumatic drill	YT-25	Set	10	60	48	12	60

S.N.	Equipment Name	Model	Units	Qty.				Total
				Year 1	Year 2	Year 3	Year 4	
5.	Hand-held pneumatic drill	Q1-30	Set	10	30	20	8	30
6.	Dump truck	5t	Nr.	5	40	40	20	40
7.	Dump truck	10t	Nr.	8	15	12	8	15
8.	Concrete mixer	6m <sup>3</sup>	Nr.	1	5	8	8	8
9.	Shotcrete machine	PH-30	Set	3	14	14	12	14
10.	Immersion vibrator	2.2kw	Set		8	14	12	14
11.	Concrete pump	HB-60	Set		4	12	12	12
12.	Steel form carrier		Set			10	8	10
13.	Hydraulic slip form		Set		1	1		1
14.	Vertical claw rock loader	LZL-120D	Set	1	12	12		12
15.	LM-200 type raises boring machine		Set		1	1		1
16.	Tower crane	SCM H3/36B	Set		2	2	2	2
17.	Geological drill	XY-2	Set		2	3	2	3
18.	Grouting pump	TBW-200/40	Set		4	14	14	14
19.	Mortar mixer	NBS-100/30	Set		4	14	14	14
20.	Axial flow ventilator	2×55 kW	Set	2	10	10	10	10
21.	Water pump	6sh-6	Set	2	12	12	10	12
22.	Winch	10t	Set		1	1	1	1
23.	Percussion drill	CZ30	Set	10	10	10		10

Source: DPR, 2021

### 2.6.9. Human resources

Nearly 1500 skilled, semi-skilled and unskilled workers will be required during peak construction period. About 20 to 25% of the required human resources will be skilled and semi-skilled. The unskilled workforce will be sourced from the local area as far as possible, while for the skilled and semiskilled not available from the local area will be sourced from Nepal. For the semi-skilled and unskilled human resources, local will be given preference. Sector wise, the manpower requirement is shown in **Table 2-10** below.

**Table 2-10: Human resources required during the construction of UM1HP**

Sector	Numbers
Headwork Construction work force	350
Underground construction work force	300
Powerhouse construction work force	250
Electro-mechanical work force	100
Others	500

*Source: DPR, 2021*

### 2.6.10. Major project activities

The construction of the project consists of different activities such as construction of access road including bridges; river diversion facilities; river intake and desander, construction of waterway system consisting of headrace tunnel, surge shaft, penstock shaft; construction of powerhouse, tailrace and switchyard. The construction will also consist of installation of the electromechanical equipment comprising of turbines, generators, accessories like governors, exciters, auxiliary equipment and 220 KV transmission line. In addition, hydro-mechanical installations such as gates, valves, hoisting devices, penstock pipes etc. will also be installed.

### 2.6.11. Project cost

The total project cost including VAT and all taxes is estimated to be NRs. 32,498,209,650.

### 2.6.12. Project area delineation

**Direct Impact Area:** This area has been studied in greater detail regarding the impacts on physical, biological as well as socio-economic and cultural environment. Since most of the project related construction activities, and establishment of project facilities are confined to Rambazaar, Ghermu, Mipra, Chhapdanda, Thakan, Arkhalebesi, Siurungbesi, Thakanbesi and Thulibesi areas, they are defined as direct impact area. Similarly, the river stretches and the immediate areas about from the intake site to the powerhouse site, including the adit site has been categorized as direct impact area.

**Indirect Impact Area:** This category includes the areas which will not receive direct impact of construction activities but may be influenced by the activities of the construction work indirectly. As the route is one of the most important tourist destinations, the villages and settlements between Syange bazaar and Nyadi bazaar could be affected due to project activities. The area consists of settlements within three to four hours walking distance from the project site including Annapurna Conservation Area, were also considered as Indirect Impact area. The physical and biological environments in this area will probably experience minimal impacts. However, some impacts may be felt in the socio-economic and cultural environment because such an area like surrounding villages may supply technical and labor force for the project. Overall, adverse impacts on such areas will be very low, hence such areas were considered as indirect impact areas. **Table 2-12** shows the Direct and Indirect impact area for the project.

**Table 2-11: Direct and Indirect Impact Area for the Project**

<b>Area</b>	<b>Direct Impact Area</b>	<b>Indirect Impact Area</b>
Upstream Zone	Dam site and impounding areas encompassing Rambazaar, Ghermu, Mipra, Chhapdanda	Immediate upstream area from dam site (Both side of Marshyangdi River) including Syange
Downstream zone	Area between intake and Powerhouse, Rambazaar to Thakanbesi, Marshyangdi RM, Lamjung	Immediate downstream area, Marshyangdi RM, Lamjung
Site area	Area and settlements in the project components or project facilities	Area and settlements around the project components or project facilities

### **3. DATA REQUIREMENT AND STUDY METHODOLOGY**

#### **3.1. Desk study and literature review**

Extensive literature review was carried out to gather secondary information on the physical, biological, socio-economic and cultural environment of the project area. Various published literatures related to hydropower projects and project area were reviewed along with the unpublished design reports, municipality and RM profile, map and photographs etc. The relevant legal provisions, EIA Guidelines and manuals, approved ToR, feasibility study reports and previously prepared EIA report of Upper Marshyangdi -1 Hydropower Project were thoroughly reviewed.

The desk study was the first step of the study and major sources of information reviewed consists of the following:

- EIA report of UM-1HPP approved by MoFE for support to overall baseline information on physical, biological, socio-economic and cultural domains
- Updated detail project report of UM-1HPP prepared by the proponent to acquaint with the project design and activities, and the changes made
- Review of reports and documents relevant to this project to the extent possible and available
- Relevant policies and legislations enacted after approval of previous EIA
- Preparation of questionnaire and checklist for focus group discussion and data collection on physical, biological and socio-economic and cultural baseline environment of the project area;
- Tentative delineation of geographic boundary of the influence area on topographic maps.

The specific published reports that were thoroughly studied for baseline data collection on all three domains are as follows:

##### **3.1.1. Physical Environment**

- Geology of the Nepal Himalayas (Dhital, 2015)
- Landslide Susceptibility assessment of the region affected by Gorkha earthquake of Nepal (Regmi et.al., 2016)
- Topographical map of 1:50,000 scale to familiarize with the land use and other features along the project alignment
- Application of GIS and Remote Sensing for Hydropower Development in Nepal (Pathak, 2009)

##### **3.1.2. Biological Environment**

- Herpetofauna of Nepal (Shah & Tiwari, 2004)
- Flowering Plants of Nepal (Rajbhandari et. al., 2019)
- Birds of Annapurna Conservation Area (Baral, 2018)
- Birds of Nepal (Inskipp and Inskipp, 2016)
- Wild Mammals of the Annapurna Conservation Area (Baral et.al., 2019)

##### **3.1.3. Socio-economic and Cultural Environment**

- National Population and Housing Census 2011
- Population Monograph of Nepal Volume I & II (2014)
- Sustainable Development Plan of Mustang (2008-2013)

#### **3.2. Identification of Project affected families**

As other developmental projects, the proposed project will also have the environmental implications that may either be beneficial or adverse. Although the indirect effect of the proposed project on the whole catchment, however the study is more concerned within the project boundary and impact zones here are classified as the upstream zone, dewatered zone and the downstream zone. But based on the project activities, the area is further classified into 2 categories which are as follows:

### **3.2.1. Direct Impact Area (DIA)**

All the areas where major activities related to the project will be taking place were considered as the Direct Impact Area. The area was identified in a way that it covers impacts mainly on the socio-economic environment followed by the impacts on physical and biological environments. Since all the project activities and establishment of project facilities generates impact on areas including Rambazar, Mipra, Ghernu, Siurungbesi, Thakanbesi, Thulibesi areas, these villages were categorized under DIA. All the environment lying withing these areas will experience major impacts due to the project.

### **3.2.2. Indirect Impact Area (IIA)**

The areas which will not receive direct impact of construction activities but may be influenced by the activities of the construction work indirectly were considered as the indirect Impact Area. This category includes the outlying areas, which are far from the project for interactions on a daily basis and consists of settlements within three to four hours walking distance from the project site. The physical and biological environments in this area will probably experience minimal impacts. However, some impacts may be felt in the socio-economic and cultural environment area.

### **3.3. Preparation of checklist and questionnaires**

A thorough survey of the proposed project area was carried out to gather information on socio-economic aspects, which mainly consisted of social surveys of the likely affected families, focused group discussions and household surveys. For this, specific checklists and questionnaires were prepared based on the suitability to the communities of the area.

For the collection of biological environmental data, structured checklist along with the standard forms were prepared. The checklist was drafted on the basis of data requirement like vegetation status and types, species distribution, medicinal plants and other NTFPs, etc. For this purpose, available literature including previous EIA document of the project were thoroughly studied and preliminary field visit was conducted. The data of trees to be felled down during the construction of the project was collected with the help of standard forms.

Semi-structured questionnaires were prepared with the help of Hydropower EIA Manual (MoFE, 2018) to gather information on status of wildlife habitat and conflicts, aquatic habitat, herpetic and avifaunal diversity.

### **3.4. Field visit and data collection**

After the receival of the permission letter from Ministry of Forests and environment, the multidisciplinary team comprising of wildlife expert, environmentalist, hydropower engineer and taxonomist visited the project area to collect baseline information on physical and biological environment. A thorough survey of the proposed areas were conducted to gather information, which mainly consisted of the quantification and evaluation of the site-specific impacts. Several visits were scheduled and carried out for the collection of baseline data regarding socio-economic and cultural environment.

### 3.4.1. Physical environment

An intensive field visit and investigation along the proposed project area was carried out in order to collect baseline information on the physical environment. The details of the land use pattern, topography and soil erosion were carried out through direct observation and field mapping. As the baseline data on geomorphology, hydrology, geology, watershed conditions and natural hazards have already been presented on the previous EIA of the proposal, those data were taken into consideration. In addition, further geological investigation was carried out by the experts and the slope stability and landslides, fan deposits and rock fall within the project area were studied through site observation and on-site delineation in maps. Further discussions were carried out with local communities to obtain information on flooding events, GLOF events, seismic history, landslide events and land degradation process etc.

Ambient air quality sampling was conducted using the air quality samplers at the headworks and Powerhouse site. Three parameters were taken into consideration including the Total Suspended Particle, PM10 and PM 2.5, in accordance to the National Ambient Air Quality Standards, 2003. For noise monitoring of the area, measurements were taken with the help of a ‘Sound Meter’ application in mobile phone in monitoring locations set at the Powerhouse and Headworks sites. The noise readings were taken for an hour in a location during the daytime and night reading was taken at headworks site.

The sample of water was collected from the headworks and powerhouse site and it was further analyzed in the laboratory. The details of the water resources in the project vicinity were recorded with visual observations.

### 3.4.2. Biological Environment

Data requirement for the biological environment were categorized as follows:

#### 3.4.2.1. Vegetation

Enumeration of tree species to be felled down during the project construction was conducted and the species composition, vegetation types etc. were determined. A checklist was used to generate field level information on major plant species, forest conditions and types. A Field Manual published by the Forest Research and Training Centre in 2019 was followed for the sampling methodologies and scientific study of the vegetation within the study area and accordingly, stratified systematic cluster sampling design was applied for the vegetation study. A total of 6 sample plots were identified in the project area. A 100 m × 100m grid was applied at an interval of 100 meter. Within the grid, a 10m×10m square sample plot was deployed and the tree species lying inside the plot was listed and inventoried. A 5m×5m square plot was deployed for the shrub species and 1m×1m square plot was deployed for the herbs. Diameter at breast height (DBH) of sampled tree was measured at 1.3meter height from the ground level, height of the tree was noticed and the above ground biomass, below ground biomass and total biomass were estimated according to the formula provided by Chave et al. (2014). Ecological parameters such as crown coverage, aspect, slope, inclination etc. were also recorded for detail analysis. Adopting the Forest Rules, 2051, the quarter girth formula for the timber plants were adopted for analysis including quarter girth formula, i.e.  $(D/4)^2 \times L$  where D is the girth and L is the length of

The volume and biomass of the affected tree species (timber, fodder and litter) were quantified together with the loss of forest. Tree species having more than 30 cm diameters at breast height (DBH) were counted and measured as tree. Tree species with DBH range between 10 cm – 30 cm were counted and measured as pole and rest were counted as saplings. Based on this information, loss of tree species, loss of standing wood volume was calculated for each tree species using the suitable equation and formulas.

Ground flora was identified in the field as far as possible and unidentified trees and other species was later identified with the help of standard literatures like A Handbook of the Flowering Plants of Nepal (Rajbhandri & Rai, 2017), Global Diversity Information Facility (GBIF) website etc. NTFPs of the area were identified with the help of available literatures such as EIAs of surrounding projects and ethnobotanical exploration reports.

### **3.4.2.2. Wildlife**

#### **Mammals**

Both primary and secondary data were used for the collection of information related to wildlife. Primary data was collected from direct observation along the project alignment by visiting the project site, as Sutherland (1997) suggests the method for collecting mammalian information. Information on wildlife was reported by site seeing and consultation with the people around and staffs of the conservation area. In order to collect the information on presence of mammals, linear transect walk method was followed. For this, the project area was divided into three transects each of 1 kilometer length. A length of transect was visited by two biologist and the transect was visited twice in a day, and each visit lasted for a time period of two hours. The walk was performed mainly in the early morning and evening. The route covering the greatest diversity of wildlife as prescribed by the officials was chosen and transect was divided into segments. The presence of wild animals seen on the project area along the alignment was noted down. Besides, pugmark/footprints, droppings/pellets, ground digging and uprooting, tree scratching and marking, remains (skin, fur, remnants), nests holes and burrows, etc. were also recorded. In addition, call counts, cries, smell/ odor, etc. were considered for the confirmation of their presence.

#### **Fish and aquatic life**

Information regarding the distribution of different species of fishes in the area was obtained by holding interviews with the people utilizing Marshyangdi River and discussions with the local fisherman. Additionally, the archives of photographs among them were taken and identified in accordance to literatures and consultations. Further, the information regarding the status and distribution of fish was already identified by the previous study on the same section of the river, and the data was obtained from the approved EIA Report, 2014.

#### **Birds**

Occurrence of birds in the project area were studied by field observation, consultation with local people and review of relevant literatures. During the field observation, sightings and call were noticed during the three lines transect survey of 1km along the alignment. The alignment was visited and birds sighted were noted down. They were photographed and identified with the help of Birds of Nepal by Grimmet et. al. (2016) and Birds of Annapurna Conservation Area by Baral (2018).

#### **Reptiles**

Information regarding the presence or distribution of herpetofauna in the project area was obtained from the relevant literatures like Herpetofauna of Nepal by Shah and Tiwari (2004). Further, consultations with local people, photo archive by them was taken as trusted source for the presence of the herpeto-faunal species.

FGDs were conducted with local people, project local field staff, Conservation Area Management Committee, etc. and field guide books containing photographs of the wildlife were shown during FGDs. Further, data recorded from the field were compared with the available secondary literatures and their presence were confirmed.



Field guidebooks Shrestha (1994) for fishes, Jnawali et.al. (2006) for mammals and Grimmett et. al. (2016) for birds were followed.

### **Butterflies**

The data collection of the butterflies is based on recording its presence or absence at visited site. Also, we have used A Photographic Pocket Guide to Butterflies of Nepal published by Collin smith during the site visit.

### **3.4.3. Socio-economic and cultural environment**

The following data were envisaged to carry out the environmental evaluations of the project due to change in design and capacity.

- Land use and land capability of Project Impact RM.
- Demographic characteristics (population, ethnicity, literacy, religion, health and sanitation, occupational status, income and expenditure, economic activities etc.) of Project Impact RM.
- Demographic characteristics (population, ethnicity, literacy, religion, health and sanitation, occupational status, income and expenditure, economic activities etc.) of Project direct impact Households
- Infrastructure and support service facilities of the Project Impact RM.
- Infrastructure and support service facilities of Project direct impact areas
- Agriculture practice and production of the Project Impact RM.
- Agriculture practice and production of Project direct impact areas
- Prevailing market price of land and property in the Project direct impact areas

The required data for socio-economic status and cultural aspects were collected from the highly impacted areas and methods adopted included mostly the household surveys and key informant interviews. To start with the surveys and data collection, the land areas to be permanently acquired was identified in the field with the help of cadastral maps that were obtained from Department of Survey and District Survey Office, Lamjung. The project affected families were then identified and baseline information on demographics, ownership pattern, economic status, energy sources, health status, economic status, etc. were collected from them. Along with this, data on social groups and strata, migration, settlements, sources of income, resource independence, energy access, agriculture, land holdings, gender roles and social issues were explored. Most importantly, the project related issues like compensation and expectations from the project were also addressed by the questionnaire interviews with them. Using the purposive sampling method, the representative of each of the household whose land has to be utilized by the project were taken into consideration for sampling.

Field study also focused on the collection on information regarding the community infrastructures and services like drinking water, educational institutions, health infrastructures, youth initiatives, existing developmental projects, cultural sites, etc. The baseline tools for the data collection were FGD Checklists, KII checklists and household survey questionnaires and they were adopted from Hydropower EIA Manual (MoFE, 2018), taking into account the local sensitiveness of the project impact area, existing social and environmental conditions.

### 3.5. Data analysis

#### 3.5.1. Physical Environment

The data obtained from the approved EIA, literature review and the field investigations on the topography and geomorphology, climate and hydrology, Geology, Soil, Erosion and Land instability, Air quality, Water quality, Noise level and Natural hazards were collated to generate comprehensive sets of databases in the respective field. Geomorphic features were analyzed which led to the development of digital terrain model that indicated the potential for slope and landslide hazards. The laboratory tests of the rocks and soil provided data which were classified to evaluate sub surface conditions. The shear strength testing performed on undisturbed soil samples determined cohesion, shear strength and stress-strain modulus, and these helped to develop foundation design data.

The climatic and hydrological records of the area were analyzed to generate spatial and temporal variations that characterize the area. Geologic maps were prepared to identify the weak geologic formations and zones that are critical in terms of geologic instabilities. Based on the industrial and anthropogenic activities of the area, the air quality and noise levels of the project area were evaluated. The water quality of the river was analyzed in terms of presence of water-soluble sulphates, nature, oxygen capacity, presence of microorganisms, minerals, etc. and the data obtained were evaluated in terms of key pollution indicators.

#### 3.5.2. Biological Environment

According to the Community Forestry Inventory Guideline, 2004, and Field Manual, 2019 by Forest Research and Training Centre, the inventory of the forest patches was carried out. For the estimation of the Above ground Biomass of the tree species found along the project alignment, allometric equation was applied in accordance to the diameter at breast height (DBH) and the height of tree (H). The allometric equation for Above ground biomass (AGB), given by Chave et. al. (2014) is,

$AGB = 0.0673 \times (\rho D^2 H)^{0.976}$  where  $\rho$  is the specific wood density, D is the diameter at breast height and H is the height of tree.

Also, according to him, the below ground biomass (BGB) of the species is 20% of the AGB and the total biomass is the sum of these two. The biomass of the tree, poles and saplings are separately identified and they are presented in the annex of the report.

The Above ground Tree Biomass (AGTB) was calculated by multiplying AGTC by carbon fraction 0.47 according to Subedi et. al. (2010).

$$AGTB = 0.47 \times AGTC$$

For the estimation of Basal area and Standing Volume of Timber along the entire alignment, equations from Forest Rules, 1995 was adopted.

$$\text{Basal Area (BA)} = \pi R^2 = 3.14 \times (\text{DBH}/2)^2$$

$$\text{Standing tree Volume (V)} = \text{BA} \times \text{H} \times f$$

Where, H is the height of the species and f is the simplest coefficient used for measuring the stem form.

Data were entered in MS- Excel and analysis was carried out.

Different types of analysis were carried out in order to assess the impacts of the project into biological resources. The habitat requirements of the species (both plants and animals) were thoroughly studied which

included habitat quality, geographical ranges, geography, surrounding land use patterns and prevalent awareness level among the local people.

The significance of potential impacts on biological resources was determined by an evaluation of the overall biological value of a habitat area in comparison with significance threshold criteria. Factors such as disturbance history, biological diversity, importance to particular plant and wildlife species, uniqueness or sensitivity status, as well as the surrounding environment and the presence of special-status resources were assessed and magnitude of impact was calculated in accordance with this. The magnitude of impacts and extent of impacts on individuals or populations of plant and animal species due to project was taken into consideration. The number of individual plants or animals which may potentially be affected, how common or uncommon the species is both on the project area and from a regional perspective, and the sensitivity status if the species is considered special status by agencies like CITES, IUCN and Government of Nepal were put into major focus and points were noted down. Evaluations were done based on the results of biological surveys and studies, results of literature and database reviews, and established and recognized ecological and biodiversity theories and assumptions.

The analysis carried out on the basis of above-mentioned criteria were summarized using an Impact Assessment matrix considering the magnitude, extent and duration.

### **3.5.3. Socio-economic and cultural environment**

The standard methods and techniques as suggested by the National EIA Guideline (1993) and Hydropower EIA Manual (2018) were adopted for the analysis of the obtained socio-economic and cultural data. After the entire field exercise was completed, the data were entered into Microsoft excel and securely stored.

These analyses were performed in a way that it could reflect the social and economic status of the people in the project areas. The data from surveys of project affected households were tabulated using the statistical tools and analyzed to reflect the basic lifestyle, work engagement, educational status, status of women and children, health and sanitation, willingness for the project, expectations, etc. The analyses are further presented as result in the baseline environmental conditions.

### **3.6. Impact identification and analysis**

The baseline environmental data of the project area obtained after the field visit resulted in different environmental parameters. These environmental parameters suggested the impacts on three environmental domains and along with this, expert judgement, learnings from projects of similar nature, project activities and project layout, public consultations, etc. were the keys to identifying the project impacts. Further, the Hydropower EIA Manual (2018) was consulted as a guideline for the categorization of impacts based on its nature, magnitude, extent and duration. The nature of the impact was considered as direct or indirect and each of the direct and indirect impacts was further evaluated in terms of its extent as site specific, local or regional. Each of these was further analyzed in terms of duration as short-term, medium-term and long-term. The magnitude of each of the impact was then evaluated as high, medium and low based on the conditions of the environmental parameter at present and estimated or projected changes with the project. For the analysis of the impacts, a numerical scale developed by the National EIA Guideline, 1993 was adopted which helps to identify the significance of the impacts based on cumulative results of the magnitude, extent and duration. Being the maximum score of 140 and a minimum of 25, impacts ranging cumulative score below 45 were considered as insignificant, between 45 to 75 were considered as significant/ moderate while score above 75 were considered as highly significant impacts.

### **3.7. Consultation and Public hearing**

#### **3.7.1. Consultation and focus group discussions**

The EIA team conducted series of consultations with the local government and local communities including stakeholders from Ministries and their Departments, District level Offices, etc. Public consultations were constantly implemented to keep local communities informed about the planned project features and activities in their areas. Community based participatory meetings were arranged related to land acquisition, planning of relocation for affected families and mitigation actions related to individual communities. The information obtained from the public consultation were included in the EIA report. After preparation of the draft EIA report, the Proponent were given access to the document and were requested for open comments and suggestions.

#### **3.7.2. Public Hearing**

According to EPR, 2020, at least one public hearing should be conducted in project areas to solicit public concerns and suggestions prior to the finalization of SEIA. For this project, the team conducted a public hearing in the Thakan Village of Marshyangdi Rural Municipality, Ward 3. A public notice was published prior to the hearing on 22<sup>nd</sup> October, 2021 in Lamjung Darpan National Daily newspaper and same notice was further disseminated to different government offices of the area. The same notice was posted in different places of the project affected wards to ensure that the notice of meeting was sufficiently widespread. In addition, information about the public hearing was disseminated through local radio Marshyangdi FM in Lamjung. A public hearing was conducted on 29<sup>th</sup> October 2021 in the presence of various stakeholders from different communities including project affected families, affected wards, nearby schools, hospital, etc. Along with this, the representatives from the Central, Provincial and Local Government bodies were present in the hearing and suggestions from them were incorporated. There were 152 male and 63 female populations present at the event and different comments/suggestions were collected on their behalf.

During the public hearing, a summary of the SEIA Report was presented in Nepali language and factsheet was disseminated among all the participants. The summary had focused on the possible impacts and proposed mitigation measures were presented by the experts and the participants were allowed to share their comments with the experts. The summary of the public hearing, notice prior to public hearing, and list of participants present in the hearing is presented in the **Annex 4**.

#### 4. REVIEW OF PLAN/POLICIES, LEGISLATIONS, STANDARDS AND GUIDELINES

##### 4.1. Plan/policies, legislations and guidelines

*Chapter 4* reviews the policies and legislative provisions of Nepal that have a direct relevance with the proposed project. The brief description of the plans, policies, legislations, guidelines, standards and conventions are shown below.

Constitution of Nepal	Part (3), article 30 of the constitution provides fundamental rights to every citizen of Nepal to live in a clean environment. Similarly, part (4), article 51 (g) (5) of the constitution requires the state to give priority to the protection of the environment and the prevention to its further damage due to physical development activities by increasing the awareness of the general public about environment cleanliness. The state shall also decide for the special protection of the environment and wildlife. Provision shall be made for the protection of the forest, vegetation and biodiversity, its sustainable use while mitigating possible risks to environment from development activities.
15 <sup>th</sup> Plan, 2019/20-2023/24	Prioritizes the infrastructure development including hydropower with specific vision, goals and objectives to contribute the prosperity of nation through sustainable and reliable development. It has put forth the 5 strategies and their respective working policies.
Hydropower development Policy, 2001	Focuses on hydropower development with various strategies and policies. Policies include environmental provision related to environmental impact assessments, water rights, investment in generation, transmission and distribution, etc.
Climate change policy, 2011	To improve livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emissions socio-economic development path and supporting and collaborating in the spirits of country's commitments to national and international agreements related to climate change.
National Wetland Policy, 2003	To conserve and manage wetlands resources wisely and in a sustainable way with local people's participation. The policy also aims to put the conservation and management aspects of wetlands conservation within the framework of broader environmental management.
Hydropower Development Policy ,2001	To generate electricity at low cost by utilizing the water resources available in the country, to extend reliable and qualitative electric service throughout the Kingdom of Nepal at a reasonable price, to render support to the development of rural economy by extending the rural electrification. The environmental provision of this policy states that the provisions to implement the programs identified under the EIA
Forest Sector Policy, 2015	Meet the needs of the people with regards to fuel wood, timber and fodder; to contribute to food production; to protect land from degradation by soil erosion,

	floods, landslides, desertification, and other ecological disturbances; to contribute to the growth of local and national economies in addition to promoting people's participation in land and forestry resource development;
Nepal Environmental Policy and Action Plan, 1993	To manage natural and physical resources efficiently and sustainably, to balance development efforts and environmental conservation, to safeguard national heritage, to mitigate the adverse environmental impacts of development projects and human actions and to integrate concerns for the environment with development plans through appropriate institutions.
National Biodiversity Strategy and Action Plan 2014-2020	To significantly enhance the integrity of Nepal's ecological systems by 2020, thereby contributing to human well-being and sustainable development of the country. The different strategy for management of rangeland biodiversity, wetland ecosystem, mountain biodiversity etc. is included in it.
National Conservation Strategy, 2014	Involves comprehensive consultation in all regions of the country and established an agenda to facilitate the integration of conservation into socio-economic development initiatives. National Conservation Strategy implementation program has resulted in major policies and institutional reforms, such as the introduction of a national system of environmental impact assessment.
Water Resources Strategy, 2002	Adopted environmental principles related, inter alia, to the integration of ecological aspects at every level of hydropower development process, conserve biodiversity, watersheds, and adopt ecosystem approach. The activities are also related to ensure compliance with environmental regulations, promote community participation for the sustainable management of watersheds and aquatic ecosystems.
Local government operation Act, 2017	Contains several provisions for the conservation of soil, forest and other natural resources and implements environmental conservation activities and local drinking water related policies, law, criteria, planning, implementation and regulation, electricity distribution system and service management, etc
Labor Act, 2017	Passed for provisions for the rights, interest, facilities and safety of workers and employees working in enterprises of various sectors, continues the general terms of hiring of foreign nationals by a local entity that the foreign nationals can only be hired if the Nepalese citizen could not be available for any skilled technical post even after publishing an advertisement in the national level public newspapers and journals. If 20 or more employees are engaged, employer shall constitute a Safety and Health Committee as per sec 74 of the New Labor Act.
Solid Waste Management Act, 2011	The local body shall, while fixing segregation at least of organic and non-organic solid waste at its source under Section 6, must make management and segregation of harmful or chemical waste separately. If it is prescribed as above, the individual, organization or agency generating such solid waste, shall have to make segregation as prescribed. The responsibility of managing the chemical or harmful

	<p>solid waste under Sub-Rule (1) shall be of concerned generator. The Local Body shall follow up on whether the individual, organization or agency which has obtained permission under Sub Rule (3) for the management of harmful chemical, organic or inorganic waste, has managed according to the permitted ways, standard, process, and technology compatible with the site for the management.</p>
Plant Protection Act, 2007	<p>The preamble of this act explains that it is expedient to make legal provisions for preventing the introduction, establishment, prevalence and spread of pests while importing and exporting plants and plant products, promoting trade in plants and plant products by adopting appropriate measures for their effective control.</p>
Aquatic Animal Protection Act, 1997	<p>Section 5'B' emphasizes that anybody which builds a dyke for electricity, water supply, irrigation or any other purpose shall build a fish ladder to the extent possible so that the movement of aquatic animals is not affected. The body shall make an aquatic animal hatchery and aquatic animal nursery in such place or in an area in vicinity thereof for the purpose of having artificial breeding of aquatic animals where it is not possible to build such ladder.</p>
Environment Protection Act, 2019	<p>Preparation of EIA Report according to Rule 3, Subrule 4 of Rule 3 states process to conduct Public Hearing, Rule 4 states about alternative analysis of the projects, Rule 5 about Scoping document and ToR</p>
National Park and Wildlife Conservation Act, 1975	<p>The act states provision regarding the conservation of floral and faunal species inside the protected area. It is expedient to make arrangements for management of national parks, conservation of wildlife and their habitat, promote, develop and make appropriate arrangement for uses of places inside.</p>
Forest Act, 2019	<p>Rule 65 of the Forest regulation stipulates that in case the execution of any project having national priority in any forest area causes any loss of harm to any local individual of community the proponents of the project itself shall bear the amount of the compensation to be paid. Similarly, the entire expenses required for the cutting and transporting the forest product in forest area to be used by the approved project should be borne by the proponents of the project. Section 49 of the Act prohibits reclaiming lands, setting fires, grazing, removing or damaging forest products, felling down trees of plants, wildlife hunting and extracting boulders, sand and soil from the National Forest without the prior approval.</p>

<p>Water Resources Act, 1992</p>	<p>Section 19 (1) mentions that the governments through notification in Nepal Gazette prescribes pollution tolerance limits for water resources. Similarly, section 19 (2) requires any person abides by the rules and not to pollute water resources beyond specific limits. Section 20 states that while utilizing water resources, there should not be significant adverse impact on the environment such as soil erosion, flood, landslide, etc. Section 16, 19 and 20 of the Acts are related to the land acquisition. The government shall, according to existing laws, acquire land for the licensed person or institution and many compensations in this regard shall be paid by the licensed person.</p>
<p>Soil and Water Conservation Act, 1982</p>	<p>The section 2(B) of the act defines the soil and water conservation. According to Section (3), GoN can acquire area/ land by giving notice for the purpose of water conservation. But for such acquisition compensation shall be paid in case private land in consultation with local authorities. This act provides legislative measures concerning soil and watershed conservation to control natural catastrophes such as floods, landslides, and soil erosion and to maintain the economic viability and welfare of the public. Section (10) of the act elaborates the activities that are considered illegal in the area which is suspected for a natural disaster.</p>
<p>Conservation Area Management Rule, 1996</p>	<p>Regarding the boundaries and management of conservation areas, committee formation, preparation of management plan and implementation of the conservation area.</p>
<p>Convention on International trade in endangered species of wildlife flora and fauna, 1973</p>	<p>The species are protected by CITES against over exploitation and they are listed in three CITES Appendices I, II and III for different levels or types of protection. Appendix I lists species that are the most endangered among the CITES listed animals and plants. These are threatened with extinction and CITES prohibits commercial international trade except for scientific research. Appendix II lists species that are not threatened with extinction at present but may become so unless trade is closely controlled. Appendix III lists species that are included at the request of a Party that regulates trade and that needs cooperation of other countries to prevent unsustainable or illegal exploitation.</p>
<p>Solid Waste Management Regulation, 2013</p>	<p>The local body shall, while fixing segregation at least of organic and non-organic solid waste at its source under Section 6, have to make management and segregation of harmful or chemical waste separately. If it is prescribed as above, the individual, organization or agency generating such solid waste, shall have to make segregation as prescribed. The responsibility of managing the chemical or harmful solid waste under Sub-Rule (1) shall be of concerned generator. The Local Body shall follow up on whether the individual, organization or agency which has obtained permission under Sub Rule (3) for the management of harmful chemical, organic or inorganic waste, has managed according to the permitted ways, standard, process, and technology compatible with the site for the management.</p>



## 4.2. Standards

### 4.2.1. National standards of different environmental parameters

**Table 4-1: Parameters and values specified by Nepal Drinking Water Quality Standards**

Category	Parameters	Units	Maximum Concentration Limits	Remarks
Physical	Turbidity	NTU	5 (10)	
	pH	-	6.5-8.5*	
	Color	TCU	5 (15)	
	Taste and Odor	-	Non-objectionable	
	Electrical Conductivity	mg/L	1500	
Chemical	Iron	mg/L	0.3 (3)	
	Manganese	mg/L	0.2	
	Chromium	mg/L	0.05	
	Fluoride	mg/L	0.5-1.5*	
	Ammonia	mg/L	1.5	
	Nitrate	mg/L	50	
	Copper	mg/L	1	
	Total Hardness	mg/L	500	
	Calcium	mg/L	200	
	Aluminum	mg/L	0.2	
	Mercury	mg/L	0.001	
	Zinc	mg/L	3	
	Residual Chlorine	mg/L	0.1-0.2*	In system using chlorination
Microbiological	E. Coli	MPN/100 ml	0	
	Total Coliform	MPN/100 ml	95%	In sample collection

### 4.2.2. National Standard of Sound in Nepal

**Table 4-2: Description of National Sound Level Criteria of Nepal**

S.N.	Area	Permitted Sound Level (Average level in decibels)	
		Day Time	Night Time
1	Industrial area	75	70
2	Business area	65	55
3	Rural settlement area	45	40
4	Urban settlement area	55	50
5	Mixed settlement area	63	55
6	Protected area	50	40

**Table 4-3: Sound Level Criteria due to Different Equipment in Nepal**

S.N.	Equipment	Maximum Sound Level (Primary level in decibels)
1	Water motor	60
2	Diesel generator	90
3	Means of entertainment	70

#### 4.2.3. National standard of air in Nepal

**Table 4-4: Description of National Standards Regarding Air Quality**

Parameters	Units	Average Time	Maximum Value of Ambient Air
Total suspended particles	$\mu\text{g}/\text{m}^3$	Annual	-
		24-hours*	230
P.M. 10	$\mu\text{g}/\text{m}^3$	Annual	-
		24-hours*	120
Sulphur dioxide	$\mu\text{g}/\text{m}^3$	Annual**	50
		24-hours*	70
Nitrogen dioxide	$\mu\text{g}/\text{m}^3$	Annual	40
		24-hours*	80
Carbon monoxide	$\mu\text{g}/\text{m}^3$	8-hours*	10,000
Lead	$\mu\text{g}/\text{m}^3$	Annual**	0.5
Benzene	$\mu\text{g}/\text{m}^3$	Annual**	5
P.M. 2.5	$\mu\text{g}/\text{m}^3$	24-hours*	40
Ozone	$\mu\text{g}/\text{m}^3$	24-hours*	157

## **5. BASELINE ENVIRONMENT**

This section compares the existing environmental status of the project area to the environmental baseline of the approved EIA report, based on the site-specific information gathered during SEIA field level studies. The objective of the environmental baseline description in this section is to provide basis for the identification and prediction of the changed environmental impacts of the project.

### **5.1. Physical Environment**

#### **5.1.1. Physiography and Topography**

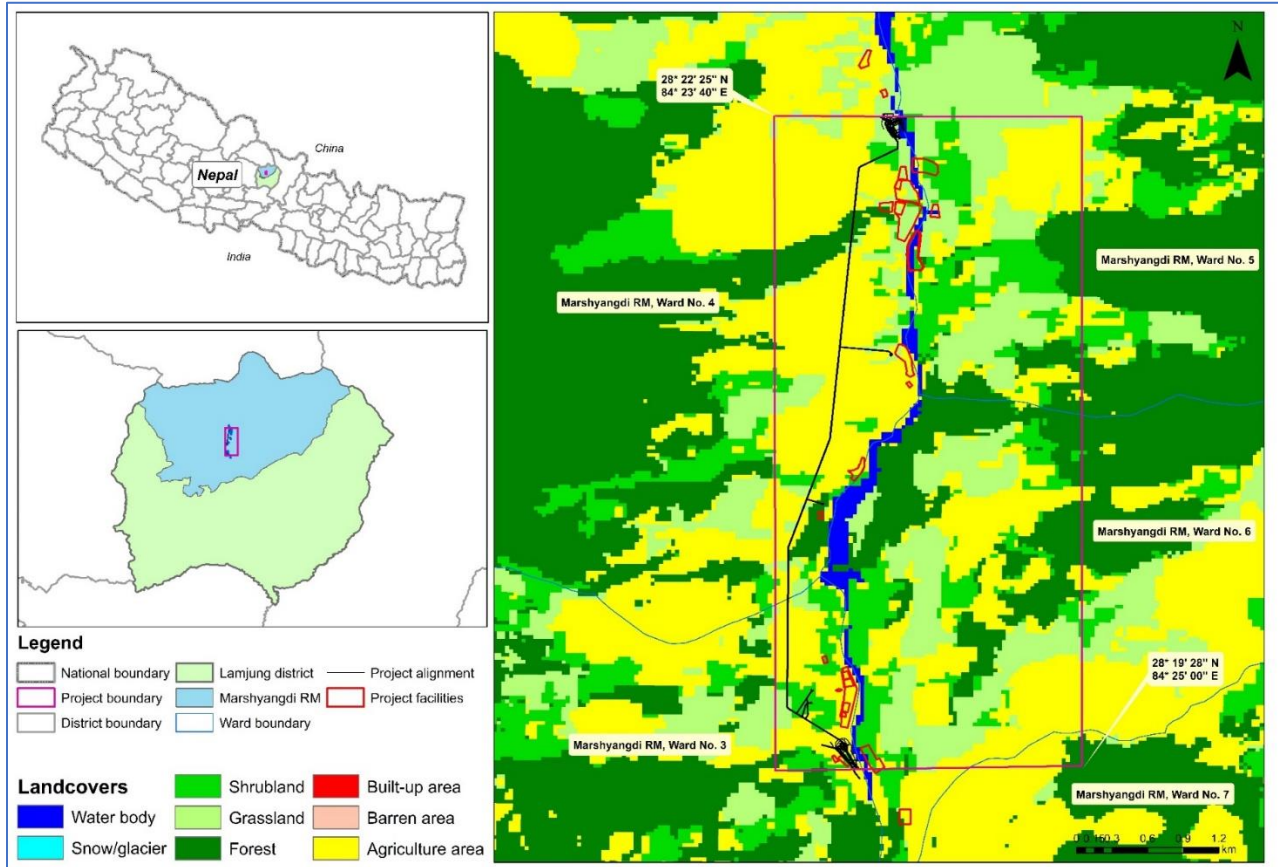
The proposed project area lies in the upper stream of Marshyangdi river, which is snow fed by the higher zones of Annapurna Region and Tibet. The watershed area of the river has topography of steep slopes with mostly rocky terrain, sharp crested ridges, narrow steep river valleys, and little area of gently sloping lowland in the valleys. The headwork area of the river is characterized by high hills with glaciers and their deposits at the base and steep valleys with slope deposits. The river valley with around 6 km length from the intake to powerhouse site has high gradient. The major geomorphic units of the project area are steep rocky slopes, scree and talus deposits, alluvial fan deposits, rock avalanche deposits, fluvial and lacustrine terrace deposits. In contrast, project area is characterized by moderate topographic relief with wider river valley except near Bahundanda, where a deep and narrow valley with steep rock cliff appears for short sector of the river corridor. River gradient also suddenly increases from the surrounding of Bahundanda area than its upstream. The Marshyangdi River flows from north to south in the project area. River terraces, alluvial fans and floodplains are the other geomorphic elements of the project area. The gently sloping alluvial and colluvial mountain slopes are used for cultivation purpose. Majority of the project area lies in slope areas with little lowlands of the river valley area. The altitude of mountainous areas of the surrounding project site has a range from about 2,100 to 3,100 m above mean sea level (masl).

The Syange Khola, Tarwali Khola, Raidu Khola, Tapre Khola, Ghopte Khola, Nalu Khola, Dod Khola, Siurun Khola and Tatpani Khola are the major tributaries of the Marshyangdi River in the project area. Debris slides are common and active near headworks areas in Syange khola and Raidu Khola. Hence these rivers have been contributing significant number of sediments into the Marshyangdi River. Rock falls are common in the steep and deep valley slope area of the Marshyangdi River particularly in the Bahundanda area. Being a typical Himalayan River with gravel – boulder bed and relatively steep slopes, the river has a potential to carry large amounts of suspended and bed loads during floods. The fine sediments are derived from land erosion of river benches and riverbed. However, landslides and rock falls are less frequent in the basin. The headwork area is the upper limit of the aquatic fauna in the river stretch may be because of the high river gradient and extreme climatic conditions of the highlands. The project lies within the access road connecting Chame with Besisahar. The road from Khudi to the Headwork site needs to be strengthened at the time of construction.

#### **5.1.2. Topography and Land Use**

Project area is characterized by rugged topography with steep slopes to vertical cliff containing residual soil and exposing hard rock. Elevation differences between the valley floor and surrounding ridges exceed over 5000 m in the upper part. Water originating on the project area is drained off to the south only by the Marshyangdi River. The proposed diversion weir site is typically narrow, steep Himalayan River-Valley. The valley slopes are very steep, rocky and "V" shaped and the valley slopes are dissected by very few rolling alluvial fans, which are the sites of settlements. Mipra, Chhapdanda, Rambazaar, Ghermu, Arkhale, Thakan and Siurungbesi are the major populated and cultivated areas in and around the project area. Land to be utilize

by the project are mainly agricultural land followed by river bank. The land use map of the project site is given in **Figure 5-1** below.



**Figure 5-1: Land use map of the project site showing all the project components**

### 5.1.3. Erosion and land stability

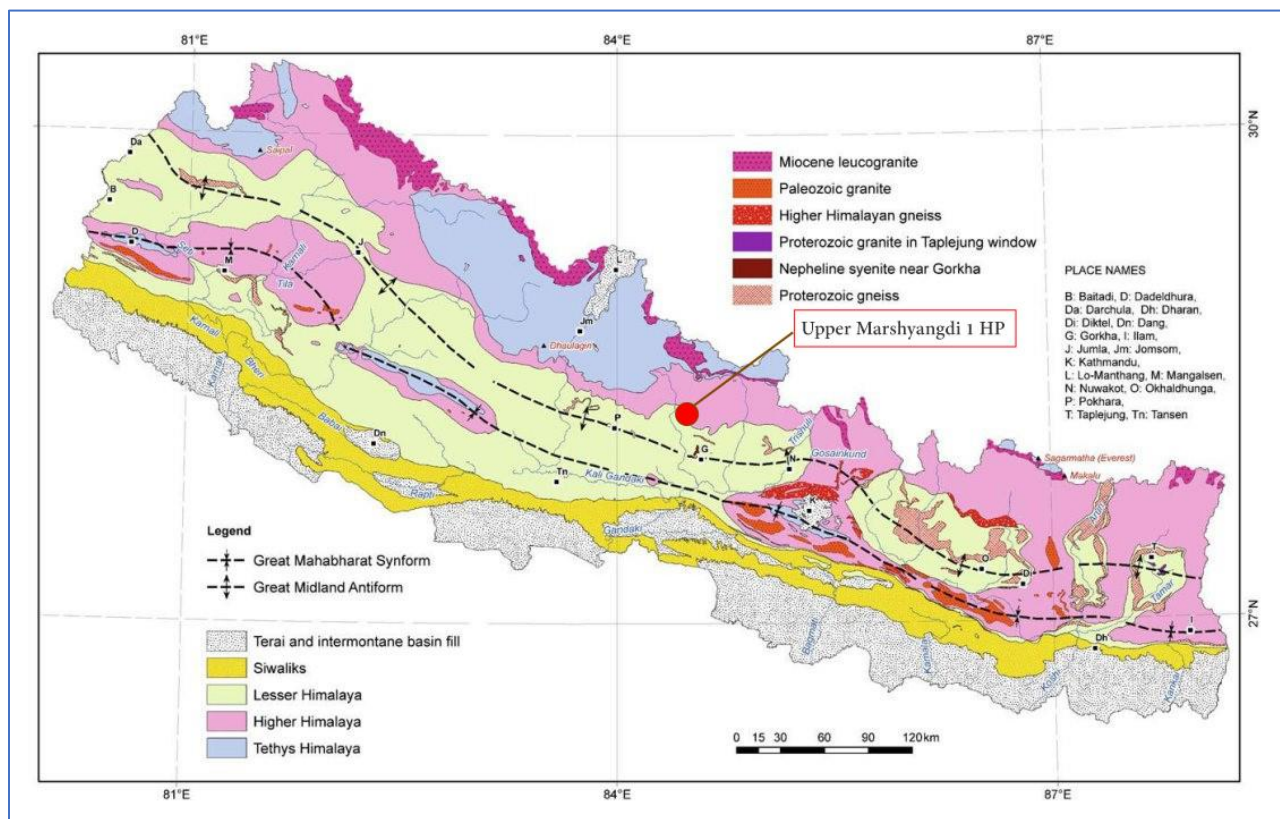
One the major concerns of construction in the mountainous/hill region is slope instability. Though steep slope dominates the project area, majority of the project components are located in stable geology consisting of rocky hills and mountains of gneiss. Some of the slopes also have colluviums deposits, which have risk of failure. Nevertheless, the project area can be considered stable in terms of slopes because of stable geology. The both slope of the valley have exposed bed rocks. These are predominantly gneiss rock, and are either blocky to locally fractured, or moderately jointed and slightly weathered. The strength of these rocks is considered to be medium to very strong with uniaxial strength of around 80 mpa. Furthermore, the foliation plane is dipping towards NE with the dip amount ranging from 20-55 degree. The remaining prominent joint sets dip towards SW and SE with dip amount ranging from 50-80 degree [Colchen, M., P. Le Fort, A. Pecher, 1986]. The geology and rock orientation make this site favorable for construction of the diversion wear, with minimum or no possibility of slope failure.

The entire headrace tunnels pass through monotonous massive, blocky, locally fractured to slightly weathered gneiss rock sequence. In some locations, schist is also observed. The proposed tunnel on right bank of the Marsyangdi River runs almost perpendicular to the strike of rock dipping at 20-35 degree due to NE. This is a favorable condition for tunnel excavations. The rock is medium strong to strong with uniaxial strength of around 70 mpa. The rock cover is found to be sufficient throughout the tunnel area in this study but detail work has to be carrying out in next phase. The dip and dip amount of foliation plane of bed rock in Gneiss is 055o/25o, whereas the other two joint sets are 175o/75o and 255o/72o. An underground powerhouse has been

proposed near Thakan on the right bank of the Marsyangdi River. The rocky outcrops are well distributed on the slope of this site, which are generally massive, slightly fracture and consists moderately of weathered Genesis. The rocks are medium strong to strong with uniaxial strength of around 65 mpa. The dipping of foliation is towards NE with dip amount varying from 20 to 30 degrees. The other two joint sets dipping SE and SW with dip amount ranging from 55 to 80 degree. The rock slope on both banks is stable. The dip and dip amount of foliation plane of bed rock in Gneiss is  $012^{\circ}/45^{\circ}$ , whereas the other two joint sets are  $278^{\circ}/72^{\circ}$  and  $120^{\circ}/58^{\circ}$ .

#### 5.1.4. Geology of the Project area

Geologically, the Upper Marshyangdi -1 Hydropower Project area lies partly in the Formation of the Higher Himalaya and partly in the Benighat Slate of the Lesser Himalaya (Le Fort, 1975; Colchen et al., 1980). These formations are separated from each other by the Main Central Thrust. The Main Central Thrust in the project area runs along northwest-southeast direction through Ghoptegau and Bahundanda villages. For simplicity, the geology of the project area can be separated into two groups as the geology of sediments and the geology of rock units. Sediment deposits are unconsolidated to consolidated and are consisting of alluvial and colluvial sediments. The exposed rocks are comprised by carbonaceous slate, phyllite, schist, gneisses, quartzite, and migmatites in occasional veins. The geological map of Nepal and the project area is given in **Figure 5-2** below.



**Figure 5-2: Geological map of Nepal locating the project area of UM1HP**

#### Headrace Tunnel

Gneiss and quartz schist are the main lithological components of rocks in the headrace area. Properties of gneiss are similar to those found in the dam site area. The MCT dominates the strata in headrace area. In the upstream and downstream are separately outcropping the gneiss (Gn) of the High Himalayan Zone and quartz

schist and mica schist (Sch) of the Low Himalayan Zone. Particularly, the gneiss outcropping in the upstream shows identical properties with that found in the dam site. The quartz schist outcropping in the downstream are in grayish-black or grayish white, having quartz content exceeding 50~60%, feldspar content 5~10% and mica content 15~20%, frequently found with pyrite (around 5%). Especially due to the action of the MCT, there is a large, deep and thick colluvial accumulation mass on the left bank where the thrust passes through. The mass is mainly composed of near-origin gneiss or quartz schist, showing no separation and appearing in angular form. The thickness of the deposits is different, mostly for overhead structures and a few for medium-density structures.

There is no major fold outcropping in the headrace area, but there is the development of the MCT, a regional thrust, which crosses the banks at about 4km downstream the dam axis. There are joints and fissures developed in rock masses in the headrace area. In general, fissures are relatively underdeveloped in rock masses of gneiss in the upstream while developed to relatively developed in rock masses of quartz schist in the downstream, especially where it is close to a thrust. Surface survey shows that there are three major joints developed in the rock mass. First is  $N70^{\circ}\sim 80^{\circ} E/NW\angle 20^{\circ}\sim 35^{\circ}$ : cleavage or bedding plane fissure, intersecting with bank slopes at a large angle, with a medium gentle dip towards the upstream, long and wide extension, frequent closure, flat, smooth and straight; 0.3m~2.0m spacing in gneiss rock mass which is medium-thick to thick; 0.1m~0.5m spacing in quartz schist in the downstream, rock mass being medium-thick to thin. Secondly,  $N70^{\circ}\sim 90^{\circ} E/SE\angle 60^{\circ}\sim 70^{\circ}$ , spacing exceeding 10m, long and wide extension, flat, straight and rough planes. Third is  $N5^{\circ}\sim 15^{\circ} W/NE(SW)\angle 40^{\circ}\sim 60^{\circ}$ : unloading fissures on both banks, mostly developed on the surface of bank slopes, becoming more obvious at higher elevations, 0.7m~2.0m spacing, mostly opened, locally filled with blocks, crushed stone and soil and roots. There are random developments of other short and small fissures as well.

### **Adit 1**

The cavern surrounding rocks of construction adit-1 are grayish-white gneiss which is hard and resistant to weathering. The cavern successively passes through weakly weathered and slightly weathered and fresh rock zones from the outside to the inside. In this section, fissures are developed, primarily bedding fissures. The rock mass is generally medium-thick. Due to weathering actions, the outside (inferred to be nearly 30m) cavern surrounding rocks are mostly Class IV rocks, which are unfavorable for tunneling; the inside cavern surrounding rocks are mostly Class III rocks. Unstable masses formed by unfavorable structural faces must be noted, for which proper support is needed.

### **Adit 2**

The cavern surrounding rocks of construction adit-2 are grayish-white gneiss which is hard and resistant to weathering. The cavern successively passes through weakly weathered and slightly weathered and fresh rock zones from the outside to the inside. In this section, fissures are developed, primarily bedding fissures. The rock mass is generally medium-thick. Due to weathering actions, the outside (inferred to be nearly 30m) cavern surrounding rocks are mostly Class IV rocks, which are unfavorable for tunneling; the inside cavern surrounding rocks are mostly Class III rocks. Unstable masses formed by unfavorable structural faces must be noted, for which proper support is needed.

### **Powerhouse Site**

The site is located on the debris fan of the Thakan Besi gully, where the terrain is gentle. Regional thrust: the MCT passes through the area from about 1.5km upstream the powerhouse site. According to surface geological survey, cleavages and fissures are the most common geological structures found in this area. Bedrocks in the powerhouse site are uniform in lithology, primarily quartz schist, locally intercalated with

thin strips or lens-like mica schist. The main mineral components of rock are quartz, feldspar, mica and calcite. Rocks are observed with schistose granular crystalloblastic and sheet structure. The stratum is mostly medium-thick, locally thinner, running in a direction of  $N70^{\circ}\sim 80^{\circ} E/NW\angle 20^{\circ}\sim 30^{\circ}$ , generally a transverse valley, where the rock saturated compressive strength is  $22\sim 64\text{Mpa}$ , indicating the domination of medium hard to hard rocks. Quaternary deposits are widely distributed on the bank slopes and at the riverbed, mostly formed by colluvial, diluvial and alluvial actions.

### Desilting Basin

On the right side of the riverbed in the dam site is outcropping a primary terrace, of which the top elevation is approximately 1,047m (about 5m above the river surface during the dry season). The terrace is about 60m wide and extends for about 600m along the river. The terrace is observed with several layers from top to bottom. The top layer consists of boulder/block-sand-gravel-cobble/macadam layer followed by mud-bearing cobble-sand-gravel layer. Below this layer lies the boulder-block-macadam layer and finally the mud-bearing cobble-sand-gravel layer. The engineering scale and foundation geology of the surface desilting basin are similar to those required for the dam.

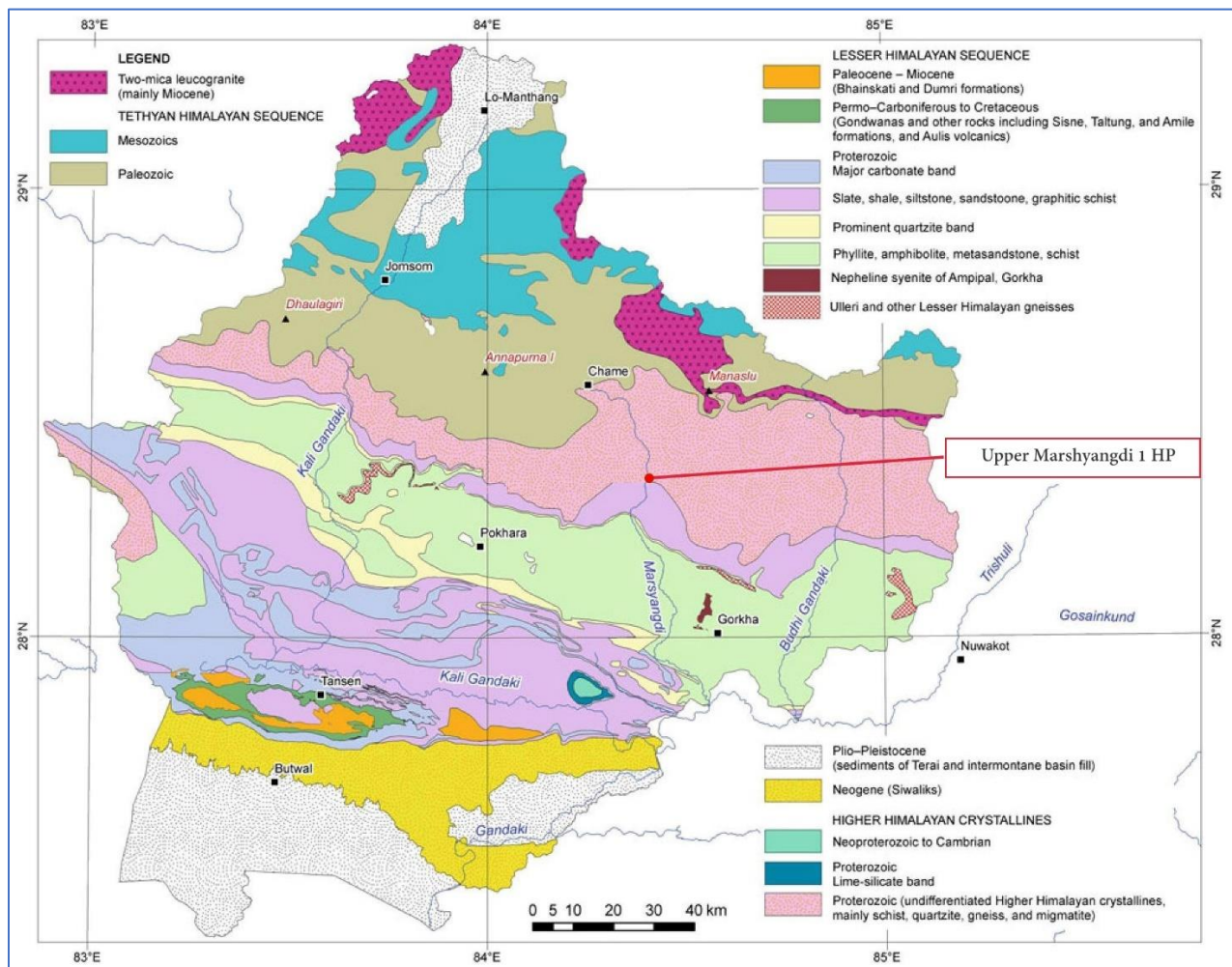
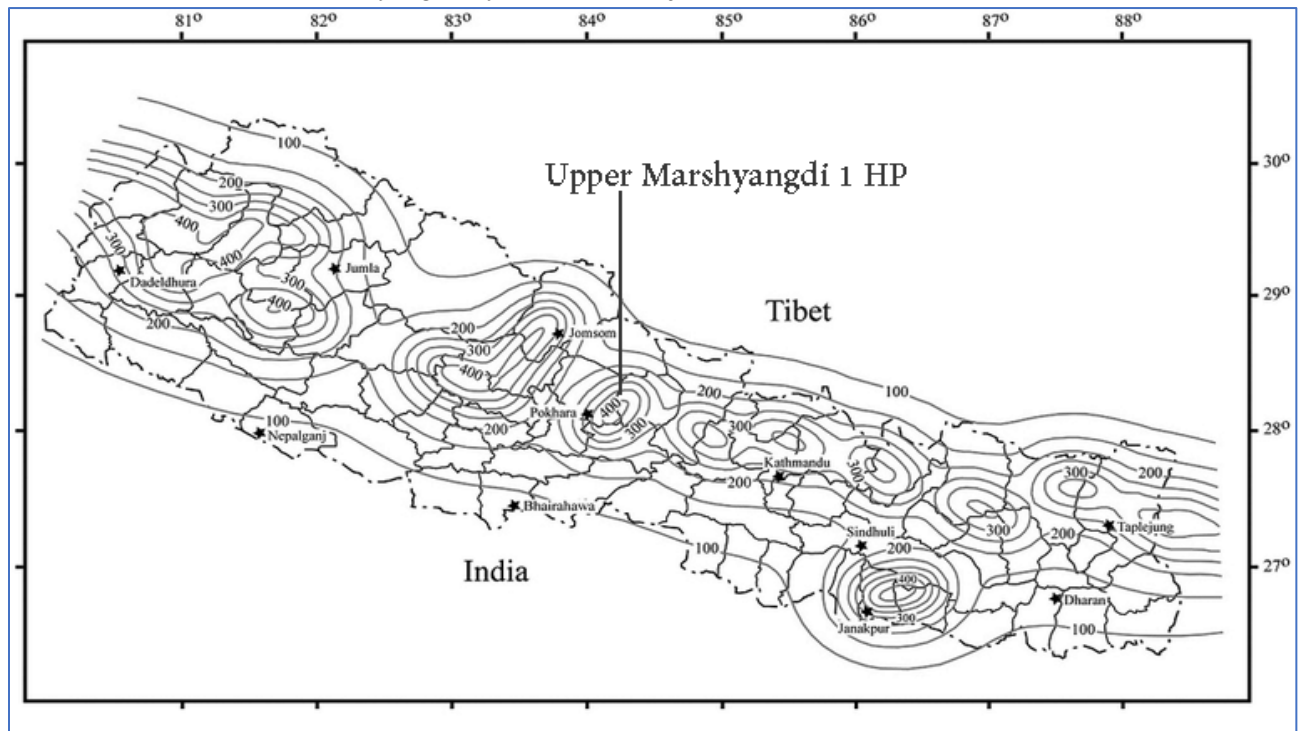


Figure 5-3: Regional geological map of project area showing the project site

### 5.1.5. Seismicity

It is reported that the Nepal Himalayas is located in the seismic risk zone. The main reason for this is due to its location in the plate boundaries. Hence, all the identified projects located within the Himalayas will have similar seismicity condition. However, the projects very close to the major regional Faults/ Thrusts, and other active local Faults/ Thrust will have high seismic risk. At present study, the seismicity evaluation has been made based on the proximity to such major regional and local active faults and thrusts.

Seismic hazard map prepared by Pandey et al. (2002) using a peak horizontal acceleration at bedrock has a 10% probability of being exceeded over 50 years. Horizontal peak ground acceleration contour map for bedrock condition shows a value range of 0.200 to 0.255g in the surveyed area for 500 years return period of M8.2 earthquake (Fig. 21). According to the specific level of seismicity, stress regime and tectonic behavior of seismogenic zones, Thapa (2008) has also prepared seismic hazard map of Nepal. For the seismic hazard analysis of Nepal, nondeterministic approach was used by computing synthetic seismograms for magnitude  $\leq 7.5$  and  $> 7.5$ . On merging small and great deep events, Thapa has estimated that the Design Ground Acceleration lies between 0.150 and 0.300g in the project area. The range is coherence with the value mentioned in the Middle Marshyangdi Hydroelectric Project.



**Figure 5-4: Seismic hazard map of Nepal showing project area of UM1HP**

A detailed active fault map prepared in the Nepalese Himalaya indicates that the active faults, i.e., source of earthquakes are situated very far from the project site (Upreti, 2009). However, convergence along the MHT has been generating earthquakes in the whole Himalaya. Deformation due to convergence in the HFT and MBT is high (Jouanne et al., 1999). The convergence along the MCT is mentioned as insignificant, nonetheless, fractured geological structure in the rocks of MCT should be attentively considered during construction of project structures. Hence, first seismic survey should be performed in the area of MCT for the proper determination of the subsurface shear zone and core should be recovered from the zone by drilling techniques for characterization of geotechnical properties.



## **5.1.6. Hydrology**

### **5.1.6.1. River system and gradient**

The Marshyangdi River is a snow fed Perennial River originating from Tilicho Lake near Annapurna at the southern foot of the Himalaya Mountains. It flows from northwest to southeast, turning south at Dharapani and converging with the Trishuli River at Mugling. The total length of Marshyangdi River is about 150km. The river consists of many major and minor tributaries within its drainage area upstream of the project area. The major tributaries of the Marshyangdi River are Khangsar Khola, Jharange Khola, Naur Khola, Dudh Khola, Nyadi Khola; the Naur Khola being the biggest tributary. Besides, Thado Khola, Dhana Khola, Mayardi Khola, Charchare Khola are minor tributaries of Marshyangdi River. Marshyangdi is a high gradient river and the average gradient of the river up to the headwork site is about 7.4%.

### **5.1.6.2. Catchment Area Ratio**

The north part of the catchment is adjacent to the upper part of Yarlung Zangbo River basin in China. The east part of the catchment is next to the catchment of Budi Gandaki River. The south part of the catchment is separated by Annapurna Himal Range and Lamjung Himal Range from the catchment of Seti River. The west part of the catchment is near by the catchment of Kali Gandaki River. The Marshyangdi River basin is rich in glaciers. There are more than twenty glaciers in the basin. Gyangapu Glacier, Pango and Pangri Glacier, Suti Glacier, Bhimdang Glacier, Thulangi Glacier, Purdi Glacier are the major glaciers.

The proposed headwork of UM-1HPP locates at the middle and lower reach of Marshyangdi River. Its catchment area is 2501 km<sup>2</sup>. UM-1HPP is of Run of river type; the catchment area at the powerhouse site is 2539 km<sup>2</sup>.

### **5.1.6.3. Climate**

The project area lies in the mountainous region in western Nepal and the climate here is widely affected by the topographical variations. Tropical to alpine types of climates is observed in the vicinity of the project area and they are controlled by altitudinal effects. Three rainfall stations are located in vicinity of the proposed project and represent the climate and hydrology of project area. The Marsyangdi basin experiences cold, subtropical to temperate climate depending upon altitude. The region receives about 70% of the annual rainfall between June to September and sub-tropical to arctic climate occurs within the catchment area of the project. Rainfall intensities vary throughout the basin with maximum intensity occurring on the basin's lower parts. Since major portion of the Marsyangdi River basin lies in the rain shadow (north of Annapurna Himal), it receives lower monsoon precipitation. During the monsoon, relative humidity reaches the highest and temperatures are lower compared to the pre-monsoon period. According to data sources, the average annual rainfall of the nearest Khudi Bazar is 3276.4 mm. The nearest hydrological station lies in Chame, Manang and it receives annual average rainfall of 942.9 mm. The maximum daily precipitation is around 164.3 mm in Chame. Under the influence of climate system, Marsyangdi River basin experiences monsoon period from June to October and non- monsoon period from November to next May.

The annual maximum air temperature in the project area occurs generally in month of May and ranges from 25 to 29°C. Likewise, the minimum temperature occurs in January and February ranging from -1.9 to 3°C. The maximum and minimum monthly relative humidity recorded within the project area is 100% and 44% respectively (Chame station). The atmosphere is humid with average monthly relative humidity (RH) ranging from 77~100 % in January. April is the driest month with relative humidity at 44%. The average monthly maximum wind speed at the site is recorded to be 8.8 km/hour.

#### 5.1.6.4. Discharge

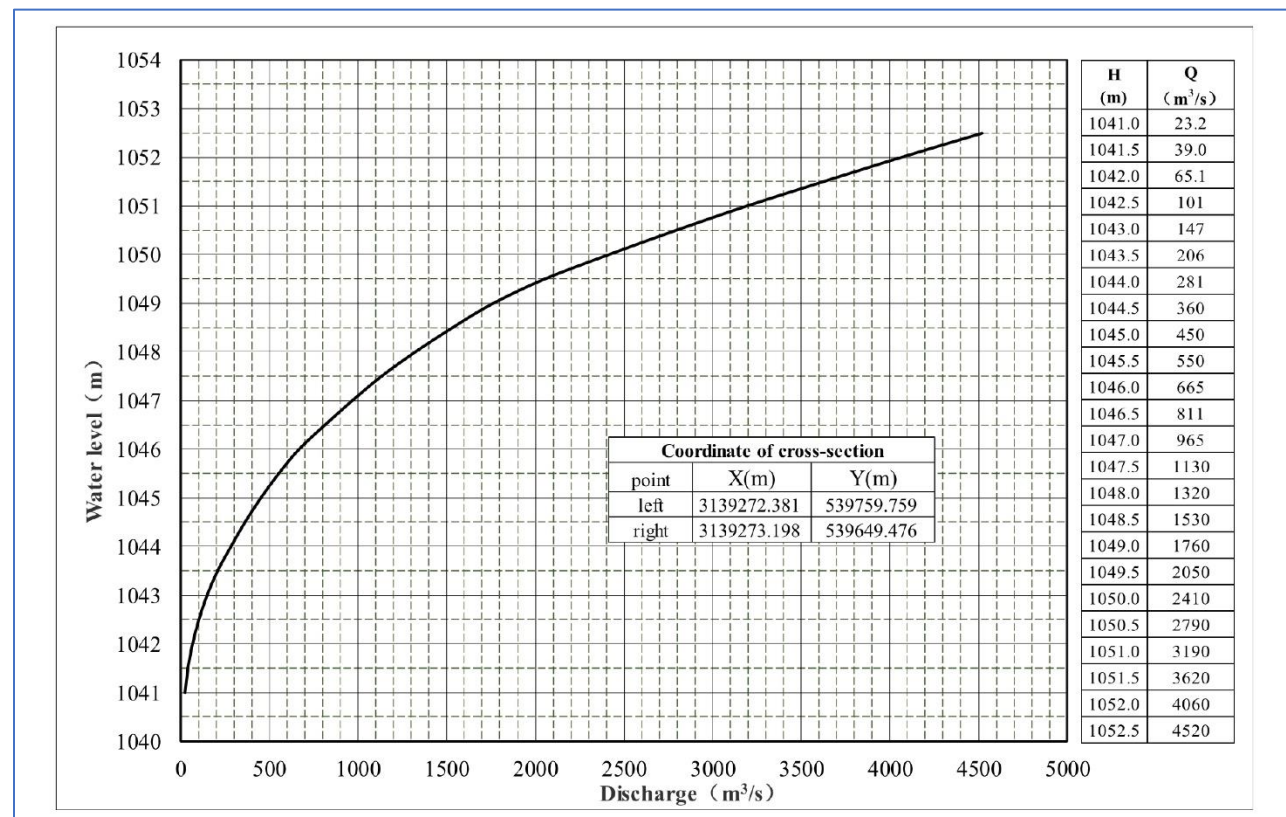
The DHM has established a gauging station in Marshyangdi River at Bhakundebesi, Bimal Nagar (St. No. 439.7) and Gopling Ghat. The following Discharge stations are available downstream the dam site, that are maintained and operated by DHM.

**Table 5-1: Information of hydrological stations in the Marshyangdi River basin**

S/N	Name	River	Code	Coordinates	Elevation (m)	Catchment Area (km <sup>2</sup> )	Data Availability
1	BhakundeBesi	Marshyangdi	439.35	N28°12'13" E84°24'11"	610	2950	2000-2015
2	Bimal Nagar	Marshyangdi	439.7	N27°57'00" E84°25'48"	354	4051	1987-2015
3	GoplingGhat	Marshyangdi	439.8	N27°55'35" E84°29'42"	320	4127	1974-1985

#### 5.1.6.5. Stage design flood at dam and powerhouse site

Stage design flood at dam and powerhouse sites of UM-1 HPP is calculated from the result of stage design flood at Bimal Nagar Hydrological Station using first power of area ratio, as shown in Table 5-2.



**Figure 5-5: Rating curve at damsite of Um-1HP**

**Table 5-2: Result of stage design flood at dam and powerhouse site of UM-1HPP**

Selection Location	Flood Stage	Design Discharge (m <sup>3</sup> /s)				
		P=2%	P=5%	P=10%	P=20%	P=50%
Dam Site	May	647	460	330	216	107
	June to October	1890	1640	1440	1230	914
	November to April	158	145	134	121	100
Powerhouse Site	May	657	467	335	219	109
	June to October	1920	1660	1460	1250	928
	November to April	161	147	136	123	102

#### 5.1.6.6. Design flood

Based on annual maximum discharge data for 2000~2015 from Bimal Nagar and Bhakunde Besi hydrological stations, annual maximum flood area ratio indices for the main stream of the Marshyangdi River are analyzed as in Table 4.6-3. According to Table 4.6-3, all area ratio indices of annual maximum discharge at Bimal Nagar and Bhakunde Besi hydrological stations from 2000 to 2015 are greater than 1. For safety reasons, this study transposes the result of design flood at Bimal Nagar Hydrological Station to dam and powerhouse sites using first power of area ratio; the result of design flood at dam and powerhouse sites of UM-1HPP is shown in Table 5-3.

**Table 5-3: Result of design flood at dam and powerhouse sites of UM-1HPP**

Section location	Design discharge (m <sup>3</sup> /s)									
	P=0.01%	P=0.05%	P=0.1%	P=0.5%	P=1%	P=2%	P=3.33%	P=5%	P=10%	P=20%
Dam site	3270	2860	2680	2260	2080	1890	1750	1640	1440	1230

#### 5.1.6.7. Environmental Release

Environmental regulations require a minimum flow to be released downstream of the intake all the time. However, it has been based on the minimum depth for the survival of the aquatic life found in the river. So, 10% of monthly flow will be released all the time in Marshyangdi river as an environmental flow. Table 5-4 gives the detail of river discharge, plant flow, environmental flow and total flow in the downstream of headworks.

**Table 5-4: Detail of river discharge, plant flow, environmental flow and total flow in the downstream of headworks of UM-1HPP**

Months	No. of Day	Discharge River	Plant Flow	Environmental Flow (10% of monthly flow)	Total flow in downstream of Headworks
Baishakh	31	46.35	41.72	4.635	4.64
Jestha	15	62.2	55.98	6.22	6.22
	16	105	85.70	10.5	19.30
Ashadh	32	209.56	85.70	20.956	123.86
Shrawan	31	293.75	85.70	29.375	208.05
Bhadra	31	272.03	85.70	27.203	186.33

Ashwin	31	163.52	85.70	16.352	77.82
Kartik	30	81.17	73.05	8.117	8.12
Mangsir	15	52.1	46.89	5.21	5.21
	14	39.4	35.46	3.94	3.94
Poush	30	34.99	31.49	3.499	3.50
Magh	29	28.92	26.03	2.892	2.89
Falgun	30	27.95	25.16	2.795	2.80
Chaitra	30	30.27	27.24	3.027	3.03

### 5.1.7. Glacial Lake and Glacial Lake Outburst Floods

A thorough review of the studies on glaciers and glacial lake in the upper catchment of Marshyangdi River revealed that the threat of Glacial Lake Outburst Flood (GLOF) is minimum in the Marshyangdi River. The types of glaciers found in the Marshyangdi River basin are ice-cap, valley glacier, mountain glacier, ice apron, Cirque, and Niche.

The Kreditanstalt für Wiederaufbau, Frankfurt, the BGR, in cooperation with the Department of Hydrology and Meteorology in Kathmandu, have carried out studies on some Glacier and have concluded that even assuming the worst case, a disastrous outburst of lakes can be excluded in the near future. Glacier's lakes are dammed up by a huge mass of dead ice, which most probably dates from the end of the last Ice Age, and not by an end moraine, as expected. The only current hazard is slope instability of the valley sides, even assuming the worst case, a disastrous outburst of the lake can be excluded for the near future.

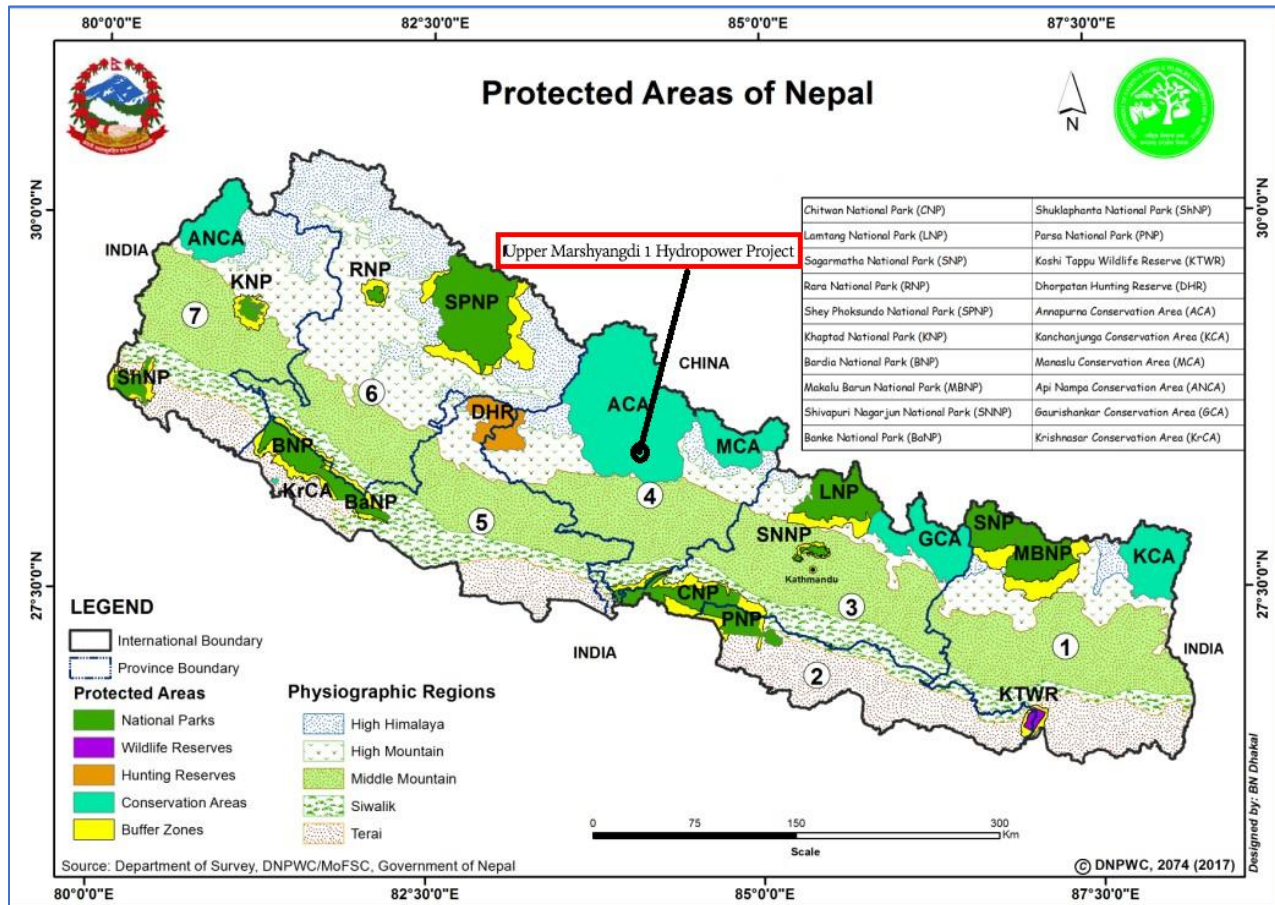
It is therefore to be noted that peak discharge in case of occurrence of GLOF for any ice dammed glacier lake in the region should not exceed 1100 m<sup>3</sup>/s at the lake itself. As concluded in the hydrology report of the project, the GLOF peak discharge at dam site will not be more than 1100 m<sup>3</sup>/s. Since GLOF due to ice melting and floods generated by heavy rains are two independents' events, the GLOF peak discharge shall not be added to floods discharge derived from hydrological studies. Moreover, it is shown that the value of GLOF peak discharge is much less than floods discharge and therefore is not a major design criterion for design of diversion structure. Based on those observations, and many inventories of glacial lake in Marshyangdi basin it was concluded that none of those lakes are identified as potential threat to the project.

A thorough review of the studies on glaciers and glacial lake in the upper catchment of Marshyangdi river revealed that the threat of Glacial Lake Outburst Flood (GLOF) is minimum in the Marshyangdi River. Type of glaciers found in the Marshyangdi river basin are ice-cap, valley glacier, mountain glacier, ice apron, Cirque, and Niche. The Marshyangdi River basin upstream of the proposed intake site of the UM-1HPP is rich in glaciers. There are more than twenty glaciers in the basin. Gyangapu Glacier, Pango and Pangri Glacier, Suti Glacier, Bhimdang Glacier, Thulagi Glacier, Purdi Glacier are the major glaciers.

### 5.2. Biological Environment

The unique geography of Nepal consists of dramatic changes in elevation along the relatively short (150 to 250 kilometer) north-south orientation, and associated variability in the physiographic and climatic conditions has resulted in rich diversity of flora in Nepal. Other important climatic factors, such as rainfall, winter snowfall, temperature, and aspect, have influenced biodiversity. Besides these local factors, the country's standing between two major biogeographic regions of the world (Indo-Malayan to the south and Palearctic to the north) has made Nepal a mixing place of species originating in both the regions (Stainton

1972). Annapurna Conservation Area lies as one of the major such region hosting exceptionally high level of biodiversity in terms of species richness and degree of endemism of both fauna and flora. The project area lies in the tropical and sub-tropical bioclimatic zonation as its altitude varies from 900m to 1050 m above the sea level. It lies in Annapurna Conservation Area which is under the management of National Trust for Nature Conservation.



**Figure 5-6: Protected areas of Nepal showing the project area of UM1HP**

### 5.2.1. Biodiversity of Annapurna Conservation Areas

The Annapurna Conservation Area is the largest protected area of Nepal covering 7,629 square kilometers. It ranges in altitude from 790 meters to 8091 meters above the sea level and stretches across the hills and mountains of Western-Central Nepal viz. Manang, Mustang, Kaski, Myagdi and Lamjung districts. The wider range of climatic conditions and altitude has provided this conservation area with diverse array of ecosystems supporting 1,352 species of plants, 128 wild mammals, 514 bird species, 348 butterfly species, 40 reptiles and 23 amphibians. **Figure 5-7** below shows the map of Annapurna conservation area along with project site.

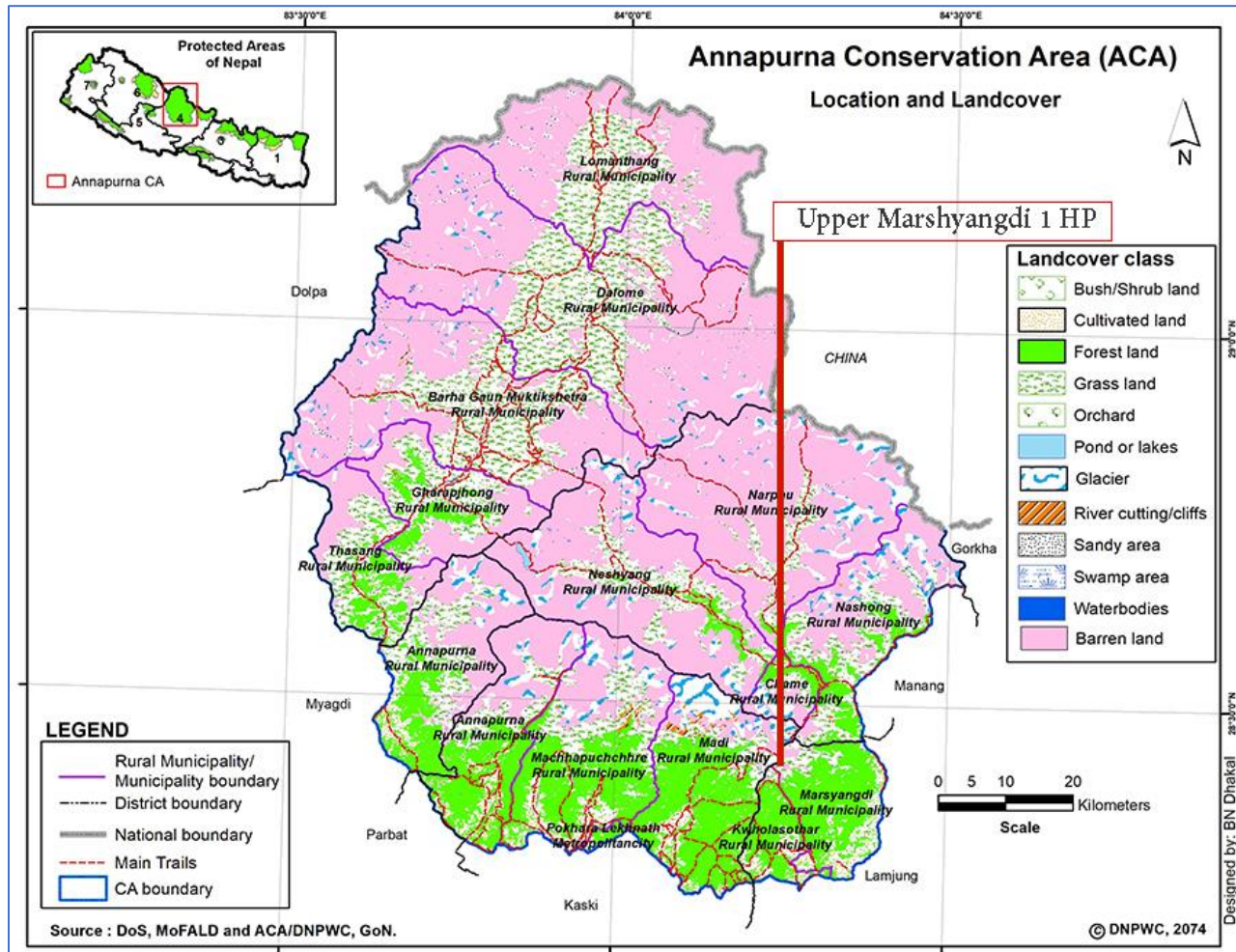


Figure 5-7: Map showing the project site in Annapurna Conservation Area

### 5.2.2. Biodiversity of the project Impact area

The project area being in the transition of tropical and sub-tropical bioclimatic zone hosts different vegetation types. Of this, the major biome falling in the project region is represented by *Schima-Castanopsis* between Khudi and Dharapani in the riverine areas, according to Kojima (1983). However, the field visit and calculation forth after showed that the basal areas of the dominant species like Chilaune (*Schima wallichii*) and Simal (*Bombax ceiba*) both exceeded 33% of the total species, the forest type here is Lower mixed hardwood forest (DFRS, 2019). As the ecological processes of the area is not disturbed to higher extent, the forest here comprises of naturally regenerated forest of native plant species with their natural age structure and natural regeneration process, the forest is healthy. It also seems that the area nearby the proposed project seems large enough to maintain its natural characteristics.

In general, the project area is covered by tree species like *Bombax*, *Alnus*, *Schima* and *Albizia* species. Most of the area is covered with shrub species like *Colebrookia oppositifolia*, *Duranta repens*, *Rubus ellipticus*, *Mucuna pruriens* and grasses species like *Impatiens glandulifera*, *Artemisia vulgaris*, *Solanum xanthocarpum*, *Cynodon dactylon* etc. As most of the project area has road linking to different villages, the environment most of the times remains disturbed by vehicular movement and due to this, less diversity of the faunal species is encountered nearby the project areas.

### 5.2.3. Site specific characteristics

There are slight variations in vegetational composition along head works area and power house area as differences can be seen among the floral species. Uttis (*Alnus nepalensis*), Chilaune (*Schima wallichii*), Maledo (*Macaranga indica*) etc are the main dominant species thriving along the core project area.

#### 5.2.3.1. Headworks Area

The proposed diversion weir is mainly composed of trees of Uttis (*Alnus nepalensis*) which has newly colonized area. Among the shrubs and herbs around the headworks area, Banmara (*Ageratina adenophora*), Titepati (*Artemisia vulgaris*), Sisnu (*Urtica dioica*), Harkato (*Carex baccans*) etc. Newly colonized patches of Uttis (*Alnus nepalensis*) are observed along the area in large number.

#### 5.2.3.2. Adits

Within the Adits, plant species such as Utis (*Alnus nepalensis*), Chilaune (*Schima wallichii*), Maledo (*Macaranga indica*), Siris (*Albizia lebeck*), Khirro (*Sapium insigne*), etc. are found. Chiple Ghans (*Oreocnide frutescens*), Manjitho (*Rubia manjith*) are The major herb species along the area includes Chiple ghans (*Oreocnide frutescens*), Manjitho (*Rubia manjith*), Banmara (*Ageratum conyzoides*), etc.

#### 5.2.3.3. Penstock Alignment

Main vegetation found in penstock alignment are Simal (*Bombax ceiba*), Chilaune (*Schima wallichii*), Kaulo Chiuri (*Diploknema butyracea*), Simal (*Bombax ceiba*), Mauwa (*Engelhardia spicata*), etc.

#### 5.2.3.4. Powerhouse and Tailrace

The powerhouse and tailrace are located in right bank of the Marshyangdi River. The land use pattern of the powerhouse and tailrace area is mainly river bank. The area hosts greater distribution of Simal (*Bombax ceiba*), Uttis (*Alnus nepalensis*), Maledo (*Macaranga indica*) and Siris (*Albizia lebeck*). Other species includes Chiple Ghans (*Oreocnide frutescens*), Manjitho (*Rubia manjith*) including some of the deadly invasive plants like *Lantana camara*, *Bidens Pilosa*, *Ageratum conyzoides* etc.

#### 5.2.3.5. Dewatered Zone

The vegetation found in the dewatered zone of the project comprises of shrubs, herbs and trees. The tree species includes Kalo Siris (*Albizia procera*), Siris (*Albizia lebeck*), Utis (*Alnus nepalensis*), Simal (*Bombax ceiba*), Amala (*Phyllanthus emblica*), Khirro (*Sapium insigne*), Chilaune (*Schima wallichii*), Tuni (*Toona celiata*), Dhayero (*Woodfordia fruticosa*) etc. Tite pate (*Artemisia vulgaris*), Malu (*Bauhinia vahlii*), Koiralo (*Bauhinia varigata*), Chutro (*Berberis asiatica*), Tikhe kuro (*Bidens Pilosa*), Fern (*Pteris sp*), Aiselu (*Rubus ellipticus*), Sisno (*Urtica dioica*), etc. are dominantly found in the area.

### 5.2.4. Floral vegetation

#### 5.2.4.1. Tree species

The major trees species sighted along the project area are Uttis (*Alnus nepalensis*), Maledo (*Macaranga indica*), Chilaune (*Schima wallichii*), Musure Katus (*Castanopsis tribuloides*), Gogan (*Saurauia napaulensis*), Khanyu (*Ficus semicordata*), Khirro (*Sapium insigne*), Siris (*Albizia lebeck*), Dudhilo (*Ficus nemoralis*), Nimaro (*Ficus alata*), Katus (*Castanopsis indica*), Paiyu (*Betula alnoides*), Kaulo (*Persea duthiei*), Simal (*Bombax ceiba*), Chuletro (*Brassaiopsis hainla*), Bhalayo (*Semecarpus anacardium*), Lapsi (*Choerospondias axillaris*), Mauwa (*Engelhardia spicata*) and Kafal (*Myrica esculenta*). There is greater diversity of trees within the area, however, Uttis (*Alnus nepalensis*) is found predominantly.

#### 5.2.4.2. Orchids

The CITES after CoP 17 has listed only 144 species of orchids in Nepal, however there is ban on collection and trade of orchids in Nepal. Many of the species has medicinal properties, used frequently by the local communities. They are commonly called as ‘Sunakhari’ and has no specific local names. Most of the epiphytic orchids are found to be hosted by different plant species like Chilaune(*Schima wallichii*), Uttis(*Alnus nepalensis*), Musure katus(*Castanopsis tribuloides*) etc. Orchid species found in project area are *Dendrobium amoenum*, *Coelogyne cristata*, *Eria coronaria*, *Habenaria dentata*, *Satyrium nepalense*, etc.

#### 5.2.4.3. Lichens

The lichen communities of this tropical region consist of dominantly found crustose and foliose lichen. They are commonly called as ‘Jhyau’ by the local communities. Some of the lichen species found in the study area are *Lecanora geophila*, *Pertusaria amara*, *Everniastrum nepalensis*, *Parmotrema tinctorium* and *Heterodermia indica* found among the rocks and barks of tree.

#### 5.2.4.4. Herbs

All together 23 herbs and grass species were identified in the project area. *Bidens pilosa*, *Phyllanthus amarus*, *Oxalis corniculata* and *Coleus barbatus* are the dominant herbs species. Other herbs species found in project area are *Clematis montana*, *Datura metal*, *Echinops echinatus*, *Erigeron bellidioides*, *Fragaria indica*, *Pteris sp*, *Morchella esculata*, *Achyranthes aspera*, *Argemone Mexicana*, *Asparagus racemose*, *Bauhinia vahlii*, *Polygonatum chinensis*, *Sonchus oleraceus*, *Ocimum basilicum*, *Andropogon*, *Aster sp*, *Chrysopogon gryllus*, *Cyperus rotundus*, *Centella asiatica*, etc.

#### 5.2.4.5. Shurbs

All together 13 plant species of shrubs were identified in project area. *Artemesia vulgaris*, *Woodfordia fruticosa*, *Dioscorea bulbifera*, *Urtica dioica*, and *Colebrookea oppositifolia* were more dominant among others. Other major shrubs specoes found in project area are *Albizzia procera*, *Mimosa rubicaulis*, *Solanum surattense*, *Canavis sativa*, *Berberis sp.*, *Flacortia indica*, *Cymbopogon flexuosus*, *Myrica esculanta*, etc.

#### 5.2.4.6. Non-Timber Forest Products (NTFPs)

Natural vegetation plays an influential role in the socio-economic condition and lifestyle of local people. Diverse ethnic groups inhabit the project area. They utilize the local plant resources for different purpose including timber, firewood, medicine and food. The non-timber yielding plant of the project area are Amala (*Phyllanthus emblica*), Ashuro (*Justicia adhatoda*), Bojho (*Acorus calamus*), Jhyau (*Everniastrum nepalensis*), Bhalayo (*Semecarpus anacardium*), etc.

#### 5.2.5. Natural Fauna in the project area

The distribution of fauna is mainly dependent on availability and type of vegetation providing feeding, breeding, hiding & resting sites. As project area is dominated by hilly tracks with less vegetation cover and interrupted by agriculture activities in the form of trench cultivation. Fauna of the project area is represented by reptiles, amphibians, birds and mammals. The reptiles were represented by *Calotes versicolor* (Common Lizard) and common Gecko (*Hemidactylus frenatus*). The amphibian is represented by Bhyaguto (*Bufo bufo*). Rhesus monkey (*Macaca mulatta*), Gray langur (*Semnopithecus schistaceus*) and Ratuwa Mriga (*Muntiacus muntjak*) where only three wildlife is recorded during the survey by direct evidences.

##### 5.2.5.1. Mammals

Some of the common mammalian species reported from the region are monkey, hare, fox, squirrel, leopard, deer, etc. The mammal species found in project area are Chituwa (*Panthera pardus*), Squirrel (*Hylopetes alboniger*), Ban Biralo (*Felis chaus*), Ratuwa (*Montiacus muntjac*), Badar (*Macaca mulatta*), Muso (*Rattus*),



Dumsi (*Hystrix indica*), Syal (*Canis aureus*), Lokharke (*Fuinambulas palamaurun*), Fayauro (*Vulpes vulpes*), Malsapro (*Martes flavigula*), Nayuri Muso (*Herpestus edwardsi*), Chamero (*Myotis nepalensis*), Chhuchundro (*Suncus murinus*), Kharayo (*Lepus nigricolis*) and Bandel (*Sus scrofa*).

#### 5.2.5.2. Birds

A total of 19 bird species were recorded from the proposed project site. Of them 12 were sighted during the field visit and the occurrences of the rest were informed by the local people. None of the birds recorded fall under endangered species. The bird species found in project area are Kuthurke (*Megalaima asiatica*), Dhukur (*Chalcophaps indica*), Koklass Pheasant (*Pucrasia macrolopha*), Kag (*Corvus splendens*), Red billed Magpie (*Urocissa erythrorhyncha*), Bakulla (*babulcus ibis*), Chil (*Aquila heliacal*), Suga (*Psittachula krameris*), Jureli (*Pycnonotus fociosus*), Bulbul (*Pycnonotus cafer*), Maina (*Acridotheres tristis*), Titra (*Francolinus pondicerianus*), King Fisher (*Alcedo atthis*), Fiste (*Orthotomus sutoris*), Kokale (*Centropus sinensis*), etc.

#### 5.2.5.3. Reptiles

Out of 100 reptiles found in Nepal (Shah, 1995), 7 species of reptiles, mainly toad and snakes were recorded in the proposed project area. The recorded herpetofauna species from project area are some of the common reptiles reported from the project area include Paha (*Bufo melanostictus*), Dhaman (*Ptyas mucosus*), Cheparo (*Calotes versicolor*), Mausuli (*Hemidactylus frenatus*), Haryu (*Trimeresurus albolabris*), Gohoro (*Varanus bengalensis*), etc.

#### 5.2.5.4. Butterflies

Butterflies helps in maintaining a healthy ecosystem as they play a crucial role in pollination of different plant species. They are sensitive to the changes in environment as they may perish due to the anthropogenic disturbances to the natural environment. According to the report of NTNC (2019), 348 species of butterflies are found in the Annapurna Conservation Area, which is almost 48% of the total species found all over Nepal. The sighted species of the project area are Common Line Blue (*Prosotas nora*), Common Bushbrown (*Mycalesis perseus*), Indian Tortoiseshell (*Aglais cashmirensis*), Jungle Brown (*Orsotrioena medus*) and Striped Blue Crow (*Euploea mulciber*).

#### 5.2.5.5. Fishes

Fish habitat of upper reaches of Marshyangdi River is having high gradient and low temperature, which is moderately productive due to low water temperatures, high water velocities and sediment loads. The project area is found to be productive for cold-water species. The aquatic ecosystem supports stone carps, snow trout and copper mahaseers.

Based on questionnaire survey and secondary sources, it was revealed that this stretch of Marshyangdi River provides shelter to at least 17 species. They are *Schizothorax plagiostomus* and *Schizothorax richardsonii* (Carps- Snow trout), *Schizothoraichthys progastus* (Long nose trout), *Neolisochelilus hexagonolepis* (Copper Mahseer), *Tor puitora* (Chuche Sahar), *Garra gotyla* (Sucker head), *Anguilla bengalensis* (Fresh water Eel), *Noemacheilus rupicola*, *Noemacheilus beavani* (Loaches – Stone loach), *Barilius barila*, *B. bendelesis* (Minows), *Glyptothorax pectinopterus* (Catfish), *Puntius chilinoides* and *Puntius conchoniis* (Barbs), *Tor tor* (Bhaisae Sahar), *Anguilla bengalensis* (Raja Bam) and *Bagarius bagarius* (Gouch).

The existing literatures and survey of the potential spawning habitat by approved EIA shows that the project area corridor hosts fish spawning sites. The predictive habitat distribution models were applied and it indicated that each spawning area was indicated by the complex channel structure which vary in complexity,

slope profile, depth of river and velocity distribution for the given flow. A comparison of the distribution of different fish species among three segments in the proposed project area showed that the total number of fishes count or the higher density per unit area was found in the first segment, i.e., 400 m downstream of headworks area. This indicated that suitable, persistent spawning site occurs on the downstream and these may be impacted due to the changes in limnological parameters, obstacles in fish migration, fish injury and predation and habitat destruction.

As per the approved EIA, Fish habitat of upper reaches of Marsyangdi River is having high gradient and low temperature, which is moderately productive due to low water temperatures, high water velocities and sediment loads. The project area is found to be productive for cold-water species. The aquatic ecosystem supports stone carps, snow trout and copper mashers. Migratory fishes of the Marsyangdi River are given in Annex 7.5.

### 5.3. Socio-Economic and cultural Environment

Lamjung District covers an area of 1692 sq.km and is divided into 8 local level for local administrative purpose. UM-1HPP covers four wards of Marshyangdi Rural Municipality as the directly and indirectly influence zone viz, ward no. 3, 4 5 and 6. Ward No. 3 and 4 of Marshyangdi RM will be directly will be directly impacted by the project development as all of the project components and project support facilities while Ward No. 5 and 6 lies in the indirect impacted area (dewater zone).

According to the CBS 2011 (Volume 03, NPHC2011), the total population of Lamjung district is 166,150 with male 74,495 and female 91,665. There are 36,525 households with average family size 4.25 in the district. Similarly, the population density is 105 persons per km<sup>2</sup>. The population distribution decreases from south to north direction indicating poor carrying capacity of northern area.

#### 5.3.1. Settlement, Population, and Households

The project area covers four wards of Marshyangdi RM i.e., Ward No. 3, 4, 5 and 6. The major project structures lie in the right bank of Marshyangdi river which is in Ward No. 3 and 4 of Marshyangdi RM. The major settlement areas near project components are: Rambazaar, Ghermu, Mipra, Arkhalebesi, Siurungbesi Thakan and Thakanbesi. The powerhouse lies in Siurungbesi and Thakanbesi where most of the houses in project area are two storied and made with stone, and galvanized roof. The settlement in the project area is not in a planned way in all the project affected wards. From the field study it is revealed that the households in the project area are densely clustered.

According to the CBS, 2011, the total population of the project affected wards is 9,590 with male population of 4,455 and female of 5,135. The total households and ward wise population are presented in the **Table 5-5**.

**Table 5-5: Population and Households of project affected wards of Marshyangdi RM**

Rural Municipality	Ward No	Households	Male	Female	Total
Marshyangdi	3	826	1510	1891	3401
	4	521	1113	1205	2318
	5	400	822	954	1776
	6	480	1010	1085	2095
	<b>Total</b>	2227	4455	5135	9590

Source: CBS, 2011.

### 5.3.2. Economically Active Population

About 88.48% of the population is economically active. The economically active male and female population of age 15-59 years is 46.61% and 53.39% respectively (**Table 5-6**).

**Table 5-6: Economically Active Population**

VDC total	Total			Economically active		
	Total	Male	Female	Total	Male	Female
Percentage	100	50.37	49.63	88.48	46.61	53.39

Source: CBS, 2011.

### 5.3.3. Caste and Ethnicity

The project area is composed of heterogeneous community. The major ethnic groups in the project area are Gurung, Chhetri, Tamang, Kami and Damai. The other caste/ethnic groups residing in the project affected wards are Gharti, Brahmin-hills, Newars and Others. The **Table 5-7** shows the detail of caste/ethnicity of the project affected wards of Marshyangdi RM.

**Table 5-7: Population distribution by caste/ethnicity for affected wards of Marshyangdi RM**

Caste	Marshyangdi RM			
	Ward No.3	Ward No.4	Ward No.5	Ward No.6
Gurung	1,356	1,762	1,551	853
Tamang	977	252	10	150
Kami	115	75	126	142
Chhetri	581	126	1	525
Brahmin	33	5	18	245
Sarki	234	30	40	0
Newar	73	14	8	44
Damai	100	27	10	87
Gharti	11	0	0	33
Others	21	27	11	16
Total	3,501	2,318	1,776	2,095

Source: CBS, 2011

### 5.3.4. Indigenous community living in the direct project impact area

Gurungs are the main indigenous communities living in the direct impact project area. The project will acquire land and other properties belonging to these families.

### 5.3.5. Religion

In the project affected wards, majority of people are Buddhist followed by Hindu representing 80.34% and 27.46% respectively. Christian and Islam followers are also residing in the project area (**Table 5-8**). The people are living in maintaining religious harmony. Their cultural pattern and social life have a deep-rooted relationship with its nature. They also believe on portfolio of God and Goddess attached with the resources on which human life exists.

**Table 5-8: Population by religion for project affected wards of Marshyangdi RM**

Religion	Hindu	Buddhist	Islam	Jain	Bahai	Christian	Total
Percent	27.46	80.34	0.18	0.07	0.01	0.80	100

Source: CBS, 2011.

### 5.3.6. Mother Tongue

Although all community can speak Nepal to some extent, Gurung (56.68%) is the widely spoken mother tongue followed by Nepali (27.36%) in the project affected wards. The other languages spoken in the project area are Tamang (13.42%), Newari (1.16%). The **Table 5-9** shows the detail of the languages spoken in the project area.

**Table 5-9: Mother tongue for project affected wards of Marshyangdi RM**

Mother Tongue	Nepali	Gurung	Tamang	Newar	Others	Total
Percent	27.36	56.68	13.42	1.16	1.37	100

Source: CBS, 2001

### 5.3.7. Literacy

The educational status of the project affected wards of Marshyangdi RM is satisfactory as compared to the other wards. The literacy rate of the project affected wards is 44.62% with male literacy rate 62.99% and female literacy rate is 36.93%. The literacy status of the project affected wards is presented in **Table 5-10**. Primary, lower secondary and secondary level educational institutions are available in each ward of the project area. People of the project area are facilitated with 22 primary schools, 2 lower secondary schools, 4 secondary schools and 1 higher secondary school in Ward No. 3 of Marshyangdi RM.

**Table 5-10: Population by literacy status (over 6 years of age considered)**

	Total			Read and write			Not stated
	Total	Male	Female	Total	Male	Female	
Percent	100	48.52	51.48	44.6	63.0	36.93	0.7

Source: CBS, 2011 and Field survey

### 5.3.8. Occupation

More than 85% of households in project district are involved in the agricultural activities and occupationally are the farmers depending upon the subsistent agriculture for their livelihood. Apart from agriculture, there are about 18.61% households in project area having some other economic activities including tourism. Marshyangdi RM ward No. 6 have significantly higher economically active population in comparing to other project wards whereas Ward No. 5 has the least once. Of the household having other economic activities nearly 45% in the project district are involved in the service sector. Percentiles in the business, transportation and manufacturing is small compared to the service sector.

**Table 5-11: Households having Economic Activity**

Project Affected Wards	Total	Other economic activities	Agricultural economic activities
		%	%
Marshyangdi RM-3	826	11.2	79.3

Project Affected Wards	Total	Other economic activities	Agricultural economic activities
		%	%
Marshyangdi RM-4	521	15.64	92.8
Marshyangdi RM-5	400	7.6	89.2
Marshyangdi RM-6	480	41.77	91.5
Total	2,227	18.61	91.2

Source: CBS, 2011 and field survey

**Table 5-12: Economic activities other than agriculture**

Project Affected Wards	Economic activities					
	Total	Manufacturing	Trade/ business	Transport	Services	Others
Marshyangdi RM-3	82	0	49	0	13	20
	<b>Percent</b>	0	59.75	0	15.85	24.39
Marshyangdi RM-4	71	2	14	7	45	3
	<b>Percent</b>	2.82	19.72	9.86	63.38	4.23
Marshyangdi RM-5	29	0	13	0	16	0
	<b>Percent</b>	0	44.82	0	55.17	0
Marshyangdi RM-6	198	14	41	17	120	6
	<b>Percent</b>	7.07	20.7	8.59	60.6	3.03

Source: CBS, 2011 and field survey

### 5.3.9. Agricultural land, livestock and poultry

About 9.5% of the households of the project affected wards have agricultural land only. The agricultural products mainly include food crops (wheat, maize, millets, paddy etc.) and cash crops (potato, oilseed, etc.).

Since the project area is located in the mid-hill region, the cropping pattern in the irrigated land is paddy-potato-maize, paddy-wheat-maize, paddy-empty-paddy, paddy-wheat-empty, paddy- vegetable-vegetable and paddy-pulse-wheat-paddy. Similarly, in the non-irrigated fields the cropping pattern follows like maize-millet-empty, maize-millet-empty, maize, mustard, maize-wheat, maize- barley and maize-potato/ maize-empty. Livestock including goat, cattle, poultry, ox, buffalos, etc. are sold at local markets for supplementary income.

**Table 5-13: Agricultural land, livestock and poultry**

	Total	Agricultural Land only	Livestock Only	Poultry only	Land and Livestock	Land and Poultry	Livestock and Poultry	Land, Livestock and Poultry	Not at all
Percentage	100	9.5	1.67	0.59	26.4	3.13	0.88	48.58	9.26

Source: CBS, 2011 and field survey

The spring and traditional canal are the major types of irrigation system in the project area. There is no major irrigation canal constructed so local people mostly depend on indigenous method of irrigation through locally

digged small canals. Most of these irrigated fields are from small tributaries and Arkhale khola, Ghopte khola, etc. are the small tributaries used for irrigation purpose.

#### **5.3.10. Public Health and Sanitation**

The health service in the project area is delivered through the existing health posts and sub health posts in each project affected wards. The hospital level service is available only in the district headquarter Besisahar. According to the health source, people generally suffer from skin disease, ear infection, urinary tract infection, chronic bronchitis, gastrointestinal, injuries and fractures, diarrhea, diabetes, abdominal pain, toothache and others. Some private health clinics are also operated in the project area. Level of awareness towards improved health and sanitation (particularly towards the safe drinking water, use of toilets, etc.) is gradually increasing in the project area. Use of modern toilets in project area is also practiced. The project affected wards of Marshyangdi RM are declared as “open Defecation Free Zone” (Khulla Disa Mukta Kshetra). This is the outstanding example of awareness level of the locals towards sanitation.

#### **5.3.11. Income and Expenditure Pattern**

The sources of income from agriculture sector contribute more than 80 percent. It is reported that income in the project area differ from place to place and it also varies according to land holding and its quality. During the field investigation it was found that the average income of the households in the project area ranges between Rs. 30,000 to NRs. 40,000 per year. However, the hotels and the restaurant owners were reported to be earning 5 lakhs to 8 lakhs per year. It is identified during the public meetings in the project affected wards. Similarly, the average expenditure of the households of the project site is equivalent to Rs. 38,000. Majority of their expenditure is in clothing's items followed by food, medicines, education, and others.

Vegetable like potato is widely grown in the project area and sold in the local markets for supplementary income. Similarly, small quantity of milk product in most of the households is used for ghee and fat production and milk products like ghee is used to sell in local markets (local markets and Khudi, Besisahar). Obviously in the project affected wards a large number of people are in a state of under employment or disguise employment in disguise. The project in the area means a new opportunity of employment to the local people. As of the date many able young from the area go out of their birth place in search of labor jobs to make the livelihood. The subsistent agriculture practice is not sufficient to meet their livelihood. The project could be an opportunity for these people, though in small number to get local employment.

#### **5.3.12. Gender Aspect**

Gender discrimination in activities such as education and outside home affairs is still prevalent in the area as in other parts of Nepal. As the society is dominantly Gurung, there are some cultural freedoms to the women members of the society. The culture of Rodi is of significance in this respect, where the female has the major role to play in keeping of the culture as well performing an independent economic activity. Even in the household decisions, the female members have major role to play which is a positive aspect of the Gurung ethnic/caste community.

#### **5.3.13. Service Facility**

##### **A. Transportation**

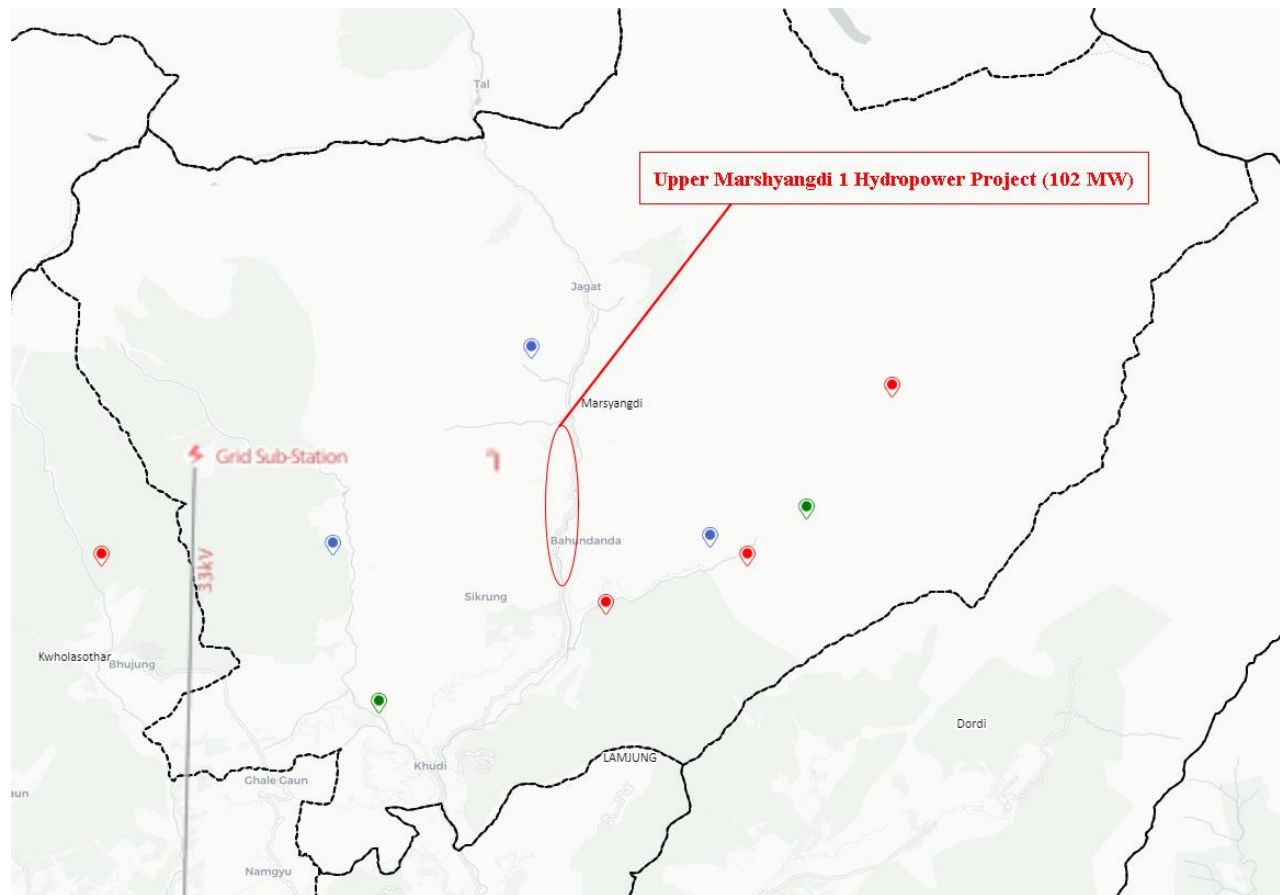
The project site is facilitated with Besisahar- Chame unpaved rough road. The intake and powerhouse sites of the proposed project are accessible through major foot trail and suspension bridges.

##### **B. Communication**

Communication service through CDMA, NTC system is available in the project area. Postal service is available in project affected wards. Cable network is available in lower reaches of the project affected wards: Rambazaar, Dobhanchaur, Bahundada, Arkhalebese and Thakanbesi. This is due to the electrification in the lower reaches of all the project affected wards of Marshyangdi RM through national grid (Public consultation). Radio and FM network is within the access of the local people. Local and national newspapers are available in Ward No. 3 and 6 whereas these are very minimum in the Ward No. 4 and 5.

### C. Electricity/ Energy

Although there are number of medium and large-scale hydropower projects proposed in Marshyangdi River (Table 5-14) to date, few small micro hydro projects are under operational and providing electricity only for lightning purpose.



Source: <https://hydro.naxa.com.np/>

**Figure 5-8: Map showing the nearby hydropower project in Marshyangdi Rural Municipality**

**Table 5-14: Nearby hydropower projects of UM1HP**

SN	Project Name	Developer	Installed capacity (MW)	Latitude/Longitude
1	Marshyangdi Besi	Divyajyoti Hydropower	50	28° 12' 00" to 28° 16' 00"N and 84° 21' 15" to 84° 24' 40"E

SN	Project Name	Developer	Installed capacity (MW)	Latitude/Longitude
2	Upper Marshyangdi A*	Sino hydro/Sagarmatha Power Co.	50	28° 17' 07" to 28° 19' 28"N and 84° 21' 55"to 84° 24' 10" E
3	Marshyangdi **	NEA	69	27° 52' 25" to 27° 56' 53"N and 84° 25' 40"to 84° 32' 42"E
4	Middle Marshyangdi **	NEA	70	28° 08' 20" to 28° 11' 50"N and 84° 24' 18"to 84° 26' 51"E
5	Upper Marshyangdi 1***	Upper Marshyangdi Hydropower Company Pvt. Ltd.	138 (Revisited Capacity 102)	28°19'28" N to 28°22'25" N and 84°23'40" E to 84°25'00" E
6	Lower Manang Marshyangdi	Butwal Power Company	140	28° 30' 00" to 28° 32' 30"N and 84° 20' 00" to 84° 21' 55"
7	Manang Marshyangdi	Manang Marshyangdi Hydropower Company Pvt. Ltd.	282	28° 31' 27" to 28° 33' 37"N and 84° 15' 38" to 84° 20' 00" E
8	Upper Marshyangdi 2	Himtal hydropower company	327	28° 22' 04" to 28° 30' 00"N and 84° 21' 30" to 84° 25' 03"E

\* Under construction, \*\* Operational, \*\*\*This Project

Still fuel wood is the main source of energy for cooking, heating and domestic activities. Fuel wood is collected from private and community forest categorized under the jurisdiction of Lamjung District Forest Office, in Marshyangdi RM Ward No. 5 and 6 whereas people from Marshyangdi RM Ward No. 3 and 4 collect from ACAP managed forests. Most of the households have large stocks of fuel wood in their houses. However, LP gas is also used in market centers and some houses along the access road.

#### D. Drinking Water

Gravelly water supply, traditional stone tap, well and streams are the main sources of drinking water in the project area. Most of the households in the project affected wards have been benefited with drinking water facility through pipe supply. The main sources of drinking water are listed in **Table 5-15** below.

**Table 5-15: Drinking water sources in the project areas**

S.N.	Village	Former VDCs/Ward	Water Source	Remarks
1	Ram Bazaar	Taghring/05	Thulibhir mul	Sufficient
2	Chhapa Dada	Taghring/03	Tin pane mul	Sufficient
3	Khani gaon	Ghermu/09	Tipro mul	sufficient
4	Arkhale	Khudi/08	Pani kholo mul	Deficit for two months
5	Thakan Gaon	Khudi/06	Rapa mul	Sufficient

Source: Field survey, 2011 and 2021

#### 5.3.14. Law and Order

During the field survey, the general law and order situation in the project area was satisfactory. There is a



police post located near Khudi and Bahundada (immediate downstream and adjacent of the proposed powerhouse) of Khudi and Bahundada. This is maintaining the law-and-order situation of the project area.

### 5.3.15. Industrial activity

The project area harbors some of the hydropower projects which has employed local people of the area. Along with some of the megaprojects, some medium sized and small sized industries are running nearby the project sites. The soap producing small scaled industry and some industries based on forest and agricultural products are operated by local small farmers. Some of the cottage industries are: Bamboo making, chitra making, Nepali Hand Paper, Bhakari, Dhoko, Thunche, Radipakhi, etc. There are some of the cooperative organizations run in coordination with the local people.

### 5.3.16. Religious, Archaeological and Historical Sites

The ritual beliefs of these religious worships are focused for the protection of the communities and are performed to increase farmland productivity, protection from disease, protection from pest, long- life and health of family members etc. Religious sites are mostly concern with Hindu and Buddhist in the project area.

**Table 5-16** shows the location of temples/Gumba.

**Table 5-16: Name, location and importance of religious, historical and archaeological sites**

Name of religious site	Former VDCs/Ward No.	Village
Shree Kalika Mandir	Taghring-05	Aathkhet
Kanya devi Mandir	Khudi 1	Thakan
Panchakanya Devi mandir	Khudi-08	Arkhale
Kanya devi	Khudi-06	Thakan
Saji	Khudi-06	Thakan

Source: Field Survey, 2011 and 2021

The main festivals celebrated in the project area are Lhosar, Maghe Sakranti, Ghatu, Baisakhe Sakranti, Dashain, Deepawali, Mangsir Purnima, Janai purnima, Teej, etc.

### 5.3.17. Cremation practices

Traditionally, all Hindus are cremated at riverside. The exceptions are small children and saints, whose bodies are considered pure, and are therefore buried. Among all Hindus the funeral rites are performed and followed similar patterns in all project affected wards.

Buddhism has four main funeral practices: air burials, water burials, cremations and inhumations. Nowadays the common funeral practice is cremation, but even today poor people that cannot afford cremation may be given air or water burials, whereas inhumations are basically for persons who died of contagious diseases. The deceased is cremated in a special crematorium, which is the foundation of a small stupa, and a stupa is a funerary mount or a Buddhist ancestral monument.

The Buddhist cremation site is situated far from the river and project component. Cremation among other casts is also far from the river in an isolated site, hence the project construction work will not affect those areas. There are two cemetery grounds in both banks of the Marshyangdi river within the project alignment, where the local Hindu community used to burn dead bodies. Cemetery sites are located in Ram bazaar (Baur Ghat) and Ghelpe bagar ghat near Dobhanchaur of Ward No. 6, Marshyangdi RM. Baur ghat cremation site lies in the dewatered zone while Ghelpe ghat is situated in the downstream from powerhouse.

### 5.3.18. Water Use and Water Rights of Marshyangdi River

The water of Marshyangdi River is not used by the inhabitants for any irrigation or other commercial purpose. Furthermore, water from Marshyangdi River in the stretch between dam and power house site is not used for running water mills and hydropower plants. It was observed that people consume either spring water or piped water for drinking purposes. There is no direct consumptive use of Marshyangdi River water by local inhabitants due to high turbidity.

The population living along the Marshyangdi River mostly relies on spring water. However, there are two cemetery grounds in both banks of the Marshyangdi river within the project alignment, where the local people of Hindu community used to burn dead body. One cemetery site is located in Ram bazaar (Baur Ghat) and Ghelpe bagar ghat near Dobhanchaur of Ward No. 6, Marshyangdi RM. Currently, Upper Marshyangdi A Hydropower Project lies just below the proposed powerhouse. People do not fully dependent in fishing in Marshyangdi river in the project area.

### 5.3.19. Infrastructures

Schools, health post/sub-health post, agriculture service center, veterinary, post office, police post, etc are the main service provider infrastructures available in the project area. The main service and facilities available in the project area are tabulated in the **Table 5-17**.

**Table 5-17: List of Infrastructures**

SN	Service	No.	Location
1	Primary Schools	22	Project affected wards
2	Lower Secondary School	2	Ward No. 6 and 3
3	Secondary School	4	One Sec. school at each ward
4	Higher Secondary School	1	Khudibeni-01, Ward No. 6 and 3
3	Health Post	4	Project affected wards
4	Agriculture service center	2	Ward No. 6 and 3
5	Veterinary	1	Ward No. 6 and 3
7	Post Office	2	Ward No. 6 and 3

### 5.3.20. Tourism

Lamjung district is located in the trekking region of ACAP. The district is full of natural resources. ACAP region is the worldwide popular destinations for tourism activity. Besides, several springs, small hot water pond (Tato pani), gorges, and mountainous range are other attraction for the tourism activities. These areas are famous for domestic tourism also.

There is local access to Thoroungla pass and Tilicho Lake (the highest altitude lake) through the project area. The visitors use this route. The activity in the Marshyangdi river corridor is increasing in recent years due to the construction of Besisahar- Chame highway.

### 5.3.21. Areas in the project vicinity

Aerial distance from diversion weir to Chhichu is 699m, Neuri 1376m, Ghermu 913m, Mipra 1303, Khanigaun 562m, Chhapagaun 813, Taghring 1740, Nayagaun 1764m, Lilibhir 1205m, Kabra 1390,

Kharikeht 1456m, Athakhet 2306m, Sildhunga 2143m, and Badalbisauna 1710m. Similarly, the nearest vertical distance from the tunnel alignment to Chhapagaun 233m, Kabre 161m, Lilibhir 1091, Sildhunga 962m, Balgu 622m, Ghopte gaun 132m, Gairigaun 1381m, Kalaghring 1562m, Siurung besi 1090m, Lampata 987m, Siurang 2263m, Kaule 793m and Thakan 110 m. From Powerhouse site Thakan is about 370m.

### **5.3.22. Project Affected Families (PAFs)**

Those families who lose their house, land and other properties due to the project's requirements are termed as Project Affected Families (PAFs). From the field survey and survey, 90 households from the Marshyangdi Rural Municipality are taken as PAFs. Due the several constructions work carried out during this project such as roads and camps, the PAFs lose some of their land and other properties permanently. Those Land which are required by the project only during the construction phase will be returned to their respective owners after the project's completion. The PAFs are from Taghring, Ma-4, Mipra, Ma-4 Syange, Ma-4 Rambazaar, Ma-4, Siurung, Ma-3, Thuli Besi, Ma-6, Khani Gaun, Ma-5 and Ghermu, Ma-5 respectively. The details of project affected families is given in **Annex 8**.

## 6. ALTERNATIVE ANALYSIS

In general, the alternative analysts of a project are carried out to assess the technical feasibility, economically viability and environmentally acceptability. The technical feasibility of the project depends upon the water availability, topographical and the geological condition of the project area whereas the economic viability depends on the project cost and benefit analysis and the environmental acceptability is the magnitude of the project impact on the physical, biological, social and cultural environment of the project area. The purpose of alternative analysis of SEIA is to assess the environmental impact of different alternatives that have been considered during the feasibility and approved EIA. Consideration of alternatives is regarded as the "heart" of environmental impact reports.

Therefore, consideration of alternatives in environmental assessment process compares "No Action" option with the implementation of the proposed action option. 'No Action' option represents the scenario of the existing condition, which means the condition without any intervention, whereas 'With Action' means the condition with some intervention in terms of implementation of the proposed action. Therefore, analysis for no action scenario has been dealt to signal out the importance of the proposed hydroelectric project development in the local and national context.

### 6.1. Implementation of UM-1HPP vs Thermal Power vs Wind Power vs Solar Power vs Atomic Power

As elaborated in the Opening remarks, the various alternatives of electric power generation are available and are being utilized all over the world depending upon the natural resource base of the country in question. In the context of Nepal, the viability of alternative is related with various aspects such as its resource base, technology at hand, capacity to handle tail end pollution, and above all the economics and financial capacity. Among the above parameters for energy project selection, the most important are resource availability in country and the environmental effects of the selected projects which ultimately determines economic, financial and sustainable capability of the project.

Hydropower does not involve fossil fuel burning and hence mitigates global warming. From the environmental point of view, water-based energy generation may be the best feasible options since it produces minor amount of air, water and soil pollution as compared to thermal power plants. To generate electric power, thermal power plants utilize raw materials like coal, oil, natural gas, biomass, waste, etc. Nepal lacks the resources needed for thermal power plants like coal, oil natural gas, etc. and needs to be imported at high price. In this situation, such resources will be very expensive for power production. Biomass and waste are the other potential sources that could be used for the generation of electricity in Nepal. However, the use of biomass for the electricity generation is restricted by declining forest status and stringent forest acts & regulations. Though the municipal waste and industrial waste could be the other available options used for power generation, the volume of waste generated in Nepal is insufficient enough to generate the calorific value required for electricity production, in turn, it induce a vicious circle to obtain more waste for electricity production. Apart from these constraints, the combustion process of coal, oil, natural gas, biomass, waste, etc. of thermal power plants release emissions such as carbon dioxides, sulfur dioxides, nitrogen oxides, and particulate emissions, besides thermal emission creating high consequence of environmental degradation. Thermal power plants are undesirable in the context of global warming as well. Thus, the high cost of fuel & technology and environmental consequence reject thermal power plant in Nepal.

Wind power plants are more beneficial than thermal power plants on environmental ground as they don't use fuel, and don't emit air pollutants, greenhouse gases, or toxic wastes, and don't consume water or other scarce resources. However, the wind power plant requires regular natural wind speed to be operated as reliable power supply system. The fluctuation in wind speed from almost stagnant to very high speed in Nepal could prevent installation of wind powerplant at large scale for sustainable supply to meet national demand.

Although solar energy is effective on a small scale, it is not possible for large-scale development purposes. The solar plant also has a number of disadvantages though being non-polluting energy source. The limitations of solar plant are requirement of large area for energy collection, high production cost, feasible for small scale application and unreliable source of continuous energy supply. The solar energy is severely hampered in cloudy weather and rainy days marking it as unreliable source of energy for uninterrupted supply. Solar battery used for solar energy storage consists of hazardous substances that require proper disposal facilities. In this backdrop, the solar energy is not considered as a suitable option to meet up the present energy demand.

The atomic power requires high technology sustainable atomic fuel supply and has a risk of radiation leakage to environment. Management of nuclear power plant including nuclear waste management, control of thermal emissions requires very meticulous management system. Above all, in the context of Nepal, is not an economically and environmentally viable option.

Nepal is blessed with abundant water resources. The characteristics of the drainage network and the available gradient make hydropower project most economical. Being a mountainous country with deeply entrenched rivers with high gradients, the runoff the river project is very suitable in Nepal. As run off the river projects does not inundate large land area to cause adverse land use and other socio-economic effects, they are environmentally least damaging to the environment. For the above reasons, to meet the required energy needs and also for commercial venture, hydropower projects are the best among oilier types of power alternative projects in Nepal even if they have significant impacts on aquatic biodiversity ecosystems. Another energy option like biogas is popular in Terai and tower mid hills for producing energy required for household cooking and lighting. However, biogas at any case cannot replace the commercial energy value of hydropower projects.

## **6.2. Alternate schemes**

Entrusted by CCK Power Holdings Limited, Powerchina Chengdu Engineering Corporation Ltd. (hereinafter referred to as Chengdu Engineering Corporation) carried out design for the feasibility study phase of the Upper Marshyangdi -1 HPP since the end of 2017. On the basis of existing achievements, Chengdu Engineering Corporation further investigated the engineering geological conditions of the dam site, headrace tunnel and powerhouse areas by means of surface geological mapping, supplementary exploration and test and engineering analogy as well as demonstrated and evaluated main engineering geological issues found in the project area. The proposed scheme was reviewed at the inception stage of the Feasibility Study. Some of the main points that emerged during this review are as follows:

- The proposed dam site is suitable. Bedrocks are exposed on banks of the selected dam site, composed of Precambrian gneiss. It is a transverse valley having stable bank slopes, with fissures developed at shallow surface. A certain degree of water permeation is expected, requiring proper anti-seepage measures. Deep and thick overburdens are developed at the riverbed. The covering cobble/macadam-gravel-sandy soil layer shows poor mechanical properties and can be liquefied in case of high seismic intensity, which shall be removed. The force bearing layer of the dam is boulder/block-sand-gravel-cobble/macadam layer, which can basically meet the requirements for building the dam, desilting basin

and other structures due to its proper bearing capacity and resistance to deformation. The foundation soil is medium-permeable, which may lead to leakage of the dam foundation. The poor anti-seepage stability also needs proper engineering actions to ensure the dam foundation is highly resistant to seepage and leakage.

- The choice that the headrace tunnel was arranged on the right bank of Marshyangdi river is suitable. In the headrace area, the geological conditions are basically the same in the upstream area on both banks. In the downstream area the terrain on the right bank is relatively complete and bedrocks frequently outcrop from the slope banks. Colluvial deposits are only found at the slope toe. However, on the left bank, large scale deep and thick colluvial accumulation masses close to the river are observed, which is unfavorable for the arrangements of headrace tunnel, surge chamber and penstock. From the engineering geological perspective, the right bank has a better background for arranging headrace tunnel, surge chamber and penstock. Besides, existing roads in the project area are located on right bank where the conditions for arranging construction adits and site are better than left bank.

The downstream boundary of the survey license area of the project was adjusted from 28°18'50"N to 28°19'28"N, which caused the downstream boundary to shift upstream by approximately 1.2km and the underground powerhouse proposed in the feasibility study report is out of the survey license area. Therefore, the powerhouse location shall be adjusted at this phase. Comprehensively comparing the topographical and geological conditions within the new survey license area, construction period and engineering investment, the surface powerhouse type is adopted at this phase.

### **6.3. Alternatives for Powerhouse site**

In terms of topographic conditions within 1km south of the survey license area, terrain on the left bank is steep and that on right bank is gentle. In terms of geologic conditions, on the left bank, large-scale continuous, thick diluvial-colluvial deposits, over 3km long along the river and nearly 2km wide across the river, are observed near the river bank, as a result of the location at the confluence of large tributary Nyadi Khola and MCT influence. Meanwhile, right-bank waterway is better than left-bank waterway. It is better to arrange the powerhouse on right bank than on left bank.

According to survey license area, topographic and geologic conditions of the powerhouse site area, in order to make full use of the head, powerhouse sites should be located close to the south boundary of the survey license area. Thakan Besi gully, a right bank tributary near to the south boundary of the survey license area, has a catchment area as large as 6km<sup>2</sup>. The current downstream boundary of survey license scope is only 70m from the gully confluence and powerhouse excavation scope exceeds the gully and downstream boundary; this requires relocating the gully, leading to safety risks during construction and operation. Therefore, surface powerhouse should not be arranged downstream of the gully confluence. Comprehensive analysis of topographic and geologic conditions of powerhouse site area identifies two possible powerhouse sites:

- upper powerhouse site -- about 100m U/S of Thakan Besi confluence with Marshyangdi river;
- lower powerhouse site -- on a terrace on the left bank of Thakan Besi just upstream of its confluence with Marshyangdi river. The two sites are 100m apart

Both upper powerhouse site and lower powerhouse site have the conditions for the placement of ground powerhouse. From the comprehensive comparison of the topographic and geological conditions, the building layout conditions, and the environmental impact and the construction layout, the lower powerhouse site plan is better than the upper powerhouse site plan. The total investment and unit kilowatt investment of lower

powerhouse site is smaller than that of upper powerhouse site. At this stage, the lower powerhouse site plan is recommended.

## 7. ENVIRONMENTAL IMPACTS

The major environmental issues identified by the Scoping document and ToR have already been described in detail in the Chapter 5 (Identification of Environmental Impacts) of the approved EIA report. The changes in design features and location of component sites have not given rise to totally new and different type of impact than those already identified however some of the impacts were found unapplicable. But this has basically changed the dimensions of some of the specific impacts already described in the EIA report. A comparative impact evaluation table has been presented in each section on three different environments.

### 7.1. Adverse Impacts on Physical Environment

#### 7.1.1. Construction Phase (Physical Environment)

##### 7.1.1.1. Impacts on land use

The changes in design of the project have impacted on the land use pattern of the project area. The project will affect various land uses and land cover which primarily includes construction activities like establishing structures, clearance of forest areas and disturbances to different land types. According to the data obtained from the recent feasibility report and further explorations, 45.97 ha of land is required for the project. Previously, the land requirement was 42.385 ha in approved EIA report.

**Table 7-1: Comparative land requirement for the project**

SN	Land Type	Approved EIA	SEIA	Remarks
<b>Permanent</b>				
1	Forest (Gov.)	13 ha	3.49	Decreased
2	Cultivation Land	4.54 ha	2.71	Decreased
3	River and Flood Plains	0.055 ha	11.48	Increased
4	Settlement Area	-	0.21	Added
5	Barren Land (Pvt.)	-	0.53	Added
	<b>Sub-Total (A)</b>	<b>17.595 ha</b>	<b>18.42</b>	<b>Increased</b>
<b>Temporary</b>				
1	Forest (Gov.)	16.21 ha	12.00	Decreased
2	Cultivation Land	6.58 ha	8.37	Increased
3	River and Flood Plains	2 ha	4.99	Increased
4	Settlement Area	-	1.72	Added
5	Barren Land	-	0.46	Added
	<b>Sub-Total (B)</b>	<b>24.79 ha</b>	<b>27.54</b>	<b>Increased</b>
	<b>Grand Total (A+B)</b>	<b>42.385 ha</b>	<b>45.97</b>	<b>Increased</b>

##### 7.1.1.2. Sedimentation, Soil erosion and Land instabilities

The impoundment created by the dam will affect the sediment distribution as some bed load and suspended sediment are to be transported through the desanding basin and flushed into the Marshyangdi River. Thus, sediment distribution pattern will be slightly affected, especially during the low flow period and due to the removal of boulders during construction. Similarly, excavated material (muck and spoil) from the tunnel may cause land instabilities and erosion in and around the spoil/muck disposal sites and increase sedimentation. Also, the muck disposal site proposed near the bank of river have equal chance to get washed off by the river.



The blasting activities, excavation, trees removal during tunnel construction may cause landslides on steep slopes especially during monsoon within the area of Rambazar, Siurung, Arkhale and Chhapdanda villages.

In summary, the project's impact on topography, geology and soil will be direct, adverse, high in magnitude, local in extent and short-term in duration with overall moderate significance.

#### **7.1.1.3. Loss of top soil and soil productivity**

The construction of project will increase soil exposure to precipitation and surface erosion specially in the areas with greater slopes. Further, the wastage of construction materials and chemicals on the soil will affect the productivity of the soil.

In summary, the project's impact on topsoil and productivity will be direct, adverse, high in magnitude, site-specific in extent and short-term in duration.

#### **7.1.1.4. Noise and Vibration**

The major activities that will generate noise and vibration are construction activities, blasting, use of batching plants and movement of heavy equipment such as drilling, vibrators, dozers, loaders, rollers, crane, generators and pumps. Addition of workforce will create additional noisy environment affecting human, wildlife and livestock of the project area. Intense vibration during tunneling may produce cracks in the existing houses, trigger rock falls in the unstable area and in some cases, the high intensity of vibration may even cause the built structures to collapse which lies in proximity of the project site.

The expected noise level from vehicular source will be around 80 to 95 dbA from the distance of 10 m and the vibration level of bulldozer, loaded truck and jack hammer is expected to be 0.15 to 0.25 inch per second (ips) at 4m distance, and this decreases as the distance from the source decreases. The noise from the surface blasting activities will be around 130 to 140 dbA nearby the source and it is expected to decrease as the distance increases. The noise and vibration related to the blasting activities decreases for the underground blasting. The blasting activities are carried out once or twice a day and mostly during the daytime.

In summary, the impact due to noise and vibration will be direct, adverse, high in magnitude, local in extent and short-term in duration.

#### **7.1.1.5. Air Quality/Pollution**

The air quality of project area will be affected during the construction activities of the project. The air quality in and around the powerhouse and intake sites, and near the audits will have adverse impacts in terms of dust and vehicular emissions. During the construction period, activities such as transportation and handling of construction material, excavation, drilling, blasting, use of heavy equipment, and the use of crushing and batching plant will generate fugitive emissions (suspended particles, carbon monoxide, sulfur oxide, hydrocarbons and oxides of nitrogen in air). As most of the area has earthen road, the dust emissions will directly affect the households in the road corridor. In case of project sites, the chances of unpleasant odor are extreme due to improper management of sewage and solid waste, and indoor smoke pollution. Construction activities will attract large number of migrant labors and people who supply goods and services to the labor force. If adequate measures are not taken to handle the sewerage and solid waste generated by this new population, there is a possibility of increase in foul odor.

In summary, the impacts will be direct, high in magnitude, short-term in duration and site-specific.

#### **7.1.1.6. Change in Surface and sub-surface hydrology**

During the construction of engineering structures and excavation activities, either surface or subsurface, there will be greater chances of decrease in water table, as shown by various studies. When the construction is in progress, the aperture of rock will certainly open to some extent and the porosity of the soil will be high, which will increase the hydraulic conductivity in some area. Because of this some area will lose the subsurface water while other would have excess water. The underground excavations lower the ground water table and increase its flow. The desanding basin at the intake structure, tunnel alignment, the surge tank, and the powerhouse require underground excavations prompting the ground water table to diminish and increase its flow. The headrace tunnel alignment runs below Chhaphanda, Sildhunga, Arkhale and Siurung villages and tunneling activities may have impacts on the water table of the area.

In summary, the impact on hydrology of the project area will be direct, adverse, high in magnitude, local in extent and short-term in duration.

#### **7.1.1.7. Change in water quality**

The construction activities are likely to increase the turbidity, suspended solids, dissolved solids, and Biological Oxygen Demand (BOD) of Marshyangdi River and its tributaries in the project site. Disturbance of the river bed, construction of diversion weir, disposal of unwanted materials on the river banks, etc. will greatly affect the water quality in project vicinity. The improper management of waste, both solid and liquid, generated by the workforce, equipment, surface runoff, batching areas and cement slurries will result in increased BOD and Fecal Coliform causing water quality degradation.

The solid and liquid wastes discharged from construction camps, active construction sites, yards and mechanical workshops, effluents and unused slurry of aggregate batching plants and tunnel, leakage and disposal of spent oils, grease and unused lubricants have greater chance of polluting the water quality.

In summary, the impact on water quality will be direct, adverse, high in magnitude, local in extent and short-term in duration.

#### **7.1.1.8. Change in soil pH and chemical composition**

Liquid waste such as spillage of lubricants, oils, paints, cleaning, construction chemicals, and other aqueous and oil-based materials may be generated as a result of the construction activities. Some liquid wastes might occur as a result of leaks from construction equipment, accidental spills during material transfer and storage, and also from improper and inadequate management, which will eventually alter the soil pH and chemical composition of it. The soil characteristics of dam site, spoil management areas, camps, access road, storage areas may change due to previously stated activities. This will further create compacted soil destroying the soil infiltration and moisture retention capacities. Some of the fugitive dusts and deposition in the surrounding areas too will have minor changes in the soil chemical composition and productivity.

The overall impacts on soil characteristics are direct, local in extent, long term in duration and high in magnitude.

#### **7.1.1.9. Change in river morphology**

The removal of boulder and gravels from the riverbed during construction will have some limited effect on river morphology. During the construction of diversion structures, some selected boulders needed to be

removed from the intake area which may affect the flowing pattern of river. The construction of dam structure will create a pooling area up to 1 km (Syange) in the upstream area and this changes the river morphology.

The river stretches within damsite areas, spoil management areas near adit 1 and adit 2, and tailrace area at Siurungbesi may receive morphological changes as the stretch will remain dewatered for the placement of dam structures and other supra structures. This will modify the river substratum and flood plains, which may eventually affect the river morphology.

The impact on water quality will be direct, adverse, high in magnitude, local in extent and short-term in duration.

#### **7.1.1.10. Impact due to Quarry, stock piling and muck disposal**

As the length of the tunnel has been decreased, the volume of spoil produced will be less than stated in the approved EIA. About 2.53 million m<sup>3</sup> volume of spoil will be produced by the tunnelling activities. The quarry requirement for the project is about 760,000 t, which amounts to 287,000 m<sup>3</sup>. But it is likely that the project doesn't utilize all the spoil for construction activities like road pavement and it is sure that all the spoil can't be used as aggregates for construction. Hence, the lack of proper management and storage may impact on the physical and ecological environment of the area.

The nature of the impact will be direct, local in extent, long term in duration and high in magnitude.

#### **7.1.1.11. Impact due to sediment load**

Geologically, the entire terrain of the project construction site lies in the high sedimentation supply zone. However, the sediment trapping by the dams, sand extractions from the river channels, land clearance and catchment disturbance by the project construction activities may decrease the sediment load which ultimately affects the structure, processes and functions of river ecosystems. There are greater chances of river sedimentation transport which eventually lead to bed aggregation, rise the flood water level, channel and shore erosions.

From the above consideration, the envisaged impact of sediment load is direct in nature, regional, long term in duration and low in magnitude.

### **7.1.2. Operation Phase (*Physical Environment*)**

#### **7.1.2.1. Impact due to sediment load and flushing**

The impoundment created due to the dam and sudden release of flow may have impacts on the riverine ecosystem during the operation phase of the project. Along with the deposition of the sediment load on the upstream, there may be the problems on the downstream due to sediment deposition in the settling basin and their flushing activities. The unnatural disposal of this sediment at high concentration may cause environmental imbalance in the river and on the other hand, washing off the trapped sediment into river intermittently may increase the load in the downstream dewatered section of the river. During the dry season, if the flushing is carried out, the sediment load derived will not be washed off effectively which will affect the flow or velocity of river water. But, in the monsoon as water volume below dam will be high, the sediment load from settling basin will be effectively washed off.

From the above consideration, the envisaged impact of sediment load is direct in nature, site-specific, long term in duration and low in magnitude.

#### **7.1.2.2. Change in river morphology and water use**

The sediment distribution pattern is likely to have few changes due to the diversion of flow at the dam site. Some bed load and suspended sediment will be trapped in the impoundment created by the dam, while some sediment will be transported through the desanding basin and flushed into the Marshyangdi River. Thus, sediment distribution pattern will be slightly affected, especially during the low flow period when the sediment will accumulate at the dam and below the desanding basin. Sediment distribution in the river will be affected to some extent by the barrier created by the dam. In comparison to the previous project, project stretch is reduced and due to this, the impact is expected to be reduced.

The erosion and sedimentation along the river course may change in hydrological characteristics. With these changes, the entire river morphology and associated ecological conditions will undergo a considerable change between the diversion point and the tailrace outlet. In case of presence of any irrigation project or other project that utilizes water between the dewatered stretch, their water use right may be impacted. But the impact on downstream projects is minimum and negligible.

The overall impacts of the change in river morphology and water use are envisaged to be direct, site-specific, long term in duration and medium in magnitude.

#### **7.1.2.3. Change in water quality of dewatered zone**

The reduction in the river discharge between dam site and tailrace will change the water quality especially in dry season. The self-cleaning capacity of the river will be decreased due to reduced flow and dissolved oxygen content. Along with this, the chemical and physical characteristics of water may change due to low discharge and this will enhance the growth of different benthic habitat which may reduce the amount of oxygen in the area.

The envisaged impact is direct, site-specific, long-term in duration and low in magnitude.

#### **7.1.2.4. GLOF risk**

The Marshyangdi River Upstream of the proposed intake site hosts more than twenty glaciers in the basin and some major lakes are Gyangapu, Tilicho, Pango and Pangeri, Suti, Bhimdang, Purdi and Thulagi. Many inventories of glacial lakes have been carried out and only one lake, Thulagi Lake has been identified as a potential risk for all projects situated upstream of this proposed project. This lake feeds the Marshyangdi river whole year and in case of worst scenario being outburst, the project may be affected. Along with this it may affect the settlements on the river basin, especially downwards the Nyadi area.

The envisaged impact is direct, regional, short term in duration and low in magnitude.

#### **7.1.2.5. Waste disposal**

As the number of operation manpower has remained the same as presented in approved EIA, the quantity of waste produced in the camp and office area is the same. But, since the location of the permanent camp has changed, the impact of waste disposal will also shift along with the location of permanent camp. The solid, semi- solid and liquid waste generated due to workforce, leakage and sipping etc. will have haphazard impacts in the nearby environment. The general impacts due to wastes will be no different than those mentioned in the approved EIA report.

However, the impact will be direct, high, remain site specific and long term in duration.

### 7.1.2.6. Impact on Annapurna Conservation Area

During the operation period, the expected activities of the project are:

- Water regulation through dam and dewatering of the Marshyangdi River with only environmental flow between Syange and Thakanbeshi.
- Formation of reservoir upstream dam in the months from October through June.
- Maintenance activities at the Dam site at Rambazaar and Powerhouse site at Arkhalebeshi.
- Operation camps at Dam site Mipra, and Powerhouse at Neapanephaat.

The operation workforce is expected as a maximum of 50 persons who will be working on a daily basis. As most of these workforces will be confined in the camps and in the operation buildings, there will not be much of the activity outside to be seen by the travelers. As all of these structures and activities will be in the already human influenced areas, the physical implications on the remote areas of ACAP is not expected. The Marshyangdi River hydrological changes could only be seen in the headworks site, near Rambazaar by the travelers visiting this area, which could be realized by the travelers who have visited the area before the project construction and is not likely to give adverse impression on the physical set up of the area.

The envisaged overall impact to the ACAP envisaged is direct, long term, local, and low in magnitude.

### 7.1.2.7. Impact on Main Trail

During the operation period, there may be impacts on the main trail leading to Manang via Rambazaar areas within the powerhouse area, adit and headworks area.

The envisaged overall impact to the main trail is direct, site-specific, long-term and low in magnitude.

The comparative beneficial impact analysis of approved EIA and SEIA is given below in **Table 7-2**:

**Table 7-2: Comparative Impact Evaluation of adverse impacts on Physical environment**

SN	Impacts in Approved EIA (138 MW)	Impacts in SEIA (102 MW)	Description	Remarks
<b>1.</b>	<b>Construction Phase</b>			
1.1.	Sedimentation, Soil erosion and Land instabilities	Sedimentation, Soil erosion and Land instabilities	Change in land requirement.	No change
1.2.	Loss of top soil and soil productivity	Loss of top soil and soil productivity	The obligatory points of the project and its components are different.	No change
1.3.	Mineral occurrence and management		Not an adverse impact	Removed
1.4.	Noise and vibration issues	Noise and vibration issues	-	No change
1.5.	Surface and subsurface hydrology	Change in surface and subsurface hydrology	-	No change

SN	Impacts in Approved EIA (138 MW)	Impacts in SEIA (102 MW)	Description	Remarks
1.6.	Change in water quality of surface and subsurface water due to construction related activities including tunnel discharge, camp management, and spoil management	Change in water quality of surface and subsurface water due to construction related activities including tunnel discharge, camp management, and spoil management	-	Extent is changed
1.7	Water Quality	Degradation of Water Quality	River diversion requires, construction	No change
1.8.	Change in River Morphology	Change in River Morphology	-	
1.9.	Main Central Thrust		As stated, that there are no effects in terms of deformation.	Removed
1.10.	Quarry, stock piling and muck disposal	Quarry, stock piling and muck disposal	Mucks are considered.	No change
1.11.	Change in Soil pH and chemical composition	Change in Soil pH and chemical composition	-	No change
1.12.	Air Quality/Pollution	Air Pollution	-	No change
1.13.	Water Chemistry Change	Water Chemistry Change	-	
<b>2.</b>	<b>Operation Phase</b>			
2.1.	Sedimentation and sediment flushing	Impact due to sediment load	-	No change
2.2.	River morphology and water use	Change in river morphology and water use	-	No change
2.3.	Change in water quality of dewatered zone	Change in water quality of dewatered zone	-	No change
2.4.	GLOF Risk-Thulagi Glacial Lake	GLOF Risk	-	No change
2.5.	-	Waste Disposal	There are greater chances of solid waste generation, and leakage during the operation phase.	Added
2.6.	-	Impact on Annapurna Conservation Area	-	Added
2.7.	-	Impact on Main trail	-	Added

**Table 7-3: Comparative Impact Evaluation of adverse impacts on Physical environment**

S.N.	Physical and Chemical Impact	Direct/Indirect Impact	Extent	Duration	Magnitude	Significance
<b>Construction Phase</b>						
1.	Sedimentation, Soil erosion and Land instabilities	D	L (20)	LT (20)	H (60)	Si
2.	Loss of top soil and soil productivity	D	S (10)	ST (5)	H (60)	Si
3.	Noise and vibration issues	D	L (20)	ST (5)	H (60)	Si
4.	Change in surface and subsurface hydrology	D	L (20)	ST (5)	H (60)	Si
5.	Change in water quality of surface and subsurface water	D	L (20)	ST (5)	H (60)	Si
6.	Degradation of Water Quality	D	L (20)	ST (5)	H (60)	Si
7.	Change in River Morphology	D	L (20)	ST (5)	H (60)	Si
8.	Quarry, stock piling and muck disposal	D	S (10)	ST (5)	LO (10)	SL
9.	Change in Soil pH and chemical composition	D	L (20)	LT (20)	H (60)	Si
10.	Air Pollution	D	S (10)	ST (5)	LO (10)	SL
<b>Operation Phase</b>						
1.	Impact due to sediment load	D	S (10)	LT (20)	LO (10)	SL
2.	Change in river morphology and water use	D	S (10)	LT (20)	H (60)	Si
3.	Change in water quality of dewatered zone	D	R (60)	LT (20)	LO (10)	Si
4.	GLOF Risk	D	R (60)	ST (5)	LO (10)	Si
5.	Waste Disposal	D	S(10)	LT(20)	H(60)	Si
6.	Impact on Annapurna Conservation Area	D	L(20)	LT(20)	LO(10)	Sm
7.	Impact on Main trail	D	S(10)	LT(20)	LO(10)	Sm

Note: D = Direct, IN = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, MT = Medium Term, LT= Long Term, H = High, M=Moderate, LO= Low, Si = Significant, Sm =Moderately Significant, SL= Insignificant

## 7.2. Adverse Impacts on Biological Environment

### 7.2.1. Construction Phase (Biological Environment)

#### 7.2.1.1. Change in land use/landcover

For construction of the project about 45.97 ha of land will be acquired out of which 18.42 ha land will be acquired permanently and remaining necessary land about 27.54 ha will be acquired temporarily. Altogether 16.48 ha of river and flood plain will be utilized by the project including submerge area, 15.50 ha of forest

land will be converted into a construction site, 11.07 ha cultivated land will be required for the project construction and operation.

In summary, the nature of impact is direct, high in magnitude, site-specific in extent and long term in duration.

#### **7.2.1.2. Loss of vegetation due to site clearance**

The direct impact on flora is attributed to loss of trees, which are required to be cleared for establishment of various project units. A total number of 347 trees, 381 poles and 78 saplings are to be felled/ cleared. Vegetation clearing activities at the project site will result in the loss of approximately 15.919 ha forest from Government. The diversion weir site is heavily degraded site with few standing trees. Besides this area, shrub and grassland where few poles size trees and fodder plants are found will also be acquired by the project. The project will remove plant life weighing 5,24,461.29 kg biomass from the forest.

The impact will be low in magnitude, local in extent and long term in duration.

#### **7.2.1.3. Encroachment of nearby forest by outside workforce**

The influx of people from surrounding area and from different part of Nepal will temporarily migrate to the project site during construction, i.e., the construction workers, their dependents and people who provide goods and services to these new migrants need large quantity of firewood for cooking and heating purposes and timber for shelter. Thus, there is a possibility of encroachment to the nearby forest for fulfilling their demand.

The magnitude of impact is considered to be low; extent is site local and duration is short term.

#### **7.2.1.4. Exploitation of Non-Timber Forest Products (NTFPs)**

The increased human encroachment in forest for firewood and timber leads to Non timber forest product (NTFPs) extraction. The clear felling in some sites and cutting of trees in other places for construction of different project components will degrade forest resources. Similarly, influx of large number of people from outside also contribute to indirect impacts on the existing forest resulting firewood demand for cooking and construction of office, warehouse, labor camps and making furniture.

The impact is direct in nature, has medium magnitude, local in extent and will have medium term impact.

#### **7.2.1.5. Fire hazard due to increased access in forest**

In and around the construction area, there are many types of fuel that create hazards, such as slash accumulation in timber cutting, dry grass and debris accumulation in fields, large accumulation in forests of flammable leaves, dead trees, dry bushes etc. and it may also the garbage disposal and improper storage of inflammable gases and liquids at the construction period of the project. One of the major causes may wildfire is the careless smoking by the labor, or local residents who smoke while in the forest or grasslands though carelessness cause disastrous fire.

The magnitude of impact is considered to be low; extent is site specific and duration is short term.

#### **7.2.1.6. Disturbance to natural habitat of wildlife**

The loss of forest due to placement of project structures and facilities will produce long term localized impact on wildlife. Felling of old and large shady tree will impact wildlife habitat. The habitat of wild animals like Porcupine (*Hystrix indica*), Yellow throated Marten (*Martes flavigula*) and Jackal (*Canis aureus*) will be disturbed by construction activities. Wildlife, which cannot tolerate such activities, may move to other areas.



Above the proposed tunnel alignment and adit site contains different types of bird's nest. Because of the construction work, the habitat will be lost and birds will be affected. Loss of habitat, breeding ground, dispersal of wildlife, habitat fragmentation escalation in human-wildlife can be observed during construction phase. As mentioned in baseline wildlife reported from the area are widely distributed in nearby forested areas, the small habitat area occupied by the project in compared to the total available forest habitat is likely to be considered as low. Disturbance to natural habitat can be harm the butterflies, caterpillars and its breeding in the project area.

The magnitude of impact is considered to be low; extent is site specific and duration is short term.

#### **7.2.1.7. Impact on Annapurna Conservation Area**

ACA is directly affected by the construction activities. The wildlife sheltering inside this are affected and along with this, the endangered plant species also face threat due to the influx of large number of workforces. Social surveys also indicated that wild animal populations have increased inside ACA since the inception of community-based conservation but this may be affected by the different activities of project. The influx of people in the area may lead to man-made hazards, illegal poaching and trade, pressure on endangered floral and faunal species, etc.

The magnitude of impact is considered to be high; extent is site specific and duration is long term.

#### **7.2.1.8. Construction disturbance**

Construction disturbances resulting from drilling, vehicle movement and other related activities would interrupt normal movement, feeding and other activities of mammals. Construction activities may continue at night for the timely completion of project. The electric light in and around the works site and human presence will affect wild animals grazing around the forested area of adits and tunnel alignment. The clearing excavation, grading and filling activities will kill less mobile, frequently smaller species such as frogs, lizards and small mammals (rats). The water pollution from project activities (muck disposal, washing of concrete batching plant, Solid waste and accidental spill of oil and lubricants) may also affect local wild fauna and aquatic birds most susceptible to water pollution.

The magnitude of impact is considered to be low; extent is site specific and duration is short term.

#### **7.2.1.9. Wildlife poaching pressure by outside workforce**

Possible wildlife poaching by labor force may occur during the project phase. The workforce might be attracted to squirrels, birds and other wild animals. The possibilities of trapping wildlife due to luring by the poachers may increase in absence of proper monitoring which will have direct impact on the faunal species. Along with this, fishing and other activities may occur, animals like deer may be poached for meat by the outsiders or even the locals.

The magnitude of impact is considered to be low; extent is site specific and duration is short term.

#### **7.2.1.10. Impact on rare, endangered, protected and threatened species**

The frequency of wildlife species visiting the project area is very low due to sparse vegetation and frequent human interference. However, some of the rare and endangered species of animals and some plants are spotted in the project area which may be affected by the construction activities. A rare fern, *Cyathea spinulosa*, listed

in CITES Appendix II is seen around the project area which may be affected during the road upgrading and clearance activities.

The magnitude of impact is considered low, extent is local and duration is short term.

#### **7.2.1.11. Fish and aquatic fauna**

Construction of diversion weir will contribute to better water storage and energy production, but could lead to changes in upstream and downstream fish species composition and, in some instances, to species loss. The project will have negative adverse impact on river ecosystems, especially fish species. Mainly Asla (*Schizothorax spp.*) and the migratory Sahar (*Tor spp.*) is common in the area. Asla needs running water with high oxygenated water, but after diverting the water into tunnel there will have a reduced amount of water where this species will experience less favorable migratory route. Sahar migrates upwards during rainy season. Due to obstruction in natural water flow caused by weir construction across the river, the river ecosystem will change and both feeding grounds and breeding grounds will be affected, leading to fish abundance loss. There will be some localized impacts in the flow regime of the Marshyangdi River where dewatered zone will face greater impact during the short period of dry season.

The magnitude of impact is considered high, extent is local and duration is long term.

### **7.2.2. Operation Phase (Biological Environment)**

#### **7.2.2.1. Impacts on Vegetation/ Forest Resources**

In operation phase, the commercial trading of medicinal plants, firewood and other useful plants will increase unless controlled. This would induce extra pressure on the existing forests of the project area. It may also initiate urban development in the project area, which further affects vegetation of the surrounding area for firewood, timber, poles and construction of buildings. The permanent labor force for operation and maintenance would pose extra demand of firewood. Such requirement might destroy adjoining forest of the project area.

The magnitude of impact is considered low, extent is site specific and duration is long term.

#### **7.2.2.2. Impacts on Wildlife and Biodiversity**

Wildlife needs a regular source of water for drinking, bathing, wallowing etc. The diversion of water from the Marshyangdi River to the tunnel will cause a decrease of the water levels in the downstream. This will have an adverse effect on mammals and aquatic birds. During the operation period a maximum of 50 workforces distributed in the powerhouse at Arkhalebeshi and Dam site is expected. All of these work forces are technical staff and will be confined to the camps busy in the operation of the project. For other maintenance works, peoples will be hired locally on daily wage basis. As these people are local, their impact to the biodiversity and habitats of ACA is equal to as is now. However, there will be some risk from operational staffs on the biodiversity and habitats of wildlife, if not regulated for camp requirements and other economic benefit.

There is a risk of wildlife poaching by the operational workforce of the project. The increased access to forest and chances of frequent encounter with the wild animals and valuable plants may lure the project staffs to conduct misleading activities, including wildlife poaching. The sudden release of water may occur due to the fault in turbine operation or regulation by the load dispatch center from the diversion weir in the dry seasons. Such sudden water release could be serious to the terrestrial wildlife particularly in the night hours. The

aquatic life, particularly fish fingerlings thriving in the dewatered stretch will also be impacted. The stabilized ecology of the zooplankton and phytoplankton in the dewatered zone seems to be disturbed.

The envisaged impact is indirect, site specific, long term and low in magnitude.

### 7.2.2.3. Impacts on Fish and Fisheries

Fish migration and spawning will be affected permanently due to minimum downstream river flow during dry season. The migrants won't be able to migrate upstream due to the minimum flow and dam structures which affects the lifecycle and ecological aspects of fishes. Along with this, the shore erosion and other ecological imbalance will occur from time to time, which will ultimately impact the diversity of fishes in the area. To some extent, overfishing will increase due to low water level and ultimately in a long run fish abundance and diversity will be low.

The envisaged impact is indirect, site specific, long term and low in magnitude.

The comparative adverse impact analysis of approved EIA and SEIA on biological environment is given below in **Table 7-4**:

**Table 7-4: Comparative Impact Evaluation of adverse impacts on biological environment**

SN	Impacts in Approved EIA	Impacts in SEIA	Description	Remarks
<b>1.</b>	<b>Construction Phase</b>			
1.1.	Change in land use/landcover	Change in land use/landcover	Changes in land requirement is observed.	No change
1.2.	Loss of vegetation due to site clearance	Loss of vegetation due to site clearance	Loss of trees and vegetation will change	Change
1.3.	Encroachment of nearby forest by outside workforce	Encroachment of nearby forest by outside workforce	Insignificant	No change
1.4.	Exploitation of Non-Timber Forest Products (NTFPs)	Exploitation of Non-Timber Forest Products (NTFPs)		No change
1.5.	Fire hazard due to increased access in forest	Fire hazard due to increased access in forest		No change
1.6.	Disturbance to natural habitat of wildlife	Disturbance to natural habitat of wildlife		No change
1.7.	Impact on Annapurna Conservation Area	Impact on Annapurna Conservation Area		No change
1.8.	Construction disturbance	Construction disturbance		No change
1.9.	Illegal hunting pressure by outside workforce	Wildlife poaching by outside workforce		No change
1.10.	Impact on rare, endangered, protected and threatened species of fauna	Impact on rare, endangered, protected and threatened species of fauna	Potential impact is considered	No change
1.11.	Fish and Aquatic fauna	Fish and Aquatic fauna		
<b>2.</b>	<b>Operation Phase</b>			

SN	Impacts in Approved EIA	Impacts in SEIA	Description	Remarks
2.1.	Vegetation/Forest Resources	Impacts on Vegetation/Forest Resources		No change
2.2.	Wildlife and Biodiversity	Impacts on Wildlife and Biodiversity		No change
2.3.	Fish and Fisheries	Impacts on Fish and Fisheries		No change

**Table 7-5: Summarized Impact Matrix for Biological Environment**

Note: D = Direct, IN = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, MT = Medium

S.N.	Physical and Chemical Impact	Direct/Indirect Impact	Extent	Duration	Magnitude	Significance
<b>Construction Phase</b>						
1.	Change in land use/landcover	D	S (10)	LT (20)	H (60)	Si
2.	Loss of vegetation due to site clearance	D	L (20)	LT (20)	LO (10)	Sm
3.	Encroachment of nearby forest by outside workforce	IN	L (20)	ST (5)	LO (10)	SL
4.	Exploitation of Non-Timber Forest Products (NTFPs)	IN	L (20)	MT (10)	M (20)	Sm
5.	Fire hazard due to increased access in forest	D	S (10)	ST (5)	LO (10)	SL
6.	Disturbance to natural habitat of wildlife	D	S (10)	ST (5)	LO (10)	SL
7.	Impact on Annapurna Conservation Area	D	S (10)	ST (5)	LO (10)	SL
8.	Construction disturbance	D	S (10)	ST (5)	LO (10)	SL
9.	Wildlife poaching by outside workforce	IN	S (10)	ST (5)	LO (10)	SL
10.	Impact on rare, endangered, protected and threatened species of fauna	D	L (20)	ST (5)	LO (10)	SL
11.	Fish and Aquatic fauna	D	L (20)	ST (5)	M (20)	Sm
<b>Operation Phase</b>						
1.	Impacts on Vegetation/Forest Resources	D	L (20)	LT (20)	M (20)	Sm
2.	Impacts on Wildlife and Biodiversity	D	S (10)	LT (20)	LO (10)	SL
3.	Impacts on Fish and Fisheries	D	S (10)	LT (20)	H (60)	S

Term, LT= Long Term, H = High, M=Moderate, LO= Low, Si = Significant, Sm =Moderately Significant, SL= Insignificant

### **7.3. Adverse Impacts on Socio-economic and Cultural Environment**

#### **7.3.1. Socio-economic and Cultural Environment (*Construction Phase*)**

Due to the relocation of the project components, the dimension of social implications of the project has changed. So, although the mitigation measures proposed for the envisaged impacts are of similar nature as mentioned in the approved EIA report, the target group and the necessary cost has changed.

##### **7.3.1.1. Loss of land and property**

UM-1HPP establishment will involve the loss of land (45.97 ha). This may lead to the economic displacement and livelihood impacts. The permanent land acquisition of private land can lead to economic displacement and small businesses like shops, poultry and different other commercial enterprises.

Permanent economic displacement can result in landlessness, loss of income and livelihoods, reduced food and fodder security, poor health and increased morbidity, reduced social and economic resilience of households (to withstand shocks like natural and other adverse events) and increased marginalization. As with physical displacement, the more vulnerable groups and households may be more significantly impacted by economic displacement given their already reduced ability to withstand shocks like the loss of land and assets, or access to land and community resources, upon which they are wholly dependent.

As most of the PAFs mainly depend on agricultural and tourism activities in the area, the long-term loss and reduction of the agricultural land affects food security of households. Some standing crops may be damaged during construction period. The expansion of activities, transportation of equipment and material will cause damage to the neighboring field. The disturbances will affect to the agriculture and livestock production and activities. The construction schedule and presence of access trail in cultivated land will also affect planning and operation of the other project activities.

The magnitude of impact due to loss of agriculture land is high, extent is local and duration is long term.

##### **7.3.1.2. Involuntary Relocation Issues**

For the project construction, 14 houses with temporary cowsheds in private land and some families residing in the governmental land by making their temporary or permanent structures needs to be relocated. This may exploit the basic right of people residing in the area.

The magnitude of impact due to relocation is high, extent is local and duration is long-term.

##### **7.3.1.3. Change in social structure, cultural and traditional practices of local people**

During the construction of the project, immigration of large number of workers from outside is expected to occur in the project area. Some of the workers required for the project construction work will be sourced from different places other than the local area. These workers apparently could have different cultural and traditional values other than that of local people. The cultural and traditional activities of migrating workers might influence the local culture and tradition, and in between quarrel, fight and dominance may happen. Excessive burden occurs on existing infrastructures facilities such as health post, local market, water supply etc. caused by inflation of population due to large numbers of immigrant work force. Moreover, the price of the services will also increase.

The magnitude of impact will be high, extent will be site-specific and duration will be long-term.

#### **7.3.1.4. Excessive burden on existing infrastructure and facilities**

Excessive burden on existing infrastructure facilities such as health post, local market, communication, water supply etc. will occur caused by influx of population due to large number of migrant work force. A major affect will occur on the transportation facility as only small and medium sized vehicles like four-wheeler pick-ups provide their services in the area. This will equally have the chances of inflation of travel rates as the vehicles are not under control of any authorities and rates vary. Nearby recreational areas like Syange waterfall, Nyadi bazar areas and parks may get crowded by the migrants and this may affect the local facilities of the area. Further, locals who are indulged in the business and local services may play roles to price hike and impact on facilities. The local residing communities are the most impacted one because of such activities and implications. They feel, because of the project, they are suffering from all kinds of service deficiencies.

The magnitude of impact will be high, extent will be site-specific and duration will be long-term.

#### **7.3.1.5. Impact on tourism**

Most of the local people of the areas are involved in the tourism sector in different roles as guides, porters and hotel business. With the chances of their involvement for the project, the area may lack people to involve in tourism and this may impact the tourists visiting the area. Along with this, the construction disturbances may impact the tourists travelling throughout the area. Most importantly, as the trekking and transportation route for Manang area lies within the powerhouse and the intake sites, this may affect the tourist passing through the area.

The magnitude of impact will be medium, extent will be site-specific and duration will be long-term.

#### **7.3.1.6. Disturbance in social harmony and settings**

There are some likely impacts, especially the adverse one that are most likely to occur on the social structures, norms and cultural practices of the communities located close to the construction area. These changes are brought by the influence of the outside construction forces of diverse social background and cultural practices. During the project construction, the influence of the outside workforce on the local way of life and traditional cultural practice can result into cultural erosion, undesired social practices, disputes, conflicts and possible dilution of social bonds among the local people. Along with this, the violation of law and order with the incidents of burglary, quarrel due to alcohol consumption, gambling, drug addiction, etc. may arise in the area.

In summary, the impact on social structure and cultural practice is high, local and short term in nature.

#### **7.3.1.7. Occupational and Safety Hazards**

During construction, injuries may happen due to lack of adequate occupational health and safety of the construction workers and in the construction sites. Unskilled workforce, unsafe use of protective personnel equipment, the occupational health hazard can be high and potential, particularly in the subcontracted part of the construction works to the local petty contractors. Inappropriate way of construction and faulty designs can be the cause of accidents among the project workers. The accidents can happen due to the lack of knowledge, training, use of safety tools, etc.

The magnitude of impact is low, extent is site-specific and the duration is short-term.

#### **7.3.1.8. Prostitution and Issues related with STD**

The outsiders may influence the people of the project on the basis of monetary power and different greed. Girl trafficking and prostitution are not found or reported in project area, but during the project implementation the said cases may likely to increase.

The magnitude of impact is low, extent is site-specific and the duration is short-term.

#### **7.3.1.9. Public Health and Sanitation**

Increase in outsider's influence during construction phase is likely to add further stress on the local health and sanitation situation. Pollution of land, water and air due to construction activities causes impact on the health to the local community. Besides, the increase in the noise level due to vehicular movement in the project area is likely to influence the physical and mental health of the local community. The outbreak of communicable diseases such as diarrhea, amoebic dysentery, paratyphoid, respiratory diseases etc. may occur. The chances of haphazard discharge of wastes of various types including toxic chemical, metals, paper, kitchen wastes, etc. occurs which are potential to degrade the sanitary hygienic conditions particularly around the construction sites and camp sites.

Taking note of the present health condition of the people of the project area, the magnitude, extent and duration of the impacts is predicted low, site-specific and short-term respectively.

#### **7.3.1.10. Water supply**

The overall impact on water supply and sanitary situation will be: shortage of drinking water due to influx of workforce, increase pressure on the existing water supply system, increase distance to the safe drinking water, increase in disease vectors, and reduced water quality due to increased sanitation problems, etc.

However, the impact on water supply and sanitation will be low, short term and site specific.

#### **7.3.1.11. Impact on structures and houses due to vibration and construction activities**

During the construction period, vehicles will be moved frequently in the project area and lot of blasting activities will be taken in the headworks, tunnel alignment, powerhouse and other construction areas. The movement of vehicle increases dust leading to air pollution, disturbances leading to air pollution. The blasting activities is likely to lead crack in the houses due to vibration produced in nearby areas of construction where blasting activities is carried out. Impact on houses and settlement areas, water springs, and wells due to tunnel construction is expected. Further, the landslide prone areas of the site also get triggered by the tunneling activities and this may cause greater impacts to the community.

The magnitude of the impact will be high, extent will be local and duration will be short term.

#### **7.3.1.12. Impact on Cremation sites**

There are practices of human dead body burial grounds on the banks of the Marshyangdi river within the project alignment. One cemetery site is located in left bank opposite to Syange village, that gets submerged due to water pooling and other on the dewatered stretch.

The magnitude of the impact will be high, extent will be site-specific and duration will be short-term.

#### **7.3.1.13. Impact on People's Behavior due to Sudden Cash Flow**

The sudden inflow of cash in the hands of local people through cash compensations and wages from working in the project may lead to development of extravagant habit among them and indulge in gambling, alcohol,

etc. Some people may speculate land prices and make difficult to purchase new land from the cash compensation. The experiences from other hydropower projects show that people do not make effective use of cash compensation amount and fall in to economic crisis after the cash is spent.

The magnitude of this impact is moderate, extent is local and duration is long term.

#### **7.3.1.14. Impacts on Gender and Vulnerable group**

Majority of the men within project area are likely to be involved in the construction activities creating shortage of labor required for agricultural and other household's activities. The shortage may need to be fulfilled by women and children. This will add burden to the women and children even though child labor is legally prohibited in Nepal. Potential adverse impacts, unless mitigated, may be disproportionately greater on vulnerable groups like marginalized and highly marginalized Adivasi Janajati and Dalit groups. The Project may also create additional risks for women and marginalized groups within project area, which includes fraudulent or forced sex trafficking as well as coercive labor practices., women and marginalized groups may be subject to employment discrimination and women's labor may be undervalued and underpaid (relative to men for the same job). Incidences of sexual harassment and gender-based violence may occur.

The magnitude of impact is low, extent is local and duration is short term.

### **7.3.2. Socio-economic and Cultural Environment (Operation Phase)**

#### **7.3.2.1. Peoples' behavior due to stoppage of cash flow**

The high flow of cash during construction will enhance the purchasing power of the people although temporarily. The people have satisfactory level of income and expenditure by local standard. During the operation phase, as the number of hired labor force withdraws from the site along with the sudden declining of cash flow in the local area, the local people have little source of cash income whereas their spending tendency remaining the same as it was during the construction phase. They therefore suffer a sudden financial depression. As a result, they move to urban centers of other district or India as well for seasonal employment and then balance their income and expenditure.

The impact is low, site specific and long term.

#### **7.3.2.2. Impact due to withdrawal of economic activities**

The commercial area developed in and around project area in construction phase such as tea stalls, hotels, restaurants, barber shops, grocery shops and consumable goods departmental stores etc. will have reduced number of customers to serve, thus, due to decline in economic activities, many of the shops will be closed down and shifted out of the project area. The allied construction related industry will also close because of the fewer business opportunities. Potential of such happening in the project area is very high. As the employment opportunities in the project area will cease once the construction phase is completed, individuals may prefer to migrate leading to household disrupting, unity and traditional social practices. This leads to low volume money flow and less economic growth in the area.

The impact is low, site specific and long term in duration.

#### **7.3.2.3. Impact on Lifestyle**

The impact on life style of the local people of the project area during the operational phase of the project activity will get affected due to reduction in economic activity because of shop closures and allied business



which were supporting their life style and income generation. With the withdrawal of construction workforce, such potential adverse activities will reduce and the employees who will continue their service during the operation phase are counseled, cautioned and monitored in order to dissuade and prevent them from indulging in such unsocial activities.

The impact is considered low, site specific and long term.

#### **7.3.2.4. Impact on foot trail and movement of people**

Due to improved roads infrastructure and accessibility around the project area local commuters will use these developed roads for day-to-day purpose this will result in fast, comfortable, cheap and safe movement of people and material. Without project scenario, the existing road already leads to the powerhouse site, Diversion site and further up to Manang. So, there will be no impact on foot trail with project scenario during the operation phase.

The impact is indirect, low in magnitude, site specific in extent and long term in duration.

#### **7.3.2.5. Impact on agricultural production**

As the people will get involved in other skilled activities (most often), the chances of their return in agriculture may become low. Further, the consequences of construction may have degraded the agricultural land and finally the production in the area.

The impact is indirect, low in magnitude, site specific in extent and long term in duration.

#### **7.3.2.6. Impact on local people and domestic animals**

Water is released suddenly to downstream area to flush out the sediment load from settling basin especially during the wet season. Impact on local people and domestic animals due to sudden release of water from the reservoir can be feasible. The fluctuation in discharge will not affect any agricultural field or settlements. However, the sudden release of water might drown the domestic animals grazing along the river bank. Apart from that, the people utilizing the river water for various recreational purposes might face the threat of drowning. Children may go swimming, local people may cross the river, and fishermen may go fishing in the downstream areas. People may be washing in the river if they are unaware of the situation. Thus, there is a high risk of accidents and even loss of life if people are unknown and are not informed about the sudden release of water.

The impact is indirect, minor significant, local in extent and short-term in duration.

#### **7.3.2.7. Burden on women**

The completion of the project may result the job deficiency in the project area. The lack of employment opportunities will result in the migration of men from the project area for search of new jobs. Thus, the responsibility of women will increase, having to perform household chores as well as farming activities. This will create extra burden on women and will have negative impact on their health status too.

The impact is direct, moderately significant, local in extent and long-term in duration.

#### **7.3.2.8. Impact on water user rights**

The water sources of Marshyangdi River are not being utilized for consumptive and non- consumptive proposes like drinking, irrigation, water mills purposes or other commercial purpose between intake and the

powerhouse site. However, there are cemetery grounds in both banks of the Marshyangdi river within the project alignment, where the local people used to burn dead body.

The impact is direct, moderately significant, local in extent and long-term in duration.

The comparative adverse impact analysis of approved EIA and SEIA on socio-economic and cultural environment is given below in **Table 7-6**.

**Table 7-6: Comparative Impact Evaluation of adverse impacts on socio-economic and cultural environment**

SN	Impacts in Approved EIA	Impacts in SEIA	Description	Remarks
<b>1.</b>	<b>Construction Phase</b>			
1.1.	Loss of land and property	Loss of land and property	Changes in quantity due to shifting the project components	No change
1.2.	Involuntary Relocation Issues	Involuntary Relocation Issues	Changes in number of households to be relocated	No change
1.3.	Change in social structure, cultural and traditional practices of local people	Change in social structure, cultural and traditional practices of local people	Somewhat changes in PAF details	No change
1.4.	Excessive burden on existing infrastructure facilities	Excessive burden on existing infrastructure facilities	-	No change
1.5.	Impact on Tourism	Impact on Tourism	-	No change
1.6.	Disturbances in social harmony and settings	Disturbances in social harmony and settings	-	No change
1.7.	Violation of Law and Order		-	Included in Disturbances in social harmony and settings
1.8.	Occupational and Safety hazard	Occupational and Safety hazard	-	No change
1.9.	Prostitution and issues related with STD	Prostitution and issues related with STD	-	No change
1.10.	Public health and sanitation	Public health and sanitation	-	No change
1.11.	Water supply	Water supply	Water sources altered due to changes in project area	Minor changes
1.12.	Impact on structures and houses due to vibration and construction activities	Impact on structures and houses due to vibration and construction activities	-	No change

1.13.	Impact on cremation sites	Impact on cremation sites	-	No change
1.14.	People's behavior due to sudden cash flow	People's behavior due to sudden cash flow	-	No change
1.15.	Gender and Vulnerable Group	Impact on Gender and Vulnerable Group	-	
<b>2.</b>	<b>Operation Phase</b>			
2.1.	People's behavior due to stoppage of cash flow	People's behavior due to stoppage of cash flow	-	No change
2.2.	Impact due to withdrawal of economic activities	Impact due to withdrawal of economic activities	-	No change
2.3.	Impact of lifestyle	Impact of lifestyle	-	No change
2.4.	Employment opportunities and human resource development activities	Employment opportunities and human resource development activities	-	No change
2.5.	Impact on foot trail and movement of people	Impact on foot trail and movement of people	-	No change
2.6.	Impact on agricultural production	Impact on agricultural production	-	No change
2.7.	Impact on local people and domestic animals	Impact on local people and domestic animals	-	No change
2.8.	Movement of people in dangerous places	Movement of people in dangerous places	-	No change
2.9.	Visual Impact	Visual Impact	-	No change
2.10.	Burden on women	Burden on women	-	No change
2.11.	Impacts on water user rights	Impacts on water user rights	-	No change
2.12.	Potential for cumulative effects with hydropower development activities	-	Not so effective in present scenario	Removed
2.13.	Local economy	-	Not so effective in present scenario	Removed
2.14.	Impact on movement and safety	-	Not so effective in present scenario	Removed

**Table 7-7: Summarized Impact Matrix for Socio-economic and Cultural Environment**

S.N.	Physical and Chemical Impact	Direct/Indirect Impact	Extent	Duration	Magnitude	Significance
<b>Construction Phase</b>						
1.	Loss of land and property	D	L (20)	LT (20)	H (60)	Si
2.	Involuntary Relocation Issues	D	L (20)	LT (20)	H (60)	Si

3.	Change in social structure, cultural and traditional practices of local people	D	S (10)	LT (20)	H (60)	Si
4.	Excessive burden on existing infrastructure facilities	D	S (10)	LT (20)	H (60)	Si
5.	Impact on Tourism	D	S (10)	LT (20)	M (20)	Sm
6.	Disturbances in social harmony and settings	D	L (20)	ST (5)	H (60)	Si
7.	Occupational and Safety hazard	D	S (10)	ST (5)	LO (10)	SL
8.	Prostitution and issues related with STD	D	L (20)	ST (5)	M (20)	SM
9.	Public health and sanitation	D	S (10)	ST (5)	LO (10)	SL
10.	Water supply	D	S (10)	ST (5)	LO (10)	SL
11.	Impact on structures and houses due to vibration and construction activities	D	L (20)	ST (5)	H (60)	Si
12.	Impact on cremation sites	D	S (10)	ST (5)	H (60)	Si
13.	People's behavior due to sudden cash flow	D	L (20)	LT (20)	M (20)	Sm
14.	Impact on Gender and Vulnerable Group	IN	L (20)	ST (5)	LO (10)	SL
<b>Operation Phase</b>						
1.	People's behavior due to stoppage of cash flow	D	S (10)	LT (20)	LO (10)	Sm
2.	Impact due to withdrawal of economic activities	D	S (10)	LT (20)	M (20)	Sm
3.	Impact of lifestyle	D	S (10)	LT (20)	LO (10)	SL
4.	Impact on foot trail and movement of people	IN	S (10)	LT (20)	LO (10)	SL
5.	Impact on agricultural production	D	S (10)	LT (20)	H (60)	Si
6.	Impact on local people and domestic animals	IN	L (20)	ST (5)	LO (10)	Sm
7.	Burden on women	D	L (20)	LT (20)	LO (10)	Sm
8.	Impacts on water use rights	D	L (20)	LT (20)	LO (10)	Sm

Note: D = Direct, IN = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, MT = Medium Term, LT= Long Term, H = High, M=Moderate, LO= Low, Si = Significant, Sm =Moderately Significant, SL= Insignificant

## 7.4. Beneficial Impacts

### 7.4.1. Construction Phase

#### 7.4.1.1. Employment Opportunities for Local People

The project requires at least about 1500 numbers of skilled, semi-skilled and unskilled workforces during four of construction period. The project has a policy to provide maximum job opportunities to the local area

people in the construction related jobs. Since most of the able-bodied populations of the area are venturing out for job opportunities, project policy of preferential opportunity in local employment is going to benefit local people directly. The local people need not go out of the project area for seeking employment opportunities, provided they are interested and dedicated to the project employment.

#### **7.4.1.2. Business Opportunity for Local People**

The proposed project involves a large number of construction workforces for a period of about 40 months. Large number of people will be at the construction site during this period. They will seek a variety of service facilities and consumer goods produced locally as well as from outside of the project area. Fresh vegetables, fresh fruits, milk and milk products produced locally will be at high demand. The local farmers of the project area producing these products will be benefited by such opportunities. Besides, opportunities of business such as tea stalls, restaurants, fast food services etc. could be fulfilled by the local people themselves

#### **7.4.1.3. Induced Development**

Customarily, large construction projects are found to generate allied construction related industrial business opportunities such as welding industry, repair and maintenance industry, electrical fixing industry, and even small petty contractor services related to the project works. All of these industrial service requirements could be met by the local people benefiting to the local economy.

#### **7.4.1.4. High Value of the Unproductive Land located close to the Headworks Area**

The prices of land in the local areas have remained same for a longer period of time. The major market areas like Rambazar and Syange has some land transactions for hotel and restaurant openings, but most of the areas don't have it at all. Other agricultural lands off the market are usually not in demand even within the community level. With the project, the land prices will increase considerably. The increased access by the project is expected to promote local cottage industries including the service industries in future. All these activities are expected to increase the demand of land for various purposes with implications on the land prices and value of land, particularly at powerhouse site, headworks site and surrounding areas.

### **7.4.2. Operation Phase**

#### **7.4.2.1. Employment Opportunities for Local People**

The project is envisaged to create around 50 job opportunities on temporary and permanent basis for the project operation and regular maintenance works. As the project has a policy to provide maximum job opportunity to the local people in the operation period as well, the local people and communities will be benefited from such job opportunities at their door steps to enhance their livelihood conditions.

#### **7.4.2.2. Link the Project Affected Area to the Main Highway**

The main access road linking Besishahar with Chame via the project site will be maintained by the project for its proper operation and maintenance. Round the year maintenance of the main access road is a direct benefit to the local communities of the project area. The main access road is envisaged to provide easy access for better educational institutions, health care facilities and market facilities. Apart from the above, due to better access, the local area communities will be able to garner government's agricultural extension services, and communication services which otherwise were not possible due to remoteness of the area in the past. Besides, the environmental enhancement programs planned and executed by the project will have a long-lasting benefit in the water supply and sanitation sector, and transportation within the project affected areas.

#### **7.4.2.3. Benefit due to Royalty**

As per the existing rules, the project affected RMs is entitled for 1% of the royalties received from the project by the government for local development. Besides, with the development of local tourism and related business and industrial development in the project affected RM, the local government's base of revenues, taxes and other royalties is envisaged to increase than the present.

## **8. MITIGATION MEASURES**

As stated earlier, the changes in design features and location of component sites have not given rise to totally new type of impact than those already identified in the approved EIA report. Since all the impacts considered in the EIA report are valid for the project, the enhancement and mitigation measures proposed in the report are also valid with respect to the identified impacts. Only the impacts that have been reassessed during the study have been considered for mitigation measures in this chapter.

### **8.1. Mitigation Measures for the Adverse Impacts on Physical Environment**

#### **8.1.1. Construction Phase (*Physical Environment*)**

##### **8.1.1.1. Impacts on land use**

The project location and design study has given enough consideration in the avoidance and minimization of land disturbance and land use changes. Within the preferred/selected location, efforts to minimize the land disturbance and land use have been considered by weighing the perceived impacts while nailing down the locations of the project ancillary facilities. Land use changes and disturbance during construction is unavoidable. However, land use changes except for the project structural location sites could be reverted back to the original conditions or of better land use categories than the present. For this following measure will be implemented as rehabilitation measures.

- Demolition of all the temporary camps, storage areas established by the project and restore the site in the original land use or better category.
- Implement adequate erosion protection measures (civil and bio-engineering) and drainage facilities and reforest the area after top soil applications.
- Rehabilitate the temporarily occupied areas structures, facilities and land use and handover to the respective owner to maintain the original land use
- Reforestation of areas not occupied by the structures at powerhouse, penstock, access roads, and headwork sites.

##### **8.1.1.2. Sedimentation, Soil erosion and Land instabilities**

To avoid and minimize the impacts related to sedimentation, soil erosion and land instabilities following measures will be implemented.

- Land clearing will be minimized to the required land areas only
- The internal access roads will apply methods of cut and fill balancing for the road construction
- High explosive charge will be avoided while blasting the geological materials during road construction
- Steep slope cutting above 35 degrees will be avoided as far as possible in colluvial materials (internal access roads) and protected through bio-engineering.
- Steep slope cutting at any given location in the colluvial and alluvial materials (internal access roads) shall not exceed a height of 3 m, above three-meter cutting will have alternating bench of 2 m width.
- All slope cutting areas will be provided with storm water collection drainage above the cut slope to safely divert the water from the slope.
- The existing drainage network of the area will be maintained. The internal access roads will be provided with a side drain

- Side casting of the spoil material on the slope will be minimized to the extent possible while excavating the internal access roads
- All the spoil material will be hauled to the designated areas for spoil management
- The spoil disposal management site adjacent to the Marshyangdi flood plains will be protected by a toe wall to avoid erosion of the spoil by the Marshyangdi Floods
- The spoil disposal site will be managed by erecting contour retaining structure and backfilling of the spoil to give a final look of terraced landscape to avoid surface erosion and debris slide on the spoil management site.

#### **8.1.1.3. Loss of top soil and soil productivity**

To avoid and minimize the impacts related to loss of top soil and soil productivity, following measures will be implemented.

- Top soil will be collected safely, protection from washout, and after completion of physical work, soil will be refilled in the excavated site so that the soil fertility will be maintained.
- Restoration of temporary land before handover, applying the remaining top soil at places upon request by the local people.

#### **8.1.1.4. Noise and Vibration**

The anticipated impacts of the noise and vibration level increments will be minimized with the implementation of the following measures.

- Avoid high explosive charged during the surface and sub-surface blasting and recommended that vibration impact assessment should be carried out before using explosive materials for blasting
- Control the speed of the construction vehicles to < than 10 km/hr. in areas close to settlements such as Khudi, Thakanbesi, Arkhalebesi, Nyadi, Rambazaar, Syange, etc.
- Regular body maintenance of the vehicles and construction equipment to minimize the body noise
- Restriction on the use of air horns and use of the horns
- Procurement of low noise compressors, and diesel generating sets
- Plan the noise generating construction activities only during the day time zone
- Prior notification to the communities of the blasting timings.
- Avoid blasting activities in the night time zone.

#### **8.1.1.5. Air Quality/Pollution**

To minimize the impacts on air quality following measures is planned for implementation.

- Water sprinkling in the main access road corridors and construction sites will be carried out three times a day in dry season and once during the winter to arrest the road blown dusts
- All vehicles and machinery used in the project will be in compliance with emission standards set for vehicles and machinery by MoFE.
- Traffic management plan will be adopted and implemented in collaboration with local regulatory authority to minimize traffic congestion.
- Sufficient water sprinkling will be done before tunnelling activities
- Open burning will be prohibited in construction and camp sites
- Reuse and recycle will be prioritized to reduce the waste and decomposable waste will be disposed only in proposed disposal sites

#### **8.1.1.6. Change in surface and sub-surface hydrology**



To minimize the impacts of the water seepage related changes in the subsurface and surface hydrology following measures will be implemented in the tunnel.

- The high seeping zones along the tunnel will be grouted and lined to minimize the water seepage into the tunnel.
- The natural springs around Chhap, Ram-Bazaar and Arkhale area will be surveyed for the yield in the dry season.
- Any change in the spring discharge in the dry season and its implication to the water using communities will be provided with alternative arrangements of water supply to meet the requirements.

#### **8.1.1.7. Change in water quality**

To minimize the water quality impacts, following measures will be implemented.

- Discharge of water after consumptive use in project camps and colonies will be treated as per site requirements before release to water bodies
- Human waste from construction camps and colonies will be arrested in septic tanks, soak pits as per site requirements before discharge to minimize BOD load of water ways.
- Contractors will be suggested to install a septic system and a package wastewater treatment plant in the most required areas
- Project will comply with the best international practices of EHS to avoid or minimize the accidental spillage from heavy machinery and equipment. Provision will be stipulated in the contractor tender document.
- In case of hazardous chemical waste, the disposal will be carried out in accordance to Solid Waste Management Act, 2011

#### **8.1.1.8. Change in Soil pH and chemical composition**

In the active construction the anticipated changes in the soil characteristics are unavoidable and will remain as the residual impact. However, to minimize the impacts followings will be implemented as mitigation measures.

- Project will comply with the best international practices of EHS to avoid or minimize the accidental spillage from heavy machinery and equipment during material transfer and storage.
- All spent Mobil, greases, lubricating oils in the mechanical and equipment yards and other hazardous waste of camps and construction sites will be collected separately and kept in plastic drums for safe disposal.
- Haphazard disposal of the spent petroleum products and hazardous waste will be prohibited.

#### **8.1.1.9. Change in river morphology**

Anticipated change in the river morphology of the Marshyangdi river is unavoidable and will remain as residual impact of the project throughout the project life. However, the boulders and debris deposition by the small tributaries in and around will fill some of the stratum. Except restoration of the river wet channel towards the end of the construction phase no other measures will be implemented.

#### **8.1.1.10. Impact due to Quarry, stock piling and muck disposal**

Following measures will be implemented in case the quarry is opened for operation to meet the aggregate quality requirements.

- A 3 m wide berm will be set for every 20 m slope and the slope will be supported by shotcrete and rock bolt after which intercepting ditch is provided outside the cut line.
- Excavation as per ratio of 1:0.75 will be proposed for quarry
- After mining operations, the cut slope will be shotcrete to enhance the slope stability

In the stockpiling areas, following measures will be implemented.

- Five spoil areas have been identified to properly manage the spoil produced during the excavation and those areas are proposed on a flat area along Marshyangdi flood plain
- All the construction material stockpiling areas will be rehabilitated after removing the unused stocks of the construction materials
- To prevent stone from rolling out of design scope of disposal areas during construction and to prevent the resultant loss of soil and water, spoil retaining wall will be constructed.
- The top soil saved at the start of the construction will be applied to restore the top soil quality of the areas and handed over to the respective owners (in case of temporary lands) or afforested (permanently occupied areas)
- As the project envisage to safely manage the surplus spoil after use as aggregate materials for the project in the designated spoil management sites in 5 places, the impacts of the spoil as a source of sediment to the rivers and adjoining agricultural fields is minimum.

#### **8.1.1.11. Impact due to sediment load**

Additional measures for the sediment load control are the implementation of the Catchment Area Treatment Plan in the immediate catchment of the project. The plan will include the delineation of watersheds and sub watersheds of free draining catchments, information on soil class and soil depth, land use and land cover details, determination of slope percentage and classification of slope range, etc. The catchment area treatment plan will be adopted considering the topographic features, soil type, climate, land, engineering and biological measures etc. and this will help prevent the siltation of reservoir, check the soil and shore erosion and maintain its storage capacity in the long run.

The gully control will be undertaken as a treatment measure where gully will be treated with the help of engineering methods and along with this, the biological prevent methods will be adopted in the shore areas.

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
1	Impacts on Land Use	Demolition of all the temporary camps, storage areas established by the project and restore the site in the original land use or better category	5,000,000.00	UM1HPP
		Reforestation of areas not occupied by the structures at powerhouse, penstock, access roads, and headwork sites	-	Included in Biological Cost
		Implement adequate erosion protection measures (civil and bio-engineering) and drainage facilities and reforest the area after top soil applications	-	Inbuilt in civil contract
		Rehabilitate the temporarily occupied areas structures, facilities and land use and handover to the respective owner to maintain the original land use	5,000,000.00	UM1HPP
2	Sedimentation, Soil erosion and Land instabilities	Land clearing will be minimized to the required land areas only	-	No additional cost
		Apply methods of cut and fill balancing for the road construction	-	Inbuilt in civil contract
		High explosive charge will be avoided while blasting	-	Inbuilt in civil contract
		Protect through bio-engineering during access road construction	-	Inbuilt in civil contract
		All slope cutting areas will be provided with storm water collection drainage above the cut slope to safely divert the water from the slope	-	Inbuilt in civil contract
		The existing drainage network of the area will be maintained. The internal access roads will be provided with a side drain	-	Inbuilt in civil contract
3	Loss of top soil and soil productivity	Top soil will be collected safely, protection from washout, and after completion of physical work, soil will be refilled in the excavated site so that the soil fertility will be maintained	-	
		Restoration of temporary land before handover, applying the remaining top soil at places upon request by the local people	-	
4	Noise and Vibration	Conduct vibration impact assessment before using explosive materials for blasting	2,000,000.00	UM1HPP

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
		Control the speed of the construction vehicles to < than 10 km/hr. in areas close to settlements	-	Inbuilt in civil contract
		Regular body maintenance of the vehicles and construction equipment to minimize the body noise	-	Inbuilt in civil contract
		Restriction on the use of horns and procurement of low noise compressors and diesel generating sets	-	Inbuilt in civil contract
		Plan the noise generating construction activities only during the day time zone and prior notification to the communities of the blasting timings	-	Inbuilt in civil contract
5	Air Quality/Pollution	Water sprinkling in the main access road corridors and construction sites will be carried out	-	Inbuilt in civil contract
		Reuse and recycle will be prioritized to reduce the waste	-	No additional cost
6	Change in surface and sub-surface hydrology	The high seeping zones along the tunnel will be grouted and lined to minimize the water seepage into the tunnel	-	Inbuilt in civil contract
		The natural springs around the project area will be surveyed for the yield in the dry season	1,000,000.00	UM1HPP
		Alternative arrangements of water supply in Khanigaun, Rambazaar, Arkhalebeshi and Siurungbeshi	2,000,000.00	UM1HPP
7	Change in water quality	Waste water treatment after consumptive use in camps and colonies will be done and Human waste will be collected in septic tank	-	Inbuilt in civil contract
		In case of hazardous chemical waste, the disposal will be carried out in accordance to Solid Waste Management Act, 2011	-	Inbuilt in civil contract
8	Change in Soil pH and chemical composition	Comply with the best international practices of EHS to avoid or minimize the accidental spillage from heavy machinery and equipment during material transfer and storage	-	No additional cost

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
		All spent Mobil, greases, lubricating oils in the mechanical and equipment yards and other hazardous waste of camps and construction sites will be collected separately and kept in plastic drums for safe disposal	-	No additional cost
		Haphazard disposal of the spent petroleum products and hazardous waste will be prohibited	-	No additional cost
9	Change in river morphology	Except restoration of the river wet channel towards the end of the construction phase no other measures will be implemented	-	No any cost required.
10	Impact due to Quarry, stock piling and muck disposal	Berm, shotcrete and rock bolt will be applied to enhance the slope stability after excavation	-	Inbuilt in civil contract
		Spoil retaining wall is proposed to built in spoil area to minimize the impacts	-	Inbuilt in civil contract
11	Impact due to sediment load	Implement the Catchment Area Treatment Plan in the immediate catchment of the project	1,000,000.00	UM1HPP
		Bio-engineering methods will be applied for gully control	-	Inbuilt in civil contract
<b>Total mitigation cost</b>			<b>16,000,000.00</b>	

## **8.1.2. Operation Phase (*Physical Environment*)**

### **8.1.2.1. Impact due to sediment load and flushing**

Except for the implementation of Catchment Area Treatment Plan in the immediate watersheds of the project between dam and tailrace other measures will not be implemented to minimize the expected sediment loads into the river. The anticipated impacts will remain as the residual impact of the project throughout the project life.

### **8.1.2.2. Change in River morphology and water use**

This is an unavoidable impact of the project and will be the residual impact of the project throughout the project life. However, implementation of Catchment Area Treatment Plan in the immediate vicinity of the project catchment including the areas of the dewatered zone is expected to minimize the impacts of river morphological change through reduction of sediment supply from the adjoining catchment into the river course of the dewatered zone.

### **8.1.2.3. Change in water quality of dewatered zone**

The anticipated impact on the water quality in the dewatered zone is insignificant and will remain as the residual impact of the project. The project design already includes this measure. Environmental flow will be released from dam to maintain the discharge of the river in dewatered zone. As per the Downstream Response to Imposed Flow Transformation Study shows the released water is sufficient for aquatic life as well as for water use and rights. Addition measures for water quality management will not be implemented.

### **8.1.2.4. GLOF risk**

The GLOF risk of Thulagi lake has been taken as a major concern in the issues section however, the stability and geophysical investigations reported that the lake is expected to be stable for foreseeable future. Thulagi lake begun to form about 60 years ago, according to the study carried out by ICIMOD, when small supra-glacial lakes began to enlarge and coalesce. It is now more than 2 km long and WECS field report indicates that lake area had increases in size from 0.22 to 0.76 square km and in length from 0.6 to 1.97 km but there was not much change in the width of the lake. Its development was described by Mool and others in a preliminary report prepared from a field survey carried out in 1995. It is also estimated that Thulagi lake is dammed by a huge mass of dead ice and the stability of the barrier depends on the melting rate of this ice body. This dead ice body cannot be breached rapidly by water pressure of the lake or by erosion by the river from the lake to the valley. It can only be removed by a large-scale melting of the huge ice mass, which would take hundreds to thousands of years. Therefore, this lake is expected to be stable and GLOF risk from the Thulagi is minimum. As precautionary step for safety management, a telemetric hydrological station for the measurement of the discharge of the Thulagi lake discharge will be established for timely response in case of the increased water discharge than the normal for the safety management at the dam site and downstream areas.

### **8.1.2.5. Waste disposal**

Following measures will be adopted during the construction phase of the project to reduce and manage waste in project area:

- Segregation of solid waste and recycling, reduce and reuse system of solid waste management system will be strictly followed. Solid Waste Management Rules of GoN, 2070 B.S will be strictly followed.
- The domestic waste will primarily consist of organic food waste. Because this is easily biodegradable and non-hazardous, it is proposed to dispose by burying in pits at distances of about 300 meters away from riverbanks and covering with soil.

- Non-biodegradable waste e.g., empty cement bags and containers, rejected material, plastic, wooden planks, small structures etc. will be stored out and kept separated instead of throwing haphazardly. Some material (cement bag, plastic drum etc.) will be sold in the nearest market, while others (waste oil, lubricants and chemicals) will be reused or recycled or disposed properly. During the preparation of contract bid for civil construction work, the provision will be made mandatory.
- Staffs of the project induced liquid waste will be managed by use of soak pits and septic tanks at safe distance from water bodies. Open burning of solid waste will be strictly prohibited.

#### **8.1.2.6. Impact on Annapurna Conservation Area**

The project will implement a separate Catchment Area Treatment Plan in the ACAP area of the Project areas to improve the watershed condition of the ACAP area. The treatment plan will highlight the management techniques that helps in the erosion control in the catchment area and adopt adequate preventive measures for stabilization against future erosion. This will further involve an eco-restoration plan involving the understandings of the erosion characteristics and suggesting remedial measures including their execution mechanisms.

#### **8.1.2.7. Impact on Main Trail**

During the operation period, the impacts on the main trail envisaged in the powerhouse location between Ram Bazar to Arkhalebesi by construction activities will be restored to the normal as the existing. In the Dam location, due to the presence of proposed reservoir, the impact to the main walking trail and the under construction Besisahar – Chame motorable road will remain as in the construction phase. The proposed powerhouse site will have an alternative way for travelling made during the construction phase. In other locations, there will be no impact to the main trail by the project structures/facilities and operational activities.

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
1	Impacts due to sediment load and flushing	Implementation of Catchment Area Treatment Plan in the immediate watersheds of the project between dam and tailrace	1,000,000.00	UM1HPP
2	Change in River morphology and water use	Implementation of Catchment Area Treatment Plan in the immediate vicinity of the project catchment	1,000,000.00	
3	Change in water quality of dewatered zone	10% of monthly flow will be released as a riparian release	-	No cost needed
4	GLOF Risk	A telemetric hydrological station for the measurement of discharge in the river will be installed	2,000,000.00	UM1HPP
5	Waste disposal	Solid Waste Management Rules of GoN, 2070 B.S will be strictly followed	-	No additional cost
		Biodegradable waste will be buried at distance of about 300 m away from river banks	-	No additional cost
6	Impact on ACA	Implement a separate Catchment Area Treatment Plan in the ACAP area of the Project areas to improve the watershed condition of the ACAP area	1,000,000.00	UM1HPP
7	Impact on Main Trail	The impacts on the main trail envisaged in the project stretch will be restored to the normal as the existing	3,000,000.00	UM1HPP
<b>Total mitigation cost</b>			<b>8,000,000.00</b>	



## **8.2. Mitigation Measures for the Adverse Impacts on Biological Environment**

### **8.2.1. Construction Phase (*Biological Environment*)**

#### **8.2.1.1. Change in land use/landcover**

For construction of the project about 44.58 ha of land will be acquired from the private owners and the government. Reasonable compensation will be provided to the private owners and the governmental land will be leased as per the appropriate policies accordingly.

#### **8.2.1.2. Loss of vegetation due to site clearance**

To recover the loss of vegetation due to site clearing, following measures will be adopted:

- Forest and vegetation will be felled only to the required by pegging the area and numbering the trees.
- Compensatory afforestation of the felled local tree species as per department of Forest guideline 2063 will be carried out in consultation with the District Forest Office on the project costs.
- A total of 347 tree species trees, 381 poles and 78 saplings cleared during the construction will be compensated by plantation in the ration of 1:25 of indigenous species.
- Forest land will be leased and appropriate cost as per Forest Guidelines shall be accounted.
- Compensatory land for project built up structure as per GoN provisions.
- Terrestrial Ecology Management Plan will be formulated, adopted during the construction period.

#### **8.2.1.3. Encroachment of nearby forest by outside workforce**

The following mitigation measures will be taken to minimize the impact of forest encroachment:

- Unnecessary forest land will not be allowed for encroachment. The provision will be made implemented via contractor clause before granting contract award to the different contractor. Illegal clearing, encroachment to forest area will be strictly banned to the project and project workers.
- Clearing of the forest vegetation and stockpiling the vegetation products before handover will be carried out. The standing forest resources such as timber, firewood, litter, fodder etc. has high value. Haphazard clearance and lack of collection will make the cleared resources valueless to the users and owners. Therefore, the project will clear the forest and stockpile the materials as per the guideline of Forest Product Collection, Sale and Distribution Guidelines, 2073 and will be handed over to the respective, CFUGs and Conservation Community Forest User Groups. Existing policies and rules of government and ACA will be obeyed during the compensation process.

#### **8.2.1.4. Exploitation of Non-Timber Forest Products (NTFPs)**

Labor force will be prohibited for the collection of non-timber forest products. Informative and warning sign at centrally located construction site will be placed to create local awareness. The cost for the construction of information board about the awareness creation against illegal activities will be allocated by the project. The following measures/task will be implemented so that cumulative, direct and indirect impact on forest resources, medicinal plants, NTFPs could be reduced:

- Provision of LPG to the workforce for cooking:
- Prohibition on the sale and purchase of the local NTFPs and fishes in the camps
- Discourage the construction of huts/houses of the laborers.
- Collect necessary information on timber and firewood demand of tea stalls, restaurants, and lodges located within 1 km on all sides of the core Project area.
- Instruct the contractor to discontinue worker's service who involved in illegal collection and sale of forest products.

- Despite the above measures, there will be some residual ecological effects of forest clearance for the structures and facilities and will remain as residual impact for a period of 20 to 30 years till the afforested forest matures.

#### **8.2.1.5. Fire hazard due to increased access in forest**

The project will take following measures to prevent the likely impact of fire hazard:

- The construction workers will be made aware of the danger and source of fire hazard. Awareness program will be conducted at the regular interval in association with CAMC and ACA to conserve forest area.
- The Environment Management Unit will draft, get endorsed and apply 'Code of Conduct' that includes leave no foot print measures in nature. Awareness program will be organized at regular interval in the project area.
- As far as possible, the workforce camp will be located at safe distance and not in the core forest area.

#### **8.2.1.6. Disturbance to natural habitat of wildlife**

Loss of existing wildlife habitat due to forest clearance during first 7 to 10 years during construction and later is unavoidable. However, implementation of the following measures in long run will improve the wildlife habitat.

- Forest and vegetation will be felled only to the required by pegging the area and numbering the trees.
- Night time blasting operations will be avoided as far as possible.
- The project staff and workforce will be strictly instructed not visit the forested areas.
- Biodiversity and Wildlife Conservation Management Plan will be formulated and adopted for implementation.

#### **8.2.1.7. Impact on Annapurna Conservation Area**

The major impacts envisaged in the biodiversity and habitat of ACA is related with the off-side activities of the construction workforce. To minimize the impacts following measures will be implemented.

- The project staff and workforce will be strictly instructed not to visit forested areas of ACA.
- Meat of wildlife in the camps will be strictly prohibited.
- Outside workforce and staff found in illegal poaching of wildlife will be terminated from project jobs and handed to the regulatory authorities for further action.
- Conservation training, establishment of anti-poaching units, and support to the conservation area.
- Endangered species conservation studies and program will be developed

#### **8.2.1.8. Wildlife poaching by outside workforce**

The measures listed below is adequate to minimize the impacts of poaching by the construction workers:

- The project staff and workforce will be strictly instructed not visit the forested areas
- Outside workforce and staff found in illegal poaching of wildlife will be terminated from project jobs.
- Meat of wildlife in the construction camps and colonies will be strictly prohibited.

#### **8.2.1.9. Impact on rare, endangered, protected and threatened species**

The impacted wildlife due to habitat loss is not the dwellers of the forested areas only. They could coexist even in the degraded conditions. The construction sounds and activities will force them out of the area during construction phase. This impact is unavoidable for the construction period; however, the following measures will bring these animals back to the area after the construction phase:

- Afforestation in area equal to project occupied area
- Afforestation of felled trees in 1:25 ratio in nearby areas

#### **8.2.1.10. Fish and aquatic fauna**

During construction phase the project may have greater effects to the aquatic life. However, to minimize the impact following measures will be implemented.

- Unless not required by the project structural placement, the riverbed will not be disturbed. The impact is residual.
- A pool type fish pass will be provided on the downstream face of the non-overflow block of the diversion weir for migration of the fishes.
- 10% of monthly flow will be released as a riparian release for aquatic life
- Discharge of spent oils, mobiles, slurry of batching plant, discharge of tunnels, settling basins, aggregate washing plants, untreated camp toiletry waste, mechanical yards will be prohibited to be discharged directly into the river
- Unauthorized spoil disposal in the river flood plain will be prohibited.
- Fishing will be restricted for the project staff and outside project workforce.
- Aquatic ecology management plan will be formulated and adopted.

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
1	Change in land use/land cover	45.42 ha of land will be acquired from the Nepal government and private owners	-	
		14.98 ha of land will be provided to government instead of using government land	74,850,000.00	UM1HPP
		12 ha of government land will be acquired for temporary use and restoration of those land will be done after construction	110,787,600.00	UM1HPP
2	Loss of vegetation due to site clearance	Forest and vegetation will be felled only to the required by pegging the area and numbering the trees	10,000,000.00	UM1HPP
		Compensatory afforestation of the felled trees will be done	12,500,000.00	UM1HPP
		Management of the afforested trees will be done for five years	5,000,000.00	UM1HPP
		Terrestrial Ecology Management Plan will be formulated, adopted during the construction period	2,000,000.00	UM1HPP
3	Encroachment of nearby forest by outside workers	Illegal clearing, encroachment to forest area will be strictly banned to the project and project workers.	-	No additional cost
4	Exploitation of Non-Timber Forest Products (NTFPs)	Provision of LPG to the workforce for cooking and discourage the construction of huts/houses of the laborers.	-	No additional cost
		Prohibition on the sale and purchase of the local NTFPs and fishes in the camps	-	No additional cost
		Instruct the contractor to discontinue worker's service who involved in illegal collection and sale of forest products.	-	No additional cost
5	Fire hazard due to increased access in forest	Awareness program will be conducted at the regular interval in association with CAMC and ACA to conserve forest area	2,000,000.00	
		As far as possible, the workforce camp will be located at safe distance and not in the core forest area	-	No additional cost
6	Disturbance to natural habitat of wildlife	Night time blasting operations will be avoided and project workforce will be strictly instructed not to visit the forest area.	-	No additional cost
		Biodiversity and Wildlife Conservation Management Plan will be formulated and adopted for implementation	2,000,000.00	

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
7	Impact on ACA	Project workforce will be strictly instructed not to visit the ACA forest area.	-	
		Conservation training, establishment of anti-poaching units, and support to the conservation area.	3,710,600.00	
		Endangered species conservation studies and program will be developed	2,000,000.00	
8	Wildlife poaching by outside workforce	Outside workforce and staff found in illegal poaching of wildlife will be terminated from project jobs.	-	No additional cost
		Meat of wildlife in the construction camps and colonies will be strictly prohibited.	-	No additional cost
9	Impact on rare, endangered, protected and threatened species	Afforestation will be done in area equal to project occupied and of felled trees in 1:25 ratio in nearby areas to maintain the forest density	-	No additional cost
10	Fish and aquatic fauna	A pool type fish pass will be provided on the downstream face of the non-overflow block of the diversion weir for migration of the fishes	-	Inbuilt in civil contract
		10% of monthly flow will be released for aquatic life	-	No additional cost
		Any type of waste will be strictly prohibited to be discharged directly into the river	-	No additional cost
		Aquatic ecology management plan will be formulated and adopted	2,000,000.00	UM1HPP
<b>Total mitigation cost</b>			<b>226,848,200.00</b>	

## **8.2.2. Operation Phase (*Biological Environment*)**

### **8.2.2.1. Impacts on Vegetation/ Forest Resources**

Following points will be considered to reduce the pressure on forest resources:

- Prohibition on the use of fuel wood in the operation camps for cooking and house heating
- The camp sites will be planted with local species around the fences and in the garden areas.
- Prohibit the operation work force to roam in the ACA forest and wildlife habitat area in the upper mountain slopes of the project site.
- Co-ordinate with the ACAP, if any body found indulging in such illegal activities for required action.
- Posters and bill boards will be placed at various location for the conservation and protection of ACA area
- Awareness campaign twice a year will be launched through the local youth groups and Ama Samuha to the local communities in collaboration with ACAP to promote conservation activities and behavior in the ACA

### **8.2.2.2. Impact on Bio-diversity and Habitats**

To minimize the impact on biodiversity and habitats following measures will be implemented.

- Prohibit the operation work force to roam in the ACA forest and wildlife habitat area in the upper mountain slopes of the project site.
- Include the above provision in the operation workforce code of conduct and implement the provision with a maximum penalty of dismissal from the job
- Co-ordinate with the ACAP, if any body found indulging in such illegal activities for required action.
- Awareness campaign twice a year will be launched through the local youth groups and Ama Samuha to the local communities in collaboration with ACAP to promote conservation activities and behavior in the ACA
- People in the downstream will be aware of sudden release of water and a siren will be placed in the downstream settlement area
- 10% of monthly flow will be released as an environmental flow for sustaining the life of micro-species within the dewatered areas

### **8.2.2.3. Impacts on fish and fisheries**

As the envisaged impact is of little significance to the project area, specific measures for the impact will be implemented. However, following measures will have to be complied by the operation workers.

- Prohibit the operation workforce to catch fish particularly at Siurungbesi, Thakanbesi, Arkhalebesi and dewatered areas
- Include the above provision in the operation workforce code of conduct and implement the provision with a penalty of dismissal from the job.
- 10% of monthly flow will be released as an environmental flow from the dam to maintain the water discharge in downstream of the project. It will mitigate the impacts on aquatic ecosystem in the downstream of the project.
- The juveniles of fish species will be brought and rehabilitated within the project area to maintain the fair population status.
- Shore erosion will be prevented using suitable bio-engineering methods like brush layering and plantation of both herbaceous and woody species nearby the shore areas around spawning sites.

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
1	Impacts on vegetation/Forest Resources	Posters and bill boards will be placed at various location for the conservation and protection of ACA area	500,000.00	UM1HPP
		Awareness campaign twice a year will be launched through the local youth groups and Ama Samuha to the local communities in collaboration with ACAP to promote conservation activities and behavior in the ACA	2,000,000.00	UM1HPP
		Prohibit the operation work force to roam in the ACA forest and wildlife habitat area and prohibits to use fuel wood in the camp	-	No additional cost
2	Impacts on bio-diversity and habitats	Prohibit the operation work force to roam in the ACA forest and wildlife habitat area and provide code of conduct to the works force	-	No additional cost
		10% of monthly flow will be released as an environmental flow from dam for sustaining the life of micro- species within the dewatered areas	-	No additional cost
		Co-ordinate with the ACAP, if any body found indulging in such illegal activities for required action	-	No additional cost
3	Impact on fish and fisheries	Prohibits workforce to catch fish from river	-	No additional cost
		10% of monthly flow will be released as an environmental flow from dam for sustaining the life of micro- species within the dewatered areas	-	No additional cost
		The juveniles of fish species will be brought and rehabilitated within the project area to maintain the fair population status.	5,000,000.00	UM1HPP
		Shore erosion will be prevented using suitable bio-engineering nearby the shore areas around spawning sites	2,000,000.00	UM1HPP
<b>Total mitigation cost</b>			<b>9,500,000.00</b>	

### **8.3. Mitigation Measures for the Adverse Impacts on Socio-economic and Cultural Environment**

#### **8.3.1. Construction Phase** (*Socio-economic and Cultural Environment*)

##### **8.3.1.1. Loss of land and property**

The summary of project affected people is based on the assessment by the project staffs and the consultants based on the overlay of the project structures and facilities over the cadastral maps (the official land ownership, and land use map in Nepal). The project affected people identification is basically based on the information of the land plots from the Land revenue office and Land Survey office of the districts of Lamjung. The subsequent census survey of the identified owners undertaken was based on this identification and verification with the land owners themselves. Following compensation and mitigation measures will be adopted:

- Proper compensation will be provided to all the affected household after the official verification from District Survey Office and Land Revenue Office and bilateral negotiations
- Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area.
- Notify the project affected people about the revenue generated from the project and its beneficial impacts to local
- Assist locals to develop and run small scale projects addressing the livelihood problems
- Special reservation to marginalized and indigenous groups within the community during the construction and operation phase

##### **8.3.1.2. Involuntary Relocation Issues**

It is a fact that the project is going to displace the land and other fixed properties of the affected households. As of the date, the people are willing to cooperate with the project and are ready to be displaced provided the project provides adequate compensation and rehabilitation. There are three options opened to the project proponent for negotiation with the affected households on compensation and rehabilitation as under:

- Compensation and rehabilitation through bilateral negotiation with individual land and property owners
- Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area.
- Compensation and rehabilitation through bilateral negotiations with the affected communities of different areas separately or in combination
- Compensation and rehabilitation through the legal procedures of the government of Nepal
- The resettlement scheme will be made with the consultation with the local government and local people.

Of the three options, the first two are most suitable for the project as it offers a win-win situation and does not require forceful evacuation of people from the project area through the legal means. The third option is legal option and will be exercised only when the bilateral negotiations could not provide a breakthrough. For this, all land acquisition process will have to comply the Land Acquisition Act 1977. This act is rather authoritarian and has many short comings such as i) valuation of property is based on the discretion of the Compensation Fixation Committee (appointed government officials as per the decree of law) or the value is not market based; ii) built property is compensated only after price depreciation; iii) there is no space to hear the voices of the affected people while determining the compensation prices; iv) it has no provision of rehabilitation measures to the affected people to restore their livelihood at least at par or better off than the present; v) only people with official landholding certificates are compensated and encroachers or traditional



users of land without landholding certificates are not entitled for compensation; and vi) all compensations are in cash and there is no option of relocation and resettlement.

In the above context, if the project has no other option than the legal one, it will acquire the land and property based on the project's resettlement and rehabilitation policy and the entitlement matrix while acquiring land under the Land Acquisition Act. The resettlement and rehabilitation policy and entitlement framework of the project will comply with all the ingredients of the best practice resettlement and rehabilitation of the international donor agencies with a robust grievance redress mechanism.

A resettlement action plan and policy framework will be prepared based on Land Acquisition Act (1997), National Policy on Land Acquisition, Compensation and Resettlement in Development Projects in Nepal and other applicable guidelines. The document will provide overview of project affected communities, livelihood impacts, involuntary resettlement along with a monitoring and evaluation framework. The households that are to be displaced physically will be surveyed and their assets will be documented for proper compensation.

#### **8.3.1.3. Change in social structure, cultural and traditional practices of local people**

To minimize the impacts in social structure, cultural and traditional practices due to flow of outside workforce following measures will be implemented.

- Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area.
- A special vulnerable community development plan will be implemented with one of the focus areas to maintain and promote cultural traditions and practices of the local people.
- The outside workforce will be instructed to respect local culture, traditions and the social structures and not to indulge in activity that affects the local social structure, culture and traditions.

#### **8.3.1.4. Excessive burden on existing infrastructure and facilities**

The following measures will be implemented to minimize the impact of outside workers on local infrastructures and facilities:

- All the outside workforce will be camped in separate camps with provisions of health care facility, water supply system, telecommunication system, grocery and consumable item shops
- The existing health posts, schools, communications systems and water supply systems will be assisted for better facilities to the local community
- The camps and construction sites will not use the existing facilities particularly water supply, communication, health services and solid waste management services of the local area
- The people will be discouraged to increase the vehicle fare and this will be deal by the social unit with coordination among local representatives, leaders and vehicle unions

#### **8.3.1.5. Impact on tourism**

Following measures will be implemented to minimize the impact of the project construction works to the project area tourism and tourist safety:

- Restriction on the use of air horns and use of the horns, procurement of low noise compressors, and diesel generating sets
- Regular sprinkling of waters on the internal access road corridors and in the settlement sections of the main road to minimize the fugitive dust emissions.
- Hotel related trainings and workshops will be organized

- The road leading to Chame will be upgraded may increase the flow of vehicles in the area and ease tourist's travel
- Alternative way will be constructed as soon as possible to solve the issues regarding ways nearby powerhouse and headworks areas

#### **8.3.1.6. Disturbance in social harmony and settings**

To minimize the impacts in social harmony and settings following measures will be implemented:

- Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area
- A special code of conduct will be made applicable to control the illegal activities, disputes, conflicts and violation of laws
- A special vulnerable community development plan will be implemented with one of the focus areas to maintain and promote cultural traditions and practices of the local people
- The outside workforce will be instructed to respect local culture, traditions and the social structures and not to indulge in activity that affects the local social structure, culture and traditions.

#### **8.3.1.7. Occupational and Safety Hazards**

To ensure the safety of the occupational workers following measures will be implemented.

- Separate well ventilated labor camps with facilities such as sleeping, resting, recreation, canteen for meals and refreshments, consumable grocery shops, toilets, bathroom etc. shall be established which are adequate for the numbers of labors in the camp
- Construction workers will be provided with basic safety issues and safety measures to be taken in each of the construction sites at least once a week before the start of days construction activity
- Signs of various risks shall be placed at appropriate locations in all the construction sites
- The construction workers will be provided with personnel safety gears such as helmets, boots with tough toes, gloves, air masks, ear plugs and other as required depending upon the work nature at least every six months.
- The construction supervisor shall ensure that all the workforce is using the personnel protective gears at all times at the construction sites and those not using the gears shall be prohibited in the construction sites
- First aid kits for minor cuts and injuries shall be placed at all times in each of the active construction sites and in the labor camps
- A stabilization health care medical facility manned with health worker, and nurse shall be established centrally in the project area with bed facility, medicine, x-ray etc.
- Emergency sirens shall be placed at each of the construction sites to inform the construction workers for evacuation from the active construction sites in case of emergency
- Handy fire-fighting gears shall be placed at each of the construction sites for immediate use in case of fire.

#### **8.3.1.8. Prostitution and Issues related with STD**

To minimize the impact of prostitution and issues related with STD following measures will be implemented.

- A code of conduct for the project staff and outside workforce will be chartered with an instruction that indulging in prostitution in the local area is an offensive crime and punishable
- An information on the operation of illegal brothel by the outside economic opportunity seekers will be given to the nearby police post for observation and legal action as per the law

- The project staffs and workers will be given free condoms from the health care facilities of the project sites

#### **8.3.1.9. Public health and Sanitation**

To address the impacts due to unhygienic status within the project area during two project phases, following activities will be adopted:

- Sanitation related programs will be proposed and informed to all the workforces
- A strong code of conduct regarding sanitation maintenance will be made and put into force
- The sources of water nearby project area will be supported to conserve them
- Proper management of water supply and drainage will be done

#### **8.3.1.10. Water supply**

To address the impacts due to shortage of drinking water, pressure on water supply and reduced water quality, following activities will be adopted:

- Structures required for managed water supply will be constructed inside camp
- The sources of water nearby project area will be supported to conserve them
- Proper management of water supply and drainage will be done

#### **8.3.1.11. Impact on structures and houses due to vibration and construction activities**

Following activities will be considered to mitigate the impacts on structures due to construction activities:

- Experts with long-term experiences on blasting materials handling will be preferred during blasting works
- Impacts on houses, settlement, water springs and other structures will be evaluated with the help of experts and proper monetary or construction compensation will be provided
- Older landslides will be evaluated and bioengineering methods will be applied to prevent further triggering by the tunneling activities around the project area
- A vibration assessment will be carried out before the initiation of blasting activity in the project area

#### **8.3.1.12. Impact on Cremation sites**

Following mitigation and compensation measures will be followed:

- The e-flow will be maintained and the water flowing is expected to be enough for cultural activities to be carried out
- As a part of compensation, permanent structures will be constructed following the cultural guidance and rituals

#### **8.3.1.13. Impact on People's Behavior due to Sudden Cash Flow**

People who do not have regular income opportunity may experience the sudden cash flow from the project and to mitigate the impact, following activities will be carried out:

- Proper guidance and awareness will be provided to the local people regarding economy and its possible impacts
- Trainings will be provided so that the locals after withdrawal from construction activities can initiate their own business and even seek for employment to maintain the economic standard
- A guiding material will be developed which will guide people towards sustainable expenditure and income during and after the project

#### **8.3.1.14. Impacts on Gender and Vulnerable group**

Majority of the men within project area are likely to be involved in the construction activities creating shortage of labor required for agricultural and other household's activities. To mitigate the impacts created, following activities will be considered:

- Awareness activities will be conducted regarding the gender, vulnerable groups and children
- As the employment will directly support the family economically, the impact is less likely to occur
- Women empowerment trainings and child support programs will be conducted
- The payment of wages will be done equally on gender basis
- A code of conduct will be implemented among the workforce and informed to treat all people equally

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
1	Loss of land and property	Proper compensation will be provided to all the affected household after the official verification from District Survey Office and Land Revenue Office and bilateral negotiations	140,888,730.80	UM1HPP
			64,654,959.27	Land acquisition contingencies cost
		Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area	-	No additional cost
2	Involuntary relocation issues	Compensation and rehabilitation through bilateral negotiation with individual land and property owners	-	Included above in number 1.
		The resettlement scheme will be made with the consultation with the local government and local people.	-	No additional cost
3	Change in social structure, cultural and traditional practices of local people	Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area	-	No additional cost
		A special vulnerable community development plan will be implemented with one of the focus areas to maintain and promote cultural traditions and practices of the local people	1,000,000.00	
		The outside workforce will be instructed to respect local culture, traditions and the social structures and not to indulge in activity that affects the local social structure, culture and traditions	-	No additional cost
4	Excessive burden on existing infrastructure and facilities	All the outside workforce will be camped in separate camps with provisions of health care facility, water supply system, telecommunication system, grocery and consumable item shops	-	No additional cost
		The existing health posts, schools, communications systems and water supply systems will be assisted for better facilities to the local community	-	No additional cost
		The camps and construction sites will not use the existing facilities particularly water supply, communication, health services and solid waste management services of the local area	-	No additional cost
5	Impacts on Tourism	Restriction on the use of air horns and use of the horns, procurement of low noise compressors, and diesel generating sets	-	No additional cost
		Regular sprinkling of waters on the internal access road corridors and in the settlement sections of the main road to minimize the fugitive dust emissions	2,000,000.00	
		Hotel related trainings and workshops will be organized	1,000,000.00	

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
		Alternative way will be constructed as soon as possible to solve the issues regarding ways nearby powerhouse and headworks areas	-	Inbuilt in civil contract
6	Disturbance in social harmony and settings	Maximum job opportunities will be provided to the local area people to reduce the number of the outside workforce in the project area	-	No additional cost
		A special code of conduct will be made applicable to control the illegal activities, disputes, conflicts and violation of laws	-	No additional cost
		The outside workforce will be instructed to respect local culture, traditions and the social structures and not to indulge in activity that affects the local social structure, culture and traditions	-	No additional cost
7	Occupational Safety Hazards and	Camps will be constructed with all the safety measures and facilities	-	No additional cost
		Construction workforce will be given basic safety issues and safety measures to be taken in construction site each day	-	No additional cost
		Signs of various risks shall be placed at appropriate locations in all the construction sites	1,000,000.00	
		The construction workers will be provided with personnel safety gears as required depending upon the work nature	-	Include in civil contract
8	Prostitution Issues related and with STD	A code of conduct for the project staff and outside workforce will be chartered with an instruction that indulging in prostitution in the local area is an offensive crime and punishable	-	No additional cost
		An information on the operation of illegal brothel by the outside economic opportunity seekers will be given to the nearby police post for observation and legal action as per the law	-	No additional cost
		The project staffs and workers will be given free condoms from the health care facilities of the project sites	100,000.00	
9	Public health and Sanitation	Sanitation related programs will be proposed and informed to all the workforces	1,000,000.00	
		A strong code of conduct regarding sanitation maintenance will be made and put into force	-	No additional cost
		The sources of water nearby project area will be supported to conserve them	2,000,000.00	
		Proper management of water supply and drainage will be done	-	No additional cost

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body/Remarks
10	Water Supply	Structures required for managed water supply will be constructed inside camp which reduce the pressure on existing water supply	-	Inbuilt in civil contract
11	Impact on structures and houses due to vibration and construction activities	Impacts on houses, settlement, water springs and other structures will be evaluated with the help of experts and proper monetary or construction compensation will be provided	5,000,000.00	UM1HPP
		Older landslides will be evaluated and bioengineering methods will be applied to prevent further triggering by the tunneling activities around the project area	5,000,000.00	UM1HPP
		A vibration assessment will be carried out before the initiation of blasting activity in the project area	1,000,000.00	UM1HPP
12	Impact on Cremation Sites	The e-flow will be maintained and the water flowing is expected to be enough for cultural activities to be carried out	-	No additional cost
		As a part of compensation, permanent structures will be constructed following the cultural guidance and rituals	1,000,000.00	UM1HPP
13	Impact on People's Behavior due to Sudden Cash Flow	Proper guidance and awareness will be provided to the local people regarding economy and its possible impacts	400,000.00	UM1HPP
		Trainings will be provided so that the locals after withdrawal from construction activities can initiate their own business and even seek for employment to maintain the economic standard	1,000,000.00	UM1HPP
		A guiding material will be developed which will guide people towards sustainable expenditure and income during and after the project	500,000.00	UM1HPP
14	Impacts on Gender and Vulnerable group	Awareness activities will be conducted regarding the gender, vulnerable groups and children	1,000,000.00	UM1HPP
		Women empowerment trainings and child support programs will be conducted	1,000,000.00	UM1HPP
		A code of conduct will be implemented among the workforce and informed to treat all people equally	-	No additional cost
<b>Total</b>			<b>229,543,690.07</b>	

### **8.3.2. Socio-economic and Cultural Environment (Operation Phase)**

#### **8.3.2.1. Peoples' behavior due to stoppage of cash flow**

This will remain as the residual impact of the project and the project has no scope to maintain the economic activity by its actions. However, the skills learnt during the project construction and economic stability gained will help people to explore further economic activities and employment.

- Community awareness will be provided to the locals
- Trainings will be provided so that the locals after withdrawal from construction activities can initiate their own business and even seek for employment to maintain the economic standard

#### **8.3.2.2. Impact due to withdrawal of economic activities**

This will remain as the residual impact of the project and the project has no scope to maintain the economic activity by its actions. The project camps particularly at Thulibesi is envisaged to keep up the developed market facilities to some extent. Further, the trainings regarding the economic activities will be organized as mitigation measure.

#### **8.3.2.3. Impact on Lifestyle**

Project will implement the following measures to further enhance the life style of the project area people.

- Enhancement of existing school infrastructures and facilities
- Construction of new community centers and enhancement of existing community centers in the project affected RMs for cultural and other traditional practices as a part of the RMP
- Development of sports related facility on consultation with the local community in the permanently occupied areas of the project such as muck management sites
- Small scaled industries will be promoted

#### **8.3.2.4. Impact on foot trail and movement of people**

Though the project does not envisage impacting the foot trails and movement of people during operation period, main foot trails (tourist trail and local community trails connecting the villages) will be assisted for maintenance by the project during operation period.

#### **8.3.2.5. Impact on agricultural production**

The loss of agricultural produce from the permanently occupied area is an unavoidable impact. The compensation measures for the land based on consensus community valuation process are envisaged to mitigate the impact. The compensation prices given to the impacted household could enable him/her to buy land in the nearby area of similar productivity. Apart from this the skill enhancement training on agriculture, animal husbandry, horticulture etc. will pave way for higher production in the other lands not occupied by the project.

#### **8.3.2.6. Impact on local people and domestic animals**

Following measures will be implemented to minimize the impacts.

- Placement of siren at various locations in the downstream areas of Marshyangdi river in the dewatered stretch to inform on the sudden opening of day
- Awareness campaign coupled with posters and bill boards at various locations downstream of the dam with information on how to move to safety in the event of siren blow.

#### **8.3.2.7. Burden on women**



Following activities will be performed to reduce burden on women of the project area:

- Women skills development programs and trainings will be organized to empower women and employ them for economic activities
- Women reservation will be placed during the operation staff recruitment

#### **8.3.2.8. Impact on water use rights**

Following activities will be carried out to mitigate the impact on cemetery grounds lying on the banks of Marshyangdi river:

- 10% of monthly flow will be released as an environmental flow in the river so that the water to be used during cultural activities and cremation practice is enough
- Permanent structures for cemetery will be constructed in consultation with the religious leaders and local people as a compensatory measure

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body
1	Peoples' behavior due to stoppage of cash flow	Community awareness will be provided to the locals	1,000,000.00	
		Trainings will be provided so that the locals after withdrawal from construction activities can initiate their own business and even seek for employment to maintain the economic standard	1,000,000.00	
2	Impact due to withdrawal of economic activities	The trainings regarding the economic activities will be organized as mitigation measure	1,000,000.00	
3	Impact on lifestyle	Enhancement of existing school infrastructures and facilities	-	Included in CSP
		Construction of new community centers and enhancement of existing community centers in the project affected RMs for cultural and other traditional practices as a part of the RMP	-	Included in CSP
		Development of sports related facility on consultation with the local community in the permanently occupied areas of the project such as muck management sites	-	Included in CSP
		Small scaled industries will be promoted	1,000,000.00	
4	Impact on foot trail and movement of people	Main foot trails around project area (tourist trail and local community trails connecting the villages) will be assisted for maintenance by the project during operation period	2,000,000.00	
5	Impact on agricultural production	The compensation prices given to the impacted household could enable him/her to buy land in the nearby area of similar productivity	-	Included in Land Acquisition Plan
		The skill enhancement training on agriculture, animal husbandry, horticulture etc. will pave way for higher production in the other lands not occupied by the project	1,000,000.00	
6	Impact on local people and domestic animals	Placement of siren at various locations in the downstream areas of Marshyangdi river in the dewatered stretch to inform on the sudden opening of day	1,000,000.00	
		Awareness campaign coupled with posters and bill boards at various locations downstream of the dam with information on how to move to safety in the event of siren blow	1,000,000.00	
7	Burden on Women	Women skills development programs and trainings will be organized to empower women and employ them for economic activities	1,000,000.00	

		Women reservation will be placed during the operation staff recruitment	-	
8	Impact on water use rights	10% of monthly flow will be released as an environmental flow in the river so that the water to be used during cultural activities and cremation practice is enough	-	
		Permanent structures for cemetery will be constructed in consultation with the religious leaders and local people as a compensatory measure	-	Included in Construction Phase
<b>Total</b>			<b>10,000,000.00</b>	

## **8.4. Enhancement Measures for the Beneficial Impacts**

### **8.4.1. Construction Phase**

#### **8.4.1.1. Employment Opportunities for Local People**

- Local people will be preferred for the operation related job opportunities and maintenance works
- Research assistances/scholarship support shall be provided to graduate and undergraduate students

#### **8.4.1.2. Business Opportunity for Local People**

Project will consume the local surplus products in the camps and colonies consumable goods

#### **8.4.1.3. Induced Development**

- The main access road leading to the project site will be regularly maintained by the project that will help in easy access of man and material.
- Ghermu will be linked to the main highway with construction of bridge over Marshyangdi river.
- Internal access road developed for project purposes will serve the local populace and enhance movement of man and material.
- Environmental enhancement package as developed by the project will enhance the local service facilities.
- The environmental enhancement package developed by the project will ensure that locals will be trained in hospitality and tourism related opportunities

### **8.4.2. Operation Phase**

#### **8.4.2.1. Employment Opportunities for Local People**

- Local people will be preferred for the operation related job opportunities and maintenance works
- Research assistances/scholarship support shall be provided to graduate and undergraduate students

#### **8.4.2.2. Link the Project Affected Area to the Main Highway**

- Ghermu will be linked to the main highway with construction of bridge over Marshyangdi river.

#### **8.4.2.3. Benefit due to Royalty**

The project will act as a means to enhance local taxes and revenue at all times. Also, the project will pay royalties as stipulated in the Hydropower Development Policy, Electricity Act and Regulation.

The detail matrix table including impacts and mitigation measures is given in **Annex 9**.

SN	Issues	Mitigation Measures	Mitigation Cost	Responsible Body
<b>A.</b>	<b>Construction Phase</b>			
A.1.	Employment Opportunities for Local People	Local people will be preferred for the construction related job opportunities and maintenance works		
		Research assistances/scholarship support shall be provided to graduate and undergraduate students	1,000,000	
A.2.	Business Opportunity for Local People	Project will consume the local surplus products in the camps and colonies consumable goods		
A.3.	Induced Development	The access road maintained by project will help the local people too for travel and Ghermu will be linked with the motorable road due to the construction of bride	30,000,000	
		Environmental enhancement package as developed by the project will enhance the livelihood of people.	5,000,000	
<b>B.</b>	<b>Operation Phase</b>			
B.1.	Employment Opportunities for Local People	Local people will be preferred for the operation related job opportunities and maintenance works		
B.2.	Link the Project Affected Area to the Main Highway	Ghermu will be linked with the motorable road due to the construction of bride		
B.3.	Benefit due to Royalty	The project will pay royalties as stipulated in the Hydropower Development Policy, Electricity Act and Regulation		
<b>Total mitigation cost</b>			<b>36,000,000</b>	

## 8.5. Summary of Environmental Impact Mitigation and Enhancement Cost

The physical environmental mitigation cost of adverse impact is highly associated with the physical and engineering work. Hence mitigation cost of environmental measures will be the integral part of contractors work for all kind of physical and engineering work. Legally, the contractors will be making responsible to restore all areas excavated by them. Land management including land instability, sedimentation, erosion, soil fertility and productivity of land will be included as a responsible work of each contractor.

The summary of environmental cost is presented in the **Table 8-1**.

**Table 8-1: The summary of environmental cost**

SN	Description	Amount in NPR.
<b>A.</b>	<b>Beneficial Impact Enhancement Cost</b>	<b>36,000,000</b>
A.1.	Physical Environment	-
A.2.	Biological Environment	-
A.3.	Socio-economic and Cultural Environment	36,000,000
<b>B.</b>	<b>Adverse Impact Mitigation Cost</b>	<b>499,891,890.1</b>
<b>B.1.</b>	<b>Physical Environment</b>	<b>24,000,000</b>
B.1.1.	Construction Phase	16,000,000
B.1.2.	Operation Phase	8,000,000
<b>B.2.</b>	<b>Biological Environment</b>	<b>236,348,200</b>
B.2.1.	Construction Phase	226,848,200
B.2.2.	Operation Phase	9,500,000
<b>B.3.</b>	<b>Socio-economic and Cultural Environment</b>	<b>239,543,690.1</b>
B.3.1.	Construction Phase	229,543,690.1
B.3.2.	Operation Phase	10,000,000
<b>C.</b>	<b>Environmental Monitoring Cost</b>	<b>20,090,000</b>
<b>D.</b>	<b>Environmental Auditing Cost</b>	<b>17,000,000</b>
<b>E.</b>	<b>CSP Cost (0.75% of total project cost)</b>	<b>243,736,572.4</b>
<b>Grand Total (2.46% of total project cost)</b>		<b>816,718,462.5</b>

## 8.6. Community Support Program

Areas of support for overall community development of the project area have been identified based on community consultations and justified cost allocation made for those initiatives in the approved EIA report (please refer section 7.4 of the approved EIA report for detail). The cost estimated under community support program in the approved EIA is NRs 94,74,000. However this cost allocation does not confirms with the provision specified by the Concept Paper on Elimination of Energy Emergency and Electricity Development Decade, 2072 BS. In this SEIA report, the costs allocated in each of the areas of support have been readjusted and additional areas of support, previously discarded by the approved EIA, reconsidered following reprioritization of the support areas to adhere with the provision of Concept Paper on Elimination of Energy Emergency and Electricity Development Decade, 2072. The total cost allocated for implementation of community support program is NRs **243,736,572.4** which is 0.75% of the project cost. The detail of cost breakdown and proposed activities are given in **Table 8-2**.

**Table 8-2: Community support program and Cost Allocation**

<b>CSP Activities</b>	<b>Amount</b>
Support to community welfare	5,000,000
Cultural Programme support	4,000,000
Walking trail maintenance and construction support	8,000,000
Support to project affected ward development activities	50,000,000
Support to Local youth clubs and Ama Samuhas	10,000,000
Educational institutions support	40,000,000
Improvement of Existing Health Facility in four affected wards	40,000,000
Sport infrastructures development and training	40,000,000
Infrastructure development for library	10,000,000
Educational trust for scholarship to local students for higher education for four affected wards	36,736,572.38
<b>Total CSP Budget (0.75% of total project cost)</b>	<b>243,736,572.4</b>

## **9. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN**

### **9.1. Background**

Environmental Management Plan (EMP) section explains the objectives and rationale of what the proposed project refers to as the Management Plan in relation to project activities, organization and approach to environmental, social, health and safety mitigation. Further, it includes the procedural frameworks to make sure that all mitigation measures and monitoring requirements specified in the EIA study report will actually be carried out. Environmental Management Plan (EMP) has been prepared as an essential part of the EIA report to set out the procedural framework to ensure the implementation of mitigation measures, monitoring and auditing requirements carried out in consecutive stages of project construction and operation phase.

The plan specifies the environmental responsibilities of all parties involved in the project, and detail the environmental management requirements of the project during the pre-construction, construction and operation phases. The plan also specifies the coordination mechanism with various line agencies, non-project participants and schedule. The project proponent will be responsible for the implementation of the EMP. Similarly, Project Development Department, Environment and Social Studies Department, Project Manager Office, Environment Management Unit, Land Acquisition, Rehabilitation and Grievances Handling Unit, Construction Contractor, Construction Management/ Supervising Consultant, Local Consultative Forum and Joint Monitoring Team are proposed for implementation of the EMP. The Project Manager Office has overall responsibility for the environmental management of the project.

This EMP is based on the experiences of previously constructed hydroelectric projects of corresponding nature, and findings of the EIA study, and review of other EMPs prepared for the Environmental Management and Government of Nepal Act, Regulations and Guidelines relevant to the hydropower projects particularly “A Guide to Environmental Management Plan of Hydropower Projects” published by MoFE.

### **9.2. Objective and strategies of EMP**

To analyze the principles, approaches, procedures and methods to control and reduce the environmental and social impacts of all construction associated with project development are the main objective of this Environmental and Social Management Plan (ESMP). The ESMP assure to fit in with the mitigation guarantee made by the project management for each of the identified impacts in this report.

- Prepare a monitoring program for baseline, impact and consent monitoring.
- Prepare an environmental auditing program to be implemented after project construction.
- Fulfill all environmental and social conditions associated with project approvals.
- Develop, promote, and foster shared sense of responsibility for environmental and social performance of project.
- Promote environmental awareness and understanding among employees and contractors through training, define stakeholders’ roles and responsibilities towards environmental and social management and linking project performance to overall environmental performance.
- Encourage an understanding of social and cultural sensitivities of local communities and the importance of minimizing project impacts on local lifestyles and culture.
- Monitor environmental and social performance throughout the project and implement an adaptive management approach for continuous improvement.
- To ensure that grievances from affected communities and stakeholders are responded to and managed appropriately.
- Work with local communities and project affected stakeholders to ensure that they benefit as a result of project development.



- Regularly disseminate project related information, continue consultations with stakeholders, and involve them throughout all phases of the project.

### 9.3. Statutory Requirements

#### 9.3.1. Environment Legislation and National Standards

The Environmental Protection Act and Environmental Protection Rules are the main rules that covers environmental aspects of the project. The MoFE acts as lead agency, which supervise the environmental matters affirming on environmental conservation and management through incorporate environmental appraisals, pollution control and prevention, conservation of natural heritage sites, allowance for environmental damages etc. Also, there are several other policies and guidelines which relate to construction and operation of UM-1HPP and should fit in with the provisions by the involved parties during the period. The relevant Government of Nepal legislation and government policies, guidelines and national standards affecting and applicable to the project are already described in the Chapter: Review of Plan/Policies, Legislations, Standards and Guidelines.

#### 9.3.2. Environmental permits and Approvals

Permits and Approvals relevant to the UM-1HPP are presented in **Table 9-1** below:

Table 9-1: Permits and Approvals relevant to the UM-1HPP

Issues	Authority	Information Required for Approval
Approval of SEIA Report	MoFE Through DoED and MoEWRI	SEIA Report as per the EIA Report format in Schedule 12 of EPR, 2077 BS.
Approval Generation License	MoEWRI Through DoED	SEIA approval letter from MoFE, approved EIA report Approved Designed Report of the project with all design details
Approval Occupation of forest land	Cabinet, through the MoFE	SEIA approval letter from MoFE, approved EIA report and detailed information on justification that forest land is required for the project, forest area, forest type, management aspect, number of trees by species and afforestation plan
'Felling permit' for trees on (cabinet permitted) Conservation area	DNPWC, Annapurna Conservation Area (Permit) and permission from Conservation Area Management Committee	Estimated number of trees to be felled / chopped; marking process; party responsible for cutting and transport of trees; monitoring process; compensatory planting proposal and budget estimate.
Approval /Permission to relocate archaeological, artifacts	Department of Archaeology	Party/s responsible for relocation – Proponent
Permit to excavate and extract material	District Coordination Committee (DCC) and Respective Rural Municipalities and Wards	Site location, extraction area dimensions and volume, timing of extraction.
Permission from Private Landowner in case of involuntary relocation	Landowner	Information on negotiation regarding land

Approval Involuntary land acquisition, resettlement and rehabilitation	Approval from MoEWRI (as per the GON's 2015 resettlement policy), Approval from District Administrative Office Permission from Land and Property Owners	Land Report with the details of cadastral maps, plots and affected households. Approved report from MoEWRI with details of entitlement matrix and Compensation fixation committee decisions
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The project management will make arrangements through its designated authority for the necessary approval, permits and permissions, including reaching a MoU with all stakeholders, taking the required time to be fully compliant with all the application requirements.

### 9.3.3. Environmental Standards

The environmental standards are gazette by MoFE and are listed in the legislative section of the report. These standards need compliance at all times during the project implementation and operation by the project proponents. The standards are same as that of approved EIA.

### 9.4.ESMP organizational Structure and Implementation Responsibility

Project environmental management will involve the following main designated parties: the project Environmental & Social Safeguard Division (ESSD) with Environmental and Social Section (ESS) and Land Acquisition, Resettlement and Grievance Management Officer (LARGMO); project appointed contractors; GoN agencies; and an independent Panel of Experts. In addition, interaction and consultation with local communities and non-governmental organizations (NGOs) during implementation of the EMP will be a regular feature of co-ordination with the local level stakeholders. The responsibilities of stakeholders in implementing ESMP are highlighted in **Table 9-2**.

Table 9-2: Project Environmental and Social Management Organizations

Category	Organization/Contractor
Project Manager	<ul style="list-style-type: none"> <li>• Project Manager</li> <li>• Environmental Technology Department (ETD)</li> </ul>
Engineering Technology Department	<ul style="list-style-type: none"> <li>• Environmental and Social officer</li> <li>• Land Acquisition, Resettlement and Grievance Management officer (LARGMO)</li> <li>• Owner's Engineer Team (OET)</li> <li>• Environmental expert (ES)</li> <li>• Social Expert (SEx)</li> </ul>
Contractor	<ul style="list-style-type: none"> <li>• Engineering Procurement Construction Contractor (EPCC)</li> <li>• Other Contractors (OC)</li> </ul>
Independent Monitoring	<ul style="list-style-type: none"> <li>• As per the PDA requirement</li> </ul>
GoN Ministries and Line Offices	<ul style="list-style-type: none"> <li>• MoFE, Department of Environment (DoEnv)</li> <li>• MoEWRI, DoED</li> <li>• Investment Board of Nepal (IBN)</li> <li>• MoFE, Department of Forest (DoF), Division Forest Office (DFO)</li> <li>• Ministry of Agriculture and Livestock Development (MoALD)</li> </ul>

Category	Organization/Contractor
	<ul style="list-style-type: none"> <li>Ministry of Land Management, Cooperatives and Poverty Alleviation (MoLMCPA),</li> <li>District Survey Office (DSO), District Land Revenue Office (DLRO)</li> <li>Ministry of Home Affairs (MoHA)</li> </ul>
Local Stakeholders	<ul style="list-style-type: none"> <li>Project District Coordination Committee (PDCCs), Local Administrative bodies, Affected Households, Local NGOs and CBOs.</li> </ul>

Organizational structure indicating chain of command, coordination roles and advisory roles of the designated responsible parties for EMP implementation to accomplish the EMP tasks and delivery of tasks is depicted in Figure 9-1.

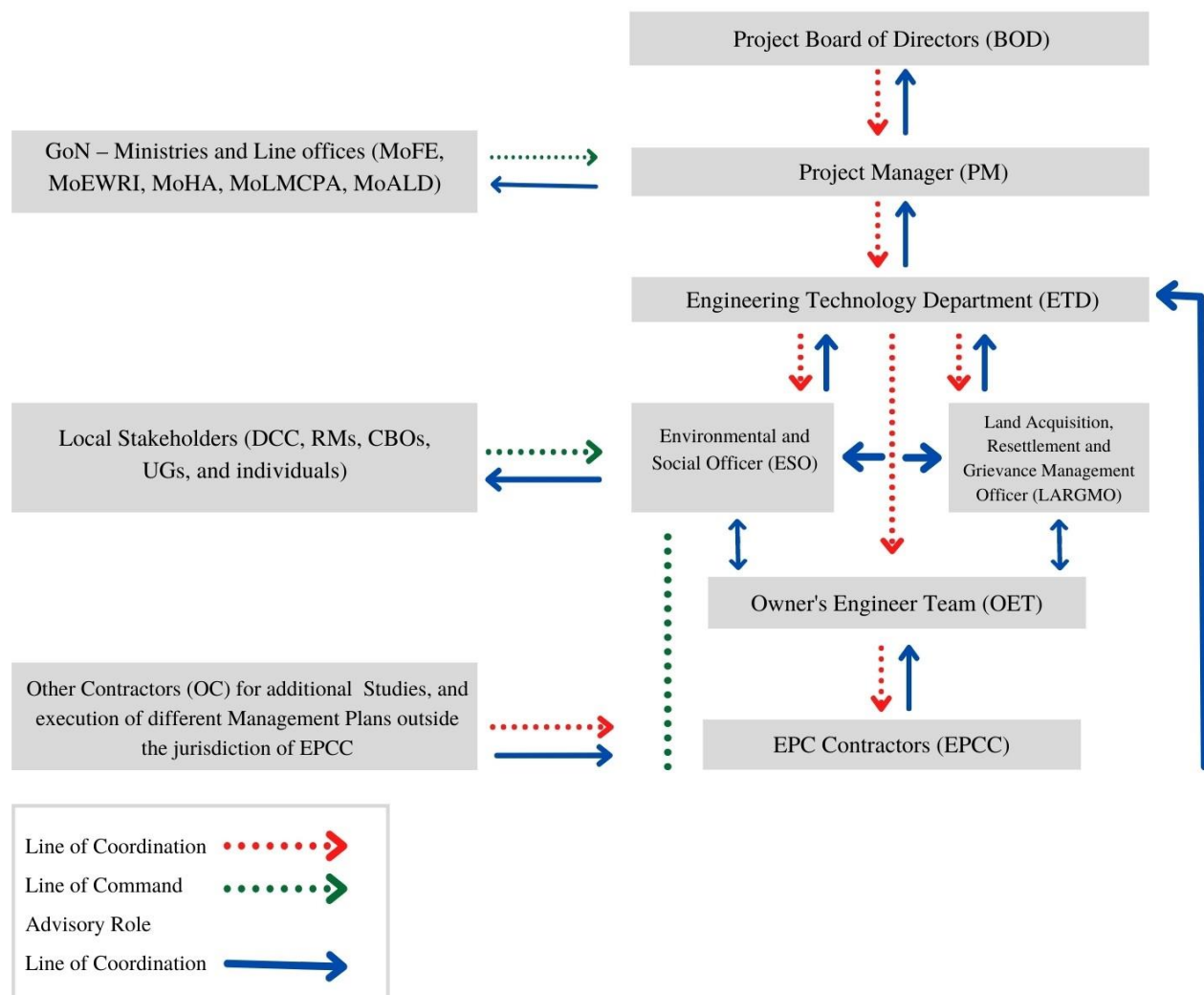


Figure 9-1: ESMP Implementation Organizational Structure

The key responsibilities and deliverables of the parties involved in the implementation of EMP are briefly summarized in **Table 9-3**.

**Table 9-3: Roles and Responsibilities of the Stakeholders**

S.N.	Stakeholder	Roles and Responsibility	Time schedule
1	MoFE	<p>Final approval of the SEIA report as per the provisions of Act and Rules</p> <p>Review of project monitoring reports during construction and operation phases and give comments for corrective actions</p> <p>Auditing of project general performance during operation phase.</p>	<p>Prior to proposal implementation</p> <p>As and when required construction and operation phases</p> <p>After two years of operation phase</p>
2	DoED	<p>Review and comments on SEIA for Final approval of SEIA</p> <p>Licensing and give permission for Project Implementation</p> <p>Review project design and contract documents, against approved EIA measures and national environmental standards and give comments for corrective actions</p> <p>Review of monitoring reports of project construction and operation and give comments for corrective actions</p>	<p>After approval of SEIA</p> <p>Before contract bidding</p> <p>As and when required construction and operation phases</p>
3	MoFE/ DNPWC/DFO	<p>Review and comments on SEIA for Final approval of SEIA</p> <p>Give approval and permission for forest clearance of the national forest land</p> <p>Assist proponent in pegging, measuring and evaluation of the forest resources of the affected forest stretch</p> <p>Review of monitoring reports of project construction and operation and give comments for corrective actions related to forest and ecology</p> <p>Assist the proponent in identification of compensatory afforestation areas as per the plans of the district and reserve areas so that Landscape Approach to Biodiversity Conservation</p> <p>Advise and assist the proponent in the forestry awareness programs</p>	<p>Prior to SEIA approval</p> <p>After approval of SEIA Pre-construction phase</p> <p>Before construction starts</p> <p>As and when required construction and operation phases</p> <p>As and when required construction and operation phases</p> <p>As and when required construction and operation phase</p>

S.N.	Stakeholder	Roles and Responsibility	Time schedule
4	Proponent and its institutional line offices	<p>Ensure that the SEIA measures are incorporated in the final project design and tender documents of project construction and operation</p> <p>Acquire necessary permits and approval for project construction and operation</p> <p>Ensure that the project construction and operation activities are in accordance with SEIA and other GON legislative requirements as well as international standards</p> <p>Monitoring and record keeping regarding environmental measures and impacts.</p> <p>Ensure public participation and involvement in project implementation and operation.</p> <p>Compilation of environmental monitoring and performance report and dispatch for review through proponent to stakeholders</p> <p>Compilation of Environmental monitoring and performance report of construction activity and dispatch for review through proponent to stakeholders</p> <p>Compilation of Environmental monitoring and performance report of operation activity and dispatch for review to stakeholders</p>	<p>During construction, and operation phase</p> <p>During construction, and operation</p> <p>During construction, and operation.</p> <p>Every 2 month during construction</p> <p>Once within 3 months of construction completion</p> <p>Once in three months for the first two years of operation</p>
5	Environmental Monitoring Engineers	<p>Supervision, baseline, compliance and impact monitoring of construction contractor's activities as per responsibilities in the contract document and advise the proponent and Supervising engineers for needed actions at the site in regular environmental management meetings.</p> <p>Monitoring of implementation of the socio-economic physical, cultural, chemical and biological environmental responsibilities of the proponent not included in the contract document and advise the proponent for needed actions</p> <p>Provide needed corrective action as per the field requirements to minimize the impacts</p> <p>Prepare environmental monitoring report of the project construction and forward to the proponent for review to the stakeholder.</p>	<p>Daily, weekly, monthly, three monthlies</p> <p>Regularly during construction phase</p> <p>Regularly during construction phase</p> <p>Bi-monthly during construction and after three months of the project construction completion.</p>

S.N.	Stakeholder	Roles and Responsibility	Time schedule
6	Construction Supervising Engineers	<p>Supervise the construction works as per the provisions of SEIA and direct construction contractor in consultation with the environmental engineers for the environmental improvement</p> <p>Preside monthly Environmental Management and Health and Safety Meetings of the supervising engineers, contractors and Environmental Engineers and maintain the records for implementation status and needed corrective actions</p>	<p>Regularly during construction phase</p> <p>Monthly during construction</p>
7	Construction Contractor	<p>Implement mitigation measures as specified in SEIA or as instructed by supervising engineer</p> <p>First hand monitoring and record keeping of environmental mitigation measures implemented and their performance</p> <p>Implement any corrective actions specified by supervising engineers within specified time</p> <p>Provide training to operator</p>	<p>Daily during construction phase</p> <p>Regularly during construction phase.</p> <p>Regularly during construction phase</p> <p>First 1 years of operation phase</p>
8	District Coordination Committees	<p>Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation</p> <p>Assist in public consultation awareness building organized by the proponent</p> <p>Assist and provide suggestions to the proponent in the matters related to community mobilization</p> <p>Assist MoFE in the proposal audit Review of monitoring reports of project construction and operation and give comments for corrective actions</p> <p>Ensure that transparency in the project activities are maintained by all the concerned stakeholders as per SEIA report and commitments</p>	<p>Prior to proposal implementation</p> <p>During construction and operation</p> <p>During construction and operation</p> <p>During Operation As and when required construction and operation phases</p> <p>Regularly during construction and operation</p>
9	Affected Municipality and ward Committees	<p>Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation</p> <p>Assist in public consultation awareness building organized by the proponent</p> <p>Assist and provide suggestions to the proponent in the matters related to community mobilization</p>	<p>Prior to proposal implementation</p> <p>During construction and operation</p> <p>During construction and operation</p>

S.N.	Stakeholder	Roles and Responsibility	Time schedule
		<p>Assist MoFE in the proposal audit</p> <p>Review of monitoring reports of project construction and operation and give comments for corrective actions</p> <p>Form Environmental Enhancement committees in each of the project affected ward and a central committee of EEC of the affected wards through a public franchise process to select and assist to implement the programs of Environmental Enhancement Programs</p> <p>Ensure that transparency in the project activities are maintained by all the concerned stakeholders as per SEIA report and commitments.</p>	<p>As and when required construction and operation phases</p> <p>Pre-construction and as and when required during construction and operation</p> <p>Regularly during construction and operation</p>
10	Conservation committee, NGOs	<p>Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation</p> <p>Assist in public consultation awareness building organized by the proponent</p> <p>Assist and provide suggestions to the proponent in the matters related to community mobilization</p> <p>Assist MoFE in the proposal audit</p> <p>Review of monitoring reports of project construction and operation and give comments for corrective actions</p> <p>Assist project affected wards to form Environmental Enhancement committees in each of the project affected wards and a central committee of the affected wards through a public franchise process to select and assist to implement the programs of Environmental Enhancement.</p> <p>Ensure that transparency in the project activities is maintained by all the concerned stakeholders as per SEIA report and commitments</p>	<p>Prior to proposal implementation.</p> <p>During construction and operation</p> <p>During construction and operation</p> <p>Operation</p> <p>As and when required construction and operation phase</p> <p>Pre-construction and as and when required during construction and operation</p> <p>Pre-construction and as and when required during construction and operation</p> <p>Regularly during construction and operation</p>

### 9.5. Project Environmental Management Framework

As per the Nepalese Environmental Protection Rules, environmental management of the project is the responsibility of the advocate/proponent. For UM-1HPP the advocate's Project Management Office (PMO)

has the liability of Project's Environmental Management advocate in Nepal. Thus, to assure that the EIA recommended mitigation and monitoring actions are appropriately implemented, monitored, assessed, and advertised to the stakeholders for evaluation. The proposed ESU has four major roles to play. They are as follows:

- Implement and administer land and property acquisition, compensation of affected parties.
- Implement and administer the program in the project-affected areas.
- Disseminate information to the project's stakeholders and co-ordinate with the different line agencies.
- Monitor the environmental and social measures and its performance as per EIA and EMP.

The ESU will constitute of two sub-units, namely environmental and social implementation Sub-unit (ESISU) and Environmental and Social Monitoring Sub-unit (ESMSU). ESISU will have the duty to implement environmental provisions which are not included in the contract documents of the contractor. The members of this sub-unit will be the regular members of organization with past experience in the implementation of environmental provisions and also in the operation of Public Information Center (PIC) and grievance handling.

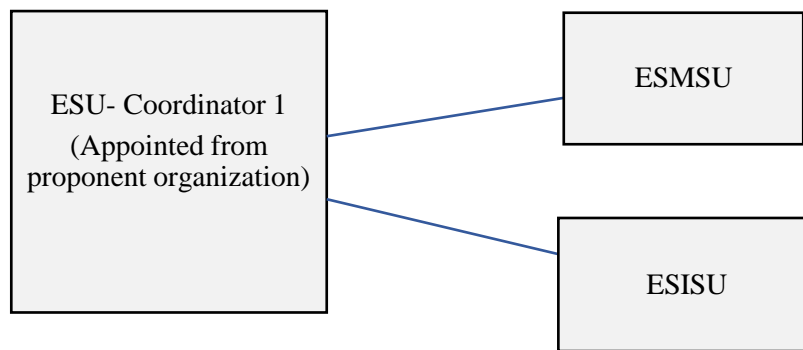


Figure 9-2: Level of Environmental Management Plan

### 9.6. Administrative and Management cost for ESU

Administrative and management cost is estimated based on the assumption that most of the persons shall be hired by the project as project regular staff in case of ESISU and as consultants for ESMSU. Office for the ESU shall be established in the engineer's camp as a part of the civil construction workforce.

Table 9-4: Cost estimation for Environment Monitoring of Mitigation Measures

Professional/Activity	Man month	Rate NPRs	Cost in (NPR)
<b>Construction Phase</b>			
Environmental Expert / Engineer	2	150000	300000
Forestry Expert (Nursery establishment, seedlings quality, site preparation for plantation, plantation, survival)	3	150000	450000
Translocation of protected species	Lump sum		100000
Sociologist	2	150000	300000
Other experts as necessary	Lump sum		100000
Environmentalist	2	150000	300000
Support Staff	2	25000	50000



Water Analyst (Chemist)	1	125000	125000
Geologist	1	125000	125000
Involvement of GO, CBO and NGO	Lump sum		50000
Administrative Support	Lump sum		100000
Stationery/Printing/Photocopy	Lump sum		60000
Computer/Secretarial Service	Lump sum		30000
Transportation	Lump sum		150000
Investigation/Laboratory tests etc.	Lump sum		50000
Miscellaneous	Lump sum		100000
<b>Total Cost in (NPR)</b>			<b>2390000</b>
<b>Operation Phase</b>			
Environmental Expert / Engineer	20	150000	3000000
Sociologist	20	150000	3000000
Environmentalist	20	150000	3000000
Support Staff	20	40000	800000
Water Analyst (Chemist)	20	125000	2500000
Geologist	20	125000	2500000
Administrative Support	20	100000	2000000
Investigation/Laboratory tests etc.	20	20000	400000
Miscellaneous	Lump sum		500000
<b>Total Cost in (NPR)</b>			<b>17700000</b>
<b>Total Monitoring Cost</b>			<b>20090000</b>

## 9.7.Environmental Management Plan

During the different phases of proposal implementation, the environmental mitigation measures will be applied. The Environmental Management Plan (EMP) has been prepared for the project that discusses the anticipated impacts, monitoring requirements, and development of mitigation measures with respect to the following stages: (i) pre-construction, (ii) construction, and (iii) operation and maintenance. Site-specific mitigation measures and monitoring plans were developed in detail and will be implemented during the project implementation phase.

### 9.7.1. Project EMP Structure and Stakeholders Responsibility

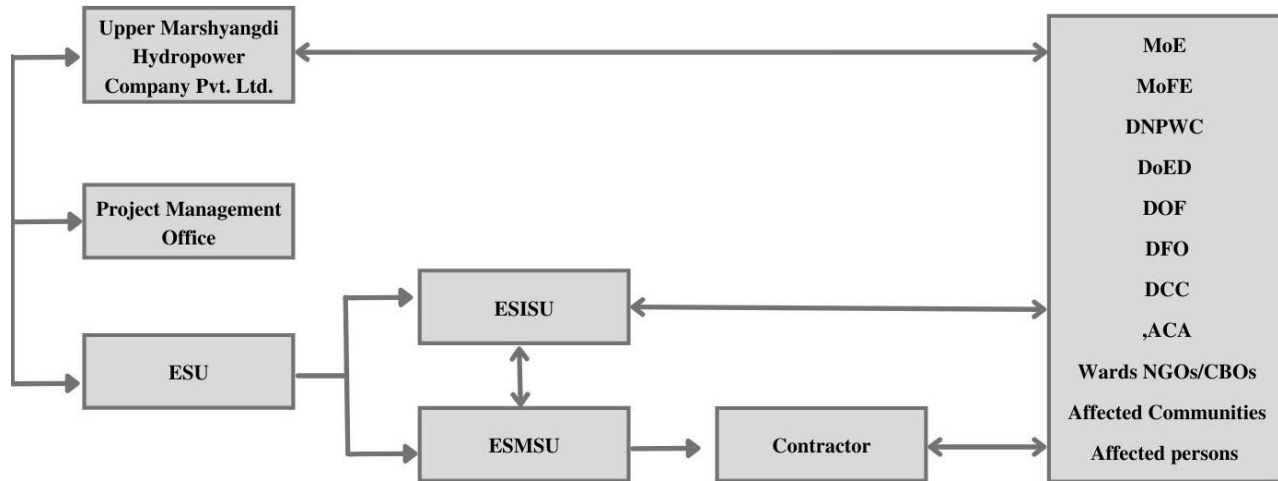
The Project Environmental Management Framework of UM-1HPP is prepared to shows linkages with different parties to be involved directly or indirectly during the different phases of project development and operation in compliance with the existing Act and Rules. Overall project Environmental Management is the responsibility of UM-1HPP, Project Management Office (PMO).

Key stakeholders including UM-1HPP, to be involved for project environmental management in the hierarchy order is as follows.

- Ministry of Forests and Environment, (MoFE);
- Ministry of Energy, Water Resources and Irrigation (MoEWRI);
- Department of National Parks and Wildlife Conservation (DNPWC)
- Department of Electricity Development (DoED)
- The Proponent and its line offices

- EIA Engineers (EE), Supervising Engineers (SE);
- Construction Contractor (CC);
- Affected Wards/Municipalities and District Coordination etc.

Non-government Organizations, Community Based Organizations (Community Forest User Groups, Irrigation User Groups, Water Supply User Groups, etc.



**Figure 9-3: Project Management Plan for Construction Phase**

### 9.8. Resettlement and Compensation

The project will prepare a Resettlement Action Plans (RAP) within the areas where the land needs to be acquired permanently or temporarily. All these action plan will depend on the Resettlement Policy Framework (RPF) which will include the Livelihood Restoration Plans as applicable. The RPF will be based on Land Acquisition Act (1977), Land Acquisition, Compensation and Resettlement in Developmental Projects in Nepal (2014) and related environmental guidelines.

The purpose of implementing the action plan is to manage and mitigate the issues arose due to the displacement of people resulting from permanent acquisition of land within the project area. It will be applicable to all the land that is privately owned and used for various purposes.

The key elements of the action plan include an overview of project affected communities, screening of involuntary resettlement and livelihood impacts, proposed entitlement matrix, institutional arrangements along with a monitoring and evaluation framework. The action plan will focus on payment of compensation to replace land, assets, income and livelihood, restoration or improvement of livelihoods, improvement in living conditions, etc.

### 9.9. Grievance Redress Mechanism

Different issues may occur during the project construction phases and people may have concern with the project's environmental performances. Any of those concerns should need to be addressed quickly and transparently, and without compensation to the Affected People (AP). To sort out the problem, certain process should be followed. A Grievance Redress Committees (GRC) will be established at local level for hearing the complaints of APs and for their appropriate resolution. Other than disputes relating to legal rights, it will review all grievances relating to land acquisition. Grievances will be redressed within two to four weeks from the date of lodging the complaints. GRC comprises:

- a) Head of District Coordination Committee/local leader (Chairperson),
- b) One representative of each ward (Chairperson);
- c) Two representatives of the APs (Male and Female representative)
- d) One representatives of civil society organizations;
- e) One representative of Project.
- f) Social mobilisers/NGO to attend as observers and to give support to APs.

Each coordination committee will form a Grievance Redresses (GR) Sub-committee at ward level involving 3 members from coordination committee and 2 members from APs to hear complaints and grievances at local level. The main steps to be followed for the grievance resolution are:

Steps 1: APs shall first file their complaints at ward level GR sub-committee. The complaints will be discussed among concerned parties to settle the issue locally (within 15 days). The social staff and NGOs working in the ward will facilitate the consultation and deliberation in this regard.

Steps 2: If no amicable solution reached at ward level (within 15 days), APs can appeal to municipal level GRC.

Steps 3: If APs are not contended with the decision of GRCs or in absence of any response from them, the AP may resort to the legal remedies available under the Land Acquisition Act.

### **During Construction**

The complaints should be directly discussed with the ward chairperson from the affected person. Then the complaint is taken to the project site engineer if the ward chairperson accepts the complaint. All complaints raised to the project site engineer are to be entered in a Register by; date, name, contact address and reason for the complaint. Also, duplicate copy of the registered complaint is given to the affected person. The Register will show who has been directed to deal with the complaint and the date when this was made together with the date when the affected person was informed of the decision and how the decision was transmitted to the affected person. The Register is then signed by the person making the complaint. For making complaint there is no any charges taken. The project Site Engineer will convey a decision to the affected person within two days. The affected person and the ward chairman may discuss the complaint directly with the project site engineer. If the complaint of the affected person is dismissed, the affected person will be informed of their rights in taking the next step. A copy of the decision is sent to the project manager.

## **9.10. Environmental Monitoring and Monitoring Framework**

The monitoring phase will include baseline, compliance, and impact monitoring periods, which are discussed further below:

### **9.10.1. Baseline Monitoring**

The baseline data will provide a benchmark for comparison of physical, biological, socioeconomic and cultural conditions for the ongoing monitoring that will occur during Project construction and operation. The major issues for the monitoring include Landslide and soil erosion, changes in air quality, land quality and sound quality, forest ecology, wildlife, health condition, market values and consumer prices.

### **Construction Phase Monitoring (Compliance and Impact Monitoring)**

The construction phase monitoring will basically emphasis on whether the works performed by different contractors comply with the terms of the EIA and environmental management plan. The main purpose of this monitoring will be to assess whether all the mitigation measures as proposed in the study are satisfactorily implemented or not.

### **Operation Phase Monitoring (Compliance and Impact Monitoring)**

The operation phase monitoring will be carried out once the project gets completed and is under the operation phase. This monitoring will continue for the first two years of operation to assure align with the impacts predicted in the study. The compliance and impact monitoring at this phase will be carried out to access the actual level of impact of the project on physical, biological, socio-economic and cultural environment of the area. This will also check the effectiveness of the mitigation measures, accuracy of predicted impacts and identify the emerging issues that requires new corrective measures or actions.

### **Monitoring Framework**

The monitoring framework has been developed for the project based on the MoFE guidance (MoFE, 2018) and indicates the issues for monitoring, indicators, locations to conduct monitoring, methods indicating the procedures, equipment and analytical approaches, frequency of monitoring and responsibilities to be carried out. The monitoring framework is presented in the **Tables 9-5, 9-6 and 9-7**.

**Table 9-5: Matrix table of baseline monitoring in pre-construction and construction phase of the project**

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
<i>Pre-construction and Construction Phase</i>						
<i>Baseline Monitoring</i>						
Landslides and erosion	Number of landslides/debris flows/gully formation sites marked and indicated in suitable maps	Headworks, Spoil disposal sites, adits, camps, powerhouse.	Direct observation and mapping in the appropriate scale map	Once	ESU	Included in construction management cost
Air Quality	TSP, PM <sub>10</sub> and PM <sub>2.5</sub>	Headworks, Powerhouse site	As per National Ambient Air Quality Standards, Nepal,	Once	Monitoring Consultants	400,000
Water Quality	Parameters as per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal, will be used for monitoring indicators	Upstream of headworks and downstream tailrace	As per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal,	Dry season, wet season (once)	Monitoring Consultants	50,000
Noise level	dBA	Headworks, Powerhouse site	Decimeter meeting Standards	Once	Monitoring Consultants	70,000
Land pollution	Open defecation and garbage disposal places	Along Marsyangdi River in the Headworks site area.	Direct observation	Once	ESISU	Included in construction management cost
Forest Ecology	Forest Status in terms coverage, species present		Three sample plots in each area	Once	Environmentalist	Included in construction management cost
	Photographic documentation showing the forest area from a fixed distant spot		Photography	Once	Environmentalist	Included in construction management cost

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
	(locate sample plot and photograph taken spot in map)					
Wildlife / Wildlife status	Wildlife status in terms of species present and reported, Raider wildlife		Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Once	Environmentalist	Included in construction management cost
Markets	No of Hotels/Tea stall and Restaurants	Headwork site, Camp site, Internal access road and ancillary facility sites	Direct enumeration	Once	ESISU	Included in construction management cost
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental for night stay etc. Labor cost/day (male and female)	Headworks' site, Camp site, Internal access road and ancillary facility sites	Market survey and documentation	Once	ESISU	Included in construction management cost
Sanitation	No of Hhs having toilets, Practice of sanitation (Child defecation, solid waste disposal), Source of water (Piped, springs, river etc.) and their quality	Headworks' site, Camp site,	Field survey and documentation, Photographs and testing water quality samples as per drinking quality standards	Once	ESISU	Included in construction management cost

**Table 9-6: Matrix table of compliance monitoring in construction and operation phase of the project**

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
<b>Compliance monitoring</b>						
<i>Construction Phase</i>						
EMP Mitigation Measures	All mitigation actions listed in Mitigation Management Plan for construction phase, all the various management plans implementation	All structural sites and facility sites and their surroundings	Direct supervision and documentation, Consultation with the people	Daily/weekly/monthly depending upon the measure	ESISU	Included in construction management cost
Project Vehicles	As per the limits stipulated in Nepal Vehicle Mass Emission Standards	Vehicles used in Project	Certifications of the vehicles	Once	CC/OC	Inbuilt with civil contract
Diesel Generators sets	As per the exhaust Emission standards for diesel generating sets	Project area	Certification of the suppliers	Once	CC/OC	Inbuilt in civil contract
Water quality	Parameters listed in “Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters for compliance	Marsyangdi River above headworks site and downstream tailrace and burrow pit areas, construction camps	As per Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters”	Every month	CC	Include in the contract bid
Climate	Air temperature, rainfall and Humidity	Headworks site, Powerhouse	Establish weather station and arrange manpower to for daily observation	Daily for temperature, rainfall, and humidity.	CC	Include in the contract bid
Water quality in the camps	As per Nepal Drinking Water Quality Standard for compliance	Water supply source and one end tap of the camps (6 Nos)	As per Nepal Drinking Water Quality Standard	Monthly	CC/OC	Include in the contract bid
Public and Occupational Health (Ambulance, medical)	Outbreak of epidemic disease in the village, in the construction camps, Number of workers reporting sickness, no of	All surrounding villages, construction camps,	Direct observation, consultation with local people/communities and health workers, managers of camps and	Twice a month	Contractor	Include in the contract bid

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
doctor, first aid, PPE)	workers injured, No of construction accident, Number of fatal incidents etc.		construction workforce, health care facilities of the construction camps and sites			
Law and order	Theft, burglary, quarrels, social unrest, Number of police case etc.	Construction areas, labor camps	Direct observation and consultation with the local communities and affected ward authority and reports of the construction camp management	Monthly	ESISU	Included in construction management cost
<b>Operation Phase</b>						
Mitigation Measures	All mitigation actions listed in EMP and Environmental Mitigation Management for Operation phase	All structural sites and facility sites and their surroundings	Direct supervision and documentation	Daily/weekly/monthly depending upon the measure	ESISU/ESMSU	Cost included in operation management cost
Water quality in the operation camp	As per Nepal Drinking Water Quality Standard for compliance	Water supply source and one end tap of the camps (4 Nos)	As per Nepal Drinking Water Quality Standard	Once in six month (project life of 30 years)	ESISU/ESMSU	400,000



**Table 9-7: Matrix table of impact monitoring in construction and operation phase of the project**

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
<b>Impact Monitoring</b>						
<i>Construction Phase</i>						
Landslides and erosion	Number of landslides/ debris flows/gully formation sites	Headworks' site, power house, Spoil disposal sites, internal access roads, pit sites, camps, storage facilities etc..	Direct observation and mapping in the appropriate scale map	Three times a year	ESISU/ESMSU	Included in construction management cost
Land pollution	Open defecation and garbage disposal places	Along Headworks and power house	Direct observation	Every month	ESISU/ESMSU	Included in construction management cost
Air Quality	TSP , PM10 and PM2.5	Headworks site and powerhouse site)	As per National Ambient Air quality Standards, Nepal	Twice a year (November, April for five year)	ESISU/ESMSU, Monitoring consultant	250,000
Water Quality	As there is no water quality standard set for fresh water bodies and rivers, parameters as per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal, will be used for monitoring indicators	Marsyangdi above dam site and downstream tailrace and all burrow pit areas, construction camps	As per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal,	Three times a year) (November, March, May, for 5 years)	ESISU/ESMSU, Monitoring laboratory	500,000
Noise level	Laeq (dBA)	Headworks site, Powerhouse site	Type 1 and type 2 sound level meter meeting standard	two times a year (, January, and, May for 5 years )	Monitoring consultant	600,000
Forest Ecology	Forest Status in terms coverage, species present		Three sample plots in each area	Twice a year (September and March)	Environmentalist	Included in construction management cost

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
	Photographic documentation showing the forest area from a fixed distant spot (locate the sample plot and photograph taken spot in map)		Photography	Twice a year (September and March)	Environmentalism	Included in construction management cost
Wildlife	Wildlife status in terms of species present and reported, Raider wildlife		Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Twice a year (September and March)	Environmentalism	Included in construction management cost
Faunal and floral diversity	Status of faunal and floral diversity	All remaining forest after forest clearance	Field survey	Once after forest clearance in the reservoir	Environmentalism	800,000
Affected people by land and property acquisition	Satisfaction on the resettlement and rehabilitation packages	All project sites	Grievances records, consultation with the affected households	Twice a year	ESISU/ESMSU	Included in construction management cost
Affected people by land and property acquisition	Economic and social status of the displaced households	Displaced households of the project	Sampling survey of the displaced households	Every Two years	ESISU/ESMSU	1,000,000
Markets	No of Hotels/Tea stall and Restaurants	Headworks site	Direct enumeration	Every month	ESISU/ESMSU	Included in construction management cost
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental	Headworks site	Market survey and documentation	Every month	ESISU/ESMSU	Included in construction management cost

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
	for night stay etc. Labor cost/day (male and female)					
Sanitation	No of Hhs having toilets, Practice of sanitation (Child defecation, solid waste disposal), Source of water (Piped, springs, river etc.)	Headworks' site, Camp site, Internal access road and ancillary facility sites	Field survey and documentation, Photographs	Once a year	ESISU/ESMSU	Included in construction management cost
<b>Operation Phase</b>						
Landslides and erosion	Number of landslides/ debris flows/gully formation sites	Headworks' site, internal access roads	Direct observation and mapping in the appropriate scale map	Twice a year for first 5 years	ESISU/ESMSU	Cost included in operation
Air Quality	TSP , PM10 and PM2.5	Headworks' site, internal access roads	As per National Ambient Air Quality Standards, Nepal,	once after operation	ESISU/ESMSU ,Monitoring Laboratory	200,000
Water Quality	Parameters listed in “Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters” 2003 – to examine impact on the receiving water body	Upstream Headworks site and downstream tailrace	As per Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters” 2003,	Twice a year (November, April) for 30 years	Monitoring Laboratory	1,000,000
Climate	Air temperature, rainfall and Humidity	Headworks site / Powerhouse site ,	As per parameter listed	Daily for the 30 years operation period	ESISU/ESMSU , monitoring laboratory	1,200,000 (the stations will be handed over to the project by EPCC
Noise level	Laeq (dBA)	Headworks site / Powerhouse site	Type 1 and type 2 sound level meter meeting IEC standard	once after operation	ESISU/ESMSU Monitoring Laboratory	40,000
Forest Ecology	Forest Status in terms		Three sample plots	Twice a year	Environmentalist	Included in

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility	Monitoring cost
	coverage, species present		in each area	for first 5 year (September and March)		Operation Management Cost
Wildlife	Wildlife status in terms of species present and reported,	PRMs forest area	Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Twice a year for first 5 year (September and March)	Environmentalists	Included in Operation Management Cost
Markets	No of Hotels/Tea stall and Restaurants	Headworks site and powerhouse site	Direct enumeration	Every month/ for the first year of operation	ESISU/ESMSU	Included in Operation Management Cost
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental for night stay etc. Labor cost/day (male and female)	Headworks site / powerhouse site)	Market survey and documentation	Every month for the first year of operation	ESISU/ESMSU	Included in construction management cost
Sanitation	No of Households having toilets, Practice of sanitation (Child defecation, solid waste disposal), Source of water (Piped, springs, river etc.)	Headworks site / powerhouse site, camp sites and internal access roads	Field survey and documentation, Photographs	once after operation	ESISU/ESMSU	Included in construction management cost

## 10. ENVIRONMENTAL AUDITING

The objectives of the environmental audit are to evaluate whether the identified risks in SEIA report are effectively mitigated and comply with the requirements of the Environmental Management Plan. The audits will also provide guidance on corrective actions required to address non-compliances and will provide baseline information for future audits and other monitoring activities. The Ministry of Forests and Environment (MoFE) is responsible for carrying out environmental audit and it assesses the actual environmental impacts, the efficiency of prediction, the effectiveness of environmental impact mitigation and enhancement measures and the functioning of monitoring mechanisms. Environmental auditing is generally carried out after two years of commencement or the operation of the project.

### 10.1. Environmental Audit Framework

Environment Audit Framework should specify who has asked to undertake the audit, which could be any one of the followings:

**Internal:** any institutions or organizations willing to do an audit to improve their own operation;

**External:** carrying out of audit of another in order to check how it has performed;

**Voluntary:** audit is done to improve the management with the consent of all concerned; or

**Mandatory:** required by the law or as conditions, which is applicable to UM-1HPP as specified in EPR 2020.

**Scale:** The size and numbers of parameters to be examined have to be stated.

**Focus:** The environmental audit aspects of examination should be as follows.

- compliance;
- monitoring program;
- impact prediction;
- physical risk and hazards;
- financial risk and liabilities;
- baseline;
- management programs; and
- Management structure.

The audit of environmental compliance may be carried out by following institutions and individuals as necessary.

**Ministry of Forests and Environment:** Audit should be carried out as a routine task or in response to public concern.

**Project Proponent:** It is done by the project proponent as a regulatory requirement, and as a routine component of the project.

**Community Groups, NGOs and CBOS:** The Audit can be done in response to the concerns of people.

The environment framework including audit type, parameters, location, method source and indicators is presented in the table below:

**Table 10-1: Environment framework including audit type, parameters, location, method source and indicators**

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
<b>Physical Aspects</b>					
Air Quality					
Compliance and Impact prediction	Total Suspended solid particulate	Weir and power house sites and access road	Low-volume Sampler	Analysis data	The amount and types of SSP from project during construction and after construction and their comparison with ambient standards
Compliance and Impact prediction	Dust from construction activities	Access Road, Head works, and Power house sites	Visual Inspection	Information from local people	Dust accumulation Pre-project during construction. After construction their comparison with ambient standards
Noise Level and Vibration					
Compliance and Impact prediction	Measurement of decibels	Weir, power house and nearby villages	Decibel meter	Measurement information from local people, Monitoring reports	Noise levels during pre-project during construction after Construction their comparison with ambient standards
Compliance	Intensity of noise during construction	Construction sites	Questionnaire	Local people	any hearing impairment case
Compliance	Cracks of buildings	Crack locations	Questionnaire	Local People	Cracks existed in house, and compensation paid
Water Quality					
Impact prediction, compliance and baseline	Temperature, pH, Turbidity TSS, DSS, hardness, chloride Sodium, oil and grease Coli form, DO, BOD, COD	Headwork and Power house sites	Water samples collected from different sources	Analytical data, Monitoring reports	Comparison with ambient water quality during Pre Project during construction after construction

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
<b>Disposal of Spoils and Construction Wastes</b>					
Compliance, baseline and impact prediction	Disposal of construction spoils	Designated sites	Observation/ interview of local people	On site information and observation	initiated erosion affected the aesthetic value affected forest and agriculture
Compliance and base line	Side casting of excavated soils and wastes	Intake, audits and Power house sites	Observation/ interview	Local information	initiated land erosion affected local drainage
<b>Erosion and Slope Stability</b>					
Baseline and impact prediction	Disturbance to natural slope	Intake, road and power house sites	Visual observation	On site information, Photograph s	Eroded and unstable areas
Erosion and	Slope Protection measures	As recommended in SEIA	Visual observation Photographs	Onsite information	Stabilized disturbed slopes
Compliance and baseline	Adequate drainage facilities such as catch drains, herringbone drains, side drains	Powerhouse, intake, road and mostly in unstable areas	Visual observation Photographs etc	Onsite information	Drainage facilities installed and number of disturbed area due to the lack of drainage
Compliance and management	Plantation of disturbed slopes	Cut slopes and area where vegetation's were cleared	Visual observation Photographs	On site information	All disturbed slopes have been vegetated
Compliance and management	Temporary workforce sites cleaned and restored to original condition	Project area labour camps	Site inspection	Contractors	Workforce camps cleared and restored to original condition
<b>Biological Aspects</b>					
Forest and Vegetation					

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
Baseline	Number of wooden houses constructed in the project site	Roadside Project and in the vicinity of the project area	Counting, Visual observation	Local People	No of wooden house increased in project area
Baseline	Number of tea stalls and restaurants established during construction	Project site	Observation and records	Local People	Number of tea stalls and restaurants increased
Baseline	Fuel wood trade location of timber depots and fire wood sale in the project construction	Project site	Records	Local People	Volume of fuel wood sold increased
Baseline	Number of stumps of cut trees in nearby forest	Forest area nearby	Examination of forest	Local people	Number of cut tree stumps increased
Compliance	Alternative Energy for cooking for labor force	Project sites	Records from the contractors	Local people	Kerosene provided
Baseline and compliance	Harvesting and trade of medicinal plants	Project sites and the market	Information from local people and market	Local people	Sales of medicinal herbs increased
Baseline and compliance	General condition of forest nearby	Forest near project site	Observation	Local people	Forest condition deteriorated
<b>Wildlife and Fauna Composition</b>					
Compliance	Wildlife hunting trapping and poaching by workforce	Forest area near the project site	Interview with local people and photographs	Local people, Monitoring reports	Decrease in number of wild animals seen
Compliance	Trading of wildlife products dried meat, leather, fur	Project site and market	Observation interview and photographs, if any	Local people, Monitoring reports	Sales of animals increased
Baseline	Frequency of the birds and mammals seen	Project area	Observation and Interview	Local people, Monitoring reports	Decreased frequency of wild animal and birds sightings in project area



Audit type	Parameters	Location	Methods	Source	Indicators
	before and after the project				
<b>Fish and Fisheries</b>					
Baseline and compliance	Species of fish occurrence and abundance before and after the project	Sampling stations at the project sites	Sampling	Local fishermen	Species of fish in the river increased / decreased
Compliance	Fishing activities by workforce	Project site	Interview	Local people	Fishing activities increased
Compliance	Use of explosive, electric rod and net	Project site intake/ powerhouse	Interview	Local people	Use of explosive observed/not observed
<b>Socio-Economic and Cultural Aspects</b>					
<b>Employment Opportunity</b>					
Compliance and impact prediction	Number of local labors employed in the project construction	Project Site	Analysis of records interview	Records from Contractors and Local people	Percentage of local labors
Compliance	Number of Women workforces	Project Sites	Records	Local people	Percentage of women workers higher than 30%
<b>Trade, Commerce and Industry</b>					
Baseline	Number and types of shops established during construction and how many of them are existing after the construction	Road sides and in project sites	Records	Records and local people	Number of shops increased / decreased during construction Majority of shops still operating / close
Baseline	Establishment of industry in the vicinity of project site	Project sites and surroundings	Records	Observation and local people	New industries established/no establishment

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
Impact prediction	Effects on already existing local and traditional industries	Local area	Records	Local people	Traditional industries suffered / flourished
Baseline	Rent of house and land space, before, during and after the project	Local area	Inquiries	Local tenants and local monitoring reports	Local tenants and local monitoring reports
<b>Compensation</b>					
Monitoring and impact prediction	Use of compensation received	Local area	Questionnaire survey and interview	Local people, monitoring reports	Beneficial use, Unnecessary use, Number of households, Migrated
<b>Price Rise</b>					
Baseline	Rise in the price of essential commodities during the construction and after construction	Local Market	Interview with Local people and shops	Local people	Rise/fall in prices during and after the project construction
<b>Occupational Health and Safety</b>					
Baseline	Types and numbers of accidents occurred during construction	Project site	Records	Records from contractors, Local people, Monitoring reports	Number and type of accident
Risk and hazardous	Adequacy of occupational safety measures provided by the project	Project site	Records	Records from contractors, Local people, Monitoring reports	Adequate/ Inadequate
Management and compliance	Facility of First aid emergency Services provided	Project site	Records	Records from, contractor office, Local people, Monitoring, reports	Provided/ not available
Management and compliance	Compensation to the loss of life or disability	Project site	Records	Records of contractor, office of	Provided/ not provided

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
				Project management & local people, monitoring reports	
Baseline	Cases of communicable diseases	Project sites	Records	Medical records from local medical center, Interview, Monitoring reports	Number of cases of communicable diseases
<b>Socio-Culturally Undesirable Activities</b>					
Baseline	Gender Inequalities	Project site and in the vicinity	Sample interview	Local people	Indication of inequalities
Management and structure	Liquor production and consumption	Project site	Interview	Local people	Liquor consumption high/moderate
Management and compliance	Disputes and crimes	Project Sites	Records from local police and project management	Local people	Cases of dispute/crime
Management and structure	Use of child labour (below 14 years of age)	Project site	Records	Records from contractor and local people	Records of child labor available/not available
<b>Complaints from The Local People</b>					
Management	Types of damages made on personal properties	Project site and its vicinities	Records	Local people, Monitoring reports	Cases of damages or no cases
Management and compliance	Damages to local infrastructure such as road and irrigation and suspensions bridges	Within the periphery of project area	Records	Concerned agencies, Monitoring reports	Damages to bridges, irrigation, road, water supply
Management	Compensation for maintenance and rehabilitation of irrigation Project	Project area	Interview	Concerned agencies and project management	Compensation for damage

<b>Audit type</b>	<b>Parameters</b>	<b>Location</b>	<b>Methods</b>	<b>Source</b>	<b>Indicators</b>
Management	Losses causes by blasting, vibration and noise and compensation paid	Project area and its vicinity	Records	Local people and project management	Compensation for losses
<b>Coordination and Communication</b>					
Management programme	Coordination among district administration, politicians, project management, contractors and labors	District Head Quarter, Project site	Records and interview	District headquarters, government line agencies, project management, contractors and labor	Coordination or No coordination No of meetings
Management programme	Information dissemination to workers, local people about the project implementation.	Local area	Means of information dissemination	Local people, project staffs, labors	Adequate or Inadequate dissemination
<b>Overall Socio-Economic and Cultural Changes</b>					
Baseline	Changes in land use pattern	Project affected wards	Interview/Observation	Farmers and local entrepreneurs	Indication of changes
Baseline	Changes in local economy (Standards of living)	Project affected wards	Interview	Local people and business community	Standard of living increased/decreased compared to pre project condition

## 10.2. Use of Environmental Audit

Environment is conducted to make sure that environmental performances carried out fits with environmental laws and standards and which are broadly and systematically reviewed. Environmental audit basically helps to examine how well these environmental instruments have worked and enable to appraise the actual environmental impacts, efficiency of prediction, effectiveness of environmental mitigation measures endorsed and functioning of monitoring mechanism. Environment Protection Act, 2019, requires the Environmental Audit to be undertaken in Nepal after the project has been in operation for two years.

## 10.3. Agencies Responsible for Auditing

The Ministry of Forests and Environment (MoFE), Department of Environment, and other relevant organization will be consulted during auditing. Local and national NGOs or consulting companies may also be entrusted to carry out the task, if they are engaged to do so by the government. In general accordance to the MoFE Hydropower EIA Manual (2018), the project proposes three types of audits:

**Completion Audit:** The purpose of these audits will be to ensure that the contractors and others involved in the implementation of the Project have complied with the terms of the EIA and the EMP. Specifically, the project will conduct these audits at the completion of each construction contract as part of the “hand-over” process.

**EIA Audit:** As stated in the MoFE Manual, “Generally, it will be appropriate to maintain uniformity between the methods employed in collecting baseline data and information, and carrying out monitoring during the EIA. The EIA audit (SEIA Audit) is carried out after 2 years of commencement of the project. The GoN is responsible for carrying out this audit” (MoFE, 2018). This is a one-time audit by the MoFE.

**Project Impact Audit:** The purpose is to identify and assess the actual Project-related impacts over time, the effectiveness of environmental impact mitigation and enhancement measures, and functioning of monitoring mechanisms. The GoN will conduct this audit every two years during the operation period.

The purpose of the audit is to identify the corrective actions needed to bring the project’s EMP performance into compliance with the applicable regulatory requirements.

## 10.4. Environmental Audit Cost

The cost estimated for the environment auditing is detailed below in **Table 10-2**.

**Table 10-2: Cost estimation for Environmental Auditing**

Professional/Activity	Man month	Rate NPRs	Cost in (NPR)
<b>Construction Phase</b>			
Forestry/Biodiversity/Fish Expert	5	80000	400000
Geologist	5	80000	400000
Chemist	5	80000	400000
Land use change	5	80000	400000
Socio-economist	5	80000	400000
Gender specialist	5	80000	400000
Environmentalist	5	80000	400000
Health & Safety	5	80000	400000
Hydrologist	5	80000	400000

<b>Professional/Activity</b>	<b>Man month</b>	<b>Rate NPRs</b>	<b>Cost in (NPR)</b>
Supporting Staff	5	80000	400000
<b>Total</b>			<b>4000000</b>
<b>Operation Phase</b>			
Forestry/Biodiversity/Fish Expert	25	60000	1500000
Geologist	25	60000	1500000
Chemist	25	60000	1500000
Land use change	25	60000	1500000
Socio-economist	25	60000	1500000
Gender specialist	25	60000	1500000
Environmentalist	25	60000	1500000
Hydrologist	25	60000	1500000
Supporting Staff	25	40000	1000000
<b>Total</b>			<b>13000000</b>
<b>Grand Total Environmental Auditing Cost</b>			<b>17000000</b>

The total environmental auditing cost is estimated to be NRs. 1,70,00,000.

## 11. CONCLUSION

Upper Marshyangdi Hydropower Company Pvt. Ltd. has proposed Upper Marshyangdi -1 Hydropower Project expected to have installed capacity of 102 MW. The construction and operation of the project will result into number of benefits and some of the impacts, that could be mitigated in proper ways. The approved Environmental Impact Assessment as well as this Supplementary assessment of the project has discussed about the identified impacts and their mitigation measures. As the identified impacts belong to different types of environments including physical, biological, socio-economic and cultural aspects, the severe or anticipated impacts are related to land and property acquisition, land, water and soil pollution.

The Supplementary Environmental Impact Assessment has been prepared in guidance to the scoping document and the approved EIA which has effectively met all the requirements. This report is based on the desk study, field study and detailed evaluation of project impacts. The report addresses all the changes in previously proposed 138 MW project and recently proposed 102 MW project, and this shows that that the environmental and social impacts of the project after change in the location of the structure are similar to approved EIA (2014) in many cases. Some of the social impacts related to cost of land acquisition and compensation of the standing crop and trees has been changed as compared to approved EIA (2014).

The proponent is committed to mitigate the project-induced impact on the environment (physical and chemical, biological, social and cultural environments). Apart from the generation of the hydroelectric power, the project will provide number of the benefits such as employment of the local people, development of the area, reduction in greenhouse gases generation, and boost in the local economy. The proponent intends to carry out number of activities, such as providing construction related trainings to the local people, counselling on the proper use of the stipulated money along with health and sanitation facilities, support in income generation activities to enhance the livelihood of the project affected people.

Any issues that have not been incorporated in approved EIA/SEIA study and are identified later will be mitigated by the project itself. Number of environmental concerns have to be reflected in the contract clauses. Hence, the provisions of approved EIA (2014) and proposed SEIA report must be included in the detailed design and the tender document, so that they are implemented. An EMU has been established within the project organization. The unit is responsible for the environmental monitoring as envisaged in this report. Apart from this unity, inter-ministerial monitoring team having representative from the MoFE, DoE, DNPWC and DoED will be formed, to make an overview of the Environment Management Unit activities.

The identified and perceived impacts of the project are small as compared to the project's benefits. All of the identified and perceived impacts can be minimize to acceptable level by the employment of the prescribed cost effective and practical mitigation measures. The environmental enhancement measures proposed for implementation by the project, targeting the affected communities will help to upgrade the quality of life of the affected communities. In view of the above considerations, proponent will commit and take responsibility of the proposed mitigation enhancement measures and CSP will be implemented. Environmental audit will be carried out with no limitation, as per the Environmental Management Plan prescribed in approved EIA (2014) and proposed SEIA report.

The overall conclusion of this study is that the substantial benefits of this project to the government, economy and people of the region outweigh the project's relatively minor residual impacts. UM-1 HPP will also adopt an environmental management plan as stated earlier and conduct a robust environmental and social monitoring program. Hence, from the environmental and social perspectives, the proposed project is similar to that of approved EIA (2014) with slight and minor changes. The mitigation measures prescribed for the implementation and ensured by the proponent adds to the environmental safety of the project area. It is recommended to approve the supplementary EIA of proposed project, in conditions that the environmental mitigation, enhancement, monitoring and auditing is implemented by the proponent, as per the environmental management plan prescribed by the approved EIA (2014) and the proposed report.



## References

Baral, R. (2018) Birds of Annapurna Conservation Area. NTNC, Annapurna Conservation Area Project, Pokhara, Nepal.

Baral, R., Subedi, A. and Yadav, S.K. (2019) Wild Mammals of Annapurna Conservation Area. NTNC, Annapurna Conservation Area Project, Pokhara, Nepal.

Chave, J., M. Réjou-Méchain, A. Búrques, E. Chidumayo, M.S. Colgan, W.B.C. Delitti, A. Duque, T. Eid, P.M. Rearnside, R.C. Goodman, M. Henry, A. Martínez-Yrizar, W.A. Mugasha, H.C. Muller-Landau, M. Mencuccini, B.W. Nelson, A. Ngomanda, E.M. Nogueira, E. Ortiz-Malavassi, R. Péliissier, P. Ploton, C.M. Ryan, J.G. Saldarriaga, G. Vieilledent (2014). *Improved allometric models to estimate the aboveground biomass of tropical trees*. Global Change Biology 12629.

Dhital, M.R. (2015). Geology of the Nepal Himalaya: Regional Perspective of the Classic Collided Orogen. Springer. UK.

FRTC, 2019 Field Manual, 2019 (Remeasurement of Permanent Sample Plot), Forest Resource Assessment (FRA), Forest Reserch & Training Center (FRTC), Nepal.

Grimmett, R., C. Inskipp, T. Inskipp & H.S. Baral (2016). Birds of Nepal. Christopher Helm, London.

RajBhandari, K.R. and Rai, S.(2017). *A Handbook of Flowering Plants of Nepal Volume I*. Department of Plant Resources, Nepal.

RajBhandari, K.R. and Rai, S.(2019). *A Handbook of Flowering Plants of Nepal Volume II*. Department of Plant Resources, Nepal.

Shah, K. B., and Tiwari, S. (2004). Herpetofauna of Nepal. A Conservation Companion. Kathmandu, Nepal: IUCN Nepal—The World Conservation Union.

Shrestha, J. (1994). *Fishes, fishing implements and methods of Nepal*. Smt. M.D. Gupta, Lalitpur Colony, Lashkar (Gwalior), India. 150 p.

Subedi, B.P., Pandey, S.S., Pandey, A; Rana, EB; Bhattarai, S; Banskota, TR; Charmakar, S; Tamrakar, R. (2010) Guidelines for measuring carbon stocks in community-managed forests. ANSAB, FECOFUN, ICIMOD, NORAD.

Sutherland, W. J., A. S. Pullin, P. M. Dolman, and T. M. Knight. (1997). *The need for evidence-based conservation*. Trends in Ecology & Evolution 19:305–308.

Upreti BR. 2009. Nepal from War to Peace: Legacies of the Past and Hopes for Future. New Delhi: Adroit Publishers.