वि.सं. १९५८ देखि
निरन्तर प्रकाशित,
बहुभाषी राष्ट्रिय दैनिक

हाम्रो गौरव, राष्ट्रको पत्रिका

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सर्वे भवन्तु सुखिनः सर्वे सन्तु निरामयाः । सर्वे भद्राणि पश्यन्तु मा कश्चिद दुःखभाग्जनः ।

नेपाल सरकार

वन तथा वातावरण मन्त्रालय

कोशी प्रदेशस्थित सङ्खुवासभा जिल्लाको भोटखोला गाउँपालिका (वडा नं. २,३,४ र ५) मा निर्माणका लागि प्रस्तावित अपर अरुण जलविद्युत आयोजना (१०६३.३६ मे.वा.) को वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा राय सुझावका लागि आह्वान गरिएको

सार्वजनिक सूचना

प्रथम पटक प्रकाशित मिति : २०८०।०९।२५

श्री अपर अरुण हाइड्रो इलेक्ट्रिक लिमिटेड प्रस्तावक रहेको कोशी प्रदेशस्थित सङ्खुवासभा जिल्लाको भोटखोला गाउँपालिका (वडा नं. २, ३, ४ र ५) मा निर्माणका लागि प्रस्तावित **अपर अरुण जलविद्युत आयोजना** (१०६३.३६ मे.वा.) को वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन प्रस्तावकले तयार गरी यस मन्त्रालयमा पेस हुन आएको छ । प्रस्तावित **अपर अरुण जलविद्युत आयोजना** (१०६३.३६ मे.वा.) कोशी प्रदेश अन्तर्गत सङ्खुवासभा जिल्लाको भोटखोला गाउँपालिका (वडा नं. २, ३, ४ र ५) मा निर्माण हुने व्यहोरा प्राप्त प्रतिवेदनमा उल्लेख गरिएको छ । यस आयोजनाको जलाशयको पानीको सतहको क्षेत्रफल २०.१ हेक्टर हुनेछ । ड्यामको उचाइ १०० मिटर र ड्याम क्रेस्ट लम्बाइ (Dam Crest Length) १८३ मिटरको निर्माण गरिनेछ र बाँधको साथिल्लो भागको चौडाइ १५ मिटर हुनेछ । २३०.०५ मि. *२५.७ मि. *५९.४३ मि. को भूमिगत जलविद्युत गृह निर्माण गरिनेछ । यस आयोजनाको ग्रस हेड ५५० मिटर रहेको छ । यस जलविद्युत आयोजनाको वार्षिक ऊर्जा उत्पादन ४,५४९.५७ गिगावाट घण्टा रहेको छ ।

प्रस्तावित आयोजनाका मुख्य संरचनाहरूमा जलाशय, बाँध, स्पिलवे, इन्टेक, हेडरेस टनेल, सर्ज टैंक, ड्रप साफ्ट, विद्युतगृह, टेलरेस टनेल आदि पर्दछन् । यस आयोजनाको इन्टेकको जलाधार क्षेत्र २५,७०० वर्ग कि.मि. क्षेत्रफलमा फैलिएको छ । आयोजनामा ९,२६५ मिटर लम्बाइको हेडरेस टनेल प्रणाली निर्माण गरिनेछ र ५२० मिटर लम्बाइका ३ वटा ड्रप साफ्टहरू रहेको प्रतिवेदनमा उल्लेख गरिएको छ । प्रस्तावित आयोजना निर्माणका लागि १३६.५२ हेक्टर जग्गा आवश्यक पर्दछ । यसमध्ये वन क्षेत्र ७३.३१ हेक्टर (सरकारद्वारा व्यवस्थित वन क्षेत्र ४०.०७ हेक्टर, सामुदायिक वन क्षेत्र ११.६२ हेक्टर तथा सकालु वरुण राष्ट्रिय निकुञ्जको मध्यवर्ती क्षेत्र २१.६२ हेक्टर) र ६३.५१ हेक्टर निजी जग्गा आवश्यक पर्ने व्यहोरा प्रतिवेदनमा उल्लेख गरिएको छ । सङ्खुवासभा जिल्लाको भोटखोला गाउँपालिका (वडा नं. २, ३ र ४) मा पानी बहाव कम हुने क्षेत्र (Reduced Flow Zone) पर्ने प्रतिवेदनमा उल्लेख गरिएको छ ।

वातावरण संरक्षण नियमावली, २०७७ को नियम ९ को उपनियम (६) बमोजिम यस प्रतिवेदनमा राय-सुझाव दिनका लागि सर्वसाधारणले प्रतिवेदन पढ्न वा उतार गरी लैजान पाउने व्यवस्था रहेकोले श्री अपर अरुण हाइड्रो इलेक्ट्रिक लिमिटेड प्रस्तावक रहेको **अपर अरुण जलविद्युत आयोजना** (१०६३.३६ मे.वा.) निर्माण गर्ने प्रस्तावको वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन देहाय बमोजिमका स्थानहरूमा सार्वजनिक गरिएको र वन तथा वातावरण मन्त्रालयको Web Site: www.mofe.gov.np मा समेत सार्वजनिक गरिएको छ । प्रतिवेदनमा उपयुक्त राय सुझाव प्राप्त भएमा यस मन्त्रालयले उक्त प्रस्ताव कार्यान्वयनका लागि स्वीकृति दिने क्रममा त्यस्ता राय सुझावहरूलाई समेत ध्यानमा राख्निनेछ । उक्त प्रतिवेदन सम्बन्धमा सर्वसाधारण व्यक्ति वा संस्थाको कुनै राय सुझाव भए यो सूचना प्रथम पटक प्रकाशन भएको मितिले सात (७) दिनभित्र आफ्नो राय सुझाव निम्न ठेगानामा पठाइदिनुहुन यसै सूचनाद्वारा आह्वान गरिन्छ ।

प्रतिवेदन हेर्न वा उतार गर्न सकिने स्थानहरू:-

श्री वन अनुसन्धान तथा प्रशिक्षण केन्द्रको पुस्तकालय, बबरमहल, काठमाडौं ।
श्री त्रिभुवन विश्वविद्यालयको केन्द्रीय पुस्तकालय, कीर्तिपुर, काठमाडौं ।
श्री नेपाल राष्ट्रिय पुस्तकालय, हरिहर भवन, काठमाडौं ।
श्री ऊर्जा जलस्रोत तथा सिँचाइ मन्त्रालयको कार्यालय, सिंहदरबार, काठमाडौं ।
श्री जिल्ला समन्वय समितिको कार्यालय, खाँदबारी, सङ्खुवासभा ।
श्री भोटखोला गाउँपालिकाको कार्यालय, हटिया, सङ्खुवासभा ।

राय सुझाव पठाउने ठेगाना

वन तथा वातावरण मन्त्रालय,
वातावरण प्रभाव मूल्याङ्कन शाखा
सिंहदरबार, काठमाडौं ।
फोन नं. ०१-४२११५६७, ४२११६३८
फ्याक्स नं. ०१-४२११८६८

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
OF THE UPPER ARUN HYDROELECTIRC PROJECT (1063.36 MW)

Bhotkhola Rural Municipality, Sankhuwasabha District
Koshi Province, Nepal

(VOLUME I: MAIN REPORT)

Submitted to:
Ministry of Forests and Environment
Through
Ministry of Energy, Water Resources and Irrigation
and
Department of Electricity Development

Submitted by:
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August, 2023

कार्यकारी सारांश

ES१ - आयोजनाको प्रस्तावक

नेपाल सरकार मन्त्री परिषद्को मिति २०७५/०६/०५ गतेको बैठक अनुसार अपर अरुण जलविद्युत आयोजनालाई नेपाल विद्युत प्राधिकरणको सहायक कम्पनि अपर अरुण हाइड्रोइलेक्ट्रिक लिमिटेड मार्फत प्रवर्धन गर्ने निर्णय भएको थियो। यस आयोजनको वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन अन्तराष्ट्रिय ख्याति प्राप्त परामर्शदाता कम्पनी Environmental Resources Management (ERM) ले स्थानीय परामर्शदाता संस्था नेपाल इन्भाईरोनमेन्टल एण्ड साइनटिफिक सर्भिसेज प्रा. लि. र टोटल म्यानेजमेन्ट सर्भिसेज प्रा. लि. को सहयोगमा तयार गरेको छ|

ES२ - आयोजनाको विवरण

अपर अरुण जलविद्युत आयोजना आयोजना कोशी प्रदेश अन्तर्गत संखुवासभा जिल्लाको भोटखोला गाउँपालिकामा पर्दछ । प्रस्तावित आयोजना काठमाडौंबाट करीब २०० कि.मी. पूर्वमा, कोशी प्रदेश को राजधानी विराटनगरबाट करीब १४० कि.मी. उत्तरमा, जिल्ला सदरमुकाम खाँदबारीबाट ४० कि.मी. उत्तर र चिनियाँ सिमानाबाट १० कि.मी. दक्षिणमा पर्दछ।

यस आयोजनाले अरुण नदीमा १०० मी. अग्लो बाँध निर्माण गर्नेछ जसको कारण करीब २०.१ हेक्टर क्षेत्र जलाशय (समुन्द्री सतहबाट १६४० मि.) बन्ने छ। उक्त पानीलाई सुरुङ्गको माध्यमबाट विद्युतगृहमा पठाई १०६३.६३ मे.वा. (इको फ्लो पावर स्टेशन सहित) बाट वार्षिक औसत ४५४९.५७ गिगावाट घण्टा उर्जा उत्पादन गरिने छ। अरुण नदीबाट विद्युतगृहसम्म सुरुङ्ग मार्फत पानी फर्काउँदा करीब १६.४५ कि.मी. (बाँध र विद्युतगृहको नदीको भाग) मा पानीको बहाव कम हुन्छ।

यो आयोजना बनाउँदा बाँध, सुरुङ्ग, अडिट र विद्युतगृह क्षेत्रमा विभिन्न सहायक संरचानाहरु बनाउनु पर्ने हुन्छ । उक्त सहायक सरंचनाहरुमा २ वटा प्रवर्द्धकको क्याम्प, ४ वटा निर्माण व्यवसायीको लागि क्याम्प, ३ वटा विद्युतको लागि आवश्यक पर्ने संयन्त्र/जेनेरेटर, २ वटा पानीको आपूर्ति तथा वितरण केन्द्र, ४ वटा फोहर पानी प्रशोधन केन्द्र, चेपुवा खानी, ५ वटा अन्य साना खानीहरु, पहुँच सडकहरु, माटो ल्याउने क्षेत्र, क्रसर प्लान्टहरु, २ वटा व्याचिङ प्लान्ट, २ वटा मर्मत कार्यशाला, २ वटा फ्याब्रिकेशन सप, ४ वटा बिग्रन बिसर्जन क्षेत्र, इन्धन डिपो र बंकर भवन आदि रहेका छन्। नदीको जल प्रवाह आयोजनाको लागि आवश्यक हाइड्रोलिक क्षमता भन्दा कम भएको अवस्थामा Peaking Run- Of- River (PROR) मोडलमा संचालन हुनेछ।

ES३ - अध्ययन विधि

वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन तयार गर्दा वातावरण संरक्षण ऐन २०७६, वातावरण संरक्षण नियमावली २०७७ र राष्ट्रिय वातावरणीय प्रभाव मूल्याङ्कन निर्देशिका २०५० को पुनरावलोकन गरिएको थियो। साथै विभिन्न सन्दर्भ सामग्रीहरुको पुनरावलोकन, आयोजना क्षेत्रको भू—गर्भ, भू—उपयोग, माटो, जलवायु, हावा, पानी, ध्वनीको गुणस्तर, नदीमा थिग्रानको अवस्था र वहाव, जैविक विविधता, सामाजिक—आर्थिक अवस्था, सामुदायिक स्वास्थ्य, आदिवासी जनजाती, लैङ्गिक र धार्मिक, साँस्कृतिक वातावरणको बारेमा स्थलगत तथ्याङ्क संकलन संकलन गरिएको थियो। साथै प्रभावहरुको आँकलन, वर्गिकरण र सकारात्मक प्रभावहरुको बढोत्तरी र नकारात्मक प्रभावहरुको न्यूनीकरणका उपायहरु, सरोकारवालाहरको संलग्नता र सहभागिता बारे अध्ययन गरिएको छ।

ES४ - प्रस्तावसँग सम्बन्धित नीति, कानून तथा मापदण्ड

वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन कार्यान्वयन गर्दा आकर्षित हुने नीति, ऐन, नियम, निर्देशिका, मापदण्ड तथा अन्तराष्ट्रिय सन्धि, सम्झौता पुनरावलोकन गरी उल्लेख गरिएको छ। आयोजनाबाट यसको पूर्ण पालना हुनेछ।

ES५ - विद्यमान वातावरणीय अवस्था

ES५.१- भौतिक वातावरणीय अवस्था

प्रस्तावित आयोजना उच्च हिमाली भौगोलिक क्षेत्र अन्तर्गत पर्दछ। आयोजनाको हेडवर्क क्षेत्र २०१० मी. र विद्युतगृह १०६५ मी. उचाईमा रहेको यस आयोजना Sub- tropical १२०० मी. र temperate १२००—२४०० मी. को जलवायु छ। जाडो महिनामा चिसो र आयोजनाको माथिल्लो भेगमा कहिलेकाहीं हिउँ समेत पर्दछ भने गृष्म कृतुमा गर्मी अनुभव हुन्छ। बाँध क्षेत्रमा अरुण नदीको जलाधार २५,७०० वर्ग कि.मी. जुन सिधै ठाडो भिरालो र गहिरो खोंच छ। अरुण नदीले धेरै मात्रामा थिग्रानहरु बगाएर ल्याउँदछ । आयोजना क्षेत्रमा पाइने सेडिमेन्टहरु तुलनात्मक रुपमा मसिना < ५० cm, अम्लीय, राम्रोसँग पानी छिर्ने, लोमी प्रकारको बालुवा (जैविक पदार्थ यथेष्ट भएको) र माटोमा पौष्टिक तत्व बढी भएको पाइन्छ। यो क्षेत्रमा धेरै झरना र सानातिना खोल्सीहरु छन् जसले ठाडो भू—भाग र जमिन मुनीको चट्टानको तह कम गहिराइमा भएको देखाउँदछ। आयोजना स्थलमा मापन गरिएको हावा र पानीको गुणस्तर नेपाल सरकारले तोकेको मापदण्ड भित्रै पर्दछ।

ES५.२- जैविक वातावरणीय अवस्था

आयोजना क्षेत्र विशेषत जंगल, साना गाउँका भू-भागहरु र सोको कृषि योग्य जमिनहरु रहेको क्षेत्रमा पर्दछ। आयोजनको प्रत्यक्ष प्रभावित क्षेत्रमा ४ प्रजातिका जंगलहरु पाइन्छन् । उतिस— चिलाउनेको मिश्रित जंगल, अंगेरी— लालीगुराँस, उतिस—सल्ला र उतिस—कटुस—अंगेरी आदि पाइन्छन्। आयोजना

क्षेत्रमा ८ वटा सामुदायिक वनहरु पर्दछन्। अरुण नदीको दाँया भागमा पर्ने आयोजनाको बाँधस्थल, जलाशय क्षेत्र तथा वहाव कम भएको क्षेत्रहरु मकालु राष्ट्रिय निकुञ्जको मध्यवर्ती क्षेत्र भित्र पर्दछ।

अरुण खोलाको पानी चिसो, धमिलो, तिब्र वहाव भएको र तुलनात्मक रुपमा सिमित मात्रामा मात्र पर्यावरणीय महत्व भएका र जलिय जीवहरु समेत तल्लो तटीय भागहरुमा भन्दा कम मात्रामा पाइन्छन्। पानी तातो हुने सहायक नदीहरुमा माछाहरुको प्रजनन् र वृद्धि विकासको लागि उपयुक्त हुन्छ तर मूख्य अरुण नदीमा चिसो पानी हुने, पानी तिब्र गतिमा बहने, पानीको उतार चढाव हुने, धमिलो हुनाले गर्दा माछाहरुले फुल पार्ने, प्रजनन् गर्ने र भुरहरुको हुर्कने वातावरण तुलनात्मक रुपमा कम हुन्छ । असला माछा (IUCN VU) प्रशस्त मात्रामा (८०% माछाहरु अध्ययनको क्रममा समातिएको मध्ये) पाइन्छ । यसैगरी माछा प्रजातिहरुमा खोलाको मध्य दुरी सम्म ओहर दोहर गर्ने प्रकारको प्रजाती, तिते (*Psilorhynchus pseudecheneis*, (IUCN LC)) र कत्ले (*Neolissochilus hexagonolepis*, (IUCN NT)) प्रजातिका माछाहरु पाइन्छन्। शहर माछा, The Golden Mahseer (*Tor putitora*, (IUCN EN)) अरुण नदीको तल्लो भागमा पाइन्छ र अरुण —३ जलविद्युत आयोजनको बाँधले गर्दा शहर माछा बाँधको माथिल्लो क्षेत्रमा ओहोरदोहोर गरी अपर अरुण जलविद्युत आयोजना क्षेत्रसम्ममा पुग्ने सम्भावना अत्यन्त न्यून छ।

ES५.३ - सामाजिक–आर्थिक र साँस्कृतिक वातावरण

प्रस्तावित आयोजना भोटखोला गाउँपालिकामा पर्दछ, जहाँ आदिवासी जनजातीहरु कुल जनसंख्याको करीब ९७.६% छन्। भोटखोला गाउँपालिकाका मुख्य जातीहरुमा भोटे (५४.१५%), राई (१५.९७%), तामाङ्ग (११.३७%) र अन्य आदिवासी जनजाती समूहमा (लोमी, शेर्पा, खालिंग, गुरुङ) आदि जनसंख्याको १६.११% रहेका छन् । आयोजना क्षेत्रमा ७४% जनसंख्या कृषि, पशुपालन र वनका स्रोतहरुमा आश्रित छन्। प्रमुख नगदे वालीको रुपमा अलैंची र अन्य वालीहरुमा धान, कोदो, मकै र जौ रहेका छन्। आयोजना क्षेत्रका धेरै परिवारहरु सामुदायिक वन उपभोक्ता समितिका सदस्य छन्। उक्त परिवारहरुले सामुदायिक वनबाट वन पैदवारहरु प्राप्त गर्दछन्। यो एउटा जिविकामुखी प्रणालीको आधार भएको छ।

समग्रमा आयोजना क्षेत्रको धेरै जसो स्थानमा सामुदायिक सेवा सुविधा र भौतिक संरचनाहरुको विकास कमजोर रहेको छ । त्यसका साथै आयोजना क्षेत्रमा सडकको पहुँच कमजोर रहेको छ। यो आयोजना क्षेत्रमा फोहोरमैला संकलन र व्यवस्थापन छैन। स्थानीय झरना र खोल्सीहरुको पानीबाट खानेपानीको आवश्यकता पुरा गरिन्छ। आयोजना क्षेत्र नजिकै प्रहरी, सैनिक चेक पोष्ट र स्वास्थ्य सेवा प्रदायक संस्थाहरु छन्। प्रायजसो घरधूरीहरुमा स्थानिय स्तरमा संचालित लघु जलविद्युत आयोजनाबाट दैनिक

केहि घण्टा विद्युत उपलब्ध हुन्छ। आयोजना क्षेत्रमा मुख्य इन्धनको रुपमा खाना पकाउनको लागि दाउराको प्रयोग हुन्छ।

आयोजना क्षेत्रमा राष्ट्रिय रुपमा नै घोषित सांस्कृतिक महत्वका स्थान छैनन्। तथापी आयोजना क्षेत्रमा स्थानीय स्तरमा महत्व रहेका मूर्त र अमूर्त रुपमा रहेका सांस्कृतिक सम्पदाहरु जस्तै, गोमपा, छेरतेन, माने, देवीस्थान, नागस्थान र चौतारीहरु छन्। आयोजना क्षेत्रका प्रत्येक जातजातीले आफ्नै प्रकारको बृहत ढंगको अर्मूत सांस्कृतिक महत्वका विषयहरु सम्बन्धित रहेको पाइन्छ। चाडपर्व, परम्परा, जन्मदा र मृत्यु हुँदा गर्ने संस्कार यहाँको समुदायमा रहने जातजातिहरुमा आधारित छ। प्रत्यक्ष प्रभावित क्षेत्रमा रहने घरधुरीहरु अध्यात्मिक ढंगले जमिन, पहाड, जंगल, देवी, देवता, भूत प्रेत पिचास आदिमा विश्वास गर्दछन् । यिनै तत्वहरुले गर्दा परिवारको स्वास्थ्य, समृद्धी, राम्रो फसलको उत्पादन आदि हुने कुरामा समेत विश्वास राख्दछन् । प्राकृतिक रुपमा रहेका केहि सांस्कृतिक महत्वका स्थानहरु समेत आयोजना स्थलमा पर्दछन् । जसमध्ये तातोपानी कुण्ड (हटिया नजिकै), अरुण—बरुण दोभान (बरुण मेलाको लागि बरुण बजार) र भेगभेगमा पानीको झांगो (अरुण आयोजनाको बाँध भन्दा तल्लो भागमा) प्रमुख हुन्।

ES६- विकल्पको विश्लेषण

तल उल्लेखित विकल्पहरुको मूल्यांकन आयोजनाको प्राविधिक , आर्थिक, वातावरणीय र सामाजिक मापदण्ड भित्र रहेर गरिएको छ। यसैको आधारमा डिजाइन, निर्माण प्रक्रिया, संचालन प्रक्रिया तय भएका छन्। प्रतिवेदनमा निम्न विकल्पहरुको विश्लेषण समावेश गरिएको छः

- आयोजना बिनाको विकल्प
- स्थान, र संरचना, सहयोगी संरचनाहरुको विकल्प
- प्रणालीको बारेमा विकल्प
- डिजाइन/प्रविधिको विकल्प
- वन फडानी नगर्ने विकल्प
- निर्माणका विकल्पहरु
- संचालनका विकल्पहरु

ES७- वातावरणीय प्रभावहरु

ES७.१ सकारात्मक प्रभावहरू

करिब ४५०० जनालाई रोजगारी, उद्यम विकासमा वृद्धि, प्राविधिक सीपको अभिवृद्धि र आर्थिक गतिविधिमा बृद्धि निर्माण चरणमा पहिचान गरिएका सकारात्मक प्रभावहरु हुन् । सञ्चालन चरणको सकारात्मक प्रभावमा ४५४९.५७ GWh स्वच्छ नवीकरणीय ऊर्जा उत्पादन, विद्युत केन्द्र सञ्चालनका

लागि १३० जनालाई रोजगारी, मर्मतसम्भार कार्यका लागि आवधिक रोजगारी र राजस्व उत्पादन समावेश छ।

ES७.२ प्रतिकूल प्रभावहरू

क) भौतिक वातावरणीय प्रभावहरु

आयोजनाले करीब १३६.८२ हेक्टर जमिनमा असर गर्दछ, जसमध्य धेरै भिरालो र वर्षयाममा पहिरो जाने सम्भावना समेत रहेको छ । आयोजनाको मुख्य सुरुङ्ग निर्माण गरी फल्ट र चिरिएको क्षेत्रहरुबाट पानी बाहिर निस्कदा जमिन मुनिको पानीको सतह घट्दछ तसर्थ खोल्सी र झरनाहरुमा पानीको बहाव कम हुन सक्दछ । अरुण नदीमा थिग्रानबाट हुने समस्या हुन नदिन आयोजनाले थिग्रान व्यवस्थापन कार्य गर्नेछ । अरुण नदीमा कुनै किसिमको औधोगिक फोहरहरुको विसर्जन नहुने र stratification अथवा eutrophication (रासायनिक यौगिक बनेर नदीमा हुने असर) को सम्भावना रहँदैन।

आयोजनाको निर्माणको चरणमा हानीकारक बस्तुहरुको ढूवानी, भण्डारण र प्रयोग गर्नुपर्ने हुन्छ । यस क्रममा हुने चुहावटलाई पूर्ण रुपमा नकार्न सकिदैन तसर्थ यसलाई आयोजनाले सुरक्षित ढंगले उचित र तोकिएको ठाउँमा व्यवस्थापन गर्नेछ। आयोजना निर्माणको चरणमा निस्कने फोहरहरुलाई पुन प्रयोग, रिसाइकल र उचित ठाउँमा विसर्जन गर्न स्थानीय गा.पा.हरु तथा खांदबारी न.पा. सँग आवश्यक समन्वय गरिने छ।

आयोजनाले निर्माण चरणमा प्रयोग हुने ३ वटा डिजेल जेनेरेटर, निर्माण चरणमा प्रयोग हुने सवारीसाधनहरु, धुलोहरु नै वायु प्रदुषणका श्रोतहरु हुनेछन्। आयोजना सञ्चालन चरणमा सवारी साधनहरुबाट निस्कने वायु प्रदुषण बाहेक अन्य श्रोतबाट वायु प्रदूषण हुँदैन। आयोजना निर्माणको चरणमा ध्वनि प्रदुषण हुन्छ जसले आयोजना वरपरका रुकुमा जस्ता गाउँ बस्तीहरुलाई असर गर्दछ।

प्राकृतिक र ग्रामिण कृषिमा आधारित आयोजना क्षेत्रका परिदृष्यहरुमा आयोजनाका संरचाहरु निर्माण गर्दा स्थायी प्रभाव पार्नेछ।

ख) जैविक वातावरणीय प्रभाव

आयोजनाका लागि ४०.०७ हेक्टर सरकारद्धारा व्यवस्थित वन, ११.६२ हेक्टर सामुदायिक वन र २१.६२ हेक्टर मकालु बरुण मध्यवर्ती वन क्षेत्र गरी ७३.३१ वनक्षेत्र जग्गा आवश्यक हुनेछ । आयोजना कार्यान्वयनको समयमा १४ हजार ४३६ पोल साइज र ३ हजार ४२८ रुख गरी १७ हजार ८६४ रुख काटिनेछ । काट्नुपर्ने कुल रुखमध्ये (१७८६४ नं.) ८३९५ सरकारद्धारा व्यवस्थित वन र ४१८४ र ५२८५ सामुदायिक वन र मध्यवर्तीक्षेत्र वनबाट रहेका छन्।

आयोजना निर्माणको चरणमा प्राणीहरुको वासस्थानमा पर्ने असरले गर्दा हिमालयन कालो भालु (IUCN Vulnerable) र चाइनिज पेंगोलिन (IUCN Critically Endangered) लाई असर पर्ने देखिन्छ । आयोजना प्रभावित क्षेत्रमा हिमालयन रेड पाण्डा (IUCN Endangered) र कालो कस्तुरी मृग (IUCN Endangered) नभएता पनि आयोजना क्षेत्र नजिकको उच्च भू-भागमा पाइन्छ। यद्यपि आयोजनाको कारणले गर्दा रेड पाण्डा र मृगको शिकार हुने सम्भावना रहन्छ।

यस आयोजनाको बाँधको माथिल्लो भागमा जलाशय निर्माण हुने हुँदा नदीमा आधारित जलीय प्राणीहरुको वासस्थानलाई तालको वासस्थानको रुपमा परिणत गर्नेछ। बाँध क्षेत्रबाट विद्युतगृहमा पानी पर्काउदा नदीको करीब १६.४५ कि.मी. भागमा जलीय प्राणीहरुको वासस्थानलाई असर पर्दछ । अरुण नदीको जलीय वासस्थानमा यस आयोजनाले मात्र नभई उक्त नदीको पानी धेरै चिसो, धमिलो, तीव्र बहावमा बग्ने हुँदा माछाको प्रजाती र संख्या कम हुने कारण हुन सक्दछ । तसर्थ जलीय वासस्थानमा पर्ने प्रभावले मात्र माछाको संखायालाई असर पार्दैन । यस आयोजनाको बाँधले असल माछाहरुलाई बाँधको माथि तर्फ जान अवरोध गर्दछ । आयोजना PRoR मोडलमा नोभेम्बर देखि मे महिनासम्म संचालन हुँदा विद्युतगृह भन्दा तल्लो भागमा पानीको प्रवाहमा उतार चढाव आउँदछ, जसले गर्दा जलीय वासस्थानमा हुने प्राणीहरुलाई असर पर्न सक्दछ । तर गहिरो नदीको भू-भाग भएको हुनाले यो असर ज्यादै न्यून हुन्छ।

ग) सामाजिक, आर्थिक र साँस्कृतिक वातावरण

आयोजना निर्माणका लागि कुल ३१.०३ हेक्टर खेतीयोग्य जमिन, ३१.९७ हेक्टर खरबारी र ०.५१ हेक्टर बाँझो रहेको गरी ६३.५१ हेक्टर निजी जग्गा अधिग्रहण गर्नेछ । जग्गा अधिग्रहणले ३२६ घरधुरीलाई असर गर्ने र आवासीय संरचना अधिग्रहणका कारण १३ घरधुरी भौतिक रूपमा विस्थापित हुनेछन् । आयोजनाको निर्माणको चरणमा करीब ४,५०० कामदारहरुको आगमनले पर्यावरणीय प्रणाली र स्वास्थ्य चौकी जस्ता स्थानीय पूर्वाधारहरुमा असर पर्दछ।

अन्य आयोजनासँग सम्बन्धित सामाजिक सवालहरु निम्न प्रकारका हुनेछन्:

- आयोजनामा कामदार छनौट र भर्ना प्रक्रियासँग सम्बन्धित
- सरसफाईको कमी र सरुवारोगको प्रकोपका सम्भावना
- स्थानीय स्तरमा उत्पादन हुने अन्य सामान र सेवाको मूल्यमा वृद्धि
- यौनजन्य क्रियाकलापमा वृद्धिका सम्भावना, लैंगिक विभेद, हिंसा, अपराधिक क्रियाकलापहरुमा वृद्धि हुने सम्भावना
- सुरक्षा निकायहरुबाट अनावश्यक बल प्रयोग हुने सम्भावना
- बाह्य कामदारहरुको आगमनले स्थानीय परम्परागत ज्ञान, कला, संस्कृति, रितीरिवाज, धर्ममा पर्ने सम्भावित प्रभाव

- बाह्य मानिसहरुको अत्याधिक आगमनले चाडवाड मनाउने ठाउँहरु, धार्मिक स्थलहरुमा भिडभाडका सम्भावनाहरु
- यातायात र सडक सुरक्षा सम्बन्धि सवालहरु
- आयोजनाले केहि स्थानीय स्तरका महत्वपूर्ण छोरटेन, देवीस्थानमा प्रभाव पार्ने साथै प्रकृतिक स्रोतहरु जस्तैः झरनाहरुमा समेत असर पर्दछ ।

ES८- सकारात्मक प्रभावहरुको बढोत्तरी र नकारात्मक प्रभावहरुको न्यूनीकरणका उपायहरु

आयोजना कार्यान्वयनका कारण पहिचान भएका सकारात्मक प्रभावहरूलाई बढाउन अभिवृद्धिका उपायहरू प्रस्ताव गरिएको छ। प्रतिकूल प्रभावहरू न्यूनीकरण गर्न रोकथाम, बचाउ गर्ने उपाय र न्यूनीकरणका उपायहरू प्रस्ताव गरिएको छ। आयोजना प्रस्तावकले सम्बन्धित सरोकारवालाहरूसँगको समन्वयमा प्रमुख जिम्मेवारीको रूपमा प्रस्तावित न्यूनीकरण र अभिवृद्धिका उपायहरू कार्यान्वयन गर्नेछ।

बोलपत्र कागजात अन्तर्गत उपयुक्त टेन्डरका सर्तहरूमा समावेश गरी ठेकेदारको जिम्मेवारी अन्तर्गत उल्लेख गरिएका न्यूनीकरण र अभिवृद्धिका उपायहरू सुनिश्चित गरिनेछ। प्रस्तावकले सामाजिक-सांस्कृतिक विकास, आर्थिक विकास, पूर्वाधार विकास र क्षमता अभिवृद्धि अन्तर्गतका गतिविधिहरूलाई समेट्ने सामुदायिक सहयोग कार्यक्रम पनि लागू गर्नेछ। न्यूनीकरण र अभिवृद्धिका उपायहरूको लागि अनुमानित लागत ने.रु. २९४२.०९ मिलियन रहेको छ । उक्त लागत अन्तर्गत आयोजना क्षेत्रमा जग्गा, घर र निजी बिरुवाको क्षतिपूर्ति वृक्षारोपण, सचेतना कार्यक्रम, सुधारका उपायहरू, पुनर्स्थापना गतिविधिहरू र सामुदायिक सहयोग कार्यक्रम समावेश छ।

ES९- वातावरणीय अनुगमन

वातावरण संरक्षण नियमावली २०७७ को धारा ४५(१) ले प्रस्तावकले प्रस्तावको निर्माण तथा संचालन चरणमा सो बाट वातावरणमा परेको प्रभावको प्रत्येक ६ महिनामा स्वः अनुगमन गरी सोको प्रतिवेदन सम्बन्धित निकाय वा विभागमा पेश गर्नु पर्नेछ। यस अन्तर्गत आयोजनाले प्रारम्भिक अवस्थाको अनुगमन, प्रभाव अनुगमन, नियमपालक अनुगमन गर्नेछ। आयोजनाको वातावरणीय अनुगमन फ्रेमवर्क (Framework) ले निर्माण र संचालन चरणमा हुने गतिविधिहरुलाई वातावरणीय प्रभाव मूल्याङ्कनले तोके अनुसार गर्न र प्रत्यक्ष तथा अप्रत्यक्ष अवशिष्ट प्रभावहरुलाई हुन नदिनु/रोक्नु हो।

ES१०- वातावरणीय परीक्षण

वातावरणीय परीक्षणको उद्देश्य वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा उल्लेख भएका वातावरणीय र सामाजिक प्रभावहरु व्यवस्थापन कार्य योजना अनुरुप कार्यान्वयन भए/नभएको जाँच गर्नु हो ।वातावरणीय परीक्षणले कार्यान्वयन नभएका/पालना नभएका प्रभावहरुलाई उचित रुपमा कार्यान्वयन

गर्न परीक्षणले सुधार गर्नु पर्ने पक्षहरु अन्तर्गत सुझाव दिनेछ। वातावरणीय परीक्षणले आयोजनाका पछिका चरणमा गर्ने परीक्षणहरुलाई आधारभुत तथ्याङ्क उपलब्ध गराउँदछ। साथै, यस प्रकारको परीक्षणले वातावरणीय अनुगमनमा समेत सहयोगीको भूमिका निर्वाह गर्दछ। वन तथा वातावरण मन्त्रालयले आयोजना सम्पन्न भई २ वर्ष भुक्तान भएको मितिले ६ महिना भित्र वातावरणीय परीक्षण गर्नु गर्नेछ। आयोजनाले निर्माण कार्यसँग संलग्न पक्षहरुको समेत काम सम्पन्न भएर हस्तान्तरण भएपछि वातावरणीय परीक्षण गर्दछ।

ES११- निष्कर्ष

अपर अरुण जलविद्युत आयोजनाले नेपालको विद्युतको माग पुरा गर्न ४,५४९.५७ गिगावाट घण्टा स्वच्छ, नवीकरणीय उर्जा उपलब्ध गराउँदछ । आयोजनाले धेरै उर्जा आवश्यक हुने सुख्खा याममा Peaking Run-of- River मोडेलमा संचालन गरेर १२५९.८५ गिगावाट घण्टा उर्जा उत्पादन गर्दछ । यो सुख्खा यामको उर्जा उत्पादन आयोजनाको सुख्खा याममा समेत उपलब्ध हुने प्रवाह र आयोजना Peaking Run-of- River मोडेलमा संचालन हुने भएर सम्भव भएको हो। आयोजनाको निर्माण चरण ६ वर्षको हुनेछ। निर्माण चरणको चरम अवस्थामा करीब ४,५०० जना कामदारहरुको आवश्यकता पर्दछ। साथै आयोजनालाई विभिन्न प्रकारका निर्माण समाग्रीहरु (जस्तैः सिमेन्ट, गिट्टी, बालुवा, छड, आदि) र सहायक सेवाहरुको (खाद्यान्न तथा अन्य आवश्यक सामाग्रीहरुको आपूर्ति) आवश्यकता पर्दछ। यस प्रकारको आवश्यकताले स्थानीय व्यवसायीहरुको लागि व्यापारिक अवसरहरु सृजना गर्नेछ।

अपर अरुण जलविद्युत आयोजनाको निर्माण र सञ्चालनले केही महत्त्वपूर्ण वातावरणीय र सामाजिक प्रभावहरू र जोखिमहरू निम्त्याउनेछ। यी मध्ये केही प्रभावहरूलाई कम गर्न सकिन्छ, तर प्रभावकारी कार्यान्वयन र वातावरणीय र सामाजिक व्यवस्थापन योजनाको अनुगमन आवश्यक पर्दछ। कानुनी रूपमा संरक्षित क्षेत्र (जस्तै, मकालु बरुण राष्ट्रिय निकुन्ज र प्राकृतिक बासस्थानमा महत्त्वपूर्ण अवशिष्ट प्रभावहरु रहनेछन्। कुल वातावरण व्यवस्थापन लागत रु ३१५४.७७ मिलियन हो जुन आयोजनाको कुल लागतको २.१९ प्रतिशत हो।

वातावरणीय प्रभाव मूल्याङ्कनको निष्कर्षमा आयोजनाले नेपाल सरकार, राष्ट्रिय अर्थतन्त्र र नेपाली जनताहरुलाई पर्याप्त लाभहरू प्रदान गर्दछ। तथापी यसको साथै आयोजनाले गर्दा धेरै उल्लेखनीय जोखिम र सम्भावित प्रभावहरू समेत हुन्छन्। यस वातावरणीय प्रभाव मूल्यांकन प्रतिवेदनले आयोजनाको सम्भावित प्रतिकूल प्रभावहरूलाई सम्बोधन गर्न आवश्यक पर्ने न्यूनीकरण र व्यवस्थापन उपायहरूको प्रस्ताव गरेको छ । प्रस्तावित न्यूनीकरण उपायहरूको प्रभावकारी कार्यान्वयनले आयोजना सफल बनाउन महत्वपूर्ण भूमिका राख्दछ। अपर अरुण जलविद्युत आयोजनाले यस वातावरणीय प्रभाव मूल्यांकनमा पहिचान

गरिएका सबै संभावित नकारात्मक प्रभावहरुको न्यूनीकरण/निराकरण, सकारात्मक प्रभावहरुको अभिवृद्धि, अनुगमनका उपायहरु लागु गर्ने प्रतिबद्धता जाहेर गर्दछु।

EXECUTIVE SUMMARY

ES.1 Project Proponent

The Government of Nepal, through a cabinet decision dated 21 September 2018 (2075/06/05), decided to develop the Upper Arun Hydroelectric Project (UAHEP) under a subsidiary company of the Nepal Electricity Authority (NEA), namely the "Upper Arun Hydroelectric Limited" (UAHEL), which is the Project Proponent. Environmental Resources Management (ERM), an international sustainability consulting firm, was selected to prepare this EIA. ERM was supported by Nepal Environmental & Scientific Services Ltd. (NESS) and Total Management Services, Ltd (TMS).

ES.2 Project Description

The Project is in Koshi Province, Sankhuwasabha District, in the Bhotkhola Municipality of eastern Nepal. It lies in a straight line about 200 km east of Kathmandu, 140 km north of the provincial capital at Biratnagar, 40 km north of the district headquarters at Khandbari, and about 10 km south of the Chinese border. The UAHEP will involve the construction of a 100 m high dam on the Arun River, which will form a 20.1-hectare (ha) reservoir at elevation 1,640 m above sea level, a headrace tunnel for transporting water from the reservoir to the powerhouse, and a powerhouse with an authorized capacity of 1063.36 MW (including eflow power station) and an annual average energy generation of 4,549.57 gigawatt-hours. The Project will create a 16.45 km long diversion reach along the Arun River (i.e. the river segment between the dam and the powerhouse), which will experience reduced flows. Construction of the hydropower component will require a variety of ancillary facilities focused in the headworks area, headrace tunnel adit portal area, and powerhouse area, including two owner's camps, four contractor's camps, three power plants, two water plants, four wastewater treatment plants, Chepuwa and five other quarry sites, several borrow areas, a crushing plant, two batching plants, two fabrication shops, two maintenance shops, four spoil disposal areas, a fuel depot, and an explosives magazine. The project will operate in a peaking run-of-river (PROR) mode when flows are below the hydraulic capacity of the project. During these periods, flow will be stored in the reservoir and then released during a six-hour period to generate power during peak electricity demand periods.

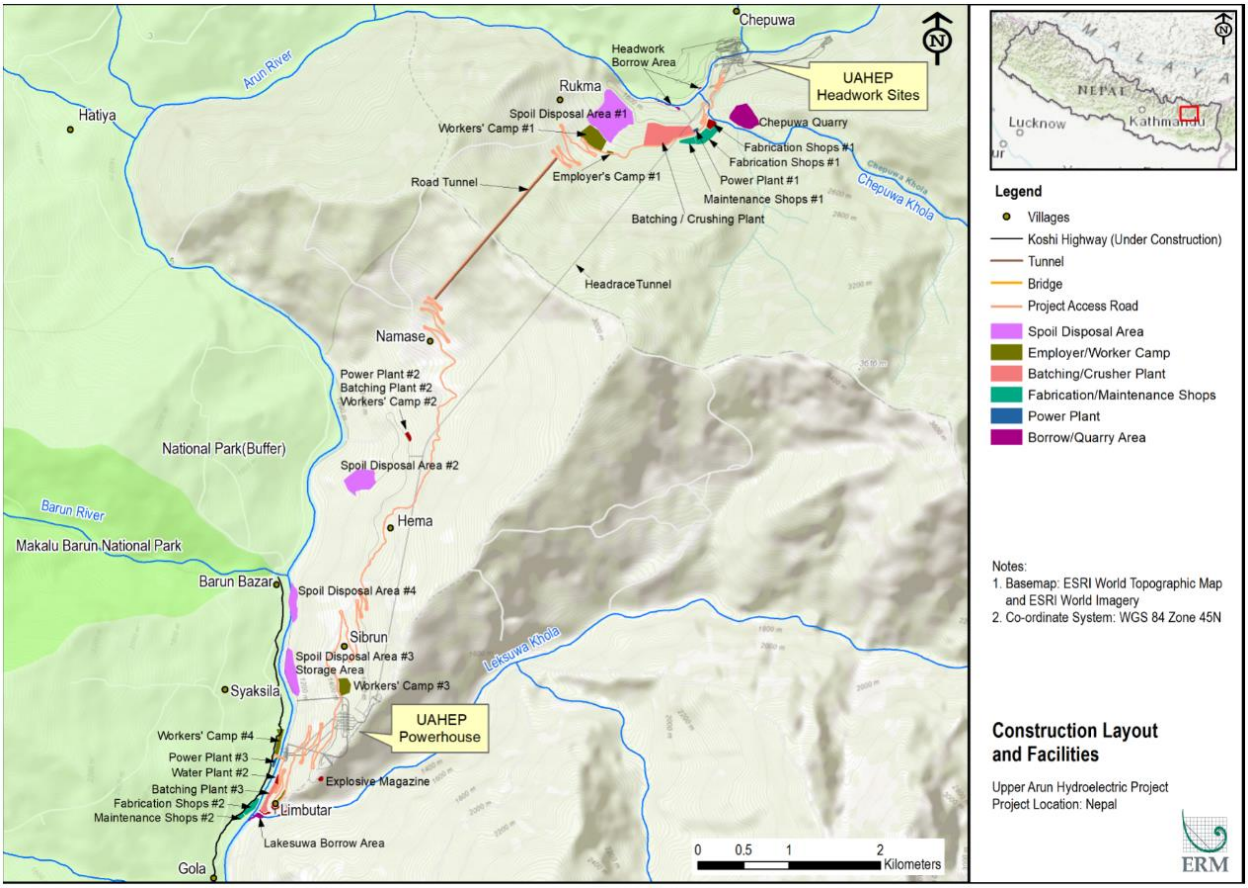

Figure ES-1: Project Layout and Facilities

ES.3 Study Methodology

The EIA process has followed the Environmental Protection Act (2076), Environmental Protection Rules (2077) and the National EIA Guidelines (2050), including a literature review, primary data collection (including topography, geology, soils, hydrology, sediment transport, water quality, air quality, noise, biodiversity, socioeconomics, community health, indigenous peoples, gender, and cultural heritage), impact identification, development of mitigation measures, stakeholder engagement, and appropriate disclosure of the EIA and its conclusions.

ES.4 Review of Policies and Legal Provisions

UAHEL will be responsible for fulfilling the provisions of all relevant acts, rules, regulations, policies, guidelines, and conventions while implementing this project. Chapter 4 of this EIA describes the administrative framework applicable to the project.

ES.5 Existing Environmental Conditions

ES5.1 Physical Environment Conditions

The Project lies within the High Mountain physiographic zone in Nepal, with the project footprint located between elevations 1,065 (near powerhouse tailrace) and 2,010 m (in the headworks area). From a climate perspective, the Project is located in the sub-tropical (up to 1200 m) and temperate (1200 – 2400 m) climatic zones, with cool to cold winters and occasional snowfall at the upper elevations, and warm summers. The area has distinct wet and dry seasons. The Arun River at the dam site has a drainage area of 25,700 km^2 with a deeply incised gorge with steep slopes rising directly up from the riverbanks. The Arun River transports a high sediment load. Project soils are relatively thin (<50 cm), acidic, well drained, loamy sands with high organic matter content and

relatively rich in nutrients, with shallow depth to bedrock. There are many springs and small streams found in the area reflecting the steep topography and shallow depth to bedrock. Ambient air quality and water quality are good.

ES5.2 Biological Environment Conditions

The project area is primarily forest with small villages and associated agricultural land in areas with less steep topography. Four distinct forest communities are found within the DIA - *Alnus-Schima* Mixed Forest, *Lyonia-Rhodendron* Forest, *Alus-Pinus*, and *Alnus-Castonopsis-Lyonia* Forest. There are eight community forests in the project area. The project abuts the Makalu Barun National Park buffer zone along the west side (right bank) of the river. The Upper Arun River is a cold, turbid, fast-flowing river with relatively limited ecological value and low number of aquatic species compared to downstream reaches of the river. The larger perennial warm tributaries seem to be of particular importance as spawning habitats and nursery areas for fish species of the region, as the torrential nature of the main river and the variations in water volume and suspended particulate levels do not provide suitable habitat conditions for fish spawning or juvenile fish rearing. Common snowtrout (IUCN VU) was by far the most abundant species in the collected fish samples in the upper part of Arun River, representing over 80% of all individuals caught. The few other relatively common species included the mid-range migrant species *Psilorhynchus pseudecheneis* (IUCN LC) and *Neolissochilus hexagonolepis* (IUCN NT). The Golden mahseer [*Tor putitora*, IUCN EN] have only been found lower reaches of Arun River and the construction of the Arun-3 HEP is likely to prevent any future migration of this species into the project area.

ES5.3 Socioeconomic and Cultural Conditions

The Project is located in Bhotkhola Rural Municipality where Adivasi Janajati (Indigenous Peoples) comprise 97.6% of the total population. The major ethnic groups in Bhotkhola Rural Municipality are Bhote (54.15%), Rai (15.97%), Tamang (11.37%), and the other Adivasi Janajati groups (e.g., Lhomi, Sherpa, Khaling, Gurung etc.) comprise the remaining 16.11% of the population. Within the project area, about 74% of the working population are engaged in agriculture, livestock keeping, and harvesting forest products. The primary crops are cardamom, and various subsistence crops like rice, millet, maize, and barley. Most households in the project area are members of a Community Forest User Group (CFUG), which provides access to various non-timber forest products, which is a key component of their subsistence livelihoods. Overall, community service provision and infrastructure development within the project area is weak, and the area currently has poor road connectivity. There is no waste collection or disposal services. The drinking water is obtained from springs, and no public transport. There are nearby police and army posts and health clinics. Most households have access to electricity from locally operated micro-hydropower projects, which provide power for fixed hours each day. Firewood is commonly used for cooking.

There are no nationally protected cultural sites within the project area, although there are many locally important tangible and intangible cultural heritage resources, such as Gompa, Chhorten, Manewall, Devithans; Naagthans, and Chautari. Each ethnic group possesses a wide spectrum of intangible cultural heritage. This includes migration history, belief system, oral traditions, life-cycle rites and rituals, belief systems linked to the cosmos and natural world, performing arts, and

traditional handicrafts. Festivals, rituals, funerals and ceremonies are a significant part of the communities. Communities in the DIA have a spiritual connection to their land as well as their surroundings and also worship mountains, hills and forests as abode of god, goddesses, or souls and spirits, for good harvest, good health, and prosperity. Some of the natural sites have cultural importance, including the Tatopani Kunda (natural hot spring near Hatiya), the Arun-Barun Dovan (site for Barun Mela in Barun Bazar), and the Bhembhema waterfall on Arun River just downstream of the proposed UAHEP dam.

ES.6 Alternatives Analysis

The following alternatives were evaluated using technical, cost, environmental, and social criteria in finalizing the project design, construction methods, and operational modalities:

- Without Project Alternative
- System Alternatives
- Location Alternatives, including ancillary facilities
- Design/Technology Alternatives
- No Forest Clearing Alternatives
- Construction Alternatives
- Operational Alternatives

ES.7 Environmental Impacts

ES 7.1 Positive Impacts

Employment to about 4500 workforces, increase in enterprises development, enhancement of technical skill and increase in economic activities are the positive impacts identified during construction phase. The operation phase impacts include generation of 4549.57 GWh clean renewable energy, employment to 130 people for the operation of the power plant, periodic employment for maintainnace works and revenue generation.

ES 7.2 Adverse Impacts

a) Physical Environment

The Project will acquire 136.82 ha of land, much of which is relatively steep and susceptible to erosion and sedimentation, especially during the monsoon season. Construction of the project headrace tunnel and caverns could intercept seepage in a fault/fracture zone, which could lower the groundwater table, thereby reducing or eliminating flow in some overlying springs or streams. The Project has developed a sediment management strategy to reduce impacts on sediment transport in the Arun River. The Project is not expected to have any meaningful impact on water quality in the Arun River as there will be no industrial wastewater discharges and the project reservoir is small and not susceptible to stratification or eutrophication. Project construction will require the transport, storage and use of relatively large quantities of various hazardous materials, and accidental spills are impossible to be completely prevented. The Project wastes will be collected and transported to Khandbari for disposal in an approved municipal landfill or recycled locally. Any hazardous wastes generated at the site will be properly stored and transported for disposal at an approved offsite facility. During construction, the Project will primarily generate air emissions from the project's three diesel power plants, construction vehicles, and fugitive dust particularly from active construction sites, quarry and aggregate crushing plants and vehicles plying on the earthen roads. Other than vehicle emissions, there are no emissions expected during

project operations. Project construction will generate noise, which has the potential to affect nearby villages, especially Rukma. The Project will result in permanent impacts to landscape values and visual amenities by introducing large, modern facilities into an otherwise predominantly natural and rural agrarian landscape.

b) Biological Environment

The Project will require 73.31 forest land consisting 40.07 ha government managed forest, 11.62 ha community forest and 21.62 ha Makalu Barun Buffer zone forest land. Due to implementation of the project 17866 trees consisting 14438 pole size and 3428 tree will be felled. Out of total trees to be felled (17866 nos.) 8397 were from government forest, 4184 from community forest and 5285 from buffer zone forest.

The Project will impact the Himalayan black bear (IUCN Vulnerable) and Chinese pangolin (IUCN Critically Endangered) via the loss of habitat, potential vehicle strikes, and poaching. The Himalayan red panda (IUCN Endangered) and Black musk deer (IUCN Endangered) are not found in the Project's area of disturbance, but are found at nearby higher elevations and may be increasingly susceptible to poaching as a result of the project.

The Project will result in the conversion of free-flowing river habitat to lakehabitat as a result of reservoir formation upstream of the UAHEP dam, reduction in aquatic habitat along the 16.45 km long diversion reach as a result of the diversion of flows through the powerhouse. Overall, habitat is not believed to be a limiting factor for fish populations as the Arun River's very cold, turbid, and high velocity flow limits both fish diversity and abundance, so a net reduction in aquatic habitat may not result in a reduction in fish diversity or abundance. The UAHEP dam will serve as a barrier to upstream migration of Common snowtrout and Dinnawah snowtrout, but these are only found in low numbers. The project's PRoR operations will result in fluctuations in flows downstream of the powerhouse from November through May when the Project will almost exclusively be operating in a peaking mode. These fluctuations can impact aquatic habitat as a result of fish stranding and exposure of the rivers margins to alternating flooding and drying, but because of the deeply incised river channel morphology, stranding risk is predicted to be low.

c) Socioeconomic and Cultural

Project construction will acquire 63.51 ha private land consisting 31.03 ha cultivated land, 31.97 ha Kharbari and 0.51 ha barren land. The acquisition of land and structures will affected 326 households and out of which 13 HHs will be physically displaced due to acquisition of residential structures.

The presence of up to 4,500 construction workers could result in impacts on ecosystem services and community infrastructure (e.g., health clinics). The Project can create social issues relating to its hiring practices and the potential for the Project to attract potential laborers, their families, vendors, and sex workers to the project area, which in turn can create social conflict, lead to increases in prices for basic goods and materials, increase crime, overburden community facilities and services, and increase pressure on, and potential for, additional exploitation of natural resources. The Project may affect community health as a result of sanitation practices, potential introduction of communicable diseases, introduction of vehicular traffic in an area unfamiliar with traffic safety measures, inappropriate use of force by security personnel, and attraction of sex workers and facilitate the spread of sexually transmitted diseases, and the increased potential for gender-based violence. The Project will affect some locally important cultural sites, such as a devithan and a chhorten, as well as some natural resources that have spiritual value like waterfalls.

The Project will also potentially impact intangible cultural heritage resources, including the use of natural resources; traditional knowledge on indigenous crafts; and ethnic or religious traditions as a result of construction activities and influx of labor. In addition, there may be impacts on festival sites during the construction period and increased mobility of people.

ES.8: Enhancement and Mitigation Measures

Enhancement measures has been proposed to enhance positive impacts identified due to implementation of the project. Preventive, avoidance and mitigation measures has been proposed to minimize the adverse impacts. The project proponent will implement the proposed mitigation and enhancement measures as a prime responsibility in coordination with line agencies.

The mitigation and enhancement measures mentioned under the contractor responsibility will be ensured by incorporation of appropriate tender clauses in tender document. The proponent will also implement community support program covering the activities under socio-cultural development, economic development, infrastructure development and capacity building. The estimated cost for mitigation and enhancement measures is NRs. 2942.09 million. The mitigation cost includes compensation cost for the land, house and private plants, compensatory plantation, awareness program, enhancement measures, rehabilitation activities and community support program in the project area.

ES.9: Environmental Monitoring

Article 45(1) of the EPR (2077) requires UAHEL to monitor impact of the project on environment every six months and submit a monitoring report to the concerned agency. The proposed UAHEP Environmental Monitoring Framework includes baseline, compliance, and impact monitoring. The focus of the UAHEP monitoring framework is to execute construction and operation activities that strictly comply with the EIA and to avoid or reduce direct and indirect Project residual environmental impacts.

ES.10: Environmental Audit

The objectives of performing an environmental audit are to evaluate whether environmental and social risks identified in the EIA are effectively mitigated and comply with the requirements of the Environmental Management Plan (EMP). 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. UAHEL will be responsible for conducting the environmental auditing of the Project during operations. In keeping with requirements of EPR, Ministry of Forests and Environment (MoFE) will conduct environmental audit after two years of project operation. UAHEL will also carry out an environmental audit upon hand-over from the Construction Contractors to ensure that all contractual requirements have been met by the Construction Contractors.

ES.11: Conclusion

The UAHEP will provide 4,549.57 GWh of clean, renewable energy to meet the electricity demands of Nepal, and will provide, 1,259.85 GWh dry season energy, which is possible because of the Arun River's naturally high dry season flow and the project's proposed PRoR mode of operation. During construction, the Project will employ up to a peak of 4,500 workers over a 6-year construction period. The Project will also need to purchase a wide variety of construction materials (e.g., aggregate, cement, rebar) and will require a wide range of support services (e.g., provision of food), which will create opportunities for local businesses. The construction and

operation of the UAHEP will result in some significant environmental and social impacts. Some of these unavoidable impacts can be mitigated, but will require effective implementation and monitoring oversight of the EMP. Significant residual impacts to legally protected area (i.e., MBNP) and natural habitat will remain. There will be some changes to social cohesion and cultural heritage in the area. The total Environment management cost is Nrs 3154.77 million which is 2.19% of total project cost.

The overall conclusion of this EIA is that the Project offers substantial benefits to the government, economy, and people of Nepal, while at the same time presenting several potential impacts. This EIA identifies key mitigation and management measures needed to address the project's potential adverse impacts. The effective implementation of the proposed mitigation measures will be critical to deliver a successful project. The UAHEL will ensure the implementation of all proposed Project mitigation, enhancement, and monitoring measures identified in this EIA.

ABBREVIATION	
CEMMP	Construction Environmental Management and Monitoring Plan
CIA	Cumulative Impact Assessment
CF	Community Forest
CFUGs	Community Forest User Groups
CITES	Convention on the International Trade for Endangered Species
CSPDR	Changjiang Survey, Planning, Design and Research Co. Ltd.
CSW	Commercial Sex Worker
CR	Critically Endangered
dB	Decibels
DD	Data deficient
DIA	Direct Impact Areas
DFO	Division Forest Office
DHM	Nepal Department of Hydrology and Meteorology
DO	Dissolved oxygen
DoED	Department of Electricity Development
EFlow	Environmental Flow
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EPA	Environmental Protection Act 2076
EPR	Environmental Protection Rules 2077
ERM	Environmental Resources Management
EMP	Environmental Management Plan
E&S	Environmental and Social
FAQ	Frequently Asked Questions
FECOFUN	Federation of Community Forests Users Nepal
FGD	Focus Group Discussions
FSL	Full supply level
GBV	Gender-based violence
GHG	Greenhouse Gas
GLOF	Glacial lake outburst flood
GRM	Grievance Redress Mechanism
GWh	Gigawatt hours
ha	hectare
HEP	Hydroelectric Project
HH	Households
HIV	Human immunodeficiency virus
IEE	Initial Environmental Examination
IP	Indigenous Peoples
KII	Key Informant Interviews
km	Kilometer
km^2	Square kilometers
kW	Kilowatt
kWh	Kilowatt hour
LC	Least Concern
LLO	Low level outlet
m	Meter
m^2	Square meters
m^3	Cubic meters
m^3/s	Cubic meters/second

MBNP	Makalu Barun National Park
MBT	Main Boundary Thrust
MCT	Main Central Thrust
MFT	Main Frontal Thrust
MLO	Mid-level outlet
MOL	Minimum Operating Level
MW	Megawatt
MoFE	Ministry of Forests and Environment
NAAQS	Nepal Ambient Air Quality Standards
NEA	Nepal Electricity Authority
NEFIN	Nepal Federation of Indigenous Nationalities
NESS	Nepal Environmental & Scientific Services Ltd
NGO	Non-governmental organization
OEMMP	Operation Environmental Management and Monitoring Plan
PAF	Project Affected Families
PAH	Project-affected households
PAP	Project-affected persons
PIC	Project Information Center
PID	Project Information Document
PRoR	Peaking Run-of-River
RAP	Resettlement Action Plan
RCC	Roller-compacted concrete
RIS	Reservoir Induced Seismicity
RM	Rural Municipality
RoR	Run-of-River
SBT	Sediment Bypass Tunnel
SEP	Stakeholder Engagement Plan
SPAF	Severely Project Affected Families
STDS	South Tibetan Detachment System
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TIP	Trafficking in Persons
TMS	Total Management Services, Ltd
ToR	Terms of Reference
UAHEL	Upper Arun Hydroelectric Limited
UAHEP	Upper Arun Hydroelectric Project
USEPA	United States Environmental Protection Agency
VU	Vulnerable
WB	World Bank
WHO	World Health Organization
WWF	World Wide Fund for Nature

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CHAPTER 1: NAME, ADDRESS, E-MAIL, PHONE, FAX OF THE PERSON/AGENCY PREPARING REPORT

1.1. Name, Address, E-Mail, Phone Number of Proponent

The Government of Nepal, through a cabinet decision dated 21 September 2018 (2075/06/05), decided to develop the Upper Arun Hydroelectric Project (UAHEP) under a subsidiary company of the Nepal Electricity Authority (NEA), namely the "Upper Arun Hydroelectric Limited" (UAHEL), which is the Project Proponent. The contact details of the Proponent are as follows:

Upper Arun Hydroelectric Company Limited,
Maharajgunj, Kathmandu, Nepal
Telephone: +977-1-4720543
E-mail address: uahepnea@gmail.com or upperarun@nea.org.np
Website*:* www.nea.org.np www.ppmo.gov.np

1.2. Name, Address, E-Mail, Phone Number of Consultant

Environmental Resources Management (ERM), an international sustainability consulting firm, was selected to prepare this EIA. ERM was supported by two local Nepalese consultants, Nepal Environmental & Scientific Services Ltd. (NESS) and Total Management Services, Ltd (TMS), both based in Kathmandu, Nepal. The contact details of the Consultant are as follows:

Environmental Resources Management (ERM)
1776 I Street, NW 20006
Washington, D.C.
Email: david.blaha@erm.com
Website: https://www.erm.com

1.3. Rationale for Conducting EIA Study

The Government of Nepal's statuary legal requirements for the environmental studies are stipulated in the Environmental Protection Act 2076 (EPA) and Environmental Protection Rules 2077 (EPR). The environmental screening criteria stipulated in the EPR, 2077 Schedule 3 mandates all the hydropower projects above the installed capacity 50 MW or that use more than 5 hectares of forest land to prepare an Environmental Impact Assessment (EIA). Since this project has an installed capacity 1063.36 MW and will require more than 5 hectares of forest land, and in accordance with the Project's approved Terms of Reference (ToR), it is required to prepare an EIA.

1.4. Objectives of EIA

The objectives of the EIA process are to:

- Introduce the Project and provide an opportunity for stakeholders to provide suggestions and identify concerns about the Project;
- Establish the existing status of the physical, biological, socio-economic, and cultural environments of the project area;
- Adopt a mitigation hierarchy approach to anticipate and avoid risks and impacts, where avoidance is not possible to minimize or reduce risks and impacts to acceptable levels, once risks and impacts have been minimized/reduced and mitigated, and where significant residual impacts remain, compensate for or offset them, where technically and financially feasible;
- Optimize the Project design for sustainability;
- Adopt differentiated measures so that adverse impacts do not fall disproportionately on the disadvantaged or vulnerable people, and these people are not disadvantaged in sharing development benefits and opportunities resulting from the Project;

- Use national environmental and social institutions, systems, laws, regulations, and procedures in the assessment, development, and implementation of the Project;
- Promote improved environmental and social performance in ways which recognize and enhance NEA's capacity; and
- Document project conformance with the Nepal permitting requirements as per EPA 2076 and EPR 2077;

1.5. Study Area

The project impact area is defined as the area affected by a project's direct and indirect impact, as follows:

Direct Impact Area (DIA) - includes all areas of direct impact, which are those areas located within the project's footprint or area of disturbance, as well as those villages and households directly affected by project construction and operation, and totals 67.2 square kilometers (km^2). The DIA includes the following (see Figure 1.1):

- The area within 1 kilometer (km) of any project construction or operational facility to account for project effects that may extend beyond the project footprint (e.g., noise, vibration, dust, light, and traffic). The 1 km buffer width was selected because these construction-related effects rarely extend beyond that distance;
- The area upstream from the headworks to Chhujun Khola, extending laterally 1 km on each side of the Arun River to account for impacts to riparian areas and the potential use of the river;
- The area downstream from the dam along the 16.45 km long diversion reach to the powerhouse and laterally 1 km on each side of the Arun River to account for impacts to riparian areas and the potential use of the river;
- All land affected by permanent land acquisition, land use restrictions, and temporary access agreements; and

Indirect Impact Area - includes the areas within the administrative boundaries of Bhotkhola Rural Municipality (RM).

1.6. Scope of the Study

The EIA study scope inludes the assessment of physical, biological, social and cultural impacts in the site-specific areas of the key project structural components and the supporting facilities as stated in the Chapter 2 of the report. The key project structures include Dam, Diversion tunnel, Surge tank, Headrace tunnel, Powerhouse etc. The project supporting facilities are, internal access road, audit tunnel, construction and labor camps, burrow areas, spoil management sites, mechanical workshops, batching plants and aggregate crushing and washing plant, perishable material storage sites, aggregate and sand. This also considers the land, construction materials, power, construction equipment's and work force required for executing the project. Apart from the key project component and project facility sites, the study scope also includes the risks that are potential in the project influence areas surrounding the key project component sites extending at the regional level. A separate EIA for the project access road and Initial Environmental Examination of Limbutar Camp has been prepared as per EPR and approved from the concerned ministry. An IEE Terms of Reference for the proposed 400 kV transmission line to evacuate power from the project was prepared and submiited to DoED for approval. This study has been carried out in accordance with the scope identified in approved ToR (Annex-2).

1.7. Survey License

The project proponent has obtained survey license from the Ministry of Energy, Water Resources and Irrigation to carry out the detailed engineering design and environmental and social study of the proposed project. The survey license was issued on 2076/05/25 B.S for 1061 MW. The survey license was extended up to 2081/5/24 and its installed capacity has been upgraded to 1063.36 MW including the power generation utilizing the ecological flow (Volume II, Annex-I).

1.8. Limitation of Study

The following limitations are applicable to this EIA study:

- Community Forest Boundaries—most community forests have not had their boundaries surveyed, so, for purposes of this EIA, the boundaries of these forests were mapped in consultation with the associated forest user groups and represent approximate boundaries.

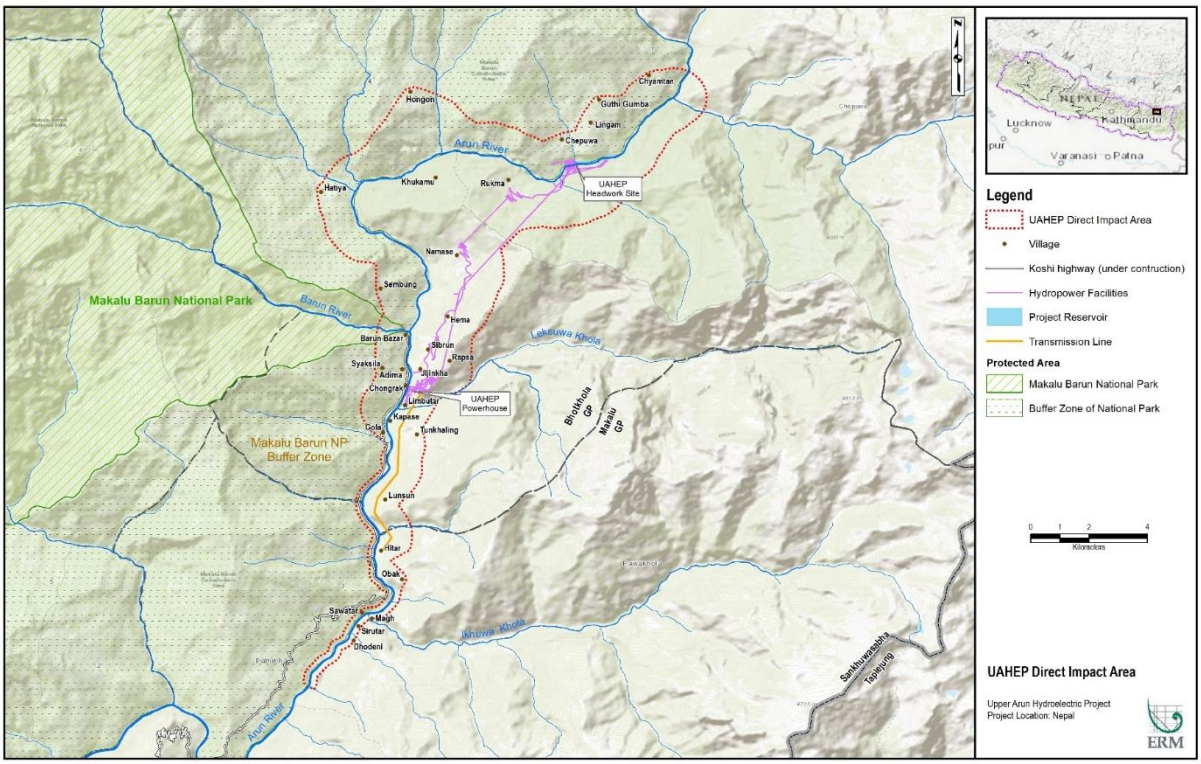


Figure 1.1: Direct Impact Area

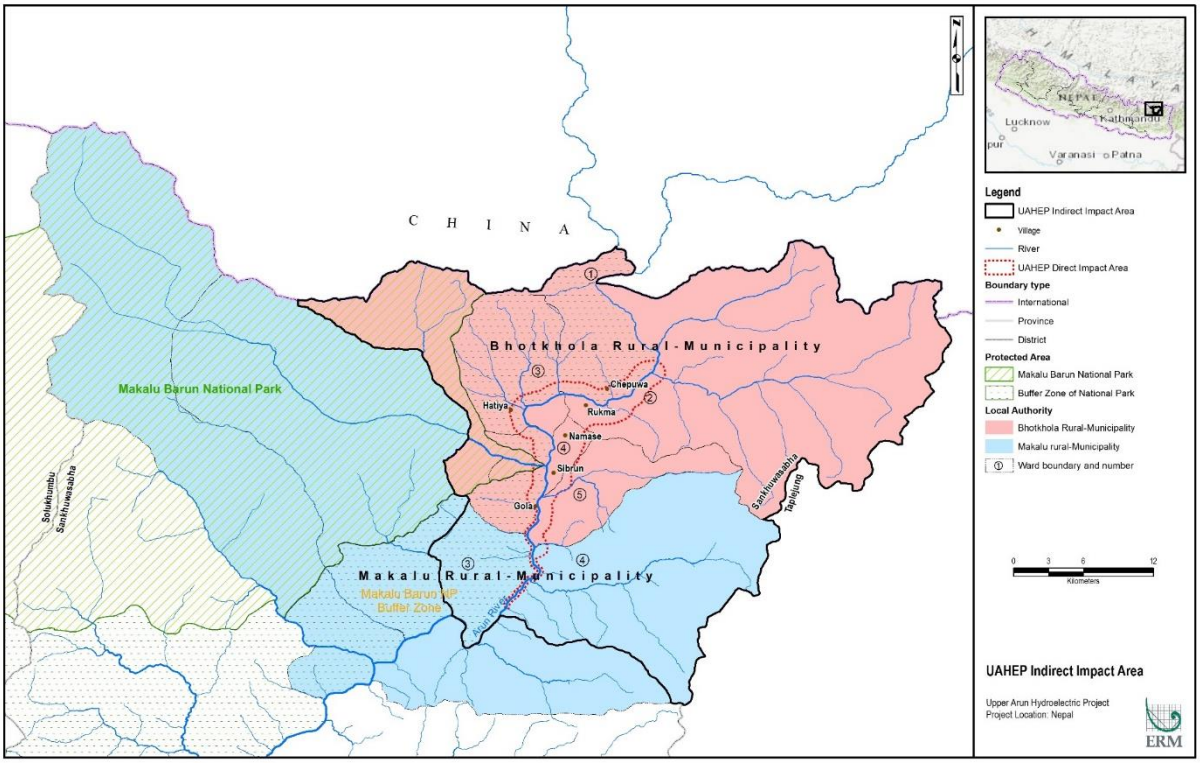


Figure 1.2: Indirect Impact Area

CHAPTER 2: INTRODUCTION OF THE PROJECT

2.1. Background

Nepal's economic and social development is being hampered by its inadequate energy supply. The country does not have its own reserves of gas, coal or oil and much of the country relies on traditional biomass (e.g., firewood) and animal residue (e.g., dung) for energy. Nepal has suffered severe electricity shortages, especially during the winter season when river flows are low. The country's poor electricity reliability has adversely affected the country's economic development. The UAHEP is intended to address these issues, as it will provide 4,549.57 GWh of average annual energy generation, including 1,250 GWh of critical dry season energy. In addition, the project will generate 18.57 GWh of average annual energy through ecological flow power station.

2.2. Project Description

The UAHEL proposes to construct the Upper Arun Hydroelectric Project (UAHEP or Project), with an installed capacity of 1,063.36 mega-watts (MW), on the Arun River. The main project component includes a 100 meter (m) high dam above foundation level, 2.1 km reservoir, headrace tunnel, surge tank and underground powerhouse.

2.3. Location and Accessibility

The Project is in Koshi Province, Sankhuwasabha District, in the Bhotkhola Rural Municipality of eastern Nepal. It lies in a straight line about 200 km east of Kathmandu, the capital of Nepal, and approximately 140 km north of the provincial capital, Biratnagar, about 40 km north of the district headquarters at Khandbari, and about 10 km south of the border with China (**Vol. II, Annex 3**). There are several other existing, under construction, and planned hydropower projects along the Arun River (Vol. II, **Annex 3**).

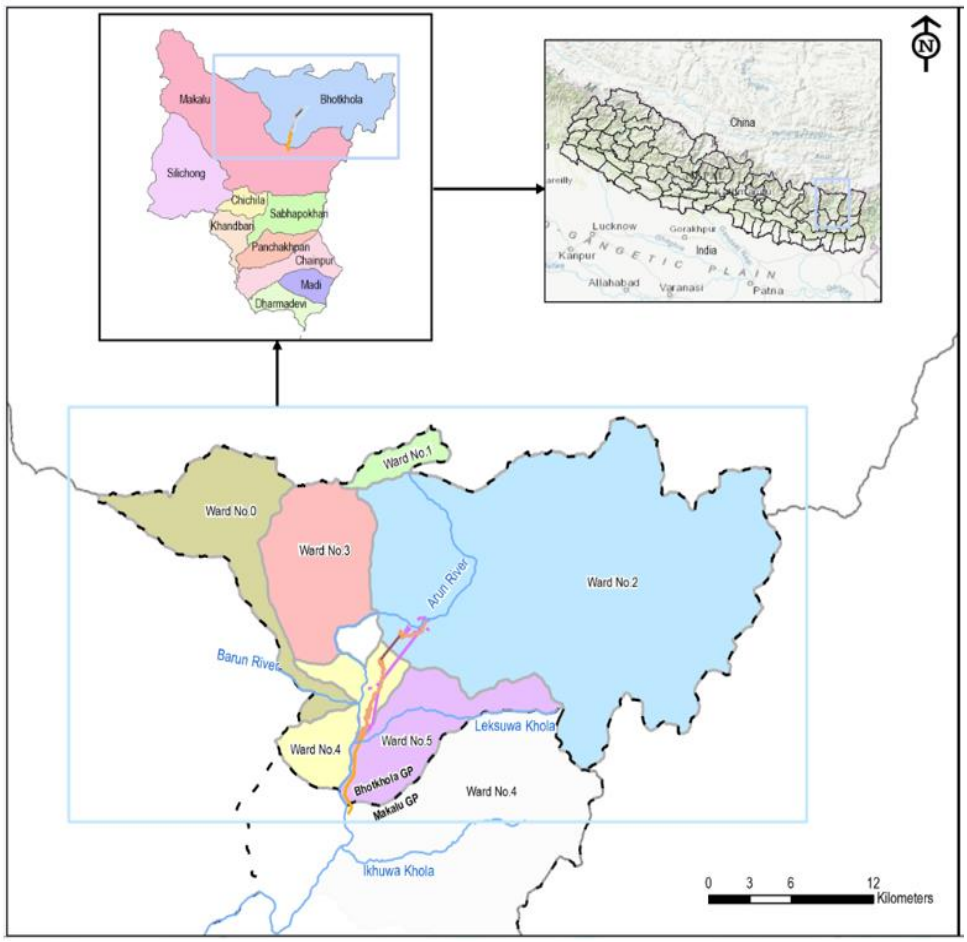


Figure 2.1: Project Location Map

The UAHEP dam site is located in a narrow gorge about 350 m upstream of the confluence of the Chepuwa Khola and the Arun River near the village of Rukma in Ward No. 2 of Bhotkhola Rural Municipality. The powerhouse lies near the village of Sibrun in Ward No. 4 of Bhotkhola Rural Municipality, about 750 m upstream from the confluence of Arun River with Leksuwa Khola. Some temporary construction phase ancillary facilities lie within Ward No. 5. Ward No 3, while not hosting any of the Project infrastructure, is located between the dam and the tailrace outlet and will experience reduced flow in the Arun River between the dam and the powerhouse once the Project is operational. The right bank of the Arun River across the river from most of the UAHEP facilities lies within the Makalu Barun National Park (MBNP) buffer zone. (See Vol. II, **Annex 3** : Project Layout Map)

The total vehicular travel distance from Kathmandu to the project headworks is approximately 610 km, which includes about 517 km on improved surfaced highway, 49 km on partially surfaced road, 23 km on unsurfaced road, and then ultimately 21.6 km on the proposed project access road (see Vol. II, **Annex 3**)

2.4. Salient Features of the Project

Table 2.1 present the salient features of the UAHEP (see additional details in Vol. II, **Annex 3.**

Table 2.1: Salient Features of the Hydropower Facility (Source: UFSR 2021)

SN	Item	Unit	Quantity	Remark
	PROJECT LOCATION	Longitude East 87°26'45" to West 87°20'30"; Latitude North 27°45'08" to South 27°40'18"; Koshi Province, Sankhuwasabha District, Bhotkhola Rural Municipality, Wards 2, 3, 4, and 5,		
1	HYDROLOGYAND SEDIMENTATION			
	Catchment Area			
	Arun River basin	km²	30,400	
	Catchment area above dam site	km²	25,700	
	Design discharge (Q32.23)	m³/s	235.44	
	Environmental release	m³/s	5.41	
	Annual average flow	m³/s	217	
	Average monthly flow at UAHEP dam	January February March April May June July August September October November December	54.1 m³/s 56,2 m³/s 62.8 m³/s 71.1 m³/s 113 m³/s 304 m³/s 529 m³/s 615 m³/s 460 m³/s 193 m³/s 75.5 m³/s 60.5 m³/s	
	2-year return period flood	m³/s	1,050	dam site
	100-year return period flood (dam site/powerhouse site)	m³/s	2,620/2,980	
2	RESERVOIR			
(1)	Water Levels			
	Maximum water level	El. m	1,649.8	GLOF
	Full supply level	El. m	1,640.0	
	MOL during peak	El. m	1,625.0	
	MOL during sediment flushing	El. M	1601.0	
(2)	Reservoir Surface Area at FSL	km²	0.201 or 20.1 ha	
(3)	Reservoir Length (Back water length)	Km	2.1	
(4)	Reservoir depth (max/average)	M	68 / 25	

SN	Item	Unit	Quantity	Remark
(5)	Reservoir Storage			
	Storage under FSL	MCM	5.07	
	Peaking pondage (live storage)	MCM	2.41	
	Storage under MOL during peak	MCM	2.66	
(6)	Pondage Factor (Live storage /Annual average runoff)	%	0.035	
(7)	Regulation Performance		Daily	
(8)	Water Utilization Rate	%	53	
(9)	Reservoir Lifespan	Years	>50 with sediment mgt	
3	POWER GENERATION			
	Installed capacity	MW	1,061	6 Units
	Firm capacity	MW	697	Under Q95 inflow conditions, daily peaking for 6 hours during the dry season from December to May of following year
	Average energy output	GWh	4,512.6	
	Dry season peak energy	GWh	833.9	
	Dry season off-peak energy	GWh	416.1	
	Wet season peak energy	GWh	956.4	
	Wet season off-peak energy	GWh	2,306.2	
	Plant factor	%	49.5	
4	MAIN STRUCTURES			
(1)	Dam			
	Dam type		concrete gravity dam	
	Foundation rock mass		slightly weathered and fresh gneiss	
	Dam crest elevation	El. m	1,653	
	Minimum foundation level	El. m	1,553	at dam heel
	Maximum dam height (above foundation level)	m	100	
	Dam crest length	m	183	
	Top width of dam	m	15	
(2)	Flood Discharge Facilities			
i)	Low-Level Outlet (LLO)Number		4	
ii)	Mid-Level Outlet Number		2	
iii)	Surface Spillway Type		Free overflow	
3	Diversion Tunnel			
	Section type		inverted D-shape	
	Length of tunnel	m	490.41	
	Dimension	m×m (W×H)	7×8	

SN	Item	Unit	Quantity	Remark
iv)	Surge Tank			
	Type		open surge tank with restricted orifice	
	Inner diameter/Shape	m	20.0/circular	
	Lining type		concrete lining	
	Gravel Trap		17m×11m×2.0m	(L × W × H)
v)	Main Tailrace Tunnel			
	Number		2	
	Section type		inverted D-shape	
	Surrounding rock characteristic		gneiss/schist	
	Dimension/Shape	m (W×H)	9.00×7.20/D-shape	
	Length	m	602/605	
vi)	Tailrace Outlet			
	Number		2	
	Plane dimension	m (L×W)	6.50×15.0	L is in flow direction
(4)	Powerhouse			
	Type		underground	
	Dimension	m (L×W×H)	230.05×25.7×59.43	
	Peaking Hours		Peaking operations will occur from 6pm-midnight during dry season.	
5	E&M EQUIPMENT			
(1)	Turbine			
	Number		6	
	Unit capacity	MW	173.33	
	Maximum head (Gross)	m	545.00	
	Maximum head (net)	m	529.54	
	Minimum head (net)	m	508.26	
	Rated head	m	508.26	
	Rated flow	m^3/s	39.24	
(2)	Generator			
	Number		6	
	Generator capacity	MVA	201.2	
	Power factor		0.90(lag), 0.965(lead)	
	Rated voltage	kV	15.75	
6	ECO-FLOW POWER STATION			
	Type		powerhouse at the dam-toe	
	Design discharge	m^3/s	5.41	
	Diameter of penstock	m	1.5/1.0	main pipe/branch pipe

SN	Item	Unit	Quantity	Remark
	Dimension of powerhouse	m (L×W×H)	23.6×16.4×19.3	
	Number of units		1	horizontal Francis turbine units
	Installed capacity	MW	2.36	
	Average annual energy	GWh	18.57	
7	TRANSMISSION LINE			
	Nominal voltage	kV	400	A separate IEE in process
	Line length	km	5.8	
	Number of circuits		Double	
	Potyard (Plane dimension of potyard)	m (L×W)	120×42	
8	CONSTRUCTION PERIOD			
	Total construction period	month	68	
9	ROADS			
	Access road	km	21.6	EIA was approved
	Total length of Project roads	km	15.2	
	Construction Adits (Total Length/ Number)	m/set	1,350/6	
10	PROJECT COST ESTIMATE			
	Hydropower complex project	Million NRs	144017.5	Excluding road and T/L USD exchange rate: 110 USD exchange rate: 110
11	ECONOMIC INDICATORS			
	Static cost per kW	USD/kW	135436.26	
	LCOE	USc/kWh	3.9	
	NPV (ic=10%)	MUSD	577	
	EIRR	%	16.5	
	B/C		1.8	

2.5. Project Activities

Annex 3 provides additional details on Project construction activities and methods.

2.5.1. Pre-Construction Activities

Once the Project receives approval of the EIA by MoFE and obtains a generation license from the MoEWRI, the following project activities will commence:

- Issue tender bid documents for the Project;

- Award the contract(s) to the Construction Contractor(s).
- Acquire required project lands and enter into temporary use agreements with affected property owners in compliance with the Land Acquisition Act of GoN and the approved EIA and RAP; Obtain the Department of Forests and Soil Conservation's Forest Clearance Permit; and

The selected Construction Contractor will be required to develop a Construction Environmental and Social Management and Monitoring Plan (CESMMP), in accordance with the Project's Environmental Management Plan, for review and approval by UAHEL. As part of this CESMMP, the Construction Contractor will develop a Worker Code of Conduct prior to the initiation of construction. Prior to mobilizing construction crews in the field, UAHEL will require the Construction Contractor to conduct induction training for all field crews and subsequently for all new hires, which will include health and safety training, provision of personal protective equipment, briefing on the Worker Grievance Redress Mechanism, environmental and cultural sensitivity training, and the Worker Code of Conduct, including penalties for non-compliance, with a requirement that all personnel sign a copy of the code.

2.5.2. Construction Activities and Methods

Construction of the UAHEP will be one of the largest civil works projects ever undertaken in Nepal, especially considering the amount of underground excavation required. Management of the Arun River represents a key construction challenge for the Project. River diversion is proposed to occur in the following sequence:

- In November of Year 1, which is the onset of the dry season, construction of the diversion tunnel will start. The diversion tunneling and lining activities will be protected from flooding by the inlet and outlet cofferdams. The river will continue to flow along its natural course.
- In November of Year 2, the river will be diverted from its natural course into the diversion tunnel.
- At the end of April of Year 3, the cofferdam protection is scheduled to be complete. By this stage, the concrete of the dam will be completed up to elevation 1,557.5 m. During the flood season of Year 3, the dam foundation will be flooded, with the flood being discharged through the diversion tunnel and by overflowing of the cofferdams.
- In November of Year 3, after clearing of the dam surface, dam concreting is scheduled to resume. At the end of April of Year 4, the dam sections are expected to reach elevation 1,590 m, while the abutment sections reach elevation 1,600 m. During the flood season, the diversion tunnel and the surface of the dam at elevation 1,590 m will discharge the flows together, while the abutment sections continue to rise.
- In November of Year 4, after clearing of the dam surface, dam concreting is scheduled to resume. At the end of April of Year 5, the dam concrete will be up to elevation 1,620 m. During the flood season of Year 5, dam construction is scheduled to continue. At the end of October, the dam concrete is expected to be up to elevation 1,644 m, which is the dam crest.
- From November of Year 5 to February of Year 6, installation of the hydraulic steel structures in the LLOs will be carried out. At the end of February of Year 6, the gate at the diversion tunnel inlet will be lowered and reservoir impoundment will start. During the period of diversion tunnel plugging, the river will discharge through the ungated spillway.
- After March of Year 6, the permanent water-releasing structure will discharge flows as designed.

2.5.3. Post-Construction Clean up and Restoration

After the completion of construction, the Construction Contractor will clean up and restore affected areas as follows:

- Dismantle and remove all remaining contractor equipment, surplus materials, rubbish, debris, waste, and all temporary facilities from the site for reuse, recycling, or disposal at an approved disposal facility;
- Repair any infrastructure damaged during the work (e.g., roads, fences);
- Complete all re-grading, slope stabilization, and re-vegetation of disturbed areas;
- Restore all disturbed areas to their previous condition either for agricultural use or replanting forest;
- Contact property owners, repair any damage, and address any claims for settlement; and
- Return land used under Temporary Access Agreements to its owner.

2.5.4. Project Commissioning

Hydropower facility commissioning involves several activities over approximately the last 12 months of the project construction period. These activities include:

- Initiate Operation Phase monitoring requirements to ensure a robust baseline to assess project operations;
- Complete the Project's Operation Phase Emergency Preparedness and Response Plan;
- Notify residents that the Project is entering the commissioning stage and provide appropriate safety briefings;
- Ensure all project safety signage is in place;
- Clear and remove forest within the reservoir's FSL – this forest will not be cleared until the reservoir is ready to be filled to minimize erosion and slope stability hazards;
- Plug the diversion tunnel and incrementally fill the reservoir to the FSL;
- Conduct wildlife survey and relocate any less mobile wildlife away from the rising reservoir water level;
- Ensure the required environmental flow is released continuously during reservoir filling;
- Install, test, and commission turbine units
- Monitor all tunnels, penstock, and hydraulic systems
- Test and commission the switchyard;
- Conduct final audit, after which the Construction Completion Certificate is issued by the Project Engineer.

2.5.5. Project Operations

Once project construction, testing, and commissioning is completed, the Construction Contractor will turn the Project over to UAHEL for operations and maintenance.

2.5.5.1 Typical Project Operations

The UAHEP will operate in a Peaking Run-of-River (PRoR) mode, as follows:

- Run-of-River (RoR) Operation Mode – the Project will generally operate in a RoR mode when river flow exceeds the project's rated discharge capacity of 235.44 m^3/s, which typically occurs from June to October (i.e., monsoon season). Under RoR operations, the project reservoir elevation will remain relatively constant at its FSL of 1,640 m. When river inflow is larger than the full discharge of the available units, excess water will be routed around the dam via the sediment bypass tunnel (SBT) weir. When river inflow is above 575 m3/s, then RoR operation will be modified in accordance with the project's sediment management strategy.

- Peaking Operation – the Project will generally operate in a daily peaking mode when river inflow is less than the full discharge of the available turbine units plus the required ecological flow, which typically occurs from November to May (i.e., the dry or lean season). During this period, the operators will ensure the Project is at FSL at the beginning of the peak period (18:00 hour) and will maximize power generation during this six-hour peak demand period, while limiting the rate of reservoir drawdown to 2.5 m/h for slope stability reasons and maintaining the Minimum Operating Level (MOL) of 1,625 m. The project reservoir will be drawdown below the FSL to meet this peak demand. Once the peak demand period is over (24:00 hour), the project operators will refill the reservoir at the rate of no more than 2.5 m/h until the reservoir water level reaches FSL. Once at FSL, the project operators will match power generation discharge with river inflow, essentially operating in a RoR mode until 18:00 hour, when the peaking operation will begin and the process repeats itself.

2.5.5.2 Sediment Management

The Arun River is a glacial fed with a high sediment load, so proper management of sediment is critical to ensure a sustainable operation. The vast majority of the river's sediment load movement occurs during the monsoon season, and given the project's primary purpose of meeting dry season peak energy demand, the relative value of river flow during the dry season is quite high, so the sediment management strategy primarily focuses on the monsoon season (June to October) when both flow and sediment loads are high. The strategy is as follows:

- Dry Season (November – May) – the Arun River carries very little sediment during this period so the Project will be operated without any specific measures for sediment management. The SBT inlet will be closed.
- Monsoon Season (June – October) – during the monsoon season, the Arun River carries a high sediment load and the Project will be operated in accordance with the following sediment management strategy:
  - When river inflow is larger than 240.5 m^3/s, but less than 575 m^3/s, the available turbine units (235.44 m^3/s) and the required Environmental Flow (EFlow) (5.41 m^3/s) will run at full discharge and excess water will be discharged via the SBT, which has a capacity of 815 m^3/s;
  - When the river inflow is larger than or equal to 575 m^3/s, but less than 1,050 m^3/s, the Project will shut down the turbines in an enforced outage, lower the reservoir level using the mid-level outlet (MLO) gates, with a sill elevation of 1596 m, and then the low level outlet (LLO) gates, with a sill elevation of 1590 m, will be opened to allow a free-flow flushing (i.e., reservoir empty) for a duration of 24 hours. The gates will then be closed and the reservoir allowed to refill at a controlled rate of no more than 2.5 m/h. The entire flushing procedure is expected to require about two days. This will occur whenever flows are above 575 m^3/s, but below 1,050 m^3/s, and it has been more than seven days since the last flush event.
  - When the river inflow is greater than 1,050 m^3/s, the Project will follow the same sediment flushing sequence described above, except the flushing will continue for as long as river inflow remains above 1,050 m^3/s. Once flow drops below 1,050 m^3/s, the LLO and MLO gates will gradually close and water levels in the reservoir will rise at a controlled rate of no more than 2.5 m/h.

2.5.5.3 Environmental Flow Release

The EFlow Assessment focused on ensuring that adequate water depths are provided to sustain fish migration and movement, as these are the most important functions provided by the mainstem

of the Upper Arun River. Minimum depth requirements are highly influenced by body size (particularly the thickness of the body in the vertical plane including fins, known as trunk size). Adult fish typically have the largest body size of any life stage, so the EFlow assessment focused on the minimum flow needed to maintain mobility of adult fish through the affected reach under the assumption that flows sufficient to sustain adult mobility would also be sufficient for immature life stages. Mathur and Kapoor (2015) reported that snowtrout prefer at least 10 cm of water above and below their trunk when swimming. Common snowtrout is known to weigh up to 2.5 kg and reach 50 - 60 cm in length, although it is sexually mature at 18 – 24 cm (Sharma 1989). Mathur and Kapoor (2015) recommend EFlow water depths of approximately 0.5 m. Connectivity studies at the Upper Trishuli-1 HEP concluded that water depths of approximately 0.25 m would be sufficient to allow passage of common snowtrout of <25 cm (Southern Waters draft 2018; Bhat et. al. 2013), which is the small end of the size for breeding stock. Common snowtrout collected during the fishery study in the Upper Arun ranged in size up to 29 cm, but did not approach the maximum size of 50 - 60 cm referenced in the literature. Personal communication with Halvard Kaasa indicates that water depths of 30 cm are adequate for most snowtrout. Based on the scientific literature and the size of common snowtrout found in the Upper Arun River, ERM recommends a minimum water depth of 30 cm to maintain common snowtrout mobility within the diversion reach.

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) was used to simulate thalweg depths at 35 cross-sections within the approximately 16.45 km long diversion reach, and another 12 cross-sections extending an additional 15.5 km downstream to approximately the Arun-3 dam). Average flows in January were used as an indicator of normal low flow conditions. It was determined that an EFlow of 5.41 m3/s would be required to provide the needed minimum water depth of 30 cm at all cross-sections in the diversion reach, as well as meet the Government of Nepal regulatory requirements (i.e., minimum flow of 10% of the lowest monthly average flow – January average monthly low flow of 54.1 m^3/s). This flow will also provide the required minimum depth of 30 cm. The EFlow will be released thru the Eco-power house to the Arun River near the toe of the dam on the left bank.

The Project will release a continuous minimum environmental flow (EFlow) of 5.41 m^3/s. The release of this environmental flow takes precedent over all other flow requirements or needs (e.g., even under extreme droughts, EFlow take precedent over flow for power generation). UAHEL proposes an eco-flow power station so as to generate some additional power from the 5.41 m^3/s EFlow release. The powerhouse will be located on the left bank of the Arun River immediately downstream of the dam and will discharge the EFlow at the toe of the dam. The power station will have a bypass valve to release the EFlow even when the power station is shut down. The EFlow intake will be located on Section No. 3 of the dam with a sill elevation of 1,615.6 m, which is below the reservoir's MOL of 1,625.0 m. The only time the reservoir will be below the MOL is when the Project has opened its gates to flush sediment, in which case far more water is being released than the EFlow requirement.

2.6. Land Type and Area

For purposes of the hydropower facility, 136.52 ha of land are required which consist 73.31 ha forest land and 63.51 ha private land. Among the forest land 40.07 ha is governmet managed forest, 11.62 ha community forest and 21.62 ha Makalu Barun Buffer zone forest land. Similarly in private land 31.03 ha is cultivated land, 31.97 ha Kharbari and 0.51 ha barren land (Table 2.2). Since project construction required about 6 years all the land necessary for the project will be

permanently acquired/leased. As per World Bank requirement land occupied for 2 years and more period shall be acquired permanently.

Land Area to be Acquired(ha)														
	Forest land				Pvt.				Barren land (Grass land, Foot trails/Kharbari/waterBodies/River)				Total Govt Area	Total Area in ha)
Project Components	Gov	CF	MBNP	Gov tot	Cultivation	Barren	Kharbari/Tree-re	Total Pvt	Gov	CF	MBNP	Govt. Tot		
Permanent Acquisition														
DAM_INTAKE_RESERVOIR	15.46	0.03	3.67	19.16	-	0.09	5.78	5.87	12.00	-	14.08	26.09	45.24	51.12
SURGE_TANK	-	-	-	-	0.49	-	1.15	1.65	0.22	-	-	0.22	0.22	1.87
SPOIL_DISP_2	0.12	-	-	0.12	4.27	-	1.48	5.75	0.97	-	-	0.97	1.09	6.84
POWERHOUSE and TAILRACE	-	-	-	-	0.28	-	7.09	7.37	0.71	2.33	-	3.05	3.05	10.42
POWER_PLANT_3	0.17	-	-	0.17	0.05	-	(0.00)	0.05	(0.00)	-	0.23	0.23	0.39	0.44
FUEL_STORAGE	0.00	-	-	0.00	-	-	(0.00)	(0.00)	0.10	-	-	0.10	0.10	0.10
OWNER_CAMP_2	-	-	-	-	0.35	-	(0.00)	0.35	0.08	-	-	0.08	0.08	0.43
POTYARD	-	-	-	-	-	-	0.05	0.05	1.77	-	-	1.77	1.77	1.82
EXPLOSIVE_MAGAZINE	-	-	-	-	-	-	0.14	0.14	-	-	-	-	-	0.14
ROAD_NO_8	-	-	-	-	0.24	-	3.41	3.65	0.65	-	-	0.65	0.65	4.30
CON_CAMP_2	-	-	-	-	-	-	0.14	0.14	0.04	-	-	0.04	0.04	0.17
CONC_BAT_PLANT_2	-	-	-	-	-	-	0.13	0.13	0.07	-	-	0.07	0.07	0.20
POWER_PLANT_2	-	-	-	-	-	-	0.10	0.10	-	-	-	-	-	0.10
ROAD_NO_13	-	-	-	-	-	0.39	1.16	1.55	0.95	-	-	0.95	0.95	2.50

VENT_TUNNEL	-	-	-	-	-	-	0.13	0.13	-	-	-	-	-	0.13
ACCESS_TUNNEL_PH	-	-	-	-	-	-	0.10	0.10	0.03	-	-	0.03	0.03	0.13
ADIT_AD5	-	-	-	-	-	-	0.03	0.03	0.00	-	-	0.00	0.00	0.03
CON_ADIT_2	-	-	-	-	-	-	0.23	0.23	0.04	-	-	0.04	0.04	0.28
ROAD_NO_12	-	-	-	-	0.05	-	0.28	0.33	0.04	-	-	0.04	0.04	0.37
ROAD_NO_10	0.07	-	-	0.07	0.53	-	0.29	0.82	0.06	-	-	0.06	0.12	0.95
CON_ADIT_3	-	-	-	-	-	-	0.26	0.26	-	-	-	-	-	0.26
ROAD_NO_9	0.08	-	-	0.08	1.12	-	0.29	1.41	-	-	-	-	0.08	1.49
WATER_PLANT_1	0.01	0.32	-	0.34	0.27	-	0.12	0.39	-	-	-	-	0.34	0.72
POWER_PLANT_1	-	-	-	-	-	-	0.35	0.35	-	-	-	-	-	0.35
FAB_SHP_1	0.01	0.44	-	0.45	1.42	-	0.86	2.27	-	-	-	-	0.45	2.72
MAIN_SHP_1	0.00	0.94	-	0.95	-	-	0.00	0.00	-	-	-	-	0.95	0.95
SPOIL_DISP_1	0.88	-	-	0.88	14.50	-	1.06	15.56	-	-	-	-	0.88	16.44
CON_ADIT_1	0.23	-	-	0.23	-	-	0.00	0.00	-	-	-	-	0.23	0.23
CON_ADIT_6	-	-	-	-	0.06	-	0.17	0.23	-	-	-	-	-	0.23
CHEPUWA_QUARRY	0.00	5.94	-	5.94	-	-	(0.00)	(0.00)	(0.00)	0.09	-	0.09	6.03	6.03
ROAD_NO_1	1.60	0.35	-	1.94	0.29	-	1.33	1.62	-	-	-	-	1.94	3.56
BRIDGE_2	0.04	-	-	0.04	-	-	(0.00)	(0.00)	0.04	-	0.08	0.12	0.15	0.15
ROAD_NO_6	0.47	0.28	-	0.75	-	-	(0.00)	(0.00)	-	-	-	-	0.75	0.75

ROAD_NO_2	(0.00)	-	0.14	0.14	0.03	-	0.00	0.03	0.00	-	1.12	1.12	1.26	1.28
CABLE_CRANE_L	-	-	-	-	-	-	0.29	0.29	-	-	-	-	-	0.29
CABLE_CRANE_R	-	-	-	-	-	-	0.23	0.23	-	-	-	-	-	0.23
BRIDGE_1	-	-	-	-	-	-	0.04	0.04	-	-	-	-	-	0.04
EXTRA_ROAD_3	(0.00)	-	0.00	0.00	0.11	-	0.02	0.13	(0.00)	-	0.00	0.00	0.00	0.13
EXTRA_2_ROAD_1	0.00	-	-	0.00	-	0.00	0.53	0.53	0.00	-	-	0.00	0.00	0.54
EXTRA_1_ROAD_1	0.13	-	-	0.13	-	-	0.16	0.16	-	-	-	-	0.13	0.29
ROAD_NO_7	0.02	0.90	-	0.92	0.10	-	0.34	0.45	-	-	-	-	0.92	1.36
ROAD_NO_5	-	-	-	-	-	-	2.46	2.46	-	-	-	-	-	2.46
ROAD_NO_4	-	-	-	-	1.96	-	0.39	2.35	(0.00)	-	0.17	0.17	0.17	2.52
ROAD_NO_3	(0.00)	-	0.13	0.13	0.19	-	0.13	0.32	(0.00)	-	0.22	0.22	0.34	0.67
CON_CAMP_3	-	-	-	-	1.98	-	(0.00)	1.98	0.00	-	-	0.00	0.00	1.99
FAB_SHP_2_MAIN_SHP_2_UAHEP_MY_AR	-	-	-	-	2.17	0.02	0.18	2.37	0.83	-	0.16	0.98	0.98	3.35
CON_CAMP_4_UAHEP_CAMP_1_AR	0.04	-	-	0.04	0.27	-	0.40	0.67	0.34	-	0.47	0.81	0.85	1.52
AGG_CRU_CONC_BAT_PLANT_1_UAHEP_BAT_CRU_PLANT_AR	-	-	1.16	1.16	0.30	-	0.63	0.93	-	-	-	-	1.16	2.09
OWNER_CAMP_1_UAHEP_CAMP_3_AR	0.15	-	-	0.15	-	-	-	-	-	-	-	-	0.15	0.15
NAMASE_QUARRY_2_AR	-	-	-	-	-	-	-	-	0.01	-	-	0.01	0.01	0.01

NAMASE_QUARRY_1_AR	-	-	-	-	-	-	(0.00)	(0.00)	0.72	-	-	0.72	0.72	0.72
LEKSUWA_QUARRY_AR	-	-	-	-	-	-	(0.00)	(0.00)	0.16	-	-	0.16	0.16	0.16
ROAD_NAMASE_QUARRY_AR	-	-	-	-	-	-	-	-	0.52	-	-	0.52	0.52	0.52
ROAD_LEKSUWA_QUARRY_AR	-	-	-	-	-	-	-	-	0.28	-	-	0.28	0.28	0.28
Total	**19.45**	**9.20**	**5.09**	**33.74**	**31.02**	**0.50**	**31.97**	**63.50**	**20.62**	**2.42**	**16.53**	**39.57**	**73.31**	**136.82**

2.7 Project Requirements

2.7.1 Human Resources

The Project will require a peak of approximately 4,450 workers with a total manpower requirement of approximately 19,400 man-years. The number of workers will also vary seasonally, with the peak workforce occurring during the dry season (October to May) and fewer workers during the monsoon season (June to September). About 20% of the required positions are considered skilled, about 50% semi-skilled, and about 30% unskilled. It is estimated that Nepali workers could fill about 40% of these construction jobs, with many of the unskilled positions likely being filled by local area workers.

The Project is estimated to employ about 130 workers during the operations phase. These workers will be primarily operating and maintaining the hydropower facility with only a few workers required to for periodic maintenance on the access road. It is estimated that the operations workforce will be about 50% skilled (e.g., project operators and management), 25% semi-skilled (e.g., facility maintenance staff), and 25% unskilled (e.g., primarily housekeeping and general maintenance). It is anticipated that initially 75% of the workers could be from Nepal, with this percentage increasing over time as Nepali staff gain more operational experience and can assume more responsibility.

2.7.2 Construction Materials

Table 2.3 presents the construction material required and likely supply source for these materials. It is envisaged that much of the construction materials required for the Project can be sourced from within Nepal, unless sufficient materials are not available in the required time to meet the construction schedule. Specialized equipment (e.g., electro-mechanical equipment) and pre-fabricated steel will need to be imported. The EPC will have a scheduler to manage the ordering and timely transport of construction materials.

Table 2.2: Key Construction Materials Required for the Project (Source: CSPDR, 2021)

Construction Material	Quantity	Sourcing
Coarse Aggregate	984,750 m^3	Chepuwa Quarry/Reuse project spoils
Fine Aggregates	984,750 m^3	Chepuwa Quarry/Reuse project spoils
Cement and admixture	341,000,000 kg	Nepal
Rebar	49,877 tonnes	Nepal and/or Foreign Import
Steel Mesh Reinforcement	1,743 tonnes	Nepal and/or Foreign Import
Steel	2,080 tonnes	Nepal and/or Foreign Import
Steel Bolts	1,255,537 kg	Nepal and/or Foreign Import
Anchor Cable	103,987 m	Foreign Import
Penstock	3,187 tonnes	Nepal and/or Foreign Import
Explosives	2,558 tonnes	Nepal
Diesel	67,894,176 liters	Nepal

The Project will require a significant quantity of aggregate for concrete production to construct the dam, and other facilities. There are no commercial sources of aggregate in the local area, and the cost of transporting it to the site would be prohibitive. Therefore, UAHEL proposes to source the required aggregate locally. At the initial stage of construction, natural aggregates will be secured from along the left bank of the Arun River to supply the headworks construction area, and along Leksuwa Khola to supply the powerhouse construction area. These borrow areas will only be used temporarily until the various tunnel excavations proceed and Chepuwa Quarry is operational. Good quality rock from tunnel excavation will be used as the primary aggregate source, with any deficient quantities sourced from the Chepuwa Quarry.

2.7.3 Construction Schedule

Overall project construction is estimated to take approximately 72 months to implement. Vol. II, **Annex 3**, shows the key implementation milestones for the overall completion of the project.

2.7.4 Ancillary Facilities

Construction of the UAHEP hydropower facility will require several ancillary support facilities (see Vol. II, **Annex 3**). All temporary facilities would be required for the duration of facility construction (~6 years) with the exception of the borrow areas, which will only be used for 6 months until the Chepuwa Quarry is operational. Project construction will require about 12,200 kW of power, plus the electrical requirements of the worker camps, for a total capacity of 20,100 kW. Due to the lack of nearby power supply from the Nepal power grid, three diesel power stations are proposed – one in the headworks area (12000 kW), one at the Headrace Tunnel adit portal (2,100 kW) to operate the ventilators and water pumps, and one at the powerhouse area (6,000 kW) (see Vol. II, **Annex 3** for more details). Alternatively, there is a possibility of using the NEA's grid power that is both environmentally friendly and economically viable too.

Six worker camps (Headrace tunnel adit – Contractor's camp #2 covering 0.17 ha; Powerhouse area – Owner's camp covering 0.43 ha, Contractor's camp #3 covering 1.99 ha, contractors camp #4 covering 1.52 ha) are proposed to house the approximately 4,500 workers needed to build the hydropower facility. The area required for army workers including the area required to manage the explosives magazine is 0.14 ha (Refer Table 2.2). **Figure 2.2** shows the location of these worker camps and Vol. II, **Annex 3** provides details on the areal size and capacity of these camps. The camps will be completely self-contained and will provide all necessary services and utilities to support the construction workforce without drawing upon local community services or supplies. It is proposed to construct two water plants for the Project. Water Plant #1 will source water from Chepuwa Khola and will service the headworks area. Water Plant #2 will source water from Leksuwa Khola and service the powerhouse area.

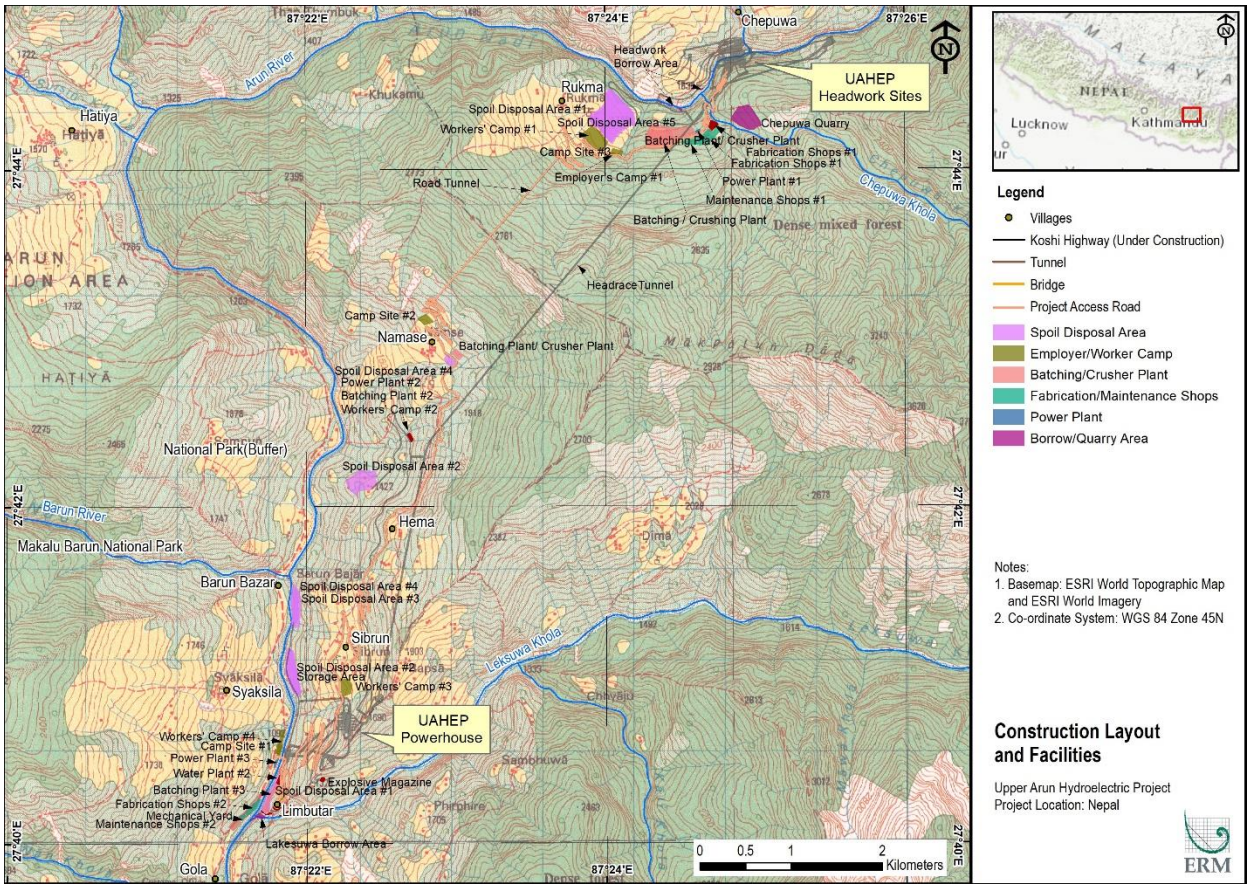


Figure 2.2: Location of Construction Layout and Facilities

Project construction will generate a large quantity of spoils, estimated at approximately 5,930,000 m^3. Some of this spoil material will be used for aggregate production (838,100 m^3) and cofferdam construction (42,300 m^3), but the remaining spoils will need to be disposed. Four spoil disposal facilities are proposed, which will be engineered facilities including fencing, slope protection, drainage, and stormwater management. In addition, approximately 500,000 m^3 of soil will be stockpiled for re-use during land restoration.

Table 2.3: Spoil Disposal Facilities

SN	Name	Location	Footprint (ha)	Volume (m^3)	Slag Quantity (m^3)	Storage Quantity (m^3)
1	Spoil Disposal Area # 1	500 m east of Rukma	15.5	3,520,000+980,000	3,460,000 +470,000	510,000
2	Spoil Disposal Area # 2	Between Namase and Sibrun	6.6	840,000+430,000	740,000+400,000	Negligible
Total			**30.9**	**5,770,000**	**5,070,000**	**510,000**

In addition to the facilities described above, there are several other ancillary facilities required for project construction, including secondary access roads (see Vol. II, Annex 3), and a water plant, crushing plant (320 tons coarse aggregate and 140 tons fine aggregate/hour covering 2.29 ha at headworks), batching plants (5,600 m^3/month covering 0.20 ha at headrace adit portal), fabrication shops (2.72 ha at headworks and 3.35 ha at powerhouse), maintenance shops (0.95 ha at powerhouse), fuel depot, explosive magazine, quarries, and borrow areas (**see Vol. II, Annex 3**). The quarries and their respective volumes include the Chepuwa quarry (surface area of 6.03 ha, volume of 2,000,000 m^3); Namase 1 and 2 and Inlet quarries (collectively surface area of 1.25 ha and volume of 2,000,000 m^3); and Leksuwa quarry (surface area of 0.44 ha and volume 1,000,000 m^3).

CHAPTER 3: METHODOLOGIES FOR PREPARING THE REPORT

3.1. Literature Review

The literature review involved collecting and reviewing secondary sources of information related to the Project and its direct and indirect impact areas, and in general include data from the following sources:

- UAHEP feasibility studies and design drawings for the project hydropower facility;
- Other projects – including feasibility studies, and IEE and EIA reports of other road, transmission line, and hydropower projects within the project impact area;
- Physical baseline conditions in the project impact area:
  - Topographic maps from Department of Survey, Google Maps, Google Earth, and WorldView-2 high resolution (accuracy of 50 cm) aerial imagery,
  - Hydrology and Meteorology data from the Department of Hydrology and Meteorology,
  - Roads data from the Department of Roads,
- Biological baseline conditions in the project impact area
  - Peer reviewed scientific literature on biodiversity,
  - Online species distribution maps produced by the Integrated Biodiversity Assessment Tool,
  - IUCN Red List Version 2019-1,
  - Red List for Birds of Nepal (Inskipp et al. 2016),
  - Red List for Mammals of Nepal (Jnawali et al. 2012),
  - Bird Data Zone from Birdlife International,
  - Data from Reptile Base and Amphi Base,
  - Final Makalu Barun National Park and its Buffer Zone Management Plan
- Social/cultural baseline conditions in the project impact area
  - National Population and Housing Census data,
  - District/municipalities/rural municipalities profiles,
  - Existing literature and studies on benefit sharing,
  - Annual Household Survey, Nepal Rastra Bank
  - Nepal Living Standards Survey, CBS
  - Ethnologies,
  - Cadastral property maps for the affected districts and municipalities, and
  - Municipality plans and policies.

3.2. Project Scoping

Pursuant to the Government of Nepal's regulations, a scoping process was conducted to define the scope of the EIA.. The objectives of the scoping process were to:

- Identify key resources and those project actions having the potential to cause or contribute to significant impacts on physical, biological, and socioeconomic and cultural resources;
- Identify potential concept design and technology alternatives for the Project;
- Obtain stakeholder views through consultation; and
- Inform the scope of the EIA through consultation and help focus the EIA process and output on the key issues.

The DoED reviewed the Terms of Reference (ToR) and forwarded the document to MOFE on 4 November 2019. MoFE approved the SD/ToR on July 30, 2020.

3.3. Primary Data Collection

In addition to the literature review, primary data collection was conducted via field surveys to collect project-specific data and fill data gaps from the literature. These field surveys focused on the DIA and, for some resources, included portions of the Indirect Impact Area. This data collection was conducted in accordance with the project's approved SD/ToR. Table **3.1** lists the key methods and sources used for the baseline studies. Most social data were collected using household (HH) surveys, Focus Group Discussions (FGD), and Key Informant Interviews (KII). **Annex 4** provides more detail on the methodology applied for each of these field studies. Vol. II, **Annex 4** provide the physical and biological baseline data, respectively, that were collected.

Table 3.1: Summary of Project Baseline Studies

Resource Area	Geographic Scope	Summary of Field Baseline Studies
Physical Resources		
Topography	Direct Impact Area	Conducted 1 m contour interval topographic survey (CSPDR, 2021)
Geology	Direct Impact Area	12 boreholes and several exploratory adits (CSPDR, 2021)
Soils	Direct Impact Area	Soil samples from 9 locations for soil texture, fertility, and physico-chemical parameters
Hydrology	Direct Impact Area and downstream	Installed stream gauges at dam in June 2018 and powerhouse in April 2018. Surveyed 48 cross sections across the Arun River from upstream of dam to Arun-3 HEP (CSPDR, 2021).
GLOF	Direct Impact Area and downstream	DHM data has been used
Dam break analysis	Direct Impact Area and downstream	Report prepared by UAHEL has been used for EIA
E flow	Direct Impact Area and downstream	Conducted as a part of EIA
Sediment	Direct Impact Area	Extensive sampling during all seasons (CSPDR, 2021)
Springs	Direct Impact Area	Collected flow data in wet and dry seasons from 32 springs in the project impact area
Water Quality	Direct Impact Area	Collected water quality samples at 12 sites, including 4 seasonal rounds of sampling at 8 sites
Air Quality	Direct Impact Area	Collected air quality samples for analysis from 5 sampling locations
Noise	Direct Impact Area	Monitored ambient noise levels at 11 locations
Land Cover	Direct and Indirect Impact Area	Mapped land cover from high resolution (i.e., 50 cm resolution) aerial imagery dated November 2017 followed by ground-truthing
Landscape Values	Direct Impact Area	Visual survey and photo-documentation
Biological Resources		

Resource Area	Geographic Scope	Summary of Field Baseline Studies
Aquatic Ecology	Direct Impact Area and Downstream	Conducted fish sampling at 12 sites, including four seasonal sampling at 8 sites. One site was located downstream of DIA at Sankhuwa Khola.
Terrestrial Ecology	Direct Impact Area	Conducted fauna surveys, including 14 line transects and 6 bird vantage point surveys. Conducted 9 flora line transect surveys in government, community and private land calculation of tree and pole loss including herbs and shrubs.
Socioeconomic and Cultural Resources		
Socioeconomic	Direct Impact Area	Household Questionnaire, FGD, KII, Cadastral Mapping, RAP Census Survey, RAP Land and Asset Survey
Community Health	Direct Impact Area	HH Questionnaire, KII with community/traditional health practitioners
Indigenous Peoples	Direct Impact Area	Household Questionnaire, FGD, KII,
Labour and Influx	Direct Impact Area	KII, FGD
Gender	Direct Impact Area	Household Questionnaire, FGD, and KII with women
Cultural Heritage	Direct Impact Area	Field walk over, KII, FGD

3.4. Impact Identification and Categorization

The EIA evaluates the direct and indirect impacts of the Project resulting from Project construction and operation, and proposed mitigation measures to avoid, minimize, and mitigate as per the mitigation hierarchy:

- Identify and avoid risks and impacts;
- Where avoidance is not possible, minimize impacts to acceptable levels by applying various measures; and
- Where significant residual impacts remain, compensate or offset them.

The impact assessment process includes four steps: predict, evaluate, mitigate/enhance, and determine residual impacts, as described below.

3.4.1. Predict Impacts

The first step in the impact evaluation process involved predicting and quantifying, to the extent possible, the nature, type, magnitude, extent, and duration of the identified impacts on receptors. These terms are defined in

Table 3.2**.**

Table 3.2: Definition of Impact Criteria

Criteria	Definition
Nature of impacts on environment/community	Beneficial—impacts that result in net benefits Adverse—impacts that result in net detriments
Type of impact	Direct—impacts resulting directly from changes caused by the project Indirect—secondary impacts caused by the project
Magnitude—takes into consideration importance of the receptor, sensitivity of the receptor to change, likelihood of the impact occurring	Low—a small, but measurable, change from the baseline conditions, typically that would not result in an exceedance of any applicable government standards Medium—a noticeable and readily measurable change from the baseline conditions that may result in an exceedance of any applicable government standards High—a substantial change from the baseline conditions that would result in an exceedance of any applicable government standards
Extent	Site-specific—impacts confined to construction sites Local—impacts extend beyond the project footprint area to affect resources up to 5 kilometers away from the project Regional—impacts observed extending more than 5 km away from the project.
Duration	Short-term—less than five years Medium-term—more than five years and less than 10 years Long-term—10 years or more

3.1.1. Evaluate Impact Significance

The second step of the impact evaluation process involved determining the significance of each identified impact. The magnitude, extent, and duration criteria each are assigned a numerical value, which are then combined in a risk matrix to characterize the overall impact significance (**Table 3.3**).

Table 3.3: Environmental and Social Impact Rating Criteria and Point Values

Magnitude	Extent	Duration	Significance	Point Range
Low (10)	Site-specific (10)	Short-term (5)	Low	0 - 40
Medium (20)	Local (20)	Medium-term (10)	Moderate	41 - 50
High (60)	Regional (60)	Long-term (20)	Substantial	51 - 89
			High	90 - 140

3.4.2. Mitigate Impacts

The next step in the process was the identification of measures that could be taken to mitigate, as far as reasonably practicable, the identified potential impacts of the Project. The development of mitigation measures followed the mitigation hierarchy of avoidance, minimization, mitigation to the extent feasible, and compensation or offsetting if necessary. Mitigation measures were

developed to address the potential impacts identified in the EIA process and reviewed with affected communities.

3.4.3. Determine Residual Impacts

The final step in the impact evaluation process was the assessment of residual impacts and risks. Residual impacts and risks are those that would remain after all relevant avoidance, minimization, and mitigation measures have been taken into consideration. In cases where a residual impact significance rating is high or substantial, emphasis is applied to reduce the impact/risk to a level that is as low as reasonably practicable. This is typically done by revisiting Steps 1 and 2 in the process (Predict Impacts and Evaluate Impacts, respectively) to identify ways of reducing impact magnitude or by considering implementation of new or additional avoidance or minimization measures aimed at reducing impact significance.

3.4.4. PAF and SPAF

As part of the impact assessment process, special consideration is given to Project Affected Families (PAF) and Severely Project Affected Families (SPAF). PAF's are defined as families/households that will lose land to the Project (i.e., will incur some level of economic displacement). SPAF's are defined as families/households that will lose their house to the Project and will have to relocate (i.e., will be physically displaced). These are discussed in more detail in Section 7.3.

3.5. Preliminary Draft EIA

Based on the primary and secondary data collection and data analysis methods described above, and applying the impact assessment methodology, ERM prepared a preliminary draft EIA for use during the EIA public disclosure meetings. The draft EIA was updated to address comments received during the disclosure process. This Draft EIA is prepared by multi diciplinary team of experts and declaration of the team member is presented in Annex 5.

3.6. EIA Public Disclosure

Public EIA disclosure meetings prior to the formal Public Hearing Meeting were held with the potentially affected communities, CFUGs, central, district and local government officials, MBNP staff, NGOs, and other interested stakeholders to disclose the findings of the Draft and to receive their input relative to the efficacy of the proposed mitigation and the residual significance of the impacts.

The formal Public hearing notice was published on the December 7th 2021 newspaper seeking active participation from concerned stakeholders (Vol. II, **Annex 6**). The Public hearing meetings were held between December 9 to 13, 2021 in the villages of Namase, Chepuwa, Rukma, and Sibrung. The summary of the suugestions and comments as well as attendance of the community members in the public hearing meeting is documented in **Vol. II, Annex 7**. Additional consultation with the gender biased and gender mixed stakeholders were conducted which are documented in Annex 7. Public consultation minute are documented in Vol. II, Annex7.

The final draft EIA was public distributed to the affected rural municipalites, district administration, Division Forest Office and the Makalu Barun National Park office from May 10 to 15, 2022 along with a 7-day public notice for the comments and suggestion (Vol. II, Annex 8). There was no response on the EIA report from the respective rural municipality. However

comments and suggestions were recived from MBNP and Division Forest Office. The recommendation letters from the concerned wards and affected rural municipality is presented in Annex 9.

The EIA report was submitted to June 29, 2022 and was presented to the DoED review Committee on 25th August 2022. The Review committee comments were received on 22nd of September 2022.

3.7. EIA

Based on the comments received prior to and from Public hearing meeting and DoED review committee, this EIA report has been revised for MoFE approval.

3.8. Overall Stakeholder Engagement

Stakeholder engagement refers to a process of sharing information and knowledge, seeking to understand and respond to the concerns of stakeholders, and building constructive and responsive relationships that are important for successful management of a project's environmental and social risks, as well as the sustainability of a project's outcomes.

3.8.1. Grievance Mechanism

The Project has established a Grievance Redress Mechanism (GRM) based on good international practices. The GRM consists of a system for receiving, recording and responding to complaints and a four-tier mechanism for formal resolution. As part of the GRM, eight grievance drop boxes were established in the Project area in locations selected based on discussions with project communities and local government representatives in the project impact area.

3.8.2. Communication Materials

To enable effective consultation with the stakeholders, the Project developed various disclosure and communication materials in Nepali language and distributed to stakeholders.The following information materials were prepared and distributed in project area.

- Project Information Document (PID) - which provides key disclosure and consultation material. This document consists of a non-technical summary of the Project, development timeline and milestones, project updates, consultation program and opportunities for the stakeholders to participate in development of the Project, timeline and venues for engagement activities, contact details for questions and queries. Three thousand copies have been distributed, primarily in the local area and are available at the Project Information Center. The PID have also been distributed through ward offices, health posts, and during consultation meetings. .
- Frequently Asked Questions (FAQ) – a FAQ document was developed for the Project, which provides answers to critical and frequently asked questions from the project communities and other stakeholders. The FAQ is also intended to ensure consistent messaging of critical project-related questions. This enables all project teams to disseminate accurate information. The FAQ provides guidelines for the project team for accurate and consistent messaging during their interactions with the communities and interested stakeholders.
- Grievance Brochure - a document simplifying the grievance process was developed to help the project communities understand how to register a grievance and what it may look like. This document also describes in simple language how the Project will respond to registered

grievances and different recourses that the project communities will have in the grievance process including contact information for grievance officers.

3.8.3. Project Information Centre (PIC)

In order to maximize regular interactions with the public, a Public Information Centre (PIC) was established in Gola in September 2019. The PIC welcomes visitors from the local communities and the district to obtain project information, ask questions, raise issues or log grievances. It has helped ensure a two-way communication between local communities and the Project.

3.8.4. Stakeholders Consulted

Major stakeholders consulted during the EIA include:

- Ministries/Departments – Ministry of Energy, Water Resources, and Irrigation, Department of Electricity Development, Ministry of Forests and Environment, Department of Archaeology; Department of National Parks and Wildlife Conservation, Department of Mines and Geology, Topographic Survey Department, Central Bureau of Statistics, Department of Hydrology and Meteorology, and Department of Plant Resources;
- District Level Offices –Women Children Development Section Office, Water Source and Divisional Irrigation Office, District Coordination Committee, Agricultural Knowledge Center, Division Forest Office (DFO), Drinking water and Sanitation;
- Local Government – Affected Rural Municipality and wards y;
- Federations – Federation of Community Forests Users Nepal (FECOFUN), Sankhuwasabha District Chamber of Commerce and Industries, Nepal Federation of Indigenous Nationalities (NEFIN), National Foundation for the Development of Indigenous Nationalities, and Barun Mela Committee;
- Non-Governmental Organizations (NGOs) – including the World Wide Fund for Nature – Nepal office (WWF) and Bird Conservation Nepal;
- Local Community – Directly and Indirectly Affected Population, women's group, youth groups, farmers group, Indigenous group, Community Forests User Groups (CFUGs)

Approximately 160 stakeholder engagement activities have been undertaken during the preparation of EIA and other environmental documents. The consultation made by the project is briefly given below:

- **S**coping Meetings – UAHEP conducted EIA scoping meetings in January 2019 to inform the potentially affected communities and officials about the Project and to obtain their input on key issues and concerns;
- Baseline Study Consultations – UAHEP shared project information and informally responded to stakeholder questions during the execution of project physical, biological and socio-economic surveys during 2019 - 2020;
- RAP Surveys – UAHEP conducted RAP surveys from December 2019 through January 2020;
- CIA Consultations – UAHEP conducted CIA consultations from March 11-14, 2020. During this time, UAHEP conducted 13 consultations including FGDs and KIIs with key stakeholders;
- Consultation with Indigenous People – A total of 41 FGDs with various indigenous, local communities, and members of CFUGs at various locations of the Project.
- EIA Disclosure Meetings – UAHEP conducted EIA disclosure meetings in December 2021.

CHAPTER 4: REVIEW OF PLANS/POLICIES, LEGISLATIONS, GUIDELINES, STANDARDS AND CONVENTIONS

Table 4.1 summarizes the administrative framework relavent to the UAHEP.

Table 4.1: Plans, policies, legislations, guidelines, standards and conventions of Nepal

Constitution	Related Provisions
Constitution of Nepal	Establishes that the economic objective of the State shall be to achieve a sustainable economic development,, while achieving rapid economic growth, by way of maximum mobilization of the available means and resources through participation and development of public, private and cooperatives, and to develop a socialism-oriented independent and prosperous economy while making the national economy independent, self-reliant and progressive in order to build an exploitation free society by abolishing economic inequality through equitable distribution of the gains and the project aligns with this directive principle. Acquisition of private property must be through legal process with appropriate compensation. Provides right to citizens to live in clean environment.
Plans	**Related Provisions**
15th Plan Approach paper (2076/77-2080-81)	The State will make such arrangements as may be required to protect the environment and emphasizes the need for sustainable utilization of natural resources.
National Biodiversity Strategy and Action Plan (2014-2020)	The strategies for managing protected area and forest biodiversity aim at reducing or managing human pressures on natural resources, reducing human-wildlife conflict, controlling invasive alien species, mitigating climatic threats to ecosystems, species and their habitats, and addressing economic and social concerns of local and indigenous communities through targeted programmes, enabling policy and legislative environment. Reducing the rate of loss and degradation of forest habitats, improving biological connectivity, enhancing knowledge and understanding about forests, promoting conservation of species and genetic diversities, enhancement of forest-based livelihoods are some of the focused areas.
National Water Plan, 2058	Section 7 of the NWP highlights the Environment Management Plan (EMP) as a strategic document for the implementation, monitoring and auditing of environmental protection programs. Emphasizes the need for Strategic Environmental Assessment and highlights the importance of EMP.
Policies	**Related Provisions**
Land Acquisition, Rehabilitation and Resettlement Policy, 2071	Recognize the need for resettlement plan to ensure the livelihoods of project-affected persons or households be at least above the pre-project conditions. Emphasize that the project development agency conducts meaningful consultation with project-affected persons, communities and sensitive groups, particularly poor, landless, senior citizens, women, children, indigenous / Janajati groups, disabled, and persons having no legal rights on the operated land while preparing land

	acquisition, resettlement and rehabilitation plan; provide employment opportunities to seriously project-affected households and vulnerable groups based on their skills and capabilities, and requires an adequate mechanism to listen to, register and resolve the grievances of the project-affected persons and communities;
Hydropower Development Policy, 2058	Establishes environmental protection standards, requires mitigation planning and local employment, provides guidance for land and property acquisition, and clarifies responsibility for resettlement and rehabilitation of project-affected people. Establishes provisions for project transfer to Government of Nepal and royalty payments to local area, and terms of license. The policy also recommends riparian release of 10% of the average minimum monthly flow or as recommended by the study.
National Forest Policy, 2075	Land use planning and change in land use categories, conservation of bio-diversity, eco-systems and genetic resources. The policy also aims to conservation of water, soil on basin level studying and planning based on catchment level. To reduce and mitigate the adverse impacts of climate related hazards and enhance climate change adaptation measures and resilience in Nepal.
Land Use Policy, 2069	The policy is formulated to improve social and economic status of project-affected families by providing fair and adequate compensation, appropriate resettlement and rehabilitation assistances/allowances while acquiring land for infrastructure development projects.
Nepal Environmental Policy, 2076	Five policy principles apply, including: a) to manage efficiently and sustainably natural and physical resources; b) to balance development efforts and environmental conservation for sustainable fulfilment of the basic needs of the people; c) to safeguard natural heritage; d) to mitigate adverse environmental impacts of development projects and human actions; and e) to integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and sufficient public resources.
Climate Change Policy, 2076	Includes climate adaptation and disaster risk reduction; low carbon development and climate resilience; access to financial resources and utilization; and importance of monitoring and evaluation.
Rangeland Policy, 2012	One of the objectives is to help maintain ecological balance by conserving, promoting, and sustainable utilization of rangeland biodiversity.
National Wetlands Policy, 2012	Objectives are to conserve biodiversity and protect environment by conservation, rehabilitation, and effective management of wetlands, involving local people in their management, and supporting the wellbeing of wetland dependent communities.
Acts	**Related Provisions**
Environment Protection Act, 2076	Mandates IEE/EIA study for development projects; prohibits project without approval; describes the approval procedures; prohibits emission of pollutants beyond the prescribed standards; stipulates

	provisions for the protection of natural heritage; stipulates compensation provisions arising from the discharge of waste and pollution; includes provision of punishment for actions against the Act and rules, guidelines and standards formulated under the Act;
Electricity Act, 2049	Mandates to develop electric power by regulating the survey, generation, transmission and distribute the survey, generation, transmission, and distribution of electricity and to standardize, and safeguard the electricity services.
Performance Based Social Security Act, 2074	It ensures the social security rights of laborers based on their contribution.
Muluki Aparadh Samhita, 2074 (Criminal Code)	The Criminal Code was adopted and outlaws the practice of Chhaupadi as was as the evangelization of citizens to other religions.
Muluki Debani Samhita, 2074 (Civil Code)	The bill includes provision on division of property.
International Trade Control Act for Endangered Species of Wild Fauna & Flora, 2073	This Act provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES, is implemented at the national level.
Soil and Watershed Conservation Act, 2039.	Prohibits actions within any protected watershed area and stipulates there are no obstacles for the Government of Nepal to use and develop of waters resources.
National Parks and Wildlife Conservation Act, 2029	Includes provisions to restrict damage to forest products and to block, divert any river or stream flowing through a national park or reserve, or any other source of water, or restrict the use of any harmful or explosive materials without obtaining written permission; Lists protected wildlife species that are prohibited from being hunting; and prohibits collection of samples from National Parks and Reserves without obtaining a license.
National Parks and Wildlife Protection Act, 2029	It states that, without permission, no one shall cut, fell, or remove any tree, plant or any forest produce or to cause forest products may die, burn or get damaged.
Water Resources Act, 2049	Stipulates the water resource rights of the Government; prohibits use of water resources without obtaining a license; establishes the order of priority for the utilization of water resources; stipulates procedures for water resource licensing; empowers Government to utilize the water resources and acquisition of other lands and property for the development of water resource; stipulates the right of the Government to fix the quality standards of water; prohibits pollution of water resources; and prohibits causing harm and adverse effects on the environment while developing a water resource project.
Land Acquisition Act,	Grants power to the Government to acquire any land anywhere for

2034	public purposes, subject to compensation under the Act; empowers Government to acquire land upon request by institutions subject to the payment of compensation and all other expenses under the Act; stipulate provisions and procedures for initiating initial land acquisition process and estimating compensation rates; stipulates procedures and provisions for notification of land acquisition; provides for the right to file complaints by those affected by public notice with regard to the land rights; stipulates procedures and provisions of setting compensation; stipulates disclosure of compensation entitlement through public notification; includes provision of complaints against the compensation rates; and that the decision of the Ministry of Home affairs on complaints is final.
Ancient Monument Protection Act, 2013	Empowers the Government to declare any place or area as a monument site/area; and restricts transfer, transaction, export or collection of ancient monuments and archaeological objects without approval of the government.
Labour Act, 2075	Prohibits on child labor and restriction on minors and women; regulates retrenchment and reemployment; working hours; remuneration; occupational health and safety; and settlements of labor disputes.
The Sexual Harassment at Workplace Prevention Act, 2071	The Act affords protection to employees, and workers employed by the entities (including contract workers) from any kind of sexual harassment.
Explosives Act, 2018	Requires government approval for the production, storage, use, transportation and import of explosives.
Land Act, 2021	Establishes rights of tenants.
Aquatic Animal Protection Act, 2017	Establishes provisions for fish ladders and fish hatcheries while constructing water diversion structures and requirement of prior permission from the government.
Guthi Corporation Act, 2033	Empowers the Corporation for the management and operation of the Guthi lands and properties and have stipulated the roles and responsibilities to the corporation.
National Foundation for Upliftment of Aadibasi/Janjati Act, 2058	The Act creates an environment for social inclusion of disadvantaged and indigenous people and ensuring participation of disadvantaged groups in the mainstream of overall national development of the country by protecting and preserving the culture, language and special knowledge of the Aadibasi/Janjati.
Forest Act, 2076	The Act aims to control the encroachment into forests and forest areas, illegal cutting, falling, hunting and trading of flora, fauna and forest products. It promotes co-operation in the conservation and development of private forest by managing the national forest in the form of government managed forest, protected forest, community forest, leasehold forest and religious forest.
Electricity Regulatory Act, 2074	Regulates the generation, transmission, distribution, and trade of electricity

Solid Waste Management Act, 2068	Establishes requirements for the management of solid waste and to protect the public health. The commercial or industrial establishments should adhere to the requirements during project construction and operation.
Right to Information Act, 2064	Makes the functions of the state open and transparent in accordance with the democratic system and to make it responsible and accountable to the citizens.
Local Government Operation Act, 2074	This Act states the roles of local bodies in Nepal. The jurisdiction, roles and responsibilities of personnel appointed in local bodies.
National Trust for Nature Conservation Act, 2039	This Act forms a trust under the guidance of Nepal government to conserve, promote and manage wildlife and other natural resources and requires consultation with the national trust for project affecting national parks.
Rules and Regulations	**Related Provisions**
Environment Protection Rule, 2077	Establishes three types of environment examination depending on the nature and size of the project - concise environment study, initial environment examination, and Environment Impact Assessment. Provides guidance for the EIA process.
Forest Rules, 2079	Prohibits change in national forest land use unless decided and agree to grant usufruct of the land to the user by GoN, forest cutting without obtaining a license; stipulates the procedures of licensing for forest products; makes a national priority project developer that uses national forest areas responsible for the compensation due to the project.
Performance Based Social Security Regulation, 2075	Provides for involvement in the program in the formal and informal sectors.
Electricity Regulatory Commission Regulation, 2076	It ensure balance between demand and supply of electricity by making the generation of electricity, transmission, distribution or business simplified, regular, systematic and transparent, to regulate the electricity tariff, to protect the right and interest of the electricity consumers, in order to make the electricity service reliable.
Wildlife Reserve Rules, 2034	Establishes entrance requirements, restricts activities, and stipulates prior approval for any research activities or study within the parks or reserves.
Electricity Regulation, 2050	This Act requires licenses related to electricity survey, generation, distribution, and import of electricity
Water Resources Regulations, 2050	Specifies the provisions and procedures of licensing for water resource utilization and the provisions, procedures and responsibilities for the acquisition of land and property for the development of water resources.
Conservation Area Management	Establishes Conservation Area Management Committee for the effective implementation of the construction works, protection of the

Regulation, 2053	natural environment, and management program related to the balanced utilization of natural heritage,
Labor Regulation, 2075	Provides for an employment contract and the matters to be covered under the employment contract.
Explosives Regulation, 2020	This regulate the production, storage, use, sale, transportation and import of explosives
Guidelines and Manuals	**Related Provisions**
Hydropower Environmental Impact Assessment Manual, 2075	Generic information on the procedures for EIA Scoping, ToR preparation, baseline environmental studies, information disclosure, public consultation, prediction and evaluation of impacts, mitigation prescriptions, monitoring and EIA report preparation in line with the EPA and the EPR.
Hydropower Licensing Guideline 2075	This guideline states all the criteria, rules and regulation regarding the survey license who want to generate the electricity.
Department of Electricity Development Manuals	Seven environmental manuals for hydropower development studies have been prepared to cover different aspects of EIA process and documents.
Guidelines for Handing Over the Forest Area for National Priority Projects, 2074	Establishes conditions for making forest lands available to development projects and required compensatory measures for the loss of forest land use and forest products.
Forest Products Collection, Sale and Distribution Guidelines 2073	The guidelines specify various procedure and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume, etc.
EIA Guidelines for Forestry Sector, 2051	The guideline specifies the EIA procedures to be followed while undertaking environmental studies that involve forest areas.
Community Forest Guidelines, 2071	Guideline sets processes and procedures to build capacity within the community forest user groups, prepare and implement community forest management plans.
Community Forest Inventory Guidelines 2062	Community Forest Inventory Guidelines detail the process and procedures for evaluating the forest stock and it's harvesting potential in Community Forests.
MoPE Guide to Environmental Management Plans of Hydropower Projects 2063	MoPE has published guidelines for conducting IEE/EIA of hydropower development projects, which detail methods and procedures for the preparation of environmental management plans, environmental auditing and environmental monitoring plans.
EIA Guidelines for Water Resource Sector 2050	The guideline sets procedures for identification of impacts from water resource projects over both short-term and long-term periods on natural and human environments; development of mitigation and monitoring

	plans; and public hearings and stakeholder engagement.
Guideline for Physical Infrastructure Development and Operation in Protected Areas 2065	Sets guidelines for infrastructure development in protected areas.
Conservation Area Management Guidelines, 2056	The objectives of this guidelines is to protect, conserve and rational use of biodiversity by the people and community living near a conservation area; and allows for the formation of management committees.
Procedure for the Use of Forest for National Priority Projects 2076	The procedure allows for projects to pay the government in cash in case of its inability to provide compensation in the form of land for the use of forest land.
Directives	**Related Provisions**
Directives on waiver of land holdings 2074	This order has made various provision for use of excess land by different industries, institution, hydropower project and other projects to acquire land.
Conservation Area Management Directives 2056	This sets different guideline for the management of the conservation area.
Electricity Licensing Directive, 2075	Establishes process for authorizing the capacity of the hydropower projects, and determining the licensing of the project based on financial and technical capability.
Social Security Schemes Operational Directives, 2075	Establishes coverage for employment and non-employment related accidents.
Conventions	**Related Provisions**
Convention on Biological Diversity, 1992	Introduces appropriate procedures requiring project EIA.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	Classifies species as Appendix I, II, and III species that are subjected to regulation so as not to endanger their survival.
Convention (No. 169) Concerning Indigenous and Tribal Peoples in Independent Countries 1989	Establishes the right of the indigenous and tribal people to decide their own priorities; safeguards the rights of the indigenous people in the land and natural resources in territories traditionally occupied by them; and participation in the decision-making process; and compensation for any resettlement.
United Nations Declaration on the Rights of Indigenous Peoples, 2007	Establishes the individual and collective rights of indigenous peoples, as well as their rights to culture, identity, language, employment, health, education and other issues and to pursue development consistent with their own needs and aspirations

UN Framework Convention on Climate Change 1992	Requires impact assessment to avoid or mitigate or adapt to climate change.
Standards	**Related Provisions**
Nepal Vehicle Mass Emission Standard, 2069	Compliance to Type I to Type V tests for vehicles fuelled with gasoline and diesel while importing vehicles for a project.
Generic Standard Part I, 2058	Establishes tolerance limits for industrial effluent discharged into inland waters.
Nepal Ambient Air Quality Standards 2069	Limits of ambient air quality parameters around construction sites.
Drinking Water Quality Standards 2063	Quality of drinking water supply in the project camps and construction sites.
Nepal Noise Standards 2069	Noise levels for different land use categories and noise generating equipment.
Indoor Air Pollution Standards 2066	Air quality for enclosed areas.
Exhaust Emission Standards for Diesel Gen Sets 2069	Emissions standards for exhaust emissions of Diesel plants / Generating sets.
National Indoor Air Quality Standards, 2066	The time weighted (1~24hrs) standards are given for PM10, $PM_{2.5}$, CO & carbon dioxide (CO_2) for indoor environments.

CHAPTER 5: EXISTING ENVIRONMENT CONDITIONS

The hydropower potential of the Upper Arun River was recognized during the Master Plan Study of the Koshi River in 1985 (JICA, 1985). Since then, there have been several studies conducted to better characterize the physical, biological, and social conditions in the project impact area. This chapter summarizes the existing physical (Section 5.1), biological (Section 5.2) and socio-economic and cultural (5.3) conditions of the project impact area, with a focus on those areas within the project's Direct Impact Area (DIA). Primary physical, biological and Socio-economic cultural baseline data are provided in **Annex 10, Annex 11** and **Annex 12** respectively.

5.1. Physical Environment Baseline

5.1.1. Physiographic/Geomorphological Setting and Topography

The UAHEP lies within the High Mountain Physiographic Zone (Vol. II, **Annex 10**). The topographic elevations of the project footprint vary between 1,065 m (near powerhouse tailrace) to about 2,010 m (Chepuwa Quarry near the headworks). This is an area with relatively young tectonic dynamism and has an eroding landscape combined with a monsoon climate, which creates high landslide potential and a heavy sediment load within the Arun River. The Arun River itself does not exhibit waterfalls along its course, nevertheless, the side tributaries (large and small) descending from either valley flanks (e.g. Chepuk Khola, Handak Khola, Tejo Khola, Sutsir Khola, and the Barun River along the right bank; and Chepuwa Khola along the left bank) invariably create a series of waterfalls (10 to 60 m height) near their respective confluences with the Arun River. The river valley between the UAHEP dam site and the Barun River confluence is a deeply incised gorge with steep slopes rising directly up from the riverbanks. The river substratum and the flooded banks are characterized by large boulders mixed with pebbles and cobbles, with little or no sandy admixture. This reflects the Arun River's high sediment transport capacity. Active landslides and other forms of mass wasting have a limited coverage within the UAHEP**.** Active landslides of debris flow nature are seen north of Namase and Than Thumbuk. The landscapes of Rukma, Namase, Sibrun and Chepuwa show feature of old stabilized landslides. Much of DIA includes area of colluvium and slope wash, which are considered to be areas of moderate instability and potentially subject to slides. Despite all the above features, the landscape hosting the structural components of UAHEP and its ancillary facilities do not show currently active land instability features. In terms of land stability, slopes below 30^{o} in the UAHEP area are relatively stable. Similarly, slopes of up to 50^{o} with exposed bedrock at the surface are also stable. The colluvium covered slopes above 30^{o} are naturally unstable slopes.

5.1.2. Geology

The UAHEP lies within the Lesser Himalayan zone about 3 to 5 km away from the Main Central Thrust fault (**Annex 10**). The bedrock in the reservoir area is mostly gneiss (Vol. II, **Annex 10**). The reservoir area, with slightly weathered and fresh rock mass, is expected to be with a low permeability and the Arun River Valley is the lowest drainage point in the regional area. The topographic and geological conditions help create an impervious reservoir. The reservoir slope mainly consists of rock, except for some areas upstream of the dam, which are covered by colluvial and deluvial deposits. After reservoir impounding, the rocky slopes are expected to remain stable as a whole, but the deposits may be subject to failure. The bedrock at dam site is made up of slightly weathered and fresh gneiss. Due to the high strength of the rock mass at the dam site, it is suitable for the dam foundation. The joints in the dam foundation are with high dip angles. In addition, the spacing of the gentle dip joints is wide with short persistence, which is suitable for

dam construction. The headrace tunnel passes through alternating layers of quartzite, mica kyanite gneiss, garnet biotite schist, muscovite schist, schistose amphibolite and calcareous rocks and micaceous quatzite. The headrace tunnel orients more or less parallel to strike direction and dip at low to moderate angles to east and southeast. The surge tank is located on carbonate rock. The pressure shaft passes through calcareous rocks, mica schist and quartzite. The powerhouse cavern is located within gneissic rock and mica schist. The tailrace tunnel passes through gneisses and schist.

5.1.3. Natural Hazards (Seismicity and Landslides)

The project development site lies in a relatively high seismic activity area (Vol. II, **Annex 10**). Nepal has experienced six known large/great damaging earthquakes (1255, 1408, 1505, 1833, 1934, and 2015) with magnitudes equal to or greater than 7.6 on the Richter Scale (Thapa et al. 2017). For seismic evaluation of the tunnel structures, the ground motion parameter are derived at the elevation of the tunnel. Ground motion generally decrease with depth below the ground surface. The proposed tunnels and caverns in the project have ground cover well above 30 m. Therefore, the PGA for tunnel construction in the project area is estimated as 0.16g. For PGA equal to or less than 0.2g ground shaking caused essentially no damage in tunnels (Source: CSPDR, 2021).

Owing to the steep Nature of the Arun river gorge and other major tributaries joining within and upstream of the project headworks, Major landslides are potential to occur in valley flank slopes above 30 degree which could even block the river resulting to landslide blocked lake outburst floods **(Annex 10)**. Such events are a common feature of this physiographic zone. Local people have a memory of such landslides related floods in the Barun river and upstream areas of headworks in the last 50 years.

5.1.4. Soil

The project impact area soils are acidic, well drained loamy sands with high organic matter content and relatively rich in nutrients. Because of the effects of tectonic dynamism and exceeding steep slopes, the area shows levels of denudation and erosion giving little time for soil development with soil thickness usually less than 50 cm (see Vol. II, **Annex 10**).

5.1.5. Climate

The UAHEP is located in the temperate (1,500 to 2,500 m elevation) to mild-temperate (800 to 1,500 m elevation) zones where winter is cool to cold, frost is common, and snowfall may occur at the upper elevations of this range, with warm summers. Chepuwa Station (elevation 2590 m) is the only meteorological station within the project impact area and it has been recording data since 1959. The annual average rainfall is 2,371 mm, with 67% of the rainfall occurring during the four-month monsoon season (**Figure 5.1**).

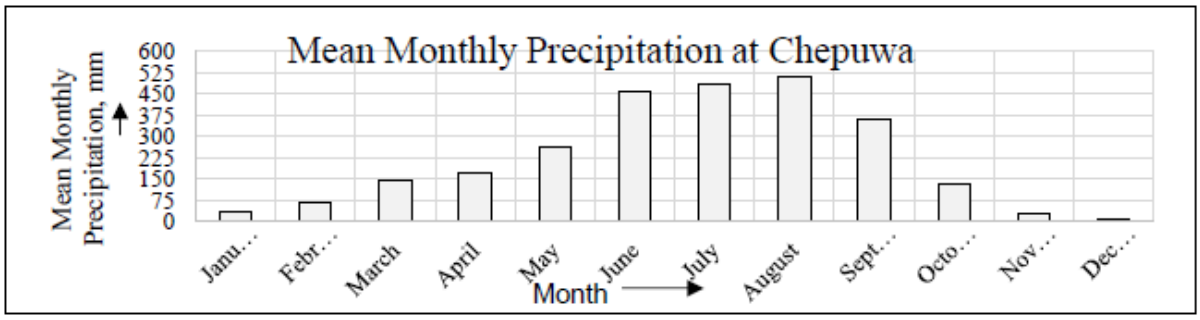


Figure 5.1: Mean Monthly Precipitation at Chepuwa

The recorded temperature and relative humidity as per DHM, khadbari station is presented in Table 5.1 The minimum and maximum tempertaure from year 2017 to 2022 is 8.25 ^{o}C and 30.49 ^{o}C respectively.

Table 5.1: Temperature and relative humidity of Kha Khandbari Metrological Station

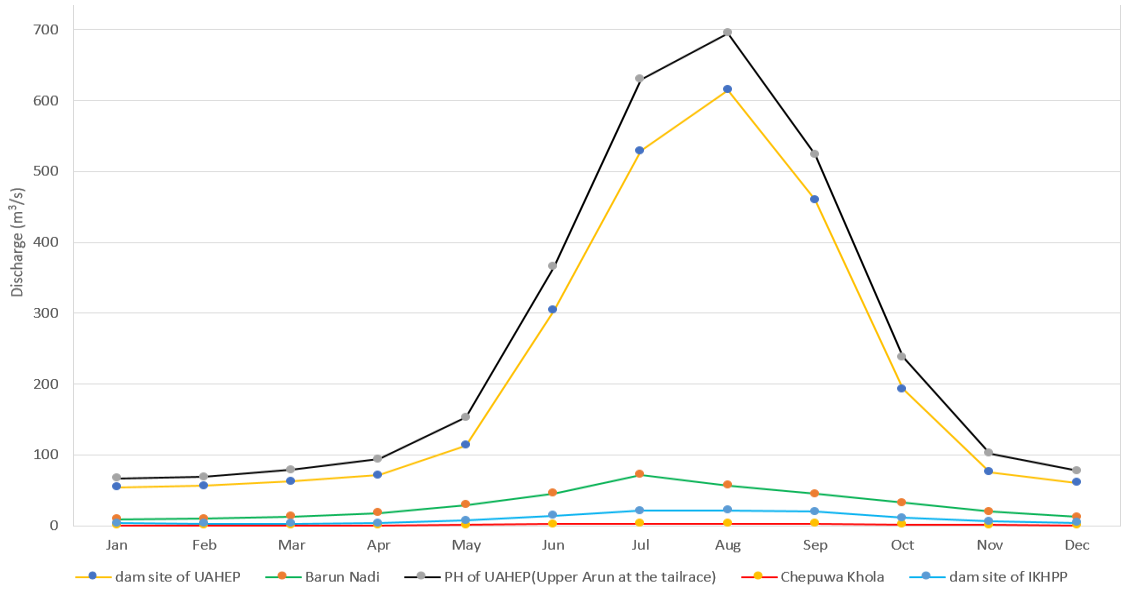
Year	Annual Temperature (Khandbari Metrological Station)			Relative Humidity (Avg)
	Min (°C)	Max (°C)	Avg(°C)	
2017	9.18	29.50	19.34	78.41
2018	8.92	28.80	18.86	78.54
2019	8.80	30.49	19.64	79.56
2020	8.25	30.10	19.17	81.53
2021	10.01	29.68	19.84	80.61
2022	9.02	30.06	19.54	81.19

Source: DHM Khandbari, 2023

5.1.6. Hydrology

The UAHEP is located on the Arun River, which is a tributary to the Sapta Koshi River, which in turn is a tributary of the Ganges River in India, which ultimately discharges to the Bay of Bengal in the Indian Ocean. The river originates from a glacier on the north slope of Mount Xixabangma (elevation 8,012 m) and the southern part of the Tibetan highlands in China. At the headworks site, the Arun River has a drainage area of 25,700 km^2, with approximately 98% of that draining from China (**see Vol. II, Annex 10**).

The Arun River is a relatively high volume, high gradient/high velocity, glacier-fed (i.e., cold with high sediment load) river. The Uwa Gaon gauging station, which is located just downstream of the UAHEP powerhouse, is the closest gauge to the project impact area and provides about 25 years of consecutive flow data. Three staff gauges were installed in April 2018 at the confluence of the Arun River with Chepuwa Khola, the powerhouse site, and Leksuwa Khola; and an automatic gauging station was installed at the dam site in June 2018. A synthetic long-term flow series was developed for the UAHEP dam site using daily flow records primarily from the Uwa Gaon gauging station. Based on hydrologic analysis of the available data, the annual average flow at the UAHEP dam site was estimated at 217 m^3/s (CSPDR, 2021). Flow in the Arun River is subject to strong seasonal effect as evidenced in average monthly flows (**Figure 5.2**). Flow velocities are high along the Arun River, with hand-measured flows ranging up to 15 m/s and computed average flows ranging up to nearly 10 m/s.



(Source: CSPDR, 2021)

Figure 5.2: Mean Monthly Arun River Flow Hydrograph at Various Locations

Vol. II, Annex 10 presents the flow duration curve for the UAHEP at the dam site, which shows a median flow of 87.4 m^3/s.

The Uwa Gaon flow station, which has a 43-year period of record (1973 – 2013 and 2016 – 2017), was used to estimate flood characteristics for the Arun River in the project impact area. The Probable Maximum Flood (1 in >10,000 year) value at the dam site and the powerhouse site are estimated to be 4,990 m^3/s and 6,060 m^3/s, respectively.

Washakh et al (2019) identified 49 glacial lakes in the Arun River Basin with surface areas greater than 0.1 km^2, including four potentially dangerous lakes for the Upper Arun dam and three potentially dangerous lakes for the Upper Arun powerhouse (**Table 5.2**).

Table 5.2: Potentially Dangerous Glacial Lakes for UAHEP

Lake #	Location	Glacial Lake Dam Type	Potential for Lake Impacts	Dam Geometry	Outburst Probability	UAHEP Facility Risk
20	China	Landslide dam	Debris flow	Stable	Medium	Dam
35	China	No dam	Debris flow	Stable	Medium	Dam/Powerhouse
36	China	Moraine dam	Ice avalanche	Unstable	High	Dam/Powerhouse
39	China	Moraine dam	Ice avalanche	Unstable	High	Dam
49	Nepal	Moraine dam	Ice avalanche	Unstable	High	Powerhouse

(Source: Washakh et al., 2019)

Lakes 36 (Qiangzongke Lake in China) and 49 (Lower Barun Lake in Nepal) were selected as posing the greatest GLOF risk, and the potential GLOF for each of these was modelled. The predicted GLOF from a Ziangzongke GLOF was predicted to be 7,576 m^3/s at the dam site and

6,935 m^3/s at the powerhouse site. The predicted GLOF from Lower Barun Lake was predicted to be 8,478 m^3/s at the powerhouse site (it is located downstream of the dam site so would not threaten that facility). The magnitude of the these GLOFs is predicted to be larger than a 10,000-year flood event; therefore, the Project has been designed to pass a 7,576 m^3/s flood at the dam site and 8,478 m^3/s flood at the powerhouse.

Natural Springs

There are many natural springs and small streams found in the project impact area which are used for various purposes by the local communities (Vol. II, Annex 10). Since the Project will require extensive tunnelling, which has the potential to affect groundwater, flow in the springs was measured (streams were estimated) during both the dry (April, 2019) and wet (November 2019)) seasons in the area where tunnelling will occur (**Vol. II, Annex 10**). Four of the natural streams are exploited for micro-hydropower by the local communities that provide power to various villages.

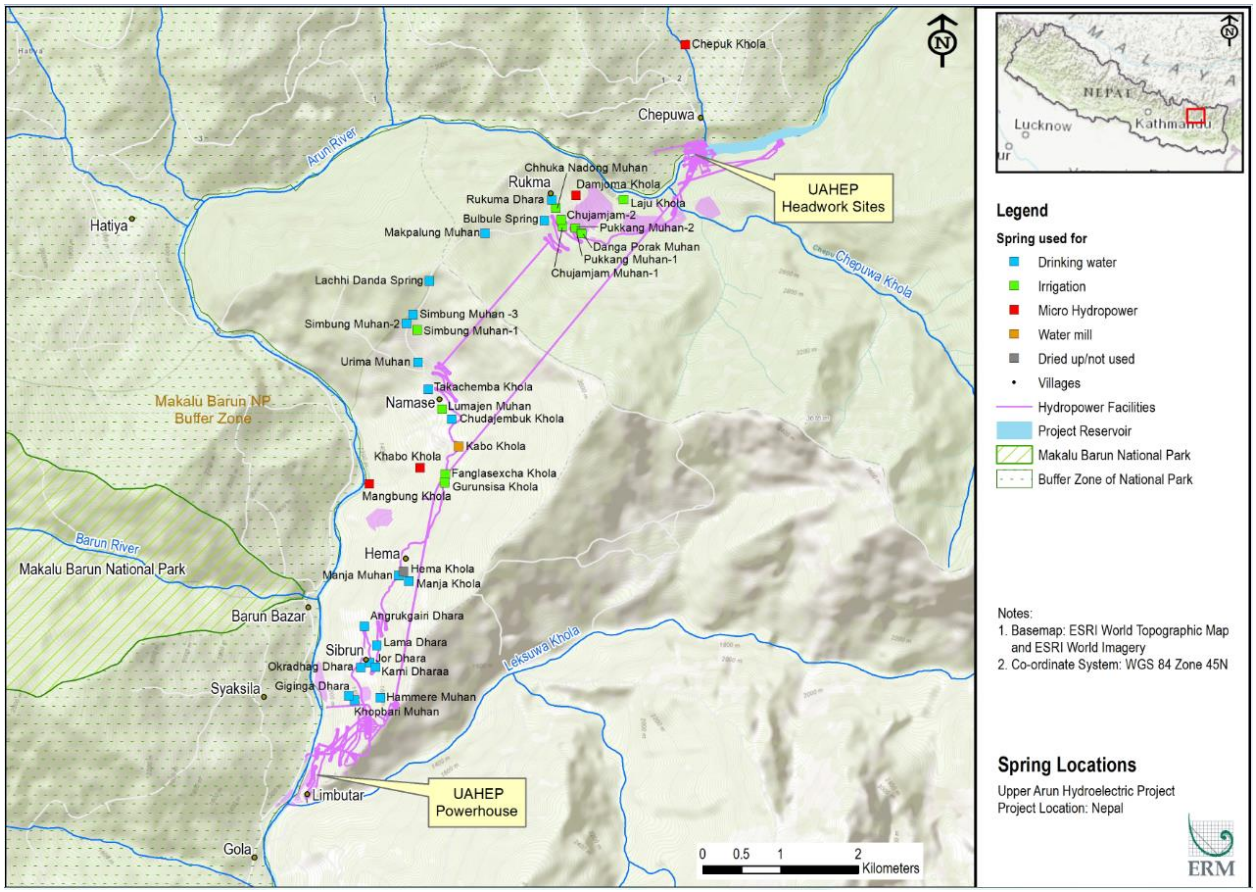


Figure 5.3: Spring and Community Micro-hydropower Plant Locations

5.1.7. Sediment

The Arun River is one of the most highly sediment laden rivers of Nepal. The sources of these sediments are excessive erosion related to tectonic dynamism of the terrain, including surface erosion landslides, mass failures, and debris flows, as well as glacial melt. Measurements of the sediment discharges on the Arun River reveals a sediment load of 16.24 million tons per year, of which 13.81 million tons is suspended sediment (average suspended sediment load is 2.01 kg/m^3) and 2.43 million tons is coarse bed load (CSPDR, 2021). Further, these studies also reveal, high sediment transport (95.5% of sediment load) occurs during the months of May to October. In the dry season (November to April), only a fraction (4.5%) of the sediment load is transported (see

Vol. II, **Annex 10**). In other words, the river discharge or conversely monsoon precipitation has a direct relationship with the sediment transport along the Arun River.

5.1.8. Water Quality

The ambient water quality of the Arun River is good with all parameters within the Nepal drinking water standards, with the exception of high turbidity levels (range of 17 – 1,702 NTU), resulting from its high sediment load, and iron and manganese, but these parameters are often high in natural waters and there is no indication here that the elevated concentrations found in the Arun River is due to anthropogenic sources. Dissolved oxygen (DO) levels were generally high across all sampling locations and seasons ranging from 6.4 mg/L to 10.7 mg/L. DO concentrations at or above 6.5 mg/L are considered indicative of good water quality and suitable for fish and aquatic life. DO concentration in freshwater is affected by several factors including water temperature, atmospheric pressure, aeration, and biological/chemical oxygen demand. The sampling shows a close inverse relationship between water temperatures and DO levels, with concentrations generally the highest during the winter and lowest during the summer, as oxygen saturation is higher in cold water. See Vol. II, **Annex 10** for more details.

Similarly, the water quality of most of the springs and small streams is also generally good, and generally meet Nepal Drinking Water Quality Standards with much lower turbidity levels (maximum of 7 NTU) relative to the Arun River. Some small streams, however, show elevated turbidity, ammonia, nitrite, and fecal coliforms concentrations, which are evidence of contamination from animal or human wastes. See Vol. II, **Annex 10** for more details.

5.1.9. Air Quality

In the rural areas of Nepal, air quality is generally good, although dust from unpaved roads and construction areas, and burning of biofuels and waste for heat and cooking can result in elevated particulate levels in isolated areas. Ambient air monitoring near the headworks and powerhouse area was very good, well below the Nepal Ambient Air Quality Standards (NAAQS). Overall, the lack of industry, fossil fuel power generation, and low vehicular traffic volume along the Koshi Highway results in relatively good air quality in the project impact area. Higher particulate matter concentrations are found along the Koshi Highway as a result of fugitive dust. See Vol. II, **Annex 10** for more details.

5.1.10. Noise

There is no vehicular traffic or industry within the DIA, so ambient noise levels are relatively low. Spot noise monitoring data bu NESS in 2019 indicate that average daily ambient noise levels in most of the project impact area is between 45 and 60 dBA, with daytime averages in the low 60's dBA and nighttime averages in the mid 50's dBA, which are fairly typical of rural locations. Elevated noise levels were found near project schools (**Vol. II, Annex 10** for more detail).

5.1.11. Land Cover

The Project is located in a relatively remote portion of northeast Nepal. It was only with the initiation of construction of the Arun-3 HEP in 2018 and the construction of the Num – Kimathanka portion of the Koshi Highway in 2019 that vehicular access was available along the west side of the Arun River, currently only as far as the Barun River. There is still no vehicle access to the east side (left bank) upstream of Arun-3 HEP. Forest is by far the dominant land

cover (67%), with agriculture (primarily cardamom, millet, and small plots of crops grown for local consumption) representing most of the remaining land (26%). **Table 5.3** and **Figure 5.4** show the existing land cover for the UAHEP DIA.

Table 5.3: UAHEP Land Cover Summary

Land Cover Classes	Area within Direct Impact Area (ha)	Area within Direct Impact Area (%)
Agriculture	1,747.6	26.0%
Barren (rock and scree)	172.3	2.6%
Forest	4,476.4	66.6%
Grassland	189.1	2.8%
Water (rivers, streams, lakes)	110.5	1.6%
Developed (villages/roads/trails)	30.5	0.4%
Total	6,726.2	100%

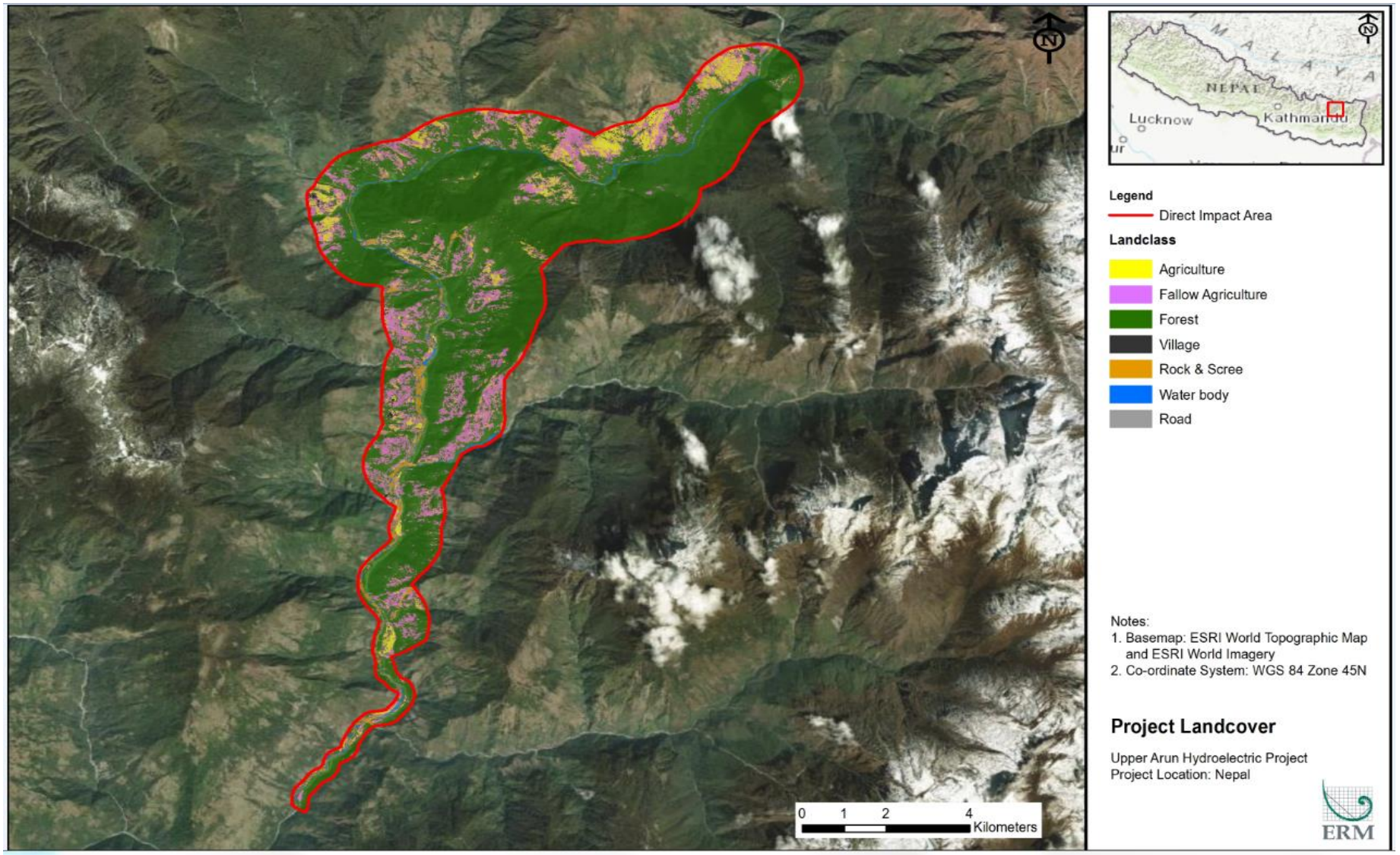


Figure 5.4: UAHEP Existing Land Cover

5.1.12. Landscape Values and Visual Amenity

The DIA is rich in natural beauty, cultural heritage, and ethnic diversity, including the MBNP and Barun Bazar, which is the site of the annual Barun Mela. Waterfalls are common throughout the DIA, with Chepuwa Khola falls located about 350 m downstream of the UAHEP dam, being one of the largest and most visible. There is also a large waterfall on the Barun River approximately 100 m upstream of its confluence with the Arun River, which is visible from Arun Valley from locations near Sibrun and Hema. The Arun River gorge cuts through steep forested slopes and fields of cardamom and millet. The area is of high scenic value

The project impact area is not one of the primary trekking areas in Nepal, and its number of visitors is far less than the more popular treks to Everest Base Camp and the Annapurna Circuit, but there is an extensive network of trails present in the area, which are used by both locals and trekkers. MBNP is the main trekking destination in the project impact area, with most trails eventually leading toward the Makalu Base Camp. The primary trekking route to Makalu Base Camp heads northwest from Num, but an alternative route does go up the Arun River Valley to the Barun River before climbing to the northwest to Makalu Base Camp. The completion of the Koshi Highway to China will make this area much more accessible and may affect the preferred trekking routes. Rafting does occur on the Arun River, but only far downstream of the project impact area, with most outfitters putting in to the river near Tumlingtar (about 50 river kilometers downstream of UAHEP), and taking out near the confluence with the Sun Koshi River. The Arun River in the project impact area would be unsafe for commercial rafting because of its steep gradient, relative high flows, and lack of takeout/rescue areas.

5.2. Biological Existing Environment

5.2.1. Terrestrial Biodiversity

The Project is located in a rural area with generally moderate to good quality habitat, especially along the Arun River valley, its tributary valleys, and along inaccessible hill ridges, as they are relatively undisturbed due to the remoteness and inaccessibility of these areas. The forest and shrub habitats close to the settlements in the project impact area are degraded by human influence, such that only species that are accustomed to human influence are expected to be present.

The Makalu Barun National Park (MBNP) Core Area (IUCN management category II) and its Buffer Zone (IUCN management category IV) is a biodiversity hotspot of international importance. It covers an area of 1,500 km^2 in the Solukhumbu and Sankhuwasabha Districts, and is surrounded by a buffer zone to the south and southeast with an area of 830 km^2 (**Figure 5.5**).

The field surveys identified four distinct forest communities in the DIA with Stainton classifications in brackets (see Vol. II, **Annex 11** for a detailed species diversity and species of conservation significance):

- *Alnus- Schima* Mixed Forest (Sub-tropical Broadleaved Forest)
- *Lyonia- Rhododendron* Forest (Upper Temperate Mixed Broadleaved Forest),
- *Alnus-Pinus* Forest (Temperate Coniferous Forest), and
- *Alnus-Castonopsis-Lyonia* Mixed Forest (Sub-alpine Forest).

There are several types of forest ownership in Nepal, which include government managed, community, leasehold, and religious forests; and private forests. There was no leasehold, religious, or private forests identified within the DIA. Government managed and Community

Forests are described below. The field surveys identified eight Community Forests within the Project Area (see **Table 5.4** and **Figure 5.6**).

The field surveys included an analysis of agricultural lands, which primarily occur around village. Thrity-four (34) agricultural species were documented on agricultural lands within the Project Area (see Vol. II, **Annex 11** for a species list). Of all the flora species identified during field surveys, 15 species are considered conservation significant species because they are (1) protected under Nepali law (8 species), (2) have an IUCN status of vulnerable or higher (1 species), and/or (3) have CITES conservation status (9 species). For details, see **Vol. II, Annex 11)**

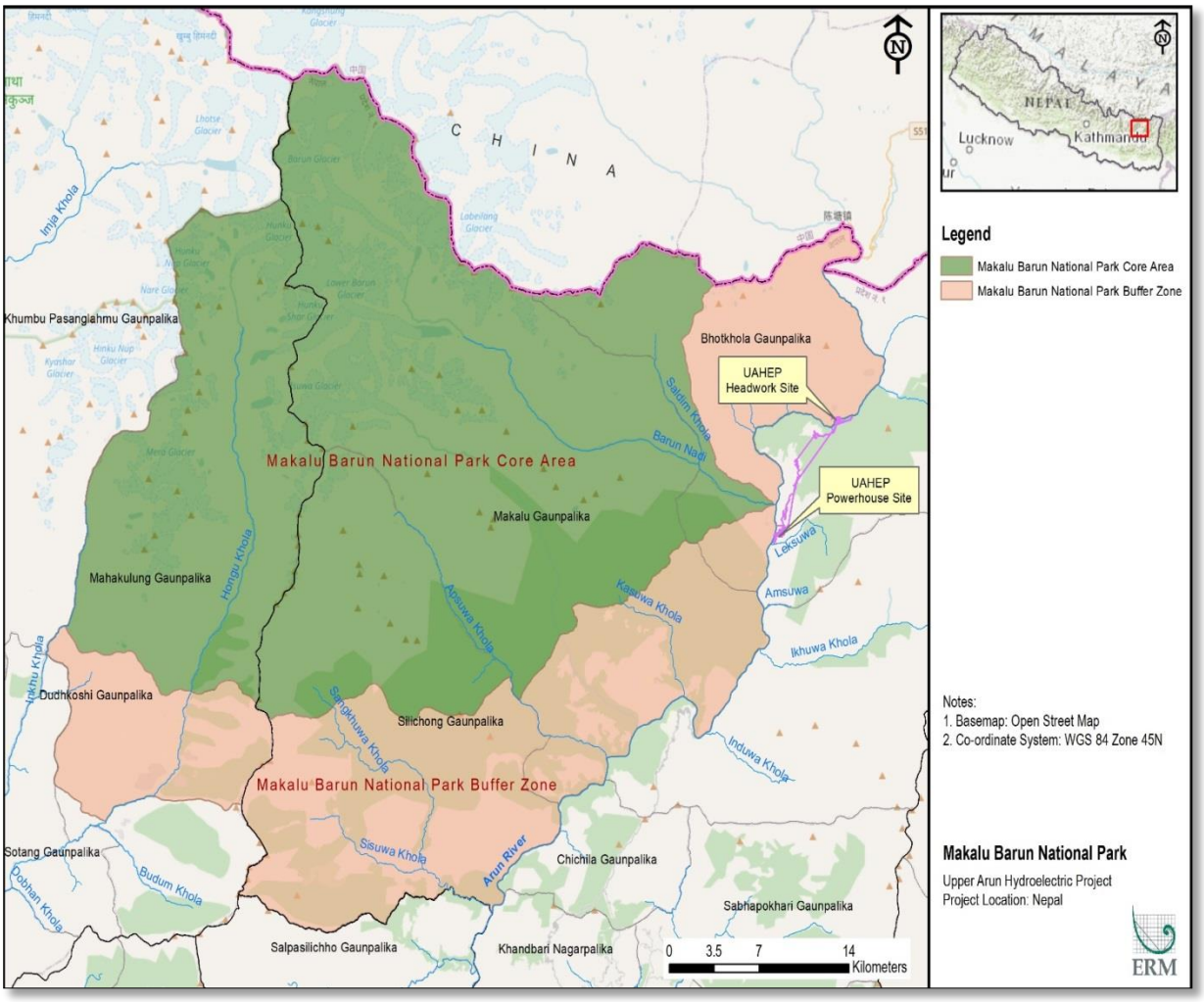


Figure 5.5: Makalu Barun National Park Core and Buffer Zone

Table 5.4: Community Forests in the Project's Direct Impact Area

Community Forest	Year Established	Area (ha)	Forest Uses	NTFP Species
Xulungma	1999	90	Fodder, timber, fuelwood, wild vegetables, forage, medicinal plant	*Swerita(Chiraito), Paris(Satuwa), Astible(Thulookhati), Urtica (Sisnu), Arundinaria(Malingo),*
Pejung Danda	2002	495	Fodder, timber, fuelwood, wild vegetables, medicinal plant	*Cinamomum(Tejpat), Amomum(Aliaichi), Urtica, Dryopteris(Niguro),*

Community Forest	Year Established	Area (ha)	Forest Uses	NTFP Species
				Acorus(Bojho), Aconogonum(Thonte), Arundinaria, Swerita
Mak Palung	1997	731	Fodder, timber, fuelwood, wild vegetables, forage, medicinal plant	*Swerita, Paris, Astible, Urtica, Arundinaria,*
Him Shikhar	1996	481	Timber, fodder, fuelwood, NTFPs, medicinal plants, forage, grass	*Daphne (Lokta), Arundinaria, Swerita*
Rapsali	1995	3.5	Fodder, fuelwood, NTFPs, forage	*Arundinaria, Swerita*
Pari Pakha	2015	3.9	Fodder, fimber, fuelwood, wild vegetables, forage, medicinal plant	*Swerita, Paris, Astible, Urtica, Arundinaria*
Gorujure	1996	312	Timber, fodder, fuelwood, NTFPs, forage,	*Daphne, Arundinaria, Swerita*
Mahavir Thaksingh Thapla	1996	500	Timber, fodder, fuelwood, forage, grass, agriculture equipment, NTFPs and medicinal plants	*Daphne, Arundinaria, Swerita, Taxus baccata*

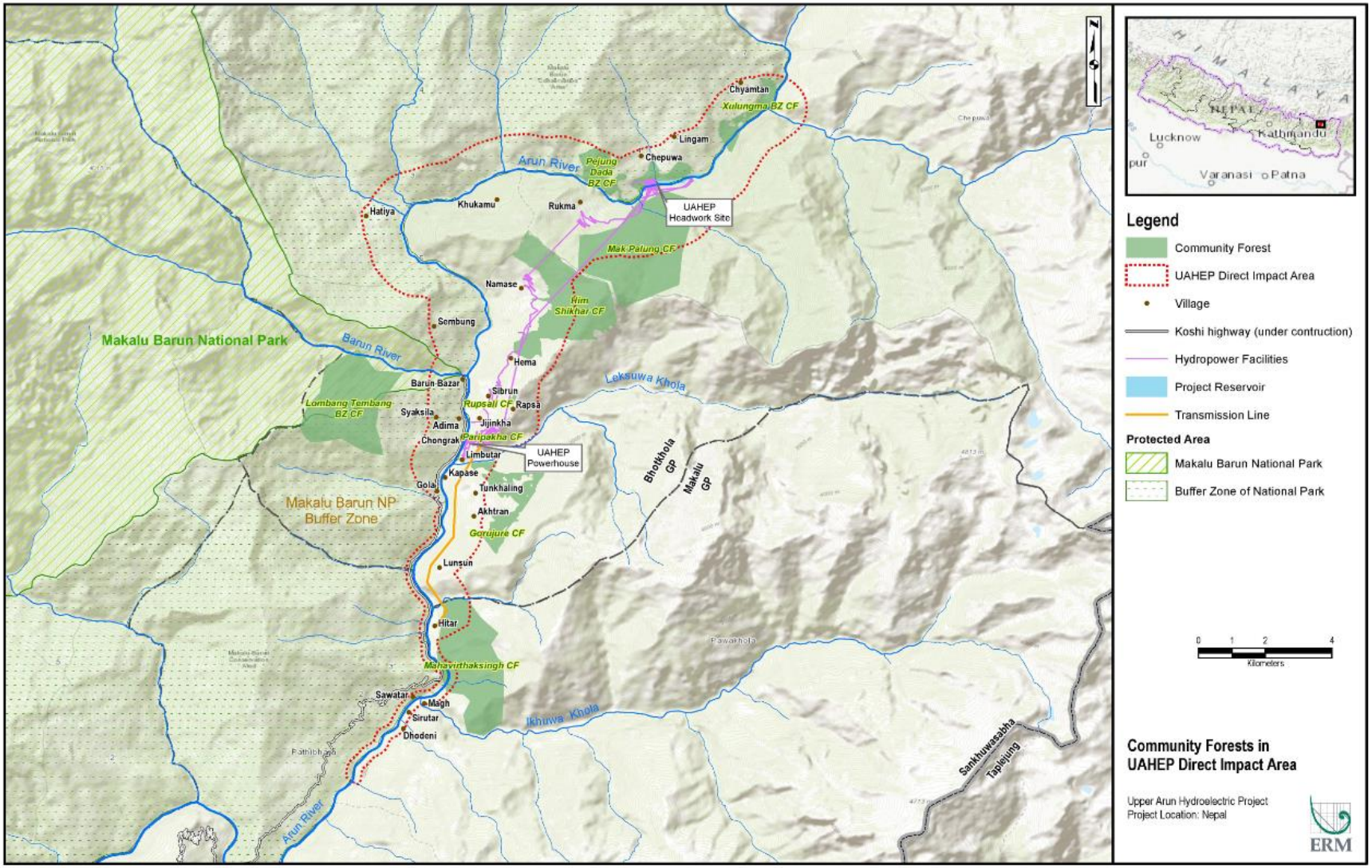


Figure 5.6: Community Forests within the Project's Direct Impact Area

The field surveys identified 43 flora species with ethnological importance to residents within and near the Project Area. The ethnologically important flora species identified have many different uses for the residents, including medicinal properties, nutrition, livestock fodder, ornamental, fuelwood, and timber. Ethnologically important flora species identified during field surveys and stakeholder consultation are listed in Vol. II, **Annex 11**.

Overall, the biodiversity field surveys recorded 266 floral species, including 239 birds, 20 mammals, and 7 herpetofauna (reptiles and amphibians).

The spring (April 2019) and autumn (October/November 2019) field bird surveys detected a total of 239 avian species (Vol. II, **Annex 12** – B, Table 12.12 and Figure 12.13 and 12.14). Four bird species identified in the DIA are classified by the IUCN as Near Threatened or higher:

- Steppe Eagle (*Aqila nipalensis*) – IUCN Endangered; Nationally Vulnerable)
- Asian Woollyneck (*Ciconia episcopus*) – IUCN Vulnerable; Nationally Near Threatened
- Bearded Vulture (*Gypaetus barbatus)* – IUCN Near Threatened; Nationally Vulnerable
- Himalayan Griffon (*Gyps himalayensis*) – IUCN Near Threatened; Nationally Vulnerable

This study identified the Steppe Eagle (*Aqila nipalensis)*, as present in both spring and autumn surveys. The Bearded Vulture (*Gypaetus barbatus*) is considered a fairly common resident of the nearby Makalu Barun National Park. A recent study of the distribution of this species recorded six individuals nearby and within the Project Area (Karki et al. 2019). The Himalayan Griffon (*Gyps himalayensis)* was identified during the spring survey at the Hatiya site; however, it was not observed during the autumn survey. This species is considered a fairly common resident within the Sankhuwasabha District. The Asian Woollyneck (*Ciconia episcopus*) was found during the autumn survey and is known to occur in MBNP. During the spring surveys, 19 of the species were detected ***(Vol. II,* Annex 11**). During the autumn (fall) surveys, 49 species were detected **(Vol. II, Annex 11).**

Twenty species of mammals were recorded during the surveys from field observations and interviews. Of these species, seven species are considered to be of conservation significance because of their IUCN status of Near Threatened or higher (**Table 5.5** and Vol. II, **Annex 11).** All seven species were recorded in mixed forest habitat and six of the species were also recorded in farmland habitat. The species considered rare within the DIA based on encounters during the transects included Assamese monkey, Himalayan black bear, Common leopard, Eurasian otter and Red panda. Nine species are listed under Nepalese Law. There were no endemic or migratory species recorded.

Table 5.5: Mammal Species Documented during Surveys

Common name	Local Name	Scientific Name	IUCN RL status	National RL status	Endemic/ Restricted Range	Observed or Reported
Red Panda	Habre	*Ailurus fulgens*	EN	EN	No	Reported
Himalayan black bear	Bhalu	*Ursus thibetanus*	VU	EN	No	Reported
Common Leopard	Chituwa	*Panthera pardus*	VU	VU	No	Reported
Assamese monkey	Pahrey Bandar	*Macaca assamensis*	NT	VU	No	Reported

Common name	Local Name	Scientific Name	IUCN RL status	National RL status	Endemic/ Restricted Range	Observed or Reported
Eurasian otter	Kalo Ott	*Lutra lutra*	NT	NT	No	Reported
Common Goral	Ghoral	*Naemorhedus goral*	NT	NT	No	Observed
Himalayan Tahr	Thar	*Hemitragus jemlahicus*	NT	NT	No	Observed
Leopard cat	Charibagh/ Banbiralo	*Felis bengalensis*	LC	VU	No	Reported
Barking deer	Ratuwa	*Muntiacus vaginalis*	LC	VU	No	Observed
Orange bellied Himalayan squirrel	Himali Ban Lokharkey	*Dremomys lokriah*	LC	LC	No	Observed
Nepal grey langur	Nepali Langur	*Semnopithecus schistaceus*	LC	LC	No	Observed
Rhesus monkey	Rato Bandar	*Macaca mulatta*	LC	LC	No	Reported
Yellow throated marten	Malsapro	*Martes flavigula*	LC	LC	No	Reported
Small Indian mongoose	Sano Neyuri Muso	*Herpestes auropunctatus*	LC	LC	No	Reported
Jungle cat	Banbiralo	*Felis chaus*	LC	LC	No	Reported
Wild boar	Bandel	*Sus scrofa*	LC	LC	No	Reported
Small Indian Civet	Sano Neer Biralo	*Viverricula indica*	LC	LC	No	Reported
Particolored flying squirrel	Maley Rajpankhi Lokharke	*Hylopetes alboniger*	LC	LC	No	Reported
Red fox	Rato Feuro	*Vulpes vulpes*	LC	DD	No	Reported
Malayan porcupine	Malaya Dumsi	*Hystrix brachyuran*	LC	DD	No	Reported

Surveys recorded seven species of herpetofauna, including two amphibians and 5 reptiles. None of the seven species meet the criteria to be of conservation significance (see Vol. II, Annex 11 for a detailed species listing).

5.2.2. Aquatic Biodiversity

The Arun River is a cold, turbid, snow-fed river, as are some of its major tributaries (e.g., Barun River) that drain the high Himalayas. Other tributaries that only drain lower elevations tend to have slightly warmer and less turbid water (e.g., Leksuwa Khola, Ikhuwa Khola), and are referred to herein as the "clear water tributaries". The Upper Arun River is fast flowing with relative rough ecological conditions and low number of aquatic species compared to the lower section of the river. The larger perennial clear water (i.e., not glacial fed) tributaries are especially important as most upstream migrating fish (e.g., Golden mahseer and Common snowtrout) prefer these streams for spawning because they have clean gravel substrate, which are more suitable for spawning, and have slightly warmer water temperatures. The Upper Arun River has been poorly studied and limited data on aquatic biota were found. No studies on the river upstream in China were found.

The baseline surveys resulted in the collection of 13 species, while an additional 22 species were reported by local fishers to be found in the Arun River (see Vol. II, **Annex 11** for a species list). Data from all sampling events show a low number of species in the upper part of the Arun River between the UAHEP dam site (1,570 m) and powerhouse (1,080 m), with fish diversity increasing in a downstream direction, as well as in clear water tributaries (i.e., Ikhuwa Khola):

- Upstream of the UAHEP dam site (Station S1) – 2 species (*Schizothorax richardsonii* and *Nemacheilus botia*);
- UAHEP proposed diversion reach (Stations S2 and S3) – 2 species (*Schizothorax richardsonii* and *Psilorhynchus psuedecheneis*);
- Downstream of UAHEP powerhouse to Ikhuwa Khola (Stations S4 and S7) – 4 species
- Ikhuwa Khola tributary (Stations S5 and S6) – 5 species
- Downstream of proposed Arun-3 HEP (Station S8) – 11 species

Schizothorax richardsonii (IUCN VU) was by far the most abundant species in the collected fish samples in the upper part of Arun River, representing over 80% of all individuals caught. The few other relatively common species included the mid-range migrants *Psilorhynchus pseudecheneis* (IUCN LC) and *Neolissochilus hexagonolepis* (IUCN NT). The abundance of fishes collected are shown in **Table 5.6.**

Of the long migratory species, information from local fishers indicates that species including Golden mahseer [IUCN EN] and *Tor tor* [IUCN DD] may utilize the Arun River, most likely below elevation 900 m, but potentially up to elevation 1,100 m (confluence of Leksuwa Khola and the Arun River). *Golden mahseer* was collected at the confluence with Sabha Khola downstream of Khandbari at approximately elevation 280 m (Shrestha, et al., 2015) and is reported to be found near the confluences of Sankhuwa Khola at approximately elevation 350 m, Pikhuwa Khola at approximately elevation 560 m, and Apsuwa Khola at approximately elevation 650 m (Arun-3 HEP, 2015). The Arun-3 HEP concluded that the upper limit of upstream migration of *Tor* species in the Arun River was likely Apsuwa Khola. As part of the UAHEP fish survey, one fisherman reported catching Golden mahseer at the mouth of the Ikhuwa Khola at approximately elevation 900 m about 15 years ago (Vol. II, **Annex 11**). Other than this single observation, no individuals of Golden mahseer have been caught or observed upstream of the Arun-3 HEP.

Achnanthidium sp., *Caloneis amphisbaena*, *Cyclotella sp*. and *Navicula radiosa* were the major species of class Bacillariophyceae recorded during different sampling period. Cyanophyceae was represented by two species namely *Oscillatoria sp.*, *Lyngbya sp*. Among the zooplankton species

Cyclops sp. Dhapnia sp. Keratella sp. Rotaria sp. Bosmina sp. Polyarthra sp. Diaptomus sp. and *Brachiomus sp*. were found in different sampling stations. The macroinvertebrates observed at the various reach of the Arun River were *Tipula sp., Caenis sp., Baetis sp., Dyticus sp., Epeorus sp.* etc. The details of phytoplankton, zooplankton and macroinvertebrates found at disffernt sampling station are presented in Vol. II, Annex 11.

Table 5.6: Fish Abundance by Species (SCI 2017-2018)

S/N	Scientific Name	Local Name	# of Individuals Collected				Total
			Winter	Spring	Summer	Fall	
1.	*Barilius barila*	*Faketa*	0	0	2	0	**2**
2.	*Botia geto*	*Baghi*	0	1	0	0	**1**
3.	*Euchiloglanis hodgarti*	*Tillkabre*	0	6	0	3	**9**
4.	*Garra annandalei*	*Lahare buduna*	0	2	0	0	**2**
5.	*Garra gotyla*	*Nakte Buduna*	0	1	0	0	**1**
6.	*Glyptothorax pectinopterus*	*Kabre*	0	1	0	3	**4**
7.	*Labeo dero*	*Gardi*	0	3	0	0	**3**
8.	*Nemacheilus botia*	*Gadela*	0	0	0	1	**1**
9.	*Neoliocheilus hexagonolepis*	*Katle*	3	8	1	9	**21**
10.	*Psedecheneis sulcatus*	*Kabre*	0	2	3	0	**5**
11.	*Psilorhynchoides pseudecheneis*	*Titae*	1	4	5	23	**33**
12.	*Schizothorax richardsonii*	*Buche Asala*	62	133	51	118	**364**
13.	*Schizothorax plagiostomus*	*Asala*	1	0	0	0	**1**
14.	*Schizothorax progastus*	*Chuche Asala*	1	1	0	3	**5**

5.3. Socio-economic and Cultural Existing Environment

5.3.1. Administration, Governance and Political Context

The Upper Arun Hydroelectric Project (UAHEP) is primarily located in Bhotkhola Rural Municpality, in the Sankhuwashabha District of Koshi Province, Nepal. In Sankhuwashabha, there are 10 local bodies (nine Rural Municpality and one Municpality) consisting of 76 wards with Khandbari serving as the district headquarters. Sankhuwashabha represents one constituency

in the National Assembly and two constituencies (1 and 2) in the Province Assembly. Bhotkhola Gaunpalika consists of five wards, each of which is comprised of multiple clusters of households referred to as villages.

5.3.2. Demographics, Ethnicity and Religion

The population Bhotkhola Rural Municipality is 6438 according to the 2021 Nepal Census. In Bhotkhola, Adivasi Janajati (Indigenous Peoples) comprise 97.6% of the total population (**Table 5.7 and Vol. II, Annex 12**). Most of the households are followers of the Tibetan-influenced schools of Buddhism (72.65%), about 3.49% reported themselves as Hindus, and 20.43% still follow Kirat or animism (Vol. II, Annex 12) . The educational level for the population above 5 years of age shows that 38.6% of the population is illiterate and 0.27% has limited to reading only simple sentences. Most of the children now are enrolled in primary and lower secondary schools available in the project area.

Table 5.7: National and District Level Demographic Comparison

Demographic Parameter	Sankhuwashabha	Nepal
Total Population	158041	29164578
Male Population	79579	14253551
Female Population	78462	14911027
Sex Ratio	101.42	95.59
Average Household Size	4.03	4.37
Population <15 years	27.01%	26.05%
Population in age group 15-59 years	60.85%	63.74%
Population >60 years	12.16%	10.21%

Source: Central Bureau of Statistics (CBS), National Population and Housing Census 2021

Bhotkhola Rural Municipality consists of five wards covering an area of 639.01 km^2 with a population of 6438 as of the 2021 National Census. Table 5.8 below provides the basic demographic parameters of Bhotkhola Rural Municipality as of 2021, disaggregated by Ward.

Table 5.8: Basic Demographic Parameters of Bhotkhola Gaunpalika

Ward No.	No. of Households	Population			Sex Ratio (Females per 100 Males)	Average HH Size
		Total	Male	Female		
1	83	300	142	158	89.87	3.61
2	387	1375	671	704	95.31	3.55
3	349	1082	527	555	94.95	3.10
4	505	2017	1006	1011	99.51	3.99
5	360	1664	854	810	105.43	4.62
Total	1684	6438	3200	3238	98.83	3.82

Source: Central Bureau of Statistics (CBS), National Population and Housing Census 2021

Each of the five Wards within Bhotkhola Rural Municipality is comprised of 22 villages or settlements (locally referred as tole or village). Table 5.9 below shows a list of the Project-affected villages, the total number of households contained therein, and the sample size covered during the socioeconomic survey ERM conducted in 2019-2020.

Table 5.9: Demographic Details of Surveyed Households

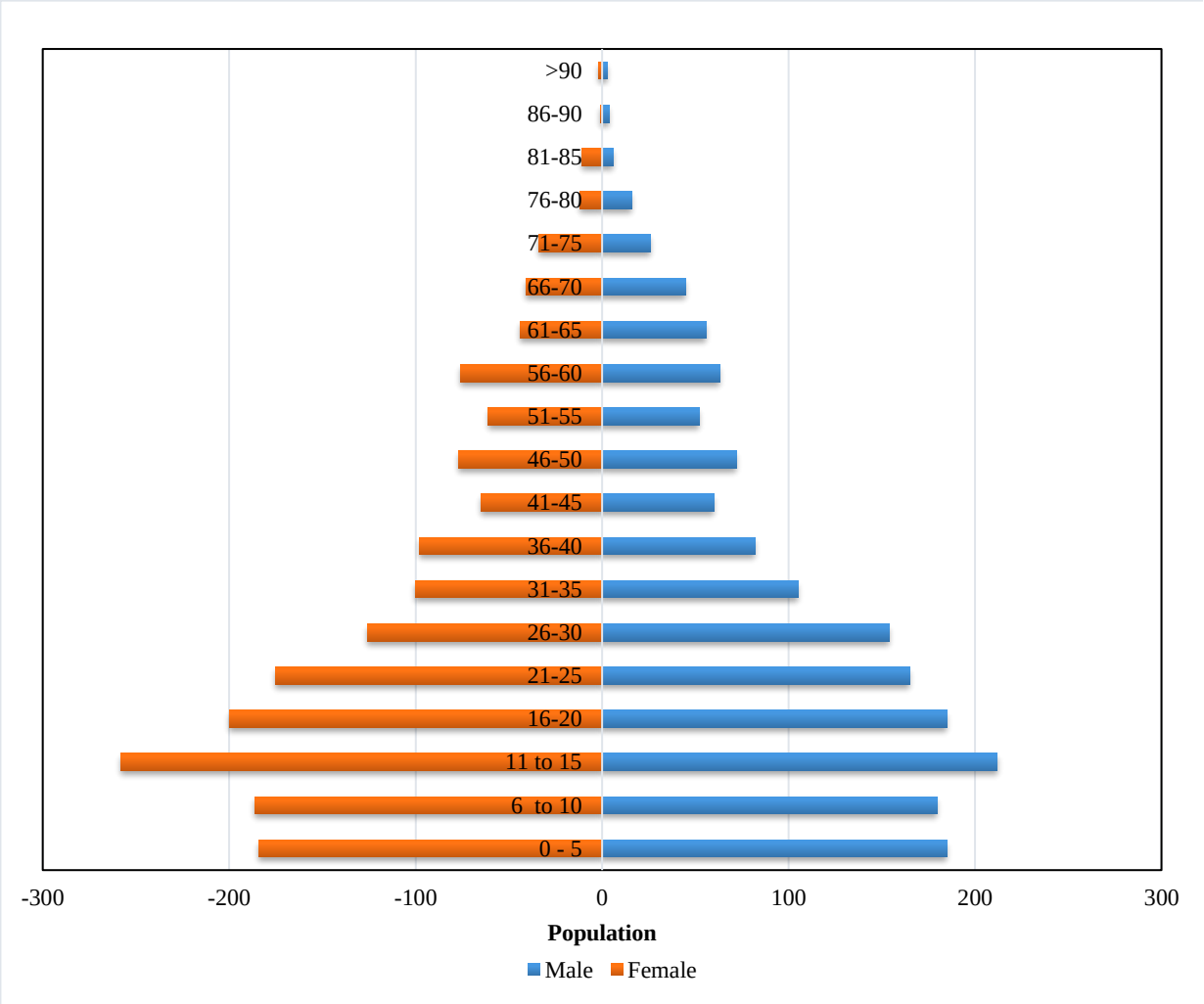
Gaunpalika	Ward Number	Village/ Settlement Name	# of Males	# of Females	Total Population	Sex Ratio	# of Households	Average HH Size
Bhotkhola	Ward2	Chepuwa	311	323	634	104	105	6
		Chyamtan	63	68	131	108	21	6
		Guthi Gumba	31	29	60	94	8	8
		Lingam	26	34	60	131	11	5
		Rukma	86	87	173	101	27	6
	Ward 2 Total		**517**	**541**	**1058**	**105**	**172**	**6**
	Ward 3	Hatiya	84	97	181	115	34	5
		Hongon	111	134	245	120	41	6
	Ward 3 Total		**195**	**231**	**426**	**118**	**75**	**6**
	Ward 4	Adima	13	14	27	107	5	5
		Barun Bazar	15	23	38	153	6	6
		Chongrak	16	14	30	88	5	6
		Gola	68	65	133	96	24	6
		Hema	80	74	154	93	25	6
		Jijinkha	13	18	31	138	6	5
		Limbutar	12	12	24	100	6	4
		Namase	180	197	377	109	71	5
		Sembung	16	10	26	62	5	5
		Sibrun	229	222	451	97	73	6
		Syaksila	110	83	193	76	35	6
	Ward 4 Total		**752**	**732**	**1484**	**97**	**261**	**6**
	Ward 5	Kapase	19	24	43	126	8	5
		Lunsun	20	18	38	90	8	5
		Rapsa	10	15	25	150	4	6
		Tunkhaling	122	145	267	118	51	5
	Ward 5 Total		**171**	**202**	**373**	**118**	**71**	**5**
Bhotkhola Total			**1635**	**1707**	**3342**	104	579	**6**

Source: ERM Socioeconomic Survey, 2019-2020

In Bhotkhola Rural Municipality, Adivasi Janajati population comprised 97.6% of the total population in 2021**.** The major ethnic groups in Bhotkhola Rural Municipality are Bhote, Rai, Yamphu, Tamang, Lhomi, Sherpa, and Gurung. The socioeconomic survey found that Adivasi Janajati households constitute ~ 99% of the total households surveyed. Specifically, Bhote households constitute 68% of total surveyed households, followed by Rai (15%) and Tamang

(11%). The 1% of the surveyed households that is non-Adivasi Janajati consists of households from Kami (Bishowkarma) castes.

Figure 5.7 presents the age pyramid for the surveyed households.



Source: ERM Socioeconomic Survey, 2019-2020

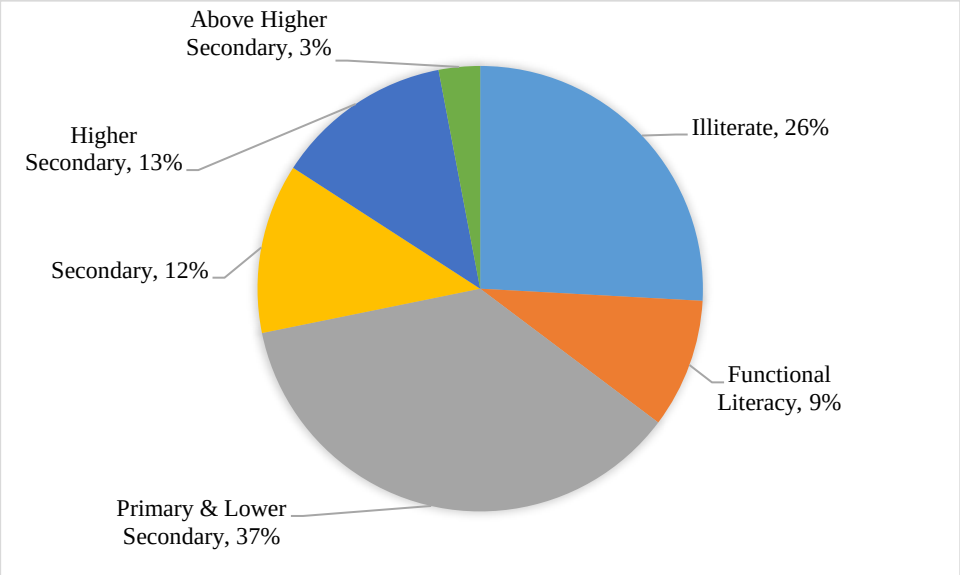
Figure 5.7: Age Distribution Pyramid for Surveyed Households

About 88% of non-Adivasi Janajati households are nuclear families where a married couple live with their children and the remaining 12% live in joint family situations (where elderly parents live with their adult children and their offspring). By comparison, only 62% of Adivasi Janajati households live in a nuclear family situation, compared to 29% living in a joint family structure and 10% living in an extended family structure (i.e., family includes members outside of immediate kin group, for example a cousin from spouse's side). Therefore, one can reasonably conclude that Adivasi Janajati ethnic groups show more propensity than non-Adivasi Janajati groups to live in a non-nuclear family structure.

Figure 5.8 shows literacy / educational levels amongst the surveyed households, disaggregated by village.[1] The villages with the highest illiteracy rates were Lunsun (45%), Limbutar (40%), Rapsa (35%), Obak (34%), Hema (31%), and Rukma (31%). Those with the lowest illiteracy rates were Sembung (13%), Guthi Gumba (14%), Barun Bazar (15%), and Chongrak (15%). In terms of higher

[1] Recall, as explained above, that while the socioeconomic survey was primarily conducted at the household information, it also collected individual level information (via the head of household) for a number of basic demographic characteristics, including education. This made it possible to disaggregate educational information by individual.

education, the villages with the highest percentage of the surveyed population having completed education beyond higher secondary were Chongrak (11%), Chyamtan (10%), Kapase (8%), and Guthi Gumba (7%).



Source: ERM Socioeconomic Survey, 2019-2020

Figure 5.8: Literacy / Education Levels[2] of Surveyed Households

Insofar as it relates to seasonal migration, 76% of individuals within the surveyed households remain in their villages throughout the year, while 24% venture out to urban centres for at least part of the year seeking employment, to trade, or for other purposes. Households within villages at higher elevations (i.e., those in Bhotkhola Ward 2) reported practicing seasonal migration – along with their livestock – from higher to lower elevations in winter months. The dependence on livestock keeping amongst these households has reduced; however, many of them still reported going to urban centers in lower elevation areas to escape the cold months and take up wage employment or trade in herbs collected from higher elevations, which are not available in lower elevations.

5.3.3. Land Use and Ownership

The average land holding in DIA of the Project is 2.3 ha or 47 ropani (1 ropani = 509 m^2). Within the DIA, women in approximately 18% of the household's own land jointly or in their name. Although, women own land in their name, the decision to sell or not to sell land is usually made by male family members.

Most households own some agricultural land, possibly some private forestland, and often will have a small orchard or at least fruit trees. This composite use of different types of land is crucial for meeting various requirements of the households and helps in making the household self-sufficient. Apart from cultivating their own land, some households cultivate additional land obtained through sharecropping or on lease (Bandagi). Some households also report cultivating some of the government-owned land.

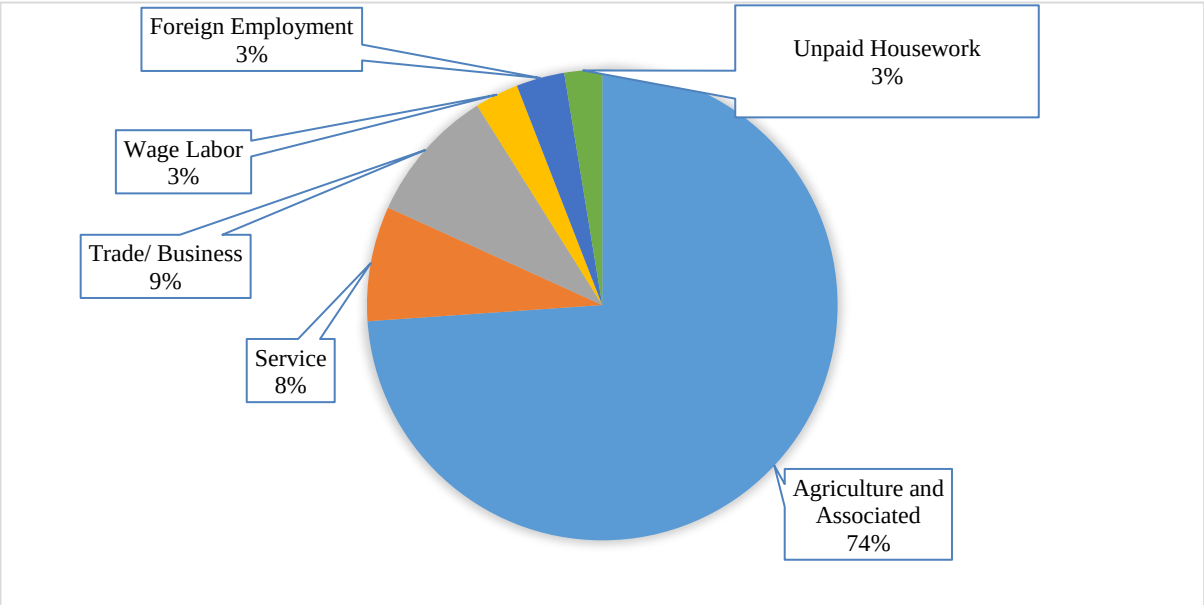
[2] According to the Government of Nepal, primary school goes from grades 1 – 5, lower secondary goes from grades 6-8, secondary goes from grades 9-10, and higher secondary goes from grades 11 – 12. "Above Higher Secondary" consists of any continued education beyond upper secondary (including vocational, professional, and university).

Most villages in the DIA make little use of the Arun River because the larger villages are found on more gently sloping land well above the river elevation. Water from Arun River in the DIA is not used for drinking water, irrigation, or transport purposes. The Arun River, however, is considered holy by several religions and oral traditions (mythology) of prominent ethnic groups describe its spiritual significance, and several ethnic groups use the Arun and Barun rivers for cremation rituals.

Households get their drinking water from streams and springs. Flow of some springs is channeled to farmland for irrigation purposes or to operate ghatta (water mills), which are used to grind maize, millet, barley, and other grains. Some streams are used to generate electricity through micro hydroelectric plants, which supply power for a fixed number of hours to one or multiple villages.

5.3.4. Economics and Livelihoods

In the DIA, about 74% of the working population are engaged in agriculture and allied activities, such as livestock keeping and harvesting forest products. Participation in trade or small business and services are reported by 9% and 8% of working population, respectively. Only 3% of the working population report being engaged in wage labor, which includes both agricultural and construction work. **Figure 5.9** presents the occupations in the Project DIA.



Source: ERM Socioeconomic Survey, 2019-2020

Figure 5.9: Occupation of Working Population in Project DIA

Many residents of the DIA participate in some form of multi-year or seasonal migration, primarily because of poverty (to meet food requirement), remoteness of villages, extreme climatic conditions, and lack of access to jobs, hospitals, and schools within their own villages. About 3% migrate outside of the country for employment, typically for several years if not permanently. According to the DIA socioeconomic survey, about 24% of the residents leave the area for at least part of the year. This includes some adults seeking temporary/seasonal work in cities such as Kathmandu, Khandbari, Dharan, and Darjeeling (India), where there is greater access to employment and economic opportunities to supplement their incomes, but these residents typically return to their home village to live for at least part of the year. Many families in the

higher elevations (e.g., Chepuwa, Rukma) will move to lower elevation villages during the winter to escape the cold, where they sell medicinal herbs and other non-timber forest products to generate income.

The livelihood strategy of most households involves subsistence agriculture and livestock keeping, along with the collection and sale of medicinal herbs or forest products and supplemented by working in trekking-tourism when the opportunity arises. Agricultural crops include rice, where suitable land is available (only 35% of households), otherwise millet, maize, and barley, along with vegetables, oilseeds, and fruits. Cardamom is the important cash crop in the DIA, with approximately 85% of households cultivating cardamom. The winters are too cold for growing crops, so most agricultural activities are seasonal, with some families migrating to lower elevations where they earn money by selling medicinal herbs and other forest products. Livestock are an integral part of the subsistence lifestyle, with 96% of the households keeping livestock. The livestock can be grouped into three categories: 1) large domestic animals such as cattle, yaks and mules; 2) small livestock such as sheep, goats and pigs, and; 3) poultry birds. The data in table 5.10 indicates that only about 40 percentage of HouseHolds (HH) in Bhotkhola Rural Municipality produce a year-round sufficient food. Majority of HHs have food deficiency which maybe attributed to the lack of sufficient agricultural land or irrigation facility or improved seeds etc. HHs who have food deficiency meet their food needs by working as labour, clerks, small business, abroad employment etc.

Table 5.10: Food Sufficiency

Ward Number	Food Sufficiency					Total HHs
	<3 months	4-6 MONTHS	6-9 MONTHS	9-12 MONTHS	12 Months	
1	60	0	0	11	38	109
2	0	3	48	278	145	474
3	2	2	4	11	256	275
4	206	0	6	30	232	474
5	109	203	35	17	10	374
Total HH	**377**	**208**	**93**	**347**	**681**	**1706**
Percentage	**22.10%**	**12.19%**	**5.45%**	**20.34%**	**39.92%**	

Source: Bhotkhola Rural Municipality, 2074/75

Most households in the DIA are members of a Community Forest User Group (CFUG), which enables them to access, manage, and collect various non-timber forest products (NTFPs), which is a key component of their subsistence livelihoods. For example, small farmers rely heavily on forests for grass and fodder to feed their livestock. They also collect leaf litter for use on their farms and firewood, which is the main source of energy for cooking and heating.

The eco-tourism is an upcoming opportunity to the local communities, however, it has yet to be realized and is in an infancy stage supporting only a limited number of households. The project site is rich in natural and cultural heritages. Makalu Barun National Park which lies close to the UAHEP is the main centre of attraction to tourists. Makalu Brun National Park (MBNP)'s buffer zone lies along the entire west (right bank) of the Arun River from the project's dam/reservoir downstream to the powerhouse. The Arun-Barun Dovan which is site for Barun Mela in Barun

Bazar is the major religious site for both Hindu and Buddhist devotees. Tatopani Kunda (natural hot spring near Hatiya), Bhembhema Waterfall, Chepuwa Waterfall etc. are other major attractions for tourists in the region. Local people in buffer zone villages like Golabazar, Barun bazar etc. run homestays or small hotels, shops etc. and are benefitted from tourism activities. After the improvement of road access, it is expected that it will help to promote tourism and boost the local economy.

Hunting was an important feature of traditional subsistence life of local communities until the MBNP was declared and community forests were established in the 1990s, both of which restrict hunting. MBNP rangers enforce the ban on hunting by regular patrolling efforts and check posts. The Arun River has several native fish species, such as Asala (Common snow-trout), Tite, and Kabre, but fishing is limited because of the difficulty in accessing the river in the upper gorge area and relatively low fish populations. The little fishing that occurs is mainly done for recreation and personal consumption; no commercial fishing occurs.

The gender disaggregation of the working population reveals that more women (54%) are engaged in agriculture than men (46%). The representation of women in services, however, is low (30%) in comparison to men (70%). There are more men in wage labor and foreign employment than women. In trade and business, though more men (56%) are engaged, women (44%) are well represented. The age distribution of working population reveals some instances of child labor (below 14 years) are engaged in wage labor or agriculture activities, but their number is small. However, there are a considerable number of adolescents (15-18 years) who are working in agriculture and allied activities.

5.3.5. Community Services and Infrastructure

Overall, community service provision and infrastructure development within the DIA is weak. The area has poor road connectivity. There is no public transport connecting Khandbari, the district headquarters, to Bhotkhola. Four private operators provide public transport service between Khandbari and Gola/Barun Bazar. In terms of policing, the DIA is within Area-1 of Sankhuwashabha District, which is controlled by a Sub-Inspector stationed at Hedengna with 19 officers. Other police posts include Hatiya (8 officers), Chepuwa (8 officers), Gola (8 officers), and Syaksila (6 officers). Armed Police Force are stationed in the border town Kimathanka with 26 APF personnel. There are two army posts, one in Gola and the other in Hatiya. The Biplap communist party is a threat for the security of the district. There were only 2 criminal cases reported in FY18-19 from Bhotkhola.

The DIA does not have a waste collection or disposal service, with most organic wastes retained as compost, and inorganic wastes reused or thrown away indiscriminately. Households primarily obtain drinking water from local perennial springs, which, in most cases, are piped from locations above the village to a central location for use by multiple households. Most households (99%) have toilets and an individual septic tank or drain-field. Only a small number of households use basic pit latrines.

Most households have access to electricity from locally operated micro-hydropower projects, which provide power for fixed hours each day. Other households use solar lamps or traditional kerosene or oil lamps for lighting. Firewood is the most commonly used cooking fuel, with 97%

of the households surveyed stated that they depend entirely on firewood for their cooking needs. Households running commercial shops and home-stay arrangements often use LPG cylinders.

5.3.6. Community Health and Wellbeing

According to the Health Department of Bhotkhola Rural Municipality, approximately 7000 cases of communicable diseases were reported during 2016-2019 period. Water- and food-borne disease cases were the most common (43%), followed by respiratory tract infections and viral influenza. No cases of vector-borne diseases were reported between 2016 and 2019. A total of 246 sexually transmitted diseases (STDs) were reported between 2016 and 2019. No cases of human immunodeficiency virus (HIV) Infection or Inguinal Bubo Syndrome were reported, nor were any cases of cancer. There were, however, 356 cases of cardiovascular and respiratory diseases reported, primarily bronchitis and chronic obstructive pulmonary diseases. There were 62 cases of nutrition and metabolic diseases (e.g., anemia, malnutrition) reported. The number of cases of anemia has almost doubled from 2017/18 to 2018/19. Although gender disaggregated statistics are not available, the health reports cite anemia as a major concern among women, as it leads to increased maternal morbidity and mortality and poor birth outcomes, as well as reductions in work productivity. Dog, insect, and snake bites are common health hazards. The number of road accidents are very few, since there are few roads or vehicles, but when they occur, they often result in fatalities because of the steep slopes.

There are health posts or community health units in Chyamtan, Gola, Chepuwa, Namase, and Sibrun, and, for more severe problems, a district hospital in Khandbari. However, there are insufficient numbers of health workers in these health posts and units. Many residents, especially the elderly, prefer to rely on traditional medicine/healing practices, which have a strong cultural and religious connection. Based on stakeholder consultations it was learned that most residents prefer to seek treatment from traditional healers and using herbal remedies before visiting the health posts and units.

5.3.7. Cultural Heritage

Most of the tangible and intangible cultural heritage resources in the DIA reflect Buddhist practices including prevalence of Gompa, Chhorten, Manewall, amongst others Vol. II, Annex 12 – C, Table 12.18, 19 and 20 including write ups). Engraved and etched stones, which included figurines from Buddhist pantheon and stupa, as well as writings in Tibetan script, were found in some of the old Gompas. Other tangible heritage sites present in the DIA include Devithans, a religious site that has been worshipped by local people since before living memory; Naagthans, where Bhote snake worship ceremonies are held; and Chautari, which are rest areas built under a tree to provide shade for travellers, but often are used as a gathering space for various community meetings. None of these cultural sites are nationally protected monuments, although they have cultural significance for local communities.

Each ethnic group (e.g., Tamang, Bhote, Gurung, Rai) in the DIA possesses a wide spectrum of intangible cultural heritage. This includes migration history, belief system, oral traditions, life-cycle rites and rituals, belief systems linked to the cosmos and natural world, performing arts, and traditional handicrafts (e.g., straw mats, bamboo baskets, and woven woollen carpets). Festivals, rituals, funerals and ceremonies are significant part of the communities, which brings the entire

communities together reflecting the tight-knit kinship that they share. In addition, labor exchange amongst households, participation in festivals and ceremonies, and *Kiduj Samaj* underpins a strong sense of community spirit amongst the communities.

Death rituals vary by ethnic group and to some extent by community. The Bhote, Gurung, Sherpa and Tamang communities perform death rituals on the hills above their villages, referred to as "Chihan Danda", the Brahmin, Gurung, and Dalit communities conduct their death rituals by the Arun River. It was reported that the number of Christians in the area have increased over the years who, regardless of their ethnicities, have started practicing burial rather than cremation. There are no specific burial grounds for Christians. Rai and Kirat communities usually have graveyards in their own gardens.

Communities in the DIA have a spiritual connection to their land as well as their surroundings and worship mountains, hills and forests as abode of god, goddesses, or souls and spirits, for good harvest, good health, and prosperity. The Phalo of Bhote and Mindum of Rai, both sacred chants, invoke the gods and natural spirits of mountains, rivers and springs around them. Some of the natural sites have cultural importance, including the Tatopani Kunda (natural hot spring near Hatiya), the Arun-Barun Dovan (site for Barun Mela in Barun Bazar), and the Bhembhema waterfall on Arun River just downstream of the proposed UAHEP dam.

5.3.8. Water Uses

Within the Direct Impact Area, the Arun River is not used to any meaningful extent for transportation, water supply, recreational boating, sand mining, recreational or commercial fishing, irrigation, operating water mills, watering livestock, or for industrial/employment purposes. This is primarily because most of the project villages are located high above the Arun River and accessing the river for water is difficult. Most villages prefer to use local perennial springs for water and have developed water mills and micro-hydropower facilities on these streams. The Arun River is used, however, for cremations by several ethnic groups, for various other cultural and religious purposes, especially near Barun Dovan, and to a lesser degree subsistence fishing and washing/bathing.

5.3.9. Other Development Projects

The existing Arun-3 HEP is located 11 km downstream from the UAHEP, but will still receive the same flow on a daily basis. The proposed Arun-4 HEP would be located downstream of the UAHEP tailwaters. The UAHEP would not have any effect, hydrologic or otherwise, on these two downstream projects, or other potential projects located farther downstream. The proposed Kimathanka HEP would be located approximately 5 km upstream of the UAHEP and upstream of the UAHEP reservoir, so the UAHEP would not affect the tailwaters or operations of Kimathanka HEP. The Chhujung HEP is proposed on Chhujung Khola, which is again upstream of the UAHEP reservoir.

5.3.10. Locals' perceptions and expectations

Local people are positive about project development and reqested project authoritized for the implementation of the project as soon as possible. Coordination between project proponent and local stakeholders, job priority for affected community, adequate compensation, and support for protection of local language, culture and customs of the indigenous community, income

generation training and fair participation of womens in project benefits are the few expectations of the local people.

CHAPTER 6: ALTERNATIVE ANALYSIS

6.1. Introduction

The following alternatives were considered in finalizing the project design, construction methods, and operational modalities:

- Without Project Alternative (Section 6.2)
- System Alternatives (Section 6.3)
- Location Alternatives, including ancillary facilities (Section 6.4)
- Design/Technology Alternatives (Section 6.5)
- No Forest Clearing Alternatives (Section 6.6)
- Construction Alternatives (Section 6.7)
- Operational Alternatives (Section 6.8)

These various alternatives to the proposed project configuration are described below. Each of the alternatives were systematically evaluated using the following criteria:

- Technical/engineering criteria
- Economic/financial criteria
- Environmental and social/cultural criteria

6.2. Without Project Alternative

Under the Without Project Alternative, the UAHEP would not be constructed. This would avoid all of the environmental and social/cultural impacts associated with construction and operation of the Project. Not constructing the Project, however, would not address the shortages in meeting Nepal's projected power demands, and especially peak demands during the dry season.

Other sources of energy that would be required to replace the annual energy production from the UAHEP would need to be 2,254 tonnes of coal (at 1,100 pounds of coal per MWh) or 5 million barrels of oil (at 1.6 barrels per MWh), both of which would need to be imported from India

The other way of examining the Without Project Alternative is to consider the likely impacts associated with other "replacement" hydropower projects that would be needed to provide the equivalent annual average energy and dry season peak demand energy provided by the UAHEP. The UAHEP takes advantage of a unique and highly valuable water resource in the Upper Arun River. The Arun River has been recognized since at least the 1980s (see Section 1.1 – Project Background) for its hydropower potential, especially considering its relatively high dry season flow. In fact, the dry season flow in the Arun River is greater in absolute terms than any other river in eastern Nepal with comparable elevation (Kattelmann, 1990). The ratio of dry season to wet season flow in the Arun River (0.23) is much higher than other tributaries of the Sapta Koshi (average of about 0.15), which is attributable to flow contributions from snow and glacier melt. Further, the Arun River's low season discharge also tends to be relatively consistent between years, which further increases its value for hydropower generation in a country subject to extreme dry and wet seasons where flows in most rivers are extremely attenuated during the dry season.

While not without its own risks and impacts, the UAHEP would be considered a high quality project by several key hydropower environmental and social metrics. The World Bank's Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects (WB, 2003) identifies several key indicators of likely environmental and social impacts. Two of the key indicators for which there are comparable metrics provided in the paper are:

- **Reservoir Surface Area –** is considered a strong proxy for many environmental and social impacts. It is measured as a ratio of surface area flooded per megawatt of capacity (ha/MW), with 60 ha/MW estimated at that time as the global average for large hydroelectric projects. The lower the value the better. The value for UAHEP is 0.2 ha/MW (20.1 ha reservoir surface area/1,061 MW of installed capacity), which would be the best value when compared to the 50 projects for which data are provided in the report (listed projects ranged from <1 to 5,333 ha/MW), and among the best in the world.
- **Persons Requiring Physical Resettlement** – is a critical social indicator and is measured as a ratio of number of people physically displaced per megawatt. The lower the value the better. The value for UAHEP is 0.14 people/MW, which would be the fifth best value when compared to the 50 projects for which data are provided in the report (listed projects range from 0 to 1,000 persons/MW), and a very low number by international standards for a project of this magnitude. It should be recognized that the physically displaced people from the UAHEP are especially vulnerable Indigenous Peoples communities, the impact of which can get lost when just looking at the numbers.

So using these two fundamental environmental and social indicators, combined with the Arun River's naturally high dry season base flow and available net head, makes the Arun River's hydrology a highly valued resource. As a result, there are quite likely no other hydropower projects in Nepal that could provide the UAHEP's average annual energy and dry season energy with similarly low environmental and social impacts based on these metrics. Since there are relatively few sites available that can support over 1,000 MW capacity project (e.g., only two have been proposed to date – the 1,902 MW Mugu Karnali HEP in northwest Nepal and the 1,200 MW Budhi Gandaki HEP in central Nepal), it is reasonable to assume that multiple smaller projects would be needed to provide equivalent energy to the UAHEP. Multiple smaller projects would mean additional dams, access roads, and transmission lines, all likely with worse indicator values than UAHEP, resulting in collectively significantly more environmental and social impacts.

In summary, the Without Project Alternative would not take advantage of a unique and high value water resource (i.e., Arun River), would not meet Nepal's energy needs, and the construction of alternative projects to provide the needed energy would likely result in significantly more environmental and social/cultural impacts. For these reasons, the Without Project is not the preferred alternative.

6.3. System Alternatives

Nepal does not have its own reserves of gas, coal, or oil, plus these fuel sources would have higher carbon emissions and pose greater climate change risk. So these options are eliminated. Many households in Nepal currently rely on biofuels (e.g., firewood, dung) for cooking and heat, but increasing the use of biofuels to meet Nepal's power needs would threaten the country's valuable forests and biodiversity and raise health concerns due to indoor air pollution, so biofuels are not considered a viable energy source on a national basis.

This leaves the renewable energy sources of hydropower, wind and solar as the most viable for Nepal. Relatively little wind or solar power generation has been developed thus far in Nepal. Both wind and solar power can contribute to meeting Nepal's power demands, but would struggle to provide the overall average annual energy or meet the peak dry season power demands that the UAHEP is intended to address. Although Nepal has relatively good wind power potential, including estimates of as much as 3,000 MW of capacity (Alternative Energy Promotion Center,

2008), other studies (Upreti and Shakya, 2010) estimated the commercially viable wind potential of Nepal at only about 448 MW, or less than half of the UAHEP capacity. Solar definitely would not be able to meet the peak period demand that UAHEP is targeting, which is primarily nighttime hours (i.e., 18:00 – 24:00 hours).

Nepal has tremendous hydropower potential, estimated at over 83,000 MW, with about 42,000 MW of this considered technically and economically feasible. The Arun River is an especially valuable hydropower water resources as discussed in Section 6.2. Hydropower is a clean, renewable energy source with extensive application and proven technology in Nepal. Further, the Government of Nepal is committed to reaching 5,000 MW of total hydropower capacity in Nepal within five years (MoEWRI, 2018), and the UAHEP is a key project for achieving this goal. Therefore, for these reasons, hydropower is considered the preferred energy source for meeting the purpose and need of the UAHEP.

6.4. Location Alternatives

6.4.1. Headworks Location Alternatives

The headworks are composed of the dam, the flood discharge and sediment flushing facilities, the power intake, and the diversion structures required during construction. Three basic alternatives were considered

- Upstream Alternatives – upstream options are limited by the proposed Kimathanka hydropower project tailrace, which is proposed less than 1 km upstream of the UAHEP headwaters.
- Chepuwa Alternative – the proposed location is located upstream of Chepuwa Khola
- Downstream Alternatives – CSPDR evaluated a site about 1.7 km farther downstream of the Chepuwa Alternative. Alternatives farther downstream were not considered viable because the very steep gorge topography would not allow sufficient suitable area for construction activities and it would lower available head, thereby reducing power generation. (Refer Annex 13)

Technical/Engineering Considerations

The proposed Kimathanka Hydroelectric Project (HEP) tailrace would be located less than 1 km upstream of the UAHEP headwaters, which limits the extent the UAHEP dam could be shifted upstream without affecting the Kimathanka operations. The Downstream Alternative site is wider with large deposits of colluvium and slope wash where the left dam abutment would be located, which would increase dam stability and safety risks.

Financial/Economic Considerations

The Upstream Alternative site would be more difficult to access as it would be located in more of a steep gorge setting, which would increase construction challenges and costs.

The Downstream Alternative site is wider and would require a larger dam and geotechnical measures to address the colluvium stability risks identified above, both of which would increase the cost of the dam relative to the Chepuwa site. The Downstream Alternative would also generate less power because of the reduced head.

Environmental and Social/Cultural Considerations

Headworks location alternatives farther upstream or downstream offer no meaningful benefits and several potential disadvantages relative to the Chepuwa Alternative. Upstream alternatives would require a longer access road, longer headrace tunnel and more associated spoil, more forest

clearing, and a longer diversion reach, relative to the Chepuwa Alternative. For these reasons, the Chepuwa Alternative is the environmentally and socially preferred site.

Summary

Upstream alternatives are limited by the proposed Kimathanka HEP and would have greater environmental impacts. Downstream headworks alternatives would have a greater impact on Rukma and would generate less power with similar environmental impacts. Therefore, the Chepuwa Alternative was adopted for the project design.

6.4.2. Powerhouse Location Alternatives

Three basic alternatives were considered for the powerhouse location:

- Upstream Alternatives – upstream from the Limbutar site to approximately a location across from the Barun River. The Arun River upstream of the confluence with the Barun is located within a steep gorge that is not suitable for hydropower development;
- Limbutar Alternative – at the location of the currently proposed UAHEP; and
- Downstream Alternatives – downstream of the Limbutar site. (Refer Annex 13)

Technical/Engineering Considerations

The Upstream Alternatives would reduce the project's net head. The Limbutar Alternative maximizes the project's net head. There are not really any technically feasible Downstream Alternatives as Leksuwa Khola functions as a barrier to any further extension of the waterway, so this alternative is not discussed further.

Financial/Economic Considerations

The Upstream Alternatives would reduce the project's average annual energy generation by reducing the net head. The Limbutar Alternative maximizes the project's energy production and net head.

Environmental and Social/Cultural Considerations

The Upstream Alternatives would bring the powerhouse and various ancillary facilities closer to the large village of Sibrun, with likely more physical and economic displacement, and closer to the confluence of the Barun River, which is considered a holy river by several faiths. The Upstream Alternative would have a 1.6 km shorter diversion reach (14.9 km vs. 16.5 km) with less impact on aquatic habitat.

The Limbutar Alternative would impact the small settlement of Limbutar, but avoid the large social impacts on the larger village of Sibrun associated with the Upstream Alternative. The Limbutar Alternative would result in a longer diversion reach than the potential Upstream Alternatives, but would not improve access for upstream migrating fish to any potential spawning streams, as there are none between Leksuwa Khola and the dam.

Summary

The Limbutar location maximizes the economic value of a highly valuable water resource. Locations further downstream are not technically feasible as Leksuwa Khola effectively limits the extent of the headrace tunnel. Locations further upstream are technically viable, but would result in more physical and economic displacement relative to the Limbutar Alternative, and greater

impact to the cultural significant Barun River. Therefore, a powerhouse location near Limbutar was adopted for the project design.

6.4.3. Ancillary Facilities Location Alternatives

The UAHEP will require nearly 30 ancillary facilities (e.g., spoil disposal sites, worker camps, power plants, water plants, quarries, crushers, batching plants, fabrication shops, fuel depot, and explosives depot).

Table 6.1 and **Table 6.2** compare the various alternative facility locations for the headworks and powerhouse areas, and **Figure 6.1** and **Figure 6.2** show the recommended facility sites. The UAHEP Ancillary Facilities Alternatives Memo (ERM, 2 July 2019) provide a detailed description of each facility, alternatives considered, and the recommended facility locations. (Refer Annex 13)

Figure 6.1: Headworks Area Proposed Ancillary Facilities

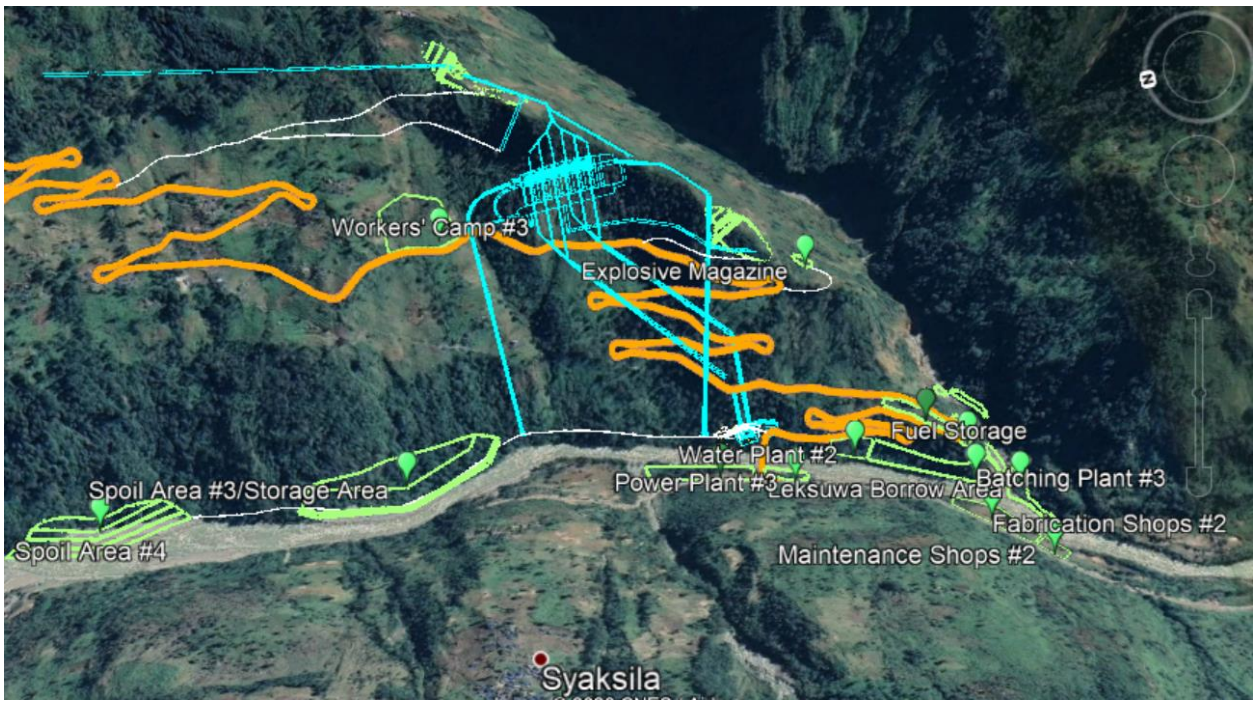


Figure 6.2: UAHEP Powerhouse Area Ancillary Facilities Alternatives

There are several challenges facing the siting of ancillary facilities for the UAHEP:

- The right bank is part of the Makalu Barun National Park (MBNP) buffer zone, so efforts were made to avoid and minimize the placement of permanent facilities on the right bank, when left bank alternatives were available;
- The topography is very steep in much of the project area and there are unstable soils and landslide prone areas, which together limit the suitability of large areas for many of the ancillary facilities, which generally require gentler slopes, or extensive grading will be required;
- Most of the extremely steep slopes are forested, and these forests help maintain the stability of these slopes, so clearing of forests, especially on steep slopes, should be minimized; and
- Most areas that are not extremely steep tend to be used for residential and agricultural uses, especially growing cardamom and millet, and agricultural lands should be avoided to the extent possible.

Therefore, in nearly all locations, the siting decisions would unavoidably involve impacting the MBNP, extremely steep slopes, forested areas, relatively high value agricultural areas, and/or displacing families. In general, the guiding principles applied in this alternative's analysis were as follows:

- Avoid physical displacement except in the case where critical project infrastructure unavoidably requires resettlement;
- Avoid placing permanent facilities in MBNP;
- Avoid extremely steep slopes and landslide prone areas;
- Avoid placing permanent facilities on agricultural land except where these impacts are unavoidable; and
- The villages of Sibrun, Namase, and Rukma will unavoidably be impacted by the Project. Facilities have been placed to minimize direct impacts and to maximize buffers to the villages.

No permanent ancillary facilities were placed within MBNP core or buffer zone, and only the following temporary facilities:

- Headworks Area – only construction access roads to access the right bank of the dam were adopted for the project design; no other ancillary facilities were located within the MBNP;
- Powerhouse Area – the powerhouse area (note that the powerhouse will be underground) is characterized by very steep slopes, which limit the placement of ancillary facilities in this area. Some limited ancillary facilities are located within the MBNP buffer zone, including a worker camp, power plant, fabrication shop, and maintenance shop. All of these facilities would be temporary and removed at the end of project construction, all would be located on land that would unavoidably be impacted by the project access road ancillary facilities, which need to be within the MBNP buffer zone until the Arun River Bridge is completed. These locations would minimize forest clearing and would restore the sites after the completion of construction for agricultural or other purposes in consultation with the property owner.

6.5. Design Alternatives

This section presents the design alternatives that were considered that have meaningful differences in potential environmental and social/cultural impacts.

6.5.1. Dam Type

Three basic alternatives were considered

- Concrete arch dam;
- Concrete gravity dam; and
- Rock-filled embankment dam.

Technical/Engineering Considerations

The geological conditions at the dam with a high stress relief zone make the site unsuitable for an arch dam. A rock-filled embankment dam is not appropriate either because an embankment dam cannot be overtopped by flow, so would require several large tunnels for passing flood flows. Given the project setting in the Himalaya's with the potential for Glacial Lake Outburst Floods during a period of uncertainty relative to the effects of climate change, an embankment dam poses a higher risk than a concrete gravity dam. The design of these large tunnels in an embankment dam would be of lower sediment flushing efficiency and be subject to severe abrasion and potential clogging. Therefore, the arch and rock-filled embankment dam types were both determined to not be technically feasible, and the concrete gravity dam was determined to be the most appropriate and safest design from a technical and engineering perspective.

In terms of concrete gravity dam, both a conventional and a roller-compacted concrete (RCC) gravity dam were evaluated. The RCC dam would use fly ash with low cement content, which simplifies construction relative to controlling temperature during concrete curing, while the conventional dam would require more complex temperature control measures.

Financial/Economic Considerations

In terms of concrete gravity dam alternatives, the RCC dam is quicker to construct and meet the requirements of reaching elevation 1,590 m by the end of Construction Year 4, so the conventional dam would increase schedule risk and associated costs.

Environmental and Social/Cultural Considerations

As indicated above, the concrete arch and embankment dams were determined to not be technically acceptable for safety reasons. The arch and embankment dams would also both generate more spoil as a result of greater excavation for the dam footings (arch dam) or more tunnelling (embankment dam). There is no meaningful difference in terms of environmental and social/cultural considerations for a conventional vs RCC dam.

Summary

A RCC dam was considered the safest, has lower cost, and poses the least schedule risk, so was adopted for the project design.

6.5.2. Reservoir Full Supply Level Elevation

Although many different dam heights and associated reservoir elevations (FSL) options were evaluated:

- FSL below elevation 1,618 m
- FSL between elevations 1,618 – 1,640
- FSL above elevation 1640

Technical/Engineering Considerations

The geology of the dam and reservoir area has been determined to support a concrete gravity dam of up to 150 m and slope treatments can ensure stability with reservoir drawdowns of up to 15 m over 6 hour period.

Financial/Economic Considerations

The project design was optimized, including dam height, reservoir FSL, and capacity to maximize dry season energy generation and to allow for dry season peaking to meet peak demand periods and to improve the reliability of the Nepal electricity grid (CSPDR, 2021). Economic alternatives were identified for all three FSL categories, but the design with a FSL of 1,640 maximized dry season energy production.

Environmental and Social/Cultural Considerations

Smaller dams are usually preferred over larger dams because of the corresponding size of the reservoir. In this case, a 91 m high dam with a 1,640 m FSL will only create a 20 ha reservoir, which is very small relative to the capacity of the Project. This dam height/FSL was needed to enable the proposed PRoR operation and would not result in any physical resettlement associated with the reservoir (ERM, 22 March 2019).

FSL above elevation 1640 has the potential for economic or physical displacement, but requires the least reservoir fluctuation per hour of peaking operation. FSL below 1618 would have the smallest reservoir surface area (approximately 8 ha), but would require the largest water level fluctuation and would still not be able to provide six hours of peaking operation.

Table 6.1: Comparison of Reservoir Elevations

FSL (Elevation in m)	Dam Height (m)	Reservoir Surface Area (ha)	Peaking Duration (hours)	Peaking Drawdown (m)
1,612 m	63 m	8.3 ha	2 hr	10 m
1,631 m	82 m	15.1 ha	6 hr	15 m
1,635 m	86 m	17.2 ha	6 hr	15 m
1,640 m	91 m	20.1 ha	6 hr	15 m
1,645 m	96 m	23.3 ha	6 hr	15 m

Summary

A dam height of 91 m and a reservoir FSL of elevation 1640 is proposed. At this dam height/FSL the reservoir surface area is small relative to project capacity (i.e, about 0.02 ha/MW), and 6 hours of peaking will only require about 5 m of reservoir fluctuation under average flow conditions. This dam height and reservoir FSL has few social impacts. FSL above 1640 have the potential for physical and economic displacement and larger reservoir surface area, so are less preferred. Note that the dam height was raised to 100 m, but the FSL was maintained at elevation 1,640 m.

6.5.3. Powerhouse Type

Two basic alternatives were considered

- Surface Powerhouse
- Underground Powerhouse

Technical/Engineering Considerations

According to the seismic hazard assessment report, the peak ground acceleration, with an exceedance probability of 10%, within the design reference period of 50 years, is 0.21g for the powerhouse site, and the seismic risk is relatively high. Compared with a surface configuration, an underground powerhouse would have better seismic performance. Similarly, the surface powerhouse would have a surface penstock, which poses a much higher risk during an earthquake then an underground penstock.

The powerhouse area has very steep terrain and a surface powerhouse would require extensive grading and excavation.

Financial/Economic Considerations

The surface powerhouse would have a turbine elevation 6 m higher (1.2%) than the underground powerhouse option, but would cost $26 million more (2.5%).

Environmental and Social/Cultural Considerations

The underground powerhouse alternative is safer from a landslide/seismic risk perspective, would impact less forest and natural habitat, and would require less land acquisition, but would generate more spoil than a surface powerhouse. The surface powerhouse alternative poses more safety risks and, although it will generate less spoil, will require extensive excavation and blasting to create a suitable construction site.

Summary

The underground powerhouse alternative is preferred for technical, financial, environmental, and social reasons and was adopted for project design.

6.5.4. Sediment Management

The UAHEP is characterized by a high sediment load, small reservoir storage, excessive hardness of sediment particles, and high net head; therefore, sediment management is critical to the project's overall design. The objectives of the sediment management strategy were to:

- Maintain the long-term sustainable live storage volume of the reservoir; and
- Reduce turbine abrasion by sediment

In terms of achieving the first objective of maintaining the sustainability of the reservoir's live storage, it was determined, with guidance from the project's Expert Panel, to include low level outlets (LLO) and mid-level outlets (MLO) within the dam body so as to allow the drawdown of the reservoir and flushing of sediment during the monsoon season.

In terms of achieving the second objective of reducing turbine abrasion, three options were considered:

- Sediment Bypass Tunnel (SBT);
- Underground Desanders – an eight bay underground pressure desander located on the left bank;
- Reservoir – for settling of sediment particles without a SBT or underground desander, but with more frequent enforced powerhouse outages to release sediment.

Technical/Engineering Considerations

The three options perform similarly in terms of sediment accumulation in the reservoir and annual turbine abrasion depths. There are very few precedents for such a large underground desander, which increases the technical uncertainty associated with this option.

Financial/Economic Considerations

The SBT or desander alternative would cost less (~6% less) but would have more average outage time per year (65 days versus 20 for SBT and 13 for desander), generate significantly less average annual energy (~19%) and have a higher levelized cost of energy (4.00 US cents/kWh) versus the SBT (3.43 cents/kWh) and underground desander (3.86 cents/kWh).

Environmental and Social/Cultural Considerations

Effective sediment management is critical for hydropower projects from an environmental and social/cultural perspective. If not properly managed, sediment can either accumulate behind the dam or reduce its storage capacity and peaking power generation, or can settle in the diversion reach, reducing the value of the remaining aquatic habitat, with potential impacts to ecosystem services as well.

The SBT or desander alternative is generally preferred from strictly an environmental and social/cultural perspective as it would avoid the spoil generated by the SBT or underground desander. The underground desander option would generate more spoils than the SBT.

Summary

The comparison above concludes that each option is technically feasible, and the degree of sediments accumulated in the reservoir and the annual turbine abrasion depths, are nearly the same for all three options. The reservoir option is preferred from an environmental perspective as it would avoid the generation of spoils resulting from the SBT and underground desander excavation. This option, however, would result in significant generation outages, reduction in energy generation, and result in a higher cost/kWh for the Project. The 293,500 m^3 of spoil generated by the SBT would only represent about 5% of the total spoil from the Project.

Therefore, the SBT option was adopted for the project design.

6.6. No Forest Clearing Alternative

It is not possible to achieve no forest clearing with the UAHEP. As described under the Location Alternatives (Section 6.4), the dam location was selected taking into consideration technical, environmental, and social criteria. The selected location, and really any location along the Upper Arun River, will unavoidably result in clearing of some forest to construct the dam and reservoir. The only areas not in native forest cover in the project impact area are villages and associated agricultural land. Further reducing forest clearing would have unavoidably resulted in more significant social impacts.

6.7. Construction Alternatives

Two river diversion alternatives were considered:

- Right-bank diversion tunnel
- Left-bank diversion tunnel

Technical/Engineering Considerations

The Left Bank Alternative is preferred in terms of geological conditions at the tunnel outlet, as the Right Bank Alternative would have an overhanging rock mass at the outlet. The Left Bank Alternative would require less slope treatment.

Financial/Economic Considerations

The Left Bank Alternative would cost less because the tunnel is shorter and less slope treatment would be required.

Environmental and Social/Cultural Considerations

The Left Bank Alternative would avoid the MBNP buffer zone, whereas the Right Bank Alternative would be entirely located within the buffer zone.

Summary

The Left Bank Alternative is preferred for technical, economic, and environmental reasons and was adopted into the project design.

6.8. Operational Alternatives

These alternatives relate to how the Project will operate during project operations, specifically relating to operating procedures and water level fluctuations, which are inter-related. Three basic alternatives were considered

- Peaking – would allow peaking to occur on a daily basis year-round;
- Peaking Run-of-River (PRoR) – would allow peaking to occur on a daily basis, but limited to the dry season; and
- Run-of-River (RoR) – would limit flow diverted to the powerhouse to no more than inflow to the reservoir, also accounting for the required Environmental Flow

Technical/Engineering Considerations

One of the UAHEP's primary purposes is to meet Nepal's need for peak demand power during the dry season. A traditional RoR operation would significantly reduce power generation during peak hours in the dry season, would not achieve this purpose, and therefore is not discussed further. The Project has not been designed for year-round peaking operations as this is not necessary given the relatively high river flows that occur during the monsoon season.

Financial/Economic Considerations

The Project has been optimized to maximize dry season peak demand power generation. Converting to RoR operations would reduce the value of the energy produced, resulting in weaker financial performance. A peaking operation would not maximize energy production or take best advantage of the valuable Arun River water resource.

Environmental and Social/Cultural Considerations

RoR operations are always preferred from strictly an environmental and social/cultural perspective as they maintain as close as possible a natural flow regime and have negligible impacts downstream of the tailrace. Peaking operations would likely require a larger reservoir and result in larger and year-round water level fluctuations both in the reservoir and downstream of the tailrace, which can have impacts on both fish and downstream water users. A PRoR operation is intermediate between these two other operating regimes, and limits the magnitude and timing (dry season only) of peaking impacts. In the case of the UAHEP, the proposed reservoir surface area is small relative to its capacity, so the area affected by reservoir water level fluctuations is small. Further, the presence of the Arun-3 HEP downstream of the UAHEP limits the extent of peaking operation impacts downstream of the tailrace to approximately 11.8 km.

Summary

The UAHEP was designed to help meet Nepal's dry season peak electricity demand, which requires limited peaking during the dry season. The proposed PRoR operation achieves this goal while keeping reservoir water level fluctuations and downstream flow variation within an acceptable range. Converting the UAHEP to a RoR operation would then require the construction of another hydropower project to meet Nepal's dry season peak demand, which would result in greater environmental and social/cultural impacts than simply operating the UAHEP in a Peaking RoR mode. A peaking operation is not necessary given the relatively high Arun River flows during the monsoon season. Therefore, a PRoR mode of operations was adopted for the project design.

CHAPTER 7: ENVIRONMENTAL IMPACTS

This Chapter illustrates the potential beneficial and adverse impacts that are likely to accrue because of implementation of the proposed Project. Based on the project details and the baseline environmental status, potential environmental impacts have been identified for the construction and operation of the project. Environmental impacts of the proposed project have been identified for the project structures and facilities i.e. headwork, headrace tunnel, surge shaft, powerhouse, tailrace tunnel and switch yard, project facilities viz. workers' camps, staff camps, construction yard, spoil/muck disposal sites, crushing/batching plant and project component roads covering the physical, biological, and socioeconomic and cultural environments. The potential impacts have been predicted in terms of their nature (direct and indirect), magnitude of impact (low, moderate and high), extent (site specific, local and regional) and duration (short term, medium term and long term). The beneficial impacts are given in sub-heading 7.1 and adverse impacts are mentioned in sub-heading 7.2

7.1. Benificial Impacts

7.1.1. Construction Phase

7.1.1.1. Employment Generation

During construction, the Project will employ up to a peak of 4,500 workers over a 6-year construction period. It is estimated that Nepali workers could fill about 40% of these construction jobs. Most of the unskilled and semi-skilled personnel will be hired locally. The amount of money that is injected in the rural economy in the form of wage earnings will directly enhance the living condition of the local people. This will also provide opportunity for the initiation of various additional monetary activities and enterprise growth and thus improve the living conditions of the local people. The impact is direct in nature with high magnitude, local extent and for short duration.

7.1.1.2. Enterprises Development and Commercialization

During construction period, different types of commercial activities in different economic sectors such as agriculture, business/trade, service etc. will come into operation to meet the demand of the workforce and visitors. Local people having experiences in running hotels, lodges, restaurants and grocery shops might start their own business/enterprises and create employment opportunities for family and others. The demand for local products such as milk, meat, vegetables, fruits etc. will increase during the construction period, which may provide added impetus for local production and marketing. As a result of increased commercial activities a significant amount of cash will flow in the local economy. The increase in trade and business will create economic opportunities and enhance the economic value of the area and living condition of local people. This is an indirect impact of moderate magnitude, local extent and of short term duration.

7.1.1.3. Increase in Local Skill

The project requires professional technical persons for implementation of the construction works. Local people who will work with these professionals will get opportunities to learn knowledge and skills from them (technology transfer). The knowledge and skills learned during the construction of the project, local people will be able to get employment in similar projects elsewhere. Such knowledge and skills will be obtained, particularly in the areas of tunnel

construction, river diversion, heavy equipment operation, masonry, construction of dry walls, gabion walls etc. The impact is direct in nature with high magnitude, local extent and for long duration.

7.1.1.4. Induced Development

Due to increase in economic activities in the project area, cash inflow, access road facilities will provide opportunity for the opening of commercial banks, government and non-government offices, development of market/ growth centers, health and educational institutions etc. The availability of better services will improve the quality of life of local people and infrastructures condition in the area .The impact is indirect in nature, moderate magnitude, local extent and for long duration.

7.1.2. Opertation Phase

7.1.2.1. Employment Generation

The Project will create 130 permanent jobs during the operations phase. Of the required employees, some will be hired locally for administrative and technical works as per their qualifications and skills. The employment will give permanent income source to some households of the area. In addition, short term employment for periodic maintenance work will be beneficial for the local unemployed people to supplement their household income as well as acquire knowledge and skills of the work. The impact is direct in nature, moderate in magnitude, local extent and for long-term.

7.1.2.2. Increase in Revenue

The project will generate average 4549.57 GWh electrical energy/year which contribute to revenue generation for the Government of Nepal. This source of revenue will support the local governments to invest in social sector such as health, education, drinking water, irrigation, access road, rural electrification, communication, agriculture, and other required areas to improve quality of life of people. This is direct impact of high magnitude, national extent and for long duration.

7.1.2.3. Enhancement of Economic Activities

The infrastructure developed during project construction will be continued during operation phase also. In addition, some new development activities might occur in the area due to easy access and availability of the reliable energy. The operation of the project offices and infrastructure will enhance the economic activities of the area. The availability of quality hotel and easy access will also promote the tourism development in the area. The impact is indirect in nature, moderate in magnitude, regional extent and for long-term.

7.1.2.4. Increase in Land Value

Implementation of the project will also contribute in rising land values in the area along the road alignment and near project structures. High value land is one of the important assets easily accepted by banks, financial institutions and cooperatives for credit as collateral. Increased land values will enhance people's capability for investment, production, consumption and saving. This is indirect impact of moderate magnitude, local extent and for long duration.

7.1.2.5. National Development

The project will generate royalty as per the provision made in the prevailing legal provisions. According to the Hydropower Development Policy, 2001 the project will pay capacity royalty (per kilowatt) and energy royalty (per kWh) for the duration mentioned in the policy as per the

rate fixed by Government of Nepal. The revenue generated through royalty will directly contribute for national development and welfare of people. This is direct impact of high magnitude, national extent and for long duration.

7.1.2.6. Electrification

The generation of the power will expand the door for the expansion of rural electrification program in the project area as well as in different parts of the country. The implementation of the project will provide opportunity for electrification in the wards and settlements of the rural municipalities. Connection of the generated power with integrated national power system (INPS), the area will receive reliable and quality electricity supply. This is direct impact of high magnitude, national extent and for long duration.

7.2. Adverse Impacts

7.2.1. Physical Environment

7.2.1.1. Construction Phase

a) Slope Failure

The four spoil disposal areas are located in terrain varying from 0^o to 40^o slopes. The spoil disposal areas #3 and #4 are located on level ground along the inside bend of the Arun River in a natural sediment deposition area at the toe of steep slopes. The risks with these two spoil disposal areas is from a slope failure above the facilities, which would damage the facilities, but would not pose a risk to people, structures, or agricultural land. Spoil disposal areas #1 and #2 are located on moderately sloping land high above the Arun River and are more susceptible to erosion and slope failure, which could result in the spoil moving or cascading down the hill slope. Neither of these sites have any houses located downslope from the facility, but spoil disposal area #2 has agricultural land located downslope. Failure of these facilities would damage downslope forest and agricultural land and introduce large quantities of spoil into the Arun River. The five proposed small quarries needed for initial construction activities are also located on steep slopes with the potential for slope failures. These impacts are considered high in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***High***.

b) Natural Hazards

Project construction is unlikely to trigger any earthquakes, GLOFs, or flooding, and the Project is designed to withstand these hazards. Construction activities will have the potential to trigger landslides or slope failures, especially in the reservoir area, along the project service roads, and as a result of vibrations from the use of explosives for tunnelling. A landslide or slope failure could pose risks to structures, agricultural land, and people, depending on the location and severity of the failure. These impacts are considered high in magnitude, local in extent, short term in duration with a pre-mitigation significance of ***Substantial***.

c) Erosion and Sedimentation

Although many project facilities will be underground, Project construction will still disturb 136.81 ha of land, of which 73.31 ha are forest land and 63.50 ha private land. Much of this disturbed land will be on steep slopes that are susceptible to erosion and sedimentation, especially during the monsoon season. These impacts are considered high in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***High***.

d) Soil Compaction and Damage

Project construction could damage soils, especially topsoil, primarily as a result of soil compaction from the construction of buildings or the use of heavy equipment. This damage could affect the

ability to return agricultural and other lands back to their original use and productivity after completion of construction Approximately 31.02 ha of agricultural land will be disturbed during project construction, although most of this agricultural land will be converted to project uses and thus not reused for agricultural purposes. These impacts are considered medium in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Moderate***.

e) Effects of Tunneling on Local Springs

The Project has the potential to affect flow in at least some springs within the project's Direct Impact Area as a result of project headrace tunnel, and powerhouse cavern, and other underground excavation. Construction of these facilities could intercept a fault/fracture zone. Since the groundwater pressure head can be quite high for these facilities as they have in some cases over 1,000 m of overlying rock, there is the risk of encountering high-pressure seepage during excavation. This seepage into the excavation areas could lower the groundwater table, thereby reducing or eliminating flow in some overlying springs or streams within the zone of influence. The construction of these tunnels using drill and blast techniques could also result in some localized fracturing of rock, which could create a preferential groundwater flow path that could also reduce or eliminate flow in some springs and streams. **Figure 7.1** shows the Project tunnels relative to the location of springs and streams that local communities rely on for drinking water, irrigation, micro-hydropower generation, mills, and other purposes.

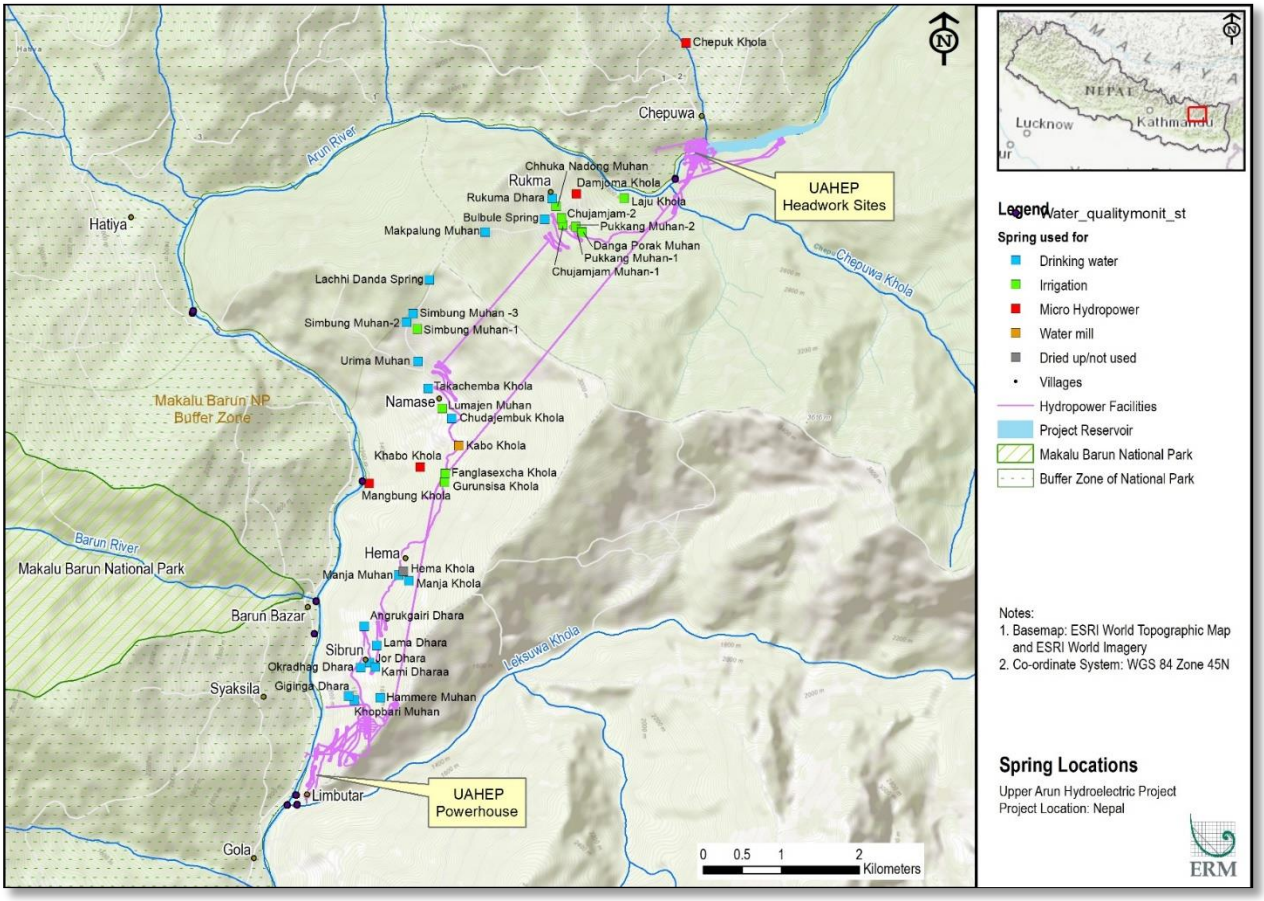


Figure 7.1: Location of Project Tunnels relative to Local Springs and Stream

The headrace tunnel lies below 30 to 1,315 m of overlying rock, with the groundwater table generally 100 to 620 m above the tunnel, except at the intake and end section. The permeability of the overlying rock (primarily gneiss) is low, although there are four small fault and fracture zones present that likely transmit groundwater, referred to as F21 to F24. The headrace tunnel

ranges in elevation from about 1,611 m at the headworks to 1,578 m at the surge tank near the powerhouse and passes under or near several springs and streams used by local communities**.** The risk of groundwater drawdown is greatest for Fanglasexcha and Gurunsisa kholas. There is the potential, that the Project could reduce flow in these or other local springs and streams, at least during the dry season. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

f) Effects of Construction Phase Water Demands

Construction will require potable water for workers as well as water for concrete production. The Project proposes to construct two water treatment plants to meet the project's water demands. The water will be sourced from Chepuwa Khola for the headworks area, and Leksuwa Khola for the powerhouse area. The Arun River will not be used as a potable water sources as it has much higher turbidity levels and would require much more significant and expensive treatment to bring the water to an acceptable quality. There is ample water available in Chepuwa Khola and Leksuwa Khola to meet these water demands. These impacts are considered medium in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***Moderate***.

g) Sediment Transport

The Project will have negligible effect on sediment transport and deposition patterns in the Arun River during construction as the river flow is diverted through the SBT with little water storage or retention time. These impacts are considered low in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Low***.

h) Stormwater Runoff

The Project will generate stormwater runoff from various facilities, including project roads, worker camps, fuel depot, crusher plant, batch plants, fabrication shops, maintenance yards, spoil disposal areas, and potential seepage from tunnel portals. This stormwater can carry various contaminants, including oil, grease, and metals, which can degrade water quality. There is the potential that the excavated spoil could include rock with the potential for causing acid rock drainage. In addition, groundwater intercepted from tunnel excavation can also have elevated dissolved and suspended solids. The water quality of project-affected streams could be degraded. Although they should still be suitable for irrigation purposes, these streams should not be used for any potable uses, at least without appropriate treatment. There are several open (unpiped) springs and streams currently used for potable water located downstream of proposed construction areas that may be exposed to project-related stormwater runoff. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

i) Wastewater Disposal

Project construction will require between up to 4,500 staff. These staff will generate up to 225,000 liters/day of domestic wastewater, assuming an average of 50 liters/day/person, which is a significant wastewater volume. The relatively shallow depth to bedrock in much of the Direct Impact Area and the quantity of wastewater requiring treatment make a traditional septic system unfeasible (i.e., too little soil and too much wastewater to allow for adequate treatment). If untreated, this wastewater would increase nutrient and fecal coliform concentrations in areas downstream from these works and living areas and increase the public health risk for various communicable diseases. These impacts are considered medium in magnitude, regional in extent, short term in duration, with a pre-mitigation significance of ***High***.

j) Solid Waste Management

The Project will generate a variety of solid wastes, primarily domestic solid waste and construction debris, which is estimated to total about 20,000 m^3 over the construction period. Improper disposal of these wastes can impact water quality, create a nuisance for local residents, and detract from the scenic beauty of the landscape. The Project does not propose to construct an on-site solid waste landfill. These impacts are considered high in magnitude, regional in extent, short term in duration, with a pre-mitigation significance of ***High***.

k) Hazardous Material/Waste Management

Project construction will require the transport, storage and use of relatively large quantities of various hazardous materials, especially diesel fuel, but also various oils, lubricants, paints, concrete additives and other materials. Accidental spills are impossible to completely prevent and, depending on the material and the volume spilled, could result in significant impacts to soils and degradation of water quality. The risk from these potential spills is especially significant because of the dependence of local residents on local streams for potable and irrigation water. The Project will also generate hazardous wastes, such as waste oils, oily rags, lubricants, paints, and batteries, which could pose risks to water quality and public health if not properly managed. The use of pesticides and/or herbicides will not be allowed and is not typical maintenance practice in Nepal. The construction materials such as explosive for blasting and fuel and lubricants will be stored in large quantities for construction of the project. If storage areas are not properly fenced and necessary precaution for the storage and handling of the petrochemicals and explosive are not followed there will be increased risk of fire hazards.These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

l) Air Quality

The project's power requirements during construction will be met by several large diesel generator sets. The emissions associated with diesel generator were based on the U.S. EPA AP-42 emission factors (USEPA 2010). Vol. II, **Annex 14** presents detailed calculation of annual diesel generator emissions based on these emission factors. One aggregate crushing plant is proposed in the headworks area for construction of the hydropower facility with a capacity of 320 tons of coarse aggregate and 140 tons of fine aggregate per hour. Vol. II, **Annex 14** presents detailed calculation of fugitive emissions from the aggregate crushing plants. Construction will require three concrete batching plants for its six-year construction schedule. Vol. II, **Annex 14** presents detailed calculation of fugitive emissions from the three concrete batching plants. These emissions should not result in an exceedance of the Government of Nepal and WB air quality standards beyond the facility property boundary. Project vehicles and equipment will also generate air emissions through fuel combustion. Project construction activities and wind will both generate fugitive dust, especially during the dry season along the headworks area, where there will be large areas of exposed soil. These impacts are considered high in magnitude, local in extent, short term in duration.

m) Noise

Project construction activities, including noise from construction equipment, use of explosives, and helicopters will affect project communities. **Table 7.1** shows the distance from the villages to the nearest major noise generating facility. Project construction will require extensive use of explosives, primarily for underground excavation of the various project tunnels and caverns. The noise generated from this underground blasting will be significantly attenuated by the surrounding rock, although blasting at the tunnel portal entrances could be heard by local residents.

Underground blasting is the only project construction activity that will be carried out at night. Noise from blasting is instantaneous and could reach up to 140 dBA at the blast location or over 90 dBA for noise sensitive receptors within approximately 150 m, depending on the explosive charge. Though noise generated during blasting can cause concern among nearby noise sensitive receptors, blasting is a relatively short duration event compared to other rock removal methods. Helicopter use is currently planned to be on an as needed basis, but will be at least seasonally limited by weather conditions (i.e., monsoon rain and low cloud cover will like limit helicopter access to the Project for much of the period from May to September). Helicopters can generate noise up to approximately 90 dBA at approximately 150 m from the aircraft (Malcolm Hunt Associates 2017), although this varies with the size of the helicopter. Helicopter noise can startle people, livestock, and wildlife. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

Table 7.1: Proximity of Hydropower Noise Generating Facilities to Villages

Village	Nearest Project Noise Generating Facility	Distance to Nearest Edge of Village
Chepuwa	Headworks construction area	540 m
Rukma	Spoil Disposal Area #1	170 m
Namase	Contractor's Camp #2 and Power Plant #2	600 m
Hema	Spoil Disposal Area #2	400 m
Sibrun	Contractor's Camp #3	100 m
Jijinkha	Contractor's Camp #3	190 m
Syaksila	Contractor's Camp #4	600 m

n) Vibrations

The Project will be excavating several underground facilities, including the river diversion tunnel, sediment bypass tunnel, headrace tunnel, powerhouse cavern/access tunnel, and the tailrace tunnel. Most of these tunnels/caverns are distant from any villages and hundreds of meters underground, so the risk of vibration is low. The proposed quarry location is relatively isolated and removed from other privately structures (~1.5 km) so should not result in any damage to these structures. The trucks hauling heavy equipment and machinery on the Koshi Highway from Khandbari to the project site pass by many houses that are located only a few feet from the road. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

o) Landscape Values and Visual Amenity

Project construction will disturb 136.81 ha of land and introduce construction activity and forest clearing in a predominantly natural or rural agrarian landscape. Some of this disturbance will be visible from key visual amenities like Chepuwa Falls and the Barun Mela. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

7.2.1.2. Operation Phase

a) Slope Failure

There is a risk of slope failure associated with the project's peaking operation where water levels within the reservoir will increase and decrease quickly, which could weaken these slopes. A slope failure would introduce a large volume of material into the reservoir and reduce its available water storage capacity. Spoil disposal areas #1 and #2 are located on moderately steep slopes that are susceptible to erosion, which can increase the risk of slope failure. Spoil disposal area often receive little maintenance attention, but, in this case, present potentially significant environmental and social risks if they were to fail. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

b) Natural Hazards

Project operation is unlikely to trigger any GLOFs or flooding, and the Project is designed to withstand these hazards. Project operation should not affect the severity of these events. The project design has considered the earthquake potential in accordance with ICOLD recommendation for the design of the dam and the other appurtenant infrastructure, thus minimizing the risks of dam break related floods in the downstream areas. There is evidence that large hydropower projects can induce seismic activity in some areas because of the pressure placed on the underlying geology by the water stored in the reservoir, which is referred to as Reservoir Induced Seismicity (RIS). CSPDR's analysis concluded that the maximum magnitude earthquake resulting from the UAHEP's RIS would be 3.5, which is far less than the project's Design Basis Earthquake. A dam break analysis has been conducted and disaggregated the downstream river into 10 reaches. The analysis indicated that for four of these reaches the Project would pose a high hazard, for five segments it would pose a moderate hazard, and one segment it would poae a low hazard (see Volume II Annex 15). These impacts are considered medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

c) Erosion and Sedimentation

The construction contractor will be required to stabilize all disturbed areas and restore them to their pre-construction condition as part of the construction close-out activities, and there will be no new ground disturbing activities during operation. These impacts are considered low in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

d) Effects of Tunnelling on Local Springs

Any Project effects on local springs as a result of underground excavation should be observed during construction. Nearly all of the tunnels with the potential to affect springs are low pressure tunnels, which means there will still be potential for the tunnels to continue to affect groundwater during operations (i.e., a high pressure tunnel would tend to exfiltrate water whereas a low pressure tunnel can infiltrate water). These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

e) Effects of Operation Phase Water Demands

Water demand for the operation of the hydropower facility will be limited to the potable water needs of the operations workforce, which is estimated at approximately 130 workers, and miscellaneous water demand for cleaning and other maintenance purposes. This demand is estimated at no more than 10,000 liters/day. The Project will construct two permanent water treatment plants (one at the headworks and one at the powerhouse area), which will withdraw water from Chepuwa Khola and Leksuwa Khola, respectively. These streams have ample supply

to meet this demand without any adverse effects on other local uses (i.e., the lowest monthly mean flow in Chepuwa Khola, the smaller of the two water sources, is 0.49 m^3/s, or about 42 million liters/day). These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

f) Sediment Deposition in the UAHEP Reservoir

The Arun River is glacier fed and transports a high sediment load with a long-term annual average of 16.24 million tons (13.81 million tons of suspended sediments and 2.43 million tons of bed load sediment). The project dam has the potential to cause this sediment to be deposited within the reservoir, which could reduce its ability to operate in a peaking mode and reduce the project's useful lifespan and sustainability. These impacts are considered high in magnitude, regional in extent, long term in duration, with a pre-mitigation significance of ***High***.

g) Sediment Transport and Deposition Downstream of the UAHEP Dam

Because of the sediment deposition that could occur within the reservoir, the Project could reduce the delivery of sediment to the diversion reach and downstream of the powerhouse, which would disrupt the natural sediment balance in the river and potentially cause geomorphic changes (e.g., erosion of riverbanks). These impacts are considered high in magnitude, regional in extent, long term in duration, with a pre-mitigation significance of ***High***.

h) Stormwater Runoff

Many of the Project facilities are underground, which limits their exposure to precipitation and reduces the volume of stormwater runoff. Several permanent facilities, however, will be located above ground, such as the project roads, switchyard, water treatment plants, parking areas, and the two permanent owner's camp complexes. Stormwater runoff from these facilities has the potential to marginally degrade downstream water quality. The water quality of these streams should still be suitable for irrigation purposes, but should not be used for any potable uses, at least without appropriate treatment. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

i) Wastewater Disposal

Project operations workforce will generate approximately 6,500 liters/day of domestic wastewater, assuming an average of 50 liters/day/person of domestic wastewater. If untreated, this wastewater would increase nutrient and fecal coliform concentrations in areas downstream from these works and living areas. These impacts are considered low in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

j) Reservoir Water Quality

The Project will impound water behind the dam, which can result in increases in water temperature, decreases in dissolved oxygen, stratification of the reservoir, and potential eutrophication. These impacts, however, are not anticipated for the UAHEP primarily because the reservoir has relatively little water storage volume with a residence time of only about 16 hours under median flow conditions. Further, the low flow period, when the longest residence time would occur, is during the late winter when air and water temperatures are cold and the potential for decreases in dissolved oxygen and stratification of the reservoir is negligible. The project's wastewater discharges will occur downstream of the reservoir and therefore will not contribute nutrients to the reservoir, which could otherwise promote eutrophication. Eutrophication modelling indicates that the project reservoir will be between ultra-oligotrophic to oligotrophic based on Vollenweider's normalized phosphorus loading, with no risk of eutrophication (Chang

et al, 2019; Rast et al, 1983). These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

k) Diversion Reach Water Quality

The domestic wastewater discharge from Owner's Camp #1 will occur in the upstream portion of the diversion reach (Laju Khola, about 1 km downstream of the UAHEP dam), while the domestic wastewater discharge from Owner's Camp #2 will occur downstream of the diversion reach. There will be no industrial discharges. The diversion reach is a high gradient (>3% channel slope), high energy river segment, so dissolved oxygen levels will remain high and conditions promoting eutrophication will remain low, even under the reduced flow conditions. River water temperature will increase marginally (1^{o}C +/-), but no other impacts to water quality are anticipated. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

l) Downstream of Powerhouse Water Quality

Water quality downstream of the powerhouse will not change in any meaningful way. There will be no industrial wastewater discharges, and the domestic wastewater will be small in volume relative to river flow and treated prior to discharge. The water released (EFlow) or discharged (spillage) from the dam will be close to ambient conditions, with only marginal increases in water temperature and decreases in dissolved oxygen and turbidity expected, and will not degrade downstream water quality. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

m)Hazardous Materials/Waste Management

During project operations there will still be need for the transport, storage, and use of various hazardous materials, including diesel fuel, and various oils, lubricants, paints and other materials, but in significantly smaller quantities than was required during construction. There will still be the potential for accidental spills, which depending on the material and the volume spilled, could result in significant degradation of water quality. The project will still generate some hazardous wastes. These impacts are considered low in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

n) Air Quality

The Project will emit few air pollutants during the Operation Phase as the Project will operate using clean renewable electricity generated by the project. The Project will generate some emissions from project-related vehicular use, but most project staff will live at the powerhouse and headworks Owner's Camps or in the nearby villages and none are expected to "commute" to work using vehicles. There will likely be a few vehicular trips per day between the powerhouse and the headworks site (~40 km round trip) and there will be periodic deliveries of supplies from Khandbari or other district cities on a weekly basis, but these vehicular trips will result in negligible air emissions. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

o) Greenhouse Gas Emissions

The GHG Reservoir Tool (G-Res Tool) developed by the International Hydropower Association and the UNESCO Chair for Global Environmental Change was used to estimate reservoir GHG emissions. The methodology takes into consideration pre-impoundment conditions (land cover to be inundated), post-impoundment conditions (GHG fluxes associated with diffusive, bubbling,

and degassing emission pathways), and anthropogenic sources associated with land use activities within the upstream catchment flowing downstream that may be affected by the presence of the reservoir. The assessment finds that the GHG emissions from the Project are expected to be 220 tCO_2-eq/yr, with a Power Intensity of 5,273.6 W/m^2 and a GHG emission intensity of 0.05 gCO_2/kWh. The UAHEP's GHG emission intensity is significantly less than IHA study median of 18.5 gCO_2-eq/kWh for hydropower projects and lower than all of the other power generation types evaluated. Project operation phase emissions are limited to vehicular GHG emissions as all other project electricity demands will be self-supplied from the project's renewable energy generation. Vehicular emissions are estimated at approximately 1,500 tons of CO_2-eq/year. These impacts are considered low in magnitude, regional in extent, long term in duration. But because this will offset use of fossil fuels with renewable energy, the overall net impact is considered ***Low***.

p) Operational Noise

The Project will have negligible noise emissions during operations as the powerhouse will be underground and all equipment will be operated by project generated electricity. There will be some noise associated with the two Owner's Camps and vehicle use. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***. The interior noise levels within the underground powerhouse is predicted to be approximately 95 dBA. This noise level will require workers to wear ear protection PPE.

q) Vibration

The Project should pose negligible vibration risk during operations as no more blasting and little heavy truck traffic will occur. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

r) Landscape Values and Visual Amenity

The Project will result in permanent on-going impacts to landscape values and visual amenities by introducing large, modern facilities into an otherwise predominantly natural and rural agrarian landscape. Many of the project facilities are underground (e.g., headrace tunnel, powerhouse), which reduces the project's impacts on landscape values and visual amenities. The project dam, however, has to be aboveground and will be visually prominent, but only within a relatively small viewshed, which includes the village of Rukma and short portions of various trails along the Upper Arun River gorge area. The dam will not be visible from most of the households in Chepuwa, Lingum, Guthigumba, and Chyamtan as the steep topography will block the view, although portions of the reservoir and Spoil Disposal Area #1 will be visible from some locations. Views of the dam elsewhere up or down the river are limited because of the river meanders and gorge setting. The dam will not be visible from the culturally significant Barun Bazar area, which hosts the Barun Mela, but from this area a person will be able to see Spoil Disposal Areas #3 and #4 that lie across the Arun River. Further, the Barun Bazar area is located along the diversion reach and will be affected by the reduced river flow. The Mela is held every year in January when Arun River flows are typically near their annual low, but under project conditions the flow would be further reduced by 90 percent. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

s) Impacts on other Hydropower Projects

Project construction and operations will not have any effect on other existing or proposed, upstream or downstream, hydropower projects. The existing Arun-3 HEP is located 11 km

downstream from the UAHEP, but will still receive the same flow on a daily basis. The proposed Arun-4 HEP would be located downstream of the UAHEP tailwaters. The UAHEP would not have any effect, hydrologic or otherwise, on these two downstream projects, or other potential projects located farther downstream. The proposed Kimathanka HEP would be located approximately 5 km upstream of the UAHEP and upstream of the UAHEP reservoir, so the UAHEP would not affect the tailwaters or operations of Kimathanka HEP. The Chhujung HEP is proposed on Chhujung Khola, which is again upstream of the UAHEP reservoir. UAHEP would not affect this project.

7.2.2. Biological Environment

7.2.2.1. Construction Phase

a) Effects on Legally Protected Areas

The Project will not directly impact any of the MBNP core area. The Project permanently convert 31.83 ha of MBNP buffer zone land (21.62 ha forest land and 10.21 ha private land) for the placement of dam, reservoir and other project structures and facilities. The proposed permanent facilities will unavoidably impact the MBNP buffer zone as the dam and reservoir must be located on the Arun River and the park boundary extends to the centerline of the river. It is impossible for any hydropower project on the Upper Arun River to avoid impacting the MBNP since the park buffer zone boundary extends along the centerline of the river from downstream of the Arun-3 HEP all the way to the China border. The proposed temporary facilities are all located on disturbed lands being used for agricultural purposes or are currently vacant land. Vol. II, **Annex 16** shows the area and location of all proposed project facilities relative to the MBNP core and buffer zone. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

b) Loss of Terrestrial Habitat

The project will result in the disturbance of 136.81 ha of land, including 73.31 ha of natural habitat (e.g., forests, grasslands, rock/scree (Vol. II, Annex 16). Habitat impacts are considered to be permanent and ongoing for all major infrastructure components following construction, with some rehabilitation of cleared areas around infrastructure components when construction finishes. Much of the natural habitat affected is edge habitat with little overall loss of habitat functions. These impacts are considered medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

c) Effects on Forests

Total forest area impacted by the UAHEP is 73.31 ha, which includes 40.07 ha government managed forest, 11.62 ha community forest and 21.62 ha buffer zone forest land. Champ *(Michelia champaca)*, Utis *(Alnus nepalensis)*, Lapsi (*Choerospondias axillaris)*, Mahuwa (*Madhuca longifolia*), Kaulo (*Persea odoratissima)*, Katus (*Castanopsis spp)* and Gogan (*Saurauria napaulensis*) are the major tree species of the forests to be cleared due to implementation of the project. A total of 17866 trees (14438 pole and 3428 tree) will need to be felled to construct the project (**Table 7.2**).

Table 7.2: Summary of Project Forest Clearing Requirements

Description	Government Managed Forest	Community Forest	Makalu Barun Buffer Zone Forest	Total
Area (ha)	40.07	11.62	21.62	73.31
Pole (No)	6,699	3,434	4,305	14,438
Tree (No)	1,698	750	980	3,428
Total Poles and Trees	8,397	4,184	5,285	17,866

Source: Field survey

In addition 6637 trees (5852 pole and 785 trees) will be removed from private kharbari land due to implementation of the project. The biomass and carbon stock of the forest vegetation to be removed is 7,209,868 kg and 3,389 tons, respectively. The loss includes the above ground and below ground of major whole (branch and foliage) tree and pole species. The standing volume of the loss (tree and poles to be removed) is 9104.85m^3 and 453.95 chatta fuel wood. These impacts are considered medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

Vol. II, Annex 16 provides more details on the forest to be cleared. 10 florals species under various conservation category are affected by forest clearance activities.

d) Effects on Key Threatened Species

There are four key threatened terrestrial species (Vol. II, Annex 16) found in the project area: Himalayan red panda (*Ailurus fulgens*), Himalayan black bear (*Ursus thibetanus*), Black musk deer (*Moschus fuscus*), and the Chinese pangolin (*Manis pentadactyla*). The project footprint does not overlap with habitat for the Red panda and Black musk deer given all construction activities will occur below the elevations of these species' distribution (over 2,400 m elevation). The project could indirectly impact these species through noise, illegal clearing, poaching, hunting, or animal collection. Vehicle strikes are considered unlikely for these species as the project transportation corridor are well below the elevation that Red panda and Black musk deer are found. Himalayan black bear (*Ursus thibetanus*, IUCN VU) occurs across the mid-hills of Nepal in forest, wetlands (inland), grassland, shrubland, artificial/terrestrial, with a lower and upper elevation limit of 0 m and 4,300 m respectively. Direct impacts to the species (e.g., vehicle strikes) and its habitat are expected. Indirect impacts, such as revenge attacks against this species due to human-bear conflict incidents, and poaching may occur. Chinese pangolin (*Manis pentadactyla*, IUCN CR) has been reported from 24 different districts mostly found in the eastern and central mid-hills of Nepal, in forest, grassland, shrubland, with a lower and upper elevation limit of 0 m and 2,000 m respectively. Direct impacts to the species and its habitat are expected. Indirect impacts, such as increased poaching pressure on this species, may occur. These impacts are considered high in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***High***.

e) Disturbance and/or Displacement of Terrestrial Fauna

Terrestrial fauna including the conservation significance species (Vol. II, Annex 16) within and adjacent to the project area are expected to be subjected to increase light, noise, vibration, and human presence/activity, which have the potential to disturb natural breeding, roosting, and/ or

foraging behaviour of terrestrial fauna species3 and/or cause temporary or permanent movement away from project facilities, especially during construction. The duration of construction activities is expected to occur over six years and cover several breeding seasons. Similarly, it should be noted that the light, noise and vibration disturbances will be continuous for the construction phase, although they are unlikely to occur at all locations simultaneously. The list of nocturnal and arboreal mammal threatened species that may be subject to potential impacts from disturbance and displacement (Vol. II, **Annex 16)**. These species are generally highly mobile and will avoid or vacate the construction area and hence impacts are considered unlikely. The impacts due to disturbance from noise and vibration as these activities will occur only during the construction phase and are unlikely to disrupt important lifecycle functions. These impacts are considered high in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Substantial***.

f) Terrestrial Barriers, Fragmentation and Edge Effects

The Project may establish barriers to wildlife movement, contribute to habitat fragmentation, and create edge impacts from forest clearance during construction and continuing through project operations. Barriers to fauna and flora dispersal include natural factors (e.g. rivers) and anthropogenic factors (e.g. roads). Barriers to dispersal limit the foraging, breeding and roosting potential of fauna, which can ultimately result in population scale impacts. Habitat fragmentation involves the division of contiguous habitat, effectively creating barriers between habitat fragments, which can negatively impact fauna and flora populations. These impacts are considered medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

g) Degradation of Terrestrial Habitat

A project has the potential to lead to terrestrial habitat degradation during the construction phase. These activities include excavation, maintenance works, land clearing, spoil disposal, movement of vehicles and excavation and blasting. The key sources of impact to terrestrial habitat include habitat degradation from slope failures and fugitive dust emissions during construction. Impacts from the introduction and proliferation of invasive species during construction and operation is also considered. Impacts from workers and the community from the collection of timber and non-timber forest products due to induced access may also occur. These impacts are considered medium in magnitude, local in extent, short term in duration, with a pre-mitigation significance of ***Moderate***.

h) Wildlife Mortality Events

Project construction may result in the direct wildlife mortality because of vehicle strikes, land clearing, hunting, and poaching during construction and operation. During the construction phase, there will be a large number of vehicle movements and construction traffic within and around the project area, which is likely to result in fauna injury and mortality events. Clearance in natural habitat is likely to affect more species that could suffer direct mortality as a result of being less mobile (e.g. reptiles, small mammals, amphibians and insects). More mobile species such as birds and large mammals may be able to avoid machinery, but will be subject to the risk of indirect mortality (e.g. tree falls, increased risk of predation). Arboreal and less mobile mammal and herpetofauna species are likely to be the most susceptible to indirect mortality. Fauna within the

[3] van der Ree, R., Smith, D.J. and Grilo, C., 2015. *Handbook of Road Ecology*. John Wiley & Sons.

DIA may be subject to elevated levels of hunting and poaching during the construction phase. Subsistence hunting is illegal within MBNP. In addition to hunting, poaching of wild fauna for the wildlife trade potentially occurs within the DIA, driven by the traditional medicine industry, the global and national exotic pet trade, and by cultural customs. The project workforce may also undertake bush meat hunting, regarding it as a culturally acceptable and habitual practice. Thirty-six (36) CITES species were identified during the biodiversity baseline surveys, with twenty-six (26) of these being fauna (see Vol. II, **Annex 16**). Himalayan black bear and Chinese pangolin could potentially be subjected to intensive poaching given their likely presence within the project footprint and the Project's location in Eastern Nepal, which is considered a major national hotspot in pangolin poaching and trafficking (Ghimire et al.). These impacts are considered high in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***High***.

i) Loss and Conversion of Aquatic Habitat in the Headworks Area

This Project reservoir will have a surface area of 20.1 ha. Based on aerial imagery interpretation and using GIS analysis, the establishment of the inundation zone (a lentic habitat), will result in the conversion of approximately 5.2 ha of existing lotic habitat and the clearing of approximately 14.9 ha of terrestrial vegetation for the development of the reservoir. Daily water level fluctuations of up to 15 m within the reservoir as a result of peaking operations during much of the year (October to May) will make establishment and self-propagation of macrophytic vegetation and macroinvertebrates along the margins of the reservoir unlikely. The peaking operation has the potential to result in stranding of fish. In addition to this conversion of aquatic habitat, the Project will result in the loss of approximately 1.0 ha of aquatic habitat for construction of the dam.

As indicated above, the only species captured upstream of the proposed UAHEP dam were *Schizothorax richardsoni* (VU) and *Schizothorax progas*tus (LC), both mid-range migrants, and *Nemacheilus botia* (LC), *Psilorhynchus pseduecheneis* (LC), and *Euchiloglanis hodgarti* (LC), all resident fish. *Nemacheilus botia*, *Psilorhynchus pseduecheneis*, and *Euchiloglanis hodgarti*, however, are all small benthic species that may be able to tolerate the conversion to lentic habitat, but will not thrive because much of the reservoir will become a depositional environment that will interfere with their feeding. These impacts are considered medium in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

7.2.2.2. Operation Phase Impacts

a) Degradation of Aquatic Habitat in the Diversion Reach

The Project will significantly alter flow conditions in the 16.45 km long diversion reach between the UAHEP dam and powerhouse. In the absence of any EFlow, the diversion reach would only receive flow as a result of spillage from the dam when river flow exceeds the hydraulic capacity of the powerhouse (i.e., 235.44 m^3/s), which only occur about 33% of the year, primarily during the monsoon season. This reduction in flow will change several characteristics of the physical habitat along the diversion reach including reductions in water depth, width, velocity, and dissolved oxygen; increases in temperature; changes in stream morphology; and potentially the loss of habitat connectivity. Further, the presence of the UAHEP dam will affect sediment transport and the influx of organic matter, which is a source of energy input for riverine habitats. Each of these changes will have effects on the species present within this segment of the Upper Arun River. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

b) Degradation of Aquatic Habitat Downstream of the Powerhouse

The Project will operate in a PRoR mode, which will result in water level fluctuations in the 11.8 km long river segment between the UAHEP tailrace and the Arun-3 HEP reservoir backwaters that may affect the approximately 40 ha of aquatic habitat present in this segment. During the monsoon season (June to September, 4 months), the Project will operate in a RoR mode and there should be negligible change in flow downstream of the tailrace. For the rest of the year (October to May, 8 months), the Project will operate in a PRoR mode with daily water level fluctuations occurring in the 11.8 km long river segment between the UAHEP tailrace and the Arun-3 HEP reservoir. The magnitude of these fluctuations will vary depending on the inflow into the reservoir. January has the lowest monthly average flows and will be expected to be the month with the most significant downstream flow modification from project operations. Using average January flows as indicative of the near worst case conditions, on an average daily basis during peaking operations, water depths will vary from 0.6 to 1.8 m, water velocities will vary from 2.0 to 4.3 m/s, and mean wetted area will vary from 24.9 to 43.4 ha.

Once a day, water depths will increase quickly, on average by over a meter in 15 minutes, and about six hours later decrease quickly by over a meter. This pattern of daily fluctuations in flow is not one to which most aquatic species are adapted; thus, such conditions can reduce the abundance, diversity, and productivity of these species. Rapid decreases in water depths can strand adult, juvenile, fry fish in shallow pools with no access to the main river channel and subject them to desiccation, predation, and collection by humans. Juvenile fish may be especially subject to stranding as they tend to concentrate in shallow water along the edge of the river, which are the areas most vulnerable to water level fluctuations, to avoid predation. Peaking operations can also degrade aquatic habitat for macro invertebrates and macrophysics in the zone subject to water level fluctuations, including exposing them to potential desiccation (i.e., drying) when water levels decline.

The geomorphology of the Arun River between the tailrace and the Arun-3 HEP backwaters is steep, moderately to deeply entrenched and confined stream channel. This channel morphology is less susceptible to fish stranding as the channel is typically narrow and relatively deep with few side channels. The daily fluctuations in flow, and particularly the sudden increase in flow during peaking, can retard upstream migrating fish. These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

c) Effects on Fish Movement and Migration

Once the diversion tunnel is plugged, the UAHEP dam will function as a barrier to fish movement and upstream fish migration. There are several species of fish that may be present in the Arun River upstream of Arun-3 HEP that are migratory, as indicated in **Table 7.3.**

Table 7.3: Migratory Fish Likely Present in the Arun River

Scientific Name	Local/Common Name	IUCN Listing	Migratory Status
Anguilla bengalensis	Bengal eel	NT	Long-range migrant
Neolissochilus hexagonolepis	Katle/Copper mahseer	NT	Mid-range migrant
Psilorhynchus pseudecheneis	Stone carp	LC	Mid-range migrant

Scientific Name	Local/Common Name	IUCN Listing	Migratory Status
Schizothorax progastus	Chunche Asala/Dinnawah snowtrout	LC	Mid-range migrant
Schizothorax richardsonii	Buche Asala/Common snowtrout	VU	Mid-range migrant
Tor putitora	Golden mahseer	EN	Long-range migrant
Tor tor	Sahar	DD	Long-range migrant

The UAHEP dam is located near the upstream limit of most migrating fish. The Common snowtrout and Dinnawah snowtrout, both mid-range migrants, are the only species that are known to migrate upstream past the UAHEP dam site, but even then are only found in low numbers. The UAHEP dam will serve as a barrier to these two fish species. The other mid-range and long-range migratory species present within the Arun River (i.e., Bengal eel, Copper mahseer, and Golden mahseer) are only found downstream of the UAHEP dam site, so the UAHEP dam will not function as a barrier for the migration of these species. The ecological corridor for long- and mid-range migrating fish will be impacted substantially by the Arun-3 HEP, which is currently being constructed and is scheduled to become operational between between 2023 and 2025. The Arun-3 HEP will create a barrier for all fish migration at the dam site (approximately 800 m elevation). These impacts are considered medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

d) Effects from Fish Impingement and Entrainment

Fish impingement occurs when the intake velocity exceeds the fish's burst swimming speed and the fish are pinned against a barrier, such as an intake screen or trash rack. Entrainment occurs when fish enter the headrace tunnel and are eventually flushed through the turbines, where they are subject to large pressure changes and the potential for being injured or killed by turbine blade strikes. Given the high head of the UAHEP, it is reasonable to assume nearly 100% mortality for all entrained fish, including adults, juveniles, and fry. Some larger fish, such as Common snowtrout and Dinnawah snowtrout, could be impinged against the trash racks protecting the headrace tunnel intake, with a high mortality rate. As indicated above, however, the relative abundance of fish likely to be present in the reservoir is expected to be relatively low and the three resident fish are all benthic dwellers and less susceptible to impingement and entrainment at the intake structure, as they are less mobile and less likely to be found at the intake elevation (1,606 m). These impacts are considered high in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***High***.

7.2.3. Socio-economic and Cultural Environment

7.2.3.1. Construction Phase

a) Land Acquisition and Physical/Economic Displacement

The implementation of the Project will acquire 63.51 ha private land. Out of this 10.21 ha land will be acquired from the buffer zone area whereas 53.30 ha will be taken from out side buffer zone. Of the total private land acquire by the project 31.03 ha is cultivated land, 31.97 ha kharbari/alainchi bari and 0.51 ha barren land. Vol. II, **Annex 17** includes a table of all affected

land parcels. Vol. II, Annex 17 shows all the respective affected land parcels in the cadastral maps. The project will acquire 13 reseidential houses, latrines, livestock and other sheds, storage structures, and cardamom dryers from 16 HHs. The acquisition of land and residential structures will affect 326 households which are defined as Project Affeted Families/ Households (PAFs/PAHs). Out of them 13 households losing residential structures are considered Severely Project Affected Families/ Households (SPAFs/ SPAHs).

The project will also result in the:

- Loss of agricultural land and preferred livelihoods: The majority of agricultural land affected by the project will be permanently lost from agricultural production. Approximately 78% of the displaced households earn income from agriculture, and for 45% of these households they obtain a majority of their income from it. Amongst the most important of these crops is cardamom, which is a key cash crop grown by many PAHs. Loss of agricultural land will affect both land owners and land users who rent plots from the land owner.
- Loss of community cohesion and social ties: Physical or even economic displacement can result in feelings of loss of community, reduced interconnectedness with neighbours, and interruption of social network and ties.
- Displacement from land used for grazing: About 84% of the PAHs earn a part of their income from raising livestock. Land take associated with the Project may result in the loss of land used for grazing by the community, therefore requiring them to walk farther distances to find grazing grounds.
- Loss of access to natural resources (severance and displacement): Many local residents use natural resources on lands to be acquired by the Project. This includes collection and sale of NTFPs such as herbs and medicinal plants, fodder, firewood, and timber. Land take may result in loss of access to these resources or their temporary destruction. This has the potential to affect both subsistence livelihoods and cash income levels.

These impacts are considered high in magnitude, local in extent and long term in duration, with a pre-mitigation significance of ***High***.

b) Project-induced In-Migration and Population Influx

The Project will stimulate in-migration to the project impact area. These may be workers contracted to the Project, or job-seekers entering the area with the hope of securing employment on the Project. Population influx may also be stimulated by the possibility of business opportunities linked to the provision of goods and services to the project, and by real or perceived opportunities arising from the general increase in economic activity in the area. The following sections address the impacts that this in-migration and population influx could have on the project impact area absent any mitigation. At its peak construction, the Project will employ approximately 4500 workers. Although steps will be taken to maximize local employment, many of the skilled and semi-skilled roles will likely be filled by workers from outside the project districts, given the low local skill base in the area. Therefore, over 70% of jobs will likely go to non-local (i.e., migrant) workers, both Nepali and third-party nationals brought into the project DIA through a managed process of recruitment and transportation. This represents a significant increase in population, given that the entire DIA of the project consists of 22 small villages with approximately 1350 households and a total population of approximately 8000 people. Villages in the DIA – particularly those located near workers' camps – will, therefore, be significantly

outnumbered by workers and any project-related population influx. Influx can result in the following impacts:

- Increased demand and competition for local public services, including health care, water, power, sanitation and waste facilities, placing strain on the already limited services currently available to residents;
- Increased pressure on accommodation and rents;
- Local inflation of prices and crowding out of local consumers;
- Gender-based violence, including sexual harassment, child abuse and exploitation;
- Increased substance abuse and criminal behaviour;
- Increased stress on public protective services: Currently there is variable police presence in the DIA, and social order is maintained largely via traditional authority mechanisms.
- Increased incidences of prostitution and casual sexual relations;
- Conflict between local community and migrant workers; and
- Conflict between local community and Project;

These impacts are considered high in magnitude, local in extent and medium term in duration, with a pre-mitigation significance of ***High***.

c) Ecosystem Services

Local residents' access many of the ecosystem provisioning services in nearby forests, especially Community Forests (CF). The project will be leased 11.62 ha community forest land for the placement of project structures and facilities from 3 community forests of the project area. This will be 0.96 % areas of the affected 3 community forest (Table 7.4). As this table indicates, the only CF with any significant impacts is Pari Pakha, which is primarily because it is small. There are only two villages that use this CF – Sibrun and Limbutar. Sibrun also has access to the much larger Him Shikhar CF so is not reliant on Pari Pakha CF. The entire village of Limbutar is being physically relocated, so they will no longer use this CF. These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

Table 7.4: Project Effects on Community Forests

Community Forest	Villages Using Community Forest	Number of Community Forest Users	Community Forest Area (ha)	Community Forest Impacts (ha)	Community Forest Impacts (% of total CF)
Him Shikhar	Namase, Hema, Sibrun	157	481	0.1	0.02
Mak Palung	Rukma	27	731	9.62	1.32
Pari Pakha	Sibrun, Limbutar	54	3.9	1.9	48.72
Total			**1,215.90**	**11.62**	**0.960**

Source: Field Survey

d) Downstream Water Users and Uses

The Project will affect flow conditions in the Arun River upstream of the dam, in the 16.45 km long diversion reach, and downstream of the powerhouse. Within the Direct Impact Area, the Arun River is not used to any meaningful extent for transportation, water supply, recreational

boating, sand mining, recreational or commercial fishing, irrigation, operating water mills, watering livestock, or for industrial/employment purposes. This is primarily because most of the project villages are located high above the Arun River and accessing the river for water is difficult. Most villages prefer to use local perennial springs for water and have developed water mills and micro-hydropower facilities on these streams. The Arun River is used, however, for cremations by several ethnic groups, for various other cultural and religious purposes, especially near Barun Dovan, and to a lesser degree subsistence fishing and washing/bathing. These impacts are considered low in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Low***.

e) Transmission of Food/Water Borne Diseases

The Project is expected to attract a significant number of migrant workers (approximately 4500 at peak construction) to the DIA. The presence of an external workforce living in camps, where interaction with nearby communities is likely, could lead to the increased transmission of communicable diseases within these communities. This includes the potential for the workforce to introduce a new disease and/or a more virulent strain of an existing disease. In addition, although the Project anticipates being able to mitigate most population influx as a result of opportunistic workers (those hoping to find employment on the Project or from related activities) migrating into the area, to the extent that influx does occurs, it could also contribute to the introduction and transmission of communicable diseases. Finally, overcrowding or living in close quarters within worker camps, poor hygiene and sanitation at worker's camps, and poor waste management could also facilitate the spread of communicable diseases. The following discusses the various causes of disease transmission and their impacts:

- **Poor hygiene, sanitation, and waste management** associated with in-migration: These can all result in increased risk of transmission of water borne communicable diseases such as hepatitis A and E and typhoid through increased risk of contamination of water and food with faecal matter. In addition, these factors could also result in increased number of pests, such as rats, which could be attracted to improperly stored food and waste and contribute to disease transmission. The additional migrant population will have a negative impact on natural resources and environmental sanitation, thus increasing the risk of transmission.
- **Changes to water and air quality:** The project's construction activities have the potential to impact water and air quality. There is already a high prevalence of water/food and respiratory diseases in the DIA. Increases in fugitive dust and other air pollutants and degradation of water quality, especially as a result of poor waste treatment, could exacerbate these conditions.
- **Crowded living conditions:** At the worker camps in particular, communicable diseases such as TB could spread quickly due to workers sharing accommodation. There is the potential for increased transmission between workers living and working in close quarters and then onwards as a result of interaction with worker's families and local communities. Further, population influx of worker's families and others seeking employment and other opportunities to the project impact area could compound these risks.
- **Pressure on health infrastructure:** An increase in population as well as disease prevalence would put additional pressure on the existing health care system.

These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

f) Transmission of Sexually Transmitted Diseases/Sexually Transmitted Infections

The Project could result in increased transmission of STD/STI during construction due to:

- Presence of a large workforce including males with higher incomes engaging high risk sexual activities with Commercial Sex Workers (CSWs), in particular near worker camps.
- Workers establishing casual relationships with young girls in communities near the worker camps. This may result in transactional sex or circumstances where the women assume will result in a more committed and long-term relationship.
- Increased numbers of CSWs, who may have higher infection rates of STDs/STIs, near worker camps.
- In-migration, resulting in the mixing of people with higher STD/STI prevalence rates than the host community, which may promote the transmission of the disease.

CSWs may be better placed than other women to negotiate safe sex practices, such as the use of condoms, but may also be willing to waive their use for a fee. Due to vertical transmission pathways, an increase in the prevalence of STDs/STIs in the project-affected communities is a risk to the health of the community. While there is access to treatment for STDs/STIs in the communities, it is limited in terms of quality. Furthermore, there are significant taboos around STDs/STIs, which may influence people's willingness to access treatment. These impacts are considered high in magnitude, local in extent, and medium term in duration, with a pre-mitigation significance of ***Substantial***.

g) Health Infrastructure

The presence of a non-local workforce is likely to lead to increased pressure on the existing health care facilities in the DIA. Despite the fact that the worker camps will have their own medical facilities, increase in demand will arise if there is increased transmission of diseases, accidents, and/or numbers of people accessing care for routine services. Considering the already limited health care capacity this increase in demand may further limit local resident's access to facilities and result in longer waiting times or patients not attended to and worsening health outcomes, such as uncontained spread of diseases/infection. These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

h) Gender, Gender-Based Violence, and Trafficking in Persons

The Project has the potential to affect gender, gender-based violence (GBV) and trafficking in persons (TIP) in the following ways:

- **Gender-based violence, including sexual harassment, and sexual/child abuse/exploitation;** As the population of men increases disproportionately and more cash and material wealth emerges in the area from an increasing presence of salaried workers, the likelihood for increased anti-social behaviours such as prostitution and consumption of drugs/alcohol also increases. The consumption of alcohol by men often contributes to GBV, sexual assault, domestic violence, and child abuse and exploitation.
- **Increased incidences of prostitution and casual sexual relations:** Increased disposable income could also lead to an increase in prostitution and casual sexual relations between workers and local women. This increased demand for prostitution in the DIA can contribute to increased risk of TIP for participation in the commercial sex trade, which disproportionately affects women and minors (particularly the poorest).
- **Forced marriage:** The influx population will be mostly young men; as such – and in combination with the increase in social vices described above – young women and girls in local

villages may face unwarranted sexual advances by men. The custom of forced marriage may legitimise such sexual advances and undermine the rights of those young women.

- **Early marriage**: Young girls may be made vulnerable due to the continued practise of early marriages. Migrant workers may also father children with local women and young girls while they are living in the DIA. Given the temporary nature of the work, it is possible that both the women and children will be abandoned when the contractors move on, leaving behind vulnerable single female-headed households.
- **Access to money and assets**: Assets tend to be registered in men's names and, even in cases where they are registered in the woman's name, typically the male heads of households make the economic decisions for the family. Women are often more likely to opt for in-kind compensation (i.e., replacement land) than are their male counterparts, and worry that men will opt for cash compensation and then spend the money on things that do not benefit the household more broadly.

These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial.***

i) Emergencies and Public Safety

During project construction, a variety of emergencies may occur involving natural disasters and accidents, which could affect community safety, including the following:

- **Natural Disasters** - although disasters like floods, GLOFs, earthquakes, landslides, and fires occur naturally, the project has the potential to increase the frequency of occurrence for some of these events and/or increase the magnitude of their impacts. Therefore, the risks during the construction and operation phases could be high in magnitude, local in extent, and long term in duration.
- **Dam Failure** - the UAHEP involves construction of a large dam (i.e., defined as having a height over 15 m and impounding more than 3 million m3 of water) as it is designed to have a total height of 100 m and store 5.07 million m^3 of water. A dam of this size poses risks to downstream communities in the event of dam failure, which could include loss of life. The effects of a dam failure during construction or operations would be expected to extend downstream to at least the Arun-3 HEP dam and impact villages and structures located near the Arun River. Therefore, the project's dam safety risks during the construction and operation phases could be high in magnitude, local in extent, and, although the duration of a dam break incident would be short, the impacts therefrom would take a long time to restore and recover from, resulting in a pre-mitigation significance of ***High***.

j) Use of Security Personnel

The project will employ security personnel to help reduce internal and external risks. This will consist of private and possibly public (Nepal Police and Nepal Army) security agencies. The impacts associated with the use of security personnel are as follows:

- **Excessive force:** In the event of protests, trespass or other actions by community members or other stakeholders, there is the potential for unlawful or abusive interaction between security guards and community members especially if site security are not adequately trained.
- **Community disquiet:** Project construction will add security personnel camps and deploy private security guards at multiple locations, which may cause a sense of insecurity and uneasiness.

- **Restrictions on community movement:** Private security personnel will enforce temporary entry restrictions to construction sites due to safety and security reasons, which may intimidate or inconvenience local people.

These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

k) Labor and Working Conditions

Workers' rights need to be considered to avoid accidents and injuries, loss of man-hours, labor abuses and to ensure fair treatment and working and living conditions. These potential construction phase impacts include:

- **Worker Health and Safety**: Poor working conditions for doing hazardous work, such as working at heights or in confined spaces, use of heavy machinery, or use of hazardous materials. Employees working informally and those with limited experience or without awareness of their rights (for example, migrant workers, or those newly entering the labor market) are likely to be most at risk.
- **Worker rights**: There is a risk that some of the project's sub-contractors/suppliers may not be fully compliant with Nepali legal requirements related to labor conditions, which can result in unfair terms and conditions of employment, unfair treatment, discriminatory hiring practices and treatment of employees, violation of recognized labor rights, and inadequate living conditions in workers' accommodation provided by contractors.
- **Forced labor:** The large demand for labor means that the Project could contribute to the risk of forced employment, which can include not paying workers fairly in a timely manner, withholding (without access) passports or other identification, and using recruitment agencies that charge large fees.
- **Child labor:** The DIA does not have secondary schools and the dropout rate for adolescents is high. In such a situation, adolescents are more likely to join – whether voluntarily or at the behest of their family members – the project workforce if strict regulations are not in place.
- **Discrimination against women:** women are at risk of being discriminated against in terms of paid employment with the Project.

These impacts are considered high in magnitude, local in extent, medium term in duration, with a pre-mitigation significance of ***High***.

l) Cultural Heritage

The absence of any protected archaeological sites or historical monument was also confirmed during consultation with Department of Archaeology in Kathmandu. However, the Project will have impacts on tangible (including natural heritage sites) and intangible cultural heritage resources of importance to multiple local Indigenous Peoples groups, and in the case of the Barun Dovan, to a much wider group of various faith communities. Project construction will result in impacts on tangible cultural heritage sites, including several privately-owned cultural sites, stupa/gumba, devithan, chautari, and manes. Each ethnic group of the villages within DIA of the Project has burial sites (graveyards) mostly at mountain peaks or cremation grounds located along riverbanks. Mostly these sites are away from construction area. However, access to some sites is likely to be impacted due to construction activities.

The construction work will include ground clearance and earth moving/excavation works at several locations. There is a chance of finding currently unknown materials with cultural heritage

significance, including grave sites, skeletal remains, archaeological artefacts, and paleontological finds. These impacts are considered high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

The Project may impact different facets of the intangible culture including traditional language, rituals, festivals, dietary habitats, knowledge (e.g. handicrafts, medicinal plants), as the communities will be exposed to other cultures and customs, which could affect their lifestyles and undermine traditional values. The Adavasi Janajati in the DIA attach cultural significance to various natural features, including the Arun River, Arun-Barun Dovan (confluence), and the Chepuwa and Bhembhema waterfalls. The construction activities will change the landscape and visual setting of these sites and may temporarily limit access for its users. These impacts are considered high in magnitude, local in extent, and long term in duration, with a pre-mitigation significance of ***High***.

7.2.3.2. Operations Phase

a) Project-induced In-Migration and Populaton Influx

Following the construction phase of the Project, it is unlikely that any further job-seekers will move into the area, given the limited employment opportunities available during the operation phase. Although the existence of a new road may encourage some continued economic migration, the lack of direct/formal jobs in the area will limit this dynamic. These impacts are considered low in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

b) Ecosystem Services

No additional impacts are anticipated related to ecosystem services during the operation phase, other than on-going impacts from the construction phase. These impacts are considered low in magnitude, local in extent, and long term in duration, with a pre-mitigation significance of ***Moderate***.

c) Effects on Downstream Water Users and Uses

The Project will affect flow differently by segment of the river, which in turn will have different effects on water users and uses. Upstream of the project dam, a reservoir will be created. Although no cremation sites are known to exist in the proposed reservoir area, the presence of the reservoir would not prevent cremations or other cultural/religious uses from occurring. The presence of the reservoir, and the associated reduction in river currents, will make this area more attractive and safer for subsistence fishing, washing, and bathing, although public access will be prohibited to portions of the reservoir near the dam and headrace intake for safety and security reasons. Flow in the diversion reach will be significantly reduced for most of the year, with only the proposed E-Flow and tributary inflow contributing to flow in the river. There will still be sufficient flow in the river to conduct cremations and for other cultural/religious activities. The reduced flow and the associated reduction in river currents and sediment will make this area safer for subsistence fishing, washing, and bathing for much of the year, except during the monsoon season. Flow downstream of the powerhouse will fluctuate daily generally from October to May when peaking operations will occur. This peaking operation should not prevent cremations, cultural/religious, subsistence fishing, or washing/bathing activities from occurring in the 11.8 km reach between the UAHEP tailrace and the Arun-3 HEP reservoir backwater. The peaking operation has the potential, however, to create some safety hazards for people in or along the edge of the river when peaking begins. Peaking operations will occur on a regular schedule beginning around 6pm and

continuing until about midnight, so downstream users will likely get accustomed to project operations. These impacts are considered high in magnitude, local in extent, and long term in duration, with a pre-mitigation significance of ***High***.

d) Transmission of Food/Water Borne Diseases

The conditions for food and water contamination contributing to communicable disease transmission will not be present during the operation phase. These impacts are considered low in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Low***.

e) Transmission of Sexually Transmitted Diseases

Once operational, the risk of transmission of sexually transmitted diseases will be reduced as the large foreign workforce will leave. These impacts are considered low in magnitude, local in extent, and long term in duration, with a pre-mitigation significance of ***Moderate***.

f) Impacts on Health Infrastructure

The project will only employ about 130 workers during operations, with about half of these workers likely drawn from the local area. There will be a health clinic at the project operations center. These workers will not place any significant demands on the local health care system. These impacts are considered low in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Low***.

g) Impacts Associated with Gender, Gender-Based Violence, and Trafficking in Persons

Many of the adverse impacts linked to the construction phase will no longer be relevant. However, the Project will bring some lasting changes to the life of community in general and women in particular. Due to their inherent inequality in the society, women may not be able to take equal advantage of the project's benefits during the operation phase, where employment positions will tend to require higher levels of skills/education. For example, while educational support programmes and skills training programmes will increase the number of educated women eligible for formal employment created by the Project and anti-discrimination practices may help to ensure women obtain some jobs during the construction phase, the employment opportunities during the operation phase of any hydroelectric project is limited. Men may be preferred for these positions and women may be marginalized. These impacts are considered medium in magnitude, local in extent, and medium term in duration, with a pre-mitigation significance of ***Moderate***.

h) Impacts Associated with Emergencies and Public Safety

Operation of the UAHEP will create some unsafe areas and conditions that could pose drowning risks to the public where flow levels may change quickly and dramatically, including the areas immediately upstream of the dam, immediately below the dam, and the area immediately below the tailrace tunnel. These impacts are considered high in magnitude, local in extent, and long term in duration, with a pre-mitigation significance of ***High***.

i) Impacts Associated with Security Personnel

During the operation phase, a reduced number of security personnel will remain. The Arun River checkpoints established during the construction phase will be removed, and all facilities that are no longer required for operations (i.e. the explosives magazine) will be decommissioned and, their security forces disbanded. These impacts are considered low in magnitude, site-specific in extent, and short term in duration, with a pre-mitigation significance of ***Low***.

j) Labor and Working Conditions

The Project will employ approximately 130 workers during the operation phase. As discussed above, in the absence of specific policies and standards, workers would be potentially subject unsafe working conditions, labor abuses, unfair remuneration, and inappropriate working and living conditions. These impacts are considered medium in magnitude, site-specific in extent, long term in duration, with a pre-mitigation significance of ***Moderate***.

k) Cultural Heritage

During the operation phase, no new construction will occur and, therefore, no new impacts on cultural heritage. Therefore, the project's impact on tangible cultural heritage during the operation phase will be low in magnitude, site specific in extent, long term in duration. The exposure of local residents to a foreign workforce for 6 years and permanent improved access may undermine some traditional intangible cultural practices. Therefore, these impacts are considered to be medium in magnitude, local in extent, long term in duration, with a pre-mitigation significance of ***Substantial***.

CHAPTER 8: MITIGATION MEASURES

The project proponent will implement the proposed mitigation and enhancement measures as a prime responsibility. The adverse and beneficial impacts that are not identified during the study, if later discovered during the construction and operation phases will be mitigated by the proponent at its own cost. The project proponent will compensate the affected parties for losses of lives or properties due to implementation of the project as per the prevailing law. Mitigation measures has been developed with due consideration of preventive, corrective and compensatory measures for all three environmental domain. The preventive, corrective and compensatory measures proposed under the contractor's responsibility will be ensured by incorporation of appropriate tender clauses in tender document. The compliance of these measures will be ensured by compliance monitoring system proposed in Chapter -9.

8.1. Mitigation and Enhancement Measures

The following mitigation measures have been proposed to ameliorate the possible adverse impacts and enhance positive impacts identified during the study. The measures outlined below are intended to mitigate the potential adverse impacts of the project and enhance the positive impacts, which involve changes to the baseline conditions. The impact mitigation and enhancement measures matrix is presented in Table 8.1.

Table 8.1: Impacts Mitigation and Enhancement Measures Matrix									
Impact	**Direct**	**Indirect**	**Beneficial**	**Adverse**	**Significance**				**Mitigation (Preventive, Corrective & Compensatory) and Enhancement Measures**
					Magnitude	**Extent**	**Duration**	**Total**	
8.1 Positive Impacts									
Construction Phase									
Employment up to a peak of 4500 workers over a 6 years construction period	Y	N	Y	N	60	60	5	125	Skill training will be given to local people and due priority will be given for hiring of PAPs, women and vulnerable group and local people. This will be ensured through appropriate tender clauses. Selected bidders will be asked to submit a hiring plan indicating how he will meet these hiring objectives. Prior information will be given to local people through RM and Project office about the possible areas of recruitment, required qualification and skills etc.
Increase in economic opportunity due to enterprises development and local products	N	Y	Y	N	20	20	5	45	Provide opportunities for the local entrepreneurs/cooperatives to serve required goods and services for the project personnel. Project will facilitate for agreements with interested suppliers and local cooperatives for supply of daily consumption goods and agricultural products for the project people. The project affected families will be encouraged to undertake such entrepreneurship development activities. Training will be given to local intrested people about the bidding procedures for local procurement for services, materials and supplies.

Increase in skill of local people particularly in tunnel construction, river diversion, heavy equipment operation, masonry, construction of dry walls, gabion walls	Y	N	Y	N	60	20	5	85	Preferential hiring procedure consiting SPAFs, PAFs, women, disadvantage group and Dalit, residents of project affected rural municipality, district and Nepali Citizen will be followed. Experience in the mentioned field will also be considered.
Opportunity for emergence of commercial banks, government and non-government organizations, health and educational facilities, and development of market centers	N	Y	Y	N	20	20	20	60	The project will encorage for such type of commercial activities by providing business.
Operation Phase									
Employment opportunity during operation	Y	N	Y	N	60	20	20	100	Supporting staff for operation of the project will be hired from local area to the extent possible.

Project will generate revenue and certain portion of the revenue will be used for local development	Y	N	Y	N	60	60	20	140	Provide training to representative of affected rural municpality for the possible uses of revenue in the development of their area.
Enhance economic opportunity and promote tourism development	N	Y	Y	N	10	20	20	50	
Land value of Gola, Sibrung, Hema, Namase, Rukma and Chhongrak will increase	N	Y	Y	N	10	10	20	40	
Revenue generated through royalty will directly contribute for national development and welfare of people	Y	N	Y	N	60	60	20	140	

Generated power will expand the door of rural electrification	Y	N	Y	N	20	20	20	60	Due priority will be given for the expansion of rural electrification via national grid through NEAs regular scheme in future.
8.2 Adverse Impacts									
Physical Environment (Construction Phase)									
Slope Failure	Y	N	N	Y	60	20	10	90	Cut-off drains and toe-drains will be provided at the top and bottom of slopes and be planted with grass or other cover. Slope works and earth moving/excavation will be conducted in order to minimize exposure of soil surface both in terms of area and duration. Steep slopes greater than 30 degrees will be protected through necessary civil structures such as breast wall, gabion structure or concreting as per the requirement of the site.
Natural Hazards	Y	N	N	Y	60	20	5	85	Alarms, including both visual and auditory alerts, to notify personnel and the public of emergency conditions will be placed at appropriate location. Communication procedures and equipment that the Contractor shall use for notifying its personnel and emergency responders will be in place and well informed to stakeholders. Awareness and other training for project workers and local residents will be conducted to aware and trained them how to protect themselves in the event of an emergency.
Erosion and Sedimentation	Y	N	N	Y	60	20	10	90	The Contractor will construct erosion control barriers around the perimeter of cuts, disposal pits, and roadways as required. Terraces and other erosion control measures will be implemented, where necessary to prevent soil erosion.

									Retaining and gabion walls will be built to prevent scouring of river banks at strategic locations, especially upstream of the river above the dam
Soil Compaction and Damage	Y	N	N	Y	20	20	5	45	Muck disposal sites will be provided with retaining walls and other engineering and biological control measures to mitigate erosion.
									Silt fencing will be provided around stockpiles at the construction sites close to river/tributaries/ and springs.
Effects of Tunneling on Local Springs	Y	N	N	Y	60	20	5	85	Only qualified and authorized personnel will handle explosives and manage the blasting process.
									The Contractor will take necessary precautions to prevent damage to special features in the surroundings (e.g. ecological, historical, or culturally important areas) and the general environment.
									The Contractor will adopt optimized blasting techniques using delay detonators for blasting in confined areas.
Effects of Water Demands	Y	N	N	Y	20	20	5	45	Water from streams used by local villages for potable water, and mill and micro-hydropower operation will not be used for project purpose.
Sediment Transport and Deposition	Y	N	N	Y	10	20	5	35	The Contractor shall maintain stable cut and fill slopes at all times and cause the least possible disturbance to areas outside the prescribed limits of the construction works.
									The Contractor will complete cut and fill operations to final cross-sections at any one location as soon as possible.
									Limit the size of individual blast charges to reduce the risk of triggering landslides.
									All areas susceptible to erosion will be protected by installing necessary drainage works and by taking other necessary measures to prevent storm water from concentrating in streams and scouring slopes, banks, etc.
Storm water Runoff	Y	N	N	Y	60	20	5	85	All seepage from the tunnel portals and from spoil disposal areas will be directed to a storm water pond to allow the settling of any suspended material before discharge to a watercourse.

									Storm water basins downslope from the two Owner's camps, switchyard, water treatment plants, and parking areas will be constructed to allow for pollutants to settle out and to moderate storm water runoff.
									Provide oil/water separators for drainage from any vehicle maintenance areas.
Wastewater Disposal and Discharge	Y	N	N	Y	60	60	5	125	Sufficient number of toilets facilities (separate toilets for men and women, typical standard is 1 toilet per 15 workers) at each work site will be provided.
									Wastewater treatment facility will be provided at each Camp to treat domestic wastewater prior to discharge to a receiving water.
Improper Solid Waste Disposal	Y	N	N	Y	60	60	5	125	Solid waste management system will be established to ensure proper collection, segregation, and disposal of solid, construction, medical, and hazardous wastes so that there is no contaminated surface runoff or public health issues.
									At all places of work, the litter bins, containers, and refuse collection facilities for later disposal will be provided.
									Recyclable materials will be re-used or sold to a waste collector for recycling.
Hazardous Materials/Waste Management	Y	N	N	Y	60	20	5	85	Trucks used for transportation of hazardous material will have appropriate safety measures in place, including use of safety placards or other indication of the material being transported, and emergency contact information.
									The transportation, storage, processing, packaging on site, blasting and the disposal of the blasting material will comply GoN regulations on the use of explosives. Above-ground blasting will not be allowed during night time. Prior to a surface blasting event water will be sprayed on the surface of the blast area to increase its moisture content, and blasting mats (constructed from truck tires bolted together), wire mesh, gunny sacks, and/or sandbags will be used on top of the blast area at each shot to prevent flying rocks and dust.
									All hazardous material/substances will be stored on site in a manufacturer recommended container, within a covered or enclosed structure with appropriate sign. Periodic inventory of all hazardous materials stored on site will be maintained.

Air Quality	Y	N	N	Y	60	20	5	85	Progressive stabilization and restoration of disturbed areas (e.g., stabilize a completed area) will be carried out before disturbing a new area.
									Batching plants and crushers will use a high-efficiency dust suppression/control system and enclosed with 3 m high barriers to minimize the spread of dust.
									Unloading from cement delivery trucks will be done on pallets, which will be covered with tarpaulin sheets during non-working periods.
									The earthen and graveled road corridors will be sprinkled regularly to minimize the fugitive dusts from the plying of the construction related vehicles particularly in the winter and Sumer dry season.
									Diesel generators for power supply will be optimally operated and regularly maintained to ensure emissions from fuel combustion remain at design levels.
Construction Noise	Y	N	N	Y	60	20	5	85	Silencers, mufflers, acoustically dampened panels/noise barriers and acoustic sheds or shields will be provided to the workers working in noise and dust prone areas.
									All hydropower diesel power plants will be placed within an acoustic enclosure to reduce impacts to workers at the camps and nearby residences.
									Noise barriers (berms or fences) or shields between the noise source and nearby receptors, especially for noisy sources such as the crusher, batching plants, and generators will be installed.
									Vehicle speeds will be restricted to 20 kilometers per hour (km/hr.) at site, including the project service roads, and use of horns will be prohibited at night and in villages except for emergencies.
									Use of helicopter and above-ground explosive will be limited to daytime hours.
Vibration	Y	N	N	Y	60	20	5	85	Physical inspection of all structures that could be potentially affected by construction related vibration will be conducted prior to start of construction and during construction.
									Prior notification of use of explosives and helicopters will be provided.
									Promptly investigate any claims of damage from construction activities.

									Prompt investigation will be made and compensation will be paid for any damage caused by project-related construction activities.
									All disturbed areas will be restored and revegetation will be done on spoil disposal sites.
Sub Total									
Physical Environment (Operation Phase)									
Slope Failure	Y	N	N	Y	60	20	20	100	Bioengineering works will be continued on the steep slopes. Appropriate grass or other erosion control material (such as jute) shall be planted on steep slopes to provide suitable vegetative cover and to minimize the risk of erosion.
Natural Hazards	Y	N	N	Y	20	20	20	60	Alarms, including both visual and auditory alerts, and communication procedures to notify personnel and the public of emergency conditions will be in place.
									Third party insurance for plant and equipment will be carried out.
									Awareness and other training for the operators and local residents will be conducted to aware them protect themselves and others in the event of an emergency.
Erosion and Sedimentation	Y	N	N	Y	10	20	20	50	Stabilize and revegetation of any eroding areas using proper techniques.
Effects of Tunneling on Local Springs	Y	N	N	Y	60	20	20	100	Water yield and water quality in springs of the affected area will be monitored on a monthly basis for the first two years of operation and in case of reduction of flow permanent alternative source of water to the affected households or villages at no cost will be provided. Likewise, power to replace any reduction in micro-hydropower generation or mill operation, at no cost to the affected households will be provided.
Effects of Water Demands	Y	N	N	Y	10	10	20	40	Water from water treatment facility will be provided as required. Water sources will be used without disturbing water uses sources of local people.

Sediment Deposition in the UAHEP Reservoir and downstream	Y	N	N	Y	60	60	20	140	When river inflow is larger than 240.5 m^3/s, but less than 575 m^3/s, the available turbine units (235.44 m^3/s) and the required Environmental Flow (EFlow) (5.41 m^3/s) will run at full discharge and excess water will be discharged via the SBT, which has a capacity of 815 m^3/s.
									When the river inflow is larger than or equal to 575 m^3/s, but less than 1,050 m^3/s, the Project will shut down the turbines in an enforced outage, lower the reservoir level using the mid-level outlet (MLO) gates, with a sill elevation of 1596 m, and then the low level outlet (LLO) gates, with a sill elevation of 1590 m, will be opened to allow a free-flow flushing (i.e., reservoir empty) for a duration of 24 hours.
Storm water Runoff	Y	N	N	Y	60	20	20	100	All storm water ponds will be routinely maintained and cleaned out, with any deposited sediments disposed of in an approved upland location.
									Prompt maintenance for a damage, failures, or evidence of erosion and stabilize/restore any identified eroding areas using appropriate vegetative or structural stabilization measures will be carried out.
Wastewater Disposal and Discharge	Y	N	N	Y	10	20	20	50	Wastewater treatment facilities in accordance with manufacturer specifications will be maintained and daily monitoring of effluent water quality will be carried out.
Reservoir Water Quality	Y	N	N	Y	10	10	20	40	Water quality monitoring in the Project reservoir, two locations in the diversion reach (one upstream and one downstream of the Barun River confluence), and at the access road bridge will be conducted on a monthly basis and necessary measures will be applied if require.
Diversion Reach Water Quality	Y	N	N	Y	10	10	20	40	Release 5.41m3/s water in dry months from the powerhouse located at dam toe.
Downstream of Powerhouse Water Quality	Y	N	N	Y	10	10	20	40	Wastewater treatment facilities will be maintained in accordance with manufacturer specifications and discharge of any untreated wastewater will be prohibited.

Hazardous Materials and Wastes	Y	N	N	Y	10	20	20	50	All hazardous material/substances will be stored on site in a manufacturer recommended container, within a covered or enclosed structure with appropriate sign. Periodic inventory of all hazardous materials stored on site will be maintained.
									Provide dry chemical or other type of fire extinguishers suitable to the type of hazardous material stored on-site.
Air Quality	Y	N	N	Y	10	10	20	40	Manufacturer-specified maintenance of vehicles and any back-up diesel generators will be done and burning and open fires will be prohibited.
									Vehicle speed will be restricted to 20 kilometers per hour (km/hr.) at site to minimize potential for dust generation in the surroundings.
GHG Emissions	Y	N	N	Y	10	20	20	40	Clear and remove forest and other decomposable vegetative material within the reservoir's FSL before inundating.
Operation Noise	Y	N	N	Y	10	10	20	40	Regular maintenance of equipment and vehicles in accordance with manufacturers' specifications will be conducted.
									Night-time vehicle traffic between the powerhouse and headwork's area will be minimized.
Project Vibrations	Y	N	N	Y	10	10	20	40	Limit truck speeds to 20 km/hr. within village or near buildings.
Landscape Values	Y	N	N	Y	60	20	20	100	Restore vegetative cover over Spoil Disposal Area #1, #2, #3 and #4 to reduce visual impacts on Chepuwa Khola waterfall and Arun Gorge area and Barun Bazar/Mela site.
Sub Total									
Biological Environment (Construction Phase)									
Effects on Legally Protected Areas (MBNP)	Y	N	N	Y	60	20	20	100	Funding will be provided to MBNP for the implementation of National Park Management Plan and to increase the number of park rangers and strengthen monitoring and enforcement of illegal activities.
									Replacement land will be provided for the leasing of buffer zone forest land in the nearby areas and plantation of saplings @ 1600/ha will be carried out or equivalent

									amount will be deposited in Forest Development Fund as per schedule 51 of Forest Regulation.
									Compensatory plantation will be done in the land designed by MNNP @ of 1:25 or equivalent cost will be deposited in Forest Development Fund as per schedule 51 of Forest Regulation.
Loss of Terrestrial Habitat	Y	N	N	Y	20	20	20	60	All disturbed land will be permanently stabilized as soon as construction activities are completed.
									Implementation of compensatory plantation in 234.50 ha area will create additional forest habitat.
Effects on Forests	Y	N	N	Y	20	20	20	60	All areas to be cleared will be marked prior to clearance and burning of cleared site will be prohibited.
									Compensatory afforestation of 257935 sapling consisting 132,125 saplings in 1:25 ratio for the tree loss from MBNP buffer zone and 125,810 seedlings from Government managed forest and community forest out side the buffer zone @ 1:10. Such plantation will be done in the land provided by the concerned authorities and management will be done for five years or project may deposit plantation and management cost as per the norms and estimate of concerned authorities in Forest Development Fund as per schedule 51 of Forest Regulation.
									In addition, plantation will be done in the 73.31ha replacement land @ 1600 /ha or equivalent cost will be deposited in Forest Development Fund.
									Areas of degraded forest within the Makalu Barun National Park; and community forests within the project area were the potential sites for plantation.
									Alternative sources of fuel wood will be provided for cooking and heating of the project workers.
									Private trees from the farm land/ Kharbari land will be compensated.
Effects on Key Threatened Species	Y	N	N	Y	60	20	10	90	Biodiversity Induction Training will be conducted.
									Proper disposal of food scraps and other forms of edible garbage removed from the site to prevent incursion of bears into the construction areas.

									Open fires being prohibited at worker camps to reduce the risk of fire during construction and operation.
									Introduce and/ or proliferate invasive species into the habitat of Red Panda. Due emphasis will be given for the plantation of bamboos.
Disturbance and/or displacement of terrestrial fauna	Y	N	N	Y	60	20	5	85	A Fauna Shepherding Protocol will be used in the Project area to ensure that any fauna have vacated the area prior to any clearance work.
									Noise attenuation will be used during construction activities. Aboveground night time (20:00 – 7:00) construction will be prohibited.
Terrestrial barriers, fragmentation and edge effects	Y	N	N	Y	20	20	20	60	Where possible, to reduce the impacts of habitat fragmentation, areas between existing fragmented forest patches will be revegetated.
									Fence areas where practicable between patches of natural habitats adjacent to project areas to promote natural restoration and prevent further damage from anthropogenic impacts (e.g. walking tracks).
									Wildlife-friendly road crossing will be constructed to facilitate the movement of small mammals, reptiles and amphibians. Crossings will be designed to allow the passage of small – medium sized mammals.
Degradation of terrestrial habitat	Y	N	N	Y	20	20	5	45	Land rehabilitation using native species of flora will be undertaken in areas disturbed during construction.
									Education program will be implemented to inform personnel about the prohibition of collecting timber and non-timber forest products and the importance of natural habitat for the conservation of significant species. It will continue with refresher training at 6 monthly intervals until the end of the construction phase.
									Use of the access road will be restricted to construction vehicles only. Checkpoints are to be used to manage access and inspect vehicles for wood and timber products taken from areas of natural habitat within the Project Area.
Wildlife mortality events	Y	N	N	Y	60	20	10	90	All vehicles will have to maintain a speed of a maximum of 20 km/hr. within the Project Area to reduce the risk of fauna strikes.

									Training will be provided to drivers within the project footprint to inform them of speed limits and awareness of potential wildlife crossings in the transportation corridor.
									Hunting and poaching will be prohibited. Provision of heavy penalties and or dismissal for repeat offences will be made in contract documents.
									Provide wildlife-friendly road crossing to facilitate the movement of small mammals, reptiles and amphibians. Crossings will be designed to allow the passage of small – medium sized mammals.
Loss and conversion of aquatic habitat at dam/reservoir	Y	N	N	Y	20	10	20	50	Revegetation and shoreline protection will be undertaken at the full supply level of the dam on steep bank slopes to prevent erosion.
Biological Environment (Operation Phase)									
Degradation of aquatic habitat in the diversion reach	Y	N	N	Y	60	20	20	100	E Flow of 5.41 m^3/s will be released to maintain downstream ecosystem (Refer Annex 18).
									Sediments will only be flushed during high flow periods when there is sufficient flow to transport sediment through the diversion reach.
Degradation of aquatic habitat downstream of powerhouse	Y	N	N	Y	60	20	20	100	Adaptive management measures such as channel improvements or ramping rates to maintain fish access to important spawning tributaries like Ikhuwa Khola and Leksuwa Khola will be provided.
									Sediments will only be flushed during high flow periods when there is sufficient flow to transport sediment through the diversion reach.
Degradation of aquatic habitat in small streams	Y	N	N	Y	20	10	20	50	Prohibit the washing of vehicles in local streams.
									Conduct plantation in available areas at both the banks of arun river and tributaries.
Effects on fish movement and migration	Y	N	N	Y	60	20	20	100	Preserve the integrity of existing warm water tributaries between Arun-3 HEP dam and UAHEP dam to support a naturally reproducing and sustainable population of these migratory fish in this river segment.

									Adaptive management measures such as a trap and haul program if monitoring indicates upstream fish diversity/abundance is decreasing after project commissioning.
Effects from fish impingement and entrainment	Y	N	N	Y	60	20	20	100	Trash rack/screens at the headrace intake with a clear spacing between the bars of 2.5 cm will be installed to reduce entrainment and impingement risk.
Socioeconomic and cultural Environment (Construction Phase)									
Land Acquisition and Physical/Economic Displacement	Y	N	N	Y	60	20	20	100	Compensation of the land will be paid as per the rates determined by CDC. If the PAHs purchase land within Bhotkhola RM additional 5% of compensation amount will be given as allowances. This amount is 10% for the vulnerable PAHs and 15% if the land is purchased in the name of male and female. In addition, vulnerability allowances @ rate of 3000 for 12 months will be given to the women headed PAHs, households have low annual income (NRs 19261), old age (70 above), Dalit, more than 4 children below 18 years, handicap and HHs loosing more than 50% land in the project district. Besides this food security allowances@ 3000 for 6 months will be given to the PAHs having annual income less than NRs19261. The PAHs will also receive agriculture construction related training, vocational training and micro and small enterprises program based on their interest.
									Assistance of NRs 15000/- for re-establishing a similar land use agreement for the leased land within 6 months. Similarly, for the PAHs losing earning from business from the acquired land will be compensated @ rate of NRs 15000/- for 6 months. In addition, transitional allowances for 6 months will be given for the loss of income from agriculture products.
									PAHs loosing residential structure will receive adequate compensation as per the rate determined. If PAHs build new house or show the evidence of another house in project area or any other part of Nepal will receive NRs 800000/ house construction allowance. He/she will also receive house rent allowance @ 2500 for 6 months and NRs 50000/- transportation allowance. Besides this he/she will be also eligible to other allowances mentioned above based on the criteria.

									Restore disturbed cardamom fields so that they are suitable for reuse for cardamom. Ensure slopes above cardamom fields are well stabilized and maintained to prevent erosion, sedimentation, and/or landslides. Spray cardamom crops that may be impacted by fugitive dust periodically with water in consultation with the property owners/farmer.
Project-induced In-migration and Population Influx	Y	N	N	Y	60	20	10	90	Due priority will be given for local employment and project office in Kathmandu and in project area will facilitate the local hiring.
									The Contractor will run a communication campaign on local radio to inform where hiring will be done, minimum requirements, available seats and procedure of application including contact person.
									People seeking employment will be restricted from entering in project construction area by security personnel at the security checkpoints.
									Training will be provided to all workers and staffs on sexual exploitation and abuse, sexual harassment (SH) and adopt a Code of Conduct.
									Training and capacity building program will be implemented for local officials at the District and affected Rural Municipality regarding monitoring and management of influx.
Effects on Ecosystem Services	Y	N	N	Y	60	20	5	85	Promotion for the plantation of edible plants used by local ethnic group.
									Due priority will be given for the plantation in land available in community forest area.
									Contractor will supply water to each of the Worker Camps without impacting the water supply of nearby villages.
									Grouting and reinforced concrete will be done as quickly as possible to minimize or eliminate groundwater seepage into the tunnels and cavern.
									Water yield and water quality in springs of the affected area will be monitored on a monthly basis for the first two years of operation and in case of reduction of flow permanent alternative source of water to the affected households or villages at no cost will be provided. Likewise, power to replace any reduction in micro-

									hydropower generation or mill operation, at no cost to the affected households will be provided.
Downstream Water Users and Uses	Y	N	N	Y	10	20	5	35	Release of 5.41m3/s water in dry months. Local resident access to cremation, cultural, and religious locations along the river will be maintained or, alternative safe locations for these activities will be developed in consultation with the community.
Transmission of Food/Water Borne Diseases	Y	N	N	Y	60	20	5	85	Mandatory health check-up of in-migrant workers will be conducted to identify pre-existing contagious diseases before they come to the workers camps. Implementation of awareness campaigns in coordination with District Hospital. Implementation of health surveillance program in the Project DIA consisting - Surveillance of all drinking water sources used by community and workers for water borne diseases. - Surveillance of vectors to contain vector borne diseases and other communicable diseases.
Transmission of Sexually Transmitted Diseases	Y	N	N	Y	60	20	5	85	Organize annual health camp in coordination with District Health Office to check reproductive health. Implementation of awareness campaigns in coordination with District Hospital and provide preventive and promotive health care services. Implementation of awareness program for workers and local communities for the prevention, detection, screening, and diagnosis of sexually transmitted diseases, especially with regard to HIV/AIDS. The program will also include information on alcohol abuse, gender-based violence, sexual exploitation and abuse, and human trafficking. Mobilize local health post or other HIV/AIDS service provider, to monitor and take appropriate preventive measures such as provision of condoms.

Impacts on Health Infrastructure	Y	N	N	Y	60	20	5	85	Each Worker Camp will be served by a health unit capable of treating all first aid cases and common sickness (e.g., flu), injuries, which will be staffed by a senior nurse. The health units will have beds, all basic equipment's and medicines for treatments. In addition, one central health post will be established headed by MBBS doctor for the treatment of more severe case, communicable diseases, and medical emergencies where patients can receive higher level care and/or be stabilized until they can be transported to district or provincial hospitals. The health post will have beds equipment, and basic laboratory facilities required for treatment.
									Funding support will be provided to District Hospital in Khandbari to run additional health units in the Project Direct Impact Area (DIA), such as establishing additional birthing centers at Rukma and Namase, and to expand its capacity to handle trauma and emergency cases.
Gender, Gender-based Violence, and **TIP**	Y	N	N	Y	60	20	5	85	Worker Code of Conduct will be developed and strictly followed.
									Request will be made to GON to establish police posts at locations where large worker camps are located (Sibrun and Rukma) and deploy female police personnel in these posts.
									Implementation of counselling program in project area covering gender-based Violence (GBV) and other relevant areas.
									Perimeter security fencing will be done in the camp areas and security guards will be in place to restrict public access around the Camps.
									Workers will be restricted in camps during night time hours unless working a night shift.
									Gender-based violence or intimidation, including physical or verbal harassment and sexual exploitation and abuse, directed toward female workers or female residents of the local villages, or other women will not be tolerated.
Natural Disasters	Y	N	N	Y	60	20	20	100	Alarms, including both visual and auditory alerts, to notify personnel and the public of emergency conditions will be placed at appropriate location.

									Communication procedures and equipment that the Contractor will use for notifying its personnel, emergency responders, nearby and downstream residents, the Owners, and local and national government officials of impending or actual emergency conditions will be in place and such information will be shared with local people.
									Awareness and other training for local residents will be conducted so they know how to protect themselves in the event of an emergency.
Dam Failure	Y	N	N	Y	60	20	20	100	Communication procedures and equipment that the Contractor will use for notifying its personnel, emergency responders, nearby and downstream residents, the Owners, and local and national government officials of impending or actual emergency conditions will be in place and such information will be shared with local people.
									Awareness and other training for local residents will be conducted so they know how to protect themselves in the event of an emergency.
Use of Security Personnel	Y	N	N	Y	60	20	5	85	The private security agency providing service must complies with the Companies Act of Nepal, and the Labour Act Nepal.
									Standard operating procedures for its security guards will be developed, and trainings will be conducted as per the Code of Conduct for private security providers.
Labour and Working Conditions	Y	N	N	Y	60	20	10	90	Use of child labor (below 14) will be completely prohibited. The workers below the age of 18 will be not allowed to undertake any work which is hazardous.
									Gender neutral hiring advertisements (i.e. avoid terms such as workmen, lines men) will be ensured and include that women are encouraged to apply).
									Priority will be given for the employment to women who have acquired new skills, such as machine operators, so that women get a fair share in the employment opportunities in construction works.
									Source as much unskilled labor as possible from Bhotkhola Rural Municipality to the extent possible.

									Minimum wages as per applicable laws will be provided to all employes. Any deduction applicable to their wages and the conditions of such deductions in accordance with the applicable Laws during their recruitment process will be informed to concerned person.
									The contractors and sub-contractors will keep a record of all workers engaged by them and make it available to the project for periodic labor audits.
									Insurance for workers as per Labor Act 2074 will be carried out.
Tangible Cultural Heritage	Y	N	N	Y	60	20	5	85	Relocation of affected cultural heritage sites will be done after wide consultation with the local community or their custodians at an acceptable alternative location.
									The Contractor will build alternative access to the natural heritage sites during construction phase.
Intangible Cultural Heritage	Y	N	N	Y	60	20	20	100	The Contractor will organize training and awareness program for employees and workers on local cultural sensitivities and ensure implementation of the Worker Code of Conduct.
									Avoid disruption of festivals, community rituals, and gatherings, in consultation with communities, including the temporarily halting the disposal of spoil for the duration of the Barun Mela.
Socioeconomic and cultural Environment (Operation Phase)									
Project-induced In-migration and Population Influx	Y	N	N	Y	10	20	20	50	Transport all non-Nepali workers out of the country at the end of their employment term.
									The Contractor will be responsible for the return of the workers to the place where they were recruited or to their place of domicile as soon as their employment in the project end.
Effects on Ecosystem Provisioning Services	Y	N	N	Y	10	20	20	50	Water yield and water quality in springs of the affected area will be monitored on a monthly basis for the first two years of operation and in case of reduction of flow permanent alternative source of water to the affected households or villages at no cost will be provided. Likewise, power to replace any reduction in micro-

									hydropower generation or mill operation, at no cost to the affected households will be provided.
Downstream Water Users and Uses	Y	N	N	Y	60	20	20	100	Implementation of a community education and awareness program focusing on project operational safety risks, installing and maintaining appropriate safety equipment, and providing alarms and signage to alert downstream water users of changing flow conditions. Periodic stakeholder engagement surveys will be conducted and closely monitor grievances during first two years of project operations to document any unanticipated project impacts on downstream water uses and users and implement an adaptive management program will be done to mitigate these impacts if necessary.
Transmission of Food/Water Borne Diseases	Y	N	N	Y	10	10	20	40	Water quality of the quarters and office will be tested on periodic basis and if E-coli and other bacteria were found further treatment will be done. Similarly, the food quality of canteen will be checked at regular interval to avoid such disease.
Transmission of Sexually Transmitted Diseases	Y	N	N	Y	10	20	20	50	Implementation of awareness program for project staff and nearby local communities for the prevention, detection, screening, and diagnosis of sexually transmitted diseases, especially with regard to HIV/AIDS will be carried out.
Impacts on Health Infrastructure	Y	N	N	Y	10	20	10	40	The existing health post will sufficient enough to provide service to project workers.
Gender, Gender-based Violence, and TIP	Y	N	N	Y	20	20	10	50	Selection of women for employment opportunities in operation phase of the project will be encouraged. Annual awareness and counselling related to Gender-based Violence (GBV) for 5 years will be conducted.
Emergencies and Public Safety	Y	N	N	Y	60	20	20	100	Operator will ensure that workers are aware of and prepared in the event of each type of emergency. Alarms, including both visual and auditory alerts, will be well maintained.

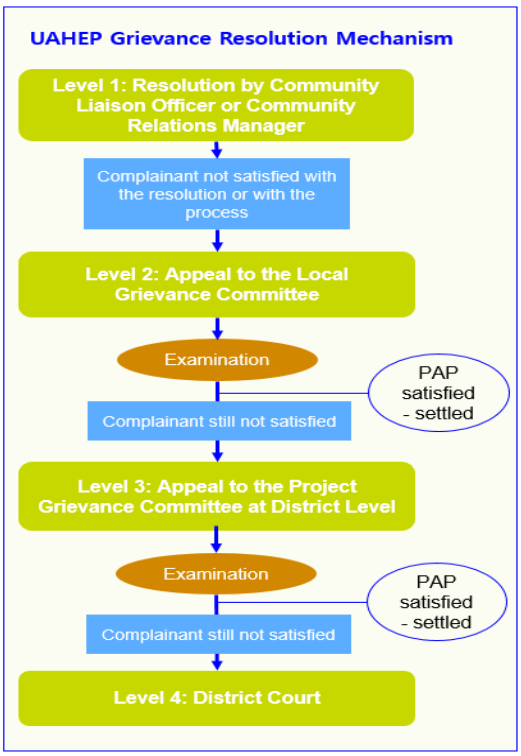
									Awareness and other training for local residents will be conducted so they know how to protect themselves in the event of an emergency.
Use of Security Personnel	Y	N	N	Y	10	10	20	40	Standard operating procedures for its security guards will be developed, and trainings will be conducted as per the Code of Conduct for private security providers.
Labour and Working Conditions	Y	N	N	Y	20	10	20	50	Accidental insurance from third party insurance company of all workers and staff including other provisions according to the Labor Act 2074 will be carried out.
									Minimum wages will be ensured and record of all workers working in project will be maintained make it available for periodic labour audits.
Tangible Cultural Heritage	Y	N	N	Y	10	10	20	40	Training and awareness program will be conducted for employees and workers on local cultural sensitivities and ensure implementation of the Worker Code of Conduct.
Intangible Cultural Heritage	Y	N	N	Y	20	20	20	60	Avoid disruption of festivals, community rituals, and gatherings, in consultation with communities.

8.2. Grivances Redress System

The GRM system consists of the following four stages of grievance management:

1. The first stage of the GRM comprises a Project-level, **in-house resolution process**, in which a stakeholder brings forward his/her concern for discussion with Project's community representatives via grievance boxes placed around the communities over the phone, via mail, or in-person at the Project Information Centres (PIC)[4], which is currently located in Gola (although the Project is considering additional locations). Here, a UAHEL Community Liaison Officer (CLO) will attempt to resolve the issue in coordination with the Project team. There will be four members (both men and women) in in-house resolution process and these members will be appointed by Project Manager. To date, the Project has entered grievances that has been received through grievance boxes into an excel sheet and shared this excel with the Project team. The Project team has an internal grievance documentation and response process wherein each grievance is written down manually and stored in hard copy.[5] It is expected that the majority of concerns will be heard and resolved internally through such in-house interactions. If this in-house process does not resolve the issue satisfactorily, complainants will be encouraged to make use of any of the other channels presented below.
2. If the complainant is not satisfied with the decision provided by the Project, the Project will forward the grievance to the **Local Grievance Committee.** There will be five members in Local level Grievance committee. The members of this Committee include the one Project CLO, one project Social specialist, one rural municipality official, one community representative, and one-woman representative to speak on behalf of project-affected households/local people. The members will be appointed in consultation with concerned stakeholders. The Project expects that this mechanism will successfully resolve most outstanding substantive grievances.
3. The third stage of the GRM is appeal to the **District Level Project Grievance Committee**. There will be five members in District level Grievance committee. The members of this committee include the one project Manager, one ESHS Manager, an official from the District Administration Office, one community representative and one-woman representative to speak on behalf of project-affected households/local people. The member will be appointed in consultation with concerned stakeholders. The above three stages comprise the non-judicial grievance management process available to stakeholders. At any time, however, complainants have the option of entering the formal judicial system through lodging a complaint with the judicial **District Court** (***Figure 8-1***).

[4] Note: in other Project documentation, i.e., the ESIA, these offices may be referred to as 'Community Liaison Offices'.
[5] It should be noted that there are plans to digitalize this process in the near future.



8.3. Community Support Program

In order to minimize the project impact on local people and to, develop cordial relation with the local community and smooth operation of the project community support program will be implemented. The basic principles of the community support program implementation will be community participation, local contribution, transparency and benefit sharing. The community support programs include assistance under socio-cultural development, economic development, infrastructure development and capacity building of the local people.

Table 8.2 Community Support Program Cost

Proposed Area of Activities	Details of program	Cost (NRs in Million)
Socio-cultural Development Program (SDP)	· Cultural Components: knowledge generation, preservation and promotion of culture, customs and practices of local people including indigenous community	140.00
	· Women/Youth/Elderly Programs	
	· Awareness about violence against women (VAW),	
	·Health and Social Wellbeing Programs	
	· ducation support program	
	· Agriculture Support Programs	155.00
	· Traditional Handicrafts Programs	

Economic Development Program	· Financial Management and Marketing Programs	
	· Herbal Plants and Medicine Programs	
	· Alternative Agriculture Programs	
	·Vocational training and Capacity Building Programs	
Infrastructure Development Program	· Health Infrastructure Improvement Programs	300.00
	·Water and Sanitation Infrastructure Support Programs	
	· Education Infrastructure Support Programs	
	·Cultural Infrastructure Support Programs	
	· Transport Infrastructure Programs	
	· Agricultural and Livestock Infrastructure Development Programs	
	· Social Infrastructure Development Programs	
	·Tourism/Recreation Infrastructure Development Programs	
Capacity Building Program	·Leadership building projects	125.09
	· Skill development program	
	·Community Awareness Program, with Rights of Indigenous People	
	·Adult literacy classes	
	Total	**720.09**

8.4. Mitigation and Enhancement Measures Cost and Implementation Responsibility

The estimated mitigation, enhancement measures and community support works cost for the proposed project is 2942.09 million NRs. (Table 8.3). Proponent will be mainly responsible for the implementation of mitigation measures mentioned in the report. The contractor will implement mitigation program associated with the civil works as per the bid documents and tender clauses.

8.3 Mitigation and Enhancement Measures Cost and Implmentation Responsibility

Mitigation/Enhancement Measures	**Implementation Area**	**Implementation Schedule**	**Estimated Cost NRs (million)**	**Implementing Agency**
Positive Impacts Enhancement Measures				
1. Skill training to local people	Project area	Construction	10	Proponent
2. Training to local people about the bidding procedures for local procurement for services, materials and supplies.	Project area	Construction	2	Proponent
3 Training to representative of affected rural municpality	Project area	Operation	1	Proponent
Sub- total			**13**	
Adverse Impacts Mitigation Measures				
1. Physical Environment	Project area	Construction, Operation	114	Contractor/ Proponent
2. Biological Environment	Project area	Construction, Operation	639	Contractor/ Proponent
3. Socio-economic and Cultural Environment	Project area	Construction, Operation	1456	Contractor/ Proponent
Sub- total			**2209**	
Community support program	Project area	Construction, Operation	720.09	Proponent
Total			**2942.09**	

CHAPTER 9: ENVIRONMENTAL MONITORING

9.1. Objectives and Requirements of Monitoring

Article 39(1) and 39(2) of the EPA (2076) make provision for environmental monitoring. Article 45(1) of the EPR (2077) requires UAHEL to monitor impact of the project on environment every six months and submit a monitoring report to concerned agency. This chapter presents the UAHEP Environmental Monitoring Framework, which was developed in accordance with the Hydropower EIA Manual (MoFE 2018). Three types of monitoring are proposed:

- Baseline monitoring—substantial baseline monitoring and data collection has already been conducted in preparation of this EIA, but some additional baseline monitoring will be conducted to better characterize existing conditions and establish a baseline for measuring change over time.
- Compliance monitoring—where applicable Nepalese regulatory standards exist (e.g., air quality, water quality, noise), compliance monitoring documents the Project's compliance with these regulatory standards as well as confirming the Construction Contractor's compliance with proposed environmental, social, health and safety mitigation and enhancement measures described in this EIA.
- Impact monitoring—where regulatory standards do not exist, impact monitoring documents the Project's performance relative to impact predictions included in this EIA.

Baseline data collection will be completed prior to the initiation of construction. The compliance and impact monitoring activities will be performed during construction and operation phases of the project. The focus of the UAHEP environmental and social monitoring framework is to execute construction and operation activities that strictly comply with the EIA and to avoid or reduce direct and indirect Project residual environmental impacts. The environmental monitoring will:

- Track and report the effectiveness of the mitigation measures and responsibilities;
- Inform on the need to implement new, or modify existing, mitigation measures;
- Identify potential new areas of impact exposure that were not identified in the EIA; and, if applicable
- Identify the need for corrective actions to bring the construction and operation of the UAHEP into compliance with the EIA and the ESMP.

9.2. Monitoring Framework

This section describes the Monitoring Framework that has been established for the UAHEP, based on MoFE guidance (MoFE 2018).

9.3. ESHS Monitoring and Reporting

UAHEL and its Owner's Project Engineer will undertake regular environmental and social (E&S) monitoring in accordance with the monitoring frequency identified in **Table 9.1, Table 9.2,** and **Table 9.3**. Project construction activities will be monitored and supervised to document that works are undertaken in accordance with the detailed Project design, environmental plans, permits, approvals, contract conditions, and the principles outlined in this ESMP. Pre-construction inspections of Project construction sites shall be jointly undertaken by UAHEL, the Owner's Project Engineer, and the Construction Contractor.

If any of these sites or activities are not in accordance with the contract and ESMP conditions, UAHEL and its Owner's Project Engineer will document these and specify corrective measures

in the reports, which will be provided to the Construction Contractor within five days of the inspection, for appropriate action.

The Construction Contractor shall submit monthly E&S Performance Reports to UAHEL. The Owner's Project Engineer will review these reports, and prepare its own independent monthly E&S report, which will be submitted to UAHEL. The report will identify whether the Construction Contractor is in conformance with its E&S performance requirements, identify opportunities for improvement, and, when the E&S Contractor is not in conformance with its E&S requirements, provide directions to the Contractor on corrective actions.

Table 9.1: Pre-Construction Baseline Monitoring

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency/Timing	Monitoring Responsibility
Landslides and Erosion	Number of landslide/ debris flow/gully sites	Within the project's area of disturbance, including sites 100 meters up/down slope.	Direct observation	Once before initiation of construction	Design engineer
Noise Levels	LAeq (dBA)	At nearest noise sensitive receptor in Rukma/Namase/Hema/Sibrun/Jijinkha/Chongrak	Type 1 and Type 2 sound level meter	Once before initiation of construction	UAHEL
Springs	Flow in liters per second	Any springs used by local communities as a water source near any project tunnels	Use measured container	Twice before initiation of construction	UAHEL
Water Quality	BOD, Nutrients, O&G, Turbidity, E-Coli, TSS,	Arun River upstream of reservoir, diversion reach, and downstream of powerhouse	Nepal Drinking Water Quality Standard	Twice before initiation of construction	UAHEL
Forests	Tree species present, forest density	All areas of proposed forest clearing	1% survey	Once before initiation of construction	UAHEL
Wildlife	Species present, protected species	Direct Impact Area	Direct observation, FGD, MBNP consult	Once before initiation of construction	UAHEL

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency/Timing	Monitoring Responsibility
Fish	Relative abundance of native fish species as indicated by CPUE	Arun River upstream of reservoir, diversion reach, and downstream of powerhouse	Cast/gill/drift net sampling, FGD	Seasonally before construction	UAHEL
Socioeconomic	Project-affected people characteristics	Direct Impact Area	Household surveys, FGD, KII	Once before initiation of construction	UAHEL
Cultural Heritage	Inventory of tangible cultural heritage sites	Direct Impact Area	Direct observation, FGD	Once before initiation of construction	UAHEL

Table 9.2: Construction Phase

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Compliance Monitoring					
Air Quality	CO, NOx, SOx, PM_{10}, $PM_{2.5}$, CO_2,	Near headworks and powerhouse worker camps	Standard air quality monitor	Once per quarter	Project Engineer
Ambient Water Quality	BOD, Nutrients, Turbidity, E-Coli, TSS, Oil and Grease, as per NDWQS	Arun River and all springs used by local residents	As per Nepal Drinking Water Quality Standard	Once per quarter	Project Engineer
Wastewater Effluent Quality	BOD, Nutrients, Turbidity, E-Coli, TSS, Oil and Grease, as per NDWQS	Wastewater treatment effluent, spoil disposal areas, batch plant/crusher, tunnel portals settling ponds	As per Nepal Drinking Water Quality Standard	Effluent – daily Settling ponds – monthly	Construction Contractor
Noise Level	LAeq (dBA)	At nearest noise sensitive receptor in villages of Rukma, Namase, Hema, Sibrun, Jijinkha, and Chongrak	Type 1 and Type 2 sound level meter meeting IEC Standard	Once continuous for 48 hours	Project Engineer
Forest Clearing	Number of trees cleared and loss of forest area.	Spot checks and grievance-based monitoring	Direct observation**,** consultation with CFUGs and Division Forest Office and grievances filed	Monthly or grievance based	Project Engineer
Law and Order	Number of police complaints attributed to the Project workforce	Bhotkhola and Makalu rural municipalities	Consultation with municipal authorities	Monthly	Project Engineer

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Impact Monitoring					
Landslides and Erosion	Number of new landslide/ debris flow/gully sites	Within entire project area of disturbance and specifically the spoil disposal areas	Direct observation	Twice per year	Project Engineer
Erosion	Condition of erosion and sediment control measures	All installed erosion and sediment control measures	Direct observation by an erosion and sediment control specialist	Weekly	Project Engineer
Springs	Flow in liters per second	Monitoring of springs located within or 100 m	Use measured container	Grievance based	Project Engineer
Wildlife	Physical relocation of slow-moving species (e.g., pangolins) prior to clearing and during construction	Within areas to be cleared or disturbed	Wildlife physical relocation of slow-moving species prior to clearing and during construction	During forest clearing	Project Engineer
Wildlife	# and species of vehicle strikes by construction contractor vehicles	Along any roads used by Project vehicles	Records by drivers	Occurrence based	Construction Contractor
Fish	Trend in relative abundance of native fish species as indicated by CPUE	Arun River upstream of reservoir, diversion reach, and downstream of powerhouse	Cast/gill/drift net sampling, FGD, MBNP consultation	Quarterly	Project Engineer
Fish and Wildlife	# of incidents of construction personnel hunting, fishing, and poaching	Direct Impact Area	Records of construction contractor and park rangers	Monthly	Construction Contractor

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Invasive Species	Presence of invasive species	Locations where forest clearance has occurred	Direct observation and photographs of the presence and spatial extent of any invasive species.	Annually and a post-construction completion audit	Construction Contractor
Vibration	Conformance with authorized peak vibration	At residences near blasting sites	Accelerometer	Monthly	Project Engineer
Community Health	Incidents of project-related communicable diseases in nearby villages	All nearby villages	Consultation with municipal health clinics	Monthly	Project Engineer
Community Safety	# of incidents of project-related injuries and fatalities	All nearby villages	Consultation with municipal health clinics	Monthly	Project Engineer
Occupational Health	Incidents of communicable diseases within workforce	All worker camps	Construction contractor health clinics	Monthly	Construction Contractor ,Project Engineer
Occupational Safety	Number of first aid and lost time incidents and fatalities	All construction work areas	Construction contractor health clinics	Monthly	Construction Contractor ,Project Engineer
Influx	Number of non-local individuals moving to Bhotkhola Rural municipality in search of employment	Direct Impact Area	Consultation with local officials	Monthly	Project Engineer
Traffic speeds	Conformance with established speed limits	Contractor vehicles	GPS	Monthly - random	Construction Contractor, Project Engineer

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Security Personnel	Number of instances of use of force by security personnel	Direct Impact Area	Grievances and consultation with community leaders	Monthly	Project Engineer
Substance abuse	Random monitoring for alcohol and substance abuse	All worker camps	Breath analyzer, blood testing	Monthly – random	Construction Contractor, Project Engineer
Gender-based violence;child labor, sexual harassment, exploitation, and abuse; and Trafficking in Persons	Documentation that required policies have been prepared, training has been provided, number of community outreach events, and the number of project-related cases identified through grievances, counselors, or by police reports, differentiating workers and community residents	Bhotkhola Rural municipality	• Review of Policy • Training delivery and number of persons trained • Direct observation • Review of Grievances for trafficking in persons and related issues	Monthly	Project Engineer, Construction Contractor

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Physical Displacement	Compliance with the Resettlement Action Plan (RAP) relative to physical displacement .	All locations of physical displacement At resettlement sites where the physically displaced HHs have resettled.	Consultations with physically displaced HHs; review of disbursement processes for compensation and allowances**; and p**ost-resettlement monitoring of physically displaced HHs	Monthly during construction One completion audit One post-completion audit Post-resettlement monitoring	UAHEL, Project Engineer, and Third-Party Independent Monitor
Economic Displacement and Livelihood Impacts	Compliance with the RAP procedures and requirements including delivery of compensation, allowances, support and assistance per entitlement matrix; restoration of livelihoods and incomes; and grievances received by issue and location	Spots checks and grievance-based monitoring at all locations of economic displacement At locations of livelihoods restoration programs	Direct observation and review of documentation maintained as part of the RAP**;** Public consultations with the local community; Consultations with economically displaced HHs	Monthly during construction phase, while RAP activities are in progress	UAHEL, Project Engineer, and Third-Party Monitor
Worker Code of Conduct and Training	Documentation that all employees have received Induction Training and signed the Code of Conduct	Construction Contractor office.	Review Contractor documentation	Quarterly	Project Engineer

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Employment	Preferential hiring of construction workforce from Bhotkhola RM	Construction Contractor office.	Review Contractor documentation	Monthly	Project Engineer
Gender	Percent of construction workforce that are women	Construction Contractor office.	Review Contractor documentation	Monthly	Project Engineer
Cultural Heritage	Chance Finds	Project footprint	Review Contractor documentation. Consult with local communities	Quarterly	Project Engineer
Grievances	Number of grievances	Entire project area	Review of the Grievance Redress Mechanism database and records filed with CLOs at PIC	Monthly	Project Engineer, UAHEL

Table 9.3: Operation Phase

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Compliance Monitoring					
Water Quality	BOD, Nutrients, Turbidity, E-Coli, TSS, Oil and Grease	Reservoir, immediately downstream of dam, upstream of Barun River, downstream of tailrace	As per Nepal Drinking Water Quality Standard	Quarterly for the first year	Plant Manager
Wastewater Quality	BOD, Nutrients, Turbidity, E-Coli, TSS, Oil and Grease,	Effluent discharge point	As per Nepal Drinking Water Quality Standard	Weekly	Plant Manager

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Noise Level	LAeq (dBA)	At nearest noise sensitive receptor in villages of Rukma and Sibrun	Type 1 and Type 2 sound level meter for 48 hours	Once after start of operations	Plant Manager
Forest	Compensatory Plantations establishment, proper maintenance, and survival	Compensatory Afforestation site(s)	Visual assessment of afforestation success/failure.	Monthly for the first year/ 2x/year for the next four yrs	Plant Manager
		Impact Monitoring			
Landslides and Erosion	Number of new landslides, debris flow, and gully sites	Within entire project area of disturbance, including sites 100 meters up/down-slope	Direct observation and mapping by professional geologist	Annually after the monsoon season for the first five years	Plant Manager
Hydrology	Flow in the Arun River upstream of UAHEP Dam	Location upstream (likely in China)	River level gauge	Continuous	Plant Manager
Forest Status	Invasive species	Entire forest clearing area	Direct observation	Once a year for the first five years	Plant Manager
Wildlife	Number of reported poaching incidents by project workers	DIA	Grievances and consultation with CFUGs/DFO	Twice a year for the first five years	Plant Manager
Fish	Number and location of any fish/fry stranding locations	From UAHEP powerhouse to backwaters of Arun-3 HEP reservoir	Direct observation	Weekly during first year of operations	Plant Manager

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Fish	Trend in relative abundance (CPUE) of native fish species	Arun River US of reservoir, diversion reach, and DS of powerhouse	Cast/gill/drift net sampling, FGD, MBNP consultation	Quarterly	Plant Manager
Fish	Number of fish by species transported over dam by trap and haul program	UAHEP dam	Direct observation/count	Monthly	Plant Manager
Sediment	Sediment deposition in diversion reach	Entire length of diversion reach	Direct observation and measurement of depth of deposition in identified areas	Annually for the first 5 years of operation	Plant Manager
Community Health	Incidents of project-related communicable diseases	All nearby villages	Consultation with municipal health clinics	Monthly	Plant Manager
Community Safety	# of incidents of project-related injuries and fatalities	All nearby villages	Consultation with municipal health clinics	Monthly	Plant Manager
Occupational Health	Incidents of communicable diseases within workforce	All worker camps	Construction contractor health clinics	Monthly	Plant Manager
Occupational Safety	Number of first aid and lost time incidents and fatalities	All construction work areas	Construction contractor health clinics	Monthly	Plant Manager
Physical Displacement	Compliance with applicable RAP requirements	All locations of resettlement (of physically displaced HHs). Those who have opted for cash	Documentation of resettlement locations. Consultations with	Annually for 5 years	Plant Manager

Issue for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
		compensation for relocation to other areas are not included in this monitoring exercise.	resettled HHs. Consultations with host communities at sites of relocation/resettlement		
Economic Displacement	Compliance with applicable RAP requirements	Spots checks and grievance-based monitoring around Direct Impact Area and all locations of economic resettlement At locations of livelihoods restoration program activities	Direct observation**.** Consultations with the local community. Discussions with a sample of those participating in LRP activities	Annually for 5 years	Plant Manager
Livelihood Restoration	The Resettlement Completion Audit will identify any residual issues/impacts along with corrective actions	Specific locations/settlements/districts as identified by the Resettlement Completion Audit	The Resettlement Completion Audit will specify completion indicators and the monitoring mechanism	To be determined by the Resettlement Completion Audit	Plant Manager
Employment	Percent of operation workers from Bhotkhola RM	Operations office.	Review Operators employment records	Annually	Plant Manager
Employment	Percent of the operation workers that are women	Operations office.	Review Operators employment records	Annually	Plant Manager

9.4. Environment Monitoring Cost

The total Environment monitoring cost for the Hydropower Project is NRs. 83.32 million. It comprises of cost in following heading:

a) Baseline monitoring- NRs.4.17 Million
b) Compliance monitoring- NRs.20.83 Million
c) Impact monitoring- NRs. 58.32 Million

CHAPTER 10: ENVIRONMENTAL AUDIT

The objectives of performing an environmental audit are to evaluate whether environmental and social risks identified in the EIA are effectively mitigated and comply with the requirements of the Environment Management Plan (EMP). 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.

In keeping with requirements of EPR, MoFE will conduct environmental audit of the Project after two years of operation. UAHEL will also carry out an environmental audit upon hand-over from the Construction Contractors of completed portions of the Project, using the guidance presented in this chapter. This will be to ensure that the provisions of the EMP and other contractual requirements have been met by the Construction Contractors.

10.1. Types of Audits

In general accordance with the MoFE Hydropower Environmental Impact Assessment Manual (MoFE 2018), UAHEL proposes three types of audits for the Project:

- **Completion Audit**: The purpose of these audits will be to ensure that the Construction Contractors and others involved in the implementation of the Project have complied with the terms of the EIA and the ESMP. Specifically, UAHEL will conduct these audits at the completion of each construction contract as part of the "hand-over" process.
- **EIA Audit**: Article 12(1) of the EPA requires MoFE or an agency designated by the MoFE to conduct environmental audit after two years of the completion of the project. 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 is carried out after 2 years of commencement of the project. The GoN is responsible for carrying out this audit" (MoFE 2018, p.66). This is a one-time audit by the MoFE.
- **Project Impact Audit:** The purpose is to identify and assess the actual Project-related environmental and social impacts over time, the effectiveness of environmental impact mitigation and enhancement measures, and functioning of monitoring mechanisms. UAHEL will conduct this audit within 2 years of completion of construction works.

The purpose of these three types of audits is to identify any corrective actions needed to bring the Project's E&S performance into compliance with the EMP and with any other applicable regulatory requirements. If necessary, a Corrective Action Plan will be developed and implemented. **Table 10.1** identifies the various responsibilities for Environmental Audits and general timing. The estimated cost of environmental audit is NRs 3 million.

Table 10.1: Responsibilities for Environmental Audits

Type of Environmental Audit	Description	Responsibility		
		Conduct	Approve	Corrective Actions
Completion Audit	Completion audits for each of the Construction Contractors working on the	UAHEL	UAHEL	Construction Contractors during defects liability period

Type of Environmental Audit	Description	Responsibility		
		Conduct	Approve	Corrective Actions
	Project prior to their close-out payment			
EIA Audit	Per MoFE requirements, these environmental audits will be conducted after two years of operation	MoFE	MoFE	Construction Contractors during defects liability period. Afterwards, Project Operator
Project Impact Audit	In order to identify environmental changes due to the UAHEP, this audit will be conducted with in 2 years of project construction	Plant Manager	UAHEL	Plant Manager

10.2. Environmental Audit Report Documentation

Section 9.7 of the Hydropower EIA Manual (MoFE 2018) specifies the format of an environmental audit. This format has been adopted by UAHEL. All Environmental Audits for the UAHEP will have the following format:

Chapter 1: Executive Summary

Chapter 2: Description of Audit Administrative Activities. Interviews conducted in project site, party conducting audit and the audit area and methods shall be included in this study. Similarly, data and details concerned with environmental monitoring and audit must also be included.

Chapter 3: Full Audit Details. This includes a full summary of the audit procedures and findings. For purposes of the Completion Audit, UAHEL will supplement this chapter to include the contents of **Table 10.2**:

- *Scope of the Audit:* A description of what the audit focused upon (where the audit was conducted), what was audited (e.g., processes, organization, operations), when the period of performance began and ended (did the audit cover a month, a year, or all operations since inception?).
- *Regulatory and Legal Setting:* Tabular summary of Nepal, local and any other applicable environmental and occupational health and safety laws, regulations, guidelines, and policies as they may directly pertain to the scope of the audit. This section would include a description of the Environmental Management Plan requirements pertaining to this EIA.
- *Audit and Site Investigation Procedure:* Brief overview of the approach used to conduct the audit. A discussion of the records review, site reconnaissance, and interview activities; a description of the site sampling plan and chemical testing plan, field investigations, environmental sampling and chemical analyses and methods, if applicable.
- *Findings and Areas of Concern:* Detailed discussion of all environmental and occupational health and safety areas of concern. The areas of concern should be discussed in terms of both existing facilities and operations and contamination or damages due to past activities, including

the affected media and its quality and recommendations for further investigation and remediation, if applicable. The report may wish to consider prioritizing findings into categories: immediate action, mid-term action, and long-term action.

Chapter 4: Suggestions and Corrective Actions. To be complied with regarding the project. The IFC Guidance specifies that this should include, for each area of concern, specifics on the appropriate corrective actions to mitigate them and their rationale. The report should indicate priorities for action; provide estimates of the cost of implementing the corrective actions, and a schedule for their implementation.

Appendices: These should include references, copies of interview forms, any details regarding the audit protocol not already included, and data obtained during the audit.

Table 10.2: Project Environmental, Social, Health & Safety Form Example

Project: _____ Project Handover Date_____

Completed by: _____ Reviewed by: _____E&S Form Completion Date_____

Item	Summary Description	Status (indicate "red flag" items)	Corrective or Other Measures Needed	Responsibility for Corrective Actions	References (e.g., links to reports)	Deadline Date for Action
Project Description	Short description of the project, sufficient to identify it uniquely	Is this changing or has it changed?	Finalization of the Project Description if needed	UAHEL	Location of this information. Can refer to reports such as EIAs and design reports.	In time to allow other activities below
Construction Contracts	Name of contractors, construction duration, completion date and defects liability period	Major delays?	Technical problems to be resolved, "snag list" requirements	UAHEL to approve. Contractor to implement	Location of the hand-over documents	Prior to hand-over
EMP	Summary of key mitigation measures, including operational requirements	Compliance? Has monitoring revealed problems?	If monitoring indicates problems, is any additional mitigation needed? (see below)	UEHL to approve. Contractor to implement	Location of the latest version of the Project EMP	Prior to hand-over
Predicted Potential Impacts	Summary of main potential impacts from EIA, Environmental Audit, and/or EMP	Have major environmental or social risks been identified?	Principal mitigation measures required in EMP	Contractor to implement	Approved EIA	Prior to construction
Actual Impacts Observed	Adverse impacts observed during monitoring and/or the Environmental Audit.	Have major residual environmental	Develop and implement adequate mitigation. If no mitigation is possible for major residual	UAHEL to approve. Contractor to implement	Location of all monitoring reports for the project, as well as design and	Prior to hand-over

Item	Summary Description	Status (indicate "red flag" items)	Corrective or Other Measures Needed	Responsibility for Corrective Actions	References (e.g., links to reports)	Deadline Date for Action
		or social risks been identified?	environmental or social risks, then the specific activity causing the risk is to be discontinued and environment to be restored		implementation reports for any new mitigation.	
Grievance/ Complaint Mechanism	UAHEL Grievance and Complaint Resolution Process applicable to the Project	Any unresolved complaints?	Grievance/ complaint to be resolved prior to hand-over, or addressed by Project Operator	UAHEL to approve. Contractor to implement, as appropriate	Location of the grievance process and complaints register	Resolution prior to hand-over
Resettlement Issues	Remaining claims whether or not covered in the RAP	Any unresolved grievances?	Grievance to be resolved as soon as possible	UAHEL	Location of the RAP and grievance process	Prior to hand-over
Community Involvement	Results of meetings, workshops, and other community involvement for Project	Any unresolved community issues?	Community issues to be resolved prior to hand-over, or addressed by new Operator	UAHEL approval. Contractor or new Project Operator to implement	Location of minutes of community and stakeholder meetings.	Prior to hand-over
Corrective Action Plan	Identified those measures required to bring the Project into conformance with E&S requirements	Compliance?	Contractor to immediately reach compliance with the Corrective Action Plan	UAHEL to approve. Contractor to implement	Location of the monitoring reports and hand-over documents	Immediatel y upon Contractor notification

Source: Consultant Team 2020

CHAPTER 11: CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the conclusions of this EIA, taking into consideration both the project's benefits and impacts.

11.1. Project Benefits

The UAHEP will provide 4549.57 GWh of clean, renewable energy to meet the electricity demands of Nepal, and will provide, in particular, 1259.85 GWh of critically needed dry season peak hour energy, which is possible because of the Arun River's naturally high dry season flow and the project's proposed PRoR mode of operation.

During construction, the Project will employ up to a peak of 4,500 workers over a 6-year construction period. It is estimated that Nepali workers could fill about 40% of these construction jobs. The Project will also create 130 permanent jobs during the operations phase. It is anticipated that initially 75% of the workers could be from Nepal, with this percentage increasing over time as Nepali staff gain more operational experience and can assume more responsibility. The hiring of qualified women and other traditionally excluded groups will be encouraged. The Project will also need to purchase a wide variety of construction materials (e.g., aggregate, cement, rebar) and will require a wide range of support services (e.g., food, cleaning, vehicle rental) which will create opportunities for local businesses.

The Project will provide construction and other skill training to help local residents to take advantage of employment opportunities and provide small business support to help local businesses secure service and supply contracts.

11.2. Projects Impacts

UAHEL has applied the concept of the mitigation hierarchy by first avoiding impacts to the extent possible; where avoidance is not possible, minimizing impacts, and then mitigating any remaining impacts so all residual impacts have been reduced to the extent possible. This has involved an extensive evaluation of project alternatives and close coordination with the project engineer.

The Project has spent over two years optimizing the project design based on detailed environmental and social baseline studies and consultations with government officials, conservation organizations, civil society groups, and affected communities. This resulted in minimizing the extent of physical displacement and the amount of forest clearing.

Despite these efforts, construction and operation of the UAHEP will result in some residual environmental and social impacts. In terms of physical resources, the Project is susceptible to slope failures and natural hazards (e.g., landslides), and wastewater treatment/disposal, solid waste management/disposal, sediment and erosion control, fugitive dust, noise, and vibration all pose significant risks to the Project and local residents. From a terrestrial biodiversity perspective, the Project will result in the disturbance of 136.52 ha of land, the loss of 73.31 ha of forest habitat. Among the forest land 40.07 ha is government forest, 11.62 ha community forest and 21.62 ha Makalu Barun Buffer zone forest land. From an aquatic biodiversity perspective, the dam will present a barrier to upstream fish movement, aquatic habitat in the diversion reach will be reduced, and the project's peaking operation will degade aquatic habitat for approximately 11.8 km downstream of the UAHEP powerhouse due to water level fluctuations. The Project will also result in the acquisition of 63.51 ha of private land, as well as the physical displacement of 16 households, as well as the lease of 73.31 ha of government land. There will also be fundamental

changes to social cohesion and cultural heritage as a result of these currently isolated villages being exposed to a large foreign workforce for approximately six years, associated influx, and improved access.

11.3. Commitment of Project Sponsor

The UAHEL will ensure the implementation of all proposed Project mitigation, enhancement, and monitoring measures identified in this EIA, including the EMP, during the appropriate construction and operation phases. This responsibility will be implemented by including appropriate language in the bid documents requiring the construction contractor, and any future project operating entity, to implement these mitigation, enhancement, and monitoring measures Wherever possible, efforts will be made to further limit adverse impacts on the environment.

11.4. Balancing Project Benefits and Impacts

The overall conclusion of this EIA is that the Project offers substantial benefits to the government, economy, and people of Nepal, while at the same time presenting several significant risks and potential impacts. This EIA identifies key mitigation and management measures needed to address the project's potential adverse impacts. The effective implementation of the proposed mitigation measures will be critical to deliver a successful project. To ensure the effective implementation of these measures and achieve successful environmental, social, health and safety performance during project construction and operations, UAHEL will also implement the following measures:

- Environmental and Social Management System (ESMS) - UAHEL will develop, adopt, and implement an ESMS to ensure they have the capacity, staffing, systems and procedures in place to effectively implement the environmental and social management measures proposed in the EIA;
- Construction Environmental and Social Management and Monitoring Plan (CESMMP) – the CESMMP will identify all of the environmental and social mitigation and management measures and plans that the Construction Contractor(s) are responsible for implementing, so that there is clear designation of requirements and responsibilities.
- Environmental Monitoring Program – implement the environmental monitoring program as described in Chapter 9 of this EIA;
- Operations Environmental Management and Monitoring Plan (OEMMP) – although most environmental and social impacts, and their associated mitigation measures will occur during project construction, there are some that will continue into the project's operation phase and others that will not occur until project commissioning and commencement of operations. This plan will identify the key environmental and social mitigation measures that the project operator will be responsible for implementing.

These measures will help ensure all required mitigation measures and other conditions of EIA approval are successfully implemented and that actual project impacts are consistent with those predicted in this EIA.

CHAPTER 12: REFERENCES

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CHAPTER 13: ANNEXES

The following 18 appendices are provided in Volumn II of the EIA:

CHAPTER 14: ENVIRONMENTAL MANAGEMENT PLAN

Introduction

The Environmental Management Plan (EMP) has been prepared as an integral part of Upper Arun HEP to set out the procedural framework to ensure the implementation of mitigation measures, monitoring and auditing requirements. The plan specifies the environmental responsibilities of the parties involved in project development and detailed environmental management requirements for 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 Environment Protection Act and Environment Protection Rules is the main umbrella Act and Rules in Nepal, which cover environmental aspects of the project. The MoFE is the lead agency, which administers environmental matters emphasizing environmental conservation and management through internalizing environmental assessment, pollution control and prevention, conservation of natural heritage sites, compensation for environmental damage etc. Likewise Ministry of Energy, Water Resources and Irrigation is responsible for the environmental monitoring of water resources projects. There are several other policies, guidelines, acts and rules which relate to construction and operation of UAHEP and the project proponent will comply with the provisions by the involved parties in relation to the project.

14.1. Environment Management Plan

Environment Management Plan for the proposed project has been prepared with clear task of the activities to be done, implementation phases, implementation responsibility, cost and monitoring and evaluation responsibility for the physical, biological and socio-economic and cultural environment. The EMP is presented in Table 14.1.

Table 14.1: Environment Management Plan								
	Environment Management Plan							
Aspect	**Impacts Mitigation and Enhancement Measures**	**What to do**	**Where to do**	**How to do**	**When to do**	**Who is responsible**	**Estimated Human Resources (budget and time) in Million NRs**	**Monitoring and Evaluation**
Enhancement Activities								
	Employment up to a peak of 4500 workers over a 6 years construction period	Skill training will be given to PAFs and due priority will be given for hiring of PAPs, women and vulnerable group and local people.	Project area	Tender clauses, information sharing and skill development	C, O	Proponent	25	EMU, Rural Municpality
	Increase in economic opportunity due to enterprises development and local products	Provide opportunities for the local entrepreneurs/cooperatives to serve required goods and services for the project personnel. Training will be given to local intrest people about the	Project area	Coordination and training	C	Proponent	2	EMU, Rural Municpality

		bidding procedures for local procurement for services, materials and supplies.						
	Project will generate revenue and certain portion of the revenue will be used for local development	Provide training to representative of affected rural municpality for the possible uses of revenue in the development of their area	Project area	Coordination and training	O	Proponent	1	EMU, DCC
	Sub Total						**28**	
Physical Environment								
a	Slope protection measures	Cut-off drains and toe-drains will be provided at the top and bottom of slopes and be planted with grass or other cover. Bio engineering works will be continued	Steep slopes at headworks, powerhouse and project component road	Enforcement of tender clauses	C, O	Contractor/ Proponent	10	Consultant/ EMU

b	Erosion and Sedimentation control measures	Construct of erosion control barriers	Around the perimeter of cuts, disposal pits, and roadways	Enforcement of tender clauses	C, O	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/EMU, Plant manager
c	Spoil management measures	Silt fencing, retaining walls and other engineering and biological control measures	Muck disposal site	Enforcement of tender clauses	C	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/EMU
d	Tunneling impacts measures	Discharge measurement, in case of reduction of flow permanent alternative source of water to the affected households or villages at no cost will be provided.	Kholsa and springs close to tunnel alignment	Flow meater, community consultation and Enforcement of tender clauses	C, O	Contractor/ Proponent	100	Consultant/EMU, Plant manager
e	Waste management measures	Sufficient number of toilets, wastewater treatment facilities, placement of litter bins, containers, and refuse collection system.	Camp area, work site and office	Observation and enforcement of tender clauses	C, O	Contractor/ Proponent	2	Consultant/EMU, Plant manager

f	Storm water Runoff measures	All seepage will be directed to a storm water pond to allow the settling of any suspended material before discharge to a watercourse.	Tunnel portals and from spoil disposal areas	Enforcement of tender clauses	C	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/ EMU
g	Hazardous Materials/Waste disposal measures	All hazardous material/substances will be stored on site in a manufacturer recommended container, within a covered or enclosed structure with appropriate sign. The transportation, storage, processing, packaging on site, blasting and the disposal of the blasting material will comply GoN regulations on the use of explosives. Above-ground blasting will not be allowed during night time. Prior to a	Storage sites	Enforcement of tender clauses	C	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/ EMU

		surface blasting event water will be sprayed on the surface of the blast area and blasting mats wire mesh, gunny sacks, and/or sandbags will be used on top of the blast area at each shot to prevent flying rocks and dust.						
h	Air quality protection measures	High-efficiency dust suppression/control systems will be applied to minimize the spread of dust. The earthen and graveled road corridors will be sprinkled regularly to minimize the fugitive dusts.	Batching plants crushers, temporary roads and other construction sites	Enforcement of tender clauses	C, O	Contractor/ Proponent	Part of civil works	Consultant/EMU, Plant manager

i	Noise protection measures	Silencers, mufflers, acoustically dampened panels/noise barriers and acoustic sheds or shields will be provided to the workers working in noise and dust prone areas.	Batching plants crushers, diesel generator and other construction sites	Enforcement of tender clauses	C, O	Contractor/ Proponent	Part of civil works	Consultant/EMU, Plant manager
j	Vibration protection measures	Physical inspection of all structures that could be potentially affected by construction related vibration. Compensation will be paid for any damage caused by project-related construction activities	Near by settlement	Observation, measurement and enforcement of tender clauses	C	Contractor/ Proponent	Part of civil works	Consultant/EMU, Plant manager
k	Natural Hazards	Alarms, including both visual and auditory alerts, to notify personnel and the public of emergency conditions will be placed.	Dam, powerhouse, tunnel and other construction sites	Enforcement of tender clauses and awarenes	C, O	Contractor/ Proponent	2	Consultant/EMU, Plant manager

		Awareness and other training for project workers and local residents will be conducted.		s program				
l	Water uses protection measures	Water sources will be used without disturbing water uses sources of local people. Trereated water will be distributed in camps and work area.	Camp area, work site and office	Enforcement of tender clauses	C, O	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/EMU,Plant manager
m	Water quality protection measures	Water quality monitoring will be conducted and necessary measures will be applied if require. Release 5.41m3/s water in dry months from the powerhouse located at dam toe.	Reservoir, two locations in the diversion reach (one upstream and one downstream of the Barun River confluence), and at the access road bridge	Sampling and lab test.	O	Proponent	Part of civil works no additional cost required	Plant manager/ ESHS Division

	GHG Emissions	Clear and remove forest and other decomposable vegetative material before inundation	Reservoir FSL	Manual clearance of trees	C, O	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/EMU, Plant manager
n	Landscape Values	Restore vegetative cover over in temporarly distubed sites	Spoil Disposal Area #1, #2, #3 and #4	Revegetation	C, O	Contractor/ Proponent	Part of civil works no additional cost required	Consultant/EMU, Plant manager
	Sub total						**114**	
Biological Environment								
a	Protected Areas (MBNP) conservation measures	Funding will be provided for the implementation of National Park Management Plan and to increase the number of park rangers and strengthen monitoring and enforcement of illegal activities.	MBNP	Budgetary support	C	Proponent/ ESHS Division	30	DNPWC, MOFE, ESHS Division, EMU
b	Terrestrial Habitat Development actiities	Implementation of compensatory plantation in 248.10 ha area will create	Project area	Plantation works	C	Proponent/ ESHS Division	Separate cost is not required	MBNP, Division Forest Office, MOFE, CFUGs, EMU

		additional forest habitat.						
c	Compensatory Plantation	Compensatory afforestation of 257935 sapling consisting 132,125 saplings in 1:25 ratio for the tree loss from MBNP buffer zone and 125,810 seedlings from Government managed and community forest out side the buffer zone @ 1:10. In addition plantation will be done in the 73.31 ha replacement land @ 1600 /ha	Buffer zone of MBNP, Community forest land and other sites provided by the concerned authorities	Plantation work and management of planted sites for 5 years	C	Proponent/ ESHS Division	375	MBNP, Division Forest Office, MOFE, CFUGs, EMU
d	Compensatory measures for the private tree	Compensation will be provided for the loss of trees from the private kharbari or farm land	Project site	Cash compensation	C	Proponent/ ESHS Division	100	MBNP, Division Forest Office, MOFE, CFUGs, EMU

e	Protection measures for key threatened species	Biodiversity Induction Training and implementation of specific habitat management program	MBNP and its Buffer zone	Nigalo and other specifc species plantatio n	C	Proponent/ ESHS Division	20	MBNP, Division Forest Office, MOFE, EMU
f	Measures to minimize disturbance to terrestrial fauna	Fauna Shepherding Protocol will be used in the Project area to ensure that any fauna have vacated the area prior to any clearance work	Forest area at project foot print sites and near by areas	Shepherd ing Protocol will be used	C	Contractor/ Proponent	4	MBNP, Division Forest Office, CFUGs, EMU
g	Terrestrial barriers, fragmentation and edge effects protection measures	Plantation in fragmented areas, fencing of areas between patches of natural habitats adjacent to project sites to promote natural restoration and prevent further damages and crossings of wildlife-friendly road crossing	Fragmented sites, forest adjecant to construction sites and project roads	Plantatio n, fencing and constructi on of wirlife friendly structures	C	Contractor/ Proponent/ ESHS Division	5	MBNP, Division Forest Office, CFUGs, EMU

h	Terrestrial habitat degradation measures	Implementation of education program to inform personnel about the prohibition of collecting timber and non-timber forest products and the importance of conservation of natural habitat. Training to drivers about the speed limits and awareness of potential wildlife crossings in the transportation corridor.	Project area	Placement of hording boards, distribution of pumphlets/posters, lecture in class etc	C	Contractor/ Proponent/ ESHS Division	5	MBNP, Division Forest Office, CFUGs, EMU
i	Measures for Wildlife accidents	Speed limit of a maximum of 20 km/hr. wildlife friendly road crossings and strict penality for hunting and poaching offence	Project area	Enforcement of tender clauses	C	Contractor/ Proponent	Part of civil works no additional cost required	MBNP, Division Forest Office, EMU
j	Reservoir shore line protection measures	Revegetation and shoreline protection will be undertaken at the full supply level	Reservoir	Plantation	C	Contractor/ Proponent/ESHS Division	Part of civil works no additional	MBNP, Division Forest Office, EMU

		of the dam on steep bank slopes to prevent erosion					cost required	
k	Aquatic habitat degradation measures	Release of 5.41 m3/s water, flushing of sediment during high flood, channel improvements or ramping rates to maintain fish access in Ikhuwa Khola and Leksuwa Khola and plantation in river banks	Down stream of dam, Arun river and river banks, Ikhuwa Khola and Leksuwa Khola	Riparian release, channel improvement and plantation	O	Proponent/ ESHS Division	20	MBNP, EMU
l	Aquatic habitat conservation and fish migration measures	Preservation of the integrity of existing warm water tributaries and implement trap and haul program	between Arun-3 HEP dam and UAHEP dam site	Habitat management program and trapping and hauling of fish	O	Proponent/ ESHS Division	100	MNNP, EMU
m	Fish impingement and entrainment measures	Trash rack/screens with a clear spacing between the bars of 2.5 cm will be installed	headrace intake	Civil works	O	Contractor/ Proponent	Part of civil works no additional cost required	MBNP, EMU

	Sub total						**639**	
Socio-economic and cultural environment								
a	Land Acquisition and Physical/Economic Displacement	Compensation of the land will be paid as per the rates determined by CDC. If the PAHs purchase land within Bhotkhola RM additional compensation amount will be given as allowances. In addition, vulnerability allowances @ rate of 3000 for 12 months will be given to the women headed PAHs, households have low annual income (NRs 19261), old age (70 above), Dalit, more than 4 children below 18 years, handicap and HHs loosing more than 50% land in the	Project area	Distribution of compensation and allowances in the account of PAHs which will be opened jointly in the name of male and female.	C	Proponent/ ESHS Division	1370	EMU, DAO, Rural Municipality

		project district. Besides this food security allowances@ 3000 for 6 months will be given to the PAHs having annual income less than NRs19261. The PAHs will also receive agriculture construction related training, vocational training and micro and small enterprises program based on their interest.						
b	Project-induced In-migration and Population Influx	Communication campaign for employment opportunity & training to all workers and staffs on sexual exploitation and abuse, sexual harassment (SH)	Project area	Broadcasting in local FM radio, posters, pumphlets and lectures	C, O	Contractor/ Proponent/ESHS Division	5	EMU, Rural Municipality

c	Measures for Ecosystem Services	Promotion for the plantation of edible plants and provide alternative sources of water if required	Project area	Plantation and implementation of water supply scheme	C, O	Contractor/ Proponent/ESHS Division	Cost is covered in physical environment	EMU, Rural Municipality
d	Measures for downstream water users and Uses	Local resident access to cremation, cultural, and religious locations along the river will be maintained	Project area	Implementation of the program	C, O	Proponent/ ESHS Division	10	EMU, Rural Municipality
e	Measures for Food/Water Borne Diseases	Mandatory health check-up of in-migrant workers, implementation of awareness campaigns and health surveillance program	Direct Impact Area	Implementation of the program, distribution of posters, pumphlets etc	C,O	Contractor/ Proponent/ESHS Division	4	EMU, Rural Municipality, District Hospitals
f	Measures for Sexually Transmitted Diseases	Organize annual health camp and implementation of awareness program for workers and local communities for the	Direct Impact Area	Implementation of the program, distribution of	C,O	Contractor/ Proponent/ESHS Division	3	EMU, Rural Municipality, District Hospitals

		prevention, detection, screening, and diagnosis of sexually transmitted diseases		posters, pumphlets etc				
g	Health Infrastructure improvement measures	Each Worker Camp will be served by a health unit capable of treating all first aid cases and common sickness. In addition, one central health post will be established headed by MBBS doctor for the treatment of more severe cases. Funding support to District Hospital Khandbari to run additional health units in Direct Impact Area,	Direct Impact Area	Establishement and operation of health units and support to district hospital	C,O	Contractor/ Proponent/ESHS Division	6	EMU, Rural Municipality, District Hospitals

h	Gender, Gender-based Violence, Measures	Implementation of counselling program in project area covering gender-based Violence (GBV) and other relevant areas, perimeter security fencing will be done in the camp areas and security guards will be in place. Attempt will be made to establsih GON security force.	Direct Impact Area, Camp sites	Establishement and operation of secutity posts, distribution of pumphlets, posters and personnel councelin g	C,O	Contractor/ Proponent/ESHS Division	20	EMU, Rural Municipality
i	Natural Disasters Measures	Establishment of alarms, including both visual and auditory alerts, use of communication procedures and equipment of the Contractor for emergency notification to the stakeholders	Project area	Establishement and operation of the system	C	Contractor/ Proponent	Part of construction works; no additional cost is required	EMU, Rural Municipality

j	Dam Failure Measures	Awareness and other training for local residents and establishment of alarms, including both visual and auditory alerts, use of communication procedures and equipment of the Contractor for emergency notification to the stakeholders	Project area	Establishement and operation of the system and distribution of posters, pumphlets etc	C	Contractor/ Proponent/ESHS Division	3	EMU, Rural Municipality
k	Standard code for Security Personnel	Standard operating procedures for its security guards will be developed, and trainings will be conducted as per the Code of Conduct for private security providers.	Project area	Develop and enforce the standard code	C,O	Contractor/ Proponent	Part of construction works, no additional cost is required	EMU, Rural Municipality
l	Labour and Working Conditions	Use of child labor (below 14) will be completely prohibited, gender neutral hiring	Direct Impact Area	Strictly follow the tender clauses	C,O	Contractor/ Proponent	Part of construction works, no additional	EMU, Rural Municipality

		advertisements, priority for the women employment and minimum wages as per applicable laws					cost is required	
m	Tangible Cultural Heritage measures	Relocation of affected cultural heritage sites and construction of alternative access to the natural heritage sites.	Direct Impact Area	Construction of new heritage structures and access	C,O	Contractor/ Proponent/ESHS Division	25	EMU, Rural Municipality
n	Intangible Cultural Heritage measures	Training and awareness program for employees and workers on local cultural sensitivities, Avoid disruption of festivals, community rituals, and gatherings, in consultation with communities	Direct Impact Area	Class by the expert, distribution of pumphlets, posters etc.	C,O	Contractor/ Proponent/ESHS Division	10	EMU, Rural Municipality
o	Emergencies and Public Safety measures	Maintain the alarms and conduct awareness and other training for local residents about	Project area	Class by the expert, distribution of	O	Proponent/ ESHS Division	5	EMU, Rural Municipality

		emergcncy preparedness.		pumphlets, posters etc				
	Sub total						**1456**	
	Total						**2209**	

14.2. Institutional Arrangement

i) Project Manager Office

The UAHEP Project Manager Office has been established under the organizational setup of UAHEL. The Project Manager will have overall responsibility regarding the implementation of the EMP and will also be responsible for acquiring necessary permits for forest clearance from Ministry of Forests and Environment, land acquisition and payment of compensation etc. The Project Manager will be responsible to make sure the incorporation of EIA recommendations in tender document and contract agreement and allocation of necessary budget for the implementation of EMP.

ii) Upper Arun Environment Monitoring Unit (EMU)

Upper Arun HEP Environment Monitoring Unit will be established under the supervising Consultant/ Project Engineer Office. The unit office will be site based for day to day environmental monitoring of the project, implementation of monitoring plan and coordination of work with concerned stakeholders.

The following fulltime manpower will be deployed in the EMU.

- Environmental Engineer/ Environment Expert/Unit Chief
- Sociologist
- Field Technician/Supervisors-2
- Support staff – 1

In addition, the intermittent input of forest expert, wildlife expert, fish expert will be taken as required during the construction period for site specific monitoring works.

iii) Environment, Social and Health Safety Division (ESHSD)

Environment, Social and Health Safety Division has already established under the Project Manager Office and this organizational setup will be continued during project construction. This office is under direct supervision of PMO. This division will have four major responsibilities namely land acquisition and rehabilitation, implementation of proposed mitigation measures and community support works, grievances management and, establishment and operation of project information center (PIC). ESHSD will consist of the following staff:

- Environmental Expert/ Division Chief
- Community Liaison Officer
- Land Acquisition and Resettlement officer
- Sociologist
- Gender expert
- Civil Engineer
- Civil overseer
- Office Assistant
- Supervisor
- Support Staff

In addition, the intermittent input of forest expert, wildlife expert, aquatic biodiversity expert will be taken as required during the construction period for the implementation of site-specific mitigation measures.

iv) Construction Contractor

The construction contractor will be responsible for implementation of mitigation measures specified in the part of contractor and compliance with the tender clauses. The contractor will be responsible for the implementation of spoil disposal, waste management, occupational safety, structural bioengineering measures, air, noise and water quality protection measures, etc.

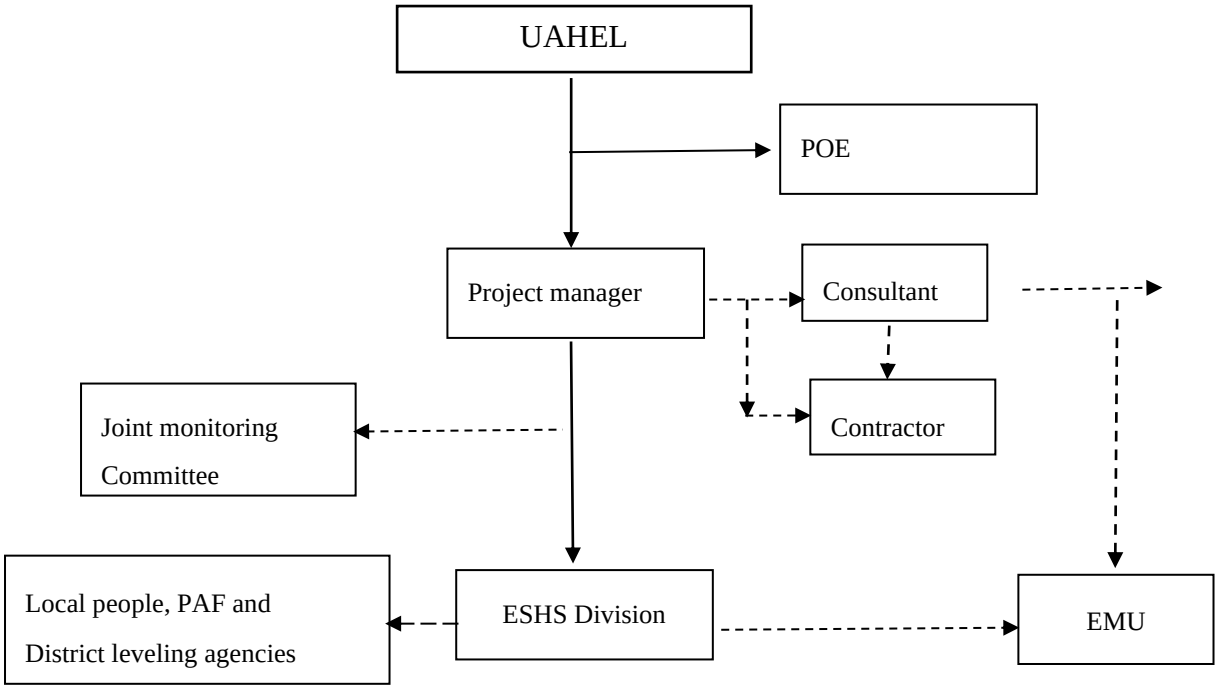

Figure 14-1: Organizational setup for environmental management

v) Construction Management/Supervision Consultant (Project Engineer)

The coordination of the compliance monitoring and mitigation program allocated under the contractor will be the responsibility of the Consultant. Environment Monitoring Unit will be established under the consultant organizational setup for the monitoring of compliance and impact and report to the chief of consultant engineer. The engineer's office will deliver written instructions to the Contractor for prompt action. The Engineer will have authority to stop work fully or partially; delay in approval of payment or otherwise penalize contractors for non-performance of environmental tender clauses. The Consultant will also be responsible for the supervision and quality control of the works conducted by the ESHS division and Contractor. The Consultant will also have responsibility for the approval of the different site-specific environment management plans prepared by the Contractor on recommendation of EMU.

vi) Project Grievances Committee

Local Grievances Committee

Local Grievances Committee (LGC) will be established to address the grievances regarding compensation and other social and environmental issues. This committee will work as an independent body and assist with grievance management for the project.

There will be five members in Local level Grievance committee. The members of this Committee include the one Project CLO, one project Social specialist, one rural municipality official, one community representative, and one-woman representative to speak on behalf of project-affected

households/local people. The members will be appointed in consultation with concerned stakeholders. The Project expects that this mechanism will successfully resolve most. Committee will promptly act to resolve the social and environmental issues related to the project.

District Level Project Grievance Committee

There will be five members in District level Grievance committee. The members of this committee include the one project Manager, one ESHS Manager, an official from the District Administration Office, one community representative and one-woman representative to speak on behalf of project-affected households/local people. The member will be appointed in consultation with concerned stakeholders.

vii) Joint Monitoring Committee

To ensure the proper implementation of mitigation measures and environmental monitoring work a joint monitoring team will be formed which will monitor the activities of the EMU, ESHS division and Contractor on periodic basis. This monitoring team will be coordinated by the ESHS Chief. The committee will include the representative of local government of the project area, DCC, DFO and Chief of Makalu Barun National Park.

viii) Panel of Expert

The project proponent will hire independent Panel of Expert (PoE) to make sure the mitigation and monitoring works are implemented according to plan. The PoE shall include environmental and social expert with relevant experience in environment management of the hydropower projects. The experts will review the work conducted by EMU, ESHS division, Joint Monitoring team, Consultant and Contractor and provide their suggestion for improvement if required based on the ground condition.

14.3. Environment Management Cost

The total estimated environmental management cost for the proposed project is 3154.77 million NRs. which is 2.19% the total project cost (Table 14.2: Environment management cost including the land compensation/lease cost and 1.28% without land cost. The estimated cost includes implementation of mitigation and enhancement measures and environmental monitoring during pre-construction, construction and operation phases of the project.

Table 14.2: Environment management cost

Item	Amount NRs. (Million)
Cost for environmental mitigation measures	2209
Cost for enhancement measures	13
Cost for community support program and corporate social responsibility	720.09
Cost for mitigation program implementation, PIC operation and grievance management	124.97
Cost for environmental monitoring	
Baseline monitoring	4.17
Compliance monitoring	20.83
Impact monitoring	58.32
Cost for environmental audit	4.39
Total environment management cost	3154.77
Total project cost	144017.5

Percentage of total environmental cost to the total project cost	2.19%
Land Compensation/lease Cost	1312.13
Total environment management cost after deduction of land cost	1842.64
Percentage of environmental cost to the total project cost after deduction of land compensation/lease cost	1.28%