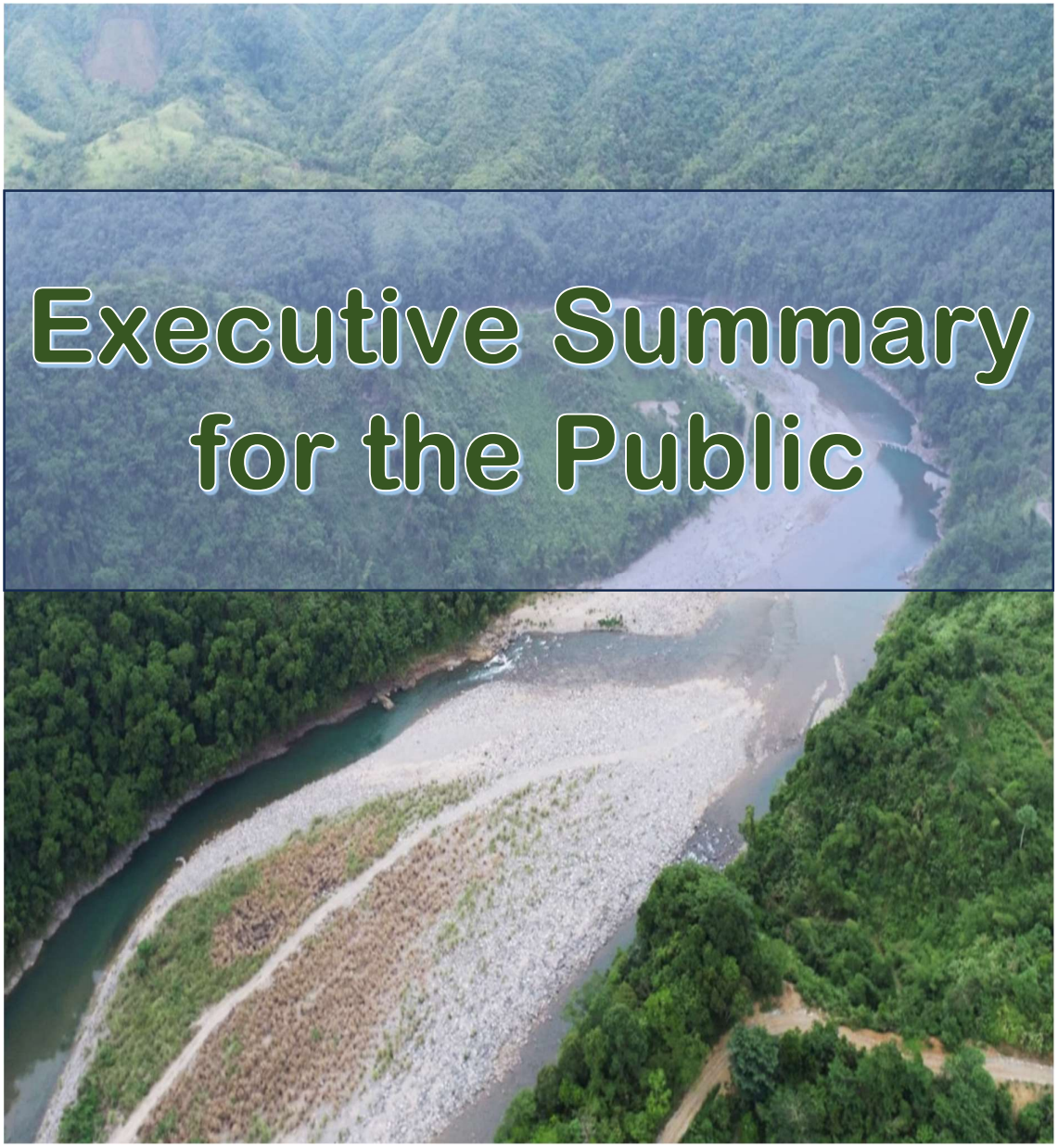
PAN PACIFIC RENEWABLE POWER PHILS. CORP.

PROPOSED 250 MW GENED-2 HYDROELECTRIC POWER PROJECT
MUNICIPALITY OF KABUGAO, PROVINCE OF APAYAO



ENVIRONMENTAL IMPACT STATEMENT (EIS)

EXECUTIVE SUMMARY

PROJECT FACT SHEET

Project Information

Table 1. Project Information

Project Name	Gened-2 Hydroelectric Power Project
Contract Number	Amendment to Hydropower Service Contract No. 2018-02-774
Geographical Coordinates	
Dam	$18^0$3'32.4" N
	$121^0$7'40.8" E
Powerhouse	18˚3"7.017" N
	121˚7'24.278" E
Project Location	Barangays Madatag, Dibagat, Tuyangan, all in the Municipality of Kabugao. Province of Apayao
Nature of Project	Hydroelectric Power Project
Installed Capacity	250MW
Full Supply Level (FSL)	190 meters above sea level(masl)
Project Cost, Including Transmission Line	US$ 437 Million (P 21.850 Billion)
Technical Consultant	Poyry Energy Ltd.

Proponent Profile

Proponent:	**Pan Pacific Renewable Power Phils. Corp.**
Proponent's Address:	Unit 2004, 20th Floor, Taipan Place Building F. Ortigas Jr. Road, Ortigas Center, Pasig City
Contact Person:	**Ms. Allee Lourdes T. Sun**
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EIS Preparer:

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Contact Person/ Designation:	**Benigno V. Resurreccion** Team Leader
Contact Numbers:	09178931073/09162361081

Pan Pacific commissioned the Nature Consulting Services, Inc. to conduct an Environmental Impact Assessment and prepare an Environmental Impact Statement (EIS) for the proposed Gened-2 Hydroelectric Power Project. This EIS evaluates the existing environmental and socio-economic conditions of the proposed project site as well as assess the potential impacts of the project.

This EIS will guide the proponent to implement environmental management strategies for all the stressors that will be generated in the operation of Gened-2 Hydroelectric Power Project. These strategies would determine the kind of development that will be allowed within the project site.

The Environmental Impact Assessment was undertaken based on the Procedural Manual for DENR Administrative Order No. 30 Series of 2003 (DAO 03-30) and the revised procedural guidelines of MC 2014-005 for the proposed project. The resulting study was documented in the form of an Environmental Impact Statement (EIS Report. Minimum required by DENR-EMB for the issuance of an Environmental Compliance Certificate (ECC) will be a detailed EIS. The EIS as outlined in the revised procedural manual was used as basis in the conduct of this study.

In terms of process, a participative process was adopted thru public consultation and information, education and communication (IEC) campaign. Implicit in the approach was allowing the proponent and the various project stakeholders to provide their inputs and ideas from which the Impact Management Plan (IMP) was crafted so that appropriate measures can be developed to ensure greater acceptance, commitment and support for the project.

The scoping process essentially determined the coverage of the study. Sensitive issues as well as other applicable parameters were included in the scoping activity. The study was limited to the primary and secondary data gathered on-site, other related literatures and fieldwork conducted. The provision of precise data determines the effectiveness of the report in supplying all the appropriate conclusion and recommendations. The study team put forth its thoroughness in completing the entire EIS. Details on the scoping checklist were carefully considered to generate a reliable and accurate report.

PROJECT DESCRIPTION SUMMARY

Pan Pacific Renewable Power Phils. Corp. (Pan Pacific) intends to develop the new 250 MW Gened-2 Hydroelectric Power Plant (HPP) on the Apayao-Abulug River about 16 km upstream of Kabugao Town in Apayao Province, Northern Luzon, Philippines. Pöyry Energy Ltd. (Pöyry) has carried out the Feasibility Study of this greenfield project in 2019.

As a background, Pan Pacific obtained the Renewable Energy Service Contract (RESC) for Gened-2 HEPP from the Department of Energy on September 2018. In an earlier study, the New Japan Engineering Corporation (NJEC 1979) identified two sites, Gened and the Agbulu sites 62 km and 123 km upstream of the river mouth, respectively, had been defined as especially suitable for hydropower development. Installed capacities of 600 MW and 400 MW, respectively, had been defined. Because Gened site was of high attractiveness, a project had been developed to Definite Design stage (NJEC 1981). Detailed studies considered hydrological, geological and topographical as well as socio-economic aspects, including a benefit-cost-analysis as well as resettlement and agricultural studies.

Gened-2 HEPP will consist of two major components: a reservoir and a powerhouse. Error! Reference source not found. below presents the general information about the proposed project.

Table 2. Gened-2 HEPP Project Details

Project Name	Gened-2 Hydroelectric Power Project
Contract Number	Hydropower Service Contract Number 2018-02-774
Geographical Coordinates	
Dam	18^0 3’ 32.4” N

	121^0 7' 40.8" E
Powerhouse	18^0 3' 7.017" N
	121^0 7' 24.278" E
Project Location	Barangays Madatag, Dibagat, Tuyangan, all in the Municipality of Kabugao. Province of Apayao
Nature of Project	Hydroelectric Power Project
Installed Capacity of Turbine	(3 x 80) + (1 x 10) = 250 MW
Hydrology	
Catchment Area	870 square kilometers
Mean Annual Precipitation	6,435 mm
Average Annual Discharge	127 cubic meters per second
Reservoir	
Maximum Flood Level(pmf)	202.50 meters above sea level(masl)
Full Supply Level(FSL)	190.0 masl
Minimum Operating Level(MOL)	170.0 masl
Total Reservoir Volume at FSL	128 million cubic meters
Live Storage Volume at FSL	76 million cubic meters
Dead Storage Volume	52 million cubic meters
Surface Area at FSL	4.9 square kilometers
Dam and Spillway	
Type of Dam	Roller Compacted Concrete (RCC) Gravity Dam
Crest Elevation	202.5 masl
Crest Length	209 meters
Maximum Height Above Foundation	94 meters
Spillway Type	Ungated Overflow
Spillway Sill Level	190.0 masl
Design Flood, 1,000 year return period	7,400 cubic meters per second
Safety Check Flood(PMF)	12,400 cubic meters per second
River Diversion	
Diversion Flood(annual 25-year Flood)	4,700 cubic meters per second
Elevation of Upstream Cofferdam	188.5 masl
Elevation of Downstream Cofferdam	140.0 masl
Length Diversion Tunnels	650 and 696 meters
Internal Diameter	11.5 meters
Bottom Outlet	
Capacity at FSL	570 cubic meters per second
Length and Shape of Diversion Tunnel(Conversion)	650 meters, Circular

Design Discharge, Q_d	485 cubic meters per second
Total Length	320 meters
Concrete Lined Section	
Excavation Shape	Horseshoe
Internal Shape	Circular with invert
Internal Diameter/Mean Flow Velocity for Q_d	11.4 meters/3.0 meters per second
Steel Lined Section	
Excavation Shape	Horseshoe
Internal Shape	Circular
Internal Diameter/Mean Flow Velocity for Q_d	8.7 meters/5.0 meters per second
Powerhouse	
Type	Surface
Rated Tailwater Level at Q_d	128.5 masl
Gross Head	61.5 meters
Designed Net head at Q_d	60.0 meters
Turbine Type	Vertical Francis
Switchyard	
Type	AIS
Voltage Level	230 kV
Project Cost, Including Transmission Line	USD 437 Million(P 21.850 Billion)

Project Location

Gened-2 HPP is located on the Apayao-Abulug River in the Municipality of Kabugao, Province of Apayao, Cordillera Administrative Region (CAR), Philippines as shown in **Table 3**. The map of the proposed project location is presented in **Figure 3**.

Table 3. Project Location

Region	Cordillera Administrative Region
Regional Center	Baguio City
Province	Apayao
Provincial Capitol	Luna
Island	Luzon
Coordinates of RCC Dam	18° 3'32.4"N / 121° 7'40.8"E

The Cordillera region is dubbed as the watershed cradle of Northern Luzon. Its forests sustain sixof Northern Luzon's major river systems. The Abulug is the 9th largest river system in the Philippines in terms of watershed size. It has an estimated drainage area of 3'372 km^2 and a length of 175 km. More than 90% of the drainage area of the river is located in Apayao Province,while the remaining area, including the mouth of the river, is in Cagayan Province. The upper reaches of the Abulug River, especially upstream from

Kabugao, are commonly known as the Apayao River.

The project site is located about 16 km upstream of Kabugao town, or 7 km to the northwest.

There is no existing hydroelectric project along the Apayao-Abulug river. Pan Pacific on the other hand has other proposed hydropower project along the river system both upstream and downstream of the Gened 2 Project as shown in **Figure 4.**

Project Components

The major and permanent project components are:

a. Concrete gravity main dam, spillway and reservoir
b. River diversion and tunnel bottom outlet
c. Intake and underground power waterway
d. Surface Powerhouse, switchyard, access roads and Employer/operator's village

The Temporary project components during Construction Stage are:

a. Cofferdams, Installation Area and Contractors Camp
b. Spoil Area and Workshop area
c. Crushing and Batching Plant
d. Temporary Access Road, Stock Pile and Quarry Area

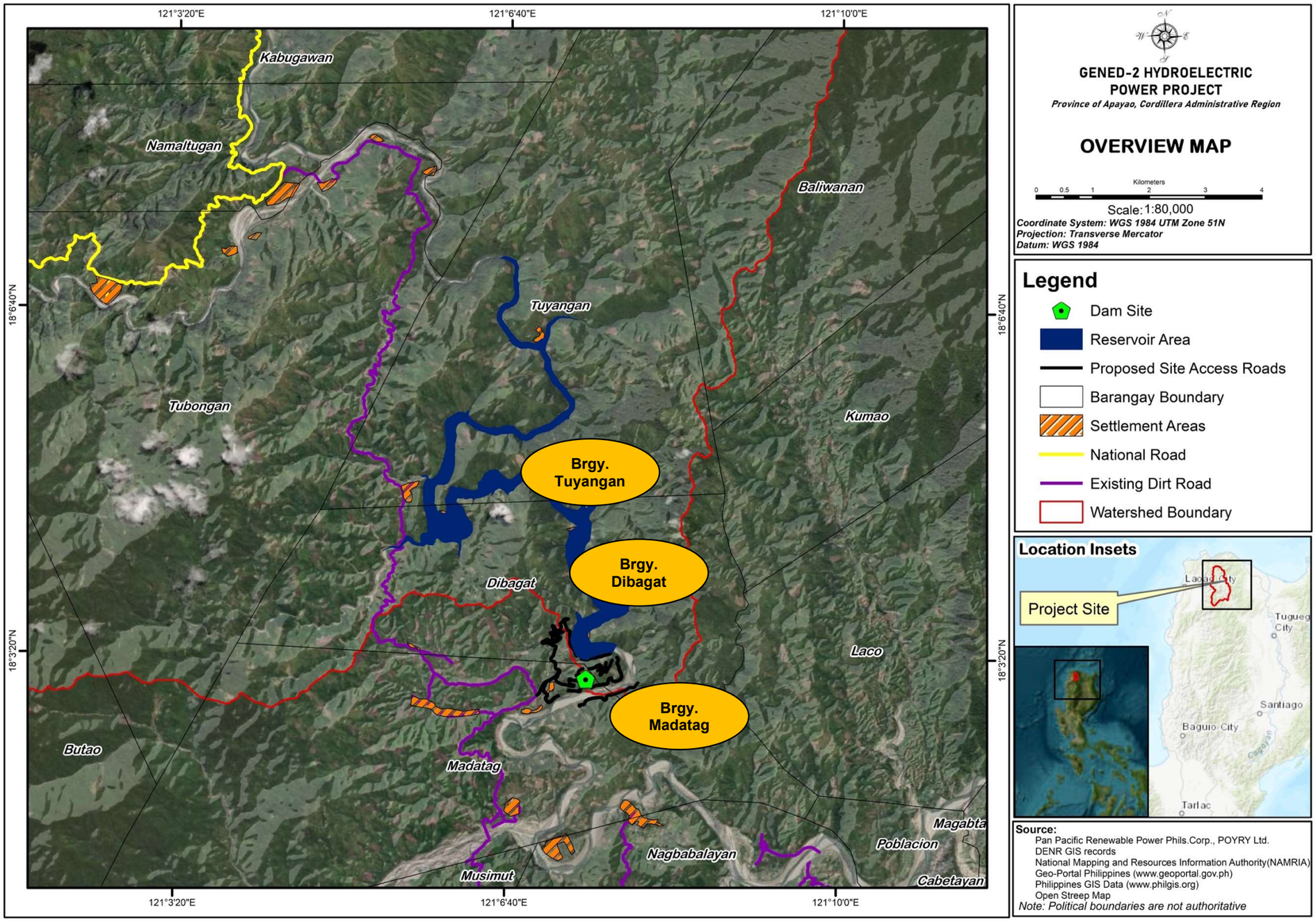

Figure 1. Project Overview, Reservoir

Source: Feasibility Study, 250MW Gened-2 Hydroelectric Power Project, AFRY Ltd, 2021

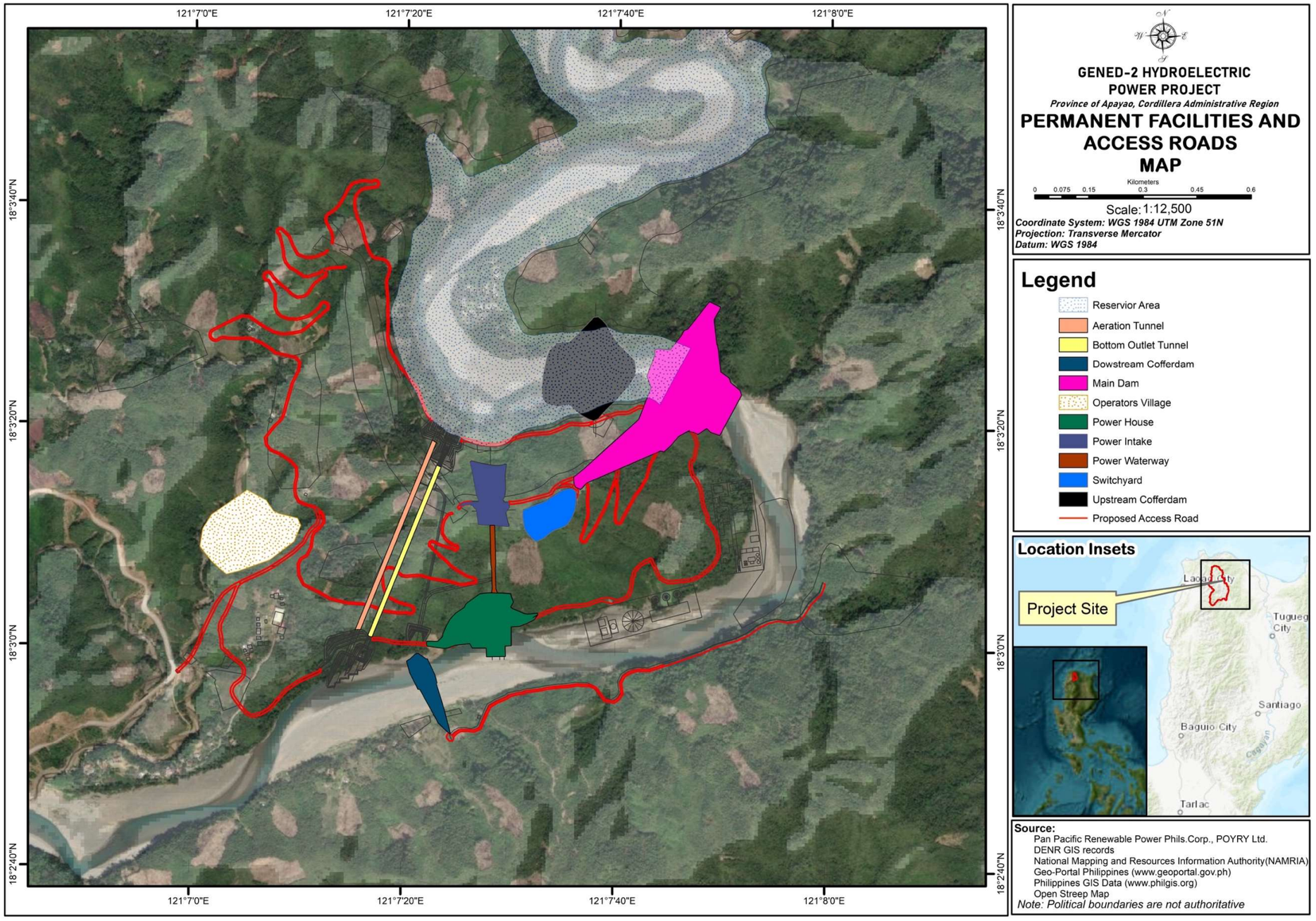

Figure 2. Permanent Site Facilities and Access Roads

Source: Feasibility Study, 250MW Gened-2 Hydroelectric Power Project, AFRY Ltd, 2021

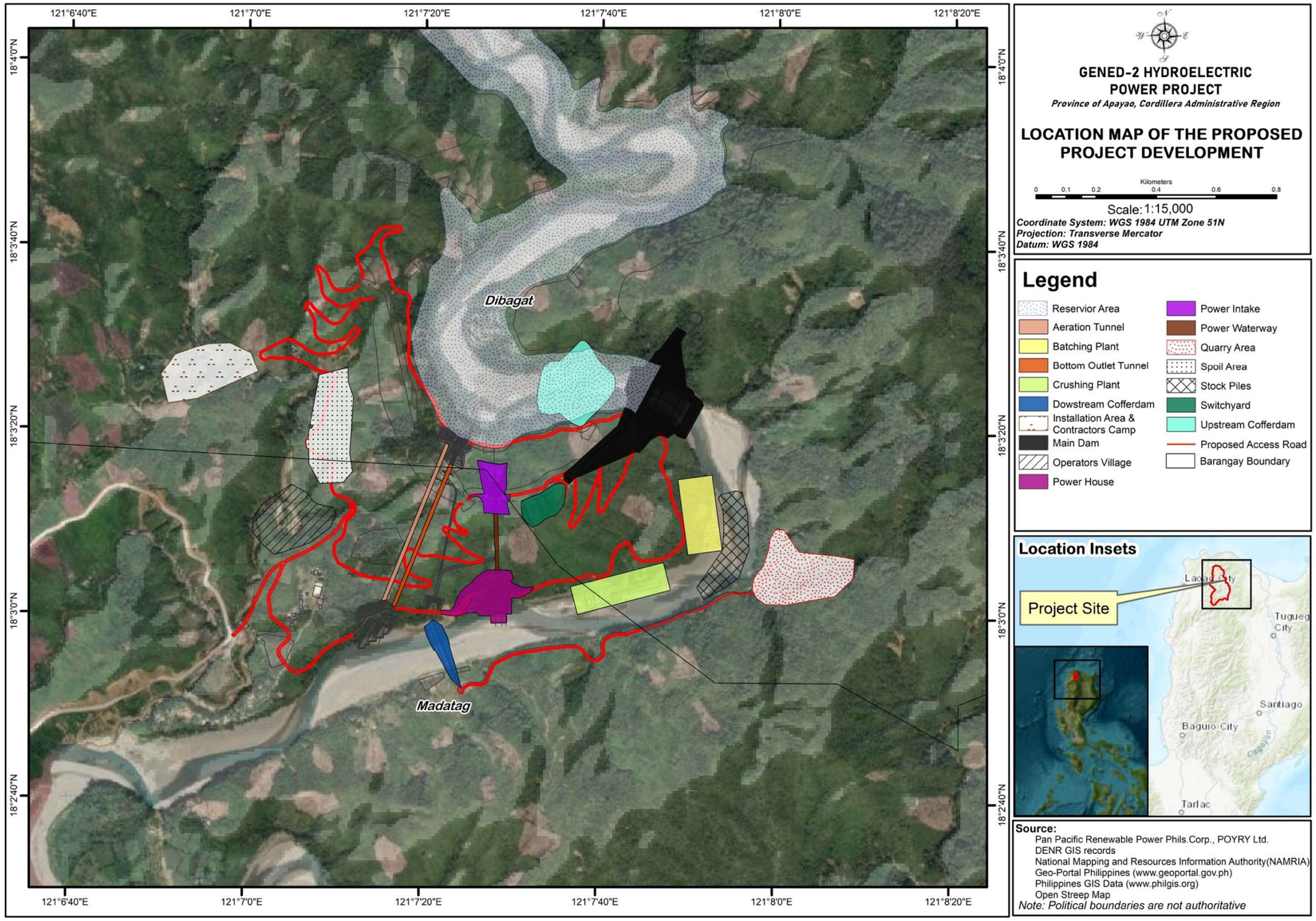

Figure 3. Project Location

Source: Pan Pacific Renewable Power Phils. Corp., POYRY Energy Ltd. DENR GIS Records

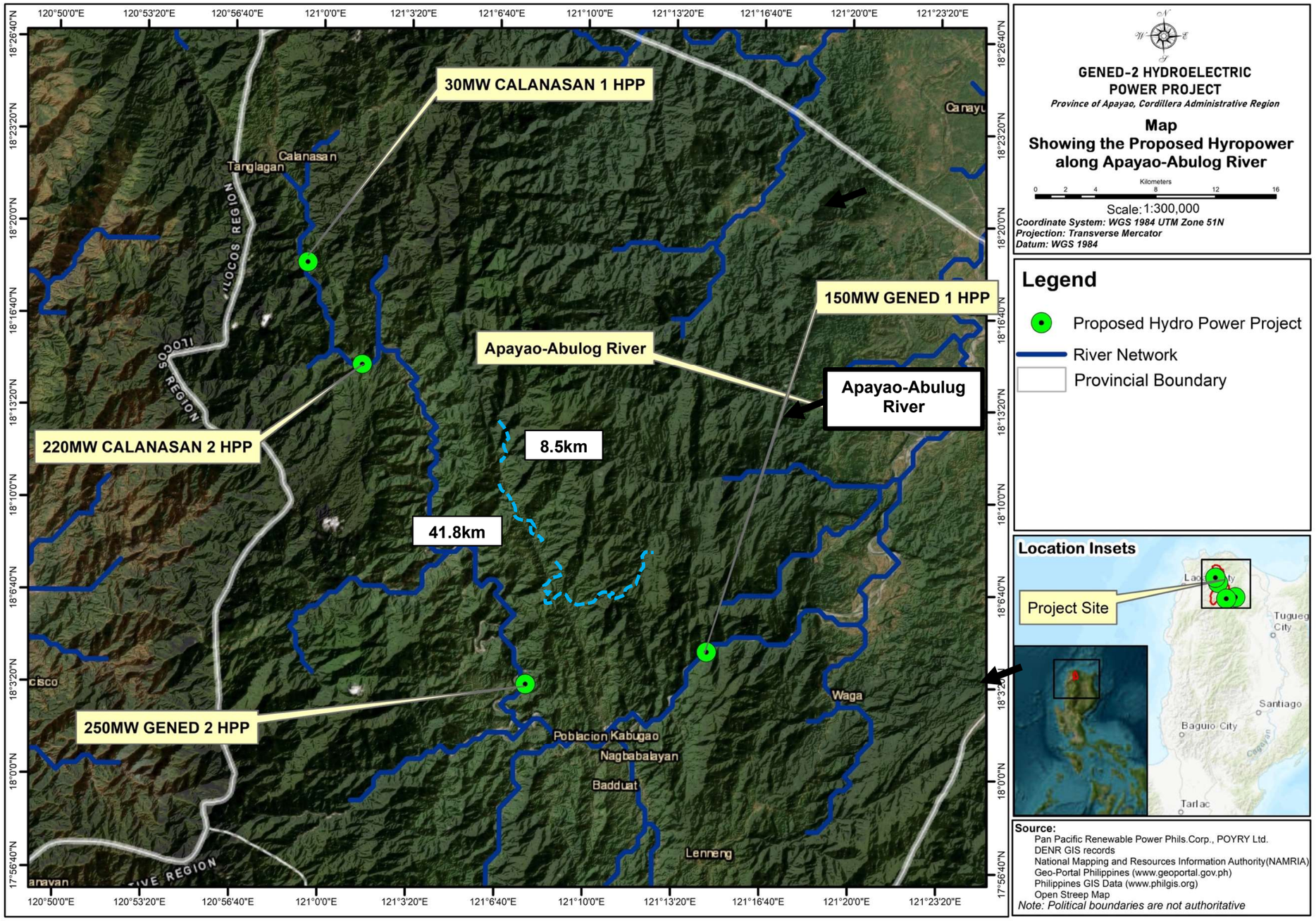

Figure 4. Proposed Hydropower Project along Apayao-Abulug River

Source: Pan Pacific Renewable Power Phils Corp. (Development Plan)

Project Area

Gened-2 HEPP is located in Barangays Madatag, Dibagat, Tuyangan, all in the Municipality of Kabugao within the Province of Apayao.

The geographic coordinates are:

Table 4. Geographic Coordinates, Gened-2 HEPP, WGS 84

Dam	18^0 3' 32.4" N
	121^0 7' 40.8" E
Powerhouse	18^0 3' 7.017" N
	121^0 7' 24.278" E

The total area of the project in hectares at Full Supply Level (FSL) of 190.0 masl is as follows:

Table 5. Total Area of Project

Project component	Area, hectares
Reservoir	490.00
Temporary Facilities (Construction Facilities)	33.24
Permanent Facilities (Dam, Spillway, Powerhouse etc.)	24.27
Total Project Footprint	**547.51**
Total Applied Area for Forest Land Use Agreement (FLAG) inlc. Buffer	**698.7**

Process Technology

There are now three types of hydroelectric installations: storage, run-of-river, and pumped-storage facilities. Storage facilities use a dam to capture water in a reservoir, created by a dam. This stored water is released from the reservoir through turbines at the rate required to meet changing electricity needs or other needs such as flood control, fish passage, irrigation, navigation, and recreation.

There are different possibilities to classify them, the first one being to use the material used to construct the dam. Dams built of concrete, stone, or other masonry are called gravity dams, arch dams or buttress dams. Dams built of earth or rocks are called embankment dams.

Embankment dams are constructed of either earth fill or a combination of earth and rock fill. Therefore, embankment dams are generally built in areas where large amount of earth or rocks are available. They represent 75% of all dams in the world.

Gravity dams depend entirely on their own weight to resist the tremendous force of stored water. In the earlier times, some dams have been constructed with masonry blocks and

concrete. Today, gravity dams are constructed by mass concrete or roller compacted concrete.

Arch dams are concrete dams that curve upstream toward the flow of water. They are generally built in narrow canyons, where the arch can transfer the water's force to the canyon wall. Arch dams require much less concrete than gravity dams of the same length, but they require a solid rock foundation to support their weight.

Buttress dams depend for support on a series of vertical supports called but tresses, which run along the downstream face.

Most of the dams are single-purpose dams, but there is now a growing number of multipurpose dams. Using the most recent publication of the World Register of Dams, irrigation is by far the most common purpose of dams. Among the single purpose dams, 48 % are for irrigation, 17% for hydropower (production of electricity), 13% for water supply, 10% for flood control, 5% for recreation and less than 1% for navigation and fish farming. The Gened 2 Hydropower Project is mainly for power generation only.

Hydropower plants harness water's energy and use simple mechanics to convert that energy into electricity. Hydropower plants capture the energy of falling water to generate electricity. A turbine converts the kinetic energy of falling water into mechanical energy. Then a generator converts the mechanical energy from the turbine into electrical energy as shown in **Figure 5.**

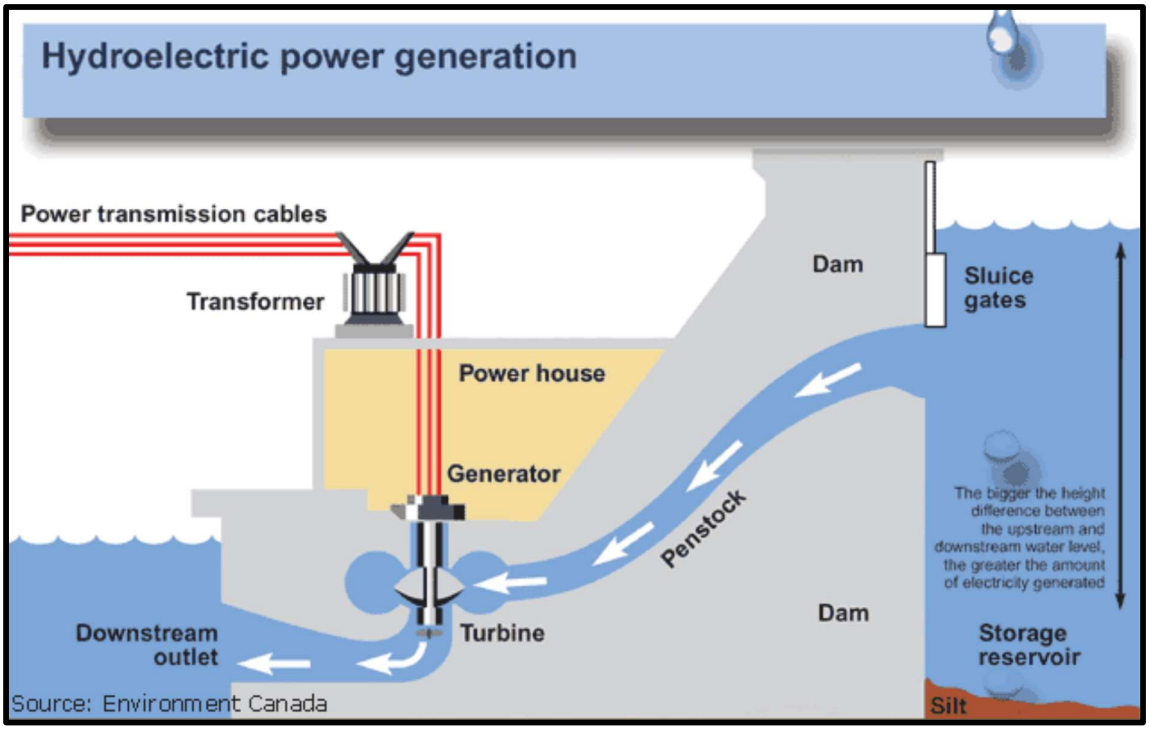

Figure 5. Hydropower Generation

EIA SUMMARY

Summary of Alternatives

Project Alternatives/Technology Selection/Operation Processes

The Technical Consultant of Pan Pacific, Poyry Energy Ltd conducted an alternatives study as follows:

Alternative 1 comprises a 120 m high concrete gravity dam and an 800 m long saddle dam. The surface powerhouse is located at the dam toe. The three Francis TG units are supplied by three separate intakes integrated into the dam with the penstocks running down the downstream face of the dam. The main purpose of Alternative 1 was to investigate whether such an arrangement would be more economic than locating the power waterway and the powerhouse away from the dam, as has is considered under Alternative 4.

Alternative 2 comprises a 130 m high concrete gravity dam and an 800 m long saddle dam. The power intake is just upstream of the dam. The scheme is a diversion scheme that discharges back into the Apayao-Abulug River 11 km downstream of the dam site. The power waterway comprises a concrete and steel-lined headrace tunnel. The three Francis TG units are located in the underground powerhouse situated midway in a ridge separating a couple of meanders of the river

Alternative 3 comprises a 125 m high concrete gravity dam. This alternative is quite similar to Alternative 2 and has been specifically developed in order to determine whether it is more economic to shift the main dam a bit further upstream where the valley is a wider but would allow for the omission of the 800 m long saddle dam.

Alternative 4 corresponds to the layout identified during the Site Visit and the Alternatives Study. It comprises a 120 m high concrete gravity dam and an 800 m long saddle dam. The power intake and powerhouse are located on the opposite side of a ridge forming a saddle and the right abutment of the dam. The power waterway consists of a short tunnel, which is lined with concrete and steel.

Alternative 5 corresponds to the request of the Isnag Indigenous People which was manifested during the Second Consultative Community Assembly. The Project redesign comprises a lower height of 94 m high concrete gravity dam and would no longer need a saddle dam. The power intake and powerhouse are located on the opposite side of a ridge forming a saddle and the right abutment of the dam. The power waterway consists of a short tunnel, which is lined with concrete and steel.

Summary of the Project Alternatives are presented as shown in **Table 6**.

Table 6. Project Alternatives

Parameter	Alternatives				
	1	2	3	4	5
Dam Height, meters	120	130	125	120	94
Reservoir Elevation	El. 252.0m	El. 252.0m	El. 252.0m	El. 252.0m	El. 190.0m
Estimated Reservoir Area	1,916 ha	1,916 ha	1,916 ha	1,916 ha	465 ha
Saddle Dam Length	800	800	-	800	-
Turbine Type	Vertical Francis	Vertical Francis	Vertical Francis	Vertical Francis	Vertical Francis
Number of TG Units (Main + Auxiliary)	2 + 1	2 + 1	2 + 1	2 + 1	3 + 1
Rated Discharge per Main Unit, $m^{3/}s$	100	100	100	100	145
Rated Gross Head, m	118.5	138.5	116.5	126.5	61.5
Rated Net Head, m	116.3	134.8	114.5	123.7	60
Total Installed Capacity, MW	315	365	310	335	250

Source: Conceptual and Feasibility Study, Gened-2 Hydroelectric Power Project, Poyry Ltd, 2019 and 2021

Summary of Baseline Characterization, Key Impacts and Mitigating Measures

Table ES-7 depicts the summary of key environmental and social findings of the EIA.

Table ES-7. Summary of the baseline environmental conditions

Module	Summary of Baseline Condition / Key Findings
Land use and Classification	The municipality of Kabugao is basically a rural hinterland. A little less than 1% of its almost 99,000 ha total land area is built-up while a large portion (58.02%) is classified as forest land. Areas devoted to agricultural purposes accounted for 7.50%. Grassland areas cover 17.61% while brushlands comprise 14.47%. River wash areas are about 1.63%. The general land classification of the municipality consists of alienable and disposable (A&D) land and forestland. Within this major land classification, there are sub classifications identified such as: commercial, residential, industrial, institutional, production, rivers and creeks, pond and water, forest, roads, grassland and the like. The A&D lands are mostly within settlement areas including the town centers. These areas have been subjected to private land ownership through the issuance of land titles to claimants for settlement and agricultural production purposes. Due to geographic conditions, some of the settlement areas are located within the designated forest zone. However, the whole municipality was awarded a Certificate of Ancestral Domain Claim (CADC), which endows the claimant indigenous people the legal rights and privileges over the area.

Module	Summary of Baseline Condition / Key Findings
	Under the Kabugao 2017-2027 CLUP, the A&D lands and forestlands are further categorized into four principal land uses, namely: built up/settlement land use; production land use (agriculture and forestry areas); protection land use; and infrastructure land use. The are no known proclaimed Protected Area that within the area of the proposed hydropower project. However, the Apayao-Abulug Watershed where the project is situated is considered as a critical watershed. Based on Provincial data, the project site does not fall within an area with a Certificate of Ancestral Domain Title (CADT) nor within a Mining Tenement Area. However, the project site falls within an 84,000-hectare Certificate of Ancestral Domain Claim (CADC) in Kabugao, Apayao claimed by Isnag Indigenous Cultural Community (ICC) with CADC No.077. The said CADC covers 21 regular barangays including one administrative barangay. The Direct impact barangays of the proposed project is three (3) in the Municipality of Kabugao namely: Brgy. Madatag, Dibagat, Tuyangan
Geology/ Geomorphology	Geology Gened-2 HPP is located in the center of Northern Luzon Island, between the main Philippine Fault zone in the West and the East Luzon Trench in the East. The main geological units were deposited as sedimentary and volcanic rocks and as plutonic intrusions during Tertiary (mainly Miocene) age to the east, the sedimentary Cagayan Basin (Tertiary: Upper Oligocene to Pleistocene age) is developed. Apayao is within the Central Physiographic Province of the Philippines. Geomorphology The morphology of the Apayao-Abulug River in the area of the Gened-2 site is characterized by a series of deeply incised meanders which the river has eroded into the bedrock. The meanders are therefore divided by pronounced ridges that rise up to 100 to 200 m above the river bed, providing ideal conditions for the arrangement of the various structures of a hydropower scheme. The project area is located on the central part of the N-S trending Cordillera Mountain range. At Kabugao Town, downstream of Gened-2 dam location, the river intersects a wider valley trending NNW-SSE. This wider valley clearly follows and has been formed by the PFZ Bangui Fault. In the wider area of Gened-2 the Apayao River has a general NNW-SSE trend in an open valley with gentle hills. Upstream of Kabugao Town the river turns to a general WSW-ENE direction and

Module	Summary of Baseline Condition / Key Findings
	crosses the eastern mountain range in a relatively deep, open V-shaped gorge and flows into the Cagayan Basin. The dendritic river network and relatively sharp ridges between valleys indicate a young age of the landscape. The highest mountain peaks in the project area reach approximately El. 700 m. Geohazard The geohazard map of the Philippines (scale 1:50,000) indicates for the project area a mainly high and partly moderate susceptibility for landslides. The area, however, is not susceptible to floods.
Pedology	The pedological assessment of the project site focused on the study of soil quality, topography, drainage and erosion susceptibility of the landscape based on limitations in the present land use. It aimed to determine soil type and their geological origin, to determine the soil quality or fertility, and to identify the soil erosion susceptibility of the watershed area. *Soil Types* Two soil types were identified, characterized and mapped in the watershed). The first type is the Aroman clay loam along the development area in Kabugao (location of the proposed dam site) and at the reservoir area in Brgys. Dibagat and Tuyangan. The second type is the Mountain soil which consist of majority of soil type in the entire watershed covering the project area – with waters flowing from Naguilian down to Kabugawan and Tubongan. *Soil Quality* Soil moisture content at the Abulug River Station in Calanasan had the highest value with 28.55% while the Gened2 Hydropower Station 1 had the lowest value with 13.38%. The organic matter was highest with 2.056% at Gened2 hydropower Station 2 while lowest at Gened2 Hydropower Station 1 with 1.442%. The cation exchange capacity (CEC) levels at upstream Calanasan Station and Abulug River Station were 55.36 and 48.83, respectively which indicates that the area contains higher amount of clay than the sampling stations while the rest of the stations indicated more mixtures of silts and sands. Soil nitrogen levels ranged from 0.1 to 0.15 for all sites. Soil phosphorus was found lowest in Upstream Calanasan Station and highest in Gened2 Hydropower Station 1 with 0.034%. Soil potassium levels were < 20 mg/kg. The Station 1 in Calanasan had the highest Ca with 6,483.43 mg/kg while Gened2 Hydropower Station 1 had the lowest amount with 611.69 mg/kg. Magnesium was highest in Upstream Calanasan

Module	Summary of Baseline Condition / Key Findings
	Station with 33,099.49 mg/kg and lowest in Gened2 Hydropower Station 2 with 12,405.08 mg/kg. With respect to heavy metals, five heavy metals analyzed (i.e., mercury (Hg), lead (Pb), arsenic (As) and cadmium (Cd)). All parameters obtained values <0.1 mg/kg in all sampling stations except for As having 3.3 mg/kg level at Gened2 Hydropower Station 2. *Soil Erodibility and Erosion Susceptibility* The four contributing factors to soil erodibility (i.e., rainfall, soil erodibility, vegetation/land use and slope) were included in the analysis to determine the extent of erosion or landslide susceptibility within the project area. Three (3) degrees of susceptibility were defined - “slightly susceptible” “moderately susceptible” and “highly susceptible”. Results show that majority of the watershed area has high to very high susceptible to landslide and only a few portions of the watershed have moderate and low susceptible to landslide or erosion.
Terrestrial Biology (flora and fauna)	The project area vegetation is composed of shrubland, agricultural and forest ecosystem. The most occurring species belongs to Moraceae followed by Malvaceae, Poaceae and Fabaceae. The species most commonly occurring with highest importance value is narra (*Pterocarpus indicus*) in the canopy layer, anabiong (*Trema orientalis*) in the intermediate layer, and tibig (*Ficus nota*) in the understory layer. Upon assessment, the area has low species richness with an evenly distributed number of individuals for each species. In terms of endemicity, majority of species recorded with 67% were identified as indigenous, 11% are endemic in the Philippines while 21% are exotic. For the conservation status, eight species were identified to be in the DAO 2017-11 list, while, 59 were in IUCN red list. In the faunal side, result of the assessment revealed the presence of 62 wild fauna species (*inclusive the reported species*) within the study area during the survey. Aves is the prevailing fauna group composed of 46 species, with a total percent share of 74.19%. Other species are represented by 6 species or 9.68%) of mammals, 6 species or 9.68% of reptiles, and 4 species or 6.45% of amphibian, respectively. Majority of the recorded species are resident/native in the country represented by 36 species or 58.1% followed by endemic species with 22 or 35.5%. While, the remaining species (6.4%) are migrant and introduced species. Habitat of recorded fauna species are commonly associated to grass lands, wet lands, shrub lands, agricultural areas and secondary forest. Remarkably, some of the species could thrive even in highly disturb habitats including urbanized areas (i.e. Yellow Vented Bulbul, Eurasian Tree Sparrow).

<table>
<tr><th>Module</th><th>Summary of Baseline Condition / Key Findings</th></tr>
<tr><td></td><td>Under DENR AO 2019-09 or known as “updated list of Philippine Threatened fauna species” there are 10 species included in the list of threatened species namely; Philippine Hawk-Eagle (Nisaetus philippensis), Indigo-Banded King Fisher (Ceyx cyanopectus), Philippine Duck (Anas luzonica), Rufous Hornbill (Bucerox hydrocorax), Philippine Hanging Parrot/Colasisi (Loriculus philippensis), Philippine Warty pig (Sus philippensis), Philippine Brown Deer (Rusa mariana), Tokay Gecko (Gecko gecko), Monitor Lizard (Varanus marmoratus) and Reticulated Python (Malayopython reticulatus).

Result of computed biodiversity index of the twelve (12) sampling sites revealed that the computed diversity values (H’) ranged from .79 to 2.31 which show a low to very low level of diversity. Similarly, the computed species evenness values (J’) of each site varies from .73 to .97. which indicates a very high species evenness.</td></tr>
<tr><td>Hydrology/ Hydrogeology</td><td>Hydrology

Watershed

Catchment areas have been derived for the proposed Gened-2 dam site and for the locations of the three gauging stations from ASTER satellite data based on watershed delineation implemented in ArcGIS 10.0. The catchment area of the Gened-2 dam covers 870 km². Based on available data and satellite imagery analysis, it is determined that the inflow to the reservoir will not be significantly affected by anthropologically factors.

Discharge

Data from daily observations has been considered from Colenco (1992) for the three stream gauges Nacagman (869 km², 1981-1990), Bulu (1551 km², 1979-1982) and Sisiritan (1894 km²,1975-1990. In 1992 recording was stopped. Thus, no more recent streamflow observations are available for the Apayao River.

A comparison of the available time series was performed, shows the discrepancies among the observation data series. Given its very low discharge sums and short record period, Bulu data was excluded in the analyses. Similarly, due to excessively high discharge results, data from Nacagman was excluded from the analyses. It is suggested that only the data from Sisiritan be considered as the most reliable information regarding streamflow due to its longest record, minimal data gaps, and its more suitable gauge location.

<table>
<tr><th>Gauge</th><th>CORR</th><th>BETA</th><th>GAMMA</th><th>Measured flow (m³/s)</th><th>Simulated flow (m³/s)</th></tr>
<tr><td>Bulu</td><td>0.43</td><td>0.88</td><td>0.88</td><td>155</td><td>132</td></tr>
<tr><td>Nacagman</td><td>0.41</td><td>1.41</td><td>1.04</td><td>145</td><td>189</td></tr>
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Module	Summary of Baseline Condition / Key Findings

Sisiritan	0.48	1.00	1.00	217	216

Precipitation

Basin	Dry season			Wet season			MAP		
	IDW [mm]	IDW El. Grad. [mm]	Increased Acc. to RR Sim. [mm]	IDW [mm]	IDW El. Grad. [mm]	Increased Acc. to RR Sim. [mm]	IDW [mm]	IDW El. Grad. [mm]	Increased Acc. to RR Sim. [mm]
Gened-2	804	1‘166	1‘574	2‘797	3‘601	4‘861	3‘601	4‘767	6‘435
Sisiritan	766	1‘034	1‘257	2‘648	3‘244	3‘935	3‘415	4‘278	5‘192

Temperature and Evapotranspiration

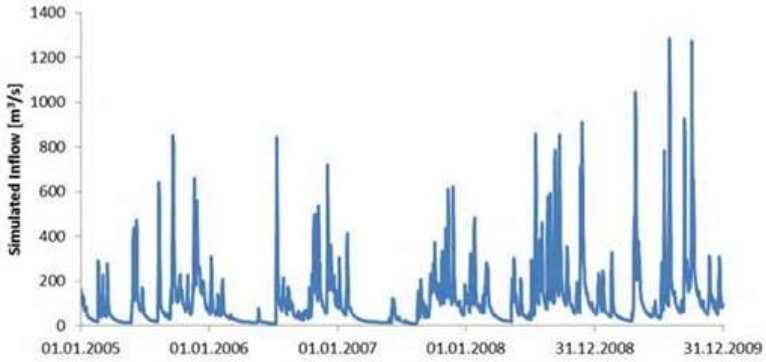
Long-term means of monthly temperature and potential evapotranspiration (ETP) have been derived from FAO’s CLIMWAT and CROPWAT databank. Mean monthly temperature and ETP for the Apayao-Abulug River were calculate using data from basin The Aparri, Laoag, Vigan, Tuguegarao, and Baguio stations. Temperature varies between 21°C and 23°C in the winter monsoon and 25°C and 27°C in spring monsoon. Daily ETP ranges from around 3 mm/day in winter monsoon and 4 to 5 mm/day in the spring monsoon. The resulting annual sum of ETP is between 1,300 and 1,400 mm.

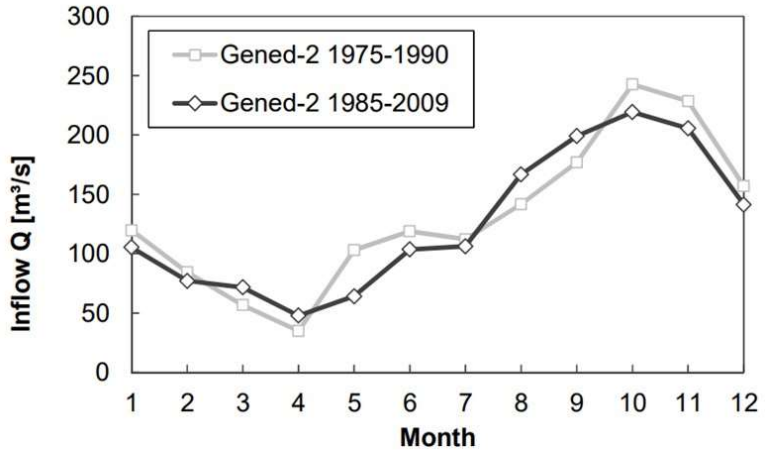
Inflows

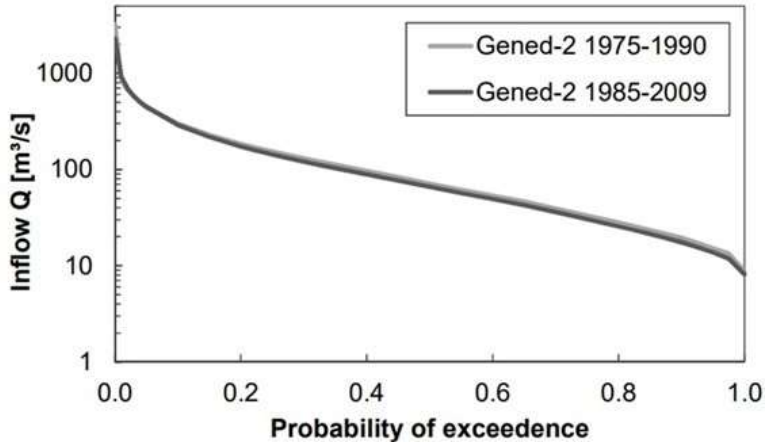
The mean inflow is strongly influenced by rainfall, which can vary substantially even within sub-catchments. Although Gened-2 is a sub-catchment of the most reliable gauging station, its relative area (1,897 km² vs 870 km²) is considered significant. Thus, to reduce the uncertainty in available inflow data, a conceptual rainfall-runoff model, similar to thewell-known HBV-model, has been developed has been developed to establish a daily inflow time series for Gened-2 Dam site.

The model utilizes the precipitation, temperature and evapotranspiration time series detailed in Chapter 2 and is calibrated using the discharge time series of the Sisiritan gauging station. The inflow simulations yield a continuous daily inflow time series for 1975-2009.The time series of four years for 2005-2009.

Module	Summary of Baseline Condition / Key Findings







Sediment Load

The total sediment load of the reservoir is determined to be 0.75 hm³/year, which includes bed load. Considering a sediment trap

Module	Summary of Baseline Condition / Key Findings
	efficiency, as determined by the Brune medium curve,of 68%, it is anticipated that 0.51 hm³ of sediment will accumulate in the reservoir each year. Previous studies partly yielded higher estimations of sediment transport to Gened-1 (Snowy 1997). However, theses conclusion were based on measurements taken during the monsoon season, when the sediment load is rather high. Thus, these result are believed to be too high. NJEC (1981) provide relatively lower results, but this can be excluded because of the changes in land use. The calculation by Colenco (1992) supports the ca.11 onclusion that erosion has increased over the years. Potential Climate Change Impact Reservoirs and hydropower plants have long life cycles. Thus, future climate conditions and their impact on the hydrology of a catchment area must be considered for the design of such facilities. Global warming and related changes in precipitation patterns can results to increasing or decreasing inflow, leading to changes in energy production and benefits. The analysis of information regarding potential changes in future extreme precipitation is highly relevant for the design of spillway structures. Hydrogeology In terms of its groundwater potential development, the National Water Resources Board (NWRB) reported that the basin can be divided into three categories namely, (1) the shallow and deep well area (alluvial), (2) deep well area (diluvium and tertiary), and (3) difficult area. The shallow and deep well area is formed by the alluvial plain, which distributed in the midstream and downstream areas of Abulug River. This alluvial plain is suitable for groundwater development and forms groundwater basin with several aquifers and aquicludes. The aquifers consist of sand and gravel layers and also impervious layersof clay and/or silt, wherein the area generally have enough magnitude, scale and perme-ability to produce large quantity of groundwater. Similarly defined, the deep well area corresponds to diluvium and/or tertiary or terrestrial sediments, which consist mainly of Neogene age. They have low groundwater potentialsas compared with that of shallow and deep well area wherein this type of area is best suited to the development of deep well hand pump requiring minimal pumping rates. In the same manner, the difficult area corresponds to the area where groundwater development is difficult. The geology in this area is mainly formed of intrusive rocks, metamorphosed rocks and volcanic rocks. The difficult areas for groundwater development can befound in

Module	Summary of Baseline Condition / Key Findings
	the Cordillera Central Mountain Range in the eastern part of the region. The Cordillera Central Mountain Range is made up of metamorphosed volcanic rocks of the geologic age. Based on the study conducted by National Water Resources Council (1980), now the NWRB, the total groundwater storage of the basin is estimated at 17085 MCM. The inflow to the groundwater reservoir system is roughly estimated to be about 1,197 MCM/year. Furthermore, the study indicated that if 50-year groundwater mining is allowed, a total of 1,539 MCM per year is available in the area. The total commended groundwater exploitation at safe yield level is about 1,197 MCM/year.
Water Quality	Based on visual observation, the main tributary of the Apayao-Abulug River is observed to be turbid. Temperature, dissolved oxygen (DO), pH and color were found to be within Class C standards. While in Class B standards, all parameters pass except for Temperature at SW 4. Temperature readings ranged from 26°C to 31 °C while DO readings ranged between 5– 6 mg/L. For pH, measurements ranged from 7-7.2 which reflect a generally neutral to slightly basic surface waters. For deepwell water quality sampling, all parameters passed the Class A standards - **Public Water Supply Class II.** Intended as source of water supply requiring conventional treatment (coagulation, sedimentation, filtration and disinfection) to meet the latest PNSDW. Laboratory Results are attached to Annex 9 including additional parameters, i.e., Benzo(a)pyrene, benzene, toluene, ethyl benzene, xylene, malathion, trichloroethylene, aldrin, chlordane, etc.
Freshwater Ecology	The aquatic ecology assessment focused on four functional aquatic groups – phytoplankton, zooplankton benthic macrofauna and fishes and other fauna present in the four different stations in the project site. The purpose of the study presented here was aimed at identifying freshwater species thriving in the Apayao River, specifically in the stretch which will be developed as part of the proposed Project. From the established seven (7) sampling stations, this component took samples in the upstream, midstream and downstream of the river to describe the fishes, benthic organisms and plankton assemblage in the area. Sampling includes macroinvertebrates, fish fauna and other aquatic floral assemblage inventory. Field surveys were conducted on January 10-13, 2020. Primary data were gathered through direct observation and field sampling. *Phytoplankton* A total of 20 phytoplankton genera belonging to diatoms (15 genera), green algae (3 genera), cyanobacterium (1 genus) and dinoflagellate (1 genus). Overall, the community was dominated by diatoms constituting 98%. Among the diatoms, the pennate taxa *Fragilaria*

Module	Summary of Baseline Condition / Key Findings
	were the most abundant with total density of 12,798 cells/L (54% of the total composition). Other diatoms species that contributed significantly to the overall abundance were *Melosira* (19%), *Nitzschia* (12%) and *Synedra* (9%). The remaining phytoplankton genera only accounted for roughly 2 % of the total density. Among the three green algae species identified, the filamentous species *Geminella* had the highest total cell density with 276 cells/L (1.17% of the total composition. The only cyanobacteria species that was recorded was *Arthrospira* with total cell density of 15 cells/L (0.06% of the total composition) and was only found in stations Ph1 and Ph2. There were no toxic or potentially harmful species identified from the seven sampling stations in Apayao River. Overall the total phytoplankton density reached 23,649 cells/L in the seven stations combined. In terms of spatial distribution, station Ph5 which is in Madatag, Kabugao, Apayao recorded the highest phytoplankton abundance with 7,808 cells/L. *Zooplankton* A total of 10 zooplankton groups belonging to Insecta, Rotifera and Copepoda. Among them, rotifers are the most abundant accounting for 94% of the total zooplankton abundance. Copepod which only accounted for 3% were only found in three stations (ZP1, ZP4, ZP6). Insect larvae which accounted for 2% were also found in three stations (ZP1–ZP3). The dominance of rotifer in all sampling stations are beneficial to the river ecosystem in Apayao. Ecologically, they are beneficial in stabilizing organic wastes, stimulating microfloral activity and decomposition, enhancing oxygen penetration, and recycling mineral nutrients. Moreover, the principal role of rotifers in wastewater is the removal of bacteria and the development of floc. Rotifers indicate increasing stabilization of organic wastes and lower BOD and TSS (Wallace *et al*. 2013). Overall, the total zooplankton abundance reached 41,533 individuals/m^3 in the seven stations combined. WA water sample collected from station ZP7 which is located at the lower stream of Madatag, Kabuayo, Apayao had the highest zooplankton abundance with 10, 767 ind/m^3. In contrast, the lowest was quantified in station ZP3 with 1,083 ind/m^3. The most taxa rich station was recorded in station ZP1 which is located in upstream area of Apayao River in Dibagat, Abugao, Apayao. Diversity index was generally low (<2) with values ranging from 0.34 to 1.22. The index of evenness was not so variable among station with values ranging from 0.49-0.86. In this survey, most of the zooplankton are common types with no endemic or rare groups encountered. *Macrobenthos*

Module	Summary of Baseline Condition / Key Findings
	The analysis showed that the macrobenthos in all stations consisted of only two (2) phyla i.e., Arthropoda and Mollusca. Specifically, a total of nine (9) taxa belonging to nine families and 378 individuals were observed and quantified in the sampling locations. The community of macrobenthos was totally dominated by arthropod accounting for 99.7% of the total organisms in the macrobenthic community. Arthropoda only accounted for 0.3%. Also, arthropods were the most family rich with eight (8) families while mollusks were only represented by a single-family. This indicated that there is a low diversity of macrobenthos at the sampling locations. The abundance of macrobenthos was low at all the locations and varied from sample to sample. The densest sample was BN2 with 144 individuals. The least dense sample was BN5 with only 6 individuals. On the other hand, taxa richness was relatively low and comparable among stations (2–6 taxa). Shannon-Wiener Diversity Index (H) is employed to measure the diversity of macrobenthos at the sampling sites. Diversity was also low. Diversity Index (H) ranged from 0.27 in station BN3 to 1.28 in station BN1. Among the arthropods, the insect belonging to the family Chironomidae (*Chiromonous* sp.) was the most abundant with total counts of 265 individuals (70% of the total composition). It was also the most dominant organism in all sampling stations with relative abundance ranging from 58% to 92%. *Freshwater Fishes* Freshwater fishes have also been significant in inspiring art, literature and society in many countries for centuries. People linked to river fisheries through culture, tradition and economics incorporate these fisheries as dominant components of their human identities (Brown *et al.*, 1996; Jackson, 1991). Likewise, they provide abundant opportunities in the field of science and research. During an interview conducted with the residents living near the rivers to be traversed by the project, fish species and other aquatic biota commonly caught are pasayan (freshwater shrimp) (*Macrobrachium sp.*), eel (*Anguilla sp.)*, tilapia (*Oreochromis niloticus)*, hito or pantat, (*Clarias batrachus*), and freshwater gobies. Based from the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List, there are no vulnerable, threatened, or endangered species observed/collected.
Meteorology/ Climatology	*Temperature* Average night, day and 24h temperatures for Calanasan Village (El. 290 m, 23 km to the north of Gened-2 site) have been collected. Since the dam site lies 140 m lower than Calansan Village, a correction has been performed based on a temperature gradient of - 5.14°C/km. The monthly

Module	Summary of Baseline Condition / Key Findings
	average temperature throughout the year lies within a narrow range of 21-26°C. The average temperature difference between the night and day is 9°C. *Rainfall* The watershed that includes the project is under two climatic types based from Corona Climate Classification – climate Type I and Type III. The amount of rainfall based on the length of rainy season is linked to how the soil or the landscape may be vulnerable to erosion. The western side of the watershed received is in a Climate Type I which has two pronounced seasons: dry from November to April and wet throughout the rest of the year. These areas although shielded by mountain ranges are open to rains brought in by *Habagat* and tropical cyclones. The eastern side of the watershed is in a Climate Type III with seasons that are not very pronounced but are relatively dry from November to April and wet during the rest of the year. These areas are partly sheltered from tradewinds but are open to *Habagat* and are frequented by tropical cyclones. Based on the rainfall information with relatively pronounce wet season less than half of the year and being under *Habagat* and tropical cyclones with partially sheltered location due to mountainous areas, the erosion susceptibility rating for the whole watershed based on rainfall criteria is "moderately susceptible to erosion".
Air and Noise Quality	All chemical parameters passed the National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations of the Department of Environment and Natural Resources Administrative Order No. 2000-81. In addition, noise level in all stations conform to the 1980 NPCC Memorandum Circular No. 002 for Class A & AA Noise in 4-time zone.
Socio-economic	The study focuses on the impact areas of the proposed project namely: Barangays Madatag, Dibagat and Tuyangan of Municipality of Kabugao. Barangays Poblacion, Eleazar, Ferdinand (Lubong), Ninoy Aquino (Tubang), Kabugawan, Namaltugan, Langnao and Tubongan of Municipality of Calanasan are included in the Social preparation conducted for the project, since originally it is included in the DIA of the 250MW Project Concept. For the final project configuration of 250MW Gened 2 HPP, only the municipality of Kabugao is affected. More than half of the population of Apayao is made up of Indigenous People. Of the 10 cultural ethnic tribes, 70% or 41,439 belong to the Isnag group. In terms of population of the areas of the proposed project, the highest in the PSA 2020 records is the municipality of Kabugao, Apayao with 16,125 household population.

Module	Summary of Baseline Condition / Key Findings
	As per census, male slightly dominates the female with a total population with percentages of 52.33% and 47.67% respectively. In terms of access to educational services, availability of school facilities is accessible. In terms of population of highest grade level completed, Philippine Statistics Authority (2015), the highest grade completed of most of the population in the affected municipalities are high school while post baccalaureate has the least number. Special education is not available in Kabugao. A total of 3,130 occupied housing units were recorded in the two municipalities affected by the project in 2015. This translates to a ratio of 100 households for every occupied housing unit, with 4.93 persons per occupied housing unit. Majority of the population in Apayao belongs to Roman Catholic comprising about 59% of the total population followed by United Pentecostal Church (Philippines), Incorporated with 8% and United Church of Christ in the Philippines with only 5 % (PSA 2015), while the remaining are composed of different religious sector with less than 1% in population. Based on the PSA (2015) fifty-six percent (56%) of the total number of households in municipality of Kabugao use protected spring and 18% use unprotected spring for drinking. On the other hand, 56% of the total number of households in two affected municipalities also use protected spring for cooking. Based on the PSA (2015), the total number of households that uses electricity for lighting is 1,546 (49% of the total number of households in Municipality of Kabugao). The municipality of Kabugao hosts a power generating plant of the National Power Corporation (NPC) through the Kalinga Electric Cooperative (KAELCO). The power plant has three (3) units of generator sets each operating 8 hours daily. The capacity of the generators is at 160KW, 260 KW and 220 KW. The existing power plant currently runs on a 24-hour basis daily. There are only 5 barangays energized by the NPC. Some barangays availed of the solar power energy from the Department of Energy. Kabugao currently has a newly constructed main health center beside the town hall with an ambulance, one 25-bed capacity district hospital with x-ray machine, an operating room. The Municipal Health Office of Kabugao extends its services to the barangays through its outreach programs. It has also a Rural Health Unit, and 10 barangay health stations.

Module	Summary of Baseline Condition / Key Findings
	In terms of occupations, Municipality of Kabugao is recorded to have the highest number of workers with 6,768, the highest number of employment are those on Skilled Agricultural Forestry and Fishery Workers with a total of 4,372
Awareness of the stakeholders to the project	78.65% of the respondents mentioned that they are fully aware of the proposed project while 21.35% of the respondents did not know about the proposed project. With regards to the source of information about the project, the information came from the local officials, government agencies, barangay councils, community leaders, and other people within their community and during the conduct of information education campaign. 64.32% of the respondents mentioned that they are in favor of the implementation of the project while 23.18% of the respondents stated that they are opposing and 12.50% stated that they are uncertain about the proposed project. To all respondents mentioned that they are in favor for the implementation it is because they are for better access to the people in the community for the electrification. Those who are not in favor and uncertain on the project are concerned that they will be demolished in their area or affected on the implementation of this project. The positive effects of the proposed project are recognized by the concerned communities and socially acceptable at this stage. The proposed Hydropower developments will provide electrification, improvement of roads and public facilities for easier access to the people as well as increase tradeoffs of goods and products among the municipalities and provinces. Increase in employment of the province are also being projected due to the direct and indirect jobs seen to be created by the hydropower development. Increase in business opportunities and investments are foreseen to happen that would greatly uplift the lives of the people in the Province of Apayao.

Table 8 presents the proposed Impact Management Plan (IMP for the Gened-2 Hydro Electric Power Project.

Table 8. Proposed Impacts Management Plan (IMP) for Gened-2 HEPP

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
PRE-CONSTRUCTION/CONSTRUCTION PHASE						
Detailed engineering design, excavation and foundation works, stockpiling, clearing and grading and other construction activities including ROW acquisition.	The Land Land Use and Classification	Impact in terms of compatibility with existing land use	- Close coordination with the LGU for land use planning - Strict adherence to the zoning in the area - Immediately Restore the adjacent areas temporarily use - Close coordination with LGU for land use planning	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Impact on compatibility with classification as an Environmentally Critical Area (ECA)	- Ensure compatibility of management plan to the existing management plans (critical watershed) - Coordination with Ips and NCIP for CADC area	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Impairment of Visual Aesthetics	- Proper design – landscape and architecture to blend with the environment and sensitive/responsive to socio-cultural values of the residents	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Devaluation of land value as a result of improper solid waste management and other related impacts	- Strict enforcement of solid and liquid management at the construction site - Provision of waste bins, regular waste collection and disposal to a sanitary landfill - Reuse of construction debris which meets foundation requirements Orientation of construction workers on proper waste management	Pan Pacific/Proponent	Part of construction cost	Part of contract
	Geology/Geomorphology	Change in surface landform/geomorphology/topography	- Formulation, implementation and strict monitoring of materials mgt. - Scheduling of earthworks, whenever possible during the dry season Identification of appropriate sites for placement of excavated materials - Possible use of excavated materials as part of foundation of structures where design allows Immediate revegetation of exposed areas not allocated for engineering structures - Use of silt ponds or traps around work areas; monitoring	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Change in sub- surface geology/underground conditions	Priority utilization of spoils for filling depressions, sheeting of access roads and as aggregate for concrete. Excess spoils will be hauled to properly constructed spoils dump sites	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Inducement of subsidence, liquefaction, landslides, mud/debris flow, etc	Boring, drilling, blasting and foundation works will be strictly confined to location of facilities. Excavation and foundation works will be limited to locations of facilities. Design of project structure will consider the natural geotechnical condition of the sites.	Pan Pacific/Proponent	Part of construction cost	Part of contract
	Pedology	Soil erosion / Loss of topsoil / overburden	- Conduct extensive geologic and geotechnical studies of structure sites - Slope stability analysis inputted into design - Deployment of experienced engineering geologist or geotechnical engineer at site - Use of appropriate slope stability measures such as rock bolts, shotcreting, etc.	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Change in soil quality/fertility	Use appropriate "housekeeping" procedures for handling different types of wastes, chemicals and petroleum products during construction and operation phase.	Pan Pacific/Proponent	Part of construction cost	Part of contract
	Terrestrial Ecology	Vegetation Removal and loss of habitat	- laying the road networks on areas without forest cover or areas with minimal forest cover - Identification and marking of ecologically/economically important species - If feasible, avoid cutting ecologically important species identified in the area, potential mother trees for these species shall be located and seeds/propagules shall be collected, to serve as genetic source for these important species - Identification and marking of ecologically/economically important species If feasible, avoid cutting or use earthballing techniques for ecologically important species identified in the area Potential	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
			mother trees for these species shall be located and seeds/propagules shall be collected, to serve as genetic source for these important species Avoidance of unnecessary clearing - Localized movement of equipment and personnel - Vegetation to be cleared should be properly delineated to avoid unnecessary clearing. Revegetation of cleared areas will be undertaken to ensure that recovery is taking place. - Establishment and operation of nursery for the production of quality native seedlings to be used in the restoration of the watershed/designated areas for rehabilitation.			
		Fragmentation/Loss of habitat, disturbance and displacement of wildlife species, threats to abundance and distribution	- Planting of native trees and or fruit bearing trees along the project boundary and access road as natural buffer as well as to serve as temporary domicile and/or transitory point and forage of visiting fauna.	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
			- Undertake immediate progressive rehabilitation using native and fruit bearing species along the project boundary and within the project site not designated for engineering structures. - Restoration/rehabilitation of areas adjacent to project site to provide alternative refuge of remaining wild fauna. - Conduct of IEC campaign for the protection and conservation of remaining wildlife. - Consider construction of box culverts along additional access roads across gulleys, channels and depression instead of overflow to facilitate safe passage of non-volant mammals, reptiles and amphibians. This is to avoid road kill of passing wildlife. - Installation of warning signages along roads and areas known or significant for wild life protection.			
		Disturbance of aquatic habitat death or temporary displacement of species	- Erosion control of excavated materials and stockpiles - Monitoring; provision of passageways through the structures for migratory species	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Threat to abundance, frequency and distribution of important species	The proponent should also ensure that its employees must be prohibited/warned/informed not to engage in any mode of wildlife collection and/or hunting for the conservation and protection of remaining wildlife species. Promote wildlife protection using innovative means such as putting up of warning signage on strategic areas for public information and warning.	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Hindrance to wildlife access	Establishment of natural noise buffer/natural perimeter along the alignment using landscape species or fruit bearing trees			
	The Water	Hydrology/Hydrogeology Change in drainage morphology / inducement of flooding/ reduction in stream volumetric flow/stream, lake water depth	- Continuous flow of water downstream of any disturbed areas will be ensured. - The riparian or ecological flow is based on National Water Resources based on National Water Resources	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Water Quality Degradation of Groundwater Quality/ Surface Water Quality	- Solid waste and sewage generated within the work area should be properly managed. - Fuel and oil storage areas should be located well away from any watercourse. There must be provision for	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
			adequate temporary sanitary facilities in construction campsites with proper drainage and sewage system to prevent leaching of untreated sewage or wash water into the groundwater and surface water. - Regular monitoring of water quality should be undertaken during the construction phase to determine the extent of changes and adequacy of control measures. - Proper disposal of wastes (excavation and solid wastes) should be strictly followed to prevent more sedimentation of the waters - Standards and guidelines for constructions of reservoir should be stringently implemented.			
		Threat to existence and/or loss species of important local and habitat Disturbance of aquatic habitat loss or temporary	Monitoring; provision of passageways through the structures for migratory species Erosion control of excavated materials and stockpiles	Pan Pacific/Proponent	Part of construction cost	Part of contract

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		displacement of species				
		Threat to abundance, frequency and distribution of species	Maintain regular and adequate flows downstream to minimize disruptions to the flow which is vital to maintaining oxygen levels, water temperature and lessen sedimentation loads. Environmental Flow is normally designed to improve water quality, restore sediment deposition, address the life-cycle needs of fish and wildlife, and restore river-based community livelihoods. The environmental flow is estimated at 10% of the surface water's dependable flow.	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Disruption of migration pattern of aquatic organisms	Provision of structures that will allow upstream and downstream movement of migratory aquatic species[1]	Pan Pacific/Proponent	Part of construction cost	Part of contract

[1] Hydropower dams on the river provide three general routes of passage for downstream migrating fish: powerhouse turbines, a spillway, and often a bypass specifically designed for fish. A fish ladder, also known as a fishway, provides a detour route for migrating fish past a particular obstruction on the river. Designs vary depending on the obstruction, river flow, and species of fish affected, but the general principle is the same for all fish ladders: the ladder contains a series of ascending pools that are reached by swimming against a stream of water. Fish leap through the cascade of rushing water, rest in a pool, and then repeat the process until they are out of the ladder (https://oceanservice.noaa.gov/facts/fish-ladder.htm).

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Impingement or entrapment of aquatic organisms	Installation of fish/intake screen to prevent fish and other aquatic organisms to enter the structures.	Pan Pacific/Proponent	Part of construction cost	Part of contract
	The Air	Dust generation during clearing of the site Dust generation associated with movement of vehicles and machinery Exhaust fumes and noise from vehicles and equipment	- Roads will be watered especially during hot and dry weather. Regular water spraying by water sprinklers (road tank watering) during construction. - Regulate speed of delivery/ hauling trucks - Provide equipment with ear plugs, mufflers and proper scheduling of noise-generating activities	Pan Pacific/Proponent	Part of construction cost	Part of contract
		Contribution in terms of greenhouse gas emissions (or GHG mitigation potential) Note: applicable only for projects with significant GHG emissions	Forest restoration plan in unaffected areas within the watershed (i.e. along upper slope of the watershed) to offset the negative impact of the project	Pan Pacific/Proponent	Part of construction cost	Part of contract
	The People	Loss of land/farm area, properties, crops and community facilities including traditional access to these areas	- Continuing IEC/consultations to update status of RAP and negotiate with remaining AF/IPs on relocation, valuation and compensation based on RAP review	Pan Pacific/Proponent	RAP Budget	ComPlan; IP Plan and RAP

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		and attendant dislocation and loss of income due to ROW acquisition	- Secure FPIC for IP-specific RAP concerns - Finalize RAP incorporating refinements based on agreements with remaining group (who still have reservations on the compensatory measures proposed)		RAP Budget	
		Increase in employment opportunities and benefit sharing	- Ensure that benefits of employment will accrue to affected groups - Consider also other qualified community members, where appropriate to spread the benefits to the community. - Contractors to orient workers on desirable working relationships especially if there is migrant labor	Pan Pacific/Proponent		RAP; SDP
		Increase in livelihood and business opportunities	- Pan Pacific to adopt policy requiring as much as possible sourcing or purchase of construction supply requirements from locally available sources - Food requirements of migrant workers/staff to be supplied locally	Pan Pacific/Proponent		RAP; SDP
		Potential health, sanitation and safety problems	- Temporary housing facilities for contractors provided with adequate water and sanitation facilities - Contractors to implement proper solid waste management in the work site, workers will be oriented to observe proper hygiene and sanitation practices and provided with	Construction Contractor	Part of construction cost	CC

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
			appropriate protection gears while working - Construction areas to be enclosed as necessary and provided with appropriate signage to avoid accidents from curious residents and workers			
		Traffic Congestion	- Preparation and implementation of traffic management scheme	Construction Contractor	Part of construction cost	Part of contract
OPERATION PHASE						
Operation and maintenance of dams, canals, reservoir and agricultural activities	**The Land**					
		Decrease of flooding of downstream areas	- Dam will lessen the amount of flood waters that can reach the downstream area			
			- Provision of structures that will allow upstream and downstream movement of migratory aquatic species	Pan Pacific/Propo nent	Part of operations cost	O & M
		Habitat loss and fragmentation	- Restoration/rehabilitation of areas at higher elevations - Continuous conduct of IEC campaign - Maintencance of warning signages - Reforestation/rehabilitation of the watershed to promote diversity and alternative refuge of wild fauna species.	Pan Pacific/Propo nent	Part of operations cost	O & M
		Large scale clearing of vegetations that are present within the	• Progressive rehabilitation methods must be done to ensure that no large tracts of land will be devoid of	Pan Pacific/Propo nent	Part of operations cost	O & M

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		construction areas/ Removal of photosynthesizing plants will affect CO_2 sequestration causing some degree of effect on the microclimate Altered movements and dispersal of wildlife, and invasion of non-native and degraded habitat-associated species	vegetation to minimize microghg in the locale conserve as much forests areas within the the project site which is not be intended for development, this could serve as biological corridor and refuge area for the wildlife to be displaced • immediate progressive rehabilitation using appropriate species, using the non-traditional planting method			
	The Water	Decrease of flooding of downstream areas	Dam will lessen the amount of flood waters that can reach the downstream area	Pan Pacific/Proponent;NWRB-DENR; PAGASA; LGUs/MMT;	Part of watershed management cost	Watershed Management Plan (WMP)
		Disruption of migration pattern of aquatic organisms Water use conflict	Provision of structures that will allow upstream and downstream movement of migratory aquatic species Formulate water allocation policy to be implemented during temporary drought period			
	The People	Increased employment opportunities	- Sharing of benefits from employment between affected and non-affected groups	Pan Pacific/Proponent		RAP; SDP
		Increased revenues for LGUs	- Use revenue generated from project to improve social services and infrastructures in the DIA			

Project Phases/Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Option for Prevention or Mitigation or Enhancement	Responsible Entity	Cost (P)	Guarantee/ Financial Agreements
		Increased migration and population	- Concerned LGUs (barangay and municipal/city) to regulate encroachment in watershed areas (forestland) through proper zoning and enforcement in conjunction with the Management Plan - LGUs to adequately plan/provide for social services and infrastructures including health services, waste management and facilities and road network	Pan Pacific/Proponent		RAP; SDP
		Increase of Power Supply	- Gened 2 will provide addition source of power in the Region/country			

Risks and uncertainties relating to the findings and implications for decision making

Many kinds of uncertainty are present in economic development; for example, financial risk analysis (such as, return on investment) has long been a part of management information. Environmental Impact Assessment (EIA) provides the scope and much of the data for explicitly dealing with uncertainties relating to environmental risks. This chapter reviews the nature of scientific uncertainties about the environment, and then provides an introduction to the concept of, and methods for, Environmental Risk Assessment (ERA). Rather than being a separate assessment, ERA is an extension of EIA, undertaken when uncertainties are large and important to project success.

The key objectives of the development of a hydropower project is to develop the project within a reasonable time, to construct the project in time and within the budget and to generate during the operation phase sufficient to service all loan demands and to meet the forecasted generation. In general, all aspects that have the potential to negatively impact these objectives are perceived as a risk. Many of the typical risks of hydropower development projects exist due to the nature of such projects which can be characterized as follows:

- Each project site is distinct which has to be designed against a set of site-specific characteristics and challenges.
- Hydropower projects are often developed in remote areas, usually exposed to natural hazards (floods, seismicity, landslides etc.), with limited/difficult access to the project area.
- They contain a high proportion of underground and foundation works, which increases variability in regards to both construction cost and progress.
- Project depends on water availability (hydrological risk) which has to be carefully assessed and is subject to natural fluctuations

The risks are treated separately as “Construction and Completion Risks” for risk exposure prior to commercial operation and “Risks during Commercial Operation” for the operation phase. Each of these risk categories will be detailed in the following.

Construction and Completion Risks

Geological and Subsoil Risks

One major risk during the construction of a hydropower project is linked to uncertainties in the actual geological conditions which will be encountered during construction. The local geology plays an important factor in the design and construction of large structures (slope stability, foundation conditions, rock and slope support requirements etc.) which can have a major influence on the construction time and the final costs.

Due to the remoteness of a typical hydropower site and the quantities of concrete aggregates and fill materials required for construction, these materials are usually sourced locally. The insufficient availability of construction materials in the required quality is thus perceived as a risk to be mitigated. Structures of a hydropower project are often constructed in difficult terrain with a

considerable excavation being required to reach the foundation level. Thus, such construction sites are often exposed to rockfall from steep slopes above.

Natural Hazards

Natural hazards have to be adequately addressed in the design in order to have the project constructed under a carefully determined residual risk.

The risk of flooding of construction sites is considered through the definition of a design flood for the construction period. The return period of a construction flood has to be defined based on the duration of construction (i.e. exposure) as well the consequences of the inflow exceeding these flood figures.

Both the access roads to a hydropower site as well as the project structures themselves often have to be located in a difficult terrain. Landslides correspond to a risk that needs to be evaluated, both in terms of loss of access and damage to structures and safety of personnel.

If adverse weather conditions, such as typhoons, are common in the project area then suitable measures must be taken. Unexpected climate conditions during construction impacting the construction activities might lead to delays. The contractor has to be aware of the climate conditions at site (rainfall and pattern, wet/dry season, typhoon/non-typhoon season, temperature etc.).

Design Risks

Design risks in the construction and completion phase are related to design changes which can lead to additional costs and delays in execution. Design changes either result from design flaws or engineering errors in design prepared prior to construction or may be requested by stakeholders (e.g. authorities, owner). Inadequate design basis (e.g. topographic maps, bathymetric surveys) might lead to an increase of quantities (e.g. excavation, concrete volume) coupled with additional costs and/or construction time increase.

The design interface of civil detailed design with equipment supplier's design has to be managed to avoid inconsistencies. All relevant information form the suppliers have to be incorporated into the civil design, and installation requirements (transport and handling of large and heavy equipment) have to be taken into account.

Construction Methods

Hydropower projects often involve increasingly challenging conditions and construction methods. In case the construction time and cost of a specific structure greatly depends on external factors, such as the actual geological conditions or the experience of a specialized contractor, care has to be taken by selecting a qualified contractor.

Construction Management

One main risk during the construction phase considers the construction management itself, which could result in additional costs, delays and quality issues. Possible causes can be found in inadequate or poor management procedures, slow decision making, incompetence etc.

Scheduling risks are risks related to shortcomings in the scheduling of the works, resulting in delays (in completion), like prioritization of activities not on the critical path, unrealistic assumptions, dependencies between tasks etc.
The availability and supply chain management of construction materials, both externally sourced and produced on site, have to be carefully managed in order to prevent delays.

The quality of work and the achieved production rates greatly depend on the contractors' experience and competence. It is therefore a crucial that suitably qualified contractors be chosen for all critical aspects of a hydropower project.

Insufficient execution quality results in delays due to rework, but may also result in decreased life time, higher O&M costs and increased forced outages of the scheme. Interface risks during construction cover risks related to interfacing between the contractor and its subcontractors as well as other contractors and suppliers working in parallel and in-hands on site. Such interfaces need to be carefully planned and coordinated, e.g. milestones for hand-over of a structure, check of access requirements, need for hoisting requirements etc.

Variations in construction costs compared to initial contract prices are a common occurrence in large scale construction projects and are mainly caused by risks related to the design, quantity, pricing, weather, price escalation, currency and geology. These risks are usually covered by contingency provisions in the financing agreements. Claims in monetary and timely terms are common in construction projects. A strong contract and claim management within the owner's organization is essential.

Other risks related to statutory requirements, insolvency of subcontractors etc. are usually covered by contingency provisions in the construction budget.

Transport Risks

Damages on equipment during the transport to the site (e.g. accident) might impact the completion and the start of Commercial Operation Date (COD). This risk is typically covered by insurance; the indemnity period for the DSU (Delayed Start-Up) cover should cover the longest replacement time of a single part (typically generator or transformer).

Health, Safety and Environment (HSE)

Health and safety is a major issue in any construction project. It is common that the contractor and its subcontractors have to implement and to follow national standards. Environmental risk during construction phase is related to pollution of water (working in river, waste water treatment etc.), soil (waste disposal, muck spoiling, oil storage, handling at workshops etc.) and air (noise, dust etc.), and their consequences. An adequate environmental management plan has to be established and followed by the contractors.

Risks during Commercial Operation

Hydrological Risks

Hydrological risks during the operational phase of a hydropower scheme can be summarized as:

- Variation in inflow, especially lower energy production in drought periods, which can lead to a lower than average production (revenues) for a sequence of several (consecutive) drought hydrological years, or shortfall in production (e.g. reservoir level below minimum level, inflow below the operating range of generating equipment).
- Sustained production deficits due to incorrect assessment of “average” hydrology, or subsequent changes in the hydrological regime should be avoided.

The hydrological inflow series are based on representative long-term hydrological and meteorological data series. Variations in the flow regime and their impact on the energy generation simulation is quantified and considered in the economic/financial assessment (sensitivity analysis).

Commercial Risks

One of the main commercial risks is related to uncertainties in the future development of electricity prices (for energy and/or ancillary services) and other expenses during the operational phase (O&M costs, wheeling charges). However, energy prices are often defined in Power Supply Agreement (PSA) or Power Purchase Agreements (PPA) to mitigate or avoid such uncertainty from purely market defined supply prices.

Natural Hazards

Natural hazards are rare events with a rather high impact, and have to be addressed adequately in the design criteria for a hydropower project being able to withstand such events. The natural hazards are site specific, and are related to the nature of the project site in remote areas and in difficult terrain. Floods and flood water levels/velocities of rivers and reservoirs constitute a key natural hazard for every hydropower project, which inherently rely on the proximity to such features for its operation. The headworks of a hydropower scheme are exposed to flooding of the river and have to be designed to safely pass a certain design flood, whose return period must be carefully selected based on the size of the structure and the impact of failure. Another risk during floods is potential clogging of spillway openings by floating debris, which could result in additional damage or malfunction of spillway facilities.

Other structures located in the proximity to water must also withstand the flooding issues. The powerhouse is designed to be flood safe from flooding up to a certain design flood water level. Earthquakes events comprise one of the key design aspects for hydropower plants.

The project must be able to withstand adverse weather conditions, such as typhoons, wind loads on certain structures (e.g. operator buildings, surge towers, transmission line) need to be taken into account. Hydropower projects are often located in difficult terrain and the construction of certain structures often requires a considerable excavation. Thus, it is not uncommon for structures to be exposed to rockfall.

Landslides, e.g. triggered by heavy rain or earthquakes, can lead to blockage of main access roads to the dam site and/or powerhouse site. Furthermore, landslides could impact the transmission line (e.g. impacting a TL tower), which would result in operation losses until the damages will be repaired. Landslides into reservoir

Design Risks

Design risks are related to design faults, which might result in additional costs during commercial operation, decrease of overall efficiencies and availability of the plant. Inadequate design basis (e.g. topographic maps, bathymetric surveys) bear the risk that the available head is smaller than anticipated, resulting in reduced power output and revenue streams.

The hydraulic concept and design is essential for the reliable operation of a hydropower plant. Common problems are often related to vortexes at the intakes (air intrusion) which may result in the full capacity of the scheme not being achieved. Sediment entrainment to the waterways is also a risk requiring consideration since it can harm the turbines, leading to significantly reduced lifetime of the turbine runner, decreased efficiencies and higher O&M costs.

Technical and Performance Risks

Technical risks are related to the performance and reliability of the main equipment during the operation of the scheme.

The quality of the main equipment (TG unit, control system etc.) is essential for the efficiency and availability of the equipment over the lifetime of the plant.

Flooding of the powerhouse might either be caused by external factors (floods) or due to failure of mechanical equipment inside the powerhouse.
In general failure of main equipment and structures will cause additional costs for repair and losses in energy production.

Human error can results in inefficiencies, production losses, forced outages, damages etc. Trained staff, high degree on automatization etc. can minimize such risks.

Fire

Fire in the powerhouse, control buildings and at certain equipment might result in severe damages and impact the health and safety of the O&M staff. Besides poor housekeeping, fire could be initiated by the following (electrical) equipment:

- Transformer fire caused by internal fault;
- Generators by internal fault or poor maintenance;
- Cables due to short circuits, contamination and poor housekeeping;
- Oil storage due to operator error and poor housekeeping;
- Diesel generator due to poor housekeeping.

Forest/Grass Fire

Forest/Grass fire adjacent the project developmemt area may disrupt the operation of the power house and distribution facilities, including safety of the Operations and Management (O & M) staff. This could be potential event in the case of unresponsible or uncontrolled burning farm lands adjacent the hydropower plant compound during site clearing. Grass fire could also commence due to burning of garbage whih is observe in within the community. Consiering that exisiting vegetation within and around the project site is highly sensitive to fire specially during summer. Hence, IEC for fire prevention is necessary in the management aspect of the project.

Environment, Health and Safety (EHS)

Accidents, e.g. falling from heights and working close to water, are a risk during O&M phase. These risks need to be addressed in the design (e.g. handrails, safety devices for working at heights).

Fire in buildings (mainly the powerhouse) could harm health of people in this area. The environmental risks during the O&M phase are related to pollution of water, soil and air.

Other Risks (Not Covered in this Risk Assessment)

Political Risk

Political risks are risks related to the legislation (legislation changes) in the host country of the project, and can include:

- Failure of host country to meet its obligations, e.g. failure to provide the site;
- No compensation for adverse changes in legislation;
- Sequestration of the project assets.

Political risks are usually insurable under guarantees (e.g. provided by multinational development banks like World Bank, Asian Development Bank etc.).

Commercial Risks
Besides the commercial risks already discussed and considered earlier (e.g. development of energy prices), the anticipated stream can be negatively impacted by further commercial/legal risks, which are partially insurable:

- Liquidity of the off-taker (default in respect of his payment obligations);
- Lack of market for the provided energy or auxiliary/ancillary services;
- Other negative impact on the generation (e.g. unforeseen business interruption, enforced changes in tariff system).

Social/ Environmental Risks

Another risk in hydropower projects (especially dam and reservoir projects) is that the project may be delayed or stopped due to environmental or social reasons. Such risks are existent and materialize quite often, especially at projects with a significant ecological impact, projects located in ecologically sensitive areas or at projects requiring considerable resettlements and expropriations. Such risks are not insurable, but require an early involvement of all affected parties, including NGOs, local authorities and communities.

Violence, e.g. terrorism, civil unrest, sabotage, vandalism, is considered as force majeure and risks to the timely completion of the project.

PROPONENT STATEMENT OF COMMITMENT

Pan Pacific ensures their commitment and capability to implement the measures discussed above to prevent the possible adverse negative impacts of the project. The signed Statement of Accountability of the proponent is shown in Figure ES-5 .

EIS ACCESSIBILITY

The copy of the complete Environmental Impact Statement for the Gened-2Hydroelectric Power Project can be accessed in the DENR-EMB Website.

SWORN STATEMENT OF ACCOUNTABILITY OF THE PROPONENT

This is to certify that all the information and commitments in this **ENVIRONMENTAL IMPACT STATEMENT (EIS)** REPORT for the **250-MW GENED 2 HYDROELECTRIC POWER PROJECT** are accurate and complete to the best of our knowledge, and that an objective and thorough assessment of the Project was undertaken in accordance with the dictates of professional and reasonable judgment. Should I/we learn of any information which would make this **ENVIRONMENTAL IMPACT STATEMENT** REPORT inaccurate, I shall immediately bring the said information to the attention of DENR-EMB.

I hereby certify that no DENR-EMB personnel was directly involved in the preparation of this **250-MW GENED 2 HYDROELECTRIC POWER PROJECT** other than to provide procedural and technical advice consistent with the guidelines in the DAO 03-30 Revised Procedural Manual.

I hereby bind myself to answer any penalty that may be imposed arising from any misrepresentation or failure to state material information in this **ENVIRONMENTAL IMPACT STATEMENT** REPORT.

In witness whereof, I hereby set my hand this ____ day of _____ at QUEZON CITY JAN 28 2022

MS. ALLEE LOURDES T. SUN
President
Pan Pacific Renewable Power Phils. Corp.

SUBSCRIBED AND SWORN TO before me this ____ day JAN 28 2022 202_, affiant exhibiting his/her Passport No. P5623570B issued at DFA NCR SOUTH on 12 OCT 2020.

Doc. No. 460
Page No. 93
Book No. 101
Series of 2022

ATTY. ELIJIO S. CALMA JR.
Notary Public
Roll No. 50183
PTR No. 2454359-D Jan. 03, 2022
IBP No. 141058, Jan. 04, 2021
MCLE Comp. No. VI-0012817 until April 14, 2022
20 Kamagong St., Sapamanni Village
East Fairview, Quezon City
ADM Matter NO. NP-067
Until Dec. 31, 2021
Extended as Commission Under B.M. 3795
Until June 30, 2022

Figure 6. Sworn Statement of Accountability of the Proponent