ENVIRONMENTAL PERFORMANCE REPORT AND MANAGEMENT PLAN (EPRMP)

EXPANSION OF THE SILICA QUARRY OF THE HEIRS OF ARTURO ZAYCO (HAZ) UNDER MINERAL PRODUCTION SHARING AGREEMENT NO. 218-2005-VII

OCTOBER 2019

Table of Contents

List of Tables

List of Figures

0. Executive Summary

A. Project Fact Sheet

The Proposed Expansion of the Silica Quarry of the Heirs of Arturo Zayco (HAZ) under Mineral Production Sharing Agreement (MPSA) No. 218-2005-VII was initiated to contribute in the country's nation building program. The MPSA 218-2005-VII, dated October 5, 2005, was granted under the name of the Heirs of Arturo Zayco (HAZ), covering a total of six (6) claims with an aggregate area of 505.4626 hectares in Barangay Maaslum, Ayungon, Negros Oriental.

Currently, the quarry operation is limited to ten (10) has out of the aggregate area of 505.4626 has. The existing extraction rate is 500 metric tons of silica per day (MTPD) with an estimated annual production of 125,316.84 metric tons (MT) for 2016. As the actual quarry site is limited to ten (10) hectares, the quarry operation is considered as small-scale.

1. ECC History

The small-scale quarry operations of HAZ is covered by ECC 701-08-23-0135303 which was issued by the Department of Environmental and Natural Resources - Environmental Management Bureau (DENR-EMB) Region VII office dated August 23, 2001. The ECC covers the ten (10) ha quarry site that is currently being mined.

This Environmental Performance Report and Management Plan (EPRMP) is prepared as compliance to the application for an ECC to the proposed expansion of quarry operations from 10 has to 50 has within the MPSA and a corresponding increase in the extraction of silica. It should be noted that there will be no modification in the quarry process. Given the increase in the extraction of silica, there area few additional mobile auxiliary equipment that will be acquired.

Background on Quarry Operation

The project site is under Mining Lease Contract No. MRD – 138 VII issued by the Department of Natural Resources on December 13, 1978 covering an area of 505.4626 hectares to Arturo Zayco. Prior to the expiration of the Mining Lease Contract (MLC), an application for Mineral Production Sharing Agreement (MPSA) was filed by the Heirs of Arturo Zayco on August 16, 2002 in the Mines and Geosciences Bureau (MGB) Regional Office VII covering the area under the same MLC. Silica extraction in Barangay Maaslum, Ayungon, Negros Oriental within the leased mining claim of Arturo Zayco has been on-going since the late 1970's up to the present. From 1979 until 1989, Maria Cristina Chemicals, Inc. (MCCI) operated a silica quarry in the mining claim of Arturo Zayco by virtue of an operating agreement between the two (2) parties. Initially, MCCI quarried silica in the area to supply its ferrosilicon plant in Iligan City. In 2001, the Heirs of Arturo Zayco entered into an operating agreement with Calamba Aggregates Co., Inc. (CACI) a subsidiary of Alsons Cement Corporation (ACC) which was approved by DENR in 2003. ACC (which later became part of Holcim Philippines, Inc.) took over the quarry operation in 2001. In March 31, 2017, a new operating agreement was signed between the Heirs of Arturo Zayco Sr. represented by Alfredo F. San Miguel Jr, Heirs of Arturo Zayco Sr., represented by Jose Maria Z. Cuenca, and Alfredo San Miguel and Holcim Resources and Development Corporation (HRDC). Currently, quarry operation is confined within a ten (10) hectare area covered by a partial declaration of mining project feasibility (**Annex 15**) out of the total 505.4626 hectares covered by MPSA 218-2005-VII. The operation for the quarry is contracted out to SiO2 Resources Corporation, a Manila-based mining contractor since year 2014.

The ECC coverage of the proposed expansion will only cover 50 hectares of the entire MPSA area.

In summary, the proposed expansion has the following information:

Table 0-1. Comparative Matrix of Existing and Proposed Project Components

Components	Existing	Proposed
MPSA	Covered by MPSA 218-05-VII	No change
Area Coverage	505.4626 hectares	No change
ECC Coverage	Existing ECC Coverage: **10 hectares** ECC No. 0701-08-03-0135303-A	Expansion of ECC Coverage: **50 hectares**
Production Capacity	**125,316.84 MTPY of silica**	**625,000 MTPY of silica**
Extraction Method	Surface Mining- Quarrying	No change
Commodity	Silica	No change
Quarry Operations	Silica quarry operation in 10 hectares	Silica quarry operation in 50 has
Quarry Equipment	The operation for the entire quarry is contracted out to SiO2 Resources Corporation. 1 Bulldozer 2 Excavators 3 Payloaders 20 Dump Trucks 1 Road Grader 1 Vibratory Roller 2 Water Trucks 1 Mobile Crusher 1 Fuel Truck 1 Service Truck 1 Service Vehicle 1 Breaker Attachment	The operation for the entire quarry is still to be contracted out. Below are the proposed equipment's for safer and efficient operation; **Loading:** 1-unit Volvo L150H 4.2cum Payloader 2-units Volvo EC300DL 1.76cum Excavator **Hauling:** 20 HOWO (15MT) on road hauling units 3-units Volvo FMX420 Off Highway Trucks (Quarry) **Auxiliary:** 1-unit Rock Breaker Attachment Rammer 3T 2-units Komatsu D155A-6R Bulldozer 2-units MotorGrader 1-unit Vibratory Roller 2-units Isuzu Forward Water Trucks (10,000lts) 1-unit Fuel Truck 1-unit Service Truck 1-unit Service Vehicle 1-set of Mobile Crusher/screening – 1 Grizzly Feeder for LT106 – 1 Primary Jaw Crusher – Metso LT106 – 1 Secondary Cone Crusher – Metso HP200 – 1 Screening Unit Deck Screen – 1 Radial Stacket

		– 3 decker Vibrating Screen ST4.8 1 Lube truck Isuzu 6BG1 for mobile crusher/HE 1 Book Truck Isuzu Elf 1 Road Grader SDLG 9190 1-unit Komatsu Eccentric Ripper for ripping hard silica materials 1 Back Hoe Kom PC200 for Xcentic 1 Back Hoe Volvo EC300DL for crusher loading and stockpile maintenance for ripping hard silica materials
Auxiliary Operations	None. There is no processing of raw silica at the quarry site.	Primary and secondary crushing, screening and washing using the mobile units on site

B. Process Documentation

The EPRMP was prepared by Berkman International, Inc. (BII), a registered professional consulting and project management firm, with address at Unit 301 ALCCO Building, Service R., San Juan City, Metro Manila. The preparation of this EPRMP was approved by the Proponent for their application of Environmental Compliance Certificate (ECC) for the 50 hectares expansion and increase in extraction rate and subsequently, a Declaration for Mining Project Feasibility (DMPF).

1. EIA Team

The EIA Team of Berkman International, Inc., is composed of the following:

Table 0-2. EIA Team

Name	Expertise	EIA Registry No.
Dr. Emmanuel Lleva	Flora and Fauna Specialist	IPCO-130
Dr. Honorato Palis	Environmental Specialist	
Dr. Edwin Combalicer	Water Quality /Hydrologist/ GIS Specialist	IPCO-321
Mr. Ephrem Gabriel Cortes	Socio-Economic/Public Participation Specialist	IPCO-322
Dr. Merlyn Carmelita Rivera	Socio-Economic Specialist	IPCO-298
Mr. Henry Salvado	Geologist, Competent Person	-
Engr. Ramon Aguilar Jr.	Air/Noise Quality Specialist	-
Dr. Thelma Dela Cruz	ERA Specialist	IPCO-387
Engr. Vicente Ballaran Jr.	Sediment Transport Specialist	-
Mr. Rory Caguimbal	Research Associate (Water Quality)	IPCO-229
Ms. Ma. Niña Regina Quibod	Research Associate (Terrestrial Ecology)	-
Ms. Fenelyn Nabuab	Research Associate (Freshwater Ecology)	IPCO-165
Ms. Ma. Lisa Lagdaan	Research Associate (Terrestrial Ecology)	IPCO-217
Mr. Ace Kevin Amarga	Research Associate (Riparian Ecology)	-
Mr. Garry Benico	Research Associate (Freshwater Ecology)	IPCO-393

2. EIA Study Schedule and Area

The project area is situated in Barangay Maaslum of the Municipality of Ayungon, Province of Negros Oriental. The project site is under Mining Lease Contract No. MRD – 138 VII issued by the

Department of Environment and Natural Resources (DENR) on December 13, 1978 covering an area of 505.4626 hectares to Arturo Zayco.

The study was conducted in the identified direct impact areas of the proposed expansion which are Barangay Maaslum, Barangay Gomentoc and Barangay Tampocon I, all situated in Ayungon, Negros Oriental.

Table 0-3. EIA Schedule

Project Activity	Date of Completion
Kick-Off Meeting	April 13, 2016
Initial Site Visit	April 25-May 2, 2016
IEC at Barangay Maaslum, Barangay Proper	April 26, 2016
IEC at Barangay Gomentoc, Barangay Proper	April 27, 2016
IEC at Barangay Tampocon 1, Barangay Proper	April 27, 2016
IEC at Municipal LGU of Ayungon	April 28, 2016
Terrestrial Ecology Study (Dry Season)	April 25-May 2, 2016
Water Quality Assessment (Dry Season)	April 25-May 2, 2016
Focus Group Discussion	April 25-May 2, 2016
Public Scoping	May 18, 2016
Freshwater Ecology (Dry Season)	May 18, 2016
Ambient Air & Noise Quality Assessment (Dry Season)	November 28-December 1, 2016
Terrestrial Ecology Study (Wet Season)	August 19-25, 2017
Freshwater Ecology (Wet Season)	August 19-25, 2017
Riparian Ecology Study (Wet Season)	August 19-25, 2017
Water Quality Assessment (Wet Season)	August 19-25, 2017
Ambient Air & Noise Quality Assessment (Wet Season)	August 19-25, 2017
Soil Sampling Analysis (Wet Season)	August 19-25, 2017
IEC Activity	October 25, 2018
Public Re-Scoping Activity	November 26, 2018
Soil Sampling Analysis (Dry Season)	February 26, 2019

3. Description of Key EIA Methodologies

Primary and secondary data were utilized for the assessment of the project impacts. Primary data were obtained from onsite investigation and field sampling/ surveys. Meanwhile, secondary data were acquired from the proponent. Relevant and previously conducted surveys were also considered.

The study itself followed various methodologies and written in detail are the study modules for air, water, land and communities. The following are the sampling/ assessment methodologies employed by the team in the preparation of the EPRMP:

Table 0-4. Key EIA Methodologies

Module	Project Activity	Methodology
Land	Land Use	Gather and review secondary data
	Geology and Geomorphology	Gather and review secondary data
	Pedology	Grab Sampling Method
	Terrestrial Ecology	Ocular Survey, Transect Method, Line Intercept, Quadrat Method Sampling
	Riparian Ecology	Ocular Survey, Transect Method
Water	Freshwater Ecology	Plankton Sampling, Periphyton Sampling, Macro-Invertebrate Sampling, Key-informants Interview
	Water Quality	Grab Sampling, In situ measurements, Gravimetric, Nephelometric, Azide Modification (Dilution Technique), Close Refu – Colorimetric, Partition Gravimetric (Petroleum Ether Extraction), Turbidimetric, Titrimetric, Diphenyl Carbazine Colorometric Method, Hydride Generation AAS, EDA titrimetric, Atomic Absorption Spectrophotometry, Cold Vapor Technique, Selective Electrode Method
Air and Noise	Ambient Air and Noise Quality	High Volume –Gravimetric Method, Low Volume – Gravimetric Method, Bubbler – Pararosaniline Method, Bubbler – Griess-Saltzman Reaction Method and Gas Analyzer – Direct Reading
People/ Community	Socio-Economic Profile	Public meeting and direct consultation, focus group Discussion, Key Informant Interview
	Health Impacts	Discussions with Municipal Heath Office, Secondary data gathering, Focus groups discussions

4. Scoping and Public Participation

Stakeholder involvement was ensured through the conduct of a series of IEC campaign, focus group discussions, meetings and key informant interviews prior to scoping. These activities served as venue for public participation where stakeholders can relay their issues, concerns and perceptions relative to the proposed expansion.

The activities conform to the provisions of public participation, Section 5 (Initial Stakeholder Identification), Section 6 (Information and Education Campaign), Section 7 (Requirements prior to Public Scoping), Section 8 (Public Participation during Public Scoping), Section 9 (Stakeholder involvement in the EIA Study/ Report Preparation by the Proponent) and Section 10 (Updating of Stakeholder Identification and Stakeholder Analysis) as required under DAO No. 2017-15

(Guidelines on Public Participation under the Philippine Environmental Impact Statement – EIS, System).

As shown in Table 0-3, there were five (5) IEC conducted in Barangay Maslum on April 26, 2016; Barangay Gomentoc on pril 27, 2016; Barangay Tampocon 1 on April 27, 2016, municipal-wide on April 28, 2016 and October 25, 2018. Annex 17 provides the summary of the IEC results conducted.

Several focus group discussion (FGD) sessions were also conducted on April 25- May 2, 2016. Meanwhile, two (2) public scoping were done on May 18, 2016 and November 26, 2018. These public participation activities were attended by various stakeholders from the direct impact areas, indirect impact areas and LGU with political jurisdiction over the project and others (implementing partners – HMDC and HAZ, contractors, NGO and government agencies. Table 0-5 provides the summary of the list of invitees in these public participation activities

Table 0-5. Summary of List of Invitees

Potential Impact Areas	Basis for Selection	Sector/ Sub-sectors to be likely Stakeholders	Specific Organizations / Entities likely to be Invited to IEC / Public Scoping / Public Hearing
A. Direct Impact Areas			
1. Brgy. Maaslum	Barangay is where the quarry site is found	Brgy. Officials, RHU, PTC, PTA rep, Coop, Farmers Association, Senior Citizen, Women's Association, SK	• Brgy. Captains • Brgy. Kagawads • School Principals / Head Teacher • RHU Officer • PTA / PTC Head • Coop Manager • Irrigator's Association Manager • President, Senior Citizen
2. Brgy. Gomentoc	Adjacent barangay. Brgy road leads to Brgy. Maaslum		
3. Brgy. Tampocon I	Gateway to Brgy. Maaslum. Brgy road leading to Maaslum		
B. Indirect Impact Areas			
1. Brgy. Jandalamanon		Brgy. Officials	• Brgy. Captains • Brgy. Kagawads
2. Brgy. Ban Ban			
3. Brgy. Anibong			
4. Brgy. Poblacion			
5. Brgy. Tampocon II			
C. LGUs with political jurisdiction over the project area (listed in A&B)			
1. Municipality of Ayungon	Ayungon has political jurisdiction over the 3 DIA & 2 IIA barangays	Municipal Officials	• Municipal Mayor • Mun Planning & Devt Officer • Mun Agriculture Officer • Mun Environment and Natural Resource Office • Mun Engineer • Mun DRRM Officer
2. Province of Negros Oriental	The province has jurisdiction over Ayungon	Provincial Officials	• Provincial Governor • Vice-Governor • Chair, Environment -Sangguiniang Panlalawigan • Provl Engineer • Provl Agricultural Officer • Provl Tourism Officer • Provl DRRM Officer
D. Others			
1. Implementing Partner/s			

Potential Impact Areas	Basis for Selection	Sector/ Sub-sectors to be likely Stakeholders	Specific Organizations / Entities likely to be Invited to IEC / Public Scoping / Public Hearing
a. Holcim Mining and Development Corporation	The Operator	Holcim HQ	• Holcim President • Holcim Vice President • Holcim Site Manager • Holcim Site Staff
b. Heirs of Arturo Zayco	The Proponent		• HAZ Legal representative
2. Contractors in the area			
a. Silica Resources Corp (SI)	SI does the hauling of silica sand deposits; water the roadside		• SI Manager
3. NGOs			
a. Ayungon Ministers Association	Signatory to the CLRF Memorandum of Agreement	• Social Action Center • Cooperatives • Associations	• Executive Directors • Managers • Association Presidents
4. Government agencies	Issuing departments; with programs and projects in the area	MGB, DENR, DA, NIA, DPWH	• Regional Directors • Provincial Directors

The summary of issues and concerns identified and discussed during the two (2) public scoping is shown in the table below. Please refer to **Annex 12** for proof of public participation, e.g., pictures, attendance sheets, program of activities, etc.

Table 0-6. Summary of Issues and Concerns Raised During the Public Scoping*

EIA Module	Issues/Suggestions Raised by Stakeholders
Project Description	• Why is the project an "expansion"? • Why is there only public scoping now? The first silica project was not subjected to public scoping. • Is the project small scale or large scale?
	• How many hectares will be used for the expansion?
	• Does the project have an EMP? • A copy of the Holcim presentation is requested.
Land	• Who is responsible for the road maintenance from the quarry site to the port area?
	• Expansion is accepted but road concerns raised should be addressed.
	• During the rainy season, there is this big possibility of the silica sands reaching and covering the irrigation canals in Sitio Campo-oc, Maaslum. • Who will do the de-silting? How do you plan to address siltation at the port area during loading? • Are there any chemicals that may seep to rivers/creeks?
	• Minerals taken away cannot be replaced again. How can the devastated area be rehabilitated? • Silica mining is destructive mining removing tons of soil and permeable under the ground. When the mining stops, what will be the next move? • Grassland and forest wildfire and watersheds are affected.
	• Where can we find the resource inventory of the 500 hectares? • What is the state of biodiversity in the 500 hectares? • Aside from the 10 hectares (in the 500 hectares), what is the silica deposit? • What seedlings species are used for reforesting? • What is the monitoring and evaluation system that will be formulated?
	Suggestions: • Provide additional water truck to assure the occurrence of dust would be minimal. • Designate street sweepers from the national highway to the stockpile area. • Hire a geotechnical person to identify the area of relocation. • Recommend including a Geohazard study in your EIA Study. Part of the study is the Geotechnical evaluation in the area. Including the relocation area, wherein it must have a geohazard plan. • ECC on impact of mining and the port. There should be data coordination between the two ECC processes
Water	• Problem on the irrigation is contaminated with silica and it causes flooding in the area. • The fish collected started to weaken. This must be because of the waste that comes from Maaslum that ends up in the coastal of Tampocon.
Air	• If there are people who might get sick and the doctor diagnosed that the cause is because of the silica dust, will the Holcim provide support to them?
	• Not a question but concern: Regarding road maintenance, since Holcim has a service contractor, there is a need for urgent manpower for rehabilitation of the roads/patching of holes.
	• How will the dust issue be resolved which is the number one problem of the residents living along the road? As regards to the transporting of the silica from the source to the port facilities, how can the dust issue be resolved since it is health hazard to students?
People/ Community	• What is the policy of Holcim with regards the hiring of personnel? Do they have benefits (SSS, PhilHealth), salaries and wages included? • Do the barangays have any complaints regarding mining operations?

EIA Module	Issues/Suggestions Raised by Stakeholders
	• Brgy. Maaslum wanted to stop the operation of Silica Resources. During the signature campaign, they thought it's only for attendance the reason why they sign it. • Silica being hauled causes inconvenience to the roads. • The existing speed limit for the dump trucks are not followed. This is dangerous to the community especially the students crossing. • Concern on tax review, employment and livelihood of the community. For how many years the mining project existed, the community expected that they will receive an excise tax share. What will happen to Barangay Maaslum if we will not receive any tax • The community is not anti-mining but the community requests that HAZ/ HMDC should be responsible miners. • To whom the excise tax is addressed? It was named or the TIN used was from Mr. Alfredo San Miguel and not from Holcim, not from HAZ also. • Request assistance from Holcim and Silica Resources for the maintenance of the dam which is located below the quarry. The dam has accumulated silt because of the mining. • When roads are watered, the silica on the sides of the roads are not included. Only the silica on the center.
	• They are not opposed to the operations of the project, but they would like to ask for help regarding the issue of the excise tax
Others	• *There were no issues identified.*

***Note:** Please see Annex 17 for the corresponding responses of the proponent to issues raised by the stakeholders.

C. EIA Summary

1. Summary of Alternatives

There are no project alternatives considered for this EPRMP as the assessment that was done is for the purpose of securing an ECC for the expansion of silica quarry operation within the MPSA with corresponding increase in production threshold. There will be no change in the location of the site, development design, process/ technology selection and resource utilization.

Siting, Development Design, Process/ Technology Selection and Resource Utilization

Since there will be no changes in the siting, development design, process/technology selection and resource utilization, there were no new criteria for the the identified factors were identified. The quarry operation will remain within the bounds of the MPSA and the quarry method being used will be the same.

The extraction of silica material follows the standard open-cut mining procedure as follows:

- Ripping the material using a bulldozer with ripping mechanism. Backhoe with breaker will be utilized in selected areas where the material is not rippable;
- Pushing the loosened material by bulldozer towards designated loading areas; and
- Loading the material using a backhoe into dump trucks for delivery to the port via passing through the developed quarry road to the barangay road onwards to the port.

Mining is handled by SiO2 Resources Corporation a subsidiary of Rock Energy International Corporation. SiO2 Resources, handles the sourcing, importation, storage and provide land transport to achieve an on-time delivery of high-grade silica sand to several plants of its valued customers.

This supply chain agreement with several manufacturing plants has been on-going for the past 14 years.

No storage is required in the quarry operation since hauled materials are directly loaded into the trucks for transport to the temporary storage area outside the MPSA prior to its loading into the barge. The temporary storage area or stock pile area outside the MPSA is located at the Calagcalag pier, in Calagcalag, Ayungon, Negros Oriental. The location is about 13 kilometers away from the quarry site. The property is owned by Silica Resources, who owns the pier.

The figure below depicts the operation process of the silica mining.

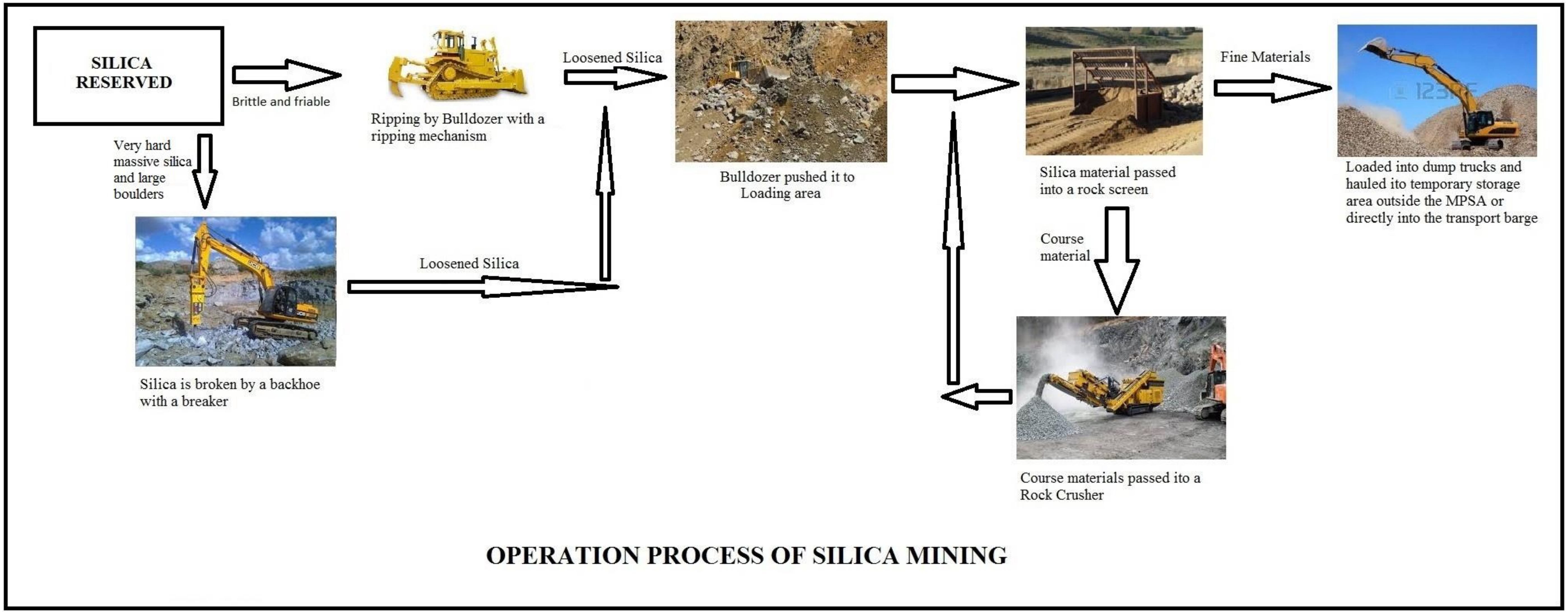

Figure 0-1. Operation Process of Silica Mining

Consequences of not Proceeding with the Project

Since mining of silica for the cement industry is one of the most important industries in the country's nation building program, shortage of its supply may significantly affect the production of cement produced in the country. Without cement, vertical and horizontal infrastructure and superstructure would not be possible. Without the project, the local consumers will still import silica or cement from other countries.

Furthermore, the project has provided considerable contributions to the benefit of the community such as improved road conditions, electrification/street lights, development of water facilities, medical missions, improved barangay facilities and livelihood options. These social development projects have impacted so much on the lives of the residents such as improved grades of students, as a result of providing electrifical connection to households and for street lighting. In addition, the safety and smooth travel to schools and workplaces due to better road conditions had been achieved. Furthermore, as a consequence of the implemented social development projects from the Social Development and Management Program (SDMP) funds, some livelihood alternatives have been undertaken which added to the income of the households and increased the money in circulation in the community. When there is more money in circulation, local economic activities/enterprises will become more stable which will consequently create a positive impact on the community.

In addition, local government revenues in terms of excise taxes and occupational fees were paid by the company during the years of its operation. In 2017 alone, the company gave their share of P626,277.59 in excise tax and P37,950 in occupational fees for a total of P664,227.59. The company disbursed in 2018, a total of P1,430,712.94 for excise tax alone. Thus, if the project does not push through, sustaining and improving on the various contributions contingent to the project will be foregone.

Since this is just an extension of the current extraction area, pollution (carbon) footprint will not be an environmental issue as the same equipment power capacity and number are the same. Proper regimen of equipment maintenance should be properly observed.

Summary of Baseline Characterization

The summary of baseline characterization is presented below.

Table 0-7. Baseline Characterization Summary

Module	Baseline Characterization
Land	
Land Use and Classification	The project area is situated in Barangay Maaslum of the Municipality of Ayungon, Province of Negros Oriental. The project is covered by MPSA No. 218-2005-VII under the name of the Heirs of Arturo Zayco (HAZ). The project area is situated within quarry/ mineral land area.
Geology and Soils	The project area is part of the delineated epithermal region with mostly andesite rocks of Middle Miocene age and consists of hydrothermally altered rocks. The Ayungon silicified rocks is part of this epithermal system and interpreted to be part of the silica cap of the system in the outflow zone of the system.

Module	Baseline Characterization
Terrestrial Flora and Fauna	There are three (3) distinct types of vegetation communities within the project site and its vicinities: shrubland, coconut area surveyed is primarily covered with druit trees and shrubs. There are 58 morpho-species of plants recorded belonging to 31 families of plants during the dry season and 62 morpho-species belonging to 34 families during the wet season. There are 31 wildlife species composed of two (2) amphibians, four (4) reptiles, 24 birds and one (1) mammal species recorded during the dry season. For the wet season, there were a total of 25 wildlife vertebrate species belonging to 19 families representing the classes Amphibia, Reptilia, Aves and Mammalia that were recorded.
Water	
Hydrology and Hydrogeology	The project area is part of the Maaslum watershed. This watershed has a total area of about 2,310 has. The tributary flows to the Maaslum River towards Ayungon Bay. Rivers in the upstream are perennial in nature and generally clear all throughout the year. Drainage pattern is generally coarse dendritic.
Oceanography	The Tanon Strait, the largest protected seascape in the Philippines is located about eight (8) km east of the quarry site. The distance from the project site to the ocean is estimated at 8 km would not have much impact on the oceanic ecosystem.
Water Quality	The temperature, DO, BOD are within the water quality guideline value of DAO 2016-08 criteria for Class C waters. Among the elemental parameters tested, Ca, Fe, Mg and Na were found to be present but are within the acceptable limits. The fecal and total coliform and E. Coli conformed to the DAO 2016-08 during the dry season but did not conform during the wet season. This could be due to the flushing of contaminants from the community upstream. The concentration of Cr+6 during the dry season slightly exceeded the threshold set but lowered during the wet season. This could be triggered by the acidic conditions of the water which oxidizes the natural soil into a hexavalent form and/ or can be attributed to the existing quarrying operation in the upstream. The water is acidic and does not conform to the guideline. This could be due to the presence of natural sulfur vent upstream of the station and can be correlated to the concentration level of sulfate during both sampling seasons.
Freshwater Ecology	A sampling on plankton, phytoplankton, zooplankton, periphyton and macrobenthos and fisheries resource use profiling were done in wet and dry season. A total of 33 plankton taxa belonging to six (6) major groups; 4 major periphyton with 17 genera, 18 macroinvertebrate taxa belonging to 10 orders and presence of species of fish (Tilapia, Salimao, Alimgao, Ulang, Carpa, Biya, Pantat, Igat. Kasili) in Stations 4 and 5.
Air	
Meteorology	There is a high volume of rain in the months of June, July and October and dry season in the months of January, February and March. The project site is located in a low hit typhoon area.
Ambient Air Quality	Four (4) designated sampling stations were assessed with TSP, PM10, PM2.5, SO2, NO2, CO and total VOCs. All are in compliant with the DENR NAAQS and DENR NAAQGV, for both wet and dry season and 1-hour and 24-hour ambient air.
Ambient Noise	Based on the results of the ambient noise level monitoring, the project has no significant effect on the noise levels that may adversely affect the nearby communities.
People/ Community	
	The three (3) directly affected barangays are Maaslum, Gomentoc and Tampocon 1 with a population of 1,721, 2,159 and 2,061, respectively. The project area has no households and structures.

2. Summary of Main Impacts and Residual Effects after Applying Mitigation

A review of the quarterly CMVRs for the first two (2) quarters of 2016-2017 showed that the quarry is compliant with the conditions of ECC 701-08-23-0135303 issued on August 23, 2001. The reports show that the approved measures to mitigate identified project impacts have been appropriately implemented. The major project impacts and their residual effects after application of mitigation enhancement measure is shown in Table 0-8 below.

Table 0-8. Matrix of Major Impact, Mitigation/ Enhancement Measures and Residual Effects

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
1. Site Preparation, Establishment of Haul Roads, Topsoil Stockpiling			
a. Land	• Loss of topsoil due to ground/site preparation activities • Induced landslides and mass wasting due to preparation activities on high angle slopes.	• Mix the stockpiled topsoil layer with limestone gravel and re-spread in disturbed areas/quarried out areas to prevent erosion and allow reestablishment of vegetation • Conserve and stockpile removed topsoil in a predetermined area to be used later in rehabilitation and backfilling activities • Grade the topsoil stockpile to a stable relief on flat ground lined out with retaining rocks to prevent it eroding out when it rains. • Continue to implement established safe working slopes. A slope angle of 40 degrees is the safe working slope for the project. This was the minimum stable slope angle from the Engineering Geologic Investigation of Ayungon Silica Quarry by Cabria et. al. in 2012.	• Possible rockslides and rockfall may occur during intense rainfall and or during earthquake. • Possible landslide and mass wasting during intense rainfall and or during earthquake.
b. Flora and Fauna	• Reduction of vegetative cover; fauna disturbance and/or displacement	• To enhance nearby riparian ecosystems, enrichment planting can be employed using water loving plants in a sparse section of the riparian. Combination of indicator species in the area to include vine, shrub, forbs, and trees, among others can be the choice plants. • Replant the surrounding area after construction, preferably with indigenous plants from the site • Keep to a minimum vegetation removal, ensuring that only necessary/planned clearings are undertaken • Replace with the same species, preferably with nursery-raised seedlings, tree and other plant species that are removed during site preparation • Utilize felled trees as construction materials at the site; cleared vegetation parts as compost materials to fertilize seedlings in the nursery and during seedling out planting and field maintenance. • Establish voluntary conservation zones and biological corridors within the Project area	• Possible loss of biodiversity
c. Groundwater Flow	• Inflow of groundwater to excavated areas could result to drawdown in ground water levels • Reduction in the spring discharge and ground water baseflow components of the streamflow of nearby water catchments • Depletion of ground water flow which affects to the distribution and availability of surface flow • Affect its potential use as a drinking water or irrigation source.	• Replace and relocate downstream affected existing ground water wells with new ones if significant loss of water yield is experienced • Provision of shallow ground water wells when necessary	• Possible reduction in groundwater flow due to earthquake.
d. Groundwater Quality	• Contamination with biological agents (e.g. fecal coliforms) from domestic and animal wastes carried by runoffs • Contamination with oil and grease from hydrocarbon leaks and spills from vehicles and heavy equipment, fuel and oil storage	• Provide access roads with drainage system to contain and limit run offs • Progressive rehabilitation and revegetation of mined out quarries and planting barren lots to prevent soil erosion • Proper management of domestic solid and liquid wastes (provision of enough toilets with appropriate septic tanks for workers); • Training for workers good housekeeping practices; • Motorpool, fuel and oil storage and maintenance areas are provided with impervious surface and well-maintained oil-water separator facility.	• Possible contamination from oil and grease from vehicles and domestic wage by runoffs during heavy rainfall and or occurrence of earthquake.
e. Surface Water Quality	• Siltation and organic loading of streams from erosion of exposed soil and overburden materials;	• Continue to implement sediment and erosion control plan • Regular maintenance of drainage systems along access roads to contain and limit downstream runoffs from quarries and roads	• Possible siltation that may occur during heavy rainfall and/ or occurrence of earthquake

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
	• Contamination with oil and grease from hydrocarbon leaks, spills from vehicles and heavy equipment • Increased susceptibility to contaminated water and water borne diseases • Decrease water quality due to washing of equipment and leakage and spills from carried by runoff to the water resources. • Acceleration of the aging process of surface water ecosystem which can lead to an imbalance in the nutrient and material cycling process.	• Proper piling and management of quarry overburden; • Continue to implement progressive rehabilitation and reforestation of mined out areas to lessen the impacts of soil erosion; revegetate exposed plots and areas • Strict implementation of sanitary practices among workers; provision of adequate toilet facilities with proper septic tanks; • Continue to implement proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal); • Continue to train and orient all workers on proper waste management, good housekeeping, and proper chemical handling • Regular monitoring of water quality in water quality monitoring stations; • Proper storage provisions for fuel oil, used oil and other oily wastes; provide fuel oil storage tanks with appropriate bunding with concrete/impervious flooring • Motorpool, fuel and oil storage and maintenance areas are provided with oil and water separator facility. • Regular water testing	
f. Air Quality	• Air pollution due to fugitive dust from ground clearing operations.	• A buffer zone of different species combination of plants including shrubs, small and medium sized trees should be established around the quarry sites. At least 20-meter buffer zone width is recommended. High density planting should be employed to assure capture of dust particulates around the extraction sites. • Regular water spraying in areas where land development activities are concentrated • Replacement of vegetation in non-structure areas. • Compact exposed soil • Cover with tarpaulin trucks loaded with construction materials, which may give off airborne dusts • Immediate hauling of spoils and wastes • Strictly implement vehicle speed limits • Install off-site ambient air quality monitors	• Possible air pollution that may come from other sources such as industries operating around the area.
	• Air pollution due to SOx, NOx, TSP and PM10 emissions from heavy equipment and vehicles	• Regular maintenance of heavy equipment and motor vehicles • Install off-site ambient air quality monitors	• Possible air pollution that may come from other sources such as industries operating around the area.
g. Sound Levels	• Noise from construction activities	• Regular maintenance of motor vehicle mufflers • Provide noisy, stationary vibrating equipment with barriers and shielding • Provide workers with free hearing PPE's (e.g. ear mufflers, ear plugs) • Schedule "noisy" activities during daytime	• None. The quarry site is situated far from the nearest inhabited community.
h. People/ Community	<u>Psycho-social</u> • Fear of air and noise pollution due to quarrying activities • Fear of landslides and flooding due to quarrying activities	• IEC on the nature and operation of the quarry project and mitigating measures • Orientation and training of affected residents on Disaster Risk Reduction Management, particularly on landslides and flooding	• Possible complaints coming from the people/ community on landslides and flooding that may occur during heavy rainfull or earthquake.
	<u>Economic</u> • Generation of employment • Generation of livelihood opportunities	• Local hiring priority for qualified barangay residents (LGU R.A. 7160) • Barangay consultation on job requirements and qualification • Training to upgrade skills of residents who can be hired by the Project	• None
	<u>Health and Safety</u> • Entry of migrant workers with families may result to health problems due to diseases; overuse of public utilities/services;	• Health certificate for workers prior to hiring into the project • Partner with the LGU on the implementation of the Social Development Program • Management of entry of migrant workers	• None

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
	competition for resources; social conflicts; peace and order; increase in pollution • Increase in traffic volume causing air and noise pollution	• Increase and train Barangay tanods to be deployed in areas where migrant workers reside • Implementation of a Traffic Management Plan • IEC on proper scheduling of quarry vehicle operations (avoid late hours) • Water sprinkling of dusty roads during dry seasons	
	Peace and Order • Population congestion, peace and order problems and security breaches	• Coordination with the Barangay LGU to control of the entry of outsiders and to manage peace and order problems	• None
	Cultural and Historical • Possible unearthing of historical artifacts and/or fossil remains	• Safeguard possible archaeological site and immediately inform the National Museum in case of finds	• None
2. Quarrying Operations			
a. Land	• Landslides and mass wasting maybe induced by activities at high angle slopes	• Grade stockpile to a stable relief • Implement established safe working slopes • Install landslide control structures	• Possible rockslides and rockfall may occur during intense rainfall and or during earthquake. • Possible landslide and mass wasting during intense rainfall and or during earthquake.
	Flooding Potential • Potential for downstream flooding	• Flood management schemes • Rainwater reservoir constructed and maintained according to design by a structural engineer, taking into account peak flood regimes	• Possible landslide and mass wasting during intense rainfall and or during earthquake.
	• Contamination of soil from diesel, motorpool	• Continue to implement procedures for proper handling, storage, disposal and transport of hazardous materials (e.g. diesel, motor oil, used batteries, used oil, etc.); • Continue use and maintenance of pollution control devices; • Continue training of all involved personnel and contractors; and • Continue to implement emergency containment and clean-up program to handle oil and other hazardous material spills.	• Possible contamination from vehicle runoffs during heavy rainfall and or occurrence of earthquake.
b.1 Surface Hydrology and Hydrogeology	• Siltation from increased erosion, surface runoff and down slope sedimentation • Decline in river carrying capacity due to siltation • Lowering of groundwater table	• Properly installed and maintained erosion/ sedimentation controls: • Rainwater and runoff collecting systems at the toe of work areas; • "Vengineering" (i.e. planting of vegetation with high rainfall intercepting capacity and high transpiration rates); • Drainage systems in access roads; • Strengthened water monitoring system (i.e. install water meters at source points; keeping a daily record of water extraction and consumption). • Development of rainwater impoundment facilities in abandoned quarry areas	• Possible siltation that may occur during heavy rainfall and/ or occurrence of earthquake
b.2 Groundwater Quality	• Contamination with biological agents (e.g. fecal coliforms) from domestic and animal wastes carried by runoffs • Contamination with oil and grease from hydrocarbon leaks and spills	• Provide access roads with drainage system to contain and limit run offs • Progressive rehabilitation and revegetation of mined out quarries and planting barren lots to prevent soil erosion • Proper management of domestic solid and liquid wastes (provision of enough toilets with appropriate septic tanks for workers); • Training for workers good housekeeping practices; • Motorpool, fuel and oil storage and maintenance areas are provided with impervious surface and well-maintained oil-water separator facility.	• Possible contamination from oil and grease from vehicles and domestic waste by runoffs during heavy rainfall and or occurrence of earthquake.
b.3. Surface Water Quality	• Siltation and organic loading of streams from erosion of exposed soil and overburden materials; • Contamination with oil and grease from hydrocarbon leaks, spills from vehicles, heavy equipment, fuel and oil storage, motorpoo	• Continue to implement sediment and erosion control plan • Regular maintenance of drainage systems along access roads to contain and limit downstream runoffs from quarries and roads • Proper piling and management of quarry overburden; • Continue to implement progressive rehabilitation and reforestation of mined out areas to lessen the impacts of soil erosion; revegetate exposed plots and areas	• Possible siltation that may occur during heavy rainfall and/ or occurrence of earthquake

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
	• Increased susceptibility to contaminated water and water borne diseases • Decrease water quality due to washing of equipment and leakage and spills from carried by runoff to the water resources. • Acceleration of the aging process of surface water ecosystem which can lead to an imbalance in the nutrient and material cycling process.	• Strict implementation of sanitary practices among workers; provision of adequate toilet facilities with proper septic tanks; • Continue to implement proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal); • Continue to train and orient all workers on proper waste management, good housekeeping, and proper chemical handling • Regular monitoring of water quality in water quality monitoring stations; • Proper storage provisions for fuel oil, used oil and other oily wastes; provide fuel oil storage tanks with appropriate bunding with concrete/impervious flooring • Motorpool, fuel and oil storage and maintenance areas are provided with oil and water separator facility. • Regular water testing	
c. Ambient Air Quality	• Fugitive particulate pollution	• Proper operation and maintenance of appropriate air pollution control devices in heavy equipment and vehicles • Provide adequate and appropriate PPEs for workers free of charge • Water spraying of exposed dusty areas during high winds • Optimize active extraction areas at the quarry • Control options for stockpile wind erosion – 50% reduction from water sprays – 30% reduction from wind breaks and rock armor • 40% reduction from vegetation (exposed surfaces)	• Possible air pollution that may come from other sources such as industries operating around the area.
	• Fugitive particulate pollution from quarry haul roads	• Vehicle restrictions that limit the speed, weight or number of vehicles on the road. • Surface improvement by (a) paving or (b) adding gravel or other surfacing materials • Surface treatment such as water sprinkling	• Possible air pollution that may come from other sources such as industries operating around the area.
	• Air pollution in terms of SOx, NOx, TSP and PM10 from heavy quarry equipment and motor vehicles	• Continue to implement appropriate maintenance program for quarry equipment and vehicles, including emissions testing	• Possible air pollution that may come from other sources such as industries operating around the area.
	• Very minimal contribution to climate change due to CO_2 gas emissions from fuel combustion in quarry equipment and motor vehicles	• Continue implementation of greening program and reforestation to serve as carbon sink, primarily to help offset the impact of greenhouse gas emissions from the operations of vehicle	• None
d. Ambient Sound Levels	• Generation of noise from quarrying equipment and activities	• Incorporate noise criteria in the specifications and selection of equipment • Regularly maintain quarry vehicles and equipment; • Provide free hearing PPE's (ear plugs, mufflers) to workers as appropriate; and • Plant appropriate vegetation as noise buffer	• None
e. People/ Community	• Safety and health risks to workers from domestic solid and liquid wastes (from guard post)	• Continue to implement procedures for proper handling, storage, disposal and transport of hazardous materials • Continue to provide appropriate free PPE's • Continue to implement proper housekeeping • Continue to implement established domestic waste handling and disposal; • Continue to provide workers with enough and well-maintained sanitary facilities (toilets, washrooms, etc.); • Segregate, collect and dispose combustible materials (e.g. plastics) through the recovery facility	• Possible contamination from oil and grease from vehicles and domestic wage by runoffs during heavy rainfall and or occurrence of earthquake.
	Economic • Local government generation of revenues from taxes, permits and	• Benefits from development programs through Social Development Management Plan (equivalent to 1.5% of operating costs)	• None

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
	LGU share in the quarrying of limestone • Taxes paid locally and shared by municipality and barangays • Generation of employment • Generation of livelihood opportunities (e.g. food stalls, variety stores and other services) • Problems of congestion, peace and order and security breaches	• Excise Tax: 60% goes to national government; 40%, to the local government (20% for host Provinces; 45% for host Municipalities; 35% for host Barangays) • Real Property Tax to province and municipalities • IEC on nature of jobs the proponents • Coordination on job requirements and qualifications • Local hiring priority for qualified barangay residents • Skills training to upgrade local skills of residents • Coordination with the Barangay LGU to ensure authorized establishments and control of unauthorized entry of outsiders as well as the management of waste	
	Health & Safety • Diseases due to influx of migrants and overuse of public utilities /services; • Increased competition for resources, • social conflicts, peace and order problems, • increase in solid and liquid wastes pollution • Increase in traffic volume causing air and noise pollution	• Management of entry of migrant workers. • Tap the auxiliary services of barangay tanods; provide trainings if needed • Provide health clinic with a doctor/nurse and health workers in the quarry area. Alternatively, coordinate jointly with the health facility of HRDC • Health certificate for workers prior to hiring into the project. • Continue to partner with the LGU in implementing the Social Development and Mgt. Program • IEC on proper scheduling of quarry vehicle and delivery trucks operations (avoid late hours). • Proper management of traffic (quarry vehicles, delivery trucks and visitors) within the quarry area • Water spraying of roads during dry seasons	• None
	Climate Change • Impact of Climate Change: La Niña and El Niño phenomena and possible consequential disasters	• Assist impact barangays on gender sensitive capability building on Disaster Risk Reduction and Management; • Continue IEC on the project's mitigating measures to protect water aquifers; identification of areas most vulnerable to natural hazards; and on strengthening the protection of ecosystems	• None
3. Decommissioning of Equipment, Rehabilitation of Disturbed Areas, Dismantling of Structures			
a. Land Use/ Topography	• Permanent land use change in areas occupied by the quarry and its facilities	• Rehabilitate quarry areas based on agreed upon final land use plan and design upon abandonment; • Ensure that the final perimeter and cover of the quarry area will have an undulating profile to facilitate drainage and future land use	• Possible landslide and mass wasting during intense rainfall and or during earthquake.
b. Water	• Failure of rainwater reservoirs • Flooding of areas downstream of the quarry	• Monitor structural integrity of the reservoirs for the duration of operation and beyond project closure; • Develop an Emergency Response Plan to handle possible water reservoir failure accidents. • Identify vulnerable areas and possible scenarios of flooding and the necessary preventive measures	• Possible flooding during intense rainfall.
c. Land	• Generation of solid wastes and hazardous wastes	• Sell recyclable materials; • Dispose residual wastes to municipal garbage collectors; dispose hazardous waste through accredited treaters; segregate and dispose combustible materials and plastics	• None
d. Ambient Air Quality	• Air pollution due to fugitive dust	• Regular water spraying in areas where dismantling activities are concentrated • Replacement of vegetation in non-structure areas. • Compact exposed soil • Cover with tarpaulin trucks loaded with debris • Impose vehicle speed restrictions	• Possible air pollution that may come from other sources such as industries operating around the area.

Environmental Aspect/ Component Likely to be Affected	Potential Impacts	Prevention or Mitigation or Enhancement	Residual Effects
e. People/ Community	• Loss of LGU revenues from proponent's taxes, permits and share when mining operations ceases	• Timely announcement and preparation of decommissioning/ abandonment	• None
	• Cumulative health impacts on the community brought about by air pollution and contaminated water	• Conduct barangay-wide medical check-up and compare results during the construction phase and before decommissioning	• None

3. Risks and Uncertainties Relating to the Findings and Implications for Decision Making

There are no safety risk types for fire, explosion or release of toxic substances in the quarrying activity. The only possible event which could significantly increase soil erosion and sedimentation of water bodies is the occurrence of strong rainfall events. However, since the proponent only stockpiles a weekly inventory, the volume of silica would not cause a significant safety risks.

Accident scenarios in terms of soil erosion and water bodies sedimentation is not a risk since silica stockpiles at the site is limited to a week's inventory. Extreme rainfall events could increase erosion of water bodies. However, due to the limited weekly inventory in the quarry site, the identified physical risk is reduced.

The physical risks in a silica quarry is also considered minimal due to the relatively safer mine techniques employed by the proponent.

The National Institute for Occupational Safety and Health in the US has identified silica to be more toxic than coal. Fresh fractured silica has also been determined as more toxic than aged silica. Long term exposure could also lead to silicosis and air passage diseases. Considering that the most affected are the heavy equipment operators who mine this mineral, the use of respiratory protective equipment (RPE) is recommended. Regular monitoring of Particulate Matter for PM10 and PM2.5 is recommended.

The safety policy guidelines shall be done for Respirable Crystalline Silica (RCS) to include institutionalized work health and safety guidelines which will be formulated by a specialist health worker which shall also include emergency preparedness and an SMDS.

Considering the small quantity of mined silica, emergency response drills have not been conducted. However, several health and management personnel have attended health and safety seminars where the use of appropriate PPEs was emphasized to employees.

The hazards to the equipment operator would be geological defects in the quarry area which could cause subsidence or sheet erosion. However, such occurrences could be classified as highly unlikely.

Inducement of Subsidence, Liquefaction, Landslides, Mud Debris Flow, etc.

Subsidence

Subsidence is the sinking or settling of the ground surface. This can be caused by natural phenomena such as removal of underground fluids, natural consolidation, or dissolution of underground minerals, or by man-made phenomena such as underground mining. Subsidence may occur gradually over many years as sags or depressions form on the ground surface. It's more infrequent, but subsidence can occur abruptly-virtually instantly-as dangerous ground openings that could swallow any part of a structure that happen to lie at that location or leave a dangerous steep-sided hole (ground subsidence). The geology at the project site is of solid rock formation that no subsidence is expected to occur in the area.

Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world.

Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

No liquefaction will occur in the project site because of the nature of its geology. The area is made up of solid volcanic rocks and due to its hydrothermal alteration, it does not develop a thick soil profile.

Landslides

The project area and its immediate vicinities are characterized by rugged topography. This rugged volcanic terrain consists of prominent ridges, gullies, steep-sided valleys and plateau. The Mines and Geosciences Bureau has mapped the area as highly susceptible to landslides. Landslides and rock fall would occur on the face of the quarry site especially during extreme heavy rainfall. In order to mitigate the worst possible effect, best-practice mining techniques will be adopted by the proponent to mitigate landslides and rock fall In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope. The benches and haulage road would serve as buffer zones to the landslides and rock fall.

Safety practices would be implemented to prevent damage to lives and properties one of which is to stay away from the quarry face and stop operation during extreme weather conditions.

Mudflow

No mud flow will occur in the project site because of the nature of its geology in which the area is made up of solid volcanic rocks which is due to its alteration does not develop a thick soil profile and or mud.

Ways to protect the slope and mine-affected zones from water-induced erosion will be the creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

1. Project Description

The silica quarry of the Heirs of Arturo Zayco (HAZ) under Mineral Production Sharing Agreement (MPSA) No. 218-2005-VII, dated October 5, 2005, was granted under the name of the Heirs of Arturo Zayco (HAZ), covering an aggregate area of 505.4626 hectares in Ayungon, Negros Oriental. Out of the total 505.4626 hectares under the said MPSA, 10 has is currently being mined for silica. This 10 has of silica quarry area is covered by Environmental Clearance Certificate 070108-230135303-A. The request for ECC modification is based on the proposed expansion of silica quarry mining area from 10 hectares to 50 hectares within the MPSA and the corresponding increase in the volume of extraction.

A. Project Location and Area

The project area is situated in Barangay Maaslum of the Municipality of Ayungon, Province of Negros Oriental. The project area is under MPSA No. 218-205-VII covering an area of 505.4626 hectares to Arturo Zayco. Figure 1-1 shows the location of the project. Meanwhile, Table 1-1 shows the geographic coordinates of MPSA No. 218-2005-VII and Figure 1-2 shows the plotted geographic coordinates.

Table 1-1. Geographic Coordinates of MPSA No. 218-205-VII

Points	Geographic Coordinates	
	Latitude	Longitude
1	9°52’00.00” N	123°05’00.00” E
2	9°51’00.00” N	123°05’00.00” E
3	9°51’00.00” N	123°04’30.00” E
4	9°50’30.00” N	123°04’30.00” E
5	9°50’30.00” N	123°04’00.00” E
6	9°51’00.00” N	123°04’00.00” E
7	9°51’00.00” N	123°03’30.00” E
8	9°51’30.00” N	123°03’30.00” E
9	9°51’30.00” N	123°04’00.00” E
10	9°52’00.00” N	123°04’00.00” E

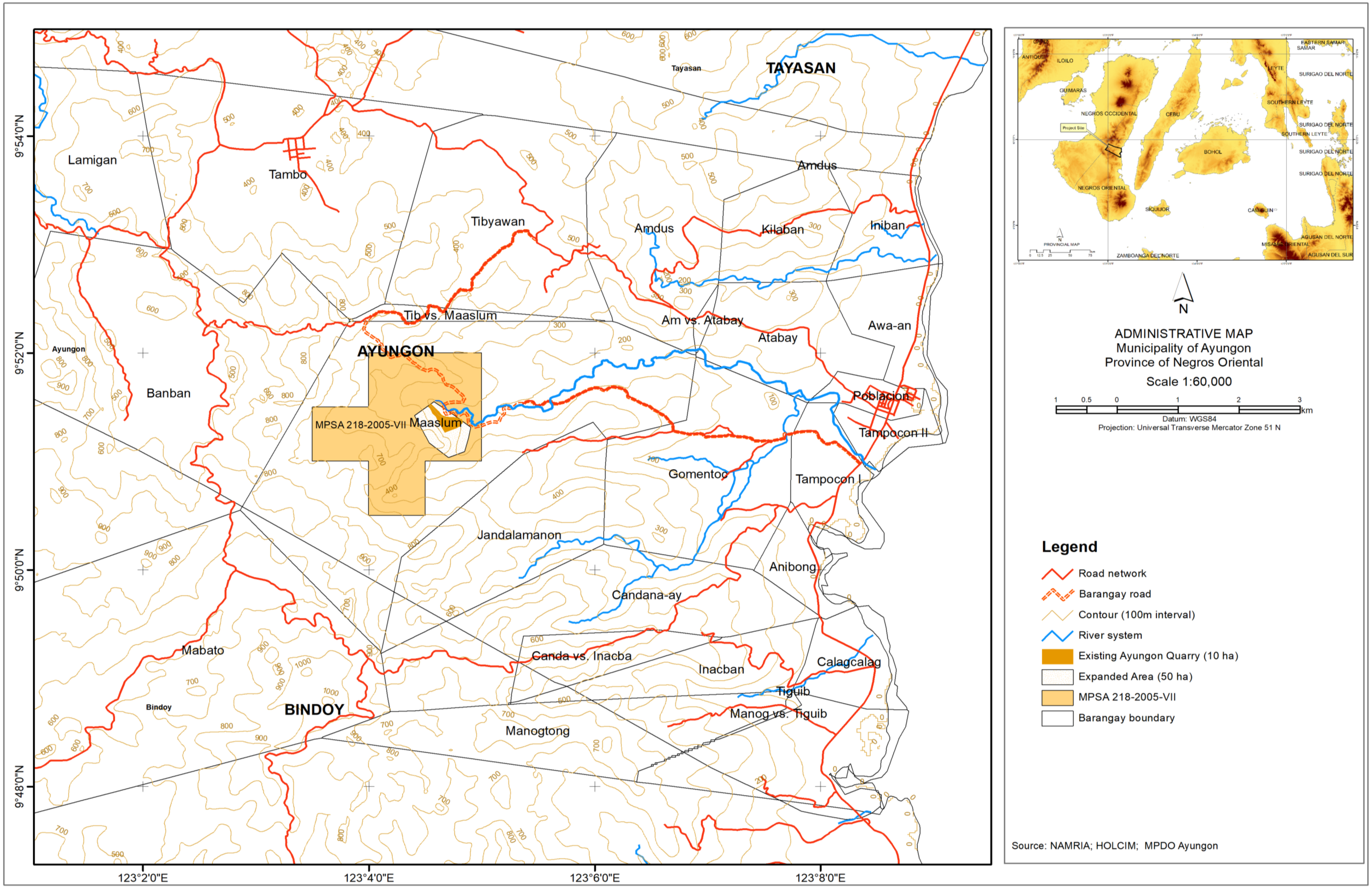

Figure 1-1. Location Map of the Project *(Source: NAMRIA, HOLCIM, MPDO Ayungon)*

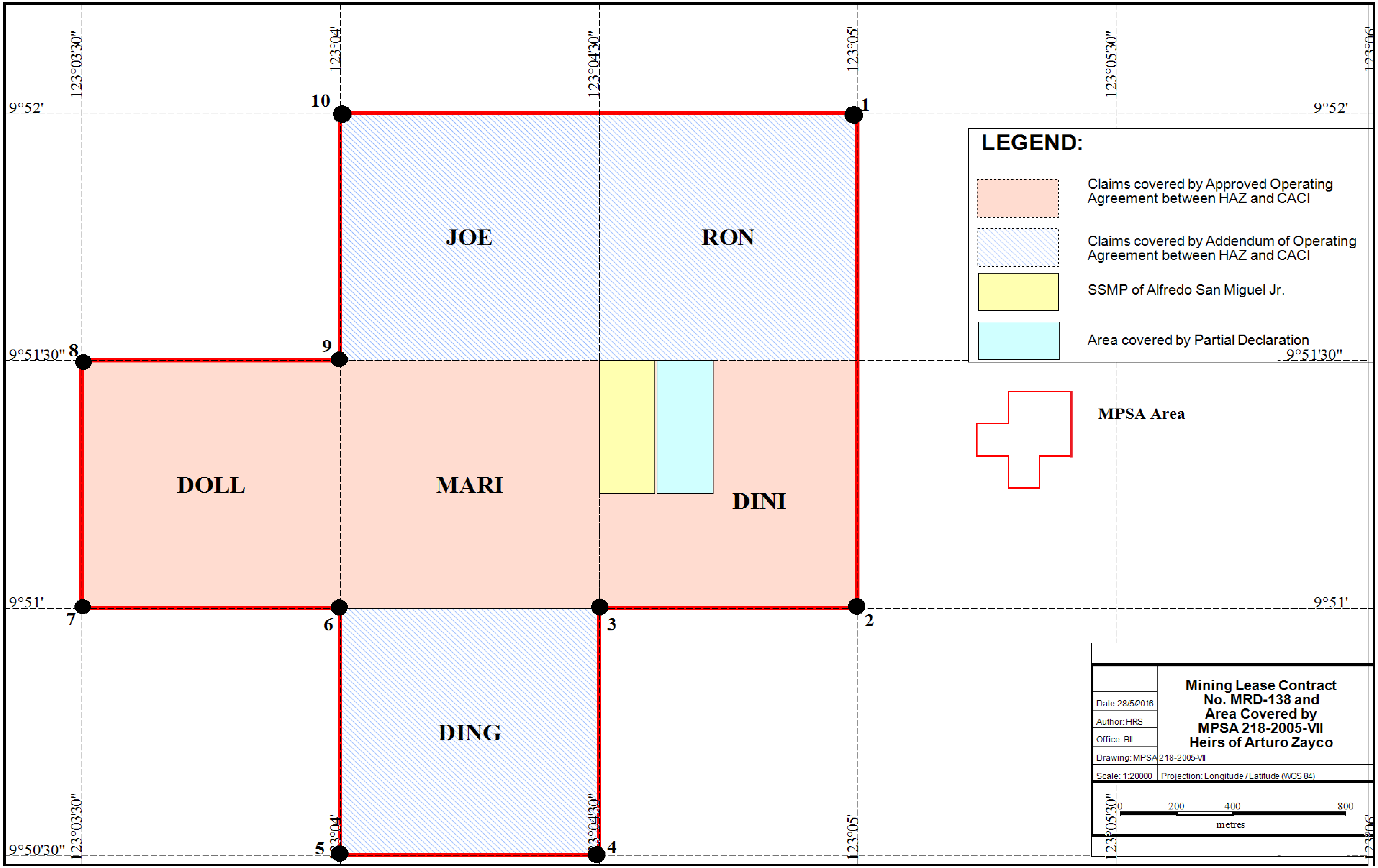

Figure 1-2. Plotted Map of the Geographic Coordinates of the Project *(Source: HRDC, 2016)*

1. Vicinity and Accessibility

The Municipality of Ayungon can be accessed from Dumaguete City, the provincial capital of Negros Oriental via the national highway which straddles the eastern coastline of the island of Negros, passing through the Municipalities of Sibulan, San Jose, Amlan, Tanjay City, Bais City, Manjuyod and Bindoy. Travel time via private vehicles is approximately 1.5-2 hours. From the Ayungon proper near Tampocon Bridge, a paved with concreted portions barangay road of about eight (8) kilometers leads to the project area. Within the project area itself, travel is mainly by secondary feeder roads, unpaved foot trails and stream courses. Access to the more remote and difficult portions are achieved mainly by cutting a trail across generally thin to moderate vegetation.

There is no major infrastructure within the MPSA area except for the unpaved eight (8) km barangay road that starts at Ayungon proper and ends in the quarry site. There is also no infrastructure within the quarry site except for a small guard outpost. Residential houses and farmlands are located at northern side of Maaslum River, north of the quarry site. HAZ has no plans of building any major infrastructure in the project area.

North, east and west of the present quarry site are used for agricultural and pastureland while south of the quarry is generally secondary forestland. The MPSA area has been classified by the Municipality of Ayungon as a quarry and mineral deposit area. Figures 1-3 and 1-4, shown below, depict the primary and secondary impact areas of the silica quarry operations and the nearest community relative to the project.

The primary and secondary impact areas of the silica quarry operations correspond also to the host and neighboring communities as defined under the DENR AO No. 2010-21 (Providing for a Consolidated Department of Environment and Natural Resources Administrative Order for the Implementing Rules and Regulations of Republic Act No. 7492, otherwise known as the Philippine Mining Act of 1995). Under the said administrative order, host community is where the mining project is located, where the MPSA is located and where activities are to be undertaken. In this case, Barangay Maaslum is where the MPSA and the mining project is located and Barangays Gomentoc and Tampocon 1 are where the access road traverses going to the mining area. Meanwhile, the Barangays of Jalamandon, Banban, nibong, Poblacion and Tampocon II are the adjacent barangays to the host communities and considered as immediate areas which will be affected by the mining operations.

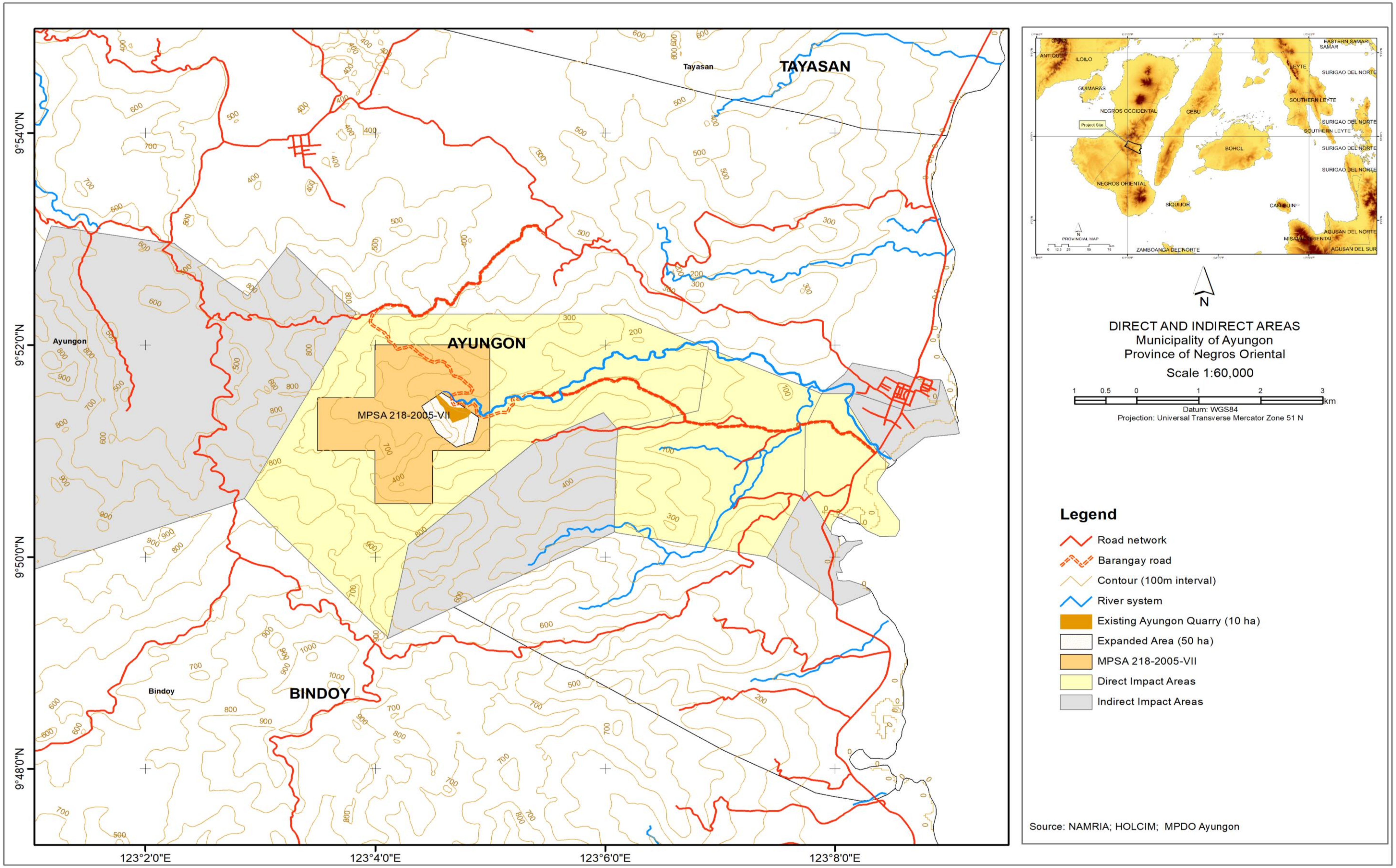

Figure 1-3 Map Showing Direct and Indirect Impact Areas of the Project *(Source: NAMRIA, HOLCIM, MPDO Ayungon)*

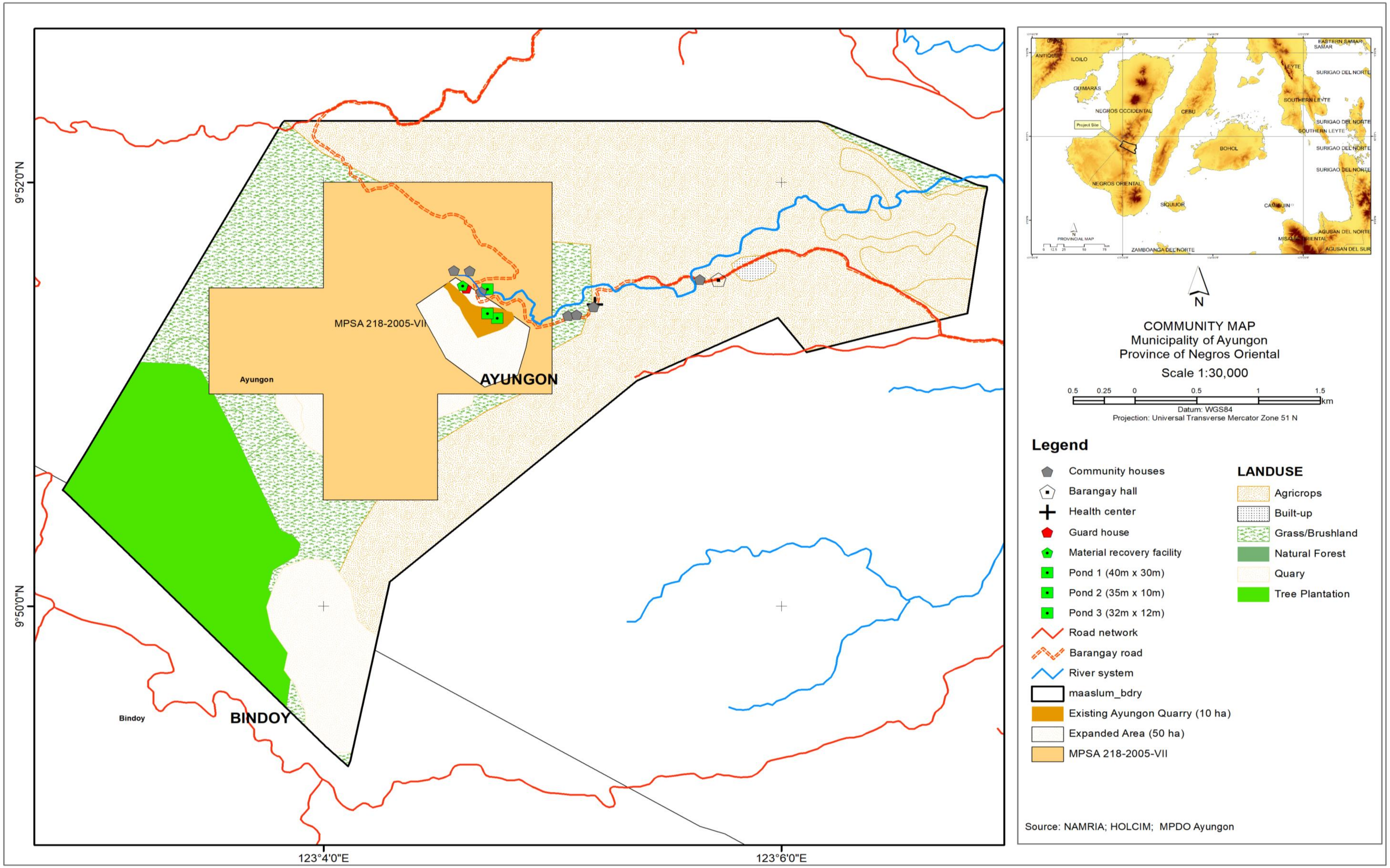

Figure 1-4. Map Showing the Nearest Community to the Project *(Source: NAMRIA, HOLCIM, MPDO Ayungon)*

B. Project Rationale

The mining of silica for the cement industry is one of the most important industries in the country's nation building program. Without cement, vertical and horizontal infrastructure and superstructure would not be possible.

Cement sales increased to 5.2 million tons in the first quarter of 2014, an 8.6% jump from the same period a year ago which is steeper than the 6% annual growth recorded in 2013 when sales totaled 19.4 million tons, according to data from the Cement Manufacturers Association of the Philippines (CEMAP). It is forecasted that the projected increase of cement consumption will be from 5% to 6.7% annually.

The expansion of the silica mining project is due to the increase in the demand of cement products in the Philippines. This impetus is also being espoused by the national government of the Philippines in its Build, Build, Build Program. At the core of the program is the plan to spend 8.4 trillion pesos on dozens of ambitious infrastructure projects all of it requiring cement.

In the words of the President himself "We will make the next few years the golden age of infrastructure in the Philippines to enhance our mobility and connectivity, and thereby spur development growth equitably," President Duterte said in his second State of the Nation Address (SONA) in July. "In other words, we are going to build, build and build."

There is also a large gap in cement local production and demand is expected to lead to a deficit in cement for the next three to four years to 2020. The Department of Trade and Industry (DTI) expects domestic demand for cement to nearly double to 40 million metric tons by 2021 with the government's ambitious infrastructure boost.

The cement industry expects annual demand growth to accelerate to 12% from the 7% to 8% initial growth projection according to DTI Undersecretary Ceferino Rodolfo. To expand local supply, Rodolfo said the Board of Investiment (BOI) is pushing for investments in cement production by including it on the list of preferred activities under the 2017 Investment Priorities Plan (IPP).

Data from the BOI showed that demand for cement in 2016 reached 25.96 million metric tons, 24.37 million metric tons of which were locally produced. Imports reached 1.59 million metric tons.

The silica extracted at the quarry will be used as a raw material for cement manufacturing. Local cement demand is generally dictated by the current local economic situation, by the local construction and infrastructure activity. Accordingly, a robust private construction and government infrastructure stance reflects a strong national economy.

Silica sand has a lot of industrial uses and it is projected that the Ayungon Silica Quarry would also supply silica to other non-cement customers such as for fibre board, metal casting and metal production. The planned revival of the Philippine Steel Industry by the new government would demand silica for its foundry.

Given this general trend, the expansion of the area coverage of the ECC from 10 has to 50 has is sought and the corresponding increase in volume of extraction from 125,316.84 MT per year to 625,000 MT per year. As required under the Philippine Mining Act of 1995 (RA 7942) and DENR Administrative Order No. 2010-21, a Declaration of Mining Project Feasibility (DMPF) has been prepared for the proposed expansion area under MPSA 218-2005-VII, where presence of an economic silica deposit has been determined.

The MPSA 218-2005-VII, dated October 5, 2005, was granted under the name of the Heirs of Arturo Zayco (HAZ), with an aggregate area of 505.4626 hectares in Ayungon, Negros Oriental.

Other than the DMPF, the proposed expansion of the silica quarry also requires the conduct of the environmental impact assessment study that is needed for the issuance of an ECC. Initial field studies have been conducted in 2012, however, this was not completed and application for the ECC did not materialize. Furthermore, reports of the field studies initially conducted need to be reviewed and assessed to determine the completeness of data needed to continue the EIA process.

Implementation of this project will minimize and possibly eliminate in the future the current importation of high-grade silica from Vietnam and the adverse environmental effect of beach silica sand mining in several parts of the Philippines. The Ayungon silica deposits are the largest known inland deposits in the Philippines (Feasibility Study for the Silica Quarrying Project of the Heirs of Arturo Zayco).

Overall, the proposed expansion will help mitigate the demand for cement products that would be sourced locally instead of having to import this material.

C. Project Alternatives

There are no project alternatives considered for this EPRMP as the assessment that was done is for the purpose of securing an ECC for the expansion of silica quarry operation within the MPSA with corresponding increase in production threshold. There will be no change in the location of the site, development design, process/ technology selection and resource utilization.

1. Siting, Development Design, Process/ Technology Selection and Resource Utilization

Since there will be no changes in the siting, development design, process/technology selection and resource utilization, there were no new criteria for the factors were identified. The quarry operation will remain within the bounds of the MPSA and the quarry method being used will be the same.

The determination of options in terms of project site location is determined by the silica deposit and location. The project site has a silica deposit that is so far the biggest silica rock deposit that has been explored in the Philippines. Exploration activity defined a combined indicated and measured silica resource of 104 million tons with an average grade of 78% SiO_2 enough to sustain the cement industry in the country. Cores retrieved from the drill holes during the exploration stage revealed that the silica deposit has varying thicknesses and is dispersed throughout a large portion of the mining tenement constituting MPSA 218-2005-VII. Further, the existing project site is within an area that is already classified as mineral lands based on the local government unit's classification. The project site is relatively far from populated communities and is not within any ancestral domain claim.

The extraction of silica material follows the standard open-cut mining procedure as follows:

- Ripping the material using a bulldozer with ripping mechanism. Backhoe with breaker will be utilized in selected areas where the material is not rippable;
- Pushing the loosened material by bulldozer towards designated loading areas; and
- Loading the material using a backhoe into dump trucks for delivery to the port passing through the developed quarry road and barangay road.

The mining process is purely surface mining which involve a simple process of break and haul with no involvement of processing, no usage of chemicals or no facilities to be sited. The technology is also straightforward as explained in the site development plan. Port facilities are also not included as these are not within the MPSA area or in the project location. The quarry operation will not use any electricity and water given that the mining process involved as discussed in the preceeding section is break and haul method. The mining process is shown in Figure 1-5.

Mining is handled by SiO2 Resources Corporation a subsidiary of Rock Energy International Corporation. SiO2 Resources, handles the sourcing, importation, storage and provide land transport to achieve an on-time delivery of high-grade silica sand to several plants of its valued customers. This supply chain agreement with several manufacturing plants has been on-going for the past 14 years.

No storage is required in the quarry operation since hauled materials are directly loaded oimtp the trucks for transport to the temporary storage area outside the MPSA prior to its loading into the barge. The temporary storage area or stock pile area outside the MPSA is located at the Calagcalag pier, in Calagcalag, Ayungon, Negros Oriental. The location is about 13 kilometers away from the quarry site. The property is owned by Silica Resources, who owns the pier.

There are no issues of supply sustainability and geological hazards, such as flooding, liquefaction, volcanic eruptions and tsunami, storm surge and extreme climatologic conditions. Ground shaking, ground rupture, earthquake induced landslides and rockfall, rain-induced landslide and rockfall under extreme climatological conditions are expected. As shown on the geohazard maps of the area (*refer to Figures2-3, 2-4 and 2-5*). the project site is located on high ground that is not susceptible to flooding and or tsunamis. The area is also underlain by solid rock without much soil development that it is not susceptible to liquefaction. The whole of the area was classified as highly susceptible to landslides and rock fall because of the steep slopes and minimal vegetal cover and soil development. Rockslides and rock fall may occur during intense rainfall and or during earthquake. Negros Island is a volcanic island with active and extinct volcanoes and active geothermal systems. The nearest active volcano is Canlaon volcano located about 90 kilometers to the north and would not affect the area when it erupts.

For expected hazards and risks such as rain and earthquake induced landslides and rockfall, ther proponent has identified various engineering and vegetative measures to provide mitigation for its occurrence.

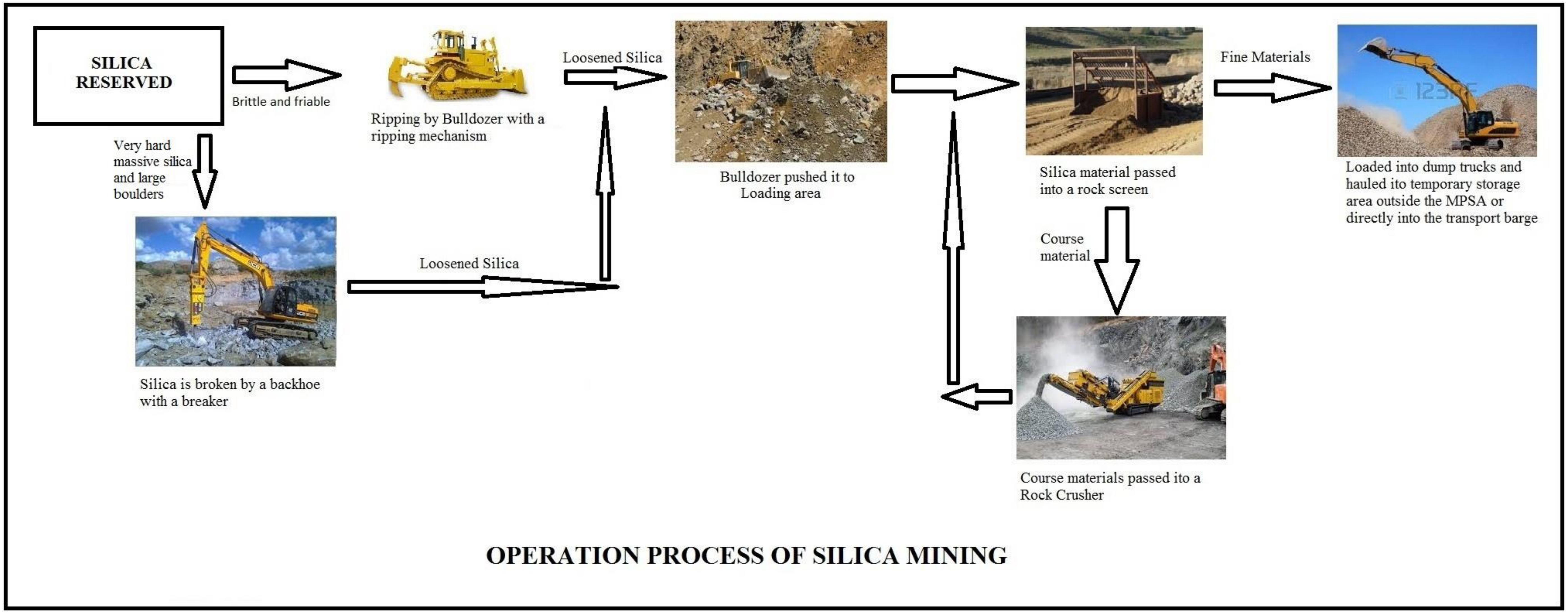

Figure 1-5. Operation Process of Silica Mining *(Source, HRDC 2016)*

2. Comparison of Environmental Impacts of Project Alternatives

As earlier mentioned, there are no project alternatives that were considered by the Proponent for this EPRMP as the request for the issuance of ECC is hinged on the expansion of the silica quarry operations within the MPSA and corresponding increase in production threshold. As such, no comparison was done.

3. Consequences of not Proceeding with the Project

Since mining of silica for the cement industry is one of the most important industries in the country's nation building program, shortage of its supply may significantly affect the production of cement produced in the country. Without cement, vertical and horizontal infrastructure and superstructure would not be possible. Without the project, the local consumers will import silica or cement from other countries.

The project has also provided considerable contributions to the benefit of the community such as improved road conditions, electrification/street lights, development of water facilities, medical missions, improved barangay facilities and livelihood options. These social development projects have significant impact on the lives of the residents such as improved grades of students, as a result of providing electricity connections to households and for street lighting. In addition, the safety and smooth travel to schools and workplaces due to better road conditions had been achieved. Furthermore, as a consequence of the implemented social development projects from the Social Development and Management Program (SDMP) funds, some livelihood alternatives have been undertaken which added to the income of the households and increased the money in circulation in the community. When there is more money in circulation, local economic activities/enterprises will become more stable which will consequently create a positive impact on the community.

The local government revenues in terms of excise taxes and occupational fees were paid by the company during the years of its operation. In 2017 alone, the company gave their share of P626,277.59 in excise tax and P37,950.00 in occupational fees for a total of P664,227.59. The company disbursed in 2018, a total of P1,430,712.94 for excise tax alone. Thus, if the project does not push through, sustaining and improving on the various contributions contingent to the project will be foregone.

Since this is just an expansion of the current extraction area, pollution (carbon) footprint will not be an environmental issue as the equipment, power capacity and number will remain the same. Proper regimen of equipment maintenance should be properly observed.

D. Project Components

1. Major Components

Given the increase in the extraction of silica, there area few additional mobile auxiliary equipment that will be acquired. The quarry equipment listed in Tables 0-1, Table 1-2 and Table 1-3 are needed in the expansion of the quarry area and increasein extraction rate. These quarry equipment are mobile and will not be stationary in the area. The existing quarry operation is limited to ten (10) hectares of the 505.4626 hectares allowed mineable area. Thus, the amendment application only intends to expand the mineable area and increase production threshold as stipulated in the ECC. *(Please see **Annex 3** and **Annex 4** for the copy of Existing ECC and MPSA, respectively.)* The extraction will only consist of non-metallic ore mining.

The operation of the project will only include mining and transport. Aside from the access road and quarry road, there is no major infrastructure planned to be constructed in the project area. Buffer zones will be established and maintained around the whole MPSA area as the proposed 50 has quarry operation expansion is still subject for expansion in the future.

The major components is shown in the table below and Figure 1-8 shows the proposed 50 has quarry mining expansion.

Table 1-2. Summary of Major Project Components

Components	Existing	Proposed
Quarry	Covered by MPSA 218-05-VII: 505.4626 hectares Quarry operation area: 10 hectares	No change Quarry operation area for expansion: 50 hectares
Total Project Area	Within 505.4626 has covering MPSA 218-05-VII: - Allowed operations area: 10 has	No change - Expansion of operations area to 50 has
Maximum allowable extraction rate:	Extraction volume:125,316.84 MTPY silica	Increase in extraction volume: 625,000 MTPY silica
Quarry Equipment	The operation for the entire quarry is contracted out. 1 Bulldozer 2 Excavators 3 Payloaders 20 Dump trucks 1 Road Grader 1 Vibratory Roller 2 Water Trucks 1 Mobile Crusher 1 Fuel Truck 1 Service Truck 1 Service Vehicle 1 Breaker Attachment	The operation for the entire quarry is still to be contracted out. Below are the proposed equipment's for safer and efficient operation; Loading: 1-units Volvo L150H 4.2cum Payloader 2-units Volvo EC300DL 1.76cum Excavator Hauling: 3-units Volvo FMX420 Off Highway Trucks (Quarry) 20 Howo (15 MT) on road Hauling units Auxiliary: 1-unit Rock Breaker Attachment Rammer 3T 2-units Komatsu D155A-6R Bulldozer 2-units MotorGrader 1-unit Vibratory Roller 2 units Isuzu Forward Water Trucks (10,000lts) 1-unit Fuel Truck 1-unit Service Truck 1-unit Service Vehicle

		1 set of Mobile Crusher – 1 Grizzly Feeder for LT106 – 1 Primary Jaw Crusher – Metso LT106 – 1 Secondary Cone Crusher – Metso HP200 – 1 Screening Unit Deck Screen – 1 Radial Stacket – 3 decker Vibrating Screen ST4.8 1 Lube truck Isuzu 6BG1 for mobile crusher/HE 1 Book Truck Isuzu Elf 1 Road Grader SDLG 9190 1-unit Komatsu Eccentric Ripper for ripping hard silica materials 1 Back Hoe Kom PC200 for Xcentic 1 Back Hoe Volvo EC300DL for crusher loading and stockpile maintenance
Extraction Method	Surface Mining- Quarrying	No change
Commodity	Silica	No change
Auxiliary Operations	None. There is no processing of raw silica at the quarry site.	Primary and secondary crushing, screening and washing using the mobile units on site

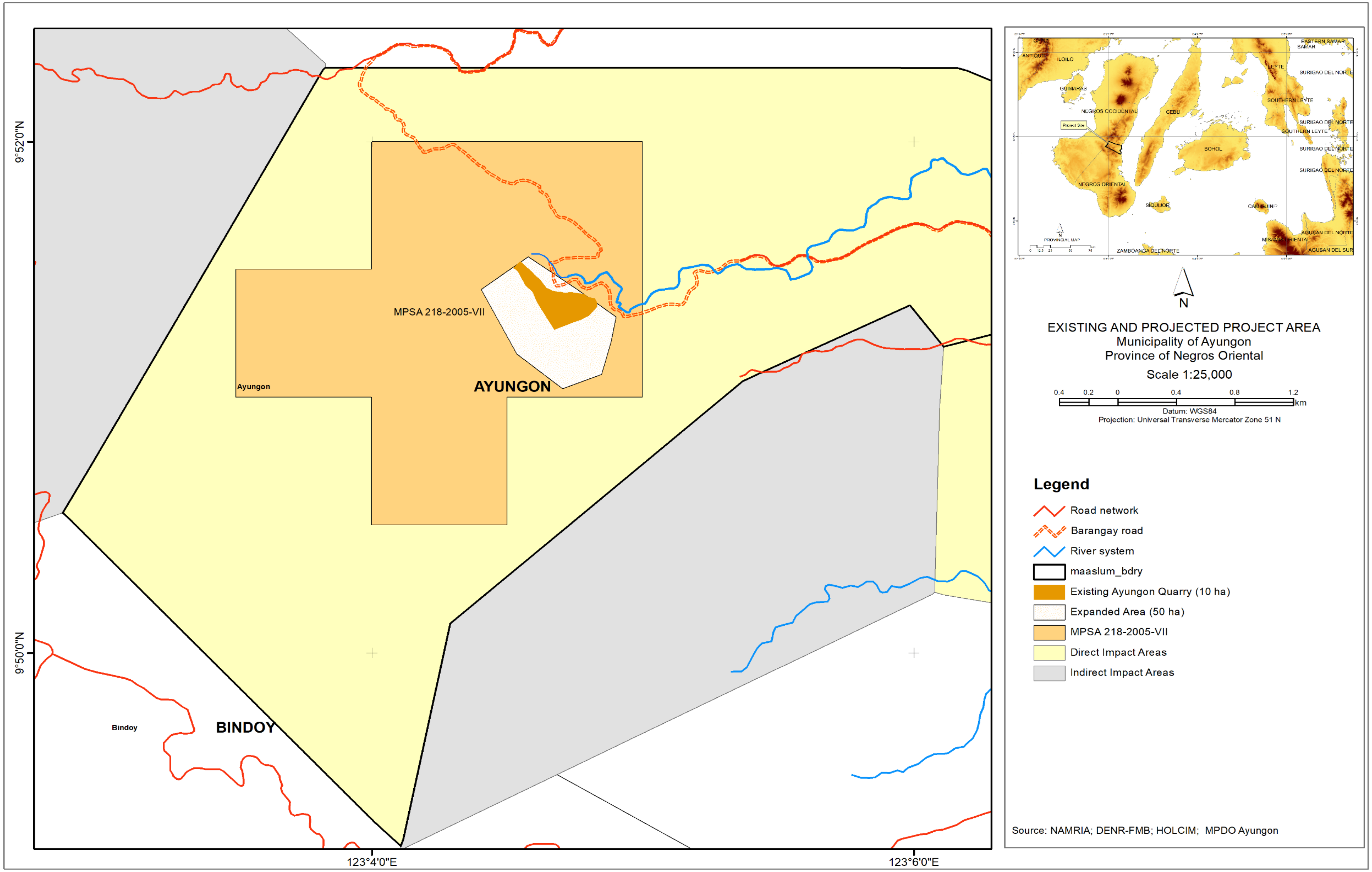

Figure 1-6. Map Showing the Existing Quarry Area and the Proposed 50 has Expansion of Quarry Area *(Source: NAMRIA, HOLCIM, DENR-FMB, BSWM, MPDO Ayungon)*

2. Silica Quarry

The silica quarry project site is situated in Barangay Maaslum in the Municipality of Ayungon, Province of Negros Oriental and is within the MPSA 218-205-VII issued to the proponent, the Heirs of Arturo Zayco. The existing quarry operations is limited to 10 has of the total MPSA area of 505.4626 has. Silica extraction in Ayungon, Negros Oriental started in 1979 within the leased mining claim of Arturo Zayco. Maria Cristina Chemicals, Inc (MCCI) entered into an operating agreement with Arturo Zayco in 1979 to operate a silica quarry under Mining Lease Contract MRD 138V VII which is now MPSA 218-205-VII. In 2001, the Heirs of Arturo Zayco entered in an operating agreement with Calamba Aggregates, Co., Inc., (CACI), a subsidiary of Alsons Cement Corporation (ACC) which was approved by DENR in 2003. ACC, which later became part of Holcim Philippines, Inc., took over the quarry operation in 2001. In March 31, 2017, a new operating agreement was signed between the Heirs of Arturo Zayco Sr. represented by Alfredo F. San Miguel Jr, Heirs of Arturo Zayco Sr., represented by Jose Maria Z. Cuenca, and Alfredo San Miguel and Holcim Resources and Development Corporation (HRDC).

The current silica quarry operation is limited to 10 hectares. The map of the general layout of facilities and location, boundaries and footprint of the project are shown in Figure 1-7. The current total quarry extraction rate is at 125,316.84 metric tons of silica per year and is proposed to be increased to 625,000 metric tons per year. As previously mentioned, quarrying is currently confined within the 10 has inside the MPSA. The proposed expansion of operations to 50 has will remain inside the same MPSA.

The general method of mining currently used at the quarry is surface open cast mining. The method is divided into two (2) stages; a) area development and b) extraction (production) stage. Area development is the stage where preparations for extraction are carried out. It involves stripping, removal of vegetation, waste overburden to expose the silica raw material resource and facilitate extraction of silica. This phase also involves the establishment of drainage and access to the deposit. The topography will be cut into a series of slices of five (5) meter height and an 80deg. bench slope. Stripping will start at the uppermost portion (Elev. B+570) of the topography and progresses downward. Once the ground is cleared / flattened, a new working level below (5m downward) is worked out to form a bench with at least 15 m width which is wide enough to allow load and haul fleets to manuever. Generally, the working parameters of the silica quarry are as follows: Bench slope 75-85deg bench height of 5 meters, Bench width 15-meter min. Pit slope is 20-50m.

In the extraction stage, exposed silica will be ripped using a bulldozer with ripping mechanism. Backhoe with breaker will be utilized in selected areas where the material is not rippable. The loosened silica will then be pushed by the bulldozer towards the designated loading areas. These will then be loaded using a backhoe into the dump trucks. Then, these will be transported to the port passing through the developed quarry road to the barangay road. There will be no blasting that will be done.

The mining process is purely surface mining which involve a simple process of break and haul with no involvement of processing, no usage of chemicals or no facilities to be sited. The technology is also straightforward as explained in the site development plan. Port facilities are also not included as these are not within the MPSA Area or in the project location. The quarry operation will not use any electricity and water given that the mining process involved as discussed in the preceeding section is break and haul method and as shown in Figure 1-5.

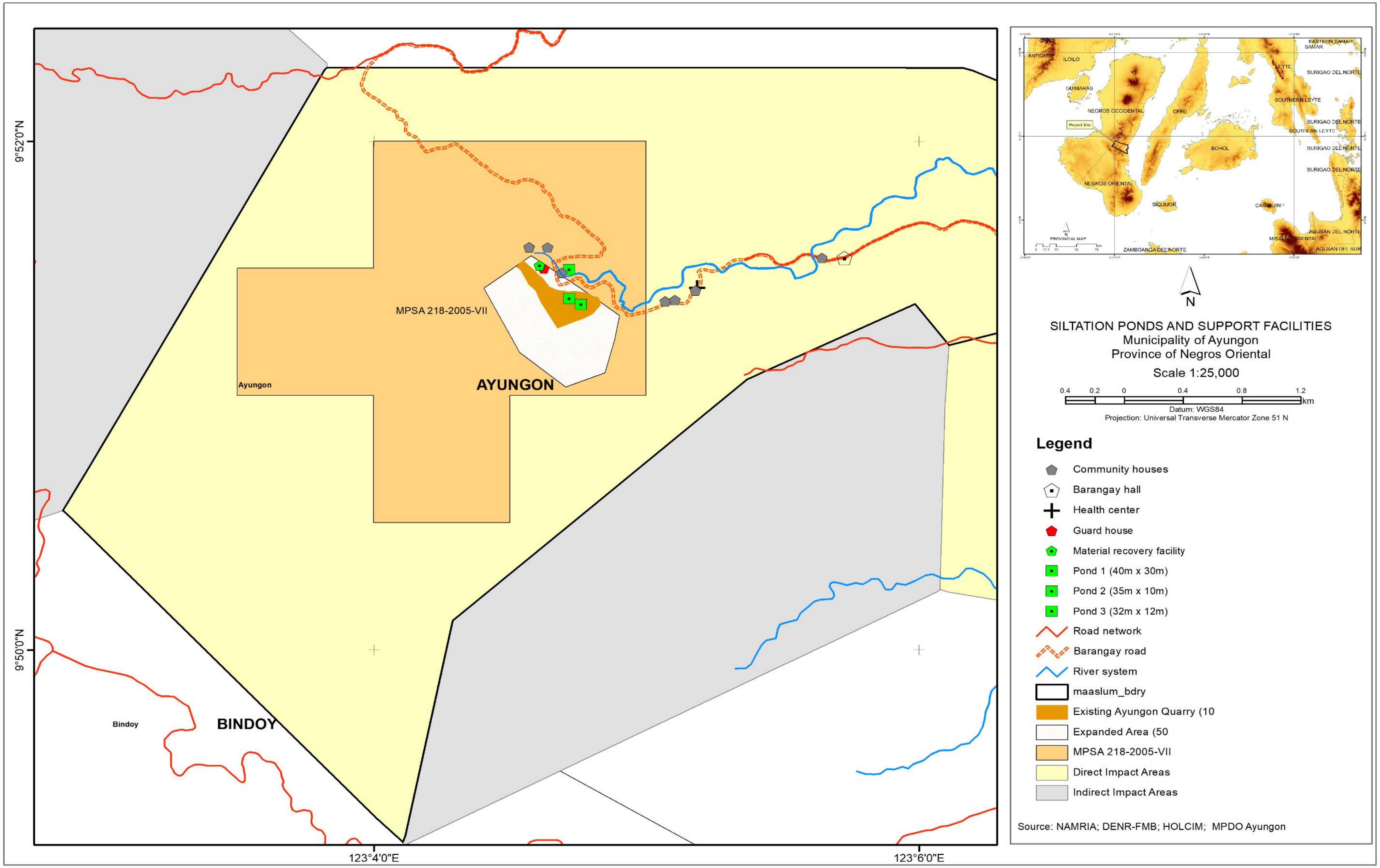

Figure 1-7. Map Showing Project Layout *(Source: NAMRIA, HOLCIM, MPDO Ayungon*

3. Quarry Equipment

The existing quarry equipment used in the operations and considered for the proposed expansion of operations is shown below.

Table 1-3. Quarry Equipment

Item	Model	Parameters (mm/m3/t)	Quantity
Loading	Volvo L150H	4.2	2
	Volvo EC300DL	1.76	2
Hauling	HOWO	20	15
	Volvo FMX 420	20	3
Auxiliary	Rock Breaker, Attachment	Rammer 3T	1
	Bulldozer Komatsu	D155A-6R/302HP	2
	Backhoe for the Breaker	Volvo EC220	1
	MotorGrader		2
	Vibratory Roller		1
	Water Truck	Isuzu Forward (10,000lts)	2
	Fuel Truck		1
	Service Truck		1
	Service Vehicle		1
	Mobile Crusher	– 1 Grizzly Feeder for LT106 – 1 Primary Jaw Crusher – Metso LT106 – 1 Secondary Cone Crusher –Metso HP200 – 1 Screening Unit Deck Screen – 1 Radial Stacket – 3 decker Vibrating Screen ST4.8	1
	Lube Truck	Isuzu 6BG1	1

4. Support Facilities and Infrastructure Requirements

Power and Water Requirements

Considering that the mining method is surface mining, there is no processing in the project area thus, no significant amount of resources is needed onsite in terms of power and water requirements.

The existing project uses generator for lighting requirements of the guardhouse. The quarry operations do not require any power supply as the mining method employed is surface mining. On the other hand, water use in the area is only for domestic and sanitary of workers onsite. The proposed expansion will not entail also entail any water requirement as there is no processing of silica at the quarry site.

Storm Water Drainage

A series of catch basins or sediment traps along the base hill will be established to trap fugitive silts and debris that may cascade down the slope from the active workings. If necessary, the wall and bottom of all drainage canals and basins will be lined or reinforced with concrete. All quarry drainage lines will be directed towards the catch basins before the hydrologic load flows to the river.

Sewerage

A portalet will be used for the machine operators and guards at the site. The regular maintenance of this facility will be done following standard procedures of the service provider. The project uses two (2) CR's (fixed structures) that were constructed (concrete) for male and female with divider and septic tank.

Telecommunications

Communication facilities such as land based, and mobile telephones and handheld radios are available at the guard house outside the quarry site. The quarry contractor personnel have their own communication facilities.

Access Road

The existing unpaved barangay road of about 8 kilometers from Ayungon Proper to the project area will be used. Within the project area itself, travel is mainly by secondary feeder roads, unpaved foot trails and stream courses. Access to the more remote portions of the quarry site is achieved by cutting a trail across generally thick vegetation.

Accommodation

There are no accommodation or housing facilities within the quarry site. The members of the operational workforce reside in Ayungon and nearby towns which is about 8 km away from quarry site. Hence, there is no need for the proponent to provide camps or housing facilities to cater to the dwelling needs of the workforce.

Emergency Facilities

There are no emergency facilities within the quarry site. However, Ayungon has twenty-three (23) Barangay Health Stations and one (1) main Health Center at Barangay Poblacion. A health service also is complemented by a private medical clinic and one (1) private dental clinic

Similar Facilities

There is also no infrastructure within the quarry site except for a small guard outpost. HAZ has no plans of building any major infrastructure in the project area.

5. Pollution Control and Waste Management System

Pollution Control Devices

There are no pollution control devices used on site since there are no structure and processing done within the project area.

Solid Waste and Wastewater Management System

Solid waste and wastewater generation is expected to be of minor concern in the project since the generation of wastes is not significant. Still, in order to address possible concerns, the Proponent has provided some management measures to mitigate its effect in the environment.

All domestic wastes will be disposed of in accordance with the construction and operations waste management procedures. A solid waste management plan will be implemented. Trash and other wastes will be collected and transported by DENR-accredited haulers.

Licensed service contractors (DENR accredited wastewater transporter and treater) will provide and service portable toilet facilities during the construction phase. Sanitary sewage from construction workers will be collected from these portable latrines and transported to the local wastewater treatment facility.

A Construction Environmental Management Program including a Health and Safety Plan that will detail the important programs/ plans that must be instituted during the entire duration of the construction activities will be prepared and strictly implemented.

Siltation Control

The principal mitigating measures that the Heirs of Arturo Zayco will implement to control probable siltation of the Maaslum River bed and by extension, the low-lying farmlands downstream consist of building a series of catch basins along the base hill to trap fugitive silts and debris that may cascade down slope from the active workings. If necessary, the wall and bottom of all drainage canals and basins will be lined or reinforced with concrete. All quarry drainage lines will be directed towards the catch basins before the hydrologic load flows to the river.

Siltation reduces the capacity of the low-lying vegetation around the quarry sites to photosynthesize due to impaired exchange of gases in the stomates leading to gradual decimation. With poor drainage system, silts will inundate nearby water bodies affecting both the primary and secondary productivity of the river systems aquatic populations that includes reduction of its population and total decimation of the species. Affected wildlife includes aquatic animals such as frogs, fish and insects and aquatic vegetation, among others. During high rainfall events, large amount of silts may clog due to soil lodging the river system impacting its navigation functions affecting local community e.g. human lives and property. If it lands on estuary areas, it will reduce benthic populations such as coral, oysters, shrimps, and mussels, among others and may affect or alter fish migration from open sea to fresh water systems and vice versa.

The table below shows the geographical locations of silt traps and siltation ponds and the map of the location of the siltation ponds can be seen in Figure 2-26.

Table 1-4. Geographical Lcoation of Silt Traps and Siltation Ponds

	Northings	Eastings	Area	
Primary Silt Traps (PST)				
PST-1	9°51'20.87"N	123° 4'45.92"E	1,000	SQ.M.
PST-2	9°51'20.36"N	123° 4'45.29"E		
PST-3	9°51'21.41"N	123° 4'44.40"E		
PST-4	9°51'21.94"N	123° 4'45.09"E		
Secondary Silt Traps (CST)				
SST-1	9°51'22.02"N	123° 4'44.76"E	1,285	SQ.M.
SST-2	9°51'21.49"N	123° 4'44.07"E		
SST-3	9°51'21.23"N	123° 4'43.24"E		
SST-4	9°51'22.70"N	123° 4'42.80"E		
SST-5	9°51'22.28"N	123° 4'43.88"E		
Primary Silt Ponds (PSP)				
PSP-1	9°51'29.20"N	123° 4'37.19"E	379	SQ.M.
PSP-2	9°51'29.32"N	123° 4'36.23"E		
PSP-3	9°51'29.72"N	123° 4'36.34"E		
PSP-4	9°51'29.55"N	123° 4'37.26"E		

The catch basins will be cleaned periodically by bailing out the accumulated silt materials as soon as they are near critical level. Augmenting this control measure is the practice of good spoils management through rigid onsite confinement and upkeep to minimized downhill flow of excess materials from the extraction zone.

Land Preservation

In quarrying, best-practice mining techniques will be adopted by the Proponent to reduce landform alteration of the quarry site to the minimum and render the area easy and amenable to post-mining restoration. In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope.

Ways to protect the slope and mine-affected zones from water-induced erosion will creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

Systematic mining that reduces selective extraction of silica or will be pursued to minimize creation of deep terrestrial voids, residual mounds and disfigured landscape.

Rock Waste Minimization

Since the silica ore occurring in this deposit is relatively high-grade, good conservation practices will be observed through maximum extraction and recovery of ore material. Except for the overburden consisting of topsoils and organic debris that will be set aside for post-quarrying reforestation substrate, most excavated materials will be shipped as final products.

Minimization of Site Clearing for Mining

The Heirs of Arturo Zayco will adopt a strategy of clearing the least necessary area for the safe operation of its quarry inside the mining lease where small colonies of second-growth trees still exist. Since very few structures and support facilities are required by the proponent by quarrying operation, site clearing will be restricted to the actual extraction pits, spoil stockpiles and equipment operating area only. The strategy will include systematic and progressive quarrying wherein no new extraction sites will be opened unless the previous excavation is completed. Absolutely no cutting of trees will be allowed on land outside of the property except when laying out new access road or improving existing ones.

Dust Emission Control

Periodic water spraying of quarry pits, haul roads, excavation faces and spoil stockpiles when operating during dry season shall be done to suppress most dusts from getting airborne, and consequently mitigate the potential impact that such pollutant may bear on the health and well-being of the quarry personnel and adjacent populace.

On dry periods when airborne dust emission is higher, quarry personnel will be mandated to wear dust respirators and their actual work schedules rotated.

Reforestation

New tree plantations will be established within and immediately outside the 10-hectare project site for progressive "re-greening" to start tree colonies or increase present tree density in areas not needed by the proponent for actual mining. To support these greening activities, the Heirs-of-Arturo Zayco will establish a forest nursery facility.

Last November 2017, HRDC planted 39 trees inside the Silica mined-out site and 670 trees in an idle lot. See **Annex 27** for the Growth and Survival Performance of the Tree Plantations. Planted trees will be monitored periodically to determine its survival rate and growth performance. Parameters to be measured are average survival rate, diameter and height increment. Surveys shall be supported by timber inventory and taking of photographs at designated fixed point.

Noise Abatement

Generation of noise and vibration from quarry equipment operation, be it of nuisance variety of physiological, will be avoided or reduced by good equipment servicing and maintenance practices such as frequent bolt tightening, greasing, lubrication and replacement of filters. Quarry personnel will be further protected from noise emission by enclosing their equipment cabs and causing them to wear ear inserts or muffs. Job rotation will also be practiced, if necessary.

6. Process Technology Option

Method/Technology for Extraction

The general method of mining currently used at the quarry is surface open cast mining. The method is divided into two (2) stages; a) area development and b) extraction (production) stage. Area development is the stage where preparations for extraction are carried out. It involves stripping, removal of vegetation, waste overburden to expose the silica raw material resource and facilitate extraction of silica. This phase also involves the establishment of drainage and access to the deposit. The topography will be cut into a series of slices of five (5) meter height and an 80deg. bench slope. Stripping will start at the uppermost portion (Elev. B+570) of the topography and progresses downward. Once the ground is cleared / flattened, a new working level below (5m downward) is worked out to form a bench with at least 15 m width which is wide enough to allow load and haul fleets to manuever. Generally, the working parameters of the silica quarry are as follows: Bench slope 75-85deg bench height of 5 meters, Bench width 15-meter min. Pit slope is 20-50m.

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Mining would be handled by SiO_2 Resources Corporation, a subsidiary of Rock Energy International Corporation. SiO_2 Resources handles the sourcing, importation, storage and provide land transport to achieve an on-time delivery of high-grade silica sand to several plants of its valued customers. This supply chain agreement with several manufacturing plants has been on-going for the past 14 years.

Area Development → Bench Development → Ripping → Pushing → Loading

Figure 1-8. Silica Extraction Process

Operations and Maintenance of Facility

Solid Waste and Wastewater Management

Solid waste and wastewater are expected to be a minimal concern in the Project since no significant sources of these wastes are present in the area. Still, in order to address possible concerns, the Proponent has provided some management measures to mitigate its effect in the environment.

All domestic wastes will be disposed of in accordance with the construction and operations waste management procedures. A solid waste management plan will be implemented. Trash and other wastes will be collected and transported by DENR-accredited haulers.

Licensed service contractors DENR accredited wastewater transporter and treater will provide and service portable toilet facilities during the construction phase. Sanitary sewage from construction workers will be collected from these portable latrines and transported to the local wastewater treatment facility.

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The catch basins will be cleaned periodically by bailing out the accumulated silt materials as soon as they are near critical level. Augmenting this control measure is the practice of good spoils management through rigid onsite confinement and upkeep to minimized downhill flow of excess materials from the extraction zone.

Land Preservation

In quarrying, best-practice mining techniques will be adopted by the proponent to reduce landform alteration of the quarry site to the minimum and render the area easy and amenable to post-mining restoration. In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope.

Ways to protect the slope and mine-affected zones from water-induced erosion will creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

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Since the silica ore occurring in this deposit is relatively high-grade, good conservation practices will be observed through maximum extraction and recovery of one material. Except for the overburden consisting of topsoils and organic debris that will be set aside for post-quarrying reforestation substrate, most, if not at all, excavated materials will be shipped as final products.

Minimization of Site Clearing for Mining

The Heirs of Arturo Zayco will adopt a strategy of clearing the least necessary area for the safe operation of its quarry inside the mining lease where small colonies of second-growth trees still existing. Since very few structures and support facilities are required by the proponent by quarrying operation, site clearing will be restricted to the actual extraction pits, spoil stockpiles and equipment operating area only. The strategy will include systematic and progressive quarrying wherein no new extraction sites will be opened unless the previous excavation is completed. Absolutely no cutting of trees will be allowed on land outside of the property except when laying out new access road or improving existing ones.

Reforestation

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Dust Emission Control

Periodic wetting of quarry pits, haul roads, excavation faces and spoil stockpiles when operating during dry season will suppress most dusts from getting airborne and consequently mitigate the potential impact that such pollutant may bear on the health and well-being of the quarry personnel.

On dry periods when airborne dust emission is higher, quarry personnel will be mandated to wear dust respirators and their actual work schedules rotated.

Noise Abatement

Generation of noise and vibration from quarry equipment operation, be it of nuisance variety of physiological, will be avoided or reduced by good equipment servicing and maintenance practices such as frequent bolt tightening, greasing, lubrication and replacement of filters. Quarry personnel will be further protected noise emission by enclosing their equipment cabs and causing them to wear car inserts or muffs. Job rotation will also be practiced, if necessary.

Safety and Accident Prevention Practices

The Heirs of Arturo Zayco will both observe and strictly enforce the applicable quarry safety rules and regulations prescribed by the Philippine Mining Laws, particularly those provided for in the DENR Mine Administrative Order No. MRD – 51, to prevent injury causing accidents and other untoward incidents. Accordingly, an annual safety and health program will be formulated and installed in compliance with the regulations, and training of proponent's employees on safe quarrying practices will be conducted. Among the pertinent safety precautions that will be observed and enforced are the following:

a) Provision of hard hats and safety footwear to all quarry workers;
b) Scaling down of all overhangs and loose rock masses suspected of falling on pit walls and extraction faces;
c) Provisions of spotters to continuously guide heavy mining equipment and mobile units in maneuvering and operating within the active extraction zones;
d) Prohibiting mining personnel from working directly below unstable slopes;
e) Prohibiting children, passerby and outsiders from loitering or staying around the project site;
f) Providing supports to reinforce pit walls/faces suspected of pending collapse;
g) Proper maintenance and servicing of all mining equipment;
h) Provision of First-Aid kit onsite;
i) Provision of adequate lightning facilities when operating during nighttime; and
j) Periodic briefing of quarry personnel on mine safe operating practices.

E. Project Size

1. Total Amount of Mineral Resource in the Project Area Based on Exploration Data

The initial geologic study conducted confirmed the existence of a significant volume of silica deposit at the project site. At a cut-off grade of 80% SiO_2 and using a density of 1.85 t/m3, the measured and indicated resource estimates are 56.8 and 47.3 million tons, respectively. An indicated resource of silica is present in the area which will last for 184 years at annual production of 300,000 metric tons per year.

Table 1-5. Measured and Estimated SiO_2 in Ayungon Mineral Resource

Resource Category	Tonnage (MT)	Average % SiO_2
Measured	56,800,000	85.9
Indicated	47,300,000	70.3
Total	**104,100,000**	**78.8**

Source: Project Feasibility Study for the Development and Commercial Extraction of Silica on MPSA 218-2005-VII

2. Extraction and Production Rates

The existing allowable extraction rate of silica as stipulated in the current ECC is 125,316.84 metric tons per year. The estimated extraction rate of the proposed expansion is 2500 metric tons/day (MTPD) or about 625,000 MT per annum for a total of 250 working days per year.

The projected production schedule is shown below.

Table 1-6. Projected Production Schedule

Year	Holcim Lugait	Non-Cement	Other Cement	Other Holcim	Grand Total
2020	115,763	40,000	115,763	69,458	340,983
2021	121,551	40,000	121,551	72,930	356,032
2022	127,628	50,000	127,628	76,577	381,833
2023	134,010	50,000	134,010	80,406	398,425
2024	140,710	50,000	140,710	84,426	415,846
2025	147,746	50,000	147,746	88,647	434,138
2026	155,133	50,000	155,133	93,080	453,345
2027	162,889	50,000	162,889	97,734	473,513
2028	171,034	50,000	171,034	102,620	494,688
2029	179,586	50,000	179,586	107,751	516,923
2030	188,565	50,000	188,565	113,139	540,269
2031	197,993	50,000	197,993	118,796	564,782
Grand Total	2,057,856	620,000	1,952,856	1,171,714	6,010,427

Source: Project Feasibility Study for the Development and Commercial Extraction of Silica on MPSA 218-2005-VII

3. Total Project Area

The project area for the existing ECC is 10 hectares. With the proposed expansion, this will be expanded to cover 50 ha of the MPSA area. The expanded area still falls within MPSA 218-05-VII.

F. Development Plan, Description of Project Phases and Corresponding Timeframes

1. Pre-Construction Phase

There will be no pre-construction activities that will take place as the mineral extraction is currently done within the existing 10 has and this will be expanded to 50 has within the MPSA area.

2. Construction Phase

In preparation of the proposed expansion area for eventual mineral extraction, the following activities shall be undertaken:

- Area Development - This involves clearing of existing vegetation and stripping of topsoil as to expose the silica raw material resource. This shall facilitate eventual bench development and extraction of mineral resource.
- Bench Development - This activity involves the construction of access roads and ramps to reach higher grounds and the eventual shaping-up of quarry benches for slope stability. In the course of the activity, incidental production may be derived.

3. Operation Phase

Full production shall start after all development works have been completed. The extraction procedure involves the following cycle of activities:

- Ripping of the deposit using a bulldozer with ripping mechanism. This is to loosen up the material for ease of handling.
- Pushing the loosened material by bulldozer towards designated loading areas.
- Loading the material using a backhoe into dump trucks for delivery to the port or to the barge for shipment to clients.

Given the increase in the extraction of silica, there area few additional mobile auxiliary equipment that will be acquired. The quarry equipment listed in Tables 0-1, Table 1-2 and Table 1-3 are needed in the expansion of the quarry area and increasein extraction rate. The expansion of the area for mining will remain within MPSA 2018-05-VOO since the existing operation covers only ten (10) hectares of the 505.4626 hectares allowed mineable area. Thus, the amendment application only intends to expand the mineable area stipulated in the ECC from 10 has to 50 has and the amount or volume of silica that would be extracted from 500 MT per day to 2,500 MT per day. *(Please see* ***Annex 3*** *and* ***Annex 4*** *for the copy of Existing ECC and MPSA, respectively.)*

The Three-Year Work Development/ Utilization Work Program of the Heirs of Arturo Zayco for CYs 2017-2019, which was approved by MGB on September 26, 2017 consisted of the following schedule of activities:

- Year 2017: Extraction of silica materials and trimming of benches and construction of quarry road
- Year 2018: Extractopm of silica materials and trimming of benches and construction of quarry road
- Year 2019: Trimming of benches and installation of drainage structures

Aside from the access road and quarry road, there is no major infrastructure planned to be constructed in the project area. All other management and mitigating measures in the existing operation will be adopted for the proposed expansion.

4. Decommissioning/Abandonment/Rehabilitation Phase

As with the end of every industry, the closure of the project can affect the host community, create loss/decrease in taxes, loss of employment, income and/or business opportunities derived from the project. In view of these, the proponent adopted an abandonment/rehabilitation strategy that can be used in mitigating the effects of the abandonment/decommissioning activities of the project.

The Final Mine Rehabilitation and Decommissioning Plan (FMRDP) for MPSA 218-2005-VII has the following objective:

- Compliance with legal requirements;
- Eliminate advser long-term environmental impacts by: a) Restoring ecological balance of the area to a reasonable/ realistic level conducive to floral growth and faunal habitation; b)

enhance the natural features of the place; c) mitigate the impacts of flood, siltation and landslides; d) ensure long term stability of the substrate; and e) ensure realization of planned ultimate land use and sustainable development;

- Improve public image by exercising corporate social responsibility;
- Open opportunities for nature studies, through educational excusions, field classes, camps, etc;
- Ensure the safety, health, social and economic well-beinng of the people both in the host and neighboring communities even after the closure of the project.

The FMRDP highlights the following:

- The mined-out area will be converted into a forest and recreational park.
- The slopes of the quarry will be stabilized, pit profile re-contoured and revegetated with appropriate tree species such as acacia mangium, madre de cacao and mahogany
- Tree planting activities will be contracted to local residents
- Pit drainage system will be stabilized.
- As the quarry operations do not have buildings and facilities and infrastructures in the area, only the heavy equipment utilized in the quarry operation shall be removed in accordance with the contract between HAZ and the quarry contractor.
- On socioeconomic activities, local residents shall be trained in skills such as masonry, electrical installation and livestock raising. Livelihood trainings shall also be done in coordination with TESDA and LGU.

The Gantt Chart below summarizes the major milestones of the project. Moreover, the 35-Year Mining Development Plan is attached in Annex 26.

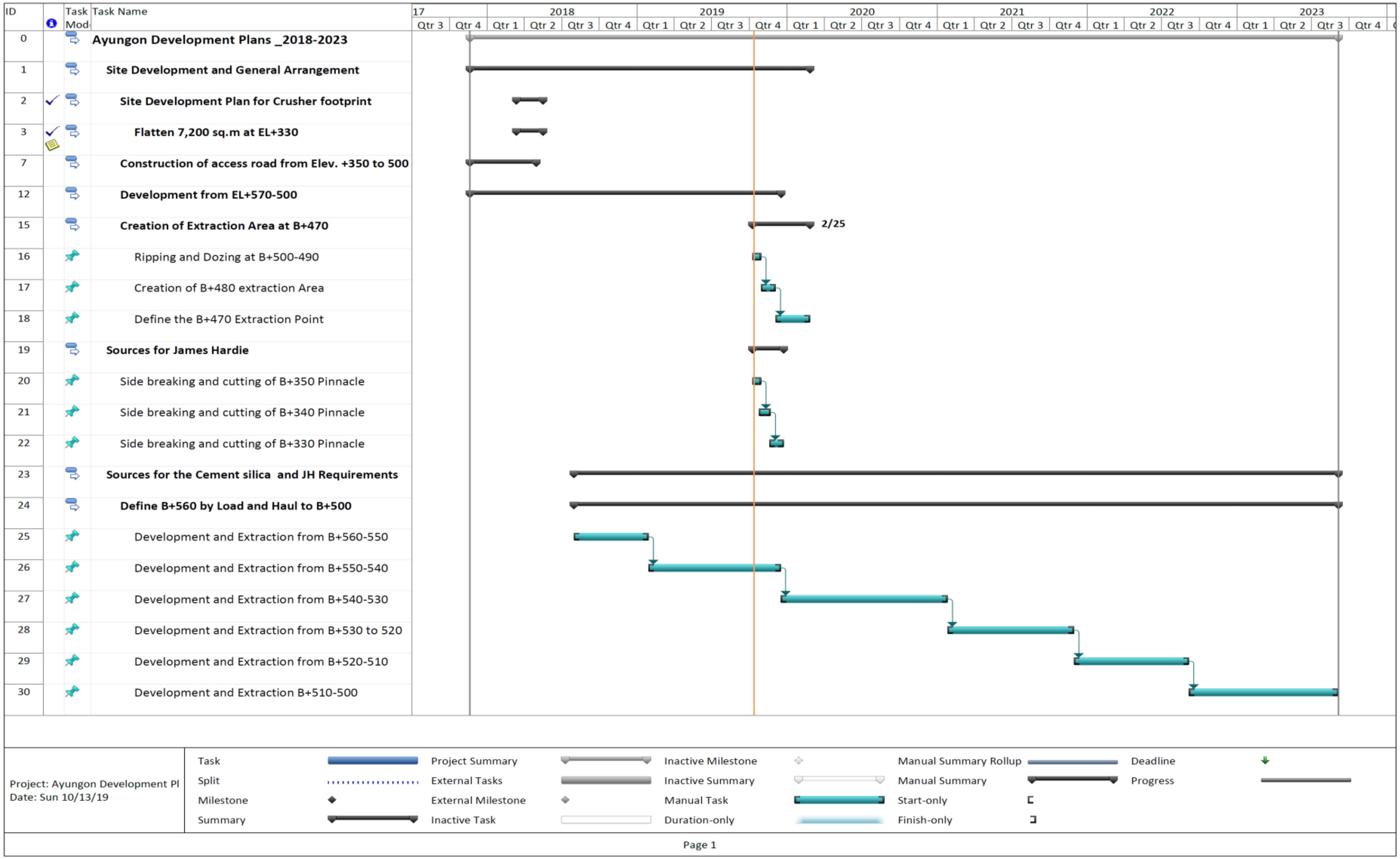


Figure 1-9. Ayungon 5-Year Development Plan (2018-2023)

G. Manpower

The manpower requirements during the operation and decommissioning /abandonment phases are shown below. The office-based positions which totals to seven (7) will be provided by HRDC while the site-based positions are provided by the mining contractor. Ninety percent (90%) of the workforce is sourced locally from the municipality of Ayungon. While the number of required manpower is relatively small, considering the unemployment rate of Ayungon at 32%, the number of people expected to be hired is foreseen to be a considerable contribution in addressing the employment needs of the communities.

Table 1-7. Manpower during Operation Phase

Position (Office-based)	Number of Persons	Position (Site-based)	Number of Persons
Project Manager	1	Drilling Operator	0
Journey/Port Supervisor	1	Loading Operator	7
Quarry Supervisor	2	Hauling Operator	30
PCO/Envi Officer	0	Auxiliary ME Operator	11
Safety Officer	1	Maintenance	15
Admin	1	TOTAL	63
Maintenance Manager	1		
TOTAL	7		
Over-all Total	70		

Table 1-8. Manpower during Decommissioning/Abandonment Phase

Position	Number
Environmental Officer (HRDC)	1
3rd Party Contractor (Forest Guard)	5

Since the quarrying operations will require the services of both skilled and unskilled workers, there will be an increase in the demand for employment. Therefore, the Project is expected to generate employment and opportunities to the unemployed labor force. With employment generated, the amount of money in circulation in the community will increase which will have a positive impact in sustaining small businesses and economic activities in the area. Other than the generation of employment for skilled and unskilled workers, the additional manpower needed for the expansion of operation will also bring about new economic activities in the area such as small food business, lodging/ accommodation, small laundry business to name a few.

1. Nature and Estimated Number of Jobs Available for Men and Women

Regarding the aspect of gender preference for job positions, all job positions are open to either men or women, provided they are qualified for the job requirements. Based on the actual manpower composition, the number of men occupying positions in the Project far outweigh the number of women.

In the absence of qualified personnel, efforts will be made on the capacity building for women workers aligned with Republic Act 9710, an Act providing for the Magna Carta of Women.

2. Scheme for Manpower Sourcing

HRDC and its contractor will prioritize the hiring of local residents from the three (3) barangays provided that the applicants' competencies fit the requirements of the job. Majority of the technical skills requirement such as the maintenance and production technicians, and operators are supplied locally. Engineering and other professional skills are sourced by standard hiring procedures with nationwide job notification. The engineering and professional skills are also shared within the Holcim Group of companies in the Philippines. The Company has an established training and succession plan policies to grow these unique competencies. Highly technical and managerial positions are mostly home grown. When needed, international experts are sourced on project-based term.

H. Project Cost

The silica quarry within the project area is already operational since 2001. It is expected that further development of the quarry would entail minimal costs. Mining will be undertaken by a contractor whose cost is per ton delivered to the loading barge in Tampocon. This means that there would be no capital cost for mining equipment's in the part of HRDC. Predevelopment cost for depreciation includes the exploration expenditure, Environmental Work Program and Community Development Programs in 2013 to 2014. Operating cash cost amount 3.32 billion pesos for the 15 years of projected production presented.

2. Assessment of Environmental Impacts

Baseline environmental conditions were gathered to determine the condition of the area given that the existing quarry operations covered by the existing ECC is only limited to 10 has. The baseline information gathered, and the compliance monitoring and self-monitoring reports were used as bases of assessing the environmental impacts of the planned expansion of ECC coverage. The impact monitoring of the project is contained in several documents including the Annual EPEPs which clearly addresses the major impact of the mining activity. This includes desiltation of silt ponds and mine drainage are regularly conducted. Attached in the **Annex 18** are the Annual AEPEP Accomplishment from 2014-2017.

Land preservation using best practice mining techniques to include quarry slope stabilization are also adopted to ensure that abrupt variances in landform are addressed and mitigated.

Included in the visual watch were the assessment of the stability of stockpiles, integrity of pits and extraction faces and condition of the drainage system.

Noise impact monitoring was based on the observations and complaints register. However, there were no complaints considering that the receptor community is more than a kilometer away from the mining area.

Dust emissions are observed from casual observations and if deemed appropriate would have resorted to dust sampling and gas monitoring. Road maintenance for dust suppression are also done on a regular basis.

For the project expansion however, the assessment of environmental impacts will be done more thoroughly considering the scope and magnitude of the project as contained in the monitoring plan.

A. Land

1. Land Use and Classification

The total administrative and geographical jurisdiction of the Municipality of Ayungon, consisting of the municipal water of 15,400 hectares, or 35.35% of its total administrative area and the land area, which is about 28,168 hectares, is 43,568 hectares.

Land use pattern of Ayungon is typical of most municipalities in the province of Negros Oriental, which is characterized by the predominance of agricultural lands and grasslands/shrubs indicating a rural environment.

Ayungon is politically subdivided into 24 barangays with a total population of 46,303. The barangays are namely:

Table 2-1. Barangays in Ayungon and its Corresponding Population

Barangay	Population	Percentage	Rank*
A. Urban			
1. Anibong	2,047	4.4%	15th
2. Awa-an	2,870	6.2%	21st
3. Tampocon I	2,061	4.5%	16th
4. Tampocon II	2,165	4.7%	18th
5. Poblacion	2,025	4.4%	14th
Sub-total	11,168		
B. Rural			
1. Amdus	1,160	2.5%	4th
2. Jandalamanon	1,148	2.5%	3rd
3. Atabay	1,274	2.8%	6th
4. Ban-ban	2,603	5.6%	19th
5. Calagcalag	1,764	3.8%	12th
6. Candana-ay	1,349	2.9%	7th
7. Carol-an	2,928	6.3%	22nd
8. Gomentoc	2,159	4.7%	17th
9. Inacban	1,376	3.0%	8th
10. Iniban	1,390	3.0%	9th
11. Kilaban	819	1.8%	1st
12. Lamigan	897	1.9%	2nd
13. Maaslum	1,721	3.7%	11th
14. Mabato	3,385	7.3%	23rd
15. Manogtong	1,500	3.2%	10th
16. Nabhang	1,189	2.6%	5th

Barangay	Population	Percentage	Rank*
17.Tambo	3,940	8.5%	24th
18.Tibyawan	1,808	3.9%	13th
19. Tiguib	2,725	5.9%	20th
Sub-total	35,135		
Total	**46,303**	**100.0%**	

Source: 2015 CLUP

The designated urban area in the Municipality of Ayungon is the entire Barangay Poblacion, which is defined by the following boundaries: by the barangay boundary of Poblacion and Tampocon (south); by the barangay boundary of Poblacion and Awa-an (north); the barangay boundary of Poblacion and Atabai (west) and the barangay of Poblacion and Tańon Strait (east).

Agricultural areas in Ayungon was reported to be devoted to crop production at 43% and livestock/poultry production at 57%. In addition, only 1,515 or 8% of those employed in Ayungon sourced their income from primary economic activity such as agriculture, fishing, forestry and quarrying/mining activities. Majority, 17,048 or 90% of those employed performed tertiary activities of wholesale/retail, transport, financial intermediation, education and other community, social and personal services.

Most of the agricultural area in Maaslum is planted with coconut, banana and a few patches of rice fields. Coconut and banana can tolerate acidic soil which is an aftermath of quarrying activities. Given the tolerance of the planted crops in the barangay, an expansion of the site for quarrying activities is foreseen not to drastically affect agricultural harvest. In addition, the predominant soil in the barangay has previously been classified for quarrying purposes which pre-disposes land use in the area.

Table 2-2. Land Use of Barangay Maaslum

Land Use	Percentage
Forest	10%
Agricultural	40%
Residential	30%
Quarry	20%

Barangay Gomentoc and Tampocon I are rice producing barangays. In Gomentoc alone, around 280 or 35% of its total area is planted to palay and coconut. The expansion of the quarry site, however, is not within these barangays, hence a drastic decrease in harvest/income from agriculture is not expected.

Impact in Terms of Compatibility with Existing Land Use

There is no impact in terms of compatibility land use. Based on the land use map of the Municipality of Ayungon, 759 hectares are classified as quarries and mineral deposit area where the MPSA 218-2005-VII is located. The project is in the designated quarry area of Ayungon, Negros Oriental as shown in the land use map below. Figure 2-1 presents the land use of the Municipality of Ayungon.

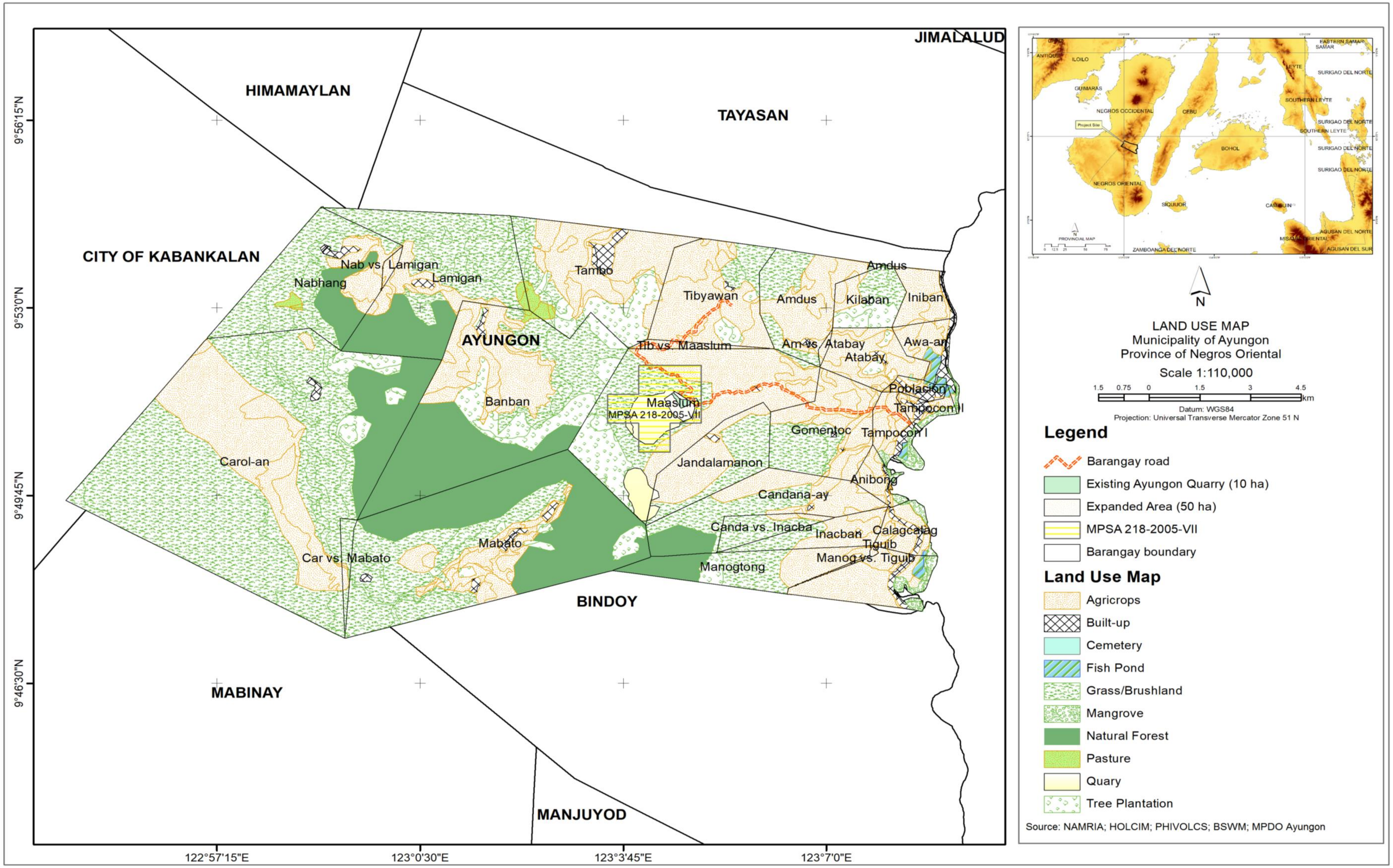


Figure 2-1. Land Use Map of the Municipality of Ayungon *(Source: NAMRIA. HOLCIM. PHIVOLCS, BSWM, MPDO Ayungon)*

Impact on Compatibility with Classification as an Environmentally Critical Area (ECA)

The Environmentally Critical Areas (ECA) is located 11 km northwest of the project site which is the Ilog-Hilabangan Watershed Forest Reserve, classified as the 11th largest watershed in the country. This reserve contains more than a dozen of endemic species. The other is the Tanon Strait, the largest protected seascape in the Philippines, located about eight (8) km east of the quarry site. It is a marine wildlife reserve that provides grounds for breeding, feeding and resting to 11 species of marine mammals (Figure 2-2).

No possible impacts to Ilog-Hilabangan Watershed Forest Reserve is identified due to its location and distance to the Project Site. On the other hand, Tanon Strait which is the direct discharge point of Maaslum River may be affected by the siltation from the quarry site, if not addressed, especially during downpours of rain in the upstream where the project site is located.

To help mitigate the effects of the siltation, the Project has provided siltation control methods to control probable siltation of the Maaslum Riverbed and by extension, the low-lying farmlands and catch basins along the base hill to trap fugitive silts and debris that may cascade down slope from the active workings.

To reduce the volume of the silts cascading downstream, the size and volume of silt should be first determined or computed to avoid generation of fugitive silts. Primary or even secondary drainage systems can be made to avoid silt lodging to a nearby water bodies or river systems.

The catch basins will be cleaned periodically by bailing out the accumulated silt materials as soon as they are near critical level. Augmenting this control measure is the practice of good spoils management through rigid onsite confinement and upkeep to minimized downhill flow of excess materials from the extraction zone.

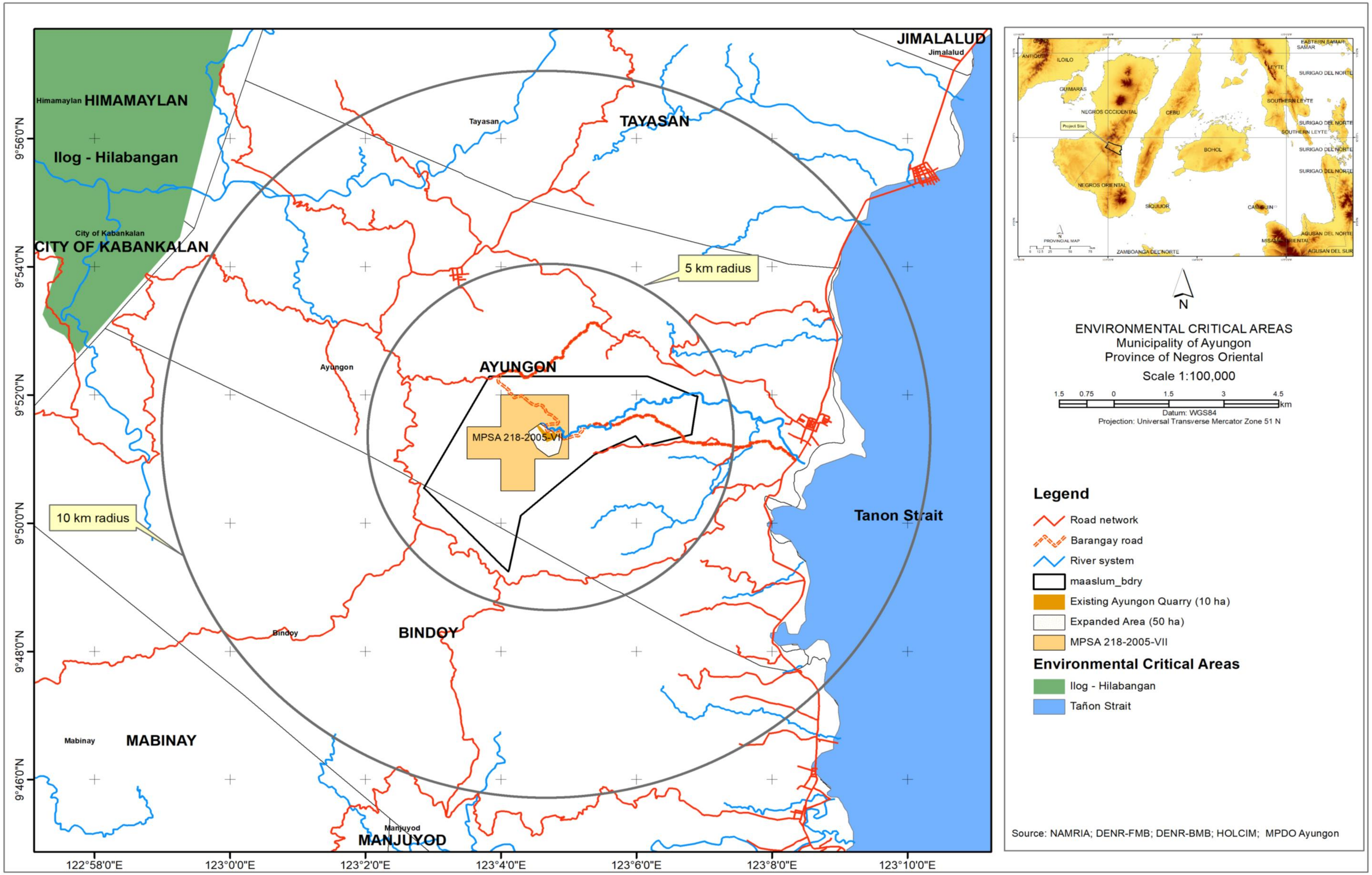


Figure 2-2. Map Showing Distance of Ilog-Hilabangan Watershed and Tanon-Strait (ECA) relative to the Project *(Source: NAMRIA, HOLCIM, MPDO-Ayungon)*

The project site is located within an area that was mapped by the Mines and Geosciences Bureau (MGB) as highly susceptible to landslides. Landslides and rock fall would occur on the face of the quarry site especially during extreme heavy rainfall. Areas classified by MGB as susceptible to landslide is considered to fall under the category of environmentally critical areas, bsed on the Revised Guidelines for Coverage Screening and Standardized Requirements, EMB Memorandum Circular 005 of July 2014. In order to mitigate the worst possible effect, best-practice mining techniques will be adopted by the proponent to mitigate landslides and rock fall In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope. The benches and haulage road would serve as buffer zones to the landslides and rock fall.

Safety practices would be implemented to prevent damage to lives and properties one of which is to stay away from the quarry face and stop operation during extreme weather conditions.

The summary of applicability and compatibility with the project vis a vis environmentally critical areas are shown below:

Table 2-3. Summary of Applicability and Compatibility vis a vis ECA

ECA Categories	Compatibility/ Applicability
1. Areas declared by law as national parks, watershed reserves, wildlife preserves and sanctuaries	NA
2. Areas set aside as aethetic, potential tourist spots	NA
3. Areas which constitue the habitat for any endhgangerd or threatened species of indigenous Philippine Wildlife (flora and fauna)	NA
4. Areas of unique historic, archeological, geological or scientific interests	NA
5. Areas which are traditionally occupied by cultural communities or tribes	NA
6. Areas frequently visited and/ or hard-hit by natural calamities. The area shall be so characterized if any of the following conditions exist: a. Geologic hazards b. Flood prone areas c. Areas frequently visited or hard-hit by typhoons d. Areas prone to volcanic activities/ earthquakes	Applicable – geologic hazard - landslide
7. Areas with critical slope	NA
8. Areas classified as prime agricultural lands	NA
9. Recharge areas of aquifers	NA
10. Water bodies	NA
11. Mangrove areas	NA
12. Coral reefs	NA

a. Flood Hazard: As evidenced by the topographic and drainage map of the area (*refer to Figure 2-3 and Figure 2-4*) the project site is located on high ground that is not susceptible to flooding and or tsunamis. Flooding is not a hazard that could affect the project site but most likely in the downstream areas. Although there is low present danger of flooding, increase in the sedimentation of stream channel will cause overflow and increase in the surface run-off. Large amounts of sediment and poor-quality water may have detrimental effects downstream from the project site after heavy downpour of rain. Extreme rainfall could induce slope failure at the banks of the overburden storage areas. If this happens, those at the lower ground will be flooded.

b. Landslide Hazard: The Mines and Geosciences Bureau has mapped the area as highly susceptible to landslides. Landslides and rock fall would occur on the face of the quarry site especially during extreme heavy rainfall. *(Refer to Figure 2-5)*

c. Liquefaction/ Subsidence Hazard: The geology at the project site is of solid rock formation that no subsidence is expected to occur in the area. No liquefaction will occur in the project site because of the nature of its geology in of the area which is made up of solid volcanic rocks and due to its alteration, it does not develop a thick soil profile. *(Refer to Figure 2-6).*

d. Ground Rupture Hazard: This is not applicable to the area.

e. Peak Ground Acceleration: This is not applicable to the area.

f. Typhoon Frequency: The project site is in a low hit typhoon area. On average, the area is visited by three (3) typhoons per year. *(Refer to Figure 2-7)*

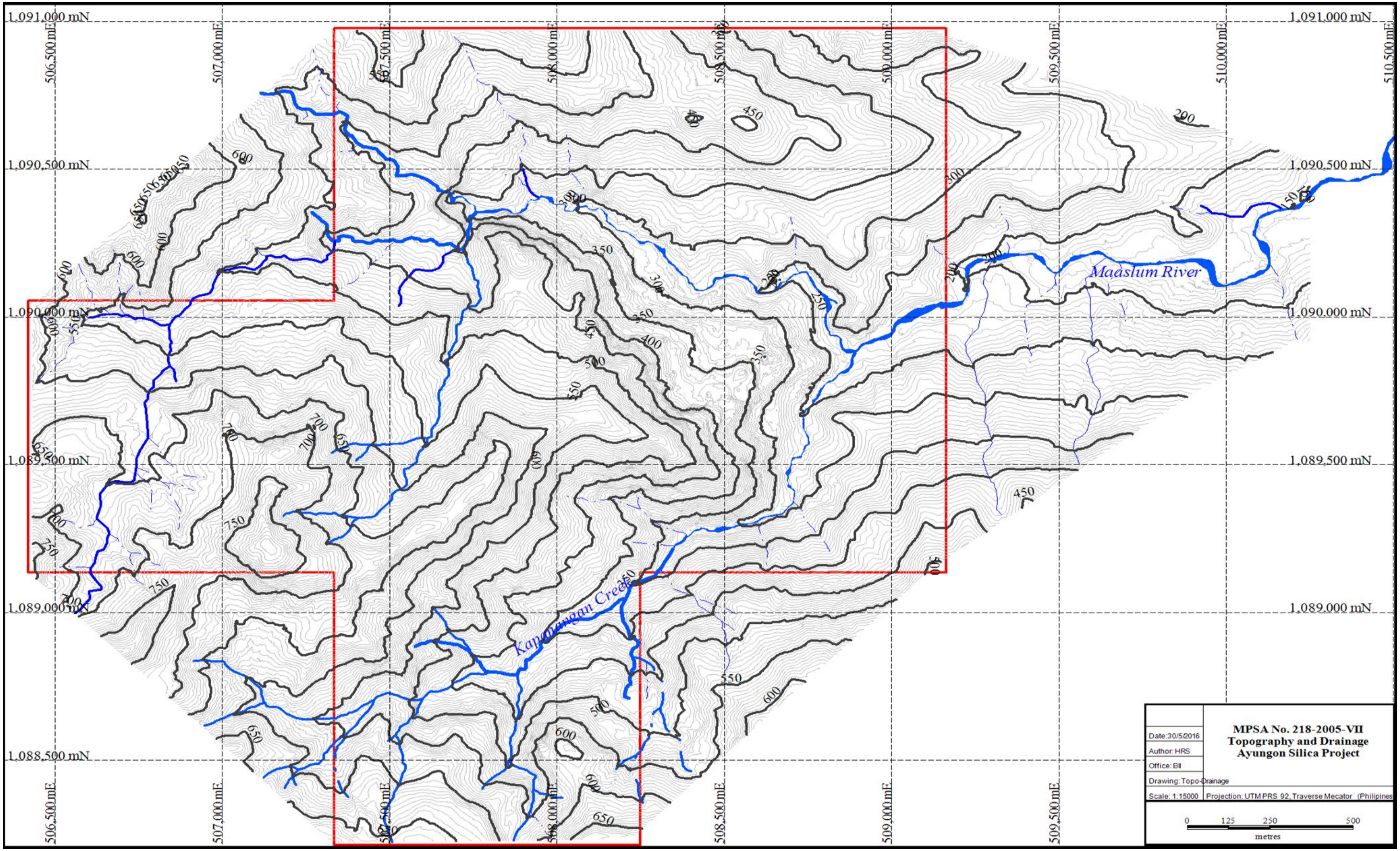


Figure 2-3. Topographic and Drainage Map of the Project *(Source: HOLCIM, 2016)*

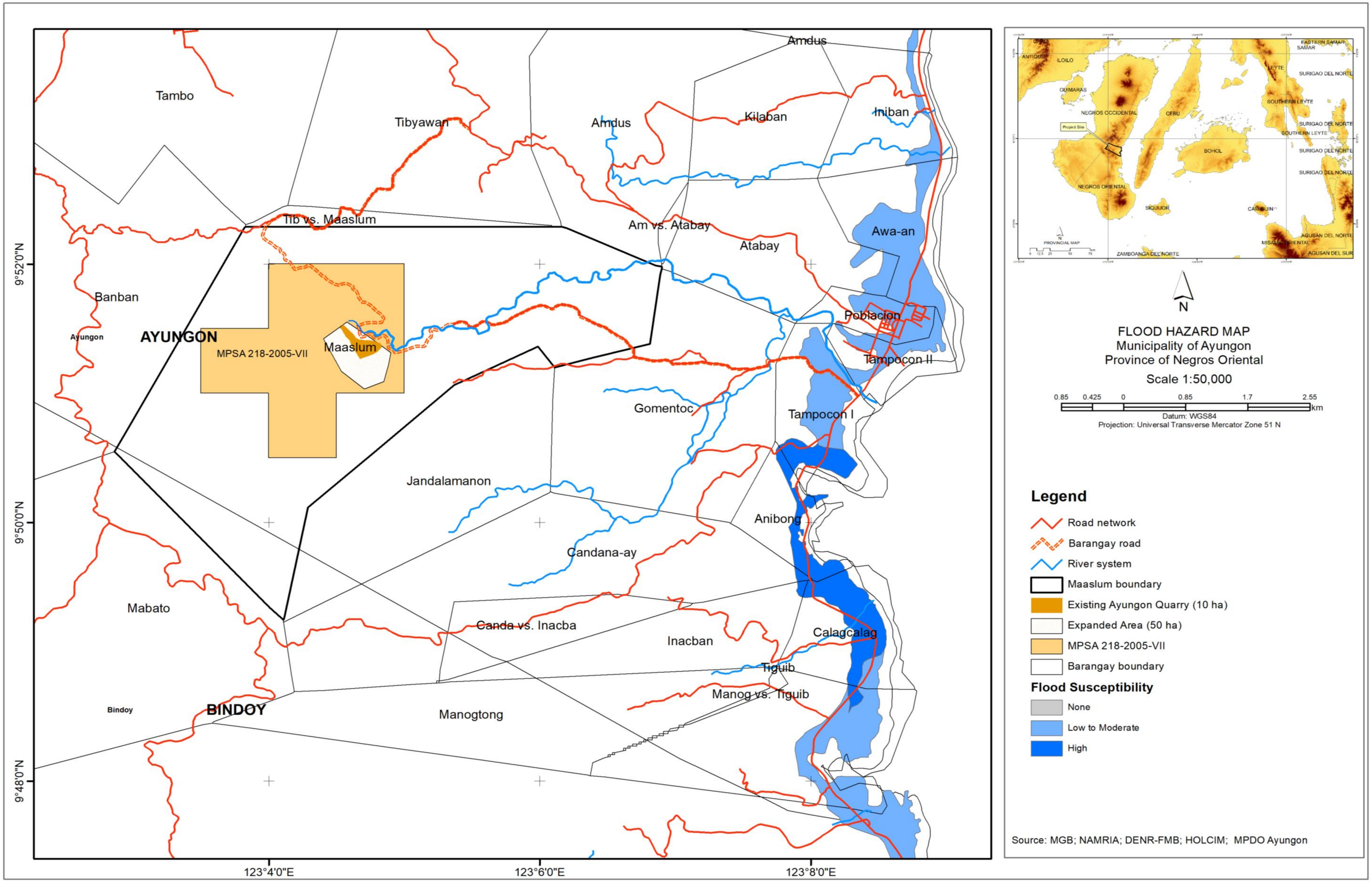


Figure 2-4. Flood Susceptibility Map of the Project *(Source: MGB, HOLCIM, MPDO Ayungon)*

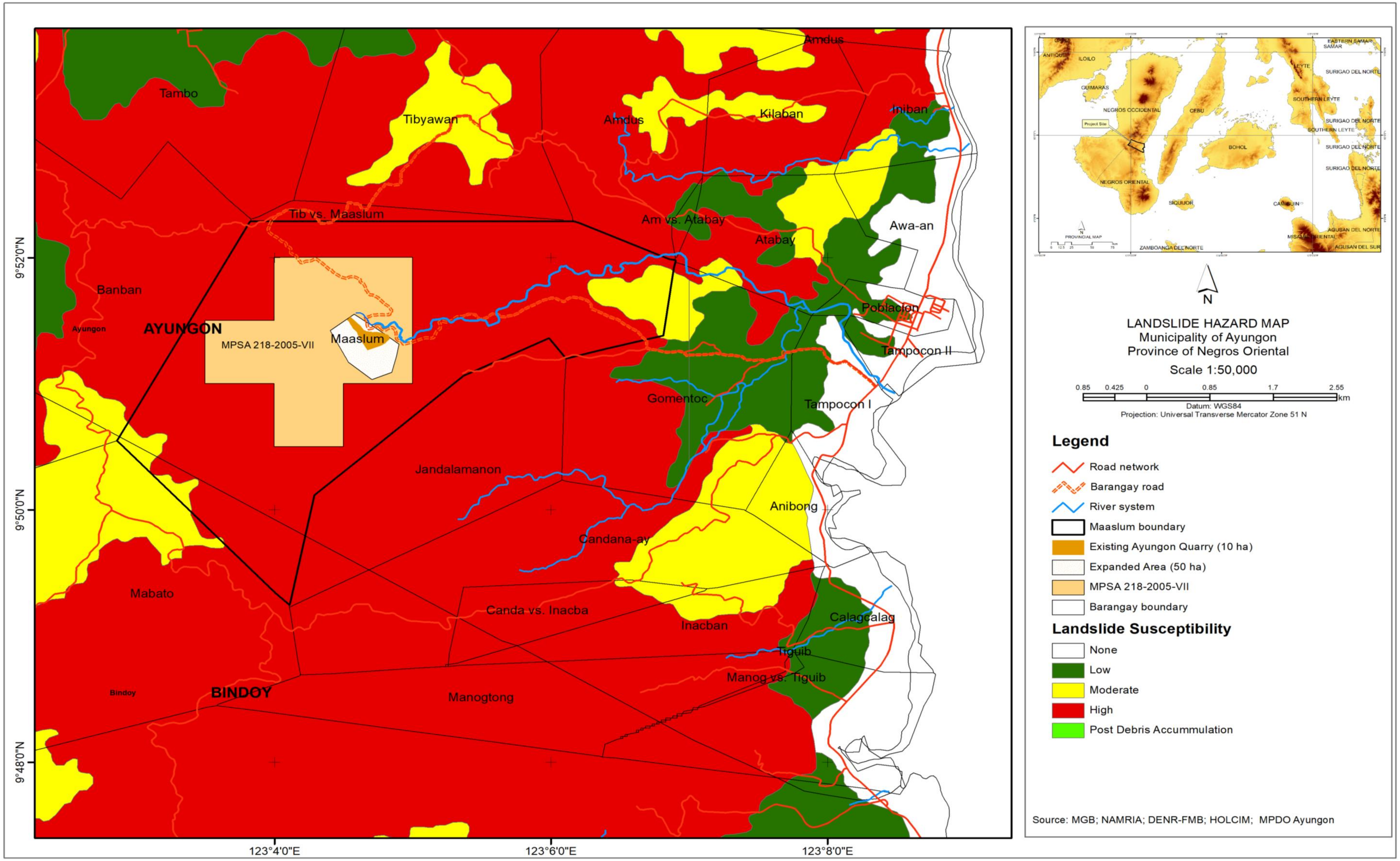


Figure 2-5. Landslide Hazard Map of the Project *(Source: MGB, HOLCIM, MPDO Ayungon)*

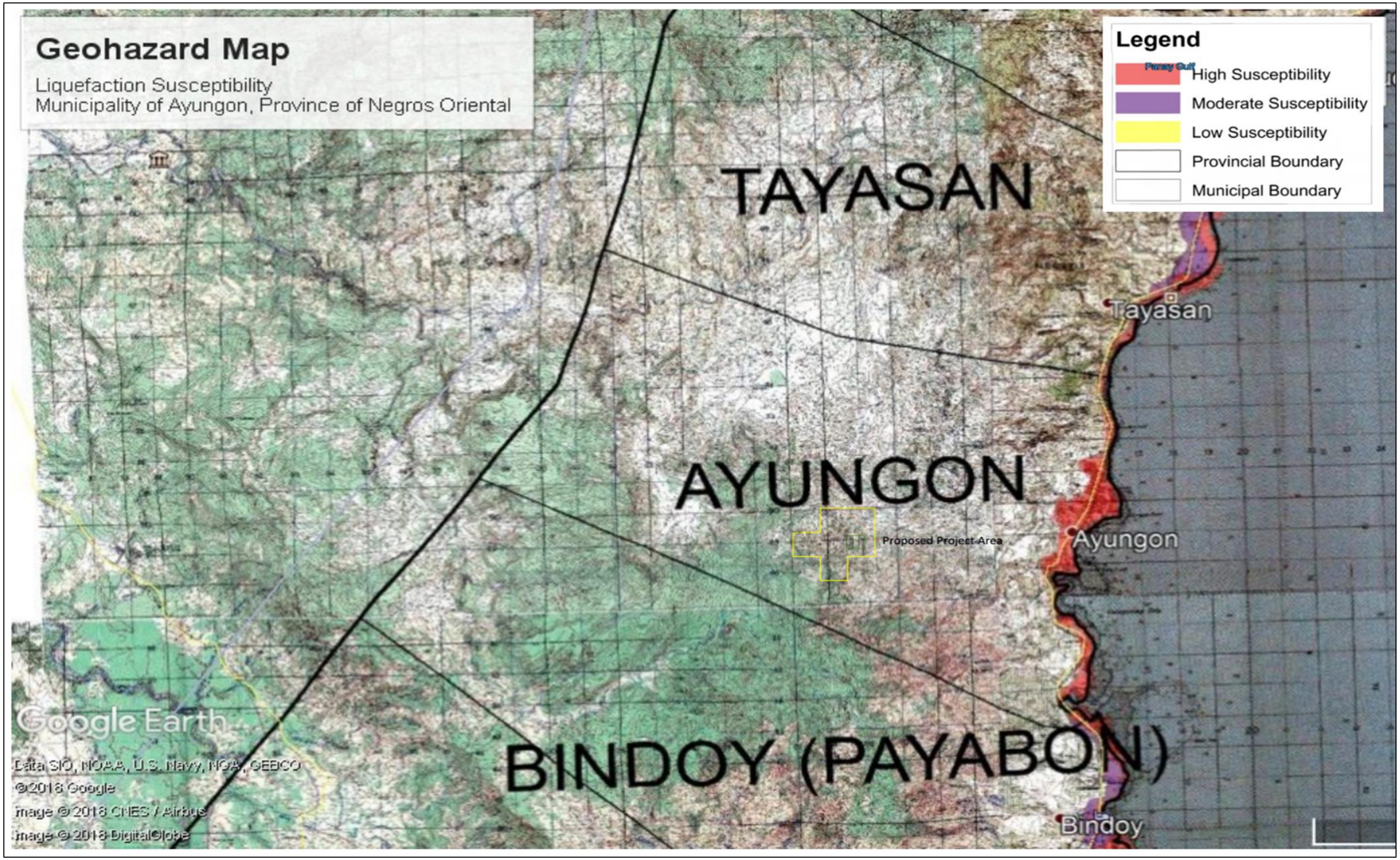


Figure 2-6. Liquefaction/ Subsidence Hazard Map of the Project *(Source: PHIVOLCS, DOST & MGB, 2018)*

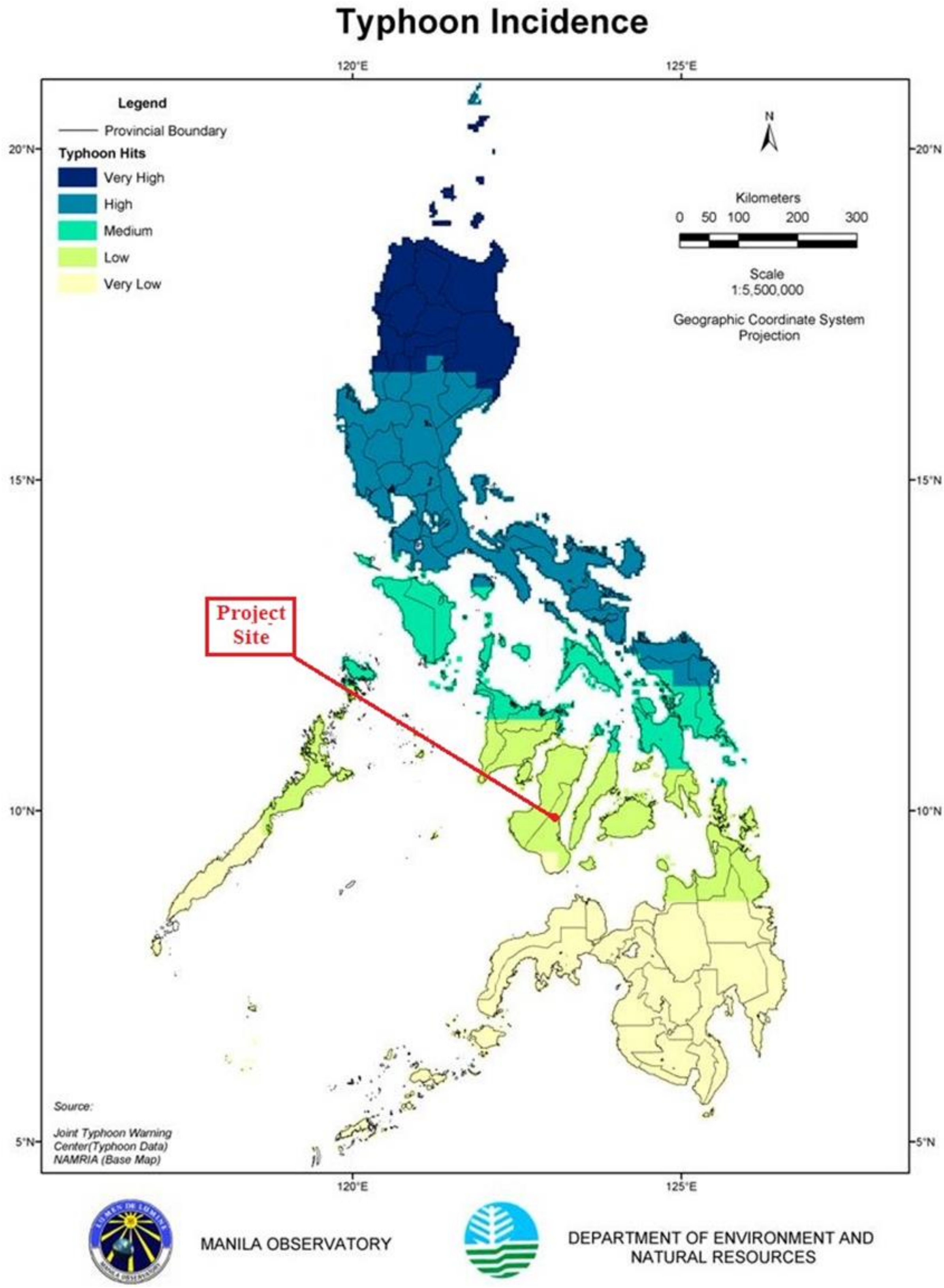


Figure 2-7. Typhoon Frequency Map of the Project *(Source: DENR, Manila Observatory)*

Impact in Existing Land Tenure Issue/s

The project site is covered by MPSA 218-2005-VII, dated October 5, 2005, which was granted under the name of the Heirs of Arturo Zayco (HAZ), the Proponent, covering an aggregate area of 505.4626 hectares in Ayungon, Negros Oriental. *See* ***Annex 4*** *for the copy of MPSA.*

There are no identified tenurial issues within the claims and no informal settlers were residing within the project site.

Impairment of Visual Aesthetics

One of the significant effects of the project is the impairment of visual aesthetics of the project site. Part of the operation includes removal and clearing of the vegetation and other landforms to extract the mineral resources. To minimize the visual impairment brought by the operation, mini-reforestation zones will be established within and immediately outside project site for progressive "re-greening" to start tree colonies or increase present tree density in areas not needed by the proponent for actual mining. To support these greening activities, the Heirs of Arturo Zayco will establish a tree nursery facility.

Figure 2-8. Latest Quarry Area

Figure 2-9. Silica Quarry as of Year 2022

Figure 2-10. Silica Quarry as of Year 2024

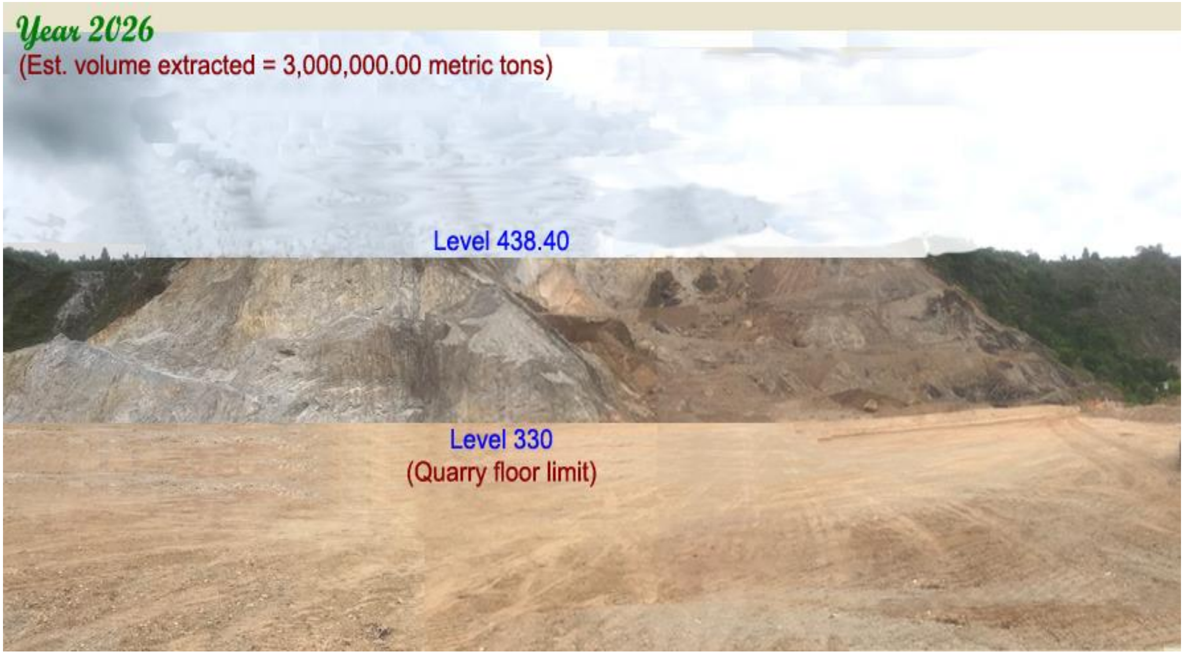


Figure 2-11. Silica Quarry as of Year 2026

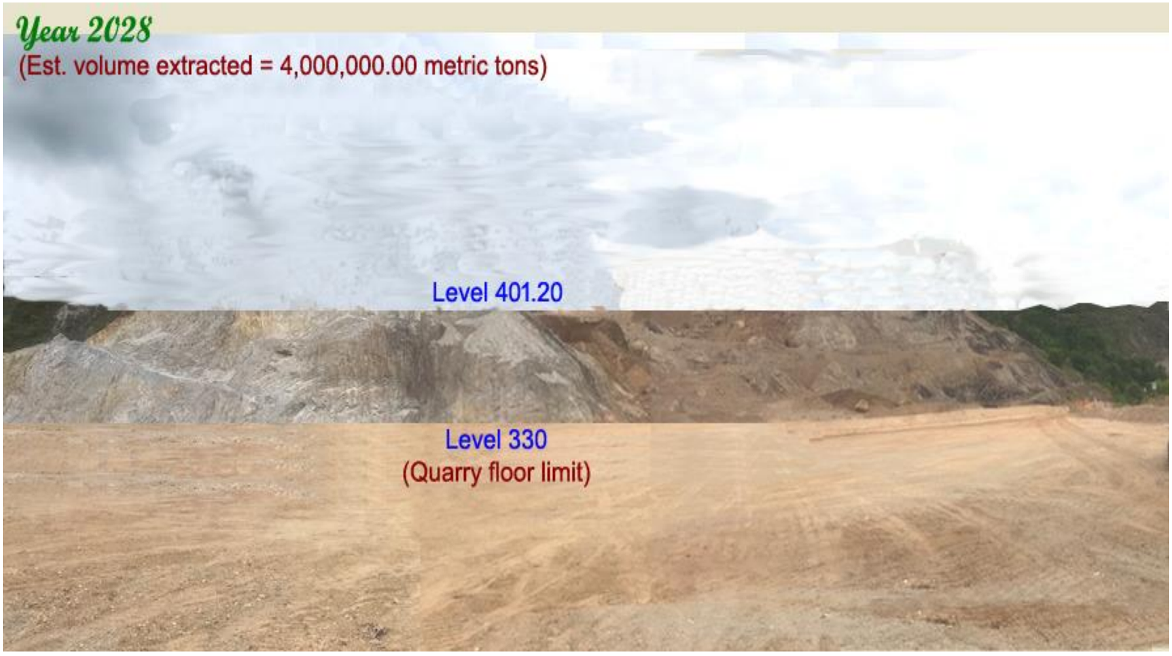


Figure 2-12. Silica Quarry as of Year 2028

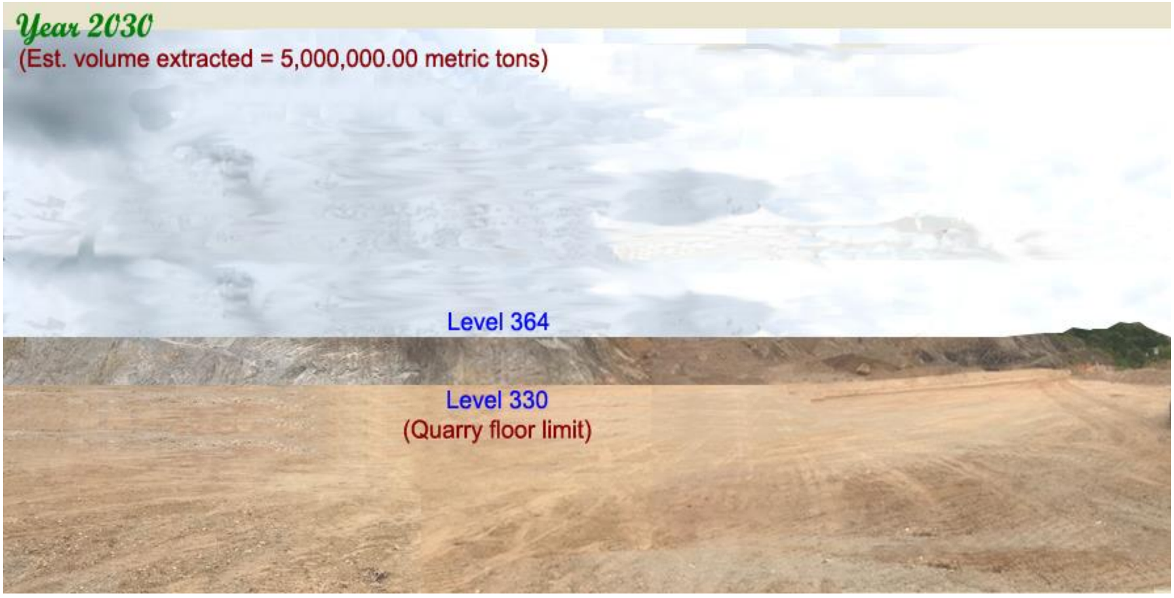


Figure 2-13. Silica Quarry as of Year 2030

Figure 2-14. Silica Quarry as of Year 2040

Devaluation of Land Value as a Result of Improper Solid Waste Management and Other Related Impacts

There are several possible effects identified that may possibly affect the site and its surrounding environment. The following are the identified management measures that are planned to be employed in the Project to mitigate or minimize potential devaluation of land value.

Solid Waste and Wastewater Management

Solid waste and wastewater are expected to be a minimal concern in the Project since no significant sources of these wastes are present in the area. Still, in order to address possible concerns, the Proponent has provided some management measures to mitigate its effect in the environment.

All domestic wastes will be disposed of in accordance with the construction and operations waste management procedures. A solid waste management plan will be implemented. Trash and other wastes will be collected and transported by DENR-accredited haulers.

Licensed service contractors (DENR accredited wastewater transporter and treater) will provide and service portable toilet facilities during the construction phase. Sanitary sewage from construction workers will be collected from these portable latrines and transported to the local wastewater treatment facility.

A Construction Environmental Management Program including a Health and Safety Plan that will detail the important programs/ plans that must be instituted during the entire duration of the construction activities will be prepared and strictly implemented.

Siltation Control

The principal mitigating measures that the Heirs of Arturo Zayco will implement to control probable siltation of the Maaslum River bed and by extension, the low-lying farmlands downstream consist of building a series of catch basins along the base hill to trap fugitive silts and debris that may cascade down slope from the active workings. If necessary, the wall and bottom of all drainage canals and basins will be lined or reinforced with concrete. All quarry drainage lines will be directed towards the catch basins before the hydrologic load flows to the river.

The catch basins will be cleaned periodically by bailing out the accumulated silt materials as soon as they are near critical level. Augmenting this control measure is the practice of good spoils management through rigid onsite confinement and upkeep to minimized downhill flow of excess materials from the extraction zone.

Land Preservation

In quarrying, best-practice mining techniques will be adopted by the proponent to reduce landform alteration of the quarry site to the minimum and render the area easy and amenable to post-mining restoration. In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope.

Ways to protect the slope and mine-affected zones from water-induced erosion will creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

Systematic mining that reduces selective extraction of silica or will be pursued to minimize creation of deep terrestrial voids, residual mounds and disfigured landscape.

Rock Waste Minimization

Since the silica ore occurring in this deposit is relatively high-grade, good conservation practices will be observed through maximum extraction and recovery of one material. Except for the overburden consisting of topsoils and organic debris that will be set aside for post-quarrying reforestation substrate, most, if not at all, excavated materials will be shipped as final products.

Minimization of Site Clearing for Mining

The Heirs of Arturo Zayco will adopt a strategy of clearing the least necessary area for the safe operation of its quarry inside the mining lease where small colonies of second-growth trees still existing. Since very few structures and support facilities are required by the proponent by quarrying operation, site clearing will be restricted to the actual extraction pits, spoil stockpiles and equipment operating area only. The strategy will include systematic and progressive quarrying wherein no new extraction sites will be opened unless the previous excavation is completed. Absolutely no cutting of trees will be allowed on land outside of the property except when laying out new access road or improving existing ones.

Reforestation

Mini-reforestation zones will be established within and immediately outside the 10-hectare project site for progressive "re-greening" to start tree colonies or increase present tree density in areas not needed by the proponent for actual mining. To support these greening activities, the Heirs of Arturo Zayco will establish a tree nursery facility.

2. Geology and Geomorphology

Regional/Provincial Geology

Central Visayas comprises several islands oriented in a northeast-southwest direction. It is bounded by major subduction zones, particularly the Negros Trench to the west and the Sulu Trench to the southwest. Bounding the Central Visayas region to the east is an extension of the Philippine Fault Zone.

The geology of Negros Island is largely attributed to the eastward subduction of Negros trench located on the western part of the island (Figure 2-10). The rocks are mostly Miocene andesitic volcanic and minor sedimentary rocks, Pliocene clastic sediments, and unconformable late Pliocene and Quaternary andesitic rocks and raised limestones. On the west of northern part of Negros, a belt of Paleogene volcanic and plutonic rocks which extends through eastern Panay and Guimaras Island is present. The Paleogene succession of rocks includes dacites and upper Eocene limestones which are exposed in a northwest-trending belt and intruded by plutons with early and late Oligocence K/Ar ages. Associated with these plutons and volcanic host rocks are several porphyry and copper deposits including Sipalay and Basay deposits. The project area lies within an epithermal system region with mostly andesite rocks of Middle Miocene age (UNDP, 1987). *(Refer to Figure 2-15 for the Regional Geological Map and Figure 2-16 for Provincial Geological Map)*

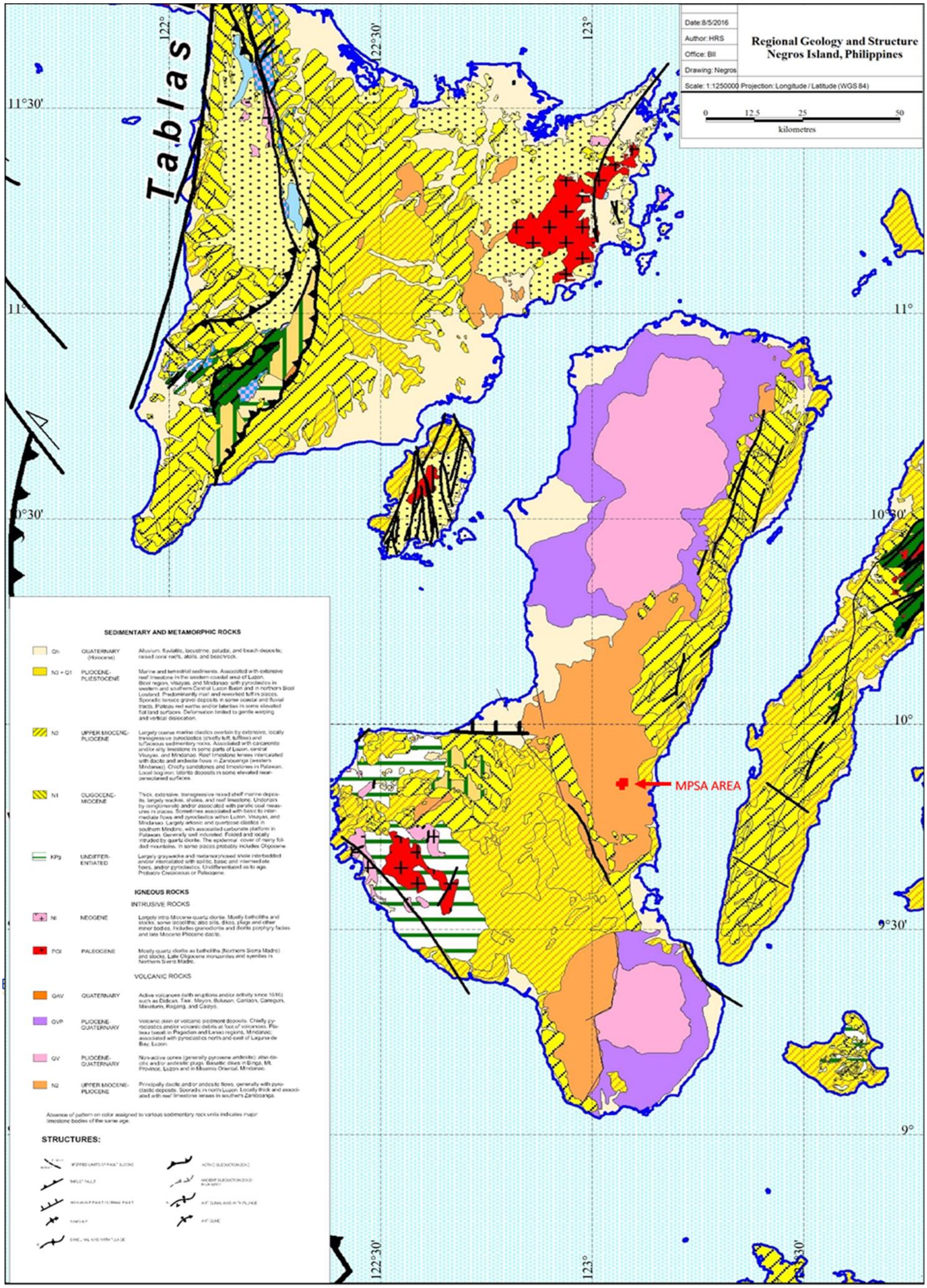


Figure 2-15. Regional Geological Map *(Source: MGB)*

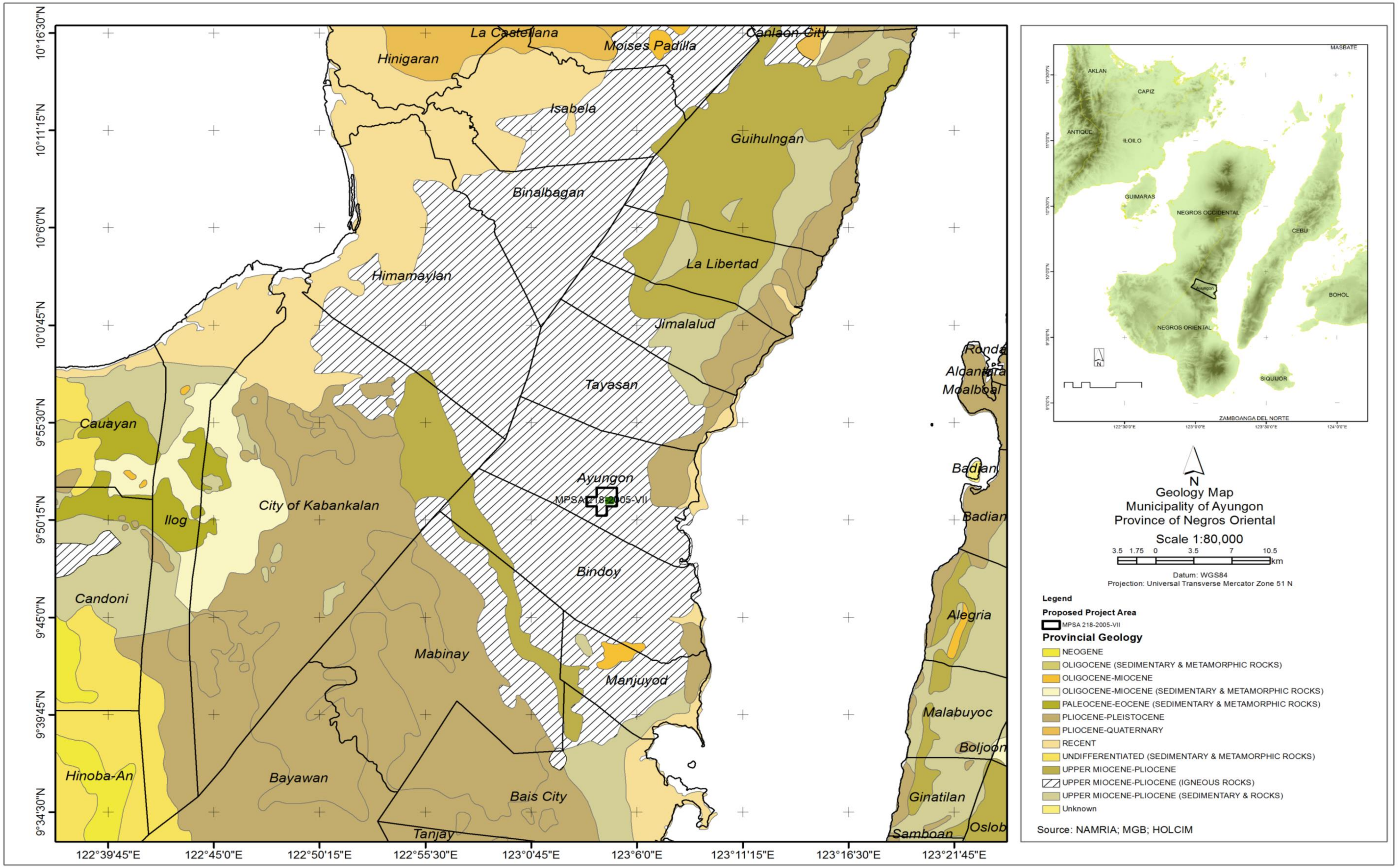


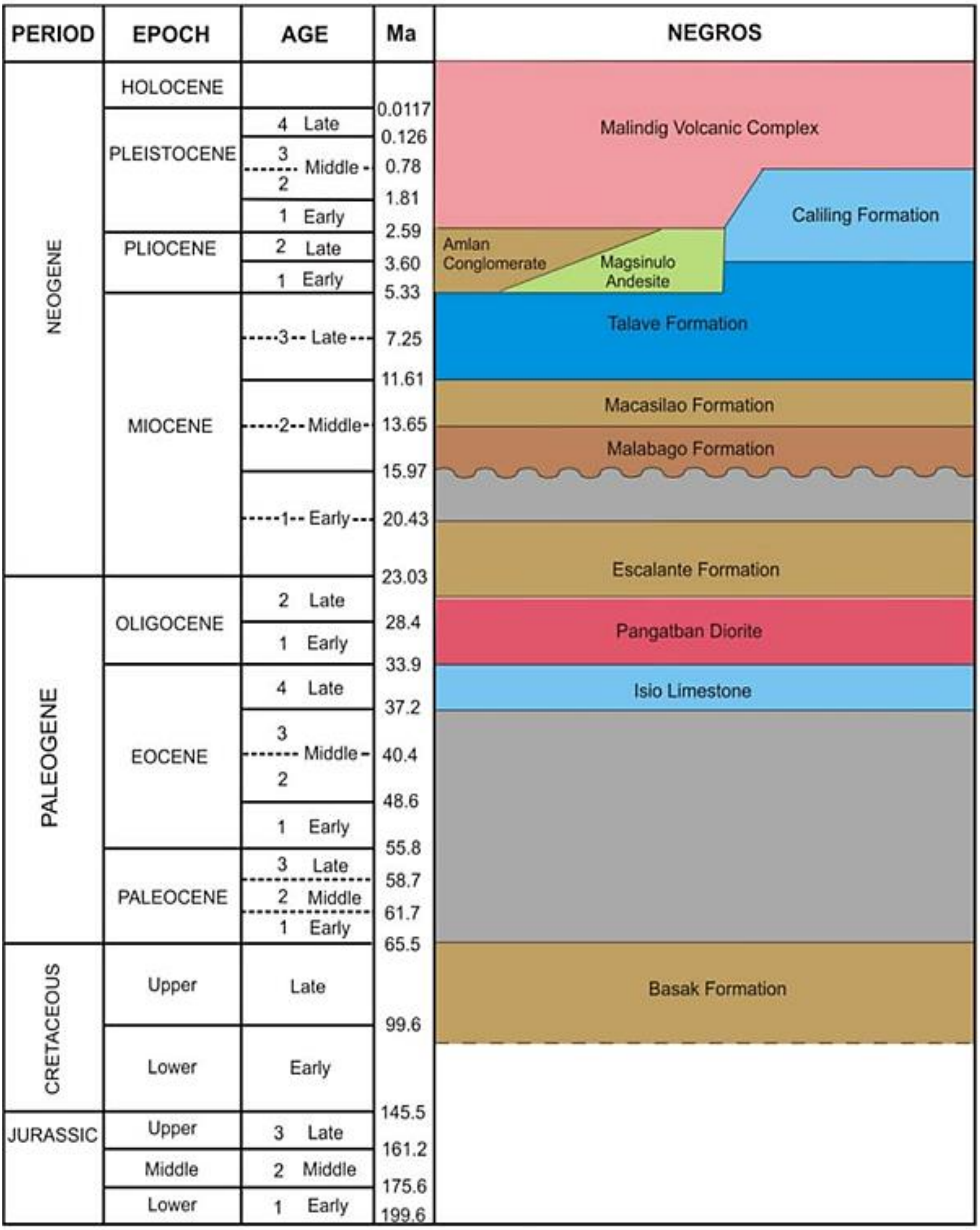
Figure 2-16. Provincial Geological Map *(Source: NAMRIA, MGB, HOLCIM)*

Regional Stratigraphy

Negros Island may be divided into three (3) distinct terranes, namely, the Recent Negros Arc, the Ancient Negros Arc, and the Visayan Sea Basin. Rock units from the Recent Negros Arc comprise the central portion of Negros Island, while units from the Ancient Negros Arc and the Visayan Sea Basin constitute the south-western and eastern portions of the island, respectively.

Ayungon and its adjacent cities and municipalities belong to the Recent Negros Arc underlain mostly by young Quaternary volcanics and volcanic clastic rocks of dacitic to andesitic composition, minor tuffaceous sandstone, shale and conglomerate. Neogene sedimentary rocks of agglomerates, conglomerate, sandstone, shale, mudstone and limestone occupy the central part of southern Negros. Quaternary bedded to massive, indurated locally conglomeratic limestone are found on the eastern coast. Intrusive rocks of quartz diorite, monzonites, dacite and syenites are mostly on the south-western part hosting several porphyry copper and gold deposits. Southern Negros is also host to active geothermal fields tapped for its geothermal energy.

Stratigraphic Column of Negros Island is shown in Figure 2-17.



Geologic Time Scale adopted from International Commission on Stratigraphy (2009)

Figure 2-17. Stratigraphic Column of Negros Island *(Source: MGB)*

Regional Structure

The most notable feature in the western Visayas is the Negros Trench. It is located offshore to the west of Panay and Negros Islands. It accommodates the eastward subduction of the oceanic crust of the Sulu Sea Basin. The active Mt. Kanlaon Volcano in central Negros and the geothermal fields in Palinpinon, southern Negros are associated with this trench. In this region PHIVOLCS has identified several active faults particularly in the major islands of the Visayas. In Negros Island, 5 active faults were delineated. One of this is the Central Negros Fault, a 57-kilometer-long NE-SW trending structure that transects the whole island at its central part. Four of the other unnamed faults are located to the west and south of the project area. The closest among these faults is located 15 km to the west of the project site. It is a NW-SE trending structure that is around 35 Km long. Several structures are also present in the island of Cebu. The closest ones are the Cebu lineaments consisting of two 42 Km long NNE-SSW structure located in the eastern and western part of the island. *(Refer to Figure 2-18).*

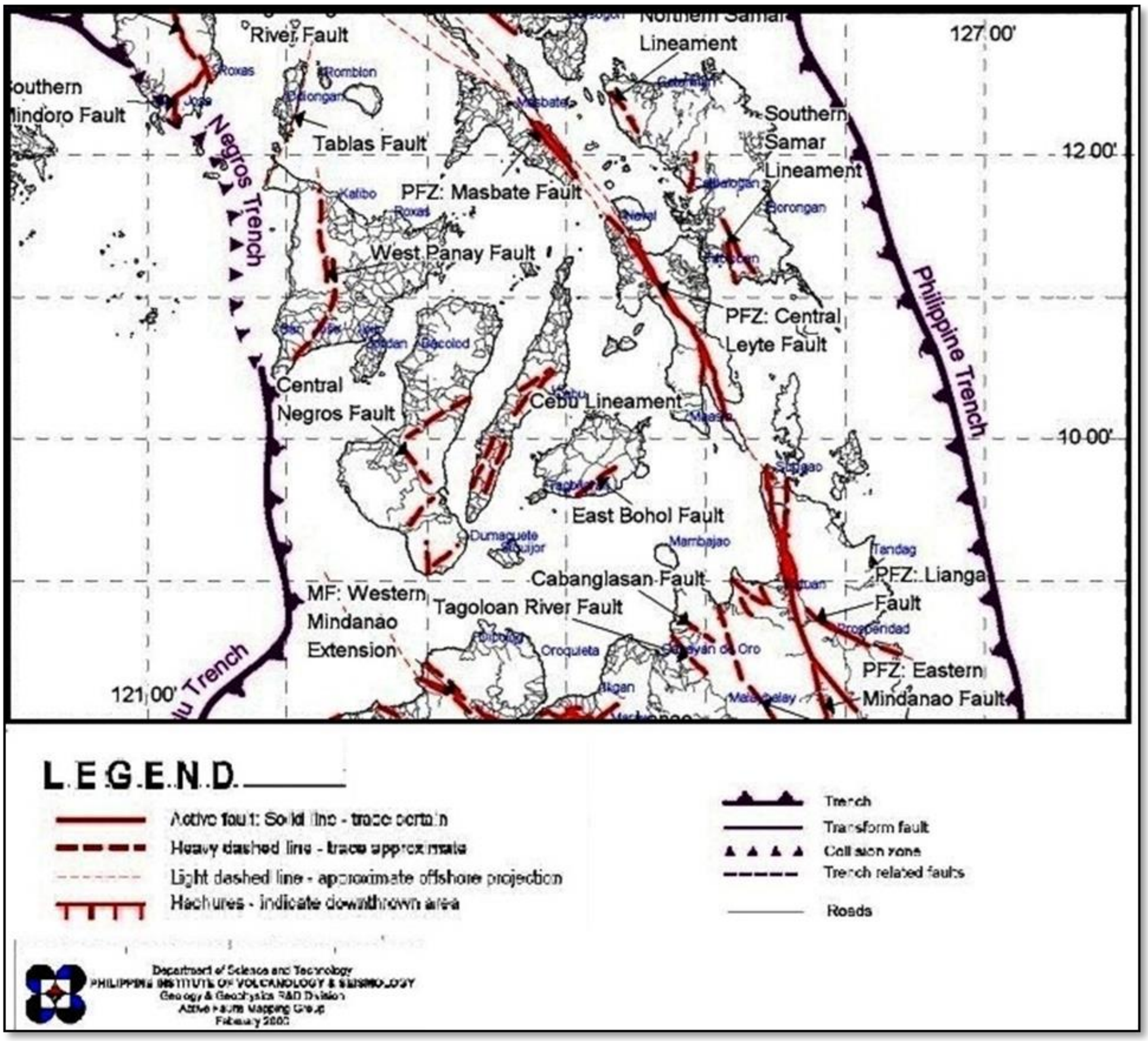


Figure 2-18. Regional Structures

Mineral Property Geology

Local Geology

The project area is part of the delineated epithermal system and consists of hydrothermally altered rocks. The rocks are mainly andesite and volcanoclastic rocks of tuff, breccia and/or agglomerate and belong to Paghumayan formation, initially identified by Salvado and Buenavista (1984). Argillic, Advance Argillic and Silicification type of hydrothermal alteration is very widespread. The hydrothermal fluids containing sulphides are believed to have travelled from vertical conduits such as fractures and faults then spread laterally which brought about massive argillization and silicification.

The Mid-miocene andesite serves as the basement rock and occurs in two types, porphyritic and massive andesite. The porphyritic andesite is grey to black and composed of hornblende and plagioclase phenocrysts. The massive andesite is fine-grained and shows pillow structures.

Hydrothermal alteration affected most of the andesite rocks; this includes silicification and argillization. Depending on the degree of alteration, the rocks vary in color from silicified andesite which is white to light brown in color and argillized andesite which is grayish brown to orange brown. Some of the argillized and silicified andesite contain disseminated pyrite and found mainly along Kapanangan and Kasalabajan creeks.

The volcanoclastic rocks overlying the andesite include breccia and/or agglomerate and tuff. The breccia is characterized by angular to sub-angular clasts of andesite within fine-grained to medium-grained matrix. Small bodies of this type of rock are found within the central portion of the project area and at Mt. Alot-alot which is highly silicified. Large breccia boulders are also found along Maaslum River. Mt. Alot-a lot is the name given by the local people of Barangay Maaslum to the peak on the upper reaches of Alot-alot Creek which is a tributay of Maaslum River. It is found on the southeastern portion of the property. On the northeast portion of the project area, where the existing quarry is located, a massive NW trending silicified zone is present. The silicified rock body is believed to be tuff which is highly jointed and permeable, so hydrothermal fluids easily spread laterally to cause massive silicification. The exposed face at the active quarry shows a silica deposit with approximate thickness of 100 m to 150 m. Surrounding the silicified zone are argillied rocks mainly andesite *(Refer to Figure 2-19).*

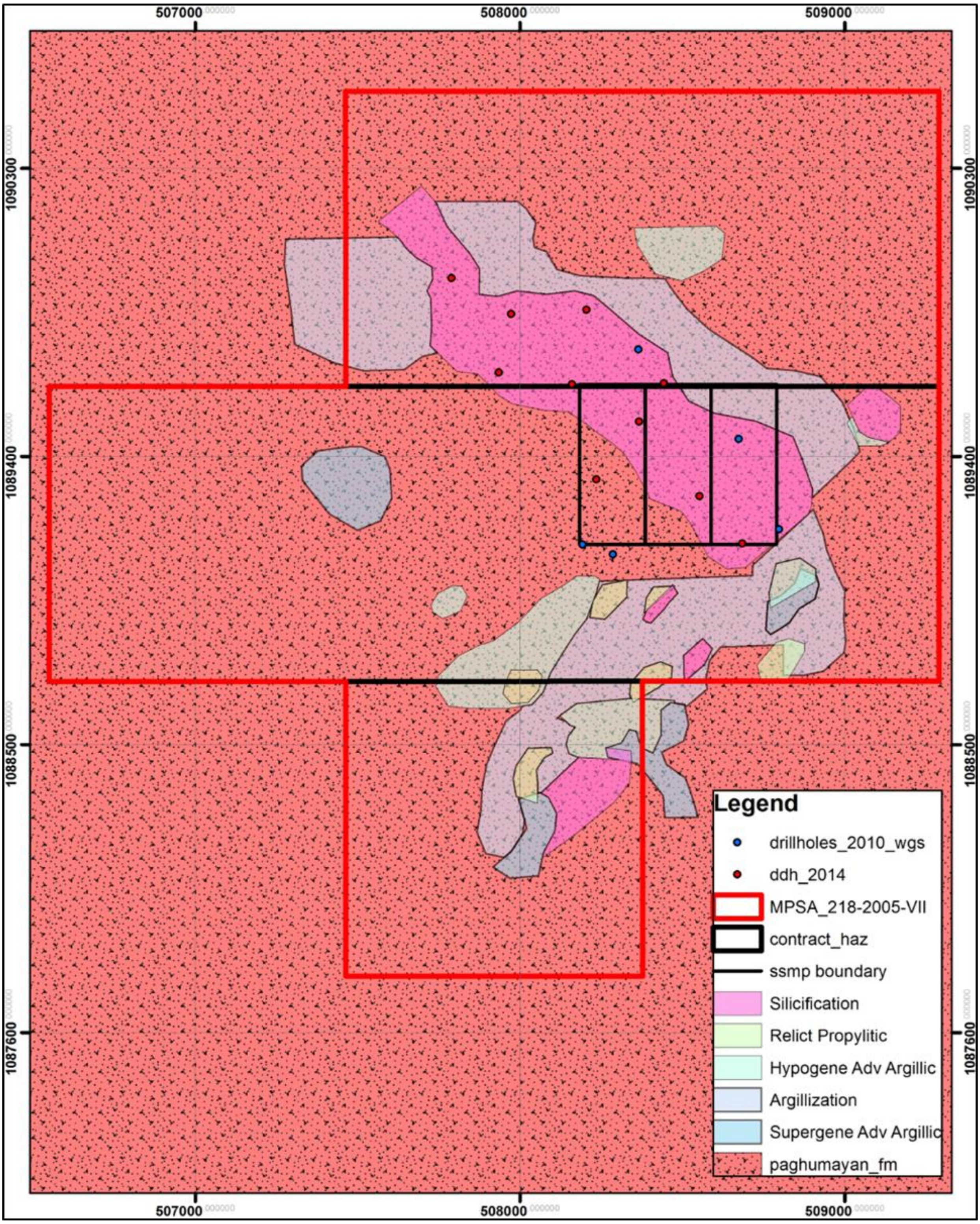


Figure 2-19. Geology of the Project Area *(Source: HRDC 2016)*

Local Lineaments and Structures

The general trends of the lineaments within at the project site are NW-SE, NE-SW and E-W. At least three (3) NW-SE lineaments were identified in the quarry area. Four (4) NE-SW lineaments are also present within the MPSA area. The projected intersection of these lineaments is basically the active quarry site. The faults exposed in the quarry correspond to the lineaments. Most of the faults are steeply dipping and oriented in two general directions, namely NW-SE and NE-SW. The newly exposed fault planes are also slight to moderately weathered indicating that these structures serve as the main conduit of water *(Refer to Figure 2-20).*

Geological Model

The Ayungon silicified rocks is part of an epithermal system and interpreted to be part of the silica cap of the system in the outflow zone of the system. The position of Ayungon hydrothermal altered zone is shown in a typical epithermal system model in Figure 2-21.

Alteration

Detailed mapping in the MPSA area focused on alteration mapping to delineate the silicified zone in the area. Alteration type and mineralogy identified is shown in Table 2-4.

Table 2-4. Alteration Type and Mineralogy

Alteration Type	Minerals in the Silica Quarry
Silicification	Quartz, Illite
Argillization	Pyrite, smectite-illite and other interlayered clays, minor zeolites, quartz
Low Temperature, near surface hypogene Advance Argillic	Alunite, kaolinite, sulphur, cristobalite, tridymite
Supergene Advance Argillic (weathering)	Alunite, kaolinite, sulphur, cristobalite,
Propylitic	Chlorite, calcite, illite, epidote

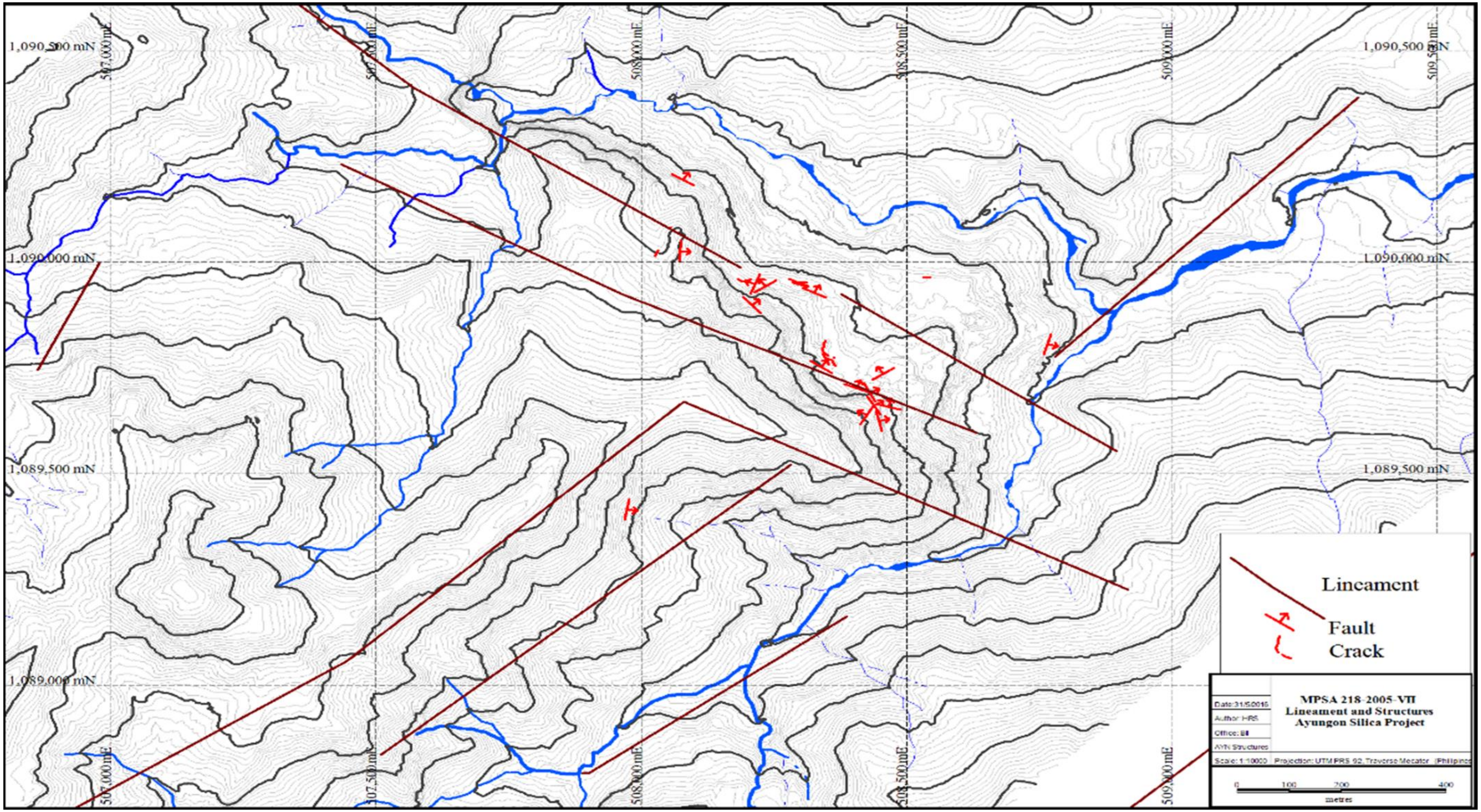


Figure 2-20. Lineaments and Structures *(Source: HRDC 2016)*

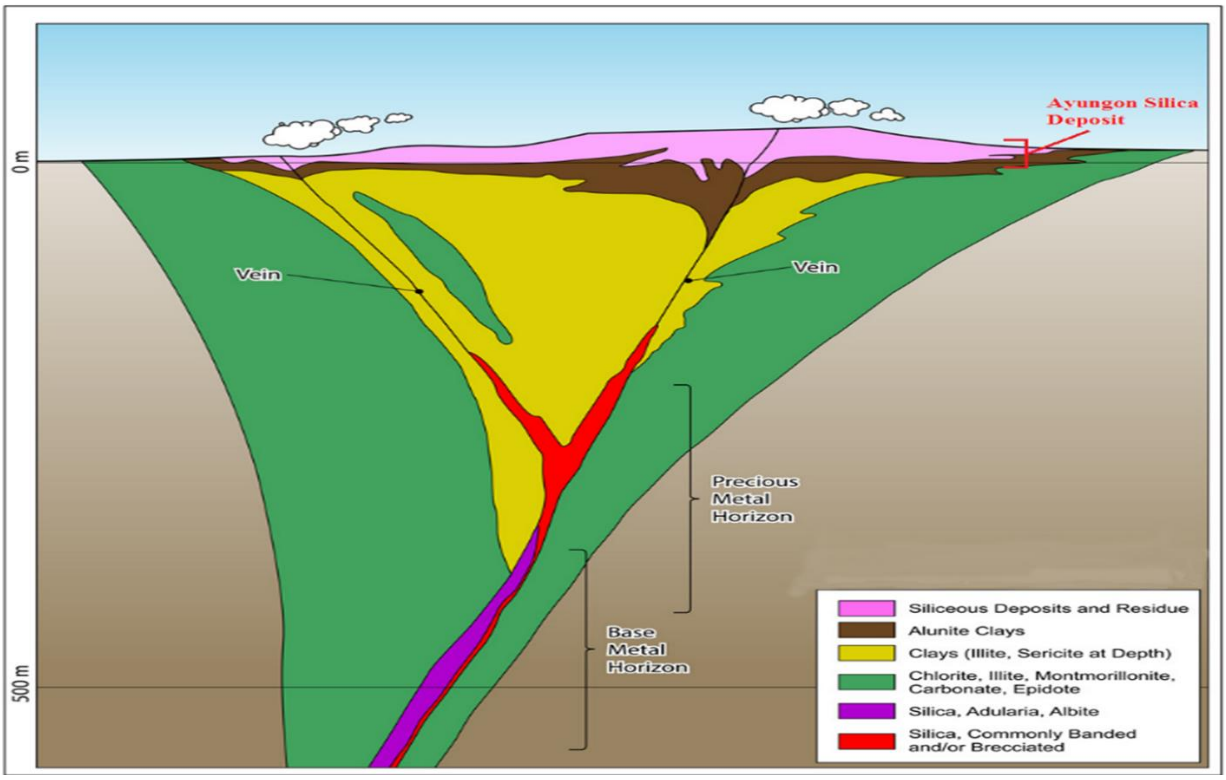


Figure 2-21. Epithermal System Model *(Source: HRDC, 2016)*

Silicification

Massive silicification is found at the center of the area about 1,580 in long and 350 wide at the center, with an area of 481,600 square meters. The silicified zone trends NW-SE parallel to the lineaments. The silica body is believed to be part of the silica cap in the epithermal system that is still active in the area. The silica body has been well exposed in the quarry face with more than 150 meters thickness. *(Refer to Figure 2-22, 2-23, 2-24 and 2-25).*

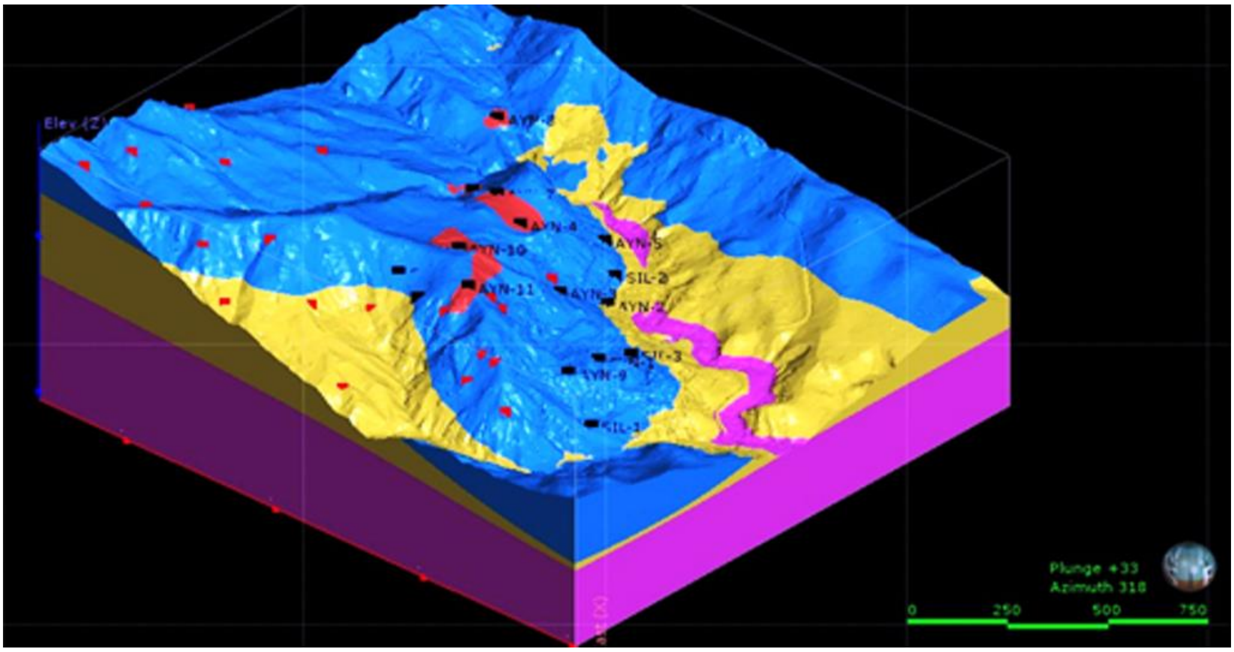


Figure 2-22. Tilted view of the deposit showing the thickness of each unit. The silicified portion pinches out towards the east

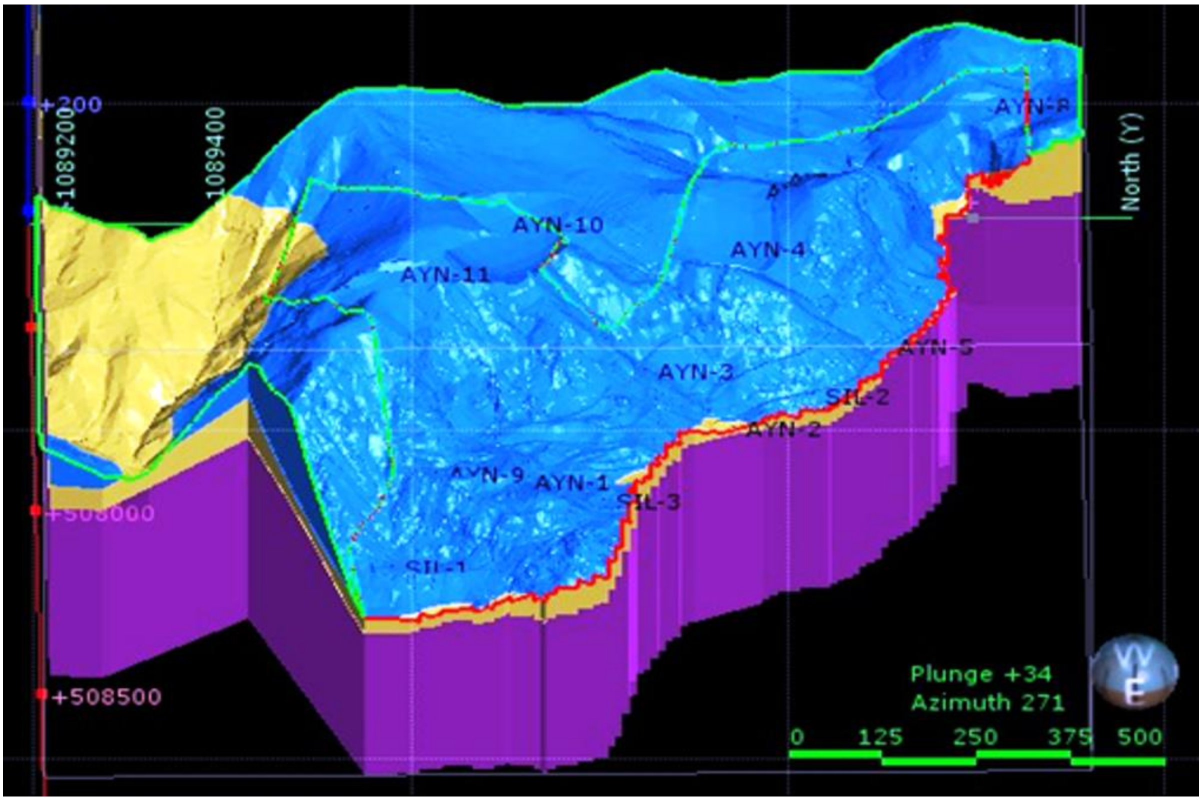


Figure 2-23. Tilted view of measured and indicated resources

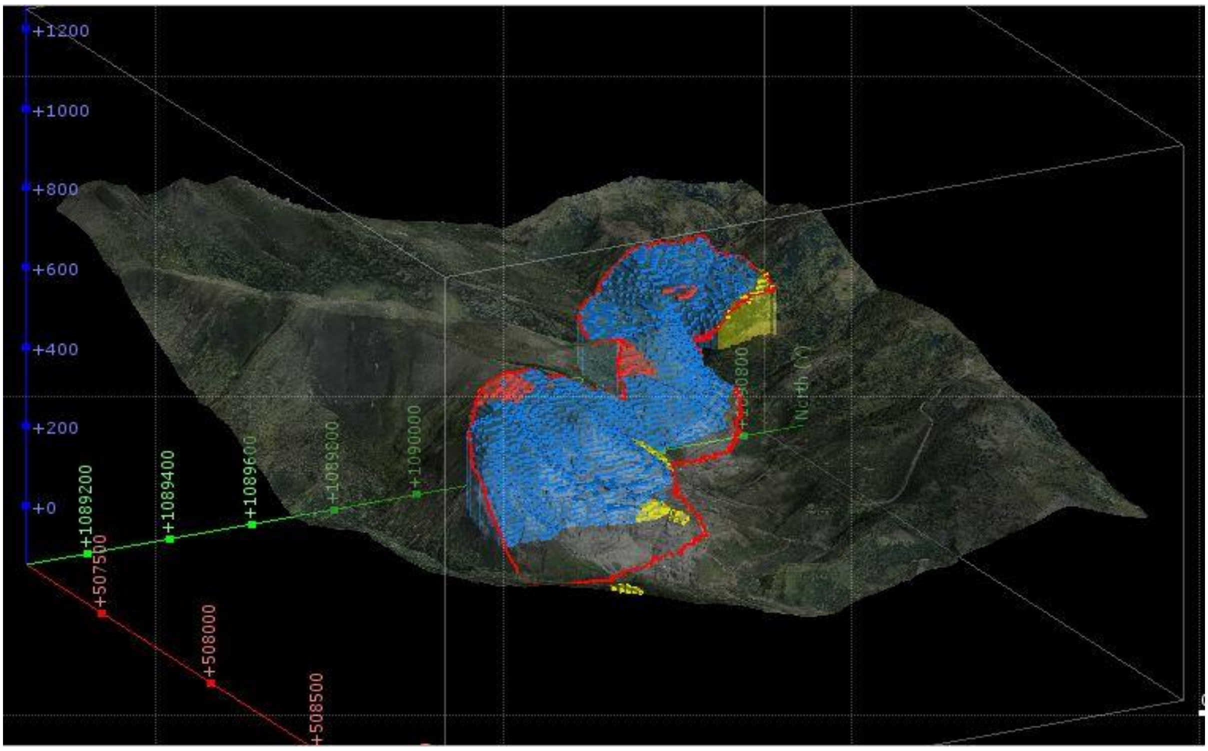


Figure 2-24. Mineable reserve looking southeast

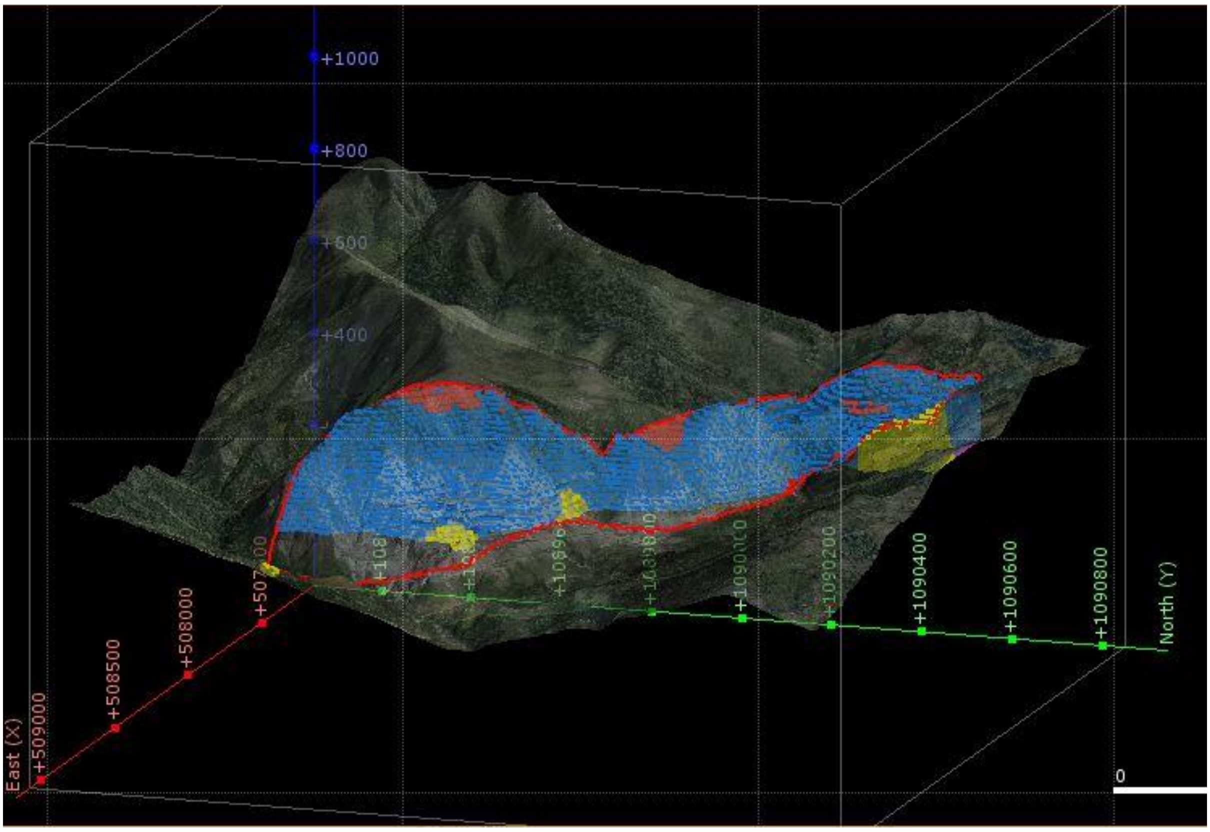


Figure 2-25. Mineable reserve looking east

The occurrence of silica deposit is only within the five (5) mining claims of the MPSA area namely JOE, DOLL, MARI, DINI and DING. The type of silica deposit identified in the area can be classified into three (3) groups; massive and crystalline type, boulder-sized silicified rocks and fine to pebble-sized silica fragments.

The massive and crystalline type of silica deposit occurs mainly in the southeastern portion of JOE. The deposit is hard and white to gray in color and generally trends northwest. It occurs at 450 m to 550 m elevations. The rock is highly fractured and joint readings give a general trend of NE and dip direction of NW. Small patches of hard silicified rocks are also present in Kapanangan creek.

The boulder-sized (0.5 m to 1 m in diameter) silicified rock deposit occurs at DOLL and scattered along topographic highs of 650m to 700m. The area where this deposit occurs is locally known as Masantikan area. In between the boulders are fine silica (1/64mm) and pebble-sized (6.4mm) silica fragments. On the eastern part of MARI near DINI at an elevation of 450 meters, this type of deposit also occurs.

The fine silica deposit and pebble-sized silica fragment occur in MARI, DOLL, DINI and DING claims. Exposed deposits are present in the NE trending ridge within DINI, MARI and DING claims. The ridge is covered with ferns which typically grow in this type of environment. Previous test pit was encountered within DINI with depth of 3m. The silica has light brown color due to oxidation and becomes lighter at depth.

Argillic Alteration

Argillic alteration borders most of the silicification in the quarry area. Three (3) types of the Argillic alteration were recognized. Argillization from ascending magmatic fluid, low temperature advance argillic mostly at the border of the silicified body and representing the outflow zone of the system and advance argillic as a product of weathering of the rocks and is found mostly in the areas of high relief. Massive very fine pyrite zone is found in the argillic zone together with smectite-Illite. The supergene and hypogene argillic alteration have the same suite of alteration minerals and is hard to differentiate. Its location in the area is the only differentiating factor.

Geometry of Silicified Body

The main silicified body is about 1,580 in long and 350 wide at the center, with an area of 481,600 square meters. The silicified zone trends NW-SE parallel to the local lineaments (and). Base on drill hole data Silicification tapers down and grade into Silicified and argillized zone at 300 to 350 meters elevation. AYN_10 and AYN_11 the topmost hole (on ridge top) bottomed on still silicified rock which is at 395-meter elevation. This equate to more than 160 meters thickness of the silicified zone.

SiO2 values and Distribution

SiO2 has a mean value of 82.28% on the drill core samples and 88.01% on the test pit samples on the silicified rock. Seventy-five (75%) percent of the samples has values greater than 63% SiO2 which pass the requirement of 62% SiO2 for raw material in cement production. SiO2 values in the silicified body are all greater the requirement for cement raw material. Values below 50% SiO2 are samples from the argillized zone. The SiO2 values are fairly distributed throughout the silicified body.

Change in Surface Landform/Geomorphology/Topography/Terrain/Slope

The project area and its immediate vicinities are characterized by rugged topography. This rugged volcanic terrain consists of prominent ridges, gullies, steep-sided valleys and plateau. The elevation varies from 200m to 800m above sea level. The highest point, Mt. Alot-a lot, reaching approximately 815 meters above sea level (msl) is in the western part of the project area *(Refer to Figure 2-3: Topographic and Drainage Map of the Project Area).* Due to the nature of the project, it is expected that the face of the active quarry site would have steep to very steep slope and significant change on the top elevation in the quarry site due to the extraction of the silica rock. Change in surface landform/ geomorphology/ topography/ terrain/ slope is therefore inevitable.

Mining Method that will be Employed

The general method of mining currently used at the quarry is surface open cast mining. The method is divided into two (2) stages; a) area development and b) extraction (production) stage. Area development is the stage where preparations for extraction are carried out. It involves stripping, removal of vegetation, waste overburden to expose the silica raw material resource and facilitate extraction of silica. This phase also involves the establishment of drainage and access to the deposit. The topography will be cut into a series of slices of five (5) meter height and an 80deg. bench slope. Stripping will start at the uppermost portion (Elev. B+570) of the topography and progresses downward. Once the ground is cleared / flattened, a new working level below (5m downward) is worked out to form a bench with at least 15 m width which is wide enough to allow load and haul fleets to manuever. Generally, the working parameters of the silica quarry are as follows: Bench slope 75-85deg bench height of 5 meters, Bench width 15-meter min. Pit slope is 20-50m.

In the extraction stage, exposed silica will be ripped using a bulldozer with ripping mechanism. Backhoe with breaker will be utilized in selected areas where the material is not rippable. The loosened silica will then be pushed by the bulldozer towards the designated loading areas. These will then be loaded using a backhoe into the dump trucks. Then, these will be transported to the port passing through the developed quarry road to the barangay road. There will be no blasting that will be done.

Change in Sub-surface Geology/Underground Conditions

The project area is part of the delineated epithermal system and consists of hydrothermally altered rocks. The rocks are mainly andesite and volcanoclastic rocks of tuff, breccia and/or agglomerate and belong to Paghumayan formation, initially identified by Salvado and Buenvaista (1984). Argillic, Advance Argillic and Silicification type of hydrothermal alteration is very widespread. The hydrothermal fluids containing sulphides are believed to have travelled from vertical conduits such as fractures and faults then spread laterally which brought about massive argillization and silicification.

The Mid-miocene andesite serves as the basement rock and occurs in two (2) types, porphyritic and massive andesite. The porphyritic andesite is grey to black and composed of hornblende and plagioclase phenocrysts. The massive andesite is fine-grained and shows pillow structures. Hydrothermal alteration affected most of the andesite rocks; this includes silicification and argillization. Depending on the degree of alteration, the rocks vary in color from silicified andesite which is white to light brown in color and argillized andesite which is grayish brown to orange brown. Some of the argillized and silicified andesite contain disseminated pyrite and found mainly along Kapanangan and Kasalabajan creeks.

The volcanoclastic rocks overlying the andesite include breccia and/or agglomerate and tuff. The breccia is characterized by angular to sub-angular clasts of andesite within fine-grained to medium-grained matrix. Small bodies of this type of rock are found within the central portion of the project area and at Mt. Alot-alot which is highly silicified. Large breccia boulders are also found along Maaslum River. Mt. Alot-a lot is the name given by the local people of Barangay Maaslum to the peak on the upper reaches of Alot-alot Creek which is a tributay of Maaslum River. It is found on the southeastern portion of the property. On the northeast portion of the project area, where the existing quarry is located, a massive NW trending silicified zone is present. The silicified rock body is believed to be tuff which is highly jointed and permeable, so hydrothermal fluids easily spread laterally to cause massive silicification. The exposed face at the active quarry shows a silica deposit with approximate thickness of 100 m to 150 m. Surrounding the silicified zone are argillized rocks mainly andesite.

There will be no change in the sub-surface geology/underground condition for the planned quarry operation is just an open cut and it would not dig down and create a pit. The silicified body to be mined persist from the top elevation to the present quarry main level. Management measures to minimize the impacts to environment are discuss in the succeeding sections. Figure 2-14 shows the Regional Geological Map.

Mitigating Measures for Surface and Sub-surface Landform Impacts

Significant impact to landform/geomorphology is expected in the nature of the project. In order to mitigate the worst possible effect, best-practice mining techniques will be adopted by the proponent to reduce landform alteration of the quarry site to the minimum and render the area easy and amenable to post-mining restoration. In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stockpiles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope. To protect the slope and mine-affected zones from water-induced erosion, creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

Systematic mining that reduces selective extraction of silica or will be pursued to minimize creation of deep terrestrial voids, residual mounds and disfigured landscape.

Inducement of Subsidence, Liquefaction, Landslides, Mud Debris Flow, etc.

Subsidence

Subsidence is the sinking or settling of the ground surface. This can be caused by natural phenomena such as removal of underground fluids, natural consolidation, or dissolution of underground minerals, or by man-made phenomena such as underground mining. Subsidence may occur gradually over many years as sags or depressions form on the ground surface. It's more infrequent, but subsidence can occur abruptly-virtually instantly-as dangerous ground openings that could swallow any part of a structure that happen to lie at that location or leave a dangerous steep-sided hole (ground subsidence). The geology at the project site is of solid rock formation that no subsidence is expected to occur in the area. *(Refer to Figure 2-5).*

Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world.

Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

No liquefaction will occur in the project site because of the nature of its geology in of the area which is made up of solid volcanic rocks and due to its alteration, it does not develop a thick soil profile. *(Refer to Figure 2-5).*

Landslides

The project area and its immediate vicinities are characterized by rugged topography. This rugged volcanic terrain consists of prominent ridges, gullies, steep-sided valleys and plateau. The Mines and Geosciences Bureau has mapped the area as highly susceptible to landslides. Landslides and rock fall would occur on the face of the quarry site especially during extreme heavy rainfall. In order to mitigate the worst possible effect, best-practice mining techniques will be adopted by the proponent to mitigate landslides and rock fall In this case, best-practice mining involves contour benching, good drainage maintenance and onsite collection and stockpiling of over burden spoils and mine waste for reintroduction into the quarry site after the mining. The stock piles will also serve as temporary earth barriers to prevent disturb soils from cascading down-slope. The benches and haulage road would serve as buffer zones to the landslides and rock fall. *(Refer to Figure 2-4).*

Safety practices would be implemented to prevent damage to lives and properties one of which is to stay away from the quarry face and stop operation during extreme weather conditions.

Mudflow

No mud flow will occur in the project site because of the nature of its geology in which the area is made up of solid volcanic rocks which is due to its alteration does not develop a thick soil profile and or mud.

Ways to protect the slope and mine-affected zones from water-induced erosion will be the creation of small diversion channels along bench toes to slow down water flow on slope and soil surface and resulting to surface ripping in special cases to improve soil permeability and encourage water infiltration.

3. Pedology

Soil Types

Generally, the soil found within the project site is categorized as rough/rocky mountainous soil. This means that the project has homogenous soil type. Other soil types found in Ayungon are shown below.

Table 2-5. Soil Types in Ayungon, Negros Oriental

Soil Type	Location Barangay	Area (ha)	Percent
San Manuel Loam	Iniban, Awa-an, Poblacion, Tampocon II, Tampocon I and Tiguib	500.00	1.78
La Casstellana Clay	Anibong, Candana-ay, Calagcalag, Tiguib	1,040.00	3.69
Isabela Clay	Tiguib	40.00	0.14
White Clay	Banban	15.00	0.05
Silica Sand	Maaslum, Banban and Jandalamanon	640.00	2.27
Benthonite Clay	Banban	52.63	0.19
Rough/Rocky Mountainous	Nabhang, Lamigan, Banban, Tambo, Tibyawan, Maaslum, Mabato, Jandalamanon, Manogtong, Candana-ay, Inaccban, Gomentoc, Amdus, Kilaban, Atabay, Iniban, Awa-an, Poblacion, Tampocon I, Tampocon II, Anibong	25,877.00	91.87
Beach Sand		2.90	0.01
TOTAL		**28,167.53**	**100.00**

Summary of Exploration Report

The project area was previously covered by quadrangle mapping by Mines and Geosciences Bureau Regional Office VII Cebu (MGB MROVII) and identified the epithermal system and the extensive hydrothermal alteration in the area in 1983 in the volcanoclastic rocks of Paghumayan Formation (Salvado and Buenavista 1984). The United Nations Development Program (UNDP) "*Strengthening the Government Capability in Gold Exploration,"* conducted a study on the hydrothermal alteration in Maaslum and Banban area in the course of its research on gold mineralization in the epithermal system in the Philippines.

By virtue of the Operating Agreement, HRDC conducted reconnaissance geologic mapping, followed by semi-detailed geologic mapping of the whole MPSA area covering the 505.4626 hectares. Test pitting was then undertaken on the area to obtain samples for chemical analysis. Diamond drilling followed this exploration activity to determine the depth extent of the silicified body and obtain sub-surface samples for resource estimation.

Surface Exploration

Geologic and Alteration Mapping

Reconnaissance and semi-detailed geologic mapping were conducted in the area in the mid-2010. Mapping and surface sampling were carried out on a scale of 1:10,000 with the aid of GPS, brunton compass and topographic map of the area. Outcrops along access routes and stream tributaries were examined to properly delineate the spatial distribution of the different rock units. The quantity and quality of these raw materials as well as structural and geological controls or features that might affect future quarry operations were also considered. Channel sampling was done whenever outcrops are encountered. A total of 38 surface samples were collected with average weight of 50 kgs. The semi-detailed mapping focused on the delineation of the surface extent of the silicified body as well as other hydrothermal alteration in the area (Argillic and Advace Argillic).

Rock Sampling

During the semi-detailed geologic mapping of the area a total of 38 surface samples were collected with average weight of 50 kilograms. The samples collected are all silicified rocks and were sent to Holcim Lugait plant's Quality Assurance Laboratory for XRF analyses.

Test Pitting

For preliminary subsurface investigation, thirty-two (32) test pits were also dug and sampled, with a total aggregate depth of 113.2 meters. The test pits average depth of 3-5 meters and width of 1 meter. Rock chip vertical channel sampling was implemented at constant interval of 1 meter and then composited per test pit. All samples were sent to Holcim Lugait plant's Quality Assurance Laboratory for XRF analyses and to TSPD Pasig Laboratory for grain size analyses. Test pit result of analysis statistics is tabulated in Table 2-6.

Table 2-6. Test Pit Results of Analysis

Rock Type	Element	No. of Sample	Min.	Max.	Mean	Median	Variance	Standard Deviation	Geometric Mean
Argillized_ Silicified	SiO2	5	40.52	58.40	49.67	48.17	51.02	7.14	49.25
Silicified	SiO2	27	62.58	98.19	88.01	94.59	130.06	11.40	87.22
Argillized_ Silicified	Al2O3	5	13.67	28.49	21.93	21.61	33.91	5.82	21.25
Silicified	Al2O3	27	0.11	19.21	4.23	0.95	36.75	6.06	1.49
Argillized_ Silicified	Fe2O3	5	6.13	19.25	11.59	9.11	29.05	5.39	10.64

Rock Type	Element	No. of Sample	Min.	Max.	Mean	Median	Variance	Standard Deviation	Geometric Mean
Silicified	Fe2O3	27	0.04	10.86	2.99	1.02	10.97	3.31	1.20
Argillized_ Silicified	MgO	5	0.08	1.78	0.71	0.42	0.45	0.67	0.46
Silicified	MgO	27	0.02	0.37	0.11	0.10	0.00	0.06	0.09
Argillized_ Silicified	K2O	5	0.11	1.96	0.70	0.23	0.66	0.81	0.37
Silicified	K2O	27	0.01	1.63	0.15	0.03	0.11	0.34	0.05
Argillized_ Silicified	TiO2	5	0.64	0.85	0.75	0.76	0.01	0.08	0.75
Silicified	TiO2	27	0.53	2.23	1.13	0.98	0.16	0.40	1.07
Argillized_ Silicified	SO3	5	0.09	5.78	1.29	0.18	6.29	2.51	0.32
Silicified	SO3	27	0.00	2.00	0.20	0.05	0.16	0.40	0.08
Argillized_ Silicified	LOI	5	7.10	16.06	12.64	13.34	13.42	3.66	12.14
Silicified	LOI	27	0.29	8.46	2.63	1.35	6.33	2.52	1.69

Drilling

Drilling Campaign

Two (2) diamond drilling campaigns have been undertaken in the area for resource definition of the silica deposit. The first drilling campaign consists of five (5) drill holes with total meterage of 200 meters. The deepest hole for this campaign (SIL1) bottomed out at 60m from the surface while the shallowest one (SIL5) bottomed out at 15m. Average core recovery for this campaign is 90.45%.

The second drilling campaign was undertaken during 2013-2014, comprising eleven (11) drill holes with a total meterage of 1,324.60m. For this campaign, the deepest hole (AYN-6) bottomed out at 250m while the shallowest holes (AYN-2 and AYN-5) bottomed out at 50m from the collar. Average core recovery is at 95.90%.

Both drilling campaigns were carried out by Construction Drilling and Specialists, Inc. (CDSI), a third-party service provider for HRDC. A Longyear_38 drill rig was used with double tube wire line system and PQ to NQ core size was used in the second drilling campaign. Drill hole statistics is shown in Table 2-7.

Collar Surveying

Survey of drill hole locations and was carried out by Nth Geographics and Geometrics, (HPI surveying contractor) from Davao City. The survey was undertaken using PRS 92 coordinate system. Survey points are tied to NAMRIA Geodetic Control Point NGE-72 located in Poblacion North, Ayungon, Negros Oriental. Survey was done using Leica Flexline TS06R1000 and Leica Flexline TS06R400 (with Bluetooth) Total Station, US Handheld Nautiz X7 and Leica GS09/GS14 GNSS (GPS+GLONASS) GPS Units. Upon completion of drilling, clearing and rehabilitation of sites were accomplished, and concrete bore hole monuments were established as markers on the location of drill holes. Re-survey was also conducted to define the actual locations of holes after drilling.

Core Logging

Drill core logging was undertaken by HRDC geologist at HRDC field office in Tampocon, Ayungon using the company logging form. Photographs were taken of each core box which contains 5 meters of core each. Lithology was described as well as porosity and degree of oxidation. Recovery per run was measured but no rock quality data (RQD) was taken from the core.

Sampling Method and Analysis

Cores obtained from the 16 drill holes with a total meterage of 1,524.60 m were sampled for chemical analyses. After the logging, sampling interval were marked and labelled on a core block. The core was split in half using a diamond saw. The half core was bagged as sample for chemical analysis and the other half was put back in the core box for storage and archive. The other split half was dried overnight in an oven at temperatures of 50°-200°C°. After drying, it was then crushed to 5-10 mm size fragments and then dried again. The crushed fragments were quartered, and the bulk of the sample is placed in a bag as reference samples. About 200-300 grams of the split is pulverized further. The pulverized sample is divided further into two; the other half is kept for reference. Processed core samples were then sent to the QA Laboratory of Holcim Philippines Lugait Plant (first drilling campaign) and to SGS Australia (second drilling campaign) for chemical analysis. A total of 1,101 core samples was collected and were prepared and then subjected to X-Ray Fluorescence to analyze for major oxides. Core samples from the first drilling campaign (109 samples) were sent to the QA Laboratory of HPHI Lugait Plant. All samples from the second drilling campaign (992 samples) were sent to SGS Australia. Borehole logs are then encoded and stored in digital format. Samples were analyzed for twelve major oxides: SiO2. Al2O3, Fe2O3, CaO, MgO, SO3, K2O, Na2O TiO2, Mn2O3, P2O5 and Cl.

Table 2-7. Diamond Drill Hole Statistics

DDH_ID	Northing	Easting	Elevation (m)	Length (m)	Azimuth (deg)	Dip (deg)	% Recovery	No. of Samples	Total Length of Sampling	Percent Sampled	Start date	Completion date
AYN-1	1089783.96	508504.01	363.00	100.0	0.00	-90	96.60	66	97.60	97.60%	11/4/2013	11/21/2013
AYN-2	1090066.31	508279.59	307.11	50.0	0.00	-90	96.35	35	49.20	98.40%	11/2/2013	11/14/2013
AYN-3	1089950.22	508223.95	375.76	75.0	0.00	-90	93.14	52	71.72	95.63%	12/3/2013	1/3/2014
AYN-4	1090049.10	508000.55	447.98	139.3	0.00	-90	98.50	97	137.80	98.92%	9/7/2014	10/2/2014
AYN-5	1090269.76	508084.01	325.38	50.0	0.00	-90	98.60	37	49.30	98.60%	11/16/2013	11/30/2013
AYN-6	1090128.39	507765.13	418.85	250.0	0.00	-90	97.00	188	244.80	97.92%	7/7/2014	8/24/2014
AYN-7	1090100.02	507874.43	468.14	75.0	0.00	-90	96.44	63	70.25	93.67%	8/21/2014	9/2/2014
AYN-8	1090406.55	507597.91	440.62	113.3	0.00	-90	97.00	113	111.50	98.41%	6/3/2014	6/20/2014
AYN-9	1089670.25	508509.14	379.60	170.0	0.00	-90	97.00	117	165.15	97.15%	1/16/2014	4/20/2014
AYN-10	1089759.59	508055.61	536.04	142.0	0.00	-90	94.95	111	135.95	95.74%	9/14/2014	10/15/2014
AYN-11	1089609.31	508224.82	558.87	160.0	0.00	-90	93.09	113	147.60	92.25%	11/29/2014	12/26/2014
SIL1	1089610.05	508639.15	295.53	60.0	0.00	-90	86.50	34	60.00	100.00%	10/30/2010	11/24/2010
SIL2	1090172.70	508206.45	315.79	50.0	0.00	-90	87.35	24	48.85	97.70%	11/29/2010	12/6/2010
SIL3	1089892.14	508515.15	333.44	30.0	0.00	-90	88.17	17	27.25	90.83%	12/9/2010	12/17/2010
SIL4	1089562.67	508034.35	590.00	45.0	0.00	-90	96.89	25	45.00	100.00%	1/10/2011	3/2/2011
SIL4B	1089532.06	508127.80	575.00	15.0	0.00	-90	93.33	9	14.10	94.00%	3/23/2011	3/26/2011
Total Average	16 Drill Holes			1,524.6			95.38	1,101	1,476.07	96.82%		

Results of Analysis

A total of 1,101 core samples were collected from the drilling campaign. All drill core samples were analyzed for twelve major oxides namely SiO2. Al2O3, Fe2O3, CaO, MgO, SO3, K2O, Na2O TiO2, Mn2O3, P2O5 and Cl. Moisture content (LOI) was also measured on all the samples. Statistics on the result of analyses on these samples is shown in Table 2-8.

Result shows that 75% of the samples passed the cut-off grade of 62% SiO2 as a raw material for HPI cement plant in Lugait and Davao. The Fe2O3 and SO3 values are acceptable. The exploration activity delineated a silica deposit with a chemical composition that can be used as a raw material on Holcim cement plants and other purposes because of its high SiO2 content.

Specific Gravity Measurement

Twenty-five half core samples from the 2014 drilling campaign were collected for specific gravity measurement of the silicified rock in the area. Samples were chosen to represent the different type of silicification in the area. Density measurement was undertaken at the Holcim Lugait Laboratory by Jobec D. Pugales, Chemical Analyst at Holcim Lugait Laboratory. The edge of all the samples were first trimmed with a diamond cutter so as both ends would have a flat edge. Height of each samples were measured using a Vernier caliper to exactly measure its height. The volume of each sample is then calculated using the different core size diameter. Mass of each samples were taken using a pan balance. Average dry density obtained was 1.80 as shown in Table 2-9.

Lost on ignition (LOI) was included in the sample analysis of core samples at SGS laboratory. By adding this lost to the dry weight of the samples. Calculated wet weight was obtained. The average wet density of the samples was calculated to be 1.85 as shown in Table 2-9.

Table 2-8. Drill Samples Statistics on Results of Analysis

Oxides/ Element	No. of Samples	Minimum	Maximum	Mean	Median	Variance	Standard Deviation	Percentile 25	Percentile 50	Percentile 75	Percentile 90	Count Equal Zero	Geometric Mean
SiO2	1,101	32.51	99.30	82.28	91.44	304.536	17.451	63.20	91.44	97.09	98.00	0	80.156
Al2O3	1,101	0.01	28.80	5.21	0.54	56.845	7.540	0.31	0.54	10.30	19.10	0	1.132
Fe2O3	1,101	0.02	36.30	5.57	4.13	38.396	6.196	0.47	4.13	8.67	12.30	0	2.074
CaO	1,101	0.01	5.46	0.19	0.08	0.203	0.450	0.04	0.08	0.16	0.39	0	0.084
MgO	1,101	0.00	5.11	0.21	0.04	0.312	0.558	0.02	0.04	0.12	0.53	64	0.068
K2O	1,101	0.01	3.67	0.39	0.03	0.482	0.694	0.01	0.03	0.45	1.48	0	0.057
Na2O	1,101	0.00	3.65	0.21	0.03	0.265	0.515	0.02	0.03	0.12	0.52	118	0.062
TiO2	1,101	0.30	11.80	1.09	0.93	0.481	0.693	0.74	0.93	1.24	1.69	0	0.988
P2O5	1,101	0.00	0.79	0.07	0.02	0.011	0.103	0.00	0.02	0.13	0.21	334	0.057
MnO	1,101	0.00	0.23	0.01	0.00	0.000	0.021	0.00	0.00	0.00	0.02	915	0.021
SO3	1,101	0.00	48.40	4.90	0.18	76.661	8.756	0.06	0.18	6.75	17.80	23	0.430
Cl	1,101	0.00	0.26	0.01	0.00	0.000	0.015	0.00	0.00	0.01	0.02	565	0.011
LOI	1,101	-0.40	37.60	4.25	1.04	32.445	5.696	0.28	1.04	7.78	12.40	0	1.314

Table 2-9. Density Measurement Data

Sample No.	Lithology	Volume (cm^3)	Dry Mass (grams)	Dry Density	LOI %	Calculated Wet Mass	Wet Density
1	silicified andesite	188.75	277.30	1.47	0.49	278.64	1.48
2	silicified andesitic breccia	239.42	422.40	1.76	1.75	429.79	1.80
3	silicified andesitic breccia	168.01	406.80	2.42	2.02	415.02	2.47
4	silicified andesite	235.14	289.30	1.23	0.10	289.59	1.23
5	silicified andesitic breccia	169.91	407.80	2.40	4.45	425.95	2.51
6	silicified andesitic breccia	240.69	309.60	1.29	1.43	314.03	1.30
7	silicified andesite	210.07	381.60	1.82	1.39	386.90	1.84
8	silicified andesite	165.00	233.20	1.41	13.00	263.52	1.60
9	silicified andesitic breccia	196.51	366.70	1.87	1.09	370.70	1.89
10	silicified tuff	209.49	370.10	1.77	0.09	370.43	1.77
11	silicified andesite	167.36	366.00	2.19	7.64	393.96	2.35
12	silicified andesitic breccia	482.62	698.30	1.45	1.74	710.45	1.47
13	silicified tuff	473.54	697.60	1.47	0.66	702.18	1.48
14	silicified andesite	143.15	289.10	2.02	2.21	295.49	2.06
15	silicified tuff	182.05	247.60	1.36	0.13	247.92	1.36
16	silicified tuff	112.47	234.80	2.09	0.34	235.59	2.09
17	silicified andesitic breccia	167.63	330.20	1.97	0.50	331.83	1.98
18	silicified tuff	79.81	175.80	2.20	1.02	177.59	2.23
19	silicified andesitic breccia	160.25	367.50	2.29	0.06	367.72	2.29
20	silicified andesite	242.64	561.50	2.31	22.10	685.59	2.83
21	silicified andesitic breccia	97.79	166.10	1.70	0.16	166.37	1.70
22	silicified andesite	109.44	194.90	1.78	0.12	195.14	1.78
23	silicified tuff	352.95	563.30	1.60	0.17	564.27	1.60
24	silicified andesite	388.42	710.80	1.83	0.18	712.04	1.83
25	silicified andesitic breccia	221.37	298.70	1.35	2.92	307.42	1.39
		Average Dry Density		1.80	Average Wet Density		1.85

Soil Erosion/ Loss of Topsoil/ Overburden and Baseline Data Parameter Requirements

Extreme rainfall could induce slope failure at the banks of the overburden storage areas. If this happens, those at the lower ground will be flooded. The effect of the projected global warming, extreme and erratic rainfalls in the future are being considered in the structural design and holding capacity of the overburden storage areas. In addition, construction of siltation ponds *(Refer to Figure 2-26)* and silt traps including slope stabilization measures (application of fiber matting and tree planting along the banks) should be done in order to avert possible increase in siltation and soil erosion.

Figure 2-26. Existing Siltation Pond

Sediments carried down from soil erosion due to existing quarry operation and construction-related activities such as land clearing activities and stockpiles may end up as runoff to nearby sections of Maaslum river, if not effectively managed, especially during storm and heavy rains which may affect the existence of identified species and their habitat. This may adversely cause water turbidity and stream flow obstruction and affect plankton and the remaining macro benthos fauna. Sediment erosion in freshwater bodies can cause localized mortality of aquatic larval forms of bivalves and gastropods, as well as impair nesting grounds of tilapia. Siltation may increase water turbidity, resulting in decreased light penetration and a decrease in photosynthetic function of primary producers such as phytoplankton and benthic algae. Due to soil erosion especially during wet season, increased in water turbidity and stream flow obstruction affect the plankton community.

In terms of siltation index, station FW2 and FW3 recorded the highest computed values with 98% and 78%, respectively. Again, this was primarily due to high number of *Navicula* and *Niztschia* recorded in these two stations which is expected since these are the station exposed to high levels of siltation caused by run-off from the existing quarry site and soil erosion from unpaved roads which is more pronounced during the rainy season.

The possible event which could significantly increase the risks of soil erosion and sedimentation of water bodies is the occurrence of strong rainfall events. However, since the proponent only stockpiles a weekly inventory, the volume of silica would not cause much safety risks.

Accident scenarios in terms of soil erosion and water bodies sedimentation would not be of great risk since silica stockpiles at the site would be limited to a week's inventory. The construction of mitigation measures such as silt ponds and other mitigation measures to decrease run-off velocities (i.e. gabions and small dikes) would also be implemented in the environmental management plan.

Change in Soil Quality/Fertility

Soil Quality

Primary data on soil quality was collected from three (3) sampling stations within the project site and vicinity. The samples were collected at the surface and at 1 m depth. The soil samples were submitted to the accredited laboratories and were analyzed for the presence of organic matter, nitrogen, phosphorus, potassium and heavy metals (chromium, arsenic, mercury, lead, cadmium). The location of the sampling stations is listed in Table 2-10.

Soil sampling was conducted in the project site to identify its existing soil quality and fertility conditions. The site's soil type is considered homogenous all over the area thus, only three (3) soil samples were collected using grab sampling method during dry and wet seasons taking into consideration its existing land use and elevation.

Table 2-10. Location of Soil Sampling Stations

Sampling station	Geographic coordinates	Description	Photograph
S1	09°51'36.7" N 123°04'24.6" E	Covered with grass and shrubs.	
S2	09°51'17.1" N 123°04'56.8" E	Mixed plantation of coconut and banana	

Sampling station	Geographic coordinates	Description	Photograph
S3	09°50'59.9" N 123°04'41.6" E	Banana plantation with some grass and shrubs	

Results of the laboratory analysis of the three (3) samples collected for each season are reflected in Table 2-11 below while the Laboratory Certificate of Analyses are presented as **Annex 9**.

Results of the soil analysis indicate the presence of heavy metals in all stations, although values for arsenic, cadmium, chromium, lead and mercury were below the detection limits during dry and wet seasons.

In the absence of a Philippine or International Standard for Soil Quality, the use of the Dutch Standards for Soil Pollution is recommended as reference in determining the soil quality of the project site. The standard indicates the levels at which there is a sustainable soil quality.

Arsenic levels are still within the permissible level at all stations. Although, it is expected to be high since arsenic occurs naturally in rocks and soil, with elevated soil levels being found close to mining project site areas.

In terms of soil physical and chemical characteristics, the project site and its vicinity are considered slightly acidic areas. All samples contain limited organic matter ranging from 0.48 to 3.31%.

The nitrogen levels are considered low at three stations in both seasons. Nitrogen in the soil is the most important element for plant development. It is required in large amounts and must be added to the soil to avoid a deficiency. The available phosphorous levels, on the other hand, are below the soil target values. It can be attributed to the low soil pH and amount of organic matter in the mining project site area. Likewise, the project site also contains a limited amount of the exchangeable potassium.

Table 2-11. Results of Soil Sample Analyses from three Stations within the Project Site and Vicinity

Parameters	Unit	Dry season			Wet season			Soil target values
		S1	S2	S3	S1	S2	S3	
pH	-	5.3	5.6	4.7	3.8	5.0	4.9	5.5 – 6.5
Organic Matter (OM)	%	0.48	1.13	0.52	3.31	1.97	2.64	
Total Nitrogen (N)	%	0.06	0.09	0.06	0.19	0.14	0.19	
Available Phosphorus (P)	ppm	3.3	2.0	5.4	7.3	3.6	7.2	10 - 20
Exchangeable Potassium (K)	cmol/kg soil	0.53	0.33	0.46	0.36	0.41	2.26	
Arsenic (As)	mg/kg	0.899	0.494	0.239	-	-	-	29.0*

Parameters	Unit	Dry season			Wet season			Soil target values
		S1	S2	S3	S1	S2	S3	
Cadmium (Cd)	mg/kg	<0.8	<0.8	<0.8	-	-	-	0.8*
Chromium (Cr)	mg/kg	<2	<2	<2	-	-	-	100*
Lead (Pb)	mg/kg	13	11	<2	-	-	-	85.0*
Mercury (Hg)	mg/kg	<0.01	<0.01	<0.01	-	-	-	0.03*

**Dutch Soil Standard for Soil Pollution, 2000*

Micronutrients and Trace Metals

Oxide analysis for all Ayungon samples is shown in the table below. It is noted that mean values for Al_2O_3 and Fe_2O_3 are just up to 5.21% and 5.57% respectively and all the other oxides has negligible values.

Table 2-12. Range of Micronutrients and Trace Metals in Ayungon, Negros Oriental

Field	Minimum (%)	Maximum (%)	Mean (%)	Median (%)
SiO_2	32.51	99.30	82.28	91.44
Al_2O_3	0.01	28.80	5.21	0.54
Fe_2O_3	0.02	36.30	5.57	4.13
CaO	0.01	5.46	0.19	0.08
MgO	0.00	5.11	0.21	0.04
K_2O	0.01	3.67	0.39	0.03
Na_2O	0.00	3.65	0.21	0.03
TiO_2	0.30	11.80	1.09	0.93
P_2O_5	0.00	0.79	0.07	0.02
MnO	0.00	0.23	0.01	0.00
SO_3	0.00	48.40	4.90	0.18
Cl	0.00	0.26	0.01	0.00
LOI	-0.40	37.60	4.25	1.04

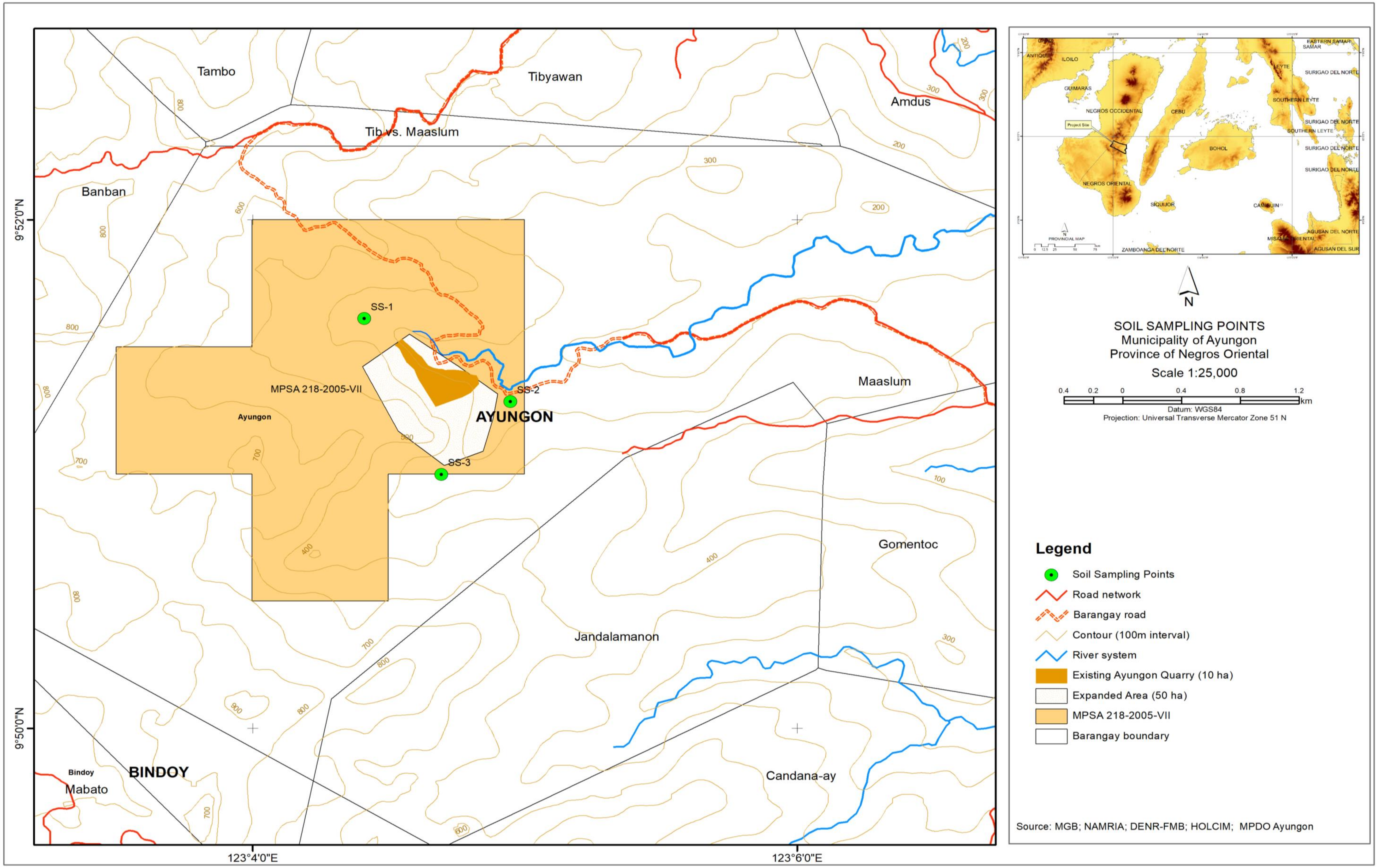


Figure 2-27. Location of the Soil Sampling in the Project Site *(Source: NAMRIA, HOLCIM. PHIVOLCS, BSWM, MPDO Ayungon)*

4. Terrestrial Ecology

Vegetation Removal and Loss of Habitat

A total of 62 floral species and 32 faunal species are expected to be affected by the proposed project. Detailed discussion of the inventory and management measures are discussed in the succeeding sections.

Flora and Fauna Species Inventory

The terrestrial ecology assessment focused within the MPSA of the current silica quarry in Ayungon, Negros Oriental (project site). The surveys were conducted from April 26-29, 2016 for the dry season and August 19-21, 2017 for the wet season. Ascertaining of species identification and data processing were conducted in-situ during the actual field survey. There were no flora or fauna specimens collected for this study.

Detailed flora and fauna surveys were conducted at strategic habitat locations. The location of transect sites and sampling points for fauna, as well as the quadrats for flora, were primarily determined based on the current location of the project's development facilities and vegetation community types within the project site. Transect line 1 is 1.30 km, 2nd line is 1.25 km, and 3rd transect line is 200 meters. The fauna transect sites, sampling points, and flora quadrats were located to focus on areas that are most likely to contain high biodiversity to maximize species record.

A total of six (6) flora quadrats and two (2) fauna transect sites were surveyed within the project site.

Flora

A total of six (6) quadrats were established within the project site. Vegetation communities (e.g. coconut plantation, shrubland, agroforest) were surveyed through transect walks and general observation. Observation points were also established on strategic areas to provide a panoramic view of the general vegetation types within the project site.

A 10 m X 10 m quadrat was established at each survey locations. All trees inside the quadrat with diameter at breast height (dbh) equal or greater than 10 cm were considered canopy individuals were recorded. The understored vegetation was measured within a sub-quadrat of 1 m x 1 m within the main 10 m x 10 m quadrat. For consistency, the sub-quadrat was established at the south western corner of each of the main quadrat. All plants not previously qualified as canopy species were identified and counted. Main plants of interest were photographed to serve as reference in validating their identification.

Incidental and transect surveys were also conducted to include in the general list as many plant species as possible that may be present within the project site. This also includes listing of plant species outside the quadrats.

Table 2-13. Geographical Location and Description of the Quadrats for Flora Assessment

Quadrat No.	Coordinates	Elevation (masl)	Locality	Habitat Description
TP-1	N9°51'32.75"; E123°4'22.85"	375	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-2	N9°51'33.52"; E123°4'27.59"	362	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-3	N9°51'28.24"; E123°4'38.97"	338	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-4	N9°51'17.67"; E123°4'57.00"	249	Brgy. Maaslum, Ayungon, Negros Oriental	Coconut plantation
TP-5	N9°50'59.42"; E123°4'39.21"	358	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland
TP-6	N9°50'47.68"; E123°4'31.11"	392	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland

Fauna

The fauna surveys targeted terrestrial vertebrate fauna composed of amphibians, reptiles, birds, and mammals. The surveys were conducted solely within the project site and it commenced with the general fauna habitat assessments followed by surveys of the said major vertebrate groups.

Amphibians and reptiles were recorded mainly through strip transect sampling and opportunistic catching. Surveys were conducted at least twice a day between 7:00AM to 9:00AM and 3:00PM to 5:00PM, where amphibians and reptiles usually bask. Suspected microhabitats were also checked for possible presence of amphibians and reptiles.

Bird transect survey was conducted by walking through existing trails (i.e. approximately 1.5 to 1.7 km) within the project site at a pace of about 250 m/15 minutes. For mixed feeding flocks, more observation time (5 to 10 minutes) were given to ascertain identities of individuals. Transect walks were performed for two (2) days between 6:00AM to 9:00AM and 3:00PM to 4:00PM, where birds are most active. Species and number of individual birds seen and/or heard were recorded. In addition to the transect walk method, four 12 m mist nets (standard length used for surveys) were used to capture nocturnal and cryptic bird species. The mist nets were left open for 24 hours for two (2) days and two (2) nights. Mist nets were checked for possible netted individuals every two (2) hours from 6:00AM to 4:00PM.

The same mist nets utilized for birds were used to capture bats (volant mammals). Mist nets were left overnight for two (2) nights and were checked early in the morning. Selected individuals were photographed, and all captured individuals were released at their site of capture. For non-volant mammals, presence and perceived abundance were obtained based on interviews with local guides during field work. Presence based on indices (e.g. footprints, wallowing area, scats, bone remains, etc.) were also recorded and considered.

Upon capture, photographs were taken to aid in species identification. All specimens were released to their site of capture. No specimens of any of the targeted vertebrate fauna were collected in this survey.

Table 2-14. Geographical Coordinates and General Description of the Fauna Transect Sites

Transect	North	Locality	General Habitat Description
T1P1	N9°51'18.87"; E123°4'56.37"	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
T1P2	N9°51'36.92"; E123°4'19.91"		
T2P1	N9°51'18.88"; E123°4'57.51"	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland
T2P2	N9°50'49.44"; E123°4'30.05"		
P1	N9°51'36.72"; E123°4'20.18"	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland
P2	N9°51'36.90"; E123°4'25.37"	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland

Figure 2-28. Flora Survey Plots (TP1-6) and Fauna Transects and Sampling Points (T1P1-T1P2; P1-P2) within the Silica Quarry Project Site

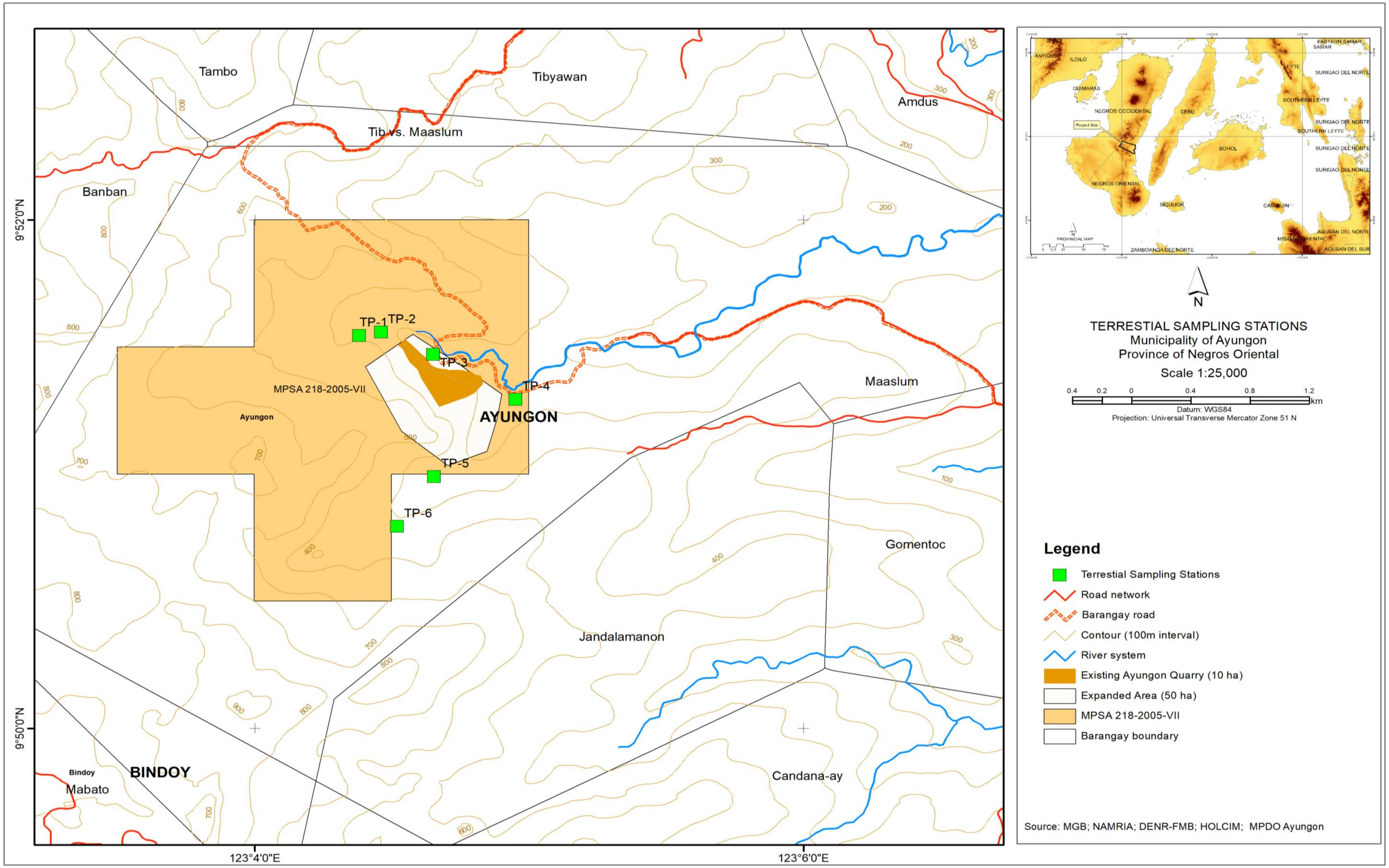


Figure 2-29. Terrestrial Sampling Stations *(Source: NAMRIA, HOLCIM, MPDO Ayungon)*

Terrestrial Inventory Results

Flora

There are three (3) distinct types of vegetation communities within the project site and its vicinities: shrubland, coconut plantation, and annual cropland. The selection of the sampling sites is based on the identified existing land use in the area which consists of annual cropland (i.e. coconut and a few fruit trees and grassland). The area surveyed is primarily covered with fruit trees (i.e. mango, *Mangifera indica;* jackfruit, *Artocarpus heterophyllus*; banana, *Musa* sp.), coconut (*Cocos nucifera*), and shrubs (i.e. ferns, weeds).

The grasslands and shrublands area in Brgy. Maaslum is characterized mostly by introduced species of grasses, sedges and other weeds. Some of the common grasses are cogon (*Imperata cylindrica*), Bermuda grass (*Cynodon dactylon*), carabao grass (*Paspalum conjugatum*), and talahib (*Spontaneum saccharum*). For the shrublands, some common species are ferns (*Gleichenia linearis* and *Nephrolepis falcata*), coronitas (*Lantana camara*), pandacaqui (*Tabernaemontana pandacaqui*), uoko (*Mikania cordata*), cassava (*Manihot esculenta*), tungaw-tungaw (*Medinilla venosa*), upli (*Leucosyke capitellata*) and hagonoy (*Chromolaena odorata*).

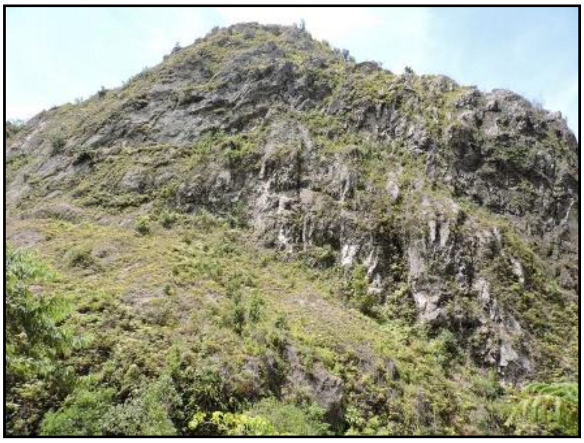


Figure 2-30. Shrublands

Figure 2-31. Coconut Plantation

Figure 2-32. Annual Cropland

During the dry season sampling there are 58 morpho-species of plants recorded within the project site, belonging to 31 families of plants. Figure 2-33 shows some of the common canopy and understory species of plants recorded within the project site. While a total of 62 morpho-species of plants recorded within the project site during wet season, belonging to 34 families of plants. Figure 2-30 to Figure 2-32 shows some of the common canopy and understory species of plants recorded within the project site.

DAO No. 2017-11 or the Updated National List of Threatened Philippine Plants and Their Categories was used as reference in the analysis of the results of the flora inventory.

Table 2-15. Plant Species Recorded within the Project Site during Dry Season

Species	Family	Common Name	Habit
Mangifera indica	Anacardiacea	mango	Tree
Tabernaemontana pandacaqui	Apocynaceae	pandacaqui	Shrub
Colocasia esculenta	Araceae	gabi-gabi	Herb
Corypha utan	Arecaceae	buri palm	Tree
Cocos nucifera	Arecaceae	coconut	Palm
Chromolaena odorata	Asteraceae	hagonoy	Shrub
Mikania cordata	Asteraceae	uoko	Shrub
Trema orientalis	Cannabaceae	hanagdong	Tree
Carica papaya	Caricaceae	papaya	Tree
Casuarina equisetifolia	Casuarinaceae	agoho	Tree
Terminalia catappa	Combretaceae	talisai	Tree
Melothria indica	Cucurbitaceae	melon daga	Vine
Luffa acutangula	Cucurbitaceae	patola	Vine
Cucurbita sp.	Cucurbitaceae	squash	Vine
Imperata cylindrica	Cyperaceae	cogon	Grass
Saccharum spontaneum	Cyperaceae	talahib	Grass
Macaranga tanarius	Euphorbiaceae	binunga	Tree
Manihot esculenta	Euphorbiaceae	cassava	Shrub
Acacia farnesiana	Fabaceae	aroma	Tree
Acacia auriculiformis	Fabaceae	auri	Tree
Centrosema sp.	Fabaceae	centrosema	Vine
Leucaena leucocephala	Fabaceae	ipil-ipil	Tree
Phaseolus lunatus	Fabaceae	lima bean (patani)	Vine
Gliricidia sepium	Fabaceae	madre de cacao	Tree
Mimosa pudica	Fabaceae	makahiya	Herb

Species	Family	Common Name	Habit
Acacia mangium	Fabaceae	mangium	Tree
Cajanus cajan	Fabaceae	pigeon pea	Vine
Albizia saman	Fabaceae	raintree	Tree
Tamarindus indica	Fabaceae	tamarind	Tree
Gmelina arborea	Lamiaceae	gmelina	Tree
Centrosema pubescence	Leguminosae	pukingganbaging	Vine
Ceiba pentandra	Malvaceae	cotton	Tree
Medinilla venosa	Melastomataceae	tungaw-tungaw	Shrub
Swietenia macrophylla	Meliaceae	mahogany	Tree
Azadirachta indica	Meliaceae	neem tree	Tree
Sandoricum koetjape	Meliaceae	santol	Tree
Artocarpus blancoi	Moraceae	antipolo	Tree
Artocarpus heterophyllus	Moraceae	nangka	Tree
Ficus nota	Moraceae	tibig	Tree
Musa sp.	Musaceae	saging	Herb (gigantic)
Eucalyptus deglupta	Myrtaceae	bagras	Tree
Syzygium cumini	Myrtaceae	black plum (duhat)	Tree
Psidium guajava	Myrtaceae	guava	Tree
Cynodon dactylon	Poaceae	Bermuda grass	Grass
Paspalum conjugatum	Poaceae	carabao grass	Grass
Dendrocalamus sp.	Poaceae	clumping bamboos	Herb (gigantic)
Drynaria quercifolia	Polypodiaceae	Pakpak lawin	Herb
Gleichenia linearis	Pteridophyta	fern	Shrub
Nephrolepis falcata	Pteridophyta	fern	Shrub
Cyathea sp.	Pteridophyta	giant fern	Shrub
Ziziphus jujuba	Rhamnaceae	mansanitas	Tree
Nauclea orientalis	Rubiaceae	bangkal	Tree
Citrus sp.	Rutaceae	kalamansi	Tree
Citrus nobilis	Rutaceae	tangerine orange (dalanghita)	Tree
Chrysophyllum cainito	Sapotaceae	star apple	Tree
Capsicum frutescens	Solanaceae	siling labuyo	Shrub
Leucosyke capitellata	Urticaceae	upli	Shrub
Lantana camara	Verbenaceae	coronitas	Shrub

Table 2-16. Plant Species Recorded within the Project Site during Wet Season Sampling

Species	Family	Common Name	Habit
Mangifera indica	Anacardiacea	mango	Tree
Corypha utan	Arecaceae	buri palm	Tree
Trema orientalis	Cannabaceae	hanagdong	Tree
Carica papaya	Caricaceae	papaya	Tree
Casuarina equisetifolia	Casuarinaceae	agoho	Tree
Terminalia catappa	Combretaceae	talisai	Tree
Macaranga tanarius	Euphorbiaceae	binunga	Tree
Acacia farnesiana	Fabaceae	aroma	Tree
Acacia auriculiformis	Fabaceae	auri	Tree
Leucaena leucocephala	Fabaceae	ipil-ipil	Tree
Gliricidia sepium	Fabaceae	madre de cacao	Tree
Acacia mangium	Fabaceae	mangium	Tree
Allbizia saman	Fabaceae	raintree	Tree
Tamarindus indica	Fabaceae	tamarind	Tree
Gmelina arborea	Lamiaceae	gmelina	Tree
Ceiba pentandra	Malvaceae	cotton	Tree
Sweitenia macrophylla	Meliaceae	mahogany	Tree

Species	Family	Common Name	Habit
Azadirachta indica	Meliaceae	neem tree	Tree
Sandoricum koetjape	Meliaceae	santol	Tree
Artocarpus blancoi	Moraceae	antipolo	Tree
Artocarpus heterophyllus	Moraceae	nangka	Tree
Ficus nota	Moraceae	tibig	Tree
Eucalyptus deglupta	Myrtaceae	bagras	Tree
Syzygium cumini	Myrtaceae	black plum (duhat)	Tree
Psidium guajava	Myrtaceae	guava	Tree
Ziziphus jujuba	Rhamnaceae	mansanitas	Tree
Nauclea orientalis	Rubiaceae	bangkal	Tree
Citrus sp.	Rutaceae	kalamansi	Tree
Citrus nobilis	Rutaceae	tangerine orange (dalanghita)	Tree
Annona muricata	Annonacea	guyabano	Tree
Chrysophyllum cainito	Sapotaceae	star apple	Tree
Cocos nucifera	Arecaceae	coconut	Palm
Melothria indica	Cucurbitaceae	melon daga	Vine
Luffa acutangula	Cucurbitaceae	patola	Vine
Cucurbita sp.	Cucurbitaceae	squash	Vine
Centrosema sp.	Fabaceae	centrosema	Vine
Phaseolus lunatus	Fabaceae	lima bean (patani)	Vine
Cajanus cajana	Fabaceae	pigeon pea	Vine
Centosema pubescence	Leguminosae	pukinggan baging	Vine
Nephentes sp.	Nepentaceae	Pitcher plant	Vine
Chromolaena odorata	Asteraceae	hagonoy	Shrub
Mikania cordata	Asteraceae	uoko	Shrub
Tabernaemontana pandacaqui	Apocynaceae	pandacaqui	Shrub
Manihot esculenta	Euphorbiaceae	cassava	Shrub
Melastoma malabathricum	Melastomataceae	tungaw-tungaw	Shrub
Gleicheria linearis	Pteridophyta	fern	Shrub
Nephrolepis falcata	Pteridophyta	fern	Shrub
Cyathea sp.	Pteridophyta	giant fern	Shrub
Capsicum frutescens	Solanaceae	siling labuyo	Shrub
Leucosyke capitellata	Urticaceae	upli	Shrub
Lantana camara	Verbanaceae	coronitas	Shrub
Alternanthera sessilis	Amaranthaceae	bunga-bunga	Shrub
Imperata cylindrica	Cyperaceae	cogon	Grass
Saccharum spontaneum	Cyperaceae	talahib	Grass
Cynodon dactylon	Poaceae	bermuda grass	Grass
Paspalum conjugatum	Poaceae	carabao grass	Grass
Calopogonium mucunoides	Fabaceae	santing	Grass
Colocasia esculenta	Araceae	gabi-gabi	Herb
Mimosa pudica	Fabaceae	makahiya	Herb
Drynaria quercifolia	Polypodiaceae	pakpak lawin	Herb
Musa sp.	Musaceae	saging	Herb (gigantic)
Dendrocalamus sp.	Poaceae	clumping bamboos	Herb (gigantic)

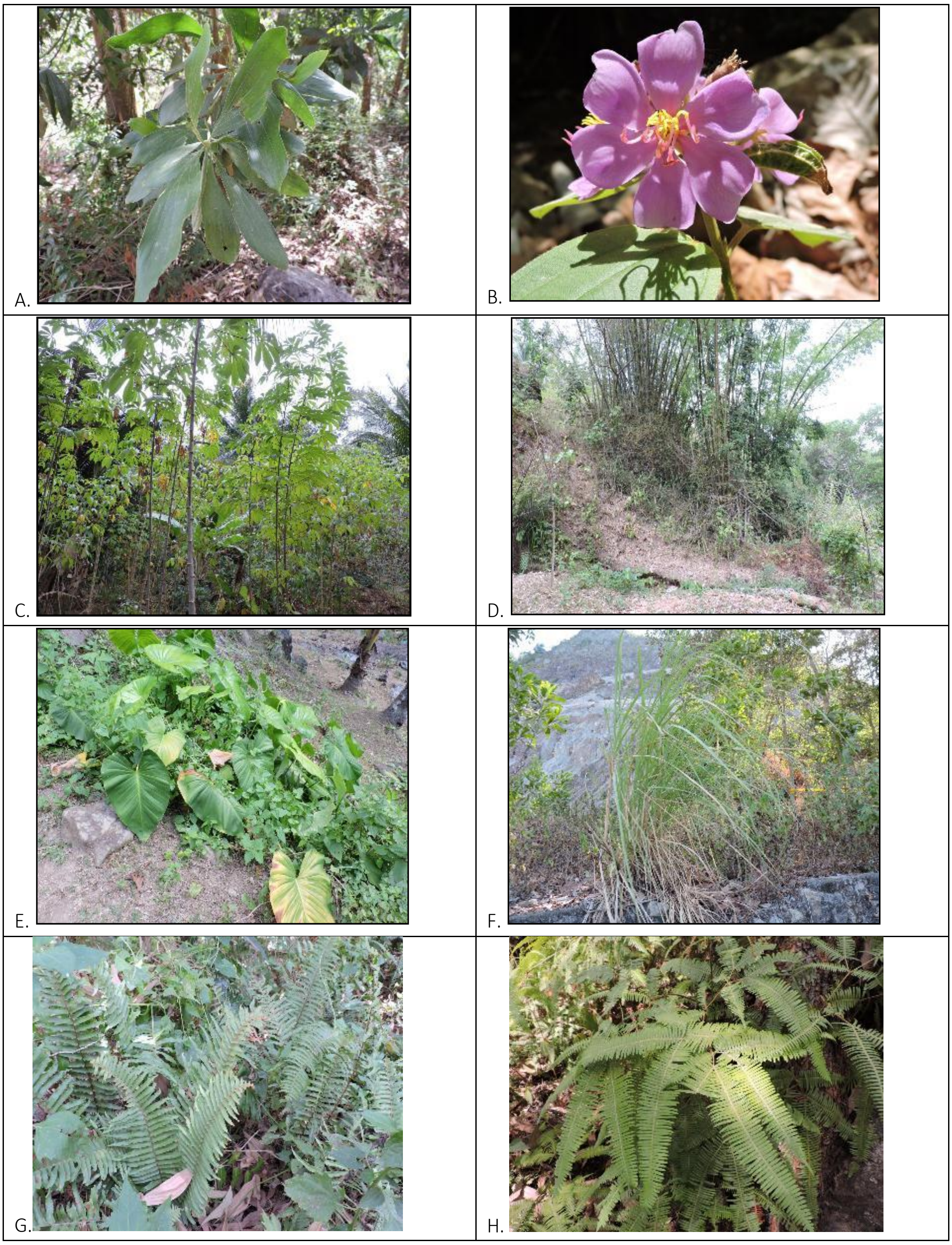


Figure 2-33. Some common plant species recorded during the dry season survey: (A) mangium (*Acacia mangium*); (B) tungaw-tungaw (*Medinilla venosa*); (C) cassava (*Manihot esculenta*); (D) clumping bamboos (*Dendrocalamus* sp.); (E) gabi-gabi (*Colocasia esculenta*); (F) cogon (*Imperata cylindrica*); (G and H) ferns (*Nephrolepis falcata* and *Gleichenia linearis*)

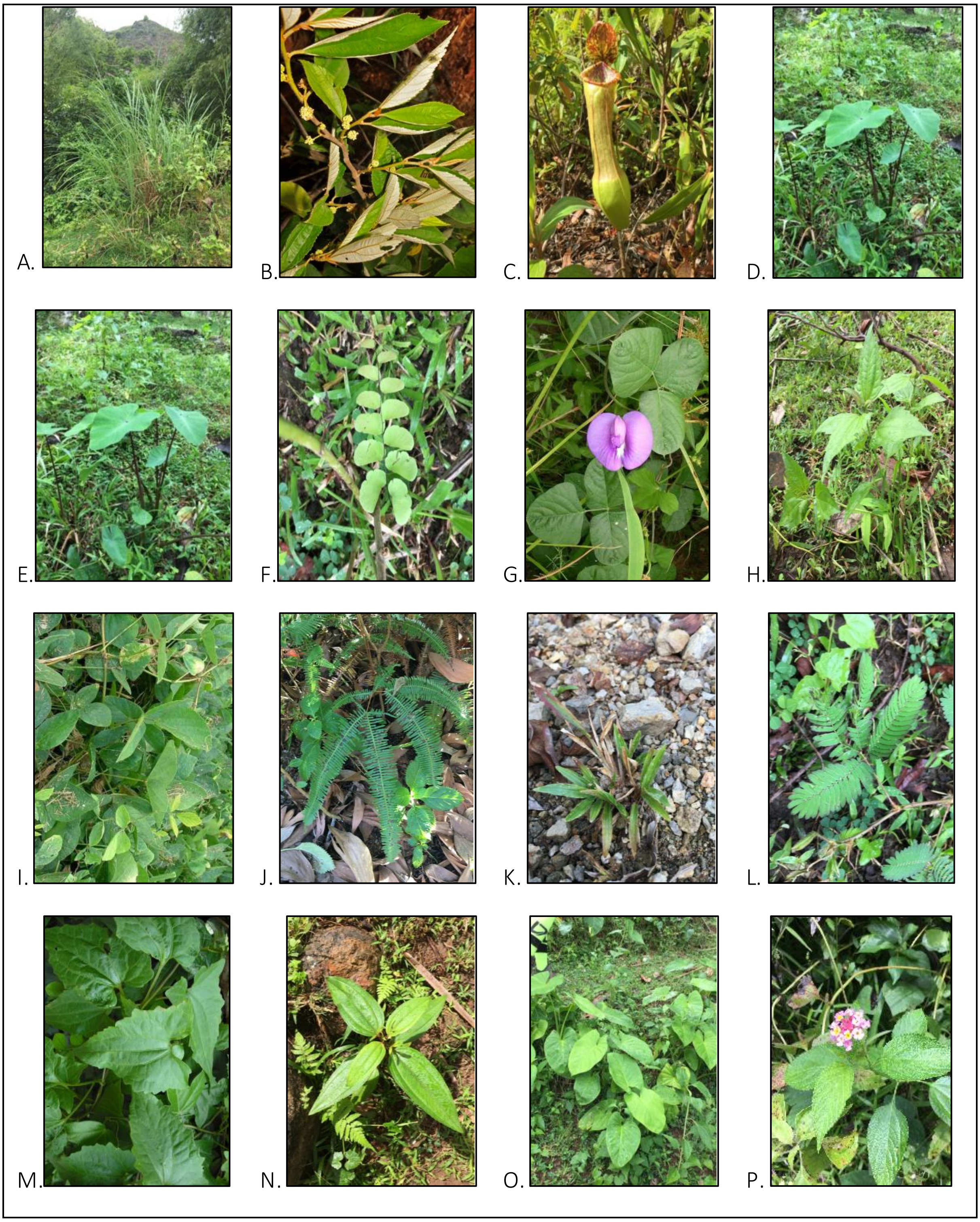


Figure 2-34. Some of the flora species recorded within the proposed expansion of the silica quarry project during wet season. (a) cogon; (b) upli; (c) pitcher plant; (d) gabi; (e) sili-sili; (f) guyabano; (g) pukinggan baging; (h) hagonoy ; (i) santing ; (j) fern: (k) carabao grass; (l) makahiya; (m) uoko ; (n)tungaw-tungaw ; (o) gabi-gabi ; (p) coronitas

Figure 2-35. Some of the flora species recorded within the proposed expansion of the silica quarry project during wet season. (a) antipolo; (b) coconut; (c) mangium; (d) ipil-ipil; (e) kakawate; (f) guyabano

Fauna

Dry season sampling identified a total of 31 wildlife species composed of two amphibians, four reptiles, 24 birds and one mammal species were recorded along the two transects and two sampling points surveyed within the project site. The amphibians and reptiles were all common and most species are native but non-endemics associated with forested to non-forested habitats. The birds were dominated by resident non endemics and common species that are associated mainly with forested to non-forested habitats. The only volant mammal species recorded was common and associated with forested to non-forested habitats; while no small non-volant mammals were recorded.

For the wet season sampling, a total of 25 wildlife vertebrate species belongs to 19 families representing the classes Amphibia, Reptilia, Aves, and Mammalia were recorded along the established transects and sampling points within the project area. Majority of the collected and observed specimens were fairly common and native taxa and can thrive on forested to agricultural areas. The amphibians were dominated by non- native whereas reptiles, birds, and mammals were dominated by native and resident species known to be found on secondary forests and can tolerate anthropogenic presence such as in agricultural lands.

No species listed as threatened or endangered in the International Union for Conservation of Nature Red List of Threatened Species (IUCN 2017) and Wildlife Conservation and Protection Act of 2001 (RA 9147) were observed and collected during the survey.

The faunistic profile presented herein were discussed per taxon basis. Discussion include abundance and species richness, residency and distribution, general ecology, and conservation status. References for the ecological aspects and distribution of the taxa presented herein were from reputable sources such as Ingle and Heaney (1992), Kennedy (2000), Alcala *et al.* (2004), Gaulke *et al.* (2011), Diesmos *et al.* (2015), Alcala (1986); Alcala and Brown (1998); Kennedy *et al*. (2000); Heaney *et al*. (1998) and from IUCN (2016). Actual field surveys of population estimate of these particular species are limited and often lacking detailed accuracy.

Amphibians and Reptiles

A total of two (2) species of amphibians and four (4) species of reptiles were recorded within the project site during the dry season. These species are the giant marine toad (*Rhinella marina*), common tree frog (*Polypedates leucomystax*), tokay gecko (*Gekko gecko*), two-striped mabuya (*Eutrophis multicarinata*), many-lined skink (*Eutrophis multifasciata*) and a flying lizard (*Draco* sp.). The identity up to the species level of the flying lizard cannot be ascertained as it was only sighted on a tree, and flying lizards have the ability to mimic their environment; thus, it (*Rhinella marina*), common tree frog (*Polypedates leucomystax*), and a flying lizard (*Draco* sp.) are shown in Figure 2-36.

A.

B.

C.

Figure 2-36. Giant marine toad (*Rhinella marina*) (A), common tree frog (*Polypedates leucomystax*) (B), and flying lizard (*Draco* sp.) recorded within the project site during dry season sampling

Wet season survey recorded four (4) species of amphibians: cane toad (*Rhinella marina*), common tree frog (*Polypedates leucomystax*), common puddle frog (*Occidozyga laevis*), and Dumeril's wrinkled ground frog (*Platymantis dorsalis*). Among the four species, only the Dumeril's wrinkled ground frog (*Platymantis dorsalis*) is endemic. Cane toad (*Rhinella marina*) is an introduced species known to inhabit a wide array of habitat ranging from secondary forests, open grasslands, agroforests and even urban areas. Furthermore, in urban areas and agricultural lands, this species is commonly found on gardens and drainage ditches. Like the cane toad, common tree frog (*Polypedates leucomystax*) and common puddle frog (*Occidozyg laevis*) are known to be very adaptable opportunist and thrives in a wide array of habitats. The former is known to occur beach forests and natural edge habitats close to both primary and secondary forests. They are also common in agricultural lands primarily banana plantation and usually seen on leaves and axils. While the latter is known to be inhabiting muddy puddles and pools near small streams and drainage ditches. The Dumeril's wrinkled ground frog (*Platymantis dorsalis*) inhabits forest floor of primary and secondary forests. They can also thrive on agroforests and forest edges with little anthropogenic disturbance.

A total of three (3) species of reptiles were observed and recorded within the sites: yellow striped slender tree skink (*Lipinia pulchella*), emerald tree skink (*Lamprolepis smaragdina*), and East Indian brown mabuya (*Eutropis multifasciata*). Both the yellow striped slender tree skink (*Lipinia pulchella*) and emerald tree skink (*Lamprolepis smaragdina*) are known to be arboreal, usually found on exposed trunks and barks, and is common on secondary forests and agroforests.

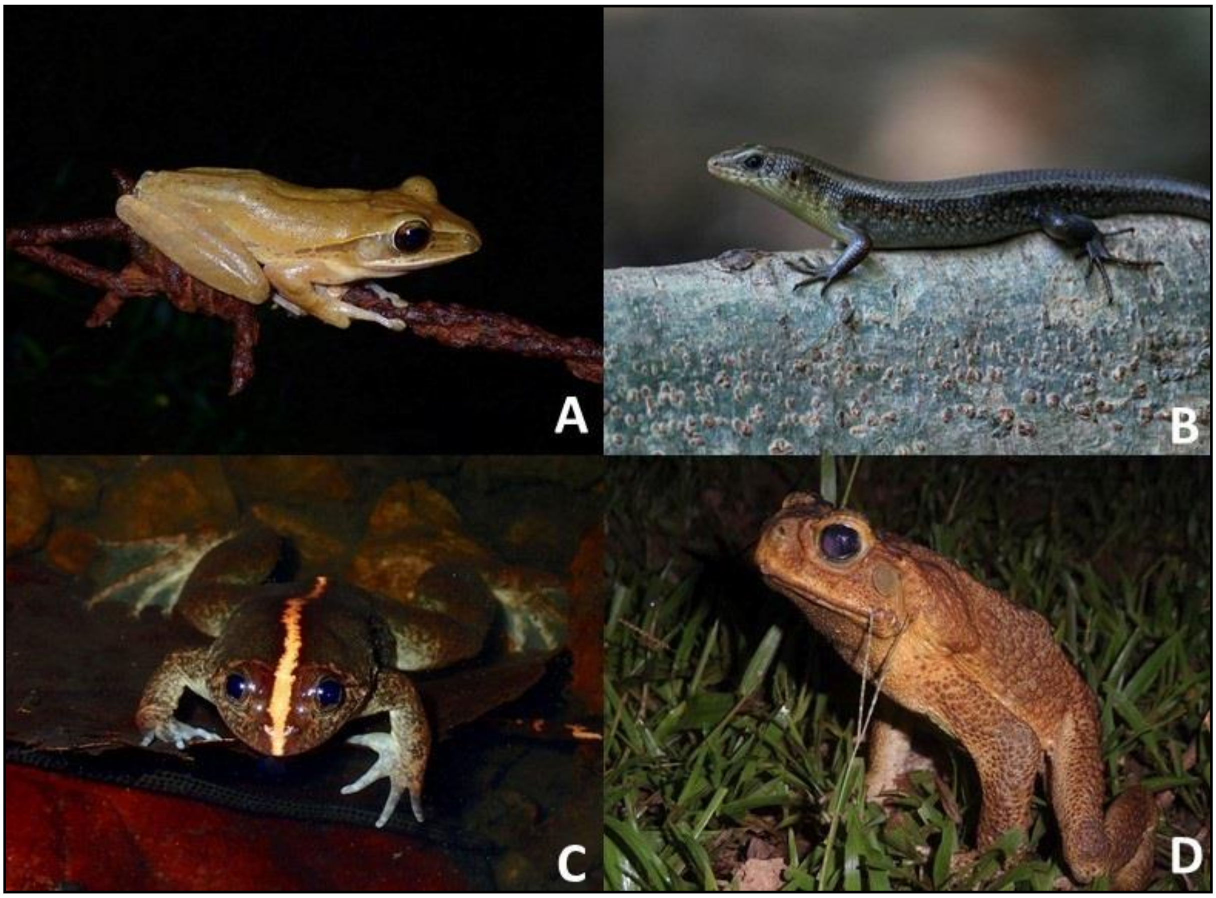


Figure 2-37. Some herpetofauna recorded during the wet season survey: (A) Common tree frog (*Polypedates leucomystax*), (B) East Indian brown mabuya (*Eutropis multifasciata*), (C) common puddle frog (*Occidozyga laevis*), (D) cane toad (*Rhinella marina*)

<u>Avifauna</u>

Recorded birds within the project site during the dry season survey summed to 24 species representing 77% of the overall total species recorded within the project site. This group was the most easily observed as they are more vocal and active during the survey. The project site was dominated by glossy swiftlets (*Collocalia esculenta*), oriental magpie robin (*Copsychus saularis*), and the olive-backed sunbird (*Nectarinia jugularis*).

A total of 15 species were recorded during wet season via visual encounter, bioacoustics survey, and mistnetting. All the observed species are diurnal in habit. The project site was dominated by glossy swiftlet (*Collocalia esculenta*) and olive- backed sunbird (*Cinnyris jugularis*). Both species are known to be common in secondary forest areas and forest edge habitats. The former is commonly known to build nests on crevices and karst areas whereas the latter build nests on trees. Also, both species can build their nests on human dwellings. The list of avifaunal species recorded in the project site is provided in the table below.

Table 2-17. Birds within the Project Site during Dry and Wet Season

Species	Common name	Presence	
		Wet	Dry
Acridotheres cristatellus	Crested Myna		Crested Myna
Aethopyga siparaja	Crimson sunbird	Crimson sunbird	
Caprimulgus manillensis	Philippine nightjar		Philippine nightjar
Centropus viridis	Philippine coucal		Philippine coucal
Cinnyris jugularis	Olive- backed sunbird	Olive- backed sunbird	
Collocalia esculenta	Glossy swiftlet	Glossy swiftlet	
Copsychus saularis	Oriental magpie- robin	Oriental magpie- robin	
Corvus macrorhynchos	Large- billed crow	Large- billed crow	
Dicaeum australe	Red- keeled flowerpecker	Red- keeled flowerpecker	
Egretta garzetta	Little egret	Little egret	
Gallus domesticus	Red jungle fowl	Red jungle fowl	
Geopelia striata	Zebra dove	Zebra dove	
Halcyon chloris	White-collared kingfisher	White-collared kingfisher	
Hirundo rustica	Barn swallow	Barn swallow	
Ixobrychus sinensis	Yellow bittern		Yellow bittern
Monticola solitarius	Blue rock-thrush		Blue rock-thrush
Motacilla flava	Yellow wagtail	Yellow wagtail	
Nectarinia jugularis	Olive-backed sunbird		Olive-backed sunbird
Passer montanus	Eurasian tree sparrow	Eurasian tree sparrow	
Phapitreron leucotis	White- eared brown dove	White- eared brown dove	
Ptilinopus occipitalis	Yellow-breasted fruit dove		Yellow-breasted fruit dove
Rhipidura javanica	Pied fantail	Pied fantail	
Saxicola caprata	Pied bush chat		Pied bush chat
Spilornis holospilus	Philippine serpent eagle	Philippine serpent eagle	
Treron pompadora	Pompadour green-pigeon		Pompadour green-pigeon

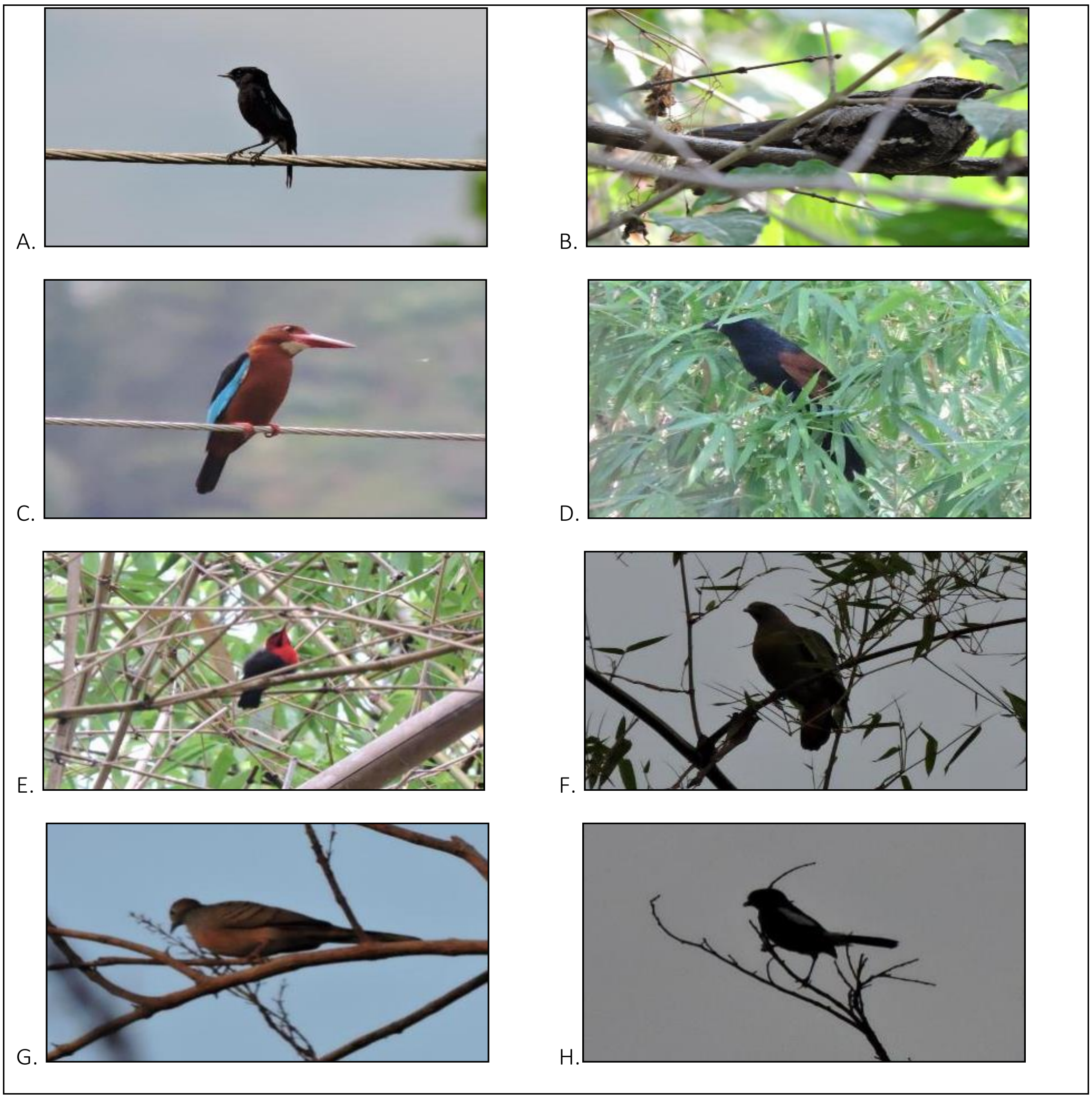


Figure 2-38. Some bird species recorded within the project site during the dry season survey: (A) pied bush chat (*Saxicola caprata*); (B) Philippine nightjar (*Caprimulgus manillensis*); (C) white-throated kingfisher (*Halcyon smyrnensis*); (D) Philippine coucal (*Centropus viridis*); (E) crimson sunbird (*Aethopyga siparaja*); (F) pompadour green-pigeon (Treron pompadora); (G) zebra dove (Geopelia striata); (H) oriental magpie-robin (Copsychus saularis)

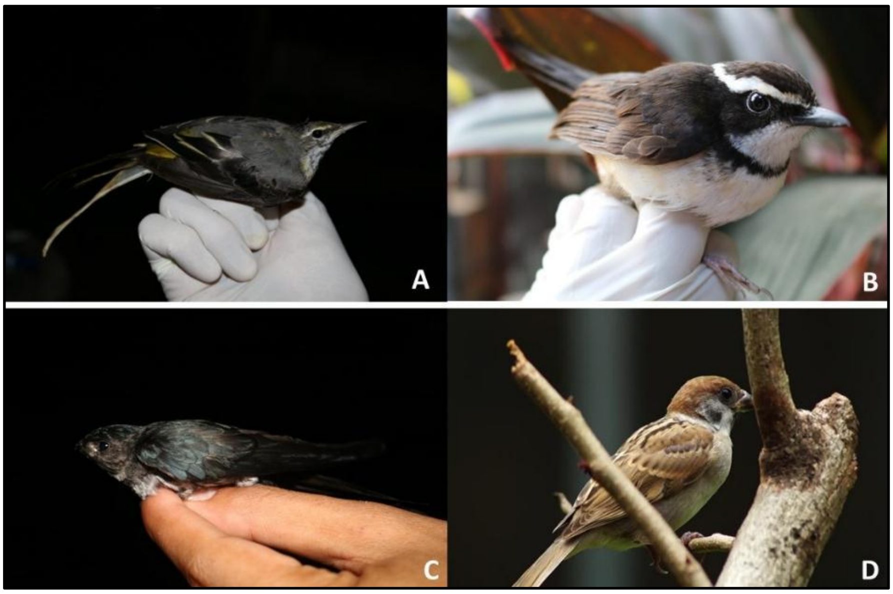


Figure 2-39. Some avifauna recorded within the project site during the wet season survey: (A) Yellow wagtail (*Motacilla flava*), (B) Pied fantail (*Rhipidura javanica*), (C) glossy swiftlet (*Collocallia esculenta*), (D) Eurasian tree sparrow (*Passer montanus*)

Mammals

Only one (1) species of volant mammals (bats) and one (1) non-volant mammal was recorded during the survey. The species of bats captured was the common short-nosed fruit bat (*Cynopterus brachyotis*) which belonged to Family Pteropodidae, while the non-volant mammals captured was the Asian house shrew (*Suncus murinus*) which belonged to Family Soricidae (Figure 2-39). No insectivorous bats were captured during the survey.

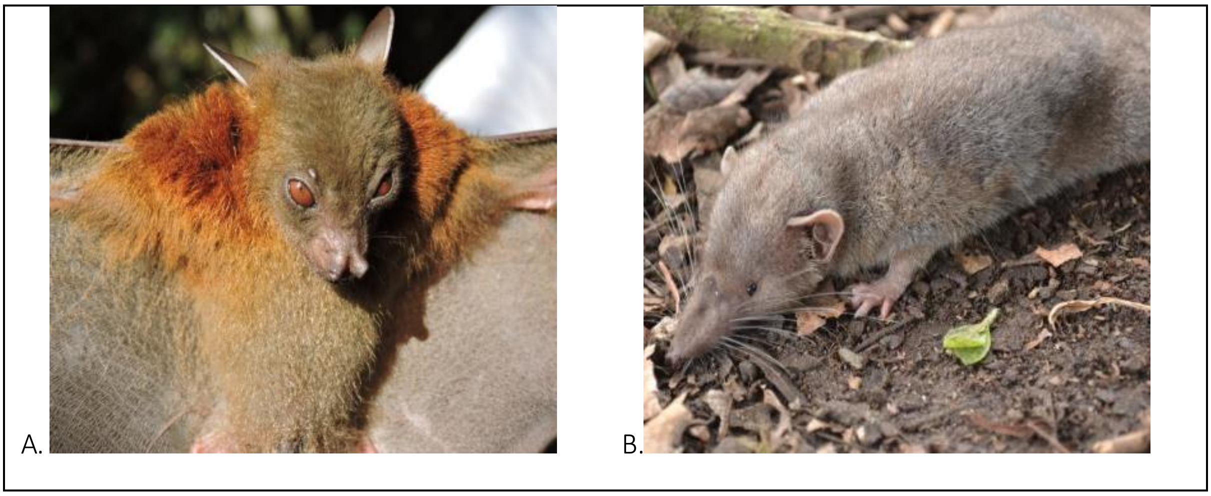


Figure 2-40. Mammal species recorded during the survey: (A) common short-nosed fruit bat (*Cynopterus brachyotis*); (B) Asian house shrew (*Suncus murinus*)

A total of three (3) mammal species belonging to two (2) families (Pteropodidae and Muridae) were captured in the project site during wet season: Common short- nosed fruit bat (*Cynopterus brachyotis*), Cave nectar bat (*Eonycteris spelaea*), and Oriental house rat (*Rattus tanezumi*). No insectivorous bats were captured during the survey. Both the volant mammals *C. brachyotis* and *E.*

spelaea are strictly herbivorous (frugivorous and nectarivorous respectively) and are native species whereas *R. tanezumi* is an introduced species and known for its high adaptability to both natural and man- made environments.

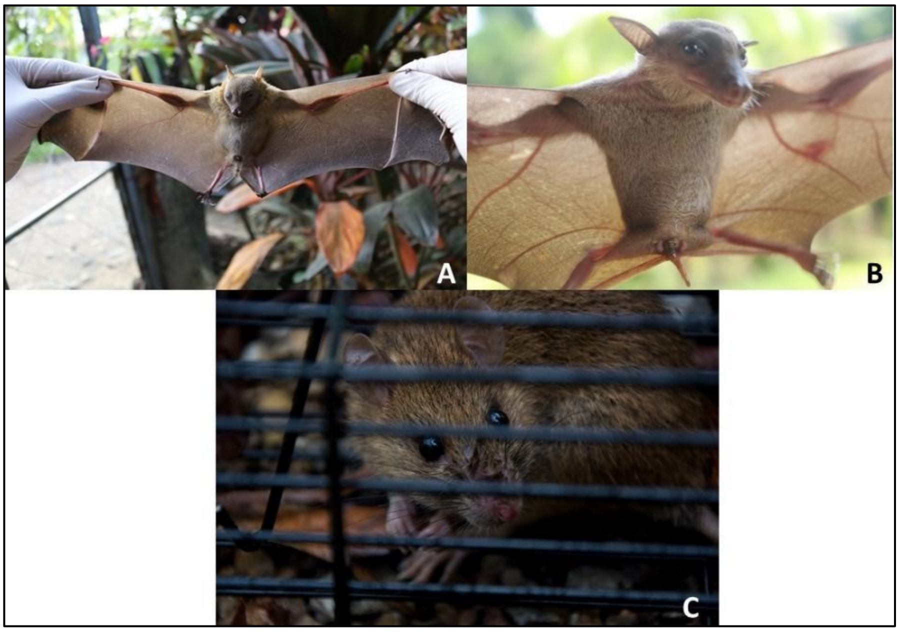


Figure 2-41. Volant and non- volant mammals recorded during the survey: (A) Common short- nosed fruit bat (*Cynopterus brachyotis*), (B) cave nectar bat (*Eonycteris spelaea*), and (C) Oriental house rat (*Rattus tanezumi*)

Historical Occurrences of Pest Infestation, Forest/Grass Fire and or Similar Incidences

All sampling sites within the proposed project site are devoid of evidences of pest infestations that occurred in the past. During the fieldwork, all plants appeared healthy showing normal coloration and form (i.e. bole/branch formation). Furthermore, there were no noticeable signs of psyllid (jumping plant lice) infestation and/or any other plant-specific parasite observed during the survey and interviews with the locals.

Also, there is no indication that a natural fire occurred in the past within the project site, which has been confirmed through interview with the locals and actual surveys. Although, it was observed that there was a part within the project site which was burned by the residents intentionally, as it was blocking their way.

Figure 2-42. Observed intentional burning in the Project Site

Threat to Existence and/or Loss of Important Local Species

Flora

Out of the morpho-species of plants, 58 in dry season and 62 for wet season, recognized within the project site, only one species has been identified to be a Philippine Endemic or plants confined only in the Philippines: the antipolo (*Artocarpus blancoi).* From the identified plants, one (1) species has been listed as threatened in DAO 2017-11 (Updated National List of Threatened Philippine Plants and Their Categories), the pitcher plant (*Nepenthes* sp.). Moreover, the latter was also recorded in the IUCN Red List.

For cases where cutting of these threatened and endemic species will be inevitable, it can be compensated by replanting similar species or indigenous species in a suitable area along the project site or avoid cutting of the trees since the species richness of this antipolo is low.

Fauna

Among the 31 species recorded during the dry season, four species were recognized to be endemic to the Philippines. These are the white-eared brown dove (*Phapitreron leucotis*), Philippine coucal (*Centropus viridis*), red-keeled flowerpecker (*Dicaeum australe*), and the yellow-breasted fruit dove (*Ptilinopus occipitalis*).

On the other hand, a total of 25 wildlife vertebrates were observed and recorded in the project area during wet season. Five (5) were recognized to be endemic in the Philippines: Dumeril's wrinkled ground frog (*Platymantis dorsalis*), yellow striped slender tree skink (*Lipinia pulchella*), Philippine serpent eagle (*Spilornis holospilus*), White- eared brown dove (*Phapitreron leucotis*), and red- keeled flowerpecker (*Dicaeum australe*). Summary of residency, conservation status, and species count of the vertebrate fauna recorded in the project site is provide on Table 2-18.

Table 2-18. Endemicity and Conservation Status of Fauna Recorded within the Project Site

Taxon	Number of Endemics		Number of Threatened Species in IUCN 2017		Number of Threatened Species in Philippine Wildlife Act of 2001	
	Dry	Wet	Dry	Wet	Dry	Wet
Amphibians	0	1	0	0	0	0
Reptiles	0	1	0	0	0	0
Birds	4	3	0	0	0	0
Mammals	0	0	0	0	0	0

Table 2-19. General Population of Fauna Recorded within the Project Site

Fauna Taxon	Common		Fairly Common		Uncommon		Rare	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Amphibians	2	1	0	2	0	1	0	0
Reptiles	3	1	0	0	0	2	0	0
Birds	20	2	1	9	3	4	0	0
Mammals	2	2	0	1	0	0	0	0

Endemicity and Conservation Status – Dry Season

The only amphibian captured, giant marine toad (*Rhinella marina*), is known to be an introduced species and widely distributed throughout the country. While the reptiles today gecko (*Gecko gecko*) and the two species of skinks (*Eutrophis multicarinata* and *E. multifasciata*) are native but non-endemic species. All recorded species are common in terms of general population status. None of the species recorded are listed under any category in the IUCN Red List of Threatened Species (IUCN, 2016) and in the List of Threatened Wildlife Species of the Wildlife Conservation and Protection Act of 2001 (RA 9147).

The bird assemblage was dominated by the native but non-endemic resident birds with 16 species recorded out of 24 (67%). These non-endemic species are mainly generalists which are able to tolerate disturbed habitat types extending to forest patches and/or forest edges. Since the survey was conducted within the migratory season (i.e. September to April), four migratory species were recorded. The presence of these species in the Philippines coincides with the winter season in their country of origin (e.g. Japan, Russia and China); they temporarily migrate to escape the harsh conditions of the winter season. Two migratory bird species, the little egret (*Egretta garzetta*) and the blue rock-thrush (*Monticola solitarius*) are known to have established resident populations in the Philippines. The general population status of recorded birds is largely composed of common species with 20 representatives (83%). In addition, one species is known to be fairly common (*Halcyon smyrnensis*); and three uncommon species, which are the Philippine nightjar (*Caprimulgus manillensis*), pompadour green-pigeon (*Treron pompadora*), and the Oriental magpie robin (*Copsychus saularis*). Though known as uncommon, the latter (*Copsychus saularis*) was the most observed bird species in the project site. It should be noted that there were no threatened bird species recorded in this survey, based on the Wildlife Conservation and Protection Act of 2001 (RA 9147) and the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2016).

Only one species of volant mammals (bats) and one none volant mammals were recorded during the survey. The common short-nosed fruit bat (*Cynopterus brachyotis*) is distributed over Southeast Asia. The Asian house shrew (*Suncus murinus*) is distributed throughout Asia and Indo-Australia

(Heaney *et al*., 2010). Both mammal species recorded are categorized as Least Concern in IUCN Red List of Threatened Species (IUCN, 2016), and is not included in the List of Threatened Wildlife Species in Wildlife Conservation and Protection Act of 2001 (Republic Act 9147). The Asian house shrew (*Suncus murinus*) is an introduced species in the country and is considered as an invasive species.

Endemicity and Conservation Status – Wet Season

Among the recorded herpetofauna, only cane toad (*Rhinella marina*) is the introduced species. This species is widely distributed in the Philippines across all major islands and is known to occur in a wide array of habitats ranging from secondary forests to degraded habitats and man- made environments. All recorded herpetofauna herein are designated as least concerned under the IUCN Red List (2017) with reference to its wide distribution, tolerance of a broad range of habitats, presumed large population, and because it is unlikely to be declining to qualify for listing in a more threatened category.

The avifaunal assemblage is dominated by native but non- endemic resident species. These species are known to thrive in a wide array of habitats ranging from secondary forests to agroforests. They can also thrive on forest edges and forest patches if the food source is available. None of the three endemic recorded avifauna is an island endemic and they are distributed across the major islands of the country. Furthermore, there are no threatened avifaunal species recorded in the project site. All listed bird species herein are categorized as least concerned under IUCN RED List of Threatened Species (2017) and Wildlife Conservation and Protection Act of 2001 (RA 9147).

Of the three (3) recorded mammals, only *R. tanezumi* is the introduced species whereas the two volant mammals, *C. brachyotis* and *E. spelaea*, were categorized as native non- endemics. Both volant mammals are known to be distributed throughout South and Southeast Asia. Furthermore, these three species are classified by the IUCN (2017) as Least Concerned and is not included in the List of Threatened Wildlife Species in Wildlife Conservation and Protection Act of 2001 (RA 9147).

Threat to Abundance, Frequency and Distribution of Species

Floral Assemblage

In general, the project site is species-poor, with only at least 62 morpho-species belonging to 34 families of plants. The most species rich families are Fabaceae. The common occurrence of species belonging to Family Fabaceae may be attributed to their special characteristics. Members of the family Fabaceae usually form root nodules in which nitrogen fixation is carried out by a symbiotic rhizobium, they are also tolerant to dry condition and are prolific seeders.

Members of Family Moraceae, Poaceae, Cucurbitaceae, Myrtaceae, and Pteridophyta are the second most numerous plants observed within the project site. Family Moraceae are often known as a fig family. Species that belong to this family serves as an important source of food for birds and small animals. As such, seeds are easily dispersed and eventually proliferate in other areas. Members of this family are usually light-tolerant and thrive both in open and semi-open spaces, making them common in grasslands even under the canopy of semi-open woodlands. On the other hand, the success of the members of Family Poaceae, or grasses, lies in part in their morphology and growth processes and in part in their physiological diversity. Most of the grasses divide into two physiological groups, depending on photosynthetic pathways used for carbon fixation. These species can increase water use efficiency, rendering them better adapted to hot, arid environments and those lacking in carbon dioxide. Pteridophytes, or ferns, live in a wide variety of habitats. They can be found from remote mountain elevations, to dry desert rock faces, to bodies of water, or in open fields. Ferns in general may be thought of as largely being specialists in marginal habitats, often succeeding in places where various environmental factors limit the success of flowering plants. One factor that makes them successful is because they reproduce via spores.

Faunal Diversity and Distribution

The scanty number (both in species richness and relative abundance) of recorded amphibians and reptiles during the dry season survey can be attributed to the highly disturbed vegetation condition. Suitable microhabitats that are associated with pristine vegetation where they are usually found such as moist decaying leaf litter, clear and free flowing streams, and diverse vertical stratification of the vegetation are no longer present within the project site. All three species of herpetofauna (amphibians and reptiles) are associated with non-forest to forest habitats, deducing that they are able to occupy a wide range of available habitats. The observed habitat associations of recorded species strongly reflect the habitat types within the project site.

The recorded bird species strongly correlate to the available habitat types (i.e. agroforest) within the project site. There were seven bird species (29%) recorded in areas associated with non-forest habitat. Species with habitat range that encompass both forest to non-forest conditions registered 12 representatives (50%). There were three species (13%) that can be found in forested areas that were recorded in the project site. These species with habitat range that extends to forested areas or those that specifically require some form of forest habitat could be considered least sensitive thus, they are able to adapt to disturbed habitat with surrounding forest patches. There were two species (8%) of wetland birds recorded. The presence of some commercial rice fields close to the project site serves as ideal wetland habitat.

The bat species recorded belong to Family Pteropodidae, or fruit bats. Most fruit bats, as compared to insect bats, are easy to capture using mist nets. Once netted, they become thoroughly entangled in mist nets and rarely escape (Heaney *et al.*, 1989). This explains why the captured bat species in this survey were all fruit bats. All captured bat species are common and are often recorded in forested to non-forested habitats (e.g. agricultural areas, residential areas, croplands and urban parts).

Table 2-20 shows the species richness and relative abundance of terrestrial fauna survey within the project site.

Table 2-20. Species, Richness, Relative Abundance, and Ecological Indices of Fauna in the Project Site

Taxon	No. of Species		Relative Abundance		Diversity Index (Simpson)		Dominance	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Amphibians	2	4	11	15	0.43	0.5	0.38	0.49
Reptiles	3	3	8	4	0.45	0.16	0.68	0.83

Birds	24	15	224	145	2.54	0.15	0.2	0.84
Mammals	2	3	22	29	0.39	0.74	0.44	0.25

Economic Importance and Uses of Significant Flora and Fauna

Ferns, mangium (*Acacia mangium*), coconut (*Cocos nucifera*), and fruit trees (i.e. mango, *Mangifera indica*; jackfruit, *Artocarpus heterophyllus*; banana, *Musa* sp.) are the most dominant plant species in the project site.

Table 2-21. Top Five (5) Canopy Species Based on Importance Value (IV)

Scientific Name	Common Name	Endemicity	Uses/Importance
Acacia mangium	Mangium	NE	shade tree; woodworks; landscaping; slope stabilization; wind protection
Cocos nucifera	Coconut	NE	light construction material; food; medicine; firewood
Mangifera indica	Mango	NE	light construction material; food; firewood
Musa sp.	Banana	NE	food; medicine
Leucaena leucocephala	Ipil-Ipil	NE	woodworks; slope stabilization; construction materials; firewood

For the terrestrial fauna, none of the species identified are known to be economically important as food or medicine; however, these species, especially birds and bats, indirectly affect the agricultural economy as they are important pollinators and seed dispersers.

Hindrance to Wildlife Access

A total of six (6) quadrats for flora survey were established within the project site. Vegetation communities (e.g. coconut plantation, shrubland, annual cropland) were surveyed through transect walks and general observation. Observation points were also established on strategic areas to provide a panoramic view of the general vegetation types within the project site. The geographic location of the quadrats and observation site are shown in Table 2-22.

The project site lies on the eastern slope of a broad volcanic range overlooking the barangay, almost eight kilometers west of the poblacion. Barangay Maaslum occupies the eastern flank of the central highland that grades sharply towards the coastline.

All transects and sampling points were located within specific areas perceived to be impacted by the silica quarry. The vertebrate fauna assessment covered two major transect sites and several sampling points: Transect 1 constitutes a diagonal line from Sitio Apanangan passing a coconut plantation and annual cropland; Transect 2 constitutes a diagonal line along the road, 0.5 km away from the main entrance of the quarry site, to the Twin Falls; and Sampling points refer to specific locations where mist nets were laid-out.

Table 2-22. Geographical Location and Description of the Quadrats

Quadrat No.	Coordinates	Elevation (masl)	Locality	Habitat Description
TP-1	N9°51'32.75"; E123°4'22.85"	375	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-2	N9°51'33.52"; E123°4'27.59"	362	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-3	N9°51'28.24"; E123°4'38.97"	338	Brgy. Maaslum, Ayungon, Negros Oriental	Shrubland (primarily covered with ferns)
TP-4	N9°51'17.67"; E123°4'57.00"	249	Brgy. Maaslum, Ayungon, Negros Oriental	Coconut plantation
TP-5	N9°50'59.42"; E123°4'39.21"	358	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland
TP-6	N9°50'47.68"; E123°4'31.11"	392	Brgy. Maaslum, Ayungon, Negros Oriental	Annual cropland

The survey revealed that the project site is highly disturbed, and thus, there are no perceived hindrances to wildlife access. Wildlife access within and outside the project site is already fragmented and disconnected from any remaining forest patch nearby.

The project site's vegetation is considered poor to marginal due to the presence and abundance of silica in the soil. The poor vegetation is not very hospitable to wildlife as a wildlife habitat which consist of shrublands and annual crops such as banana and coconut. The soil macronutrient values in the three (3) sampling sites indicate that organic matter, phosphorous, exchangeable potassium and total nitrogen are relatively low.

It is proposed that the project provide buffer zones or green corridors to ensure that wildlife can access wildlife habitats inside and outside the MPSA on the upper southwestern portion and also Maaslum River on the south eastern corridor of the project site.

Figure 2-43 shows the proposed buffer zones or green corridors that need to be maintained by the proponent so wildlife can access other habitats and water sources.

5. Riparian Ecology

Sampling locations of Riparian Ecology Study *(Refer to Figure 2-44)* were based on the sampling sites of Water Quality Sampling and Freshwater Ecology Study for consistency and comparative presentation of sampling analysis.

Vegetation Profile

The area is predominantly patches of secondary forest mixed with agroforest ecosystems. A total of 27 morpho-species of plants were recorded on the riparian area within the sites which belong to 22 families. Majority of which can occur in a wide range of ecosystems especially with anthropogenic influences.

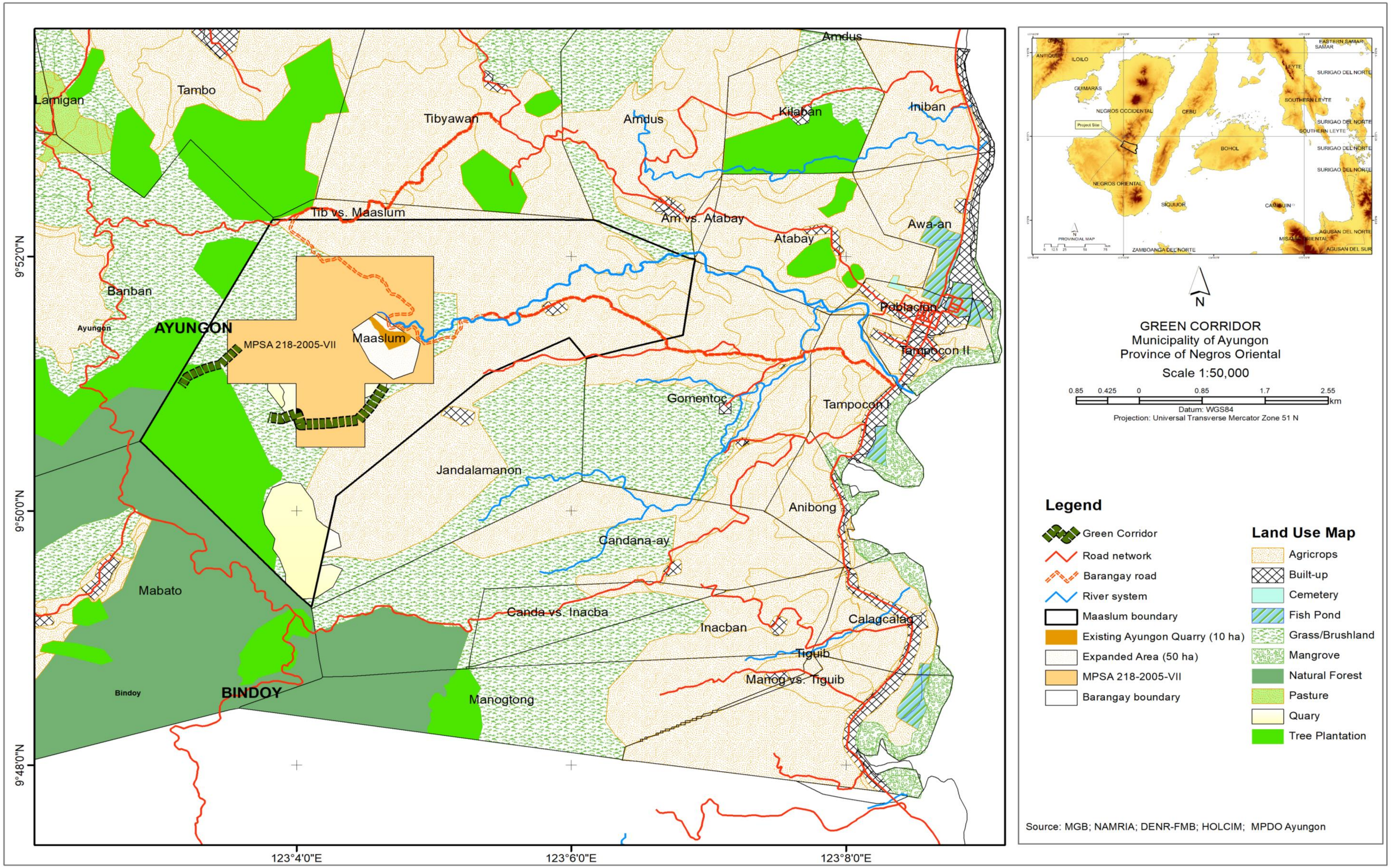


Figure 2-43. Proposed Wildlife Green Access Corridor *(Source: NAMRIA, HOLCIM, MPDO-Ayungon)*

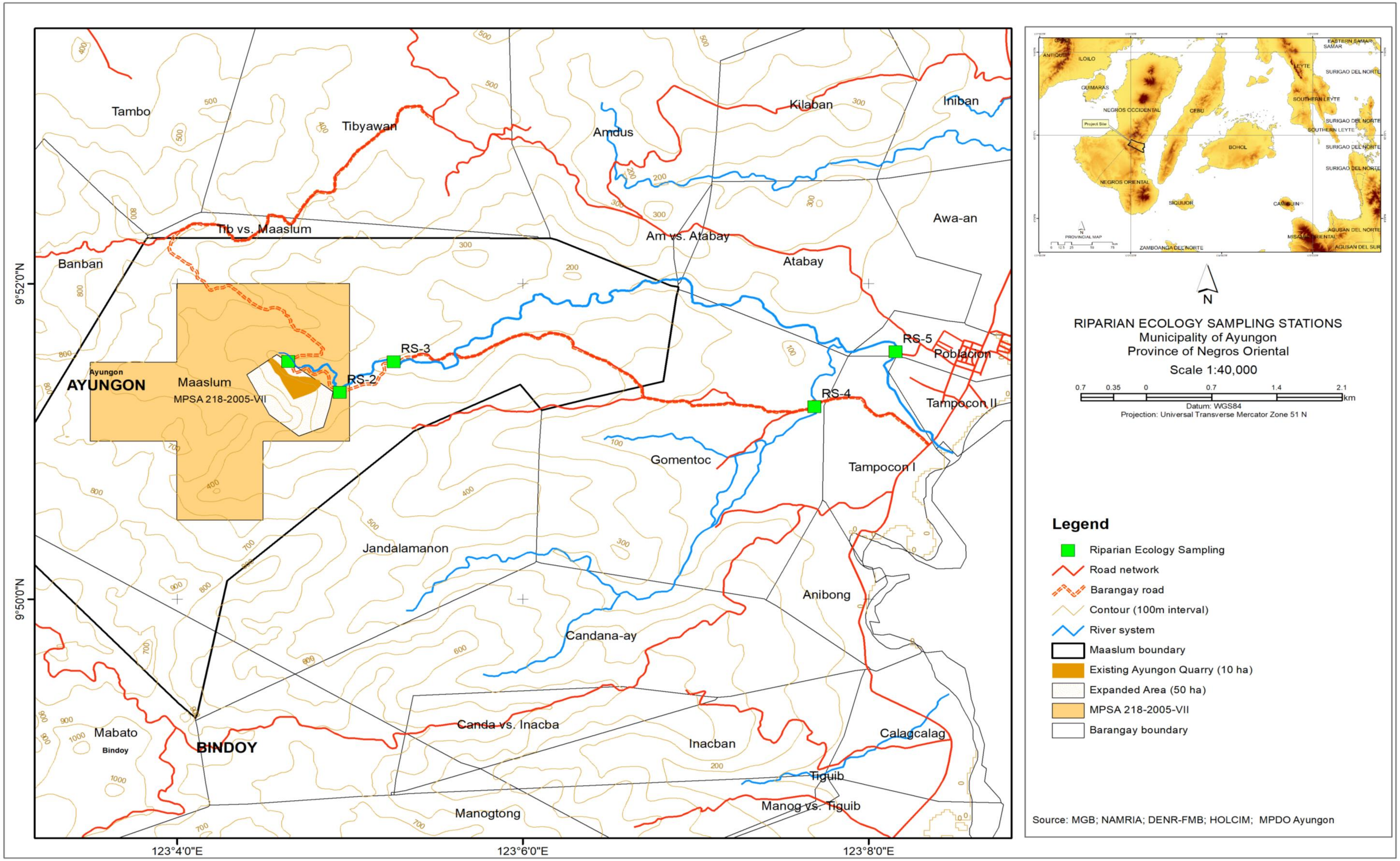


Figure 2-44. Riparian Ecology Sampling Stations *(Source: NAMRIA, HOLCIM, MPDO-Ayungon)*

Table 2-23. Vegetation Recorded in the Sampling Sites

Family	Species	Vernacular Name
Anacardiaceae	*Mangifera indica* Linn.	Mango
Apocycnaceae	*Tabernaemontana pandacaqui* Lam.	Pandakaki
Araceae	*Colocasia esculenta* (L.) Schott	Gabi
Arecaceae	*Cocos nucifera* Linn.	Coconut
Asteraceae	*Chromolaena odoarata* (Linn.)	Hagonoy
	Mikania cordata (Burm.)	Uoko
Cannabaceae	*Trema orientalis* (Linn.) Blume	Hanagdong
Casuarinaceae	*Casuarina equisetifolia* Linn.	Agoho
Combretaceae	*Terminalia catappa* Linn.	Talisay
Cucurbitaceae	*Melothria indica* Lour.	Melon Daga
Cyatheaceae	*Cyathea sp.*	
Davalliaceae	*Nephrolepis falcata* (Cav.)	
Euphorbiaceae	*Macaranga tanarius* (Linn.)	Binunga
Fabaceae	*Centrosema pubescens* Benth.	
	Leucaena lecuocephala (Lam.)	Ipil- Ipil
	Mimosa pudica Linn.	Makahiya
	Tamarindus indica Linn.	Sampaloc
Gleicheniaceae	*Dicranopteris linearis* (Burm.f.)	Dilim
Lamiaceae	*Gmelina arborea* Roxb.	
Meliaceae	*Swietenia macrophylla* King	Mahogany
Moraceae	*Artocaprus blancoi* Merr.	Antipolo
	Ficus nota (Blanco)	Tibig
Musaceae	*Musa x paradisiaca* Linn.	Saging
Myrtaceae	*Syzygium cumini* (Linn.)	Duhat
Poaceae	*Saccharum spontaneum* Linn.	Talahib
	Paspalum conjugatum Berg.	Carabao Grass
Rhamnaceae	*Ziziphus jujuba* Mill.	Mansanitas
Verbenaceae	*Lantana camara* Linn.	Coronitas

Figure 2-45. Some tree species in the riparian area of the project site: *Mangifera indica* (A), *Ficus nota* (B), *Swietenia macrophylla* (C), and *Ziziphus jujuba* (D)

Figure 2-46. Some shrub and herb species found in the riparian zone of the project area: *Lantana camara* (E), *Mimosa pudica* (F), *Saccharum spontaneum* (G), and *Colocasia esculenta* (H)

Floral Assemblage and Community Ecology

The vegetation community in the area is an admixture of secondary forest-agroecosystem-scrubland. The most prominent taxa in the area are Fabaceae, Moraceae, Poaceae, and ferns (Pteridophyta). Among the recorded species, only Artocarpus blancoi is the endemic species. No species in the area is listed in the IUCN Red List (2019) and DAO 2017-11 (Updated National List of Threatened Philippine Plants and Their Categories).

In the riparian zone and nearby areas, agriculturally important crops can be observed and is dominated by coconut (*Cocos nucifera*), varieties of banana (*Musa x paradisiaca*), and mango (*Mangifera indica*). Furthermore, majority of the recorded shrub and herb species were fluvial system associates. These plants such as makahiya (*Mimosa pudica*) and gabi (*Colocasia esculenta*) thrives in the areas where there is a constant water supply.

In general, the species diversity of plants in the sampling areas across the project sites is low and majority of the flora are classified as relatively common species. Majority of these species are usually growing on open areas wherein there is abundant sulight and are elements of open grasslands to semi- open woodlands. Furthermore, herbs and shrubs species are pioneering species and may help in the stabilization of the soil due to their long and firm root system (e.g. Poaceae). They also place carbon in the ground and prevent it from drying.

Vertebrate Faunal Profile

A total of 11 vertebrate species belonging to 11 genera representing 10 families were observed in the riparian area during the wet season sampling and 17 vertebrate species belonging to 17 genera representing 14 families during wet season. These species are known to thrive in a wide array of habitats ranging from secondary forests to agricultural areas. None of the observed species are recorded as threatened according to the IUCN Red List (2017).

Table 2-24. Conservation Status of Vertebrate Species

Family	Species	Common Name	Residency
Bufonidae	*Rhinella marina*	Cane toad	Introduced
Dicroglossidae	*Occidozyga laevis*	Common puddle frog	Native
Ranidae	*Hylarana erythraea*	Common green frog	Native
Scincidae	*Eutropis multifasciata*	East Indian brown mabuya	Native
Pythonidae	*Malayopython reticulatus*	Reticulated python	Native
Trionychidae	*Pelodiscus sinensis*	Chinese softshell turtle	Introduced
Pteropodidae	*Cynopterus brachyotis*	Lesser short-nosed fruit bat	Native
	Eonycteris spelaea	Cave nectar bat	Native
	Ptenochirus jagori	Greater musky fruit bat	Endemic
	Macroglossus minimus	Dagger- toothed long- nosed fruit bat	Native
Muridae	*Rattus tanezumi*	Oriental house rat	Introduced
Apodidae	*Collocalia esculenta*	Glossy swiftlet	Native
Ardeidae	*Egretta garzetta*	Little egret	Native
Corvidae	*Corvus macrorhynchos*	Large- billed crow	Native
Hirundinidae	*Hirundo rustica*	Barn swallow	Native
Nectariniidae	*Cinnyris jugularis*	Olive backed sunbird	Native
Passeridae	*Passer montanus*	Eurasia tree sparrow	Introduced

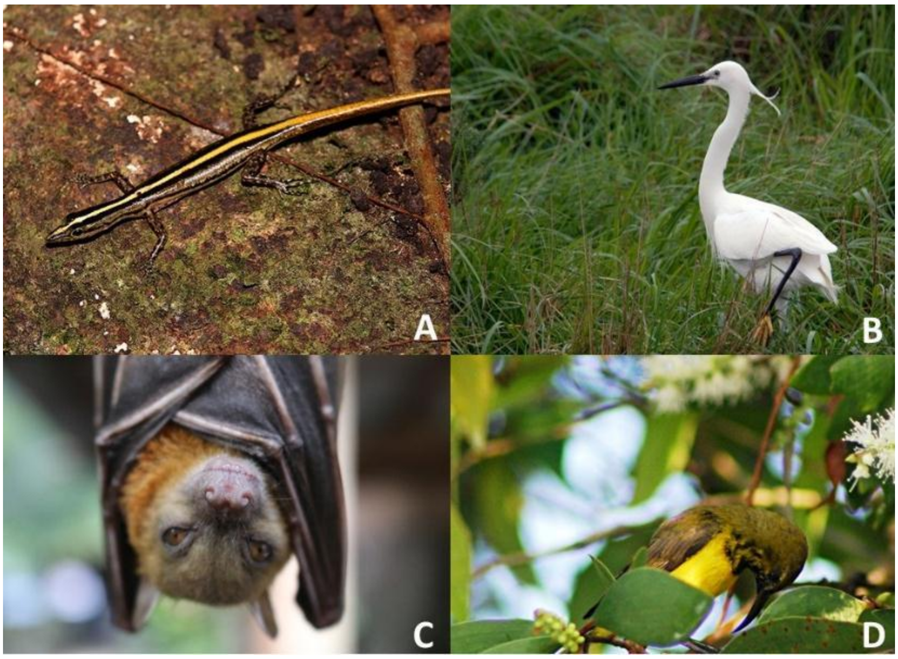


Figure 2-47. Some terrestrial fauna observed in the riparian zone during wet season: *Lipinia pulchella* (A), *Egretta garzetta* (B), *Cynopterus brachyotis* (C), and *Cinnyris jugularis* (D)

Figure 2-48. Mammal species observed in the riparian zone: *Cynopterus brachyotis* (A), *Macroglossus minimus* (B), *Rattus tanezumi* (C), and *Eonycteris spelaea* (D)

Faunal Assemblage and Diversity

Wet Season

A total of three herpetofaunal species were observed in the area: cane toad (*R. marina*), East Indian brown mabuya (*E. multifasciata*), and yellow-striped slender tree skink (*L. pulchella*). The former is introduced species whereas the latter two are native taxa. Cane toads are normally observed in the nearby riverbanks on the sites for easy access to water bodies (i.e. river) to avoid desiccation of eggs and dehydration of their skin. In the sampling areas, the skins are observed to bask between 8-9am in the morning on trees and exposed rocks.

As of the mammals observed, two species are documented: lesser short- nosed fruit bat (*C. brachyotis*) and Asian house rat (*R. tanezumi*). The presence of the former in the riparian zone can be explained by the availability of one of its main diet, *Ficus* sp. These species are normally found on areas near river and other fluvial systems. Whereas, the presence of *R. tanezumi* is due to presence nearby human settlements in the area. This species is known to be associated with human inhabitation and agricultural lands.

The avifaunal species on the sampling sites are known to thrive in a wide array of ecosystem which ranges from secondary forest to agricultural lands with human settlements. *C. esculenta* and *H. rustica* are commonly observed in open areas foraging on insects in flight. *C. macrorhynchos* is normally observed on the coconut groves near the riparian zones. *E. gazertta* is observed on riverbanks searching for its food such as gobies and other small fishes.

Dry Season

A total of six (6) herpetofaunal species were observed in the area: cane toad (*R. marina*), East Indian brown mabuya (*E. multifasciata*), common puddle frog (*O. laevis*), reticulated python (*M. reticulatus*), common green frog (*H. erythraea*), and Chinese softshell turtle (*P. sinensis*). Among the six species observed, two are known to be invasive: cane toad (*R. marina*) which originated from South America and Chinese softshell turtle which came from the Chinese subcontinent, hence the name. In the Philippine setting, cane toads are known to thrive in lowland forests, agroecosystems, grasslands, and even degraded habitats and man- made environment. It primarily feeds on variety of arthropod species and in some cases feeds on small vertebrates. On the other hand, the Chinese softshell turtles are commonly seen on rivers and streams near human settlements. In China, this species is listed as vulnerable since its wild population is continuously declining. In the sampling areas, both the *H. erythraea* and *O. laevis* are seen on puddles and vegetation near streams.

In the sampling areas, five (5) species are observed, four of which are volant (*C. brachyotis, P. jagori, E. spelaea,* and *M. minimus*) and one non- volant (*R. tanezumi*). Among the five species, only *P. jagori* is endemic. This species is widely distributed across all major faunal regions of the Philippines except in the Batanes group of Islands and Greater Palawan. All the volant species observed are known to be inhabitants of lowland forest and agricultural areas. On the other hand, the only non-volant mammal observed is both an introduced and an invasive species. *T. tanezumi* was listed as Least Concern due to its wide distribution and tolerance to a wide array of habitats (IUCN 2017).

The avifaunal species on the sampling sites are known to thrive in a wide array of ecosystem which ranges from secondary forest to agricultural lands with human settlements. *C. esculenta* and *H. rustica* are commonly observed in open areas foraging on insects in flight. *C. macrorhynchos* is normally observed on the coconut groves near the riparian zones. *E. gazertta* is observed on riverbanks searching for its food such as gobies and other small fishes.

Freshwater Insects

Wet Season

A total of 108 individuals representing six (6) species belonging to the families *Pisauridae* (Arachnida), *Gyrinidae*, *Veliidae*, and *Gerridae* were collected on the sampling sites. These families are strongly associated with aquatic environs especially fluvial systems and can serve as bioindicator. Furthermore, none of the collected species are included in the IUCN Red List for Threatened Species (2017).

Gyrinidae (also known as whirligig beetles) (n= 20) are water beetles usually found in the surface of water if undisturbed. They are ellipsoid in appearance and commonly observed near riverbanks. In the sampling areas, the whirligig beetles belong to the genus *Orechtochilus*.

Gerridae (also known as water striders) are predatory water bugs that is commonly observed to walk on water due to its hydrophobic micro hair's presence on the legs and body. They are normally found on water surface and prefer environment abundant with insects or zooplanktons. In the sampling areas, there are two genera of water striders present: *Limnometra* (n= 15) and *Aquarius* (n= 6).

Veliidae (also known as riffle bugs) are similar to gerrids but smaller in size and in the sampling sites it is represented by the genus *Rhagovelia* (n= 63). Among the collected aquatic insects, this group has the highest species count. This is due to their aggregating nature on the water surface which makes them easy to catch.

Fishing spider from the genus *Dolomedes* (n= 4) is also observed in the riverbanks on the sampling sites. These spiders are covered with short, velvety hair which allows them to float on water surface. They usually feed on aquatic insects and even small fishes.

Presence of these species presents the idea that the fluvial system in the area still sustain life forms and is not yet ecologically degraded. Aquatic insects are known to sensitive to availability of oxygen, fluctuation of temperature, sediment and substrate types, and presence of pollutants in an area. Thus, they can be used as bio indicators in ecological studies.

Dry Season

A total of 75 individuals representing 10 morphospecies belonging to the families *Pisauridae* (Arachnida), *Gyrinidae*, *Veliidae*, *Gerridae*, *Cicindellidae*, *Notonectidae*, and *Dytiscidae* were collected on the sampling sites. These families are strongly associated with aquatic environs especially fluvial systems and can serve as bioindicator. Furthermore, none of the collected species are included in the IUCN Red List for Threatened Species (2017).

Gyrinidae (also known as whirligig beetles) (n= 7) are water beetles usually found in the surface of water if undisturbed. They are ellipsoid in appearance and commonly observed near riverbanks. In the sampling areas, the whirligig beetles belong to the genus *Orechtochilus*.

Gerridae (also known as water striders) are predatory water bugs that is commonly observed to walk on water due to its hydrophobic microhairs presence on the legs and body. They are normally found on water surface and prefer environment abundant with insects or zooplanktons. In the sampling areas, there are two genera of water striders present: *Limnometra* (n= 10) and *Aquarius* (n= 4).

Veliidae (also known as riffle bugs) are similar to gerrids but smaller in size and in the sampling sites it is represented by the genus *Rhagovelia* (n= 42). Among the collected aquatic insects, this group has the highest species count. This is due to their aggregating nature on the water surface which makes them easy to catch.

Fishing spider from the genus *Dolomedes* (n= 2) is also observed in the riverbanks on the sampling sites. These spiders are covered with short, velvety hair which allows them to float on water surface. They usually feed on aquatic insects and even small fishes.

Cicindellidae (n= 5), also known as tiger beetle, are aggressive predatory group from which the larvae are aquatic having large curved mandibles whereas the adult is terrestrial. They are usually found on riverbanks preying on soil- dwelling arthropods.

Notonectidae (n=2), also known as back swimmers, are freshwater inhabiting insects characterized by elongated hind legs fringed with hairs which are used for swimming. All notonectid bugs are predatory in nature.

Dytiscidae (n =3), also known as predaceous diving beetles, are highly predatory group bearing short but sharp mandibles. Immediately upon biting, the deliver digestive enzymes. Both adult and larvae are strictly aquatic.

Presence of these species presents the idea that the fluvial system in the area still sustain life forms and is not yet ecologically degraded. Aquatic insects are known to sensitive to availability of oxygen, fluctuation of temperature, sediment and substrate types, and presence of pollutants in an area. Thus, they can be used as bio indicators in ecological studies.

Riparian Soil Quality

Soil characteristic in the area is considered homogenous in nature. The location of the project and its surrounding environment is lying on rocky mountainous of soil. Three (3) sampling stations where selected base on its elevation and surrounding land use. On August 21, 2017 grab sampling was conducted.

Different parameters were tested to identify the soil characteristics of the riparian areas which might get affected by the project. These are as follows:

- pH
- Organic Matter
- Available Phosphorus (P)
- Exchangeable Potassium (K)
- Total Nitrogen
- Cation Exchange Capacity
- Texture
- Water Holding Capacity
- Particle Density
- Moisture Content
- Electrical Conductivity

The riparian area of where the samples were collected were also part of the riparian ecology study for flora and fauna.

Riparian soil sampling locations are described as follows:

Table 2-25. Riparian Soil Sampling Stations

Sampling ID	Coordinates		Site Description
	Latitude	Longitude	
RS 1	9°51'30.36"N	123° 4'38.64"E	Within the project site, near the river. Covered with grasses and shrubs.
RS 2	9°51'30.30"N	123° 5'15.24"E	Near residential areas and agricultural farms
RS 3	9°51'2.75"N	123° 8'18.56"E	Coconut plantation with some other fruit-bearing trees

Table 2-26. Soil Sampling Results for Riparian Areas

Parameters	Unit	Results		
		RS1	RS2	RS3
pH	-	4.1	4.4	4.7
Organic Matter	%	2.78	4.44	2.37
Available Phosphorus	ppm	5.1	4.8	24
Exchangeable Potassium	cmol/kg soil	0.05	0.64	1.07
Total Nitrogen	%	0.12	0.22	0.15
Cation Exchange Capacity		5.29	15.36	23.37
Texture	-	Sandy Loam	Loam	Loam
Water Holding Capacity	%	35	61	65
Particle Density	gm/cm	2.57	2.48	2.61
Moisture Content	%	6	21	17
Electrical Conductivity	uS/cm	175	220	678

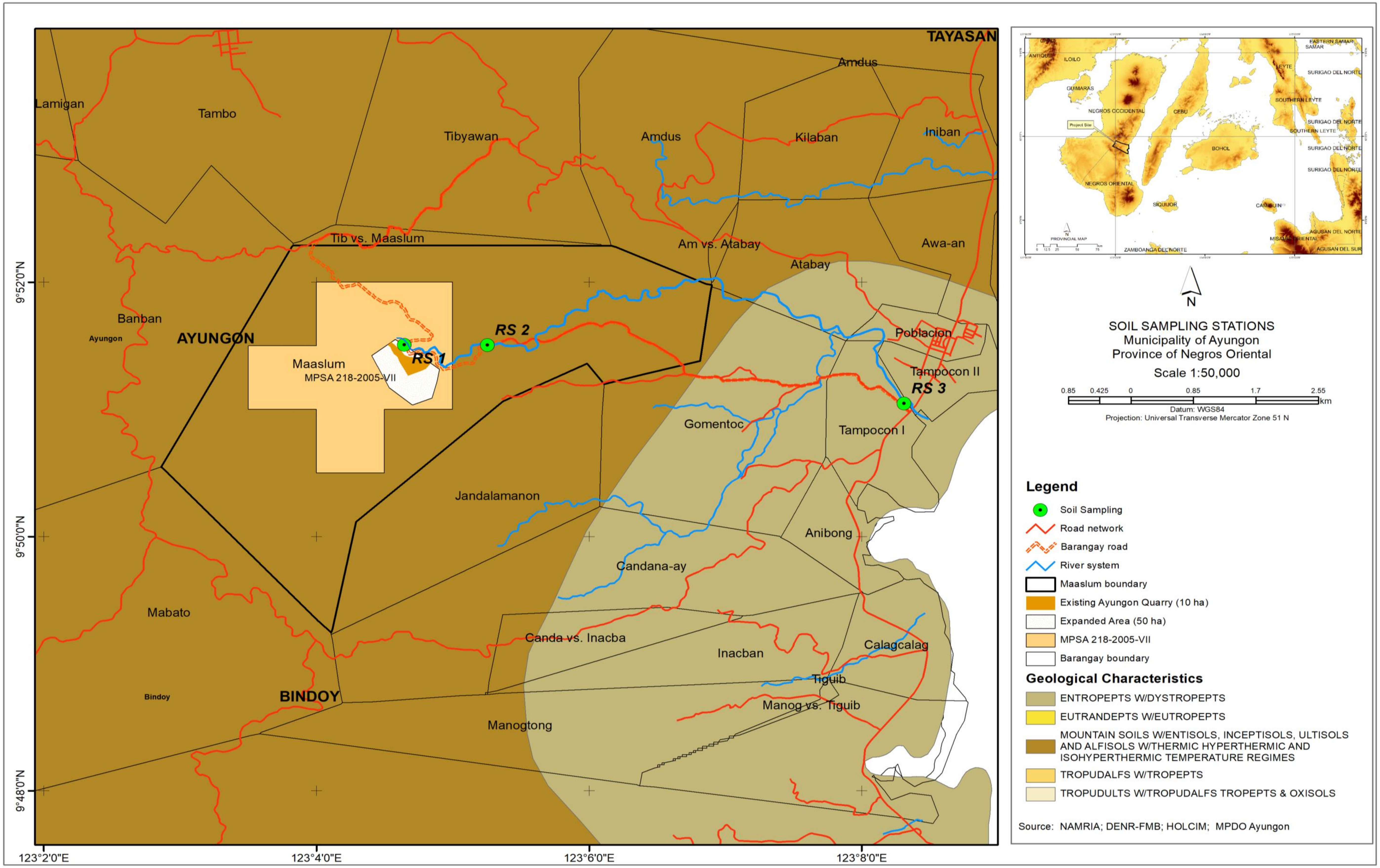


Figure 2-49. Soil Sampling Stations in Selected Riparian Areas *(Source: NAMRIA, HOLCIM, BSWM, MPDO-Ayungon)*

B. Water

1. Hydrology/Hydrogeology

The proposed expansion project site is part of the Maaslum watershed *(Refer to Figure 2-50).* This watershed has a total area of about 2,310 hectares (Figure 2-51). Its tributary flows to the Maaslum River towards Ayungon Bay. The tributary is almost 100 to 250 meters away from the perimeter broundary of the 50-has expanded quarry area. Rivers in the upstream are perennial in nature and generally clear all throughout the year. Drainage pattern is generally coarse dendritic. In terms of water quality, the downstream and mainstream areas are physically affected due to siltation, kaingin making, quarrying, mining and other activities. At present, surface and groundwater areas of the watershed is a major source of water for commercial, domestic and agricultural uses.

Generation of mine tailings is a common aftermath of a quarrying activity thus appropriate rehabilitation measures both biological and engineering measures can be made. Vengineering as a technique where vegetative materials are used in combination with engineering intervention, e.g. leguminous cover crops are introduced to improve soil fertility on a terrace landscape, for example, before shrubs or small trees are introduce. This is to improve soil fertility and achieve optimal micro climate requirements of the plants.

Difficulty of greening mine tailings is the common concerns of the company. However, this can be carried out with high success if appropriate techniques and decent funding is employed. Greening should involve using a lot of use of organic materials to assure planted seedlings would have enough nutrients to survive in this marginal soil condition.

The proposed expansion project in some unexpected instances will cause the deposition of mine tailings and effluents to the overburden storage areas which will be located on the upper stream of the Maaslum River. With appropriate mitigation and implementation, problem with the siltation and possible river water contamination will be addressed.

Change in Drainage Morphology/Inducement of Flooding/Reduction in Stream Volumetric Flow

Change in Drainage Morphology

The silica mining expansion operation itself would not alter the drainage morphology. It is the continuous deposition that will subsequently affect the drainage morphology in the long run. Unchecked deposition of silt to the overburden storage areas will cause overflowing of the river waters especially during the heights of heavy rains. If this happens, the original coarse dendritic pattern will be diverted into lines of water channels finding their ways to the lower ground.

Progressive rehabilitation and tree plantation at the bank of the overburden storage areas will stabilize the surface morphology. In the course of time, water will find its way following the course where nature will dictate. To address this problem, the company will regularly desilt the storage pond. In short, desilting of overburden storage areas will be done on a regular basis especially before and after rainy season.

Inducement of Flooding

Flooding is not a hazard that could affect the project site but most likely in the downstream areas. Although there is low present danger of flooding, increase in the sedimentation of stream channel will cause overflow and increase in the surface run-off. Large amounts of sediment and poor-quality water may have detrimental effects downstream from the project site after heavy downpour of rain. Extreme rainfall could induce slope failure at the banks of the overburden storage areas. If this happens, those at the lower ground will be flooded. The effect of the projected global warming, extreme and erratic rainfalls in ther future are being considered in the structural design and holding capacity of the overburden storage areas. In addition, construction of siltation ponds and silt traps including slope stabilization measures (application of fiber matting and tree planting along the banks) should be done in order to avert possible increase in siltation and soil erosion.

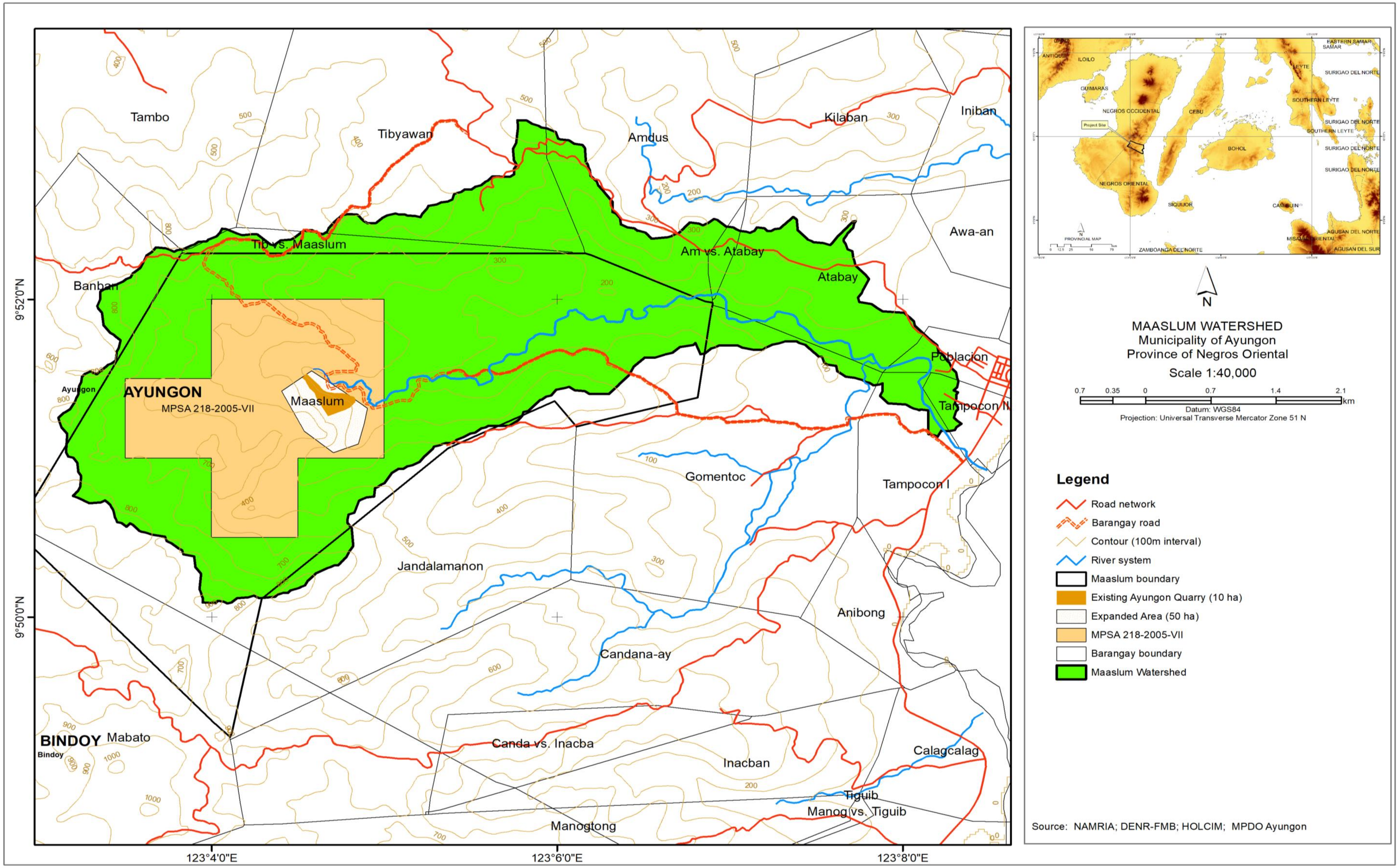


Figure 2-50. Maaslum Watershed *(Source: NAMRIA, HOLCIM, DENR-FMB, MPDO-Ayungon)*

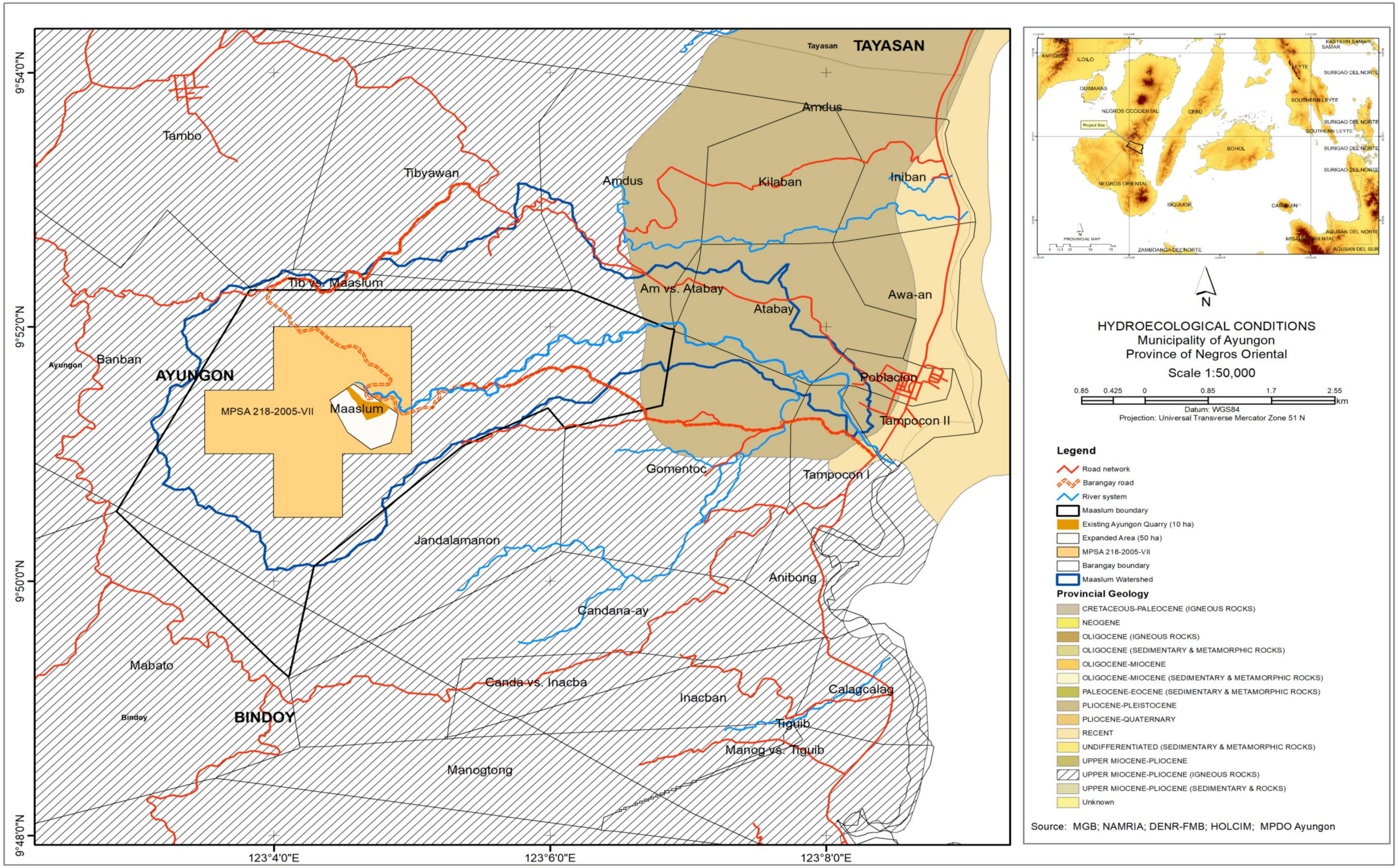


Figure 2-51. Hydrogeological Conditions of the Maaslum Watershed in Negros Oriental *(Source: NAMRIA, HOLCIM, DENR-FMB, BSWM, MPDO-Ayungon)*

Reduction in Stream Volumetric Flow

The photograph below exhibits the minimum discharge rate of the Maaslum River. Water depth is relatively shallow with sand, silt and clay deposits accumulating at the creek beds. Increase in sediment deposition along creek and steam channels will cause reduction in the stream volumetric flow. As with the reduction in water depth, reduction in the volumetric flow will also adversely affect the aquatic habitat. There will be a decrease in oxygen supply, decrease in the area of aquatic habitat, and consequently an increase in aquatic resource competition.

Figure 2-52. Water level manual monitoring in the Maaslum watershed

Change in Stream Water Depth

Current siltation problem is attributed to the rampant kaingin making, illegal logging, quarrying, and mining activities. Subsequent to uncontrolled siltation, sediments will later fill the stream beds, thus reducing the water depth.

Mine tailing deposition will induce siltation of the natural water channels, thus reducing stream water depths. Consequent to uncontrolled siltation, bank erosion could happen.

In order to address the siltation and erosion impact, slope stability measures should be undertaken together with the development of silt dams / sumps, and using riprap or gabion baskets where applicable. As much as possible, affected creeks should be restored to its original configuration. Regular desiltation should be done on sumps / dams especially after heavy rainfall.

Water Balance Study

The assessment was made using a hydrologic model to estimate the distribution and pattern of streamflow discharge of the identified water source. This approach is useful, practical, and realistic based on the lumped parameter variables suitable to the existing biophysical conditions. The assessment was considered in the downstream areas of the Maaslum Watershed.

A water balance equation is often used to express the contributions of hydrologic processes to streamflow. At the watershed scale, the water balance equation links streamflow (*R*), precipitation (*P*), evaporation (*E*), losses to regional groundwater (*G*), and changes in watershed storage (ΔS):

$$R = P - E - G \pm \Delta S$$

where the variables are measured in water depth equivalent (mm) over time. The quantity *G* represents water that leaves the watershed as groundwater and thus does not contribute to streamflow.

This assessment considered the use of BROOK90 hydrologic model. The model has a strong physically-based description, which simulates the above and below liquid phases of the precipitation–evaporation-streamflow-groundwater flow part of the hydrological cycle for a point scale stand on a daily time-step.

Mathematically, the BROOK90 model water distribution is expressed as follows:

$$P = EVAP + FLOW + SEEP$$

where *P* is the precipitation (mm), *EVAP* is the evaporation (mm), *FLOW* is the corresponding simulated total streamflow (mm) derived from surface flow and the groundwater flow, and *SEEP* is the deep seepage loss or recharge from the groundwater (mm).

In the application of the above equation, the model calculates evaporation with the Shuttleworth–Wallace equation, an improvement of the Penman–Monteith equation as well as the temporal and quantitative flow mechanisms within a catchment. The Penman–Monteith equation is given as:

$$L_v \rho_w E = \frac{\Delta(R_n - S) + C_p \rho D_a / r_a}{\Delta + \gamma + \gamma(r_c / r_a)}$$

where *E* is the evaporation rate in volume of water per unit land area per unit time, L_v is the latent heat of vaporization for water, ρ_w is the density of water, Δ is the rate of change of vapor pressure with temperature, R_n is the net radiation above the surface, *S* is the subsurface heat flux, C_p is the heat capacity of air, *r* is the density of air, D_a is the vapor pressure deficit in the air, γ is the psychrometer constant, r_c is the canopy resistance, and r_a is the aerodynamic resistance between the canopy and a reference height z_a at which D_a is measured. The vapor pressure deficit, D_a, is e_a* - e_a. The equation assumes that the vapor pressure at the effective evaporating surface, e_0, is the saturated vapor pressure at the surface temperature. Then r_c and r_a are the two resistances through which water vapor passes as it moves down the vapor pressure gradient from e_0 to e_a. The canopy resistance, r_c, represents resistance to flow of vapor through the stomates and cuticle of individual leaves and through the air around each leaf to some effective source height of water vapor in the plant canopy. The aerodynamic resistance, r_a, is a measure of the turbulent transfer capability of the atmosphere between the effective source height and z_a. The Penman-Monteith equation is derived from the energy balance equation and the mass transfer equation for sensible and latent heat fluxes.

Evaporation in the BROOK90 model is analogous to evapotranspiration (ET) which is the sum of five (5) components, namely: evaporation of intercepted rain, evaporation of intercepted snow, snow evaporation, soil evaporation, and transpiration. However, evaporation in the given sites are concentrated only on three (3) components in the absence of snow effects.

For streamflow, it is derived from the given equation below:

$$FLOW = SRFL + GWFL$$

where *SRFL* is the surface flow, and *GWFL* is the groundwater flow. Equally, streamflow is generated using the following simplified processes: storm flow by source area flow or subsurface pipe-flow and delayed flow from vertical or downslope soil drainage and first-order groundwater storage.

Meanwhile, groundwater flow is assumed to be a first order reservoir as:

$$GWFL = GWAT * GSC * (1 - GSP)$$

where *GWAT* is the groundwater storage below soil layers, *GSC* is the fraction of groundwater storage that is transferred to groundwater flow and deep seepage (*SEEP*) daily, and *GSP* is the fraction of groundwater discharge produced by *GSC* that goes to deep seepage and is not added to streamflow (*FLOW*).

Finally, the case of seepage loss is calculated as:

$$SEEP = GWAT * GSC * GSP$$

The simulation process was initiated from the evaluation of parameters and collection of weather data for the catchment. Daily weather data and lumped parameter variable values were the main inputs for hydrologic model simulation. The program was repeatedly run in much iteration for the purpose of assessing the water balance of the Maaslum Watershed given the existing conditions and assumptions.

Water Balance Distribution of the Maaslum Watershed

Table 2-27 shows the distribution and partitioning of water balance processes under the Maaslum Watershed conditions. The average annual rainfall for the three-year period (2013-2015) was 968 mm. On an annual basis, approximately 48% of the precipitation turned into evaporation, 39% became streamflow, and 13% into seepage loss. Outcome of the streamflow simulation was likely affected by the increasing rate of surface flow (*SRFL*) and saturated groundwater flow (*GWFL*). The model mechanism assumed that upon reaching the forest floor, rainwater may enter the soil through infiltration or flow over the surface as overland flow. A large portion of the rainfall remained as streamflow mainly through *SRFL* and *GWFL*, which contributed 37% and 24%, respectively.

For evaporation, a portion of rain falling on a forest was intercepted by the canopy, the under story and ground vegetation and then evaporated to the atmosphere. Total evaporation losses within the Maaslum Watershed accounted for more than 459 mm, which were mainly influenced by transpiration, interception loss, and soil evaporation.

Regarding the below ground liquid component, the total seepage losses were estimated to be more or less 122 mm, which were derived from interactions groundwater storage.

The distribution of water balance components was basically reflected on a pronounced seasonal variation and the fluctuating patterns in rainfall in Negros Oriental (Figure 2-51). It must be noted that the annual rainfall can be considered as relatively low. Based on the simulation, the mean monthly streamflows declined from December to June and following the pattern for mean monthly rainfall. However, streamflow during the months of November to February increased due to surface flows that mainly responded to high rainfall events, exceeding soil storage and (or) infiltration capacity. As a result, an average streamflow of 380 mm was accounted with distinct peak flow that occurred in November (58 mm) while the lowest peaks were usually recorded during the months of July to August.

The monthly water distribution demonstrated how evaporation rates affected the streamflow components of the Maaslum Watershed. Low evaporation losses ranging from 10 – 90 mm happened for a watershed while monthly evaporation significantly increase for the duration of June to September. Basically, evaporation losses were mainly controlled by transpiration and evaporation from the intercepted rain throughout the rainy season while evaporation from the soil dominated during the duration of the dry seasons.

Meanwhile, the simulated seepage losses ranging from 3 to 19 mm did not significantly vary throughout the year. The proportion of the seepage primarily relied on the soil moisture antecedent conditions and not on rainfall availability, nor the land cover type.

Table 2-27. Water Balance Distributions of the Maaslum Watershed in Ayungon, Negros Oriental

Month	Rainfall (mm)	Streamflow		Evaporation		Seepage	
		Amount (mm)	Streamflow (%)	Amount (mm)	Evaporation (%)	Amount (mm)	Seepage (%)
Jan	83.48	39.10	4.0	12.31	1.3	13.54	1.4
Feb	46.99	37.11	3.8	12.85	1.3	14.03	1.5
Mar	63.75	52.10	5.4	12.21	1.3	14.13	1.5
Apr	15.58	27.62	2.9	10.45	1.1	11.66	1.2
May	47.33	24.64	2.5	26.39	2.7	7.17	0.7
Jun	88.92	15.18	1.6	76.78	7.9	5.88	0.6
Jul	130.71	13.61	1.4	88.19	9.1	3.37	0.3
Aug	66.63	11.93	1.2	84.53	8.7	4.50	0.5
Sep	131.40	19.75	2.0	75.85	7.8	3.76	0.4
Oct	96.85	29.06	3.0	29.43	3.0	8.44	0.9
Nov	134.11	57.90	6.0	17.08	1.8	16.58	1.7
Dec	61.73	52.31	5.4	12.77	1.3	19.33	2.0
Total	***967.48***	***380.30***	***39.31***	***458.84***	***47.43***	***122.40***	***12.65***
Max	*134.11*	*57.90*	*5.98*	*88.19*	*9.12*	*19.33*	*2.00*
Min	*15.58*	*11.93*	*1.23*	*10.45*	*1.08*	*3.37*	*0.35*
SD	*37.65*	*16.01*		*32.50*		*5.39*	

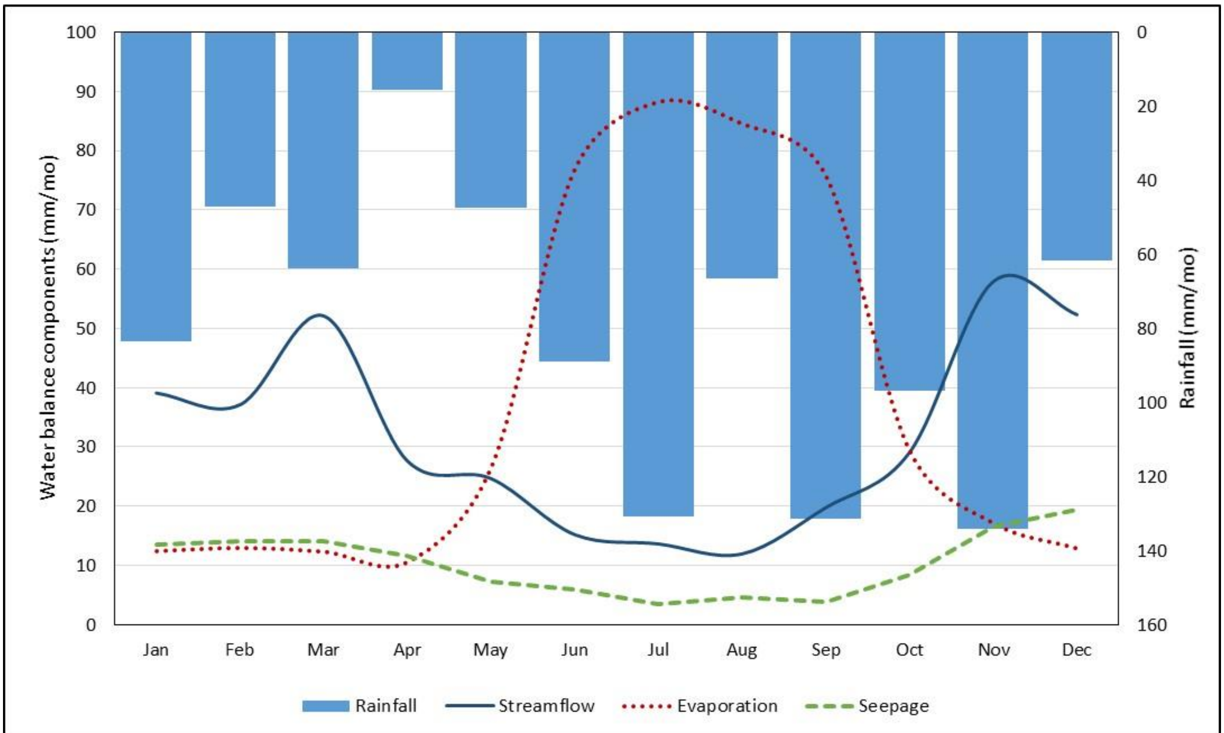


Figure 2-53. Average Monthly Water Balance (2013 – 2015) of the Maaslum Watershed in Ayungon, Negros Oriental

Table 2-28. Distribution of Streamflow Components in the Maaslum Watershed

Month	Surface Flow (mm)	Flow				
		Percent of Surface Flow	Ground Water Flow (mm)	Percent of Ground Water Flow	Streamflow (mm)	Percent of Streamflow
Jan	7.51	2.0	31.59	8.3	39.10	10.3
Feb	4.37	1.1	32.73	8.6	37.11	9.8
Mar	19.13	5.0	32.97	8.7	52.10	13.7
Apr	0.40	0.1	27.22	7.2	27.62	7.3

Month	Surface Flow (mm)	Flow				
		Percent of Surface Flow	Ground Water Flow (mm)	Percent of Ground Water Flow	Streamflow (mm)	Percent of Streamflow
May	7.90	2.1	16.74	4.4	24.64	6.5
Jun	1.47	0.4	13.71	3.6	15.18	4.0
Jul	5.73	1.5	7.88	2.1	13.61	3.6
Aug	1.43	0.4	10.50	2.8	11.93	3.1
Sep	10.97	2.9	8.78	2.3	19.75	5.2
Oct	9.37	2.5	19.69	5.2	29.06	7.6
Nov	19.20	5.0	38.69	10.2	57.90	15.2
Dec	7.21	1.9	45.10	11.9	52.31	13.8
Total	*94.7*	*24.9*	*285.6*	*75.1*	*380.3*	100.0
Max	*19.2*	*5.0*	*45.1*	*11.9*	*57.9*	*15.2*
Min	*0.4*	*0.1*	*7.9*	*2.1*	*11.9*	*3.1*

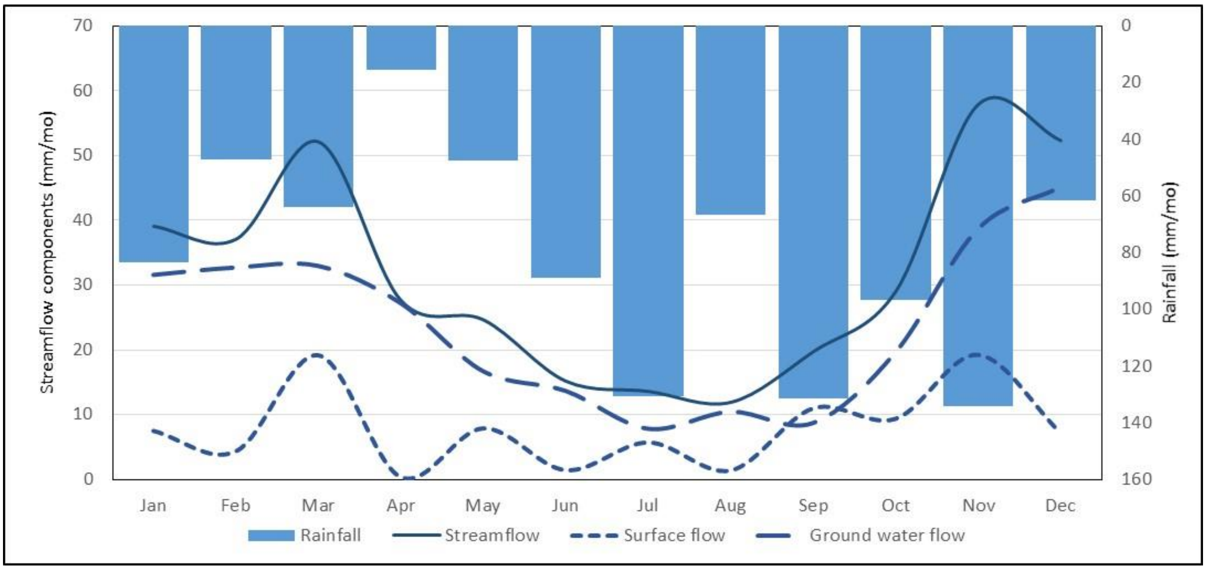


Figure 2-54. Monthly Streamflow Distributions in Maaslum Watershed

Stream Discharge Assessment

The stream discharge of a watershed was assessed based on lumped variables of weather, flow, canopy, physical and morphometric characteristics. The discharge was converted given the 2310 ha area of a watershed.

Table 2-29 presents the monthly and annual volume of stream discharge of the Maaslum Watershed. The fluctuation of flow discharges closely followed the availability of rainfall. However, the amount of streamflow can also be attributed to the watershed size and its biophysical responses to hydrology. Streamflow increased immediately after the onset of rainfall events. This increase was shown as the rising limb of the hydrograph from September to November (Figure 2-55). The maximum discharge in response to extreme rainfall events is referred to as peak flow. The definition of peak flow depends on the time period of interest (*e.g.,* event, seasonal, annual). The magnitude of a peak flow is a function of rainstorm duration volume; storm intensity; antecedent conditions affecting storage opportunities, such as soil moisture, soil characteristics, forest floor conditions, and canopy wetness; and catchment characteristics, including watershed area, topography, and physiography. Generally, low streamflows were simulated for two different years during months of March to December in 2013 and 2015 due to long dry spell in the area.

On a monthly basis, the minimum discharge was as low as 1.75 cu m/sec during the month of June while the highest discharge of about 33.99 cu m/sec occurred during the month of November. The average monthly stream discharge for a watershed was from 3.19 to 15.48 cu m/sec, which accounted to 101.68 cu m/sec annual discharges.

Table 2-29. Summary of Streamflow Discharge of the Maaslum Watershed

Month	Streamflow Discharge (cu m/sec)			Average
	2013	2014	2015	
Jan	7.77	8.71	14.89	10.46
Feb	8.58	12.56	8.63	9.92
Mar	8.55	27.33	5.91	13.93
Apr	4.4	14.54	3.22	7.39
May	3.29	14.27	2.2	6.59
Jun	2.79	7.64	1.75	4.06
Jul	5.22	3.72	1.97	3.64
Aug	4.49	2.89	2.18	3.19
Sep	3.3	9.53	3.02	5.28
Oct	2.6	17.39	3.31	7.77
Nov	7.41	33.99	5.04	15.48
Dec	8.67	26.58	6.71	13.99
Annual streamflow (cu m/sec)	*67.06*	*179.15*	*58.82*	101.68
Min	*2.6*	*2.89*	*1.75*	*3.19*
Max	*8.67*	*33.99*	*14.89*	*15.48*

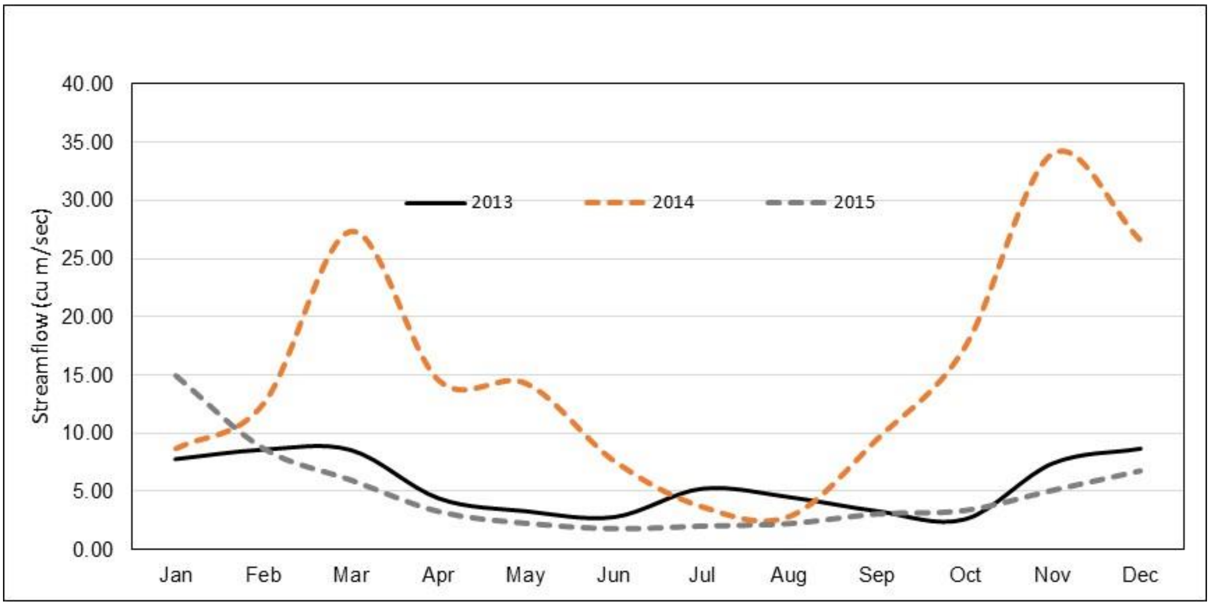


Figure 2-55. Simulated distributions of streamflow discharge for the last three (3) years (2013-2015)

It must be pointed out that the existing silica mining activity does not utilize the surface water of the Maaslum River. The activities are concentrated on the ground which does not require any water consumption. The water is mainly used for agricultural farming. Hence, the projected water consumption of the project will be the same with the current water management practices. There will be more than enough supply of water from the watershed. The Maaslum Watershed has an estimated average total discharge of about 101 cubic meters per second that is equivalent to 101,000 liters per second.

Reduction / Depletion of Groundwater Flow

Groundwater flow is the continuous and immediate source of water of the Maaslum Watershed. Table 2-30 presents the monthly groundwater flow discharge. The fluctuation of groundwater flow did not significantly vary for each month. Basically, increase of groundwater flows were noted for the duration of November to April, which attributed to the microclimate conditions and soil moisture of the site. On a monthly basis, the average minimum groundwater flow was as low as 2.11 cu m/sec during the month of July while the highest discharge of about 12.06 cu m/sec occurred during the month of December. The average groundwater discharge of a watershed was 76.36 cu m/sec.

Table 2-30. Summary of Groundwater Flow of the Maaslum Watershed

Month	Ground water flow (cu m/sec)			
	2013	2014	2015	Average
Jan	5.28	6.13	13.93	8.45
Feb	7.30	10.80	8.15	8.75
Mar	8.47	12.07	5.91	8.81
Apr	4.30	14.36	3.17	7.28
May	3.06	8.16	2.20	4.47
Jun	2.46	7.04	1.51	3.67
Jul	1.97	3.15	1.20	2.11
Aug	4.18	2.76	1.48	2.81
Sep	3.14	2.14	1.77	2.35
Oct	2.02	11.06	2.71	5.26
Nov	4.51	21.93	4.59	10.34
Dec	8.50	22.62	5.06	12.06
Ground water flow (cu m/sec)	*55.20*	*122.21*	*51.67*	*76.36*
Min	*1.97*	*2.14*	*1.20*	*2.11*
Max	*8.50*	*22.62*	*13.93*	*12.06*

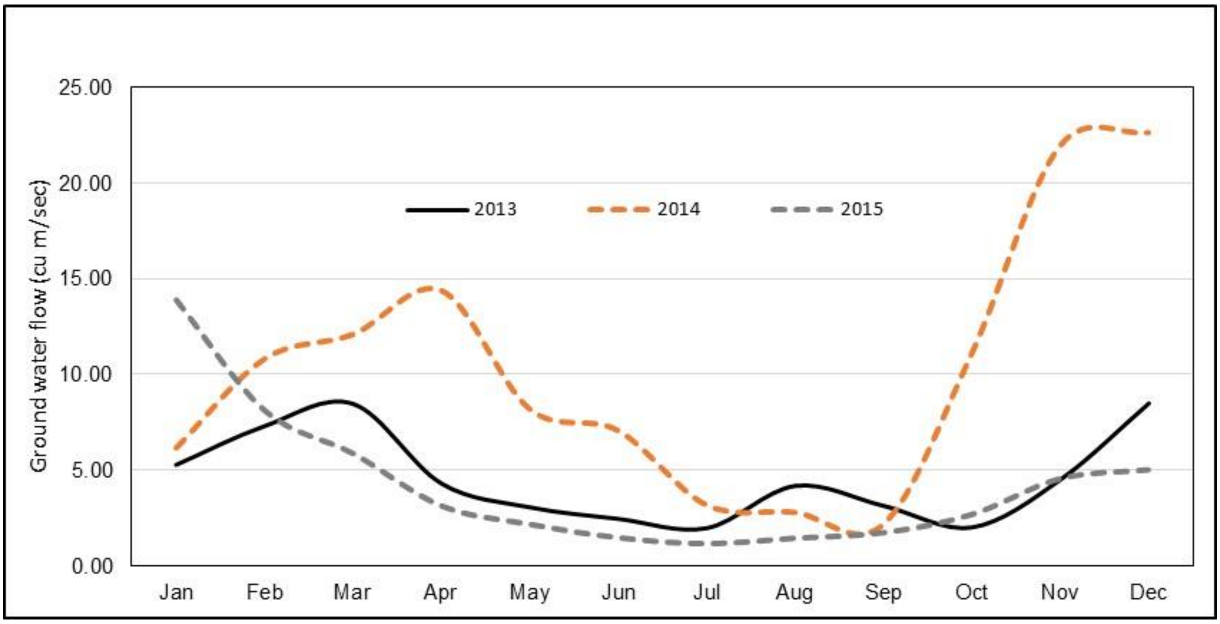


Figure 2-56. Simulated distributions of groundwater discharge for the last three (3) years (2013-2015)

Generally, the Negros Oriental area has fairly productive groundwater supply. Depletion of ground water flow will be triggered by the loss of vegetative cover at the site. Impacts that could be induced by the plant operations may include depletion of usable water from shallow aquifers; lowering of water levels in adjacent areas and changes in flow directions within aquifers; contamination of usable aquifers below plant site due to infiltration or percolation of poor-quality water; and increased infiltration of precipitation on spoil piles.

In effect, removal of vegetation should be confined only to areas affected by the operation. Thus, the company should actively participate in the tree planting, reforestation and rehabilitation programs. Also, remaining patches of forest should be preserved.

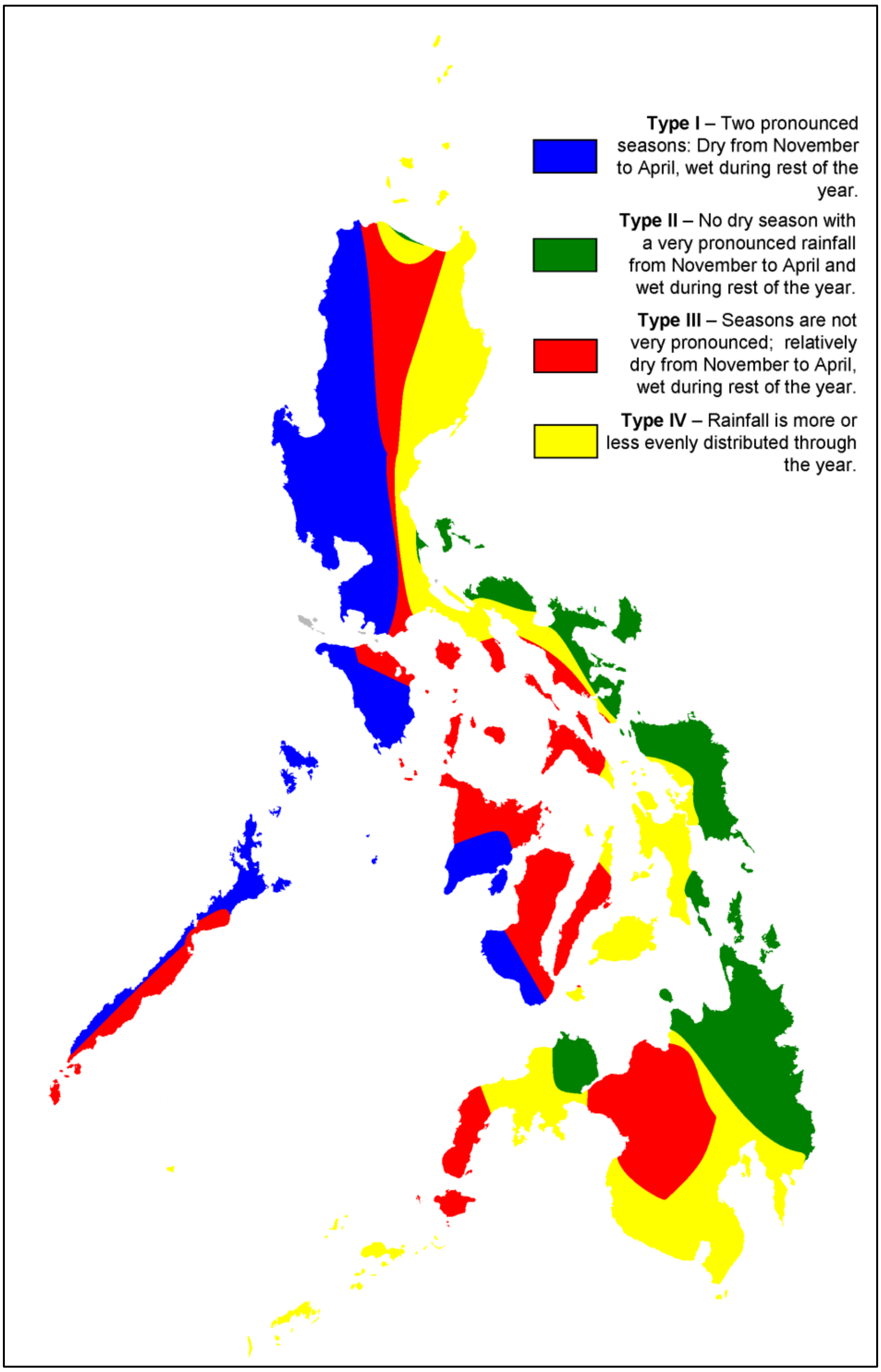
It must be noted that the current project does not utilize any groundwater for its operation and activities. The groundwater availability is utilized mainly for human consumption and agriculture production purposes. The groundwater availability in the project area and its influence area is more than enough to supply the community households' consumption and their agricultural farming activities.

<u>*Baseline Climate*</u>

Based on Modified Corona's Classification System, the climate in the area belongs to Type III which is characterized by two very distinct seasons (Agpao *et al.*, 1975) (**Figure 2-57**). The dry season usually starts in November and ends in April while the wet season begins in May and peaks in July or August and ends in October.

A total of 68 tropical cyclones passed within 50 km while some 101 cyclones passed within 100 km in the Negros Island between 1948 and 2015. Weather conditions of the Negros Island are often experiencing erratic and extreme events. The Negros Island is frequently visited by typhoons or cyclones. In particular, the area has been experiencing more or less 3 typhoons a year on average.

It is during November and December that the greatest number of cyclones crossed the watersheds whereas the months of July to September are almost free of tropical cyclones except for a few cyclones that passed during these months. The tracks of past tropical cyclones in the area are shown in **Figures 2-58.**



(Source: PAGASA)

Figure 2-57. Climate Map of the Philippines

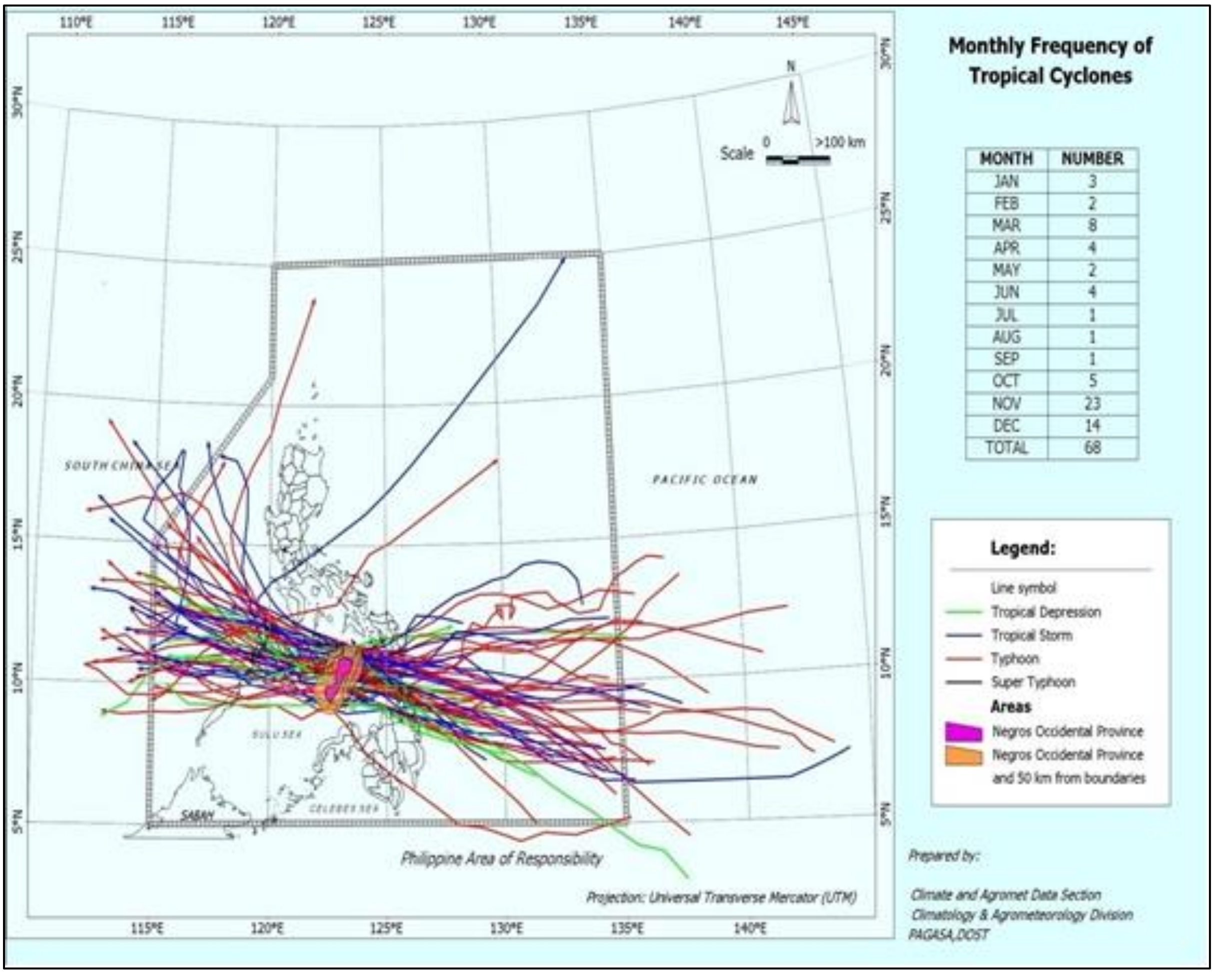


Figure 2-58. Tracks of tropical cyclones that crossed the province of Negros Occidental and within 50 km from boundaries

Climate scenario for Negros in 2020 and 2050

In order to assess future vulnerabilities to hazards, projections of future changes in rainfall in 2020 and 2050 were prepared by the PAGASA using the CNRM-CM3 model (also known as CNCM3 model) with two (2) scenarios. CNRM-CM3 coupled generation circulation model is the sum of the updated version of the different model components already present in CNRM-CM2 (Salas-Melia *et al.*, 2005).

In this assessment, the model outputs under the two (2) scenarios were within a planning horizon of up to 2050. Outputs of the model under the A1B and A2 scenarios will only diverge after 2050 due to the long lifetimes of the greenhouse gases. The outputs of the model run for the observed monthly, and changes in the monthly rainfall both in 2020 and 2050 were used in the vulnerability assessments.

The simulated monthly rainfall ranges from 29 mm to 652 mm. The mean monthly rainfall of two scenarios (A1B and A2) was not significantly different from each period. The driest month, April, still sees on average, over 62 mm of precipitation per year. The wettest months are August and December with a monthly mean of more than 300 mm (Figure 2-58 and Table 2-31).

In particular, the monthly precipitation fluctuated each month for two (2) periods. However, the most distinct changes were predicted to be in the 2020s period under A2 scenario where the months of May, August and December had indicated a potential decrease. Other periods closely followed the trends and patterns. Overall, an increase of annual rainfall was predicted in each scenario for two (2) periods (Table 2-32).

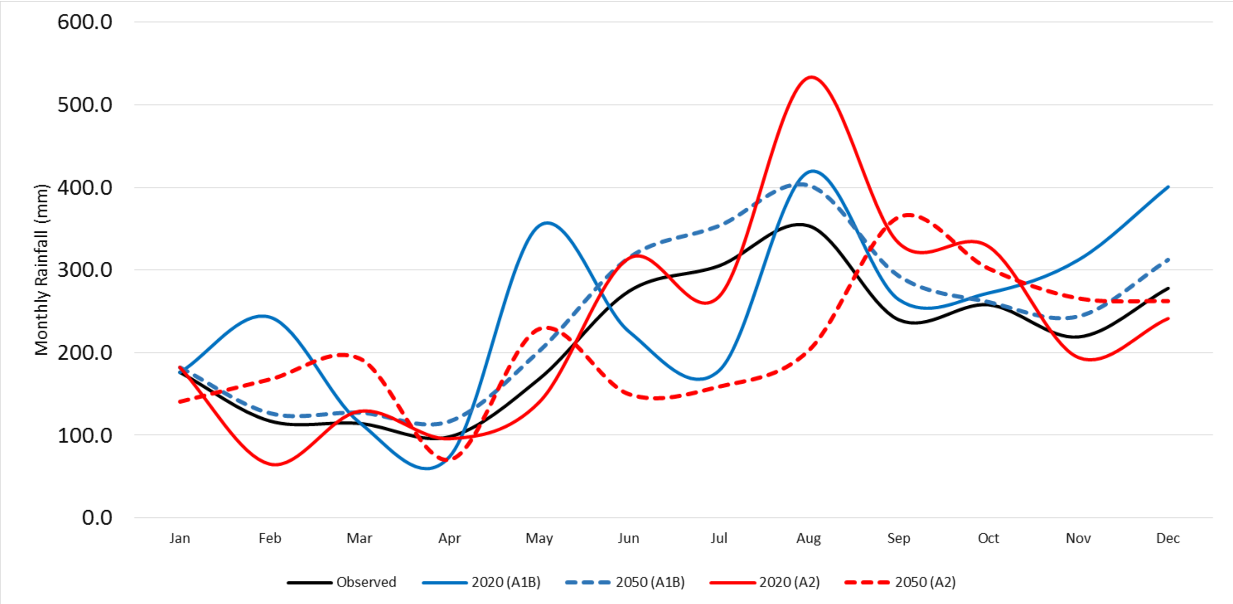


Figure 2-59. Observed and projected monthly rainfall in Negros Island

Table 2-31. Projected rainfall based on CNCM3 model with two scenarios

Month	Observed	A1B		A2	
		2020	2050	2020	2050
Jan	176.3	176.0	182.4	182.5	140.9
Feb	117.5	243.2	127.1	65.2	167.9
Mar	114.5	115.5	127.8	129.2	193.0
Apr	98.2	73.9	117.3	95.9	70.5
May	168.3	353.7	202.5	140.1	228.9
Jun	274.5	225.5	315.4	314.4	149.8
Jul	305.1	178.2	353.7	267.8	159.0
Aug	353.6	418.8	402.7	533.1	202.8
Sep	239.9	264.4	293.2	332.9	364.0
Oct	258.1	272.3	261.7	328.6	302.0
Nov	219.1	312.2	244.2	194.2	265.9
Dec	278.0	400.9	312.7	241.5	262.5
Total	***2603.1***	***3,034.5***	***2,940.8***	***2,825.3***	***2,507.2***
Min	*98.2*	*73.9*	*117.3*	*65.2*	*70.5*
Max	*353.6*	*418.8*	*402.7*	*533.1*	*364.0*
SD	*82.14*	*176.0*	*182.4*	*182.5*	*140.9*

Ave	*216.9*	*243.2*	*127.1*	*65.2*	*167.9*

Table 2-32. Estimated changes in average monthly rainfall by 2020 and 2050

Month	A1		A2	
	2020	2050	2020	2050
Jan	0	3	3	-20
Feb	107	8	-45	43
Mar	1	12	13	69
Apr	-25	19	-2	-28
May	110	20	-17	36
Jun	-18	15	15	-45
Jul	-42	16	-12	-48
Aug	18	14	51	-43
Sep	10	22	39	52
Oct	6	1	27	17
Nov	43	11	-11	21
Dec	44	12	-13	-6
Total	*17*	*13*	*9*	*-4*

2. Oceanography

The Tañon Strait, the largest protected seascape in the Philippines is located about eight (8) kilometers east of the quarry site. The distance from the project site to the ocean which is estimated at eight (8) kilometers would not have much impact on the oceanic ecosystem.

The proponent has also provided various mitigation measure including silt ponds and retaining walls to ensure that silt would not be deposited on the river systems.

3. Water Quality

Baseline Conditions of Surfacewater and Groundwater Quality

The river water quality samples were taken from four (4) sampling stations identified along the stretch of Maaslum River and one (1) sampling station along Gomentoc River. Station SW-01 was chosen due to its proximity of the area to the upper portion of the existing quarrying. Station SW-02 was chosen as a sampling station since it is directly below the other side of the quarrying area. It is important to note that Stations SW-01 and SW-02 do not meet. The consideration of the two (2) stations will provide better inference on the possible source of contamination in the future.

Station SW-03, on the other hand is the confluence of Stations SW-01 and SW-02. Station SW-04 is along a different river system (Gomentoc River). This will serve as a control point to check whether the possible degradation of water quality along Station SW-05 is caused by the quarrying or by point sources from the households. Station SW-05 is the confluence of Maaslum and Gomentoc River.

In terms of groundwater sampling, two (2) stations were identified to represent the groundwater within the project area. Sampling points are based on the existing well and spring. Station GW-01 is a spring located in the nearby hills while Station GW-02 is an artesian well located near the highway of Ayungon.

Sampling activity was conducted on April 28, 2016 for the dry season and August 21, 2017 for the wet season. Results of the sampling activity are discussed in the following subsections.

Table 2-33. Methods for Water Quality Sampling

Parameter	Approved Method of Analysis	Source*
Temperature	*In situ* measurement (Thermostat)	S,G
pH	*In situ* measurement (Glass Electrode Method)	S,G
Conductivity	*In situ* measurement	S,G
Dissolved oxygen (DO)	*In situ* measurement (Membrane electrode method)	S,G
Total Suspended Solids (TSS)	Gravimetric (Filtration and Drying at 103ºC – 105ºC)	S,G
Turbidity	Nephelometric	S
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique)	S,G
Chemical Oxygen Demand (COD)	Closed Reflux - Colorimetric	S,G
Oil and Grease	Partition Gravimetric (Petroleum Ether Extraction)	S
Sulfate	Turbidimetric	S
Alkalinity	Titrimetric	S
Cr^{+6}	Diphenyl Carbazine Colorimetric Method	S
As	Hydride Generation AAS	S
Ca	EDA Titrimetric	S
Fe, Pb, Mg, Ni, Cd, Na	Atomic Absorption Spectrophotometry	S
Hg	Cold Vapor Technique	S
CN	Selective Electrode Method	G
Fecal Coliform	Multiple Tube Fermentation Technique	S,G
Total Coliform	Multiple Tube Fermentation Technique	S,G
E. Coli	Pour Plate Method	S,G
HPC	Pour Plate Method	G

*Note: *S-surface water; G-groundwater*

The results of the water quality analyses were assessed based on the local guidelines set by DENR Administrative Order (DAO) No. 08 series of 2016. The DAO 2016-08 describes the classification and the beneficial use of fresh water and coastal/marine water bodies in the Philippines. This DAO prescribes the water quality guideline criteria for a freshwater body and groundwater corresponding to its designated best use.

Maaslum River and Gomentoc River are not yet classified by the DENR. However, for the purpose of referencing its water quality with the DAO 2016-08 criteria, the results were compared against the criteria for its observed beneficial use. The assumed classification guideline for Maaslum River and Gomentoc River is both Class C which is best used for the propagation and growth of fish and other aquatic organisms and recreation.

In terms of the groundwater quality analysis, the laboratory results were compared to the guidelines for a Class A river as Section 6.2 of DAO 2016-08 prescribes that groundwater used as potable water and other domestic use will adopt the guideline of a Class A river with exception to BOD and DO.

Results and Discussion

Surface Water Quality

Table 2-34 presents the summary of the river water quality results (i.e. physical, chemical and bacteriological) from the five (5) water sampling stations. The result of the wet and dry seasons was presented together to provide a comparative view of the laboratory analysis results. The observations noted during the time of sampling are summarized and the Certificates of Analysis are presented in **Annex 8**.

Water quality characteristics during wet and dry season's samplings are as follows:

- The temperature at five (5) stations passed the set environmental standards (25 °C – 31 °C) except during summer (37 °C) at Station 5. The increase in temperature at this station can be attributed to the location and amount of discharge wherein directly expose to sunlight with low streamflow.
- The pH levels failed to meet the set environmental standards (6.5 – 9.0) at four (4) upstream stations during the dry and wet seasons. The pH level in the downstream (SW-04) is within the set standards. The acidity of the surface water in the upstream ranges from slightly to extremely acidic. This can be attributed to the ground surface disruption and silica mining exploration in the areas.
- All DO concentrations passed with the set minimum standard (5mg/L) for Class C of DAO 2016-08. The increased level of DO in the Maaslum and Gomentoc Rivers indicates that there is a good oxygen level circulating in the water. The water has sufficient oxygen to sustain aerobic organisms. The presence of good DO levels indicates that the river water is still a good thriving environment for aquatic life.
- TSS amounts passed the set standards except at Station 5 (168 mg/L) during the summer season. High TSS amounts in the said stations can be attributed to the decaying plant and animal matter, and sewage into the river. High TSS in a water body can often mean higher concentrations of bacteria and nutrients in the water. It can also cause DO levels to fall even further and can harm aquatic life in many other ways.
- Turbidity values ranging from 0.10 - 57 NTU in all stations passed the set standards (75 NTU).
- BOD concentrations passed the set standards (7 mg/L) in all stations and seasons except at SW-05 station (20 mg/L). In particular, BOD directly affects the amount of dissolved oxygen in the river. The greater the BOD, the more rapidly oxygen is depleted in the river. This means less oxygen is available to higher forms of aquatic life.
- COD amounts ranged from 5 to 35 mg/L during the two (2) seasons baseline measurements. There are no set environmental standards for COD.
- Oil and grease levels ranging from <1 to 1 mg/L and below to the set standards.
- Sulfate levels are below the set standards (275 mg/L) in all stations.
- Alkalinity ($CaCO_3$) levels ranging from <1 to 84 mg/L in all stations. There is no set standard for alkalinity.
- Chromium levels are above the set standard in all stations during the summer season except at station SW-02. However, chromium levels are below the set standard in all stations during the rainy season. The concentration of Cr^{+6} could be triggered by the acidic condition of the water which oxidizes the natural soil into a hexavalent form and/or could be attributed to the existing quarrying operation upstream of the station. Likewise, Cr^{+6} is an odorless and tasteless metallic element. It is found naturally in

rocks, plants, soil and volcanic dust, and animals. Prolonged exposure to elevated level of Cr+6 could trigger lung cancer, irritation to nose, throat, eye and skin. This could severely affect the direct receptor of the water such as the employees and the residents of immediate barangay. The mandatory monitoringof CR+6 in surface water and ground water will be included as part of monitoring requirement.

- Calcium levels accounted in the Maaslum River are within the range of <1 to 174 mg/L. There is no set standard of the Ca for Class C water.
- Iron levels are above standards (1.5 mg/L) in SW-01 and SW-03 stations during the wet season. This can be attributed to the surface runoff from the mining areas.
- Higher magnesium levels are observed during the summer season as compared to rainy season magnesium levels. There is no set standard of the magnesium for Class C water.
- There was no trace of lead, arsenic, nickel, and cadmium in all sampling stations.
- Sodium levels accounted in the Maaslum River are within the range of <1 to 4.1 mg/L. There is no set standard of the sodium for Class C water.
- There is a trace of mercury level at SW-04 accounted for 1.76 mg/L, which is located part of the Gomentoc River, during the rainy season. This can be attributed to the settlements along the riverbank and their domestic wastes. It must be noted that the station (SW-04) is near a bridge, adjacent to a road and houses. Other stations given the two seasons passed to the set standards.
- There is a high total coliform count which are up to 7,000,000 MPN/100 ml presence during the summer season at SW-05 of the Maaslum River. The Gomentoc River also accounted for a high total coliform during the rainy season. This could be due to the agricultural and other domestic activities, and settlements along the riverbanks of the upstream and downstream portions.

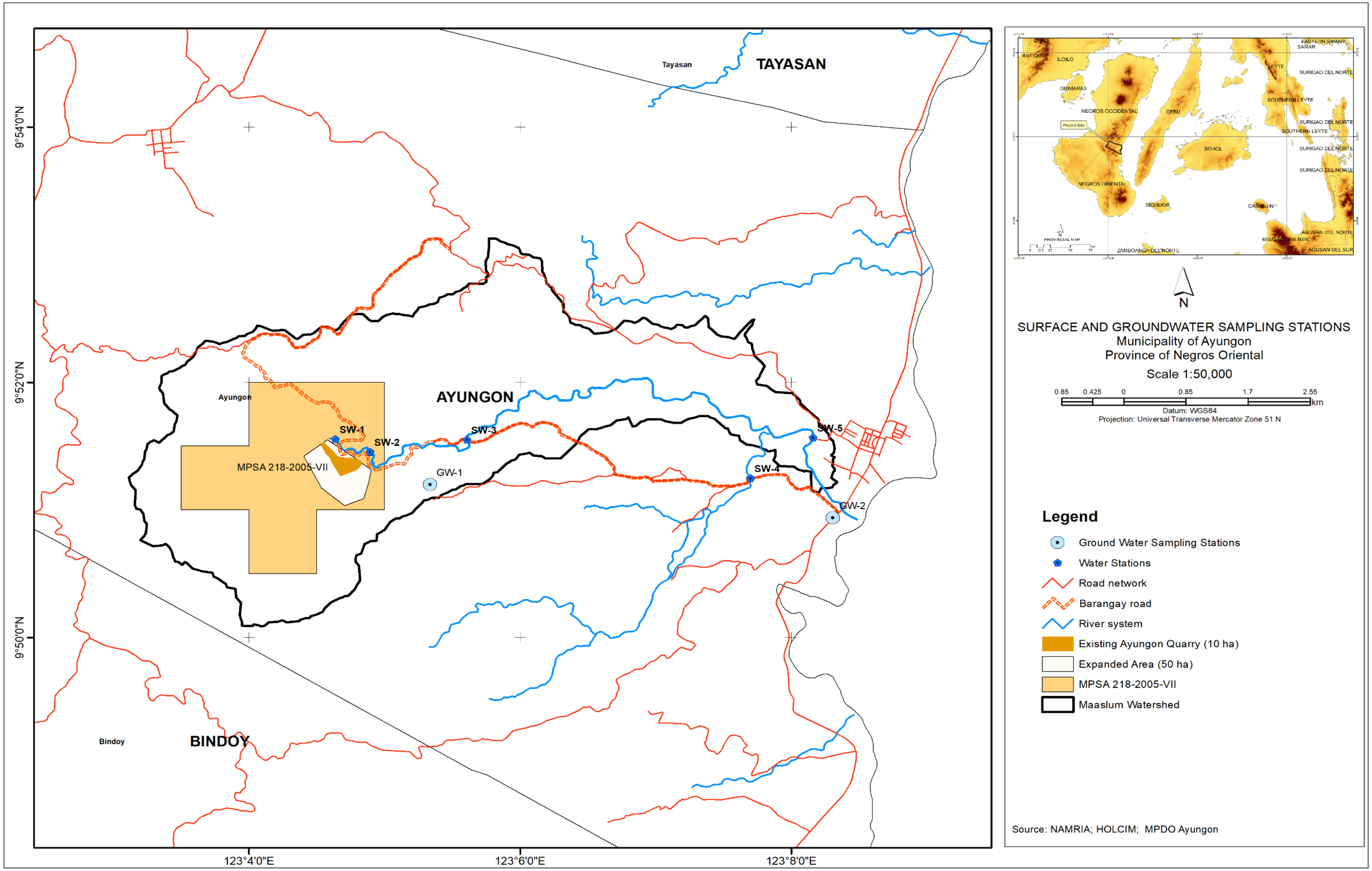


Figure 2-60. Sampling Stations for Physico-Chemical Characterization of Surface Water and Groundwater *(Source: NAMRIA, HOLCIM, MPDO Ayungon)*

Table 2-34. Physical, Chemical and Bacteriological Characteristics of the Water

Parameter	Unit	Maaslum								Gomentoc		DAO 2016-18 Class C Guideline Value
		SW-01		SW-02		SW-03		SW-05		SW-04		
		28/Apr/16 8:45AM	21/Aug/17 7:02AM	28/Apr/16 9:00AM	21/Aug/17 7:25AM	28/Apr/16 10:10AM	21/Aug/17 9:20AM	28/Apr/16 11:00AM	21/Aug/17 10:25AM	28/Apr/16 10:40AM	21/Aug/17 9:43AM	
Temperature[1]	Celsius	27.3	24.8	29.6	26.3	29.7	25.7	37.0	26.8	34.0	27.6	25-31
pH	-	3.04	3.9	3.44	4.6	3.39	4.2	8.00	6.53*	6.16	6.44*	6.5-9.0
Dissolved oxygen (DO)[2]	mg/L	8.37	7.40	7.80	6.46	6.20	7.14	6.8	6.19	5.20	6.20	5
Total Suspended Solids (TSS)	mg/L	<5	22	<5	<5	<5	<5	168	<5	24	44	80
Turbidity	NTU	0.10	6.41	0.16	0.20	0.70	0.20	56.30	10.34	12.66	14.35	-
Biochemical Oxygen Demand (BOD)	mg/L	4	6	2	3	2	3	20	6	3	9	7
Chemical Oxygen Demand (COD)	mg/L	6	13	5	6	5	6	35	28	10	17	-
Oil and Grease	mg/L	<1	<1	<1	1	<1	1	<1	<1	<1	<1	2
Sulfate (SO_4)	mg/L	225.0	80.2	146.0	25.6	166.8	25.6	173.0	95.4	73.4	10.3	275
Alkalinity ($CaCO_3$)	mg/L	<1	<1	<1	<1	<1	<1	61	31	84	<1	-
Cr^{+6}	mg/L	0.08	<0.002	0.05	<0.002	0.13	<0.002	0.27	<0.002	0.33	<0.002	0.01
As	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.02
Ca	mg/L	26	<1	17	<1	36	<1	32	68	20	174	-
Fe	mg/L	0.81	1.25	0.22	0.18	0.60	27.6	0.46	0.81	0.85	1.43	1.5
Pb	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.003	<0.03	<0.03	<0.03	<0.03	0.05
Mg	mg/L	2.43	0.77	1.39	0.77	2.38	0.76	2.39	0.91	2.35	0.84	-
Ni	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2
Cd	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Na	mg/L	3.9	1.76	3.9	1.75	3.8	1.76	4.1	2.51	3.8	<0.0006	-
Hg	mg/L	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.0010	0.0027	<0.0006	0.0011	1.76	0.002
Fecal Coliform	MPN/100ml	<1.8	790	<1.8	2,300	230	2,300,000	3,300,000	350,000	1,100	79,000	200

[1]The natural background temperature as determined by EMB shall prevail if the temperature is lower or higher than the WQG; provided that the maximum increase is only up to 10% and that it will not cause any risk to human health.
[2] Sampling taken between 9:00AM and 4:00PM

Parameter	Unit	Maaslum								Gomentoc		DAO 2016-18 Class C Guideline Value
		SW-01		SW-02		SW-03		SW-05		SW-04		
		28/Apr/16 8:45AM	21/Aug/17 7:02AM	28/Apr/16 9:00AM	21/Aug/17 7:25AM	28/Apr/16 10:10AM	21/Aug/17 9:20AM	28/Apr/16 11:00AM	21/Aug/17 10:25AM	28/Apr/16 10:40AM	21/Aug/17 9:43AM	
Total Coliform	MPN/100ml	<1.8	1,300	<1.8	2,300	230	2,300,000	7,000,000	1,600,000	1,100	240,000	-
E. Coli	-	Negative	Positive	Negative	Positive	Positive	Positive	Positive	Positive	Positive	Positive	-

Table 2-35. Field Observations of the River Water Sampling Stations

Station ID	Name and Location of Water Body	Description of Sampling Station		Geographical Coordinates
		Dry Season	Wet Season	
SW-01	Maaslum River at Sitio Ilaya	The river is being used for swimming of the community and bathing of cows. There is presence of boulders; vegetated (trees and bamboos) riverbanks; brown sediments and presence of algae. Upstream of SW-01 is the Twin Falls and a source of sulfur vent. The river has medium flow and is about 0.1m deep. The water is clear and has no odor.	The weather was overcast during the sampling time. An odor of sulfur can be distinguished in the area indicating that a sulfur vent is nearby. The boulders are brown, and the river is silted. There are people doing laundry in the area, present vegetation and water striders. The river flow is slightly laminar and there is an indication of turbid water.	9º 51.506’ N 123º 04.644’ E
SW-02	Maaslum River (tributary) at Sitio Panagan	The SW-02 is located downstream of the quarrying site and near a spillway. During the sampling, there is a presence of small scale burning in the upstream portion of the area. The location is vegetated and has a brown silts and algae. There are boulders in the river and dusty. The flow condition of the river is medium and is about 0.1m in depth. The water is clear and has no foul odor. This area does not immediately meet with the river system of SW-01.	The area is heavily silted which reduced the river flow. Cows and goats are present in the upstream portion of the sampling station. The riverbanks are vegetated and there are water striders observed in some pockets of the river (particularly on the pond area). There is an active rear erosion on the side of the river.	9º 51.310’ N 123º 04.941’ E

Station ID	Name and Location of Water Body	Description of Sampling Station		Geographical Coordinates
		Dry Season	Wet Season	
SW-03	Maaslum River	The SW-03 is located at the broken Bridge and downstream of where SW-01 and SW-02 meet. Similar to the condition of the rivers upstream, this station has boulders, brown silts, and vegetated riverbanks and has presence of algae. The river flow in this portion is fast, has clear water and is shallow.	The area has boulders within the river; vegetated riverbanks; settlements upstream; and presence of agricultural practices. The flow in this station is fast due to the weather condition during the sampling (raining) which caused the water to become brown and turbid.	9º 51.505' N 123º 05.254' E
SW-04	Gomentoc River at Barangay Gomentoc	The river is used for washing cows. The water is turbid and is populated with water lilies making the flow laminar. The station (SW-04) is near a bridge, adjacent to a road and houses. The riverbank is vegetated.	The river in this area has medium flow. The riverbanks are vegetated and have small pockets used for agriculture. There are settlements near the river which also keep livestock. The water is turbid.	9º 51.221' N 123º 07.689' E
SW-05	Maaslum River at Barangay Tampocon	The sampling station (SW-05) is the place where the waters from SW-03 and SW-04 mix/meet. There is an existing dike in the river and during the time of the sampling, there is an on-going gravel mining and trucks are plying in and out of the river. The river is shallow and can be seen with patches of vegetation and small fishes. The water is turbid and has a laminar flow.	The height of the river is high due to the weather condition and the tidal schedule. This area is near the mouth of the river where it meets the sea. The sampling area is in a brackish water, has nipa plants and other vegetations, and within a completed flood wall.	9º 51.568' N 123º 08.159' E

Table 2-36. Site Photographs

Station ID	Name and Location of Water Body	Photo	
		Dry Season	Wet Season
SW-01	Maaslum River at Sitio Ilaya		
SW-02	Maaslum River (tributary) at Sitio Panagan		

Station ID	Name and Location of Water Body	Photo	
		Dry Season	Wet Season
SW-03	Maaslum River		
SW-04	Gomentoc River at Barangay Gomentoc		

Station ID	Name and Location of Water Body	Photo	
		Dry Season	Wet Season
SW-05	Maaslum River at Barangay Tampocon		

Groundwater Quality

Table 2-37 presents the summary of the groundwater quality results (i.e. physical, chemical and bacteriological) from the two (2) groundwater sampling stations while Table 2-38 summarizes the observations gathered on the surrounding of the sampling stations. The Certificates of Analysis are presented in **Annex 8**.

Table 2-37. Physical, Chemical and Bacteriological Characteristics of the Water

Parameter	Unit	GW-01		GW-02		DAO 2016-18 Class A Guideline Value[3]
		28/Apr/16 9:45AM	21/Aug/17 8:10AM	28/Apr/16 11:20AM	21/Aug/17 10:45AM	
Temperature[4]	Celsius	29.37	26.80	29.6	29.1	26-30
pH	-	5.76	7.02**	7.42	7.87**	6.5-8.5
Conductivity	mS	88.77	0.165**	1.037	0.850**	-
Dissolved oxygen (DO)[5]	mg/L	6.0	5.88	2.3	1.52	-
Total Suspended Solids (TSS)	mg/L	<5	8	<5	<5	50
Biochemical Oxygen Demand (BOD)	mg/L	2	2	6	2	-
Chemical Oxygen Demand (COD)	mg/L	11	10	7	7	-
CN	mg/L	<0.025	<0.025	<0.025	<0.025	0.07
Fecal Coliform	MPN/100ml	4.6	>8.0	<1.1	>8.0	<1.1
Total Coliform	MPN/100ml	4.6	>8.0	<1.1	>8.0	<1.1*
E. Coli	-	Positive	Positive	Negative	Positive	-
HPC	CFU/mL	286	2,400	141	5,700	<500*

Notes:

Red font Failure to conform to the guideline value
"-" no guideline value specified
"" adopted from PNSDW*
*"**" tested at laboratory*

Groundwater quality characteristics during wet and dry season's samplings are as follows:

- The temperature in both stations are found within the set environmental standards (26 °C – 30 °C) for Class A guideline.
- pH in both stations is found within the set environmental standards (6.5 – 8.5) for Class A guideline. Although, the station GW-01 is observed the acidic water during the dry season with pH 5.76 which could be due to the influence of the naturally occurring rocks surrounding the sampling station. The pH during wet season sampling became 7.02 due to the difference in the weather condition.
- TSS amounts passed the set standards except in both station 5 (50 mg/L) during the summer and wet season.
- BOD levels accounted in the two (2) stations are found within the range of 2 to 6 mg/L. There is no set standard of the BOD for the Class A guideline.

[3] *Adopted Class A guideline due to the use of groundwater as potable water and other domestic use*
[4] *The natural background temperature as determined by EMB shall prevail if the temperature is lower or higher than the WQG; provided that the maximum increase is only up to 10% and that it will not cause any risk to human health.*
[5] *Sampling taken between 9:00AM and 4:00PM*

- COD levels accounted in the two (2) stations are found within the range of 7 to 11 mg/L. There is no set standard of the COD for the Class A guideline.
- The presence of fecal and total coliform in the water is found which makes the water unsuitable for human consumption without treatment. The two stations are also positive for E. *coli* bacteria. It should be noted that this could be due to the presence of pipes installed by the local water district as HPCs usually thrive in the pipes. The potential increase of HPC count is brought about by the installation of these pipes which can result in the formation of biofilms.

Table 2-38. Field Observations of the Groundwater Sampling Stations

Station ID	Photo	Name and Location of Water Body	Description of Sampling Station		Geographical Coordinates
			Dry Season	Wet Season	
GW-01		Spring at Sitio Binatkan	The sampling station (GW-01) is located 325mals. Currently, the spring is being utilized by the local water district and has installed water pipes. There is a small portion or opening at the source where water sampling was done. The vicinity of the spring is concretized.	The water sample in this station is clear (in terms of color) with some suspended particles. There are some patches of settlements below the sampling station. Vegetation is still present in the area and the source of water is concretized.	9º 51.199' N 123º 05.334' E 325 masl
GW-02		Beside Municipal Road	GW-02 is located beside the municipal road and is owned by the vulcanizing shop owner beside it. It is being used for drinking and other domestic use. The pump well was said to have been established since the 1970s.	Similar observation in the area. No changes observed in the vicinity.	9º 50.940' N 123º 08.306' E

Impact Analysis and Mitigation of Ground Water and Surface Water Quality Degradation

The project would have the most impact on surface water quality. However, it is also expected that water quality would be affected as well. For this purpose, baseline environmental water quality assessments have been made for the existing water bodies that would be most affected. In this case, the Maaslum and Gomentoc Rivers were sampled for water quality parameters. This baseline would be compared to the conditions of the river during project operations.

Table 2-39. Summary of Water Quality Assessments Conducted

Parameters	Surface Water	Groundwater
BOD	✓	✓
COD	✓	✓
TSS	✓	✓
Oil and Grease	✓	
Turbidity	✓	
Sulfate	✓	
Alkalinity	✓	
Cr+6	✓	
Na, Ca	✓	
As, Fe, Pb, Mg, Ni, Cd	✓	
Hg	✓	
CN		✓
E. Coli	✓	✓
Total Coliform	✓	✓
Fecal Coliform	✓	✓
HPC		✓

Mitigation measures would both engineering and vegetative measures that would reduce sedimentation of the existing water bodies.

Degradation of Groundwater Quality

The sampling for oil and grease, Hg, Pb, Cd, As and Cr was not done for groundwater since these parameters were already analyzed for surface water. The major consideration for this activity is that the quarry operation is a simple cut and grab operation of silica and does not entail the production of effluents and pollutants containing oil and grease, Hg, Pb, Cd, As and Cr.

Degradation of Coastal/ Marine Water Quality

The project site is very far from any coastal/marine body of water. As such, this section is not relevant to this EPRMP.

Circulation/ Plume Modelling for Required Discharges, Leaks/ Spills Worst Case Scenario of Failure of WTF and other Emergency/ Accident Scenarios for Facilities with Structures in Water Bodies

A circulation/plume modelling for required discharges, leaks/spills worst case scenario is not required considering the kind of mining method that is employed which is strip mining. As soon as the silica has been extracted, the material is brought to a staging area near the wharf which is then loaded to a barge. Thus, the possibility of leaks/spills scenario is quite farfetched.

Aquifer (Groundwater) Vulnerability Assessment/ Groundwater Modelling

It must be noted that the expansion of the ECC coverage for the quarry is based on strip mining of the existing deposits of silica in the mountain relief at a maximum of 700 masl but will not go below 200masl. Thus, there would be no adverse impact to aquifer (groundwater) since the operation will not go beyond the water table. Figure 2-60 shows the sampling sites for monitoring purposes based on this assessment.

Table 2-40. Sampling Coordinates: Proposed Sampling Sites for Groundwater Monitoring

Sampling Stations	Coordinates
GS 1	9°51'3.926"N / 123° 4'34.358"E
GS 2	9°51'56.727"N / 123° 4'31.617"E
GS 3	9°50'36.515"N / 123° 4'20.481"E
GS 4	9°50'26.232"N / 123° 4'57.144"E

Sediment Transport Modelling

A sediment transport modelling was done for Ayungon using GIS and remote sensing data. Manual segmentation approach was done from the classified mining areas that were imported from Landsat Imageries. Catchments and outflow points were identified using flow tracing analysis of SAGA. Upon loading the Digital Elevation Model (DEM) of the study site, the flow accumulation process using the sink filled DEM and the classified mining area was run by SAGA in order to forecast the flow accumulation. Flow visualization was then followed as shown in the succeeding figures (please refer to Annex 25 for the Sediment Transport Modelling Report). Three dimensional images with different views are also shown for each satellite data. The flow accumulation forecast based on the identified mined areas are classified into three categories. From white (least likely to accumulate) to dark blue (most likely to accumulate) indicating the likelihood of sediment transportation. The computation of areas in hectares of the flow accumulation inside the project area are also shown in the said figures. It can be noticed that on the average, 18 hectares of land out of the total 505 hectares of the project area is expected to have most likely the accumulation of sediments brought about by silica mining.

Please see Annex 25 for the Sediment Transport Modelling for the Ayungon Mining Site.

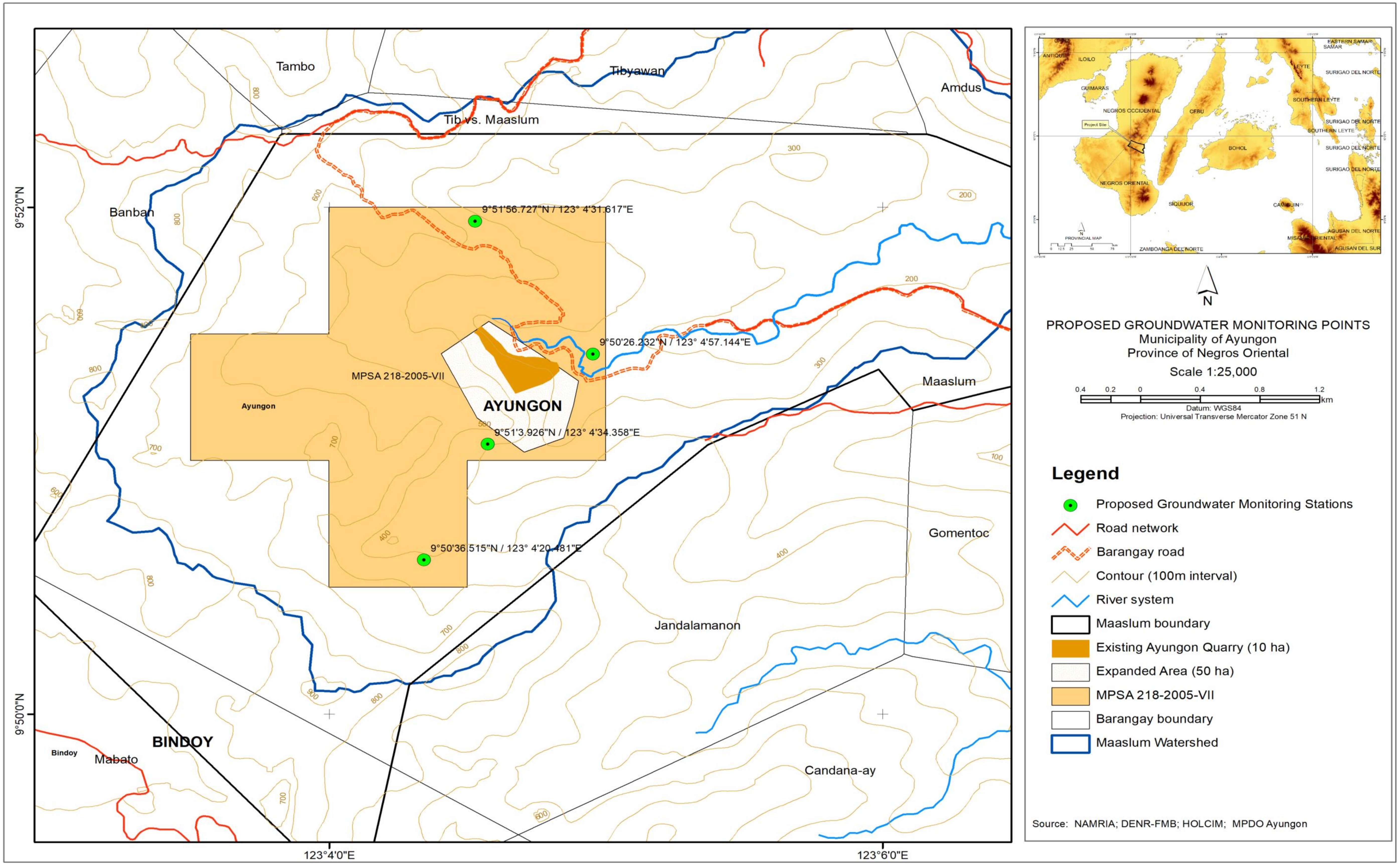


Figure 2-61. Proposed Sampling Sites for Groundwater Monitoring *(Source: NAMRIA, HOLCIM, DENR-FMB, BSWM, MPDO-Ayungon)*

4. Freshwater Ecology

Ecological assessment of the freshwater environment was conducted in two (2) different seasons, wet and dry, to properly identify the baseline condition of the freshwater body located adjacent to the project site and the possible effect of its operation to the identified waterbody.

The sampling activities were conducted on May 18, 2016 for the dry season and August 23, 2017 for the wet season. Results of the sampling are discussed in the succeeding sections of this report. Location of samplings are shown in Table 2-41.

Table 2-41. Sampling Coordinates

Sampling Stations	Coordinates
FW 1 - Upstream of the Quarry Site, Barangay Maaslum	9°51'30.35"N / 123° 4'38.64"E
FW 2 - Adjacent to Quarry Site, Barangay Maaslum	9°51'18.61"N / 123° 4'56.46"E
FW 3 - Barangay Maaslum	9°51'30.31"N / 123° 5'15.25"E
FW 4 - Brgy. Gomentoc	9°51'13.21"N / 123° 7'41.34"E
FW 5 - Brgy. Poblacion	9°51'34.09"N / 123° 8'9.53"E

Methodology

Plankton

Plankton samples were collected using a 20 µm plankton net with a mouth diameter of 0.3 meter. In every station, scooping technique was employed especially in shallow river and streams. A total of 10L water samples were collected and concentrated in the plankton net. Duplicate samples of zoo- and phytoplankton will be collected for each station and placed in properly labelled plastic containers. Phytoplankton samples were preserved with Lugols solution, while samples of zooplankton were fixed with 10% formalin immediately after collection. All samples were gravimetrically settled, and excess liquid was carefully decanted until about 20 ml of the samples are left. For phytoplankton samples, a 1ml aliquot subsample was placed in a Sedgewick-Rafter cell counter and was examined under a Nikon Alphaphot II YS2 microscope. For zooplankton samples, a 1ml aliquot subsample was placed in a petri dish with grids and examined under a microscope. Phytoplankton was counted and identified to the lowest taxonomic level possible using standard taxonomic guide. Zooplankton was identified to major groups using available references.

Periphyton

Periphyton was collected by scraping the surfaces of three rocks (approximately of the same sizes) by a blunt blade or brush. The scrapings were directly placed into a sampling bottle in replicates and fixed with Lugol solution. The bottle was then shaken vigorously until all the materials will be fully suspended and homogenized. Siltation and pollution indices were computed and used as reference to infer ecological conditions and biological integrity of the sampling stations (Bahls 1993).

Epibenthic Fauna (Macroinvertebrates or Macrobenthos)

A macro-invertebrate survey was conducted in exposed and shallow submerged portions of the river where ideal conditions exist for the presence of macroinvertebrates. Since macroinvertebrates, like mollusks and bivalves, are sessile organisms, they are usually used for the assessment of site-specific effects. Their sedentary nature allows effective analyses of pollutants and effects of benthic disturbance. Macroinvertebrates were collected using a rectangular kick net with a mesh size of 500µm at the riffle sections of each sampling stations. In riverine flats, streambeds and riverbanks, sampling points/cores (depending on the expanse of the area) will be randomly established. After the collection, a coarse macro-invertebrate identification was done by hand-sorting the visible macro-benthic organisms from the sediment.

Fisheries Resource Use Profiling

Information was gathered to describe dominant fisheries resources and practices; including information on fishing gears, catch rates and catch effort, fisheries-dependent livelihoods, fishing grounds and collection of important macro-invertebrates focusing on commercially important species of shellfish in the River. Through key informants, identification of known fish or shellfish spawning, and nursery grounds will also be conducted, if any.

Freshwater Study Results

Plankton

Plankton are free-drifting organisms typically found in the upper layers of the water column. They are often important components at the lower base of marine and aquatic food webs. Changes in ecological conditions in a stream often lead to changes in the community structure of planktons. Being at based of the food chain, they are among the first to be affected when the freshwater environment is disturbed either by anthropogenic or natural events.

In this sampling, a total of 33 plankton taxa were identified belonging to six major groups i.e. Bacillariophytes (diatoms) with 14 genera, Chlorophytes (green algae) with 8 genera, Euglenophytes with 3 groups, Dinophytes (dinoflagellates) with one (1) specie, Cyanophyte with one (1) genus and zooplankton (animal-like plankton) with six (6) groups. Overall, the most dominant group was diatom accounting for 57% of the plankton community (). This was followed by green algae accounting for 16%, euglenoids for 12%, cyanobacteria 11%, zooplankton for 4% and the least represented group, dinoflagellates for only less than 1%. Among the diatoms, the *Fragillaria* was the most abundant constituting 38% of the total plankton count. For green algae, the genus *Staurastrum* represented the bulk of this group accounting for almost 6%. The only cyanobacteria genus observed during this sampling was *Oscillatoria* which constituted 11%. For euglenophytes, three (3) genera were identified but the most significant genus was *Euglena* which contributed 8% to the plankton community. The only dinoflagellates species identified was *Ceratium hirudinella* but almost negligible with relative abundance of 0.17%.

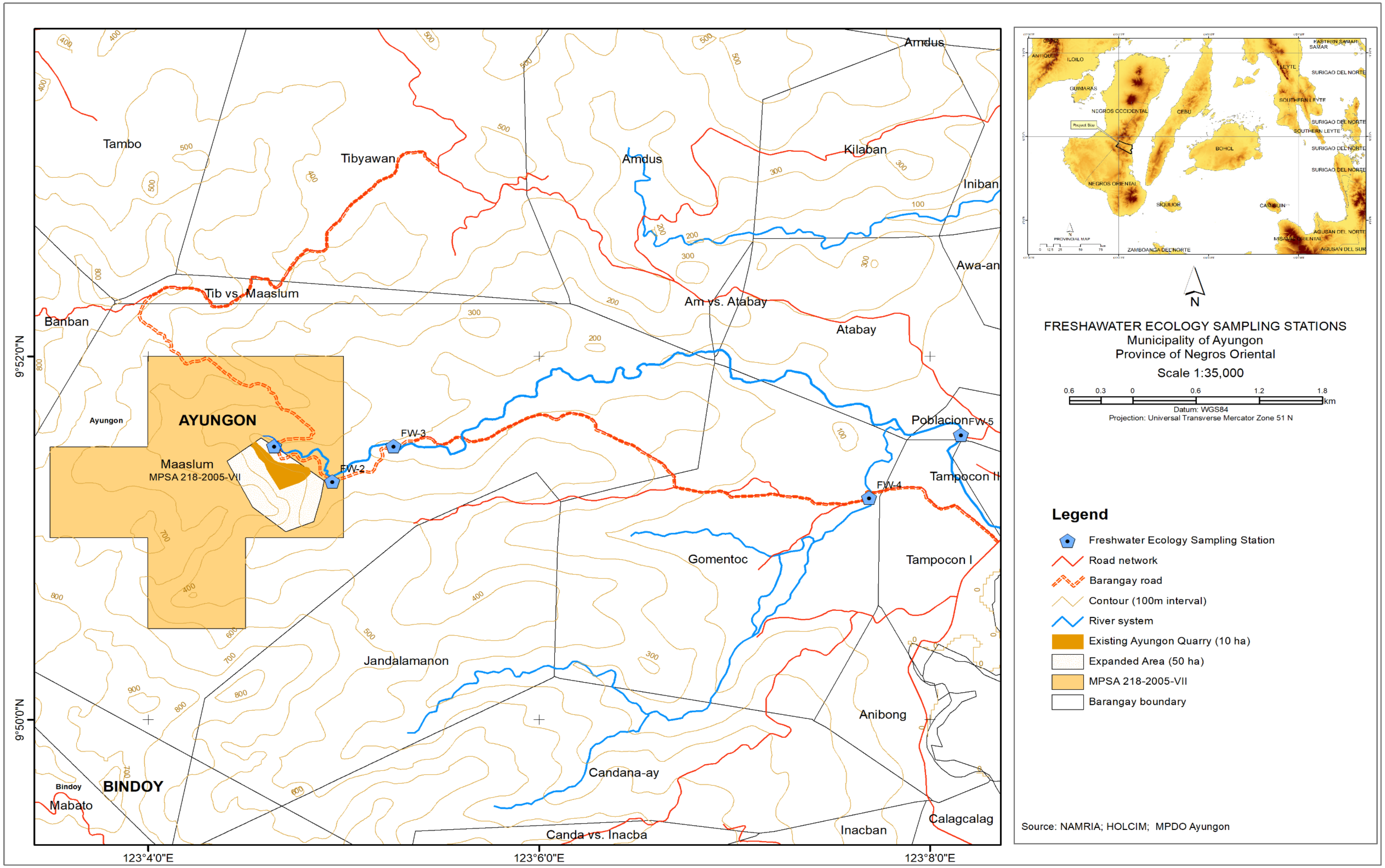


Figure 2-62. Freshwater Ecology Sampling Stations for Wet and Dry Season *(Source: NAMRIA, HOLCIM, MPDO-Ayungon)*

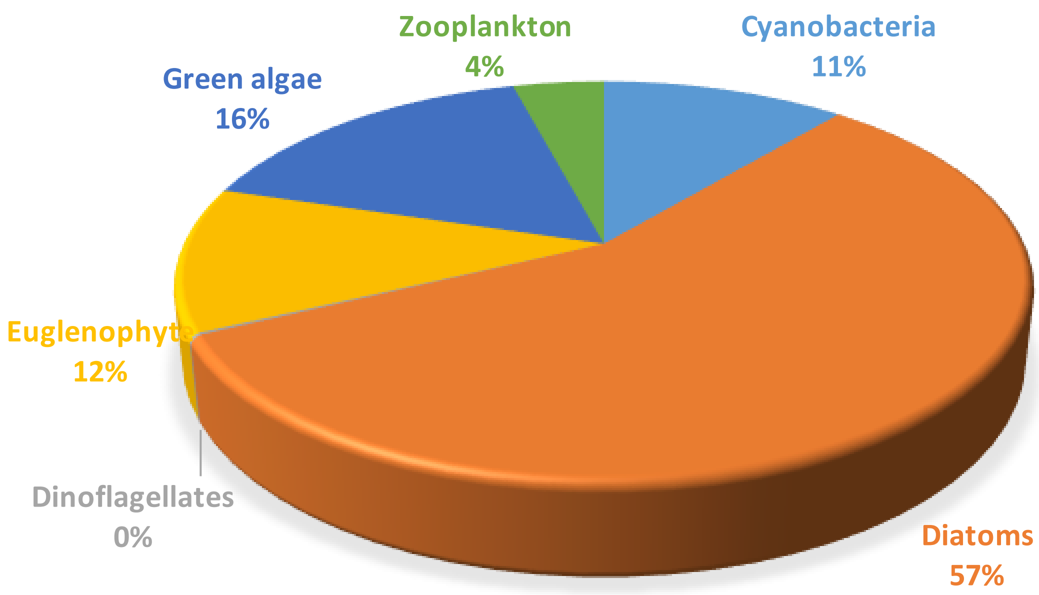


Figure 2-63. Percentage Composition of Major Plankton Groups Recorded in Maaslum River during the Wet Season Sampling

The only potentially harmful microalgal species found in the river are *Oscillatoria* which are reported as toxic (Carmichael, 1992). However, the cell density of this species was very low indicative low nutrient water condition. Cyanobacteria blooms usually occur in highly eutrophic stagnant bodies of water. The pollution tolerant genera observed in this survey include *Oscillatoria, Synedra, Navicula, Nitzschia* and *Euglena*. Other important phytoplankton genera were *Synedra*, and *Fragillaria*. Blooms of *Synedra* and *Fragillaria* have been recorded to block canals and clog filters especially in water treatment facilities.

Table 2-42. Plankton abundance and composition (cells or ind/L)

Taxa	Stations					Grand Total	Relative Abundance
	FW1	FW2	FW3	FW4	FW5		
Cyanobacteria	**60**	**110**	**1,210**	**213**	**1,360**	**2,953**	**11.06**
Oscillatoria	60	110	1,210	213	1,360	2,953	11.06
Diatoms	**555**	**70**	**825**	**6,400**	**7,280**	**15,130**	**56.68**
Amphora					1,413	1,413	5.29
Aulacosierra	285	30	330			645	2.42
Bacillaria					560	560	2.10
Closterium	30		220	240	80	570	2.14
Coscinodiscus	45			240		285	1.07
Cymbella				53		53	0.20
Fragillaria			275	5,493	4,320	10,088	37.79
Melosira	60	20			240	320	1.20
Navicula				187	347	533	2.00
Nitzschia				27		27	0.10
Pleurosigma	60					60	0.22
Rhizosolenia	30					30	0.11
Surirella	45	20		133	267	465	1.74
Syndera					53	53	0.20

Taxa	Stations					Grand Total	Relative Abundance
	FW1	FW2	FW3	FW4	FW5		
Terpsinoe				80		80	0.30
Dinoflagellates		**20**		**27**		**47**	**0.17**
Cerartium hirudiniella		20		27		47	0.17
Euglenophyte				**3,040**	**107**	**3,147**	**11.79**
Euglena				2,080		2,080	7.79
Phacus				293	107	400	1.50
Trachelomonas				667		667	2.50
Green algae	**60**	**920**	**935**	**1,573**	**827**	**4,315**	**16.16**
Cosmarium				640		640	2.40
Geminella	30			107		137	0.51
Mougetia		30				30	0.11
Oedegonium	30	50	935			1,015	3.80
Pandorina				240	187	427	1.60
Spirogyra				507		507	1.90
Staurustrum		840		27	640	1,507	5.64
Zooplankton	**137**	**20**	**110**	**293**	**560**	**1,103**	**4.13**
Arcellidae (Protozoan)	30		110		133	273	1.02
Calanoid Copepod	35					30	0.11
Loricate rotifer		20				20	0.07
Nauplius	27			267	347	643	2.41
Nematode larvae					80	80	0.30
Rotifer (*Branchionus*)	45			27		57	0.21
Grand Total	**752**	**1,140**	**3,080**	**11,547**	**10,133**	**26,695**	**100**
Mean Abundance	**58**	**127**	**513**	**577**	**676**		
Richness	**14**	**9**	**6**	**20**	**15**		
Evenness	**0.86**	**0.48**	**0.83**	**0.63**	**0.72**		
Diversity	**2.27**	**1.06**	**1.49**	**1.90**	**1.94**		

Generally, the stations sampled in the upstream, midstream and downstream (Stations FW1-3) of Maaslum River were poor in plankton with only 6 to 14 genera/groups observed. Abundance-wise, they were also low compared to station FW 4 and FW5. Sediments carried down from soil erosion due to existing quarry operation and construction-related activities such as land clearing activities and stockpiles may end up as runoff to nearby sections of Maaslum River, if not effectively managed, especially during storm and heavy rains which may affect the existence of identified species and their habitat.

Due to soil erosion especially during wet season, increased in water turbidity and stream flow obstruction affect the plankton community. This might explain why this station was depauperate with these organisms. Station 4 was the most taxa rich and harbors the most abundant of plankters with 11,547 cells/individual per liter. It is evident that this tributary (FW4) is still relatively productive river since the local community could still benefits from fisheries resources in this body of water (see macrobenthos and fish section for additional discussion). It is worth noting that Station 5 can still be considered as another downstream station of Maaslum river since it is still connected (see map) but being brackish waterbody, it has different conditions for plankton community thriving in this habitat compared to the three (3)stations (1-3) located near the project. Station 2 had the highest number of *Fragillaria* at 5493 cells/L which is a freshwater diatom that forms an important component of the food chain, especially in the production of primary organic material. Excessive diatom blooms, however, are known to cause eutrophic conditions and the free-flowing nature of the river system needs to be sustained in this regard.

In terms taxa evenness computed based on Pielou's Index, Stations 1, 3, 4, 5 had relatively high values indicating a more relatively even distribution of plankton taxa within the community (Figure 2-61). Station 2 had the lowest computed value with 0.48. The same is true with the diversity measurement based on Shannon-Weiner Index where Station 2 and 3 had the lowest computed value with 1.06 as compared to the other three (3) stations with diversity value of almost 2. Diversity values below (<3) is generally categorized as low based on the Wilhm criteria (1975) classifying these values as low diversity and community stability indicative of disturbance in the freshwater habitat negatively affecting the plankton community particularly in Stations 1-3.

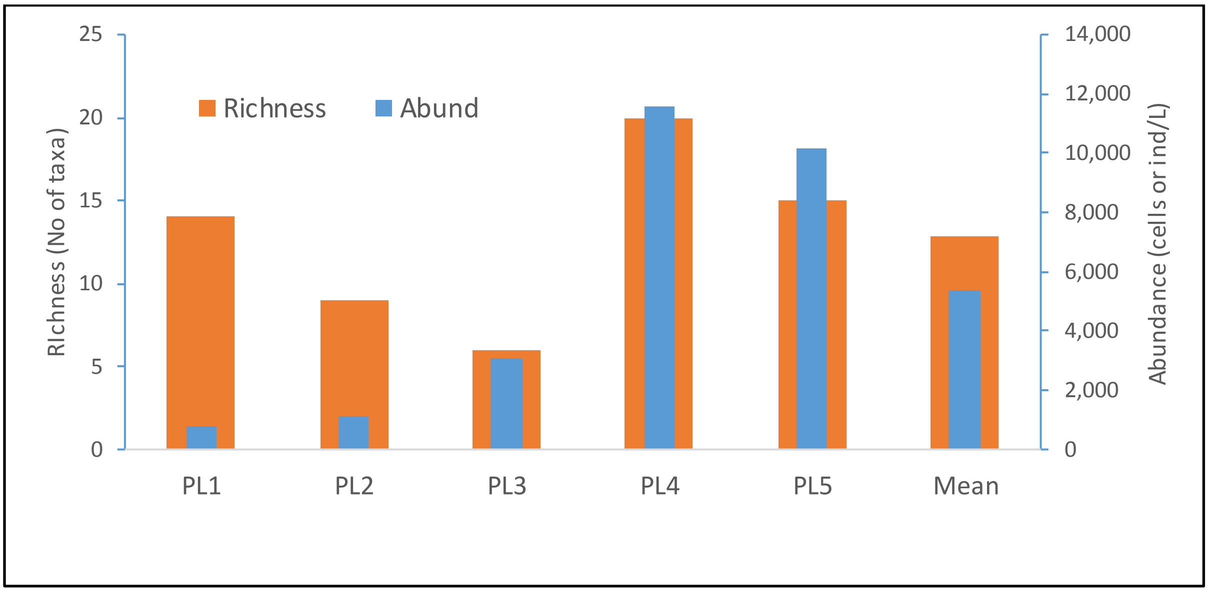


Figure 2-64. Taxa Richness and Abundance

Periphyton

Periphyton communities are primarily composed of benthic algae that are attached to rocks and other stable substrates at the bottom and edges of waterways. They play a significant role in freshwater ecosystems as they constitute the fundamental component of the food resources by converting the dissolved nutrients into food for macroinvertebrates, and thus fish in local and downstream systems. Periphyton communities are also responsive to disturbances that can result to degradation of water quality, often changing in taxonomic composition and abundance even with slight disturbance (Biggs and Kilroy 2000). Consequently, in many areas around the world, periphyton are considered appropriate indicators of ecological conditions and pollution.

For the dry season, identified periphyton communities were composed of blue – green algae, diatoms, euglenoids, and green algae. From these major groups, a total of 17 genera was identified, of which the diatoms, *Synedra* and *Navicula*, were the most abundant, contributing to almost 40 % and 26 % of the total sampled population, respectively. *Synedra* and *Navicula* are characteristically pennate and generally motile diatoms. High percentage of motile diatoms is typical of sites with high concentrations of suspended solids as these diatoms have the capability of avoiding deposited silt layer, which enable them to survive this type of ecological condition (Bellinger et al. 2006).

A total of 15 periphyton genera was identified during wet season belonging to three main groups i.e. diatoms, cyanobacteria and green algae. Diatoms totally dominated the periphyton community comprising of 98%, followed by green algae with 2% and cyanobacteria with only less than 1%. Among the diatoms, the pennate chain-forming genus, *Fragillaria* represented most of the group with 52%. Other pennate form diatoms such as *Navicula* and *Nitzschia* contributed significant number with 23% and 20% respectively. These two (2) genera are able to crawl towards the surface if they are covered by silt; their abundance is thought to reflect the amount and frequency of siltation (Barbour et al 1999). For green algae, *Stigeoclonium* were the most abundant genus with almost 1%. The only cyanobacteria observed was *Oscillatoria* which only constituted less 1%. The diatom *Navicula* was the most frequently occurring genera being present in all sampling stations. The pollution tolerant genera identified *include Navicula, Nitzschia, Coscinodiscus, Gomphonenema, Surirella* and *Fragillaria.*

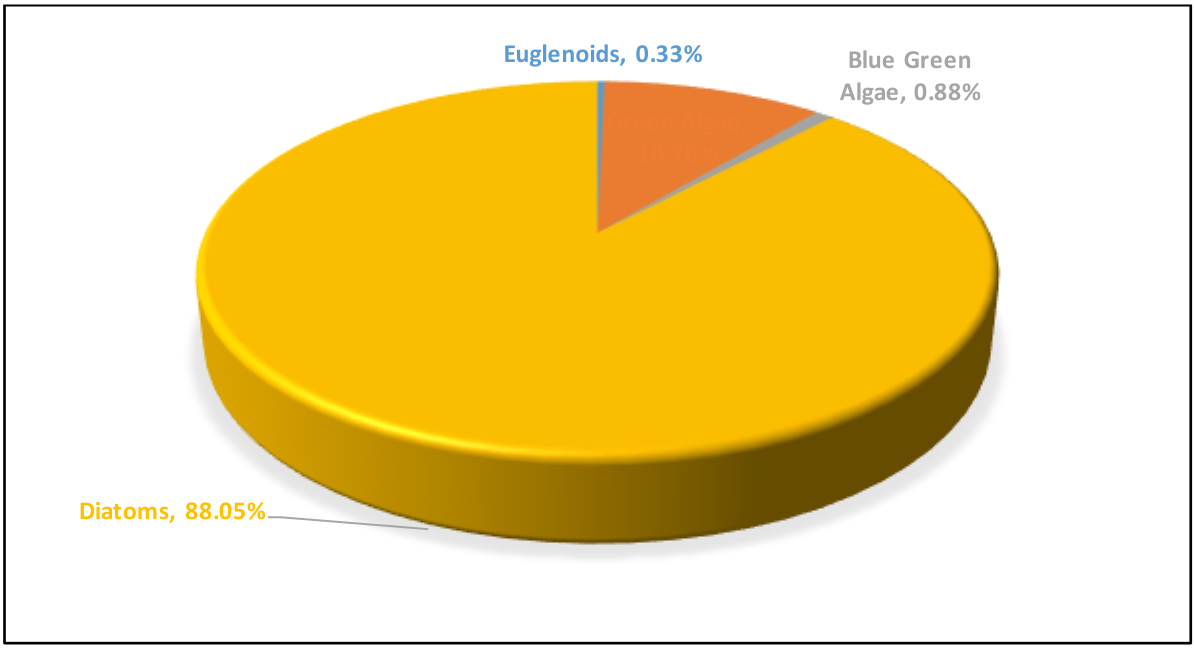


Figure 2-65. Percent Composition of Periphyton, Dry Season

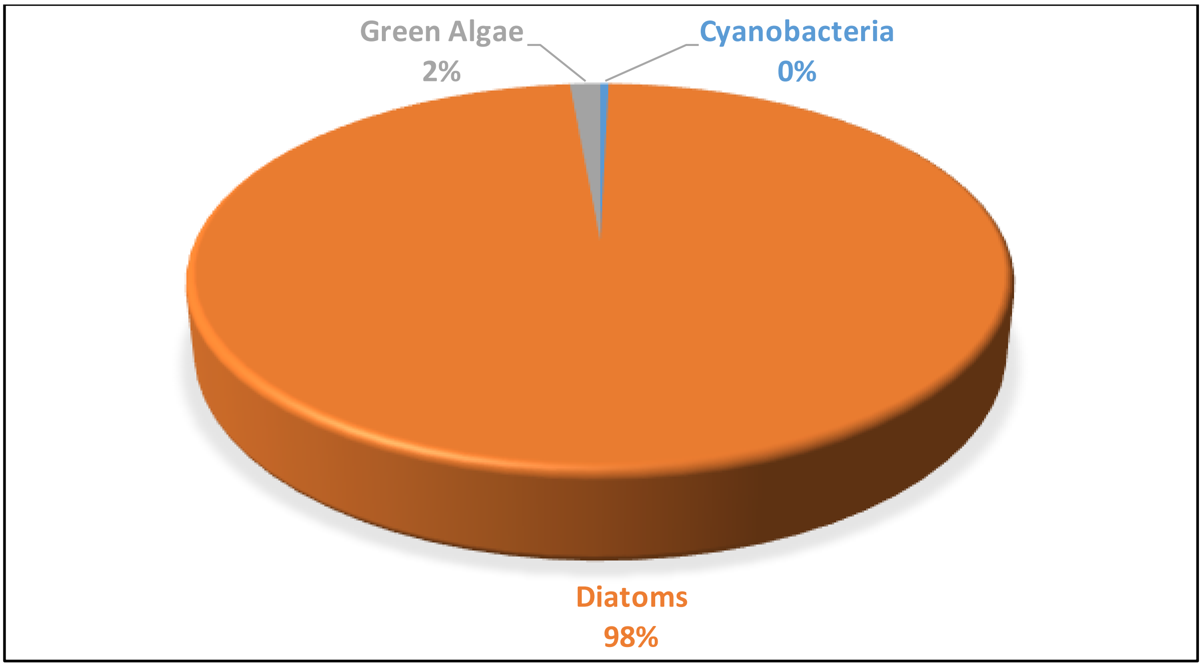


Figure 2-66. Percent Composition of Periphyton, Wet Season

Periphyton Total Abundance

Total abundance of periphyton communities ranged from 36,603 cells to 97,970 cells (mean = 62,482 cells ± 24,977 cells) during the dry season. Highest abundance was observed in FW5, relatively moderate abundances in STN01 and STN03, and relatively low abundances in STN02 and STN04. The habitat type in STN05 is run, stretches of the river downstream of pools and riffles where stream flow and current are moderate and the smooth surface allows for light to penetrate.

Table 2-43. Periphyton Composition and Abundance, Dry Season

Taxa	Stations					Mean
	STN01	STN02	STN03	STN04	STN05	
	Upstream of Quarry Site Brgy. Maaslum	Brgy. Maaslum	Brgy. Maaslum	Brgy. Gomentoc	Brgy. Poblacion	
Blue-green algae	**735**	**576**	**441.0**	**147**	**776.**	**535**
Anabaena	147.	576.0	441.	-	194	272
Oscillatoria	588	-	-	147	582	263
Diatoms	**52,626**	**38,088**	**53,067**	**35,280**	**96,030**	**55,018**
Cymbella	-	-	735	-	485	244
Fragilaria	588	576.0	882	441	97	517
Gyrosigma	-	-	-	735	291	205
Melosira	-	-	-	6,174	1,164	1,468
Navicula	15,582	27,072	31,164	5,292	2,037	16,229
Nitzschia	5,586	792	17,934	4,410	6,402	7,025
Pinnularia	1,911	72	1,176	441	291	778
Rhopalodia	-	-	-	294	97	78
Surirella	-	9,576	1,029	6,762	291	3,531
Synedra	28,959	-	147	10,731	84,875	24,942
Euglenophyta	**-**	**-**	**-**	**147**	**873**	**204**
Euglenoids	-	-	-	147	873	204
Green algae	**15,876.**	**1,728**	**14,700**	**1,029**	**291**	**6,724**
Closterium	882	72	4,263	441	194	1,170

Taxa	Stations					Mean
	STN01	STN02	STN03	STN04	STN05	
	Upstream of Quarry Site Brgy. Maaslum	Brgy. Maaslum	Brgy. Maaslum	Brgy. Gomentoc	Brgy. Poblacion	
Cosmarium	14,847	1,152	5,292	147	97	4,307
Staurastrum	147	-	-	-	-	29.4
Stigeoclonium	-	504	5,145	441	-	1,218
Grand Total	**69,237**	**40,392**	**68,208**	**36,603**	**97,970**	**62,482**

During the wet season sampling, the total periphyton abundance for all stations was 243,306 cells/ml which was lower than what was observed during the dry season sampling with 312,410 cells/m (Figure 2-66). The highest abundance and taxa richness were observed in station P4 similar to what was observed in plankton community assessment. Previous sampling i.e. dry season also indicated relative higher taxa richness in station PL4 and PL5. Periphyton density is generally highly variable and could changes drastically depending on the magnitude of physico-chemical change in water quality. Comparing the total density, it appears that there is no significant decrease in periphyton population since drastic changes could occur at several folds less in other areas. Taxa richness was however was generally low during the wet season sampling with numbers ranging from 2 to 12 compared to dry season sampling where taxa richness ranges from 9 to 15. High species richness is assumed to indicate high biotic integrity because many species are adapted to the conditions present in the habitat. Species richness is predicted to decrease with increasing pollution because many species are stressed. However, many habitats may be naturally stressed by low nutrients, low light, or other factors. Slight increases in nutrient enrichment can increase species richness in headwater and naturally unproductive, nutrient-poor streams (Bahls et al. 1993).

Table 2-44. Periphyton abundance (cells/ml) and composition, Wet Season

Taxa	STATION					Grand Total	Relative Abundance
	P1	P2	P3	P4	P5		
Cyanobacteria		**280**	**680**			**960**	**0.39**
Oscillatoria		280	680			960	0.39
Diatoms	**280**	**95,075**	**5,400**	**137,911**	**200**	**238,866**	**98.18**
Coscinodiscus				560		560	0.23
Cymbella				400		400	0.16
Fragillaria				126,111		126,111	51.83
Gomphonema		160	200	440		800	0.33
Navicula	120	46,966	5,080	4,040	120	56,726	23.31
Nitzschia		47,949	120	840		48,909	20.10
Pinnularia				520	80	600	0.25
Pleurosigma				440		440	0.18
Surirella				4,120		4,120	1.69
Syndera	160					160	0.07
Terpsinoe				440		440	0.18
Green Algae		**1,720**	**560**	**1,200**		**3,480**	**1.43**
Closterium				280		280	0.12
Spirogyra				920		920	0.38
Stigeoclonium		1,720	560			2,280	0.94
Grand Total	**280**	**97,075**	**6,640**	**139,111**	**200**	**243,306**	**100**
Mean Abundance	**140**	**19,415**	**1,328**	**11,593**	**100**		
Pollution Index	**2.24**	**0.97**	**1.62**	**2.90**	**2.40**		
Siltation Index	**17.65**	**97.77**	**78.31**	**6.47**	**60**		

Taxa	STATION					Grand Total	Relative Abundance
	P1	P2	P3	P4	P5		
Richness	2	5	5	12	2		
Evenness	0.79	0.50	0.51	0.20	0.97		
Diversity	0.55	0.80	0.82	0.49	0.67		

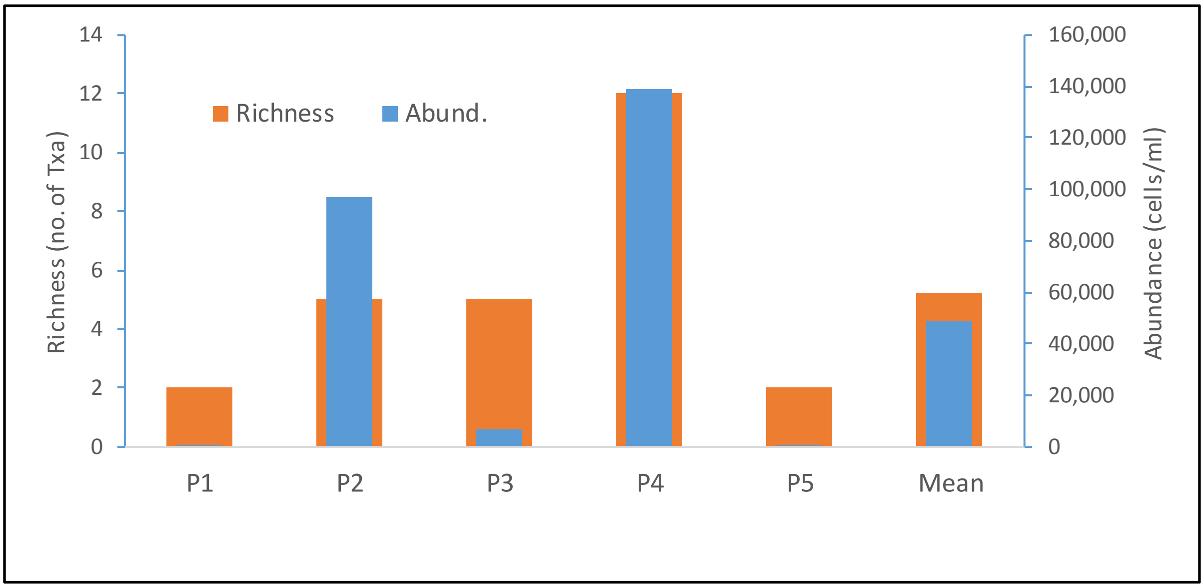


Figure 2-67. Periphyton Taxa Richness and Abundance, Wet Season

Periphyton Diversity Index

The Shannon Diveristy Index is a function of both the number of species in a sample and the distribution of individuals among those species (Klemm et al. 1990). Because species richness and evenness may vary independently and complexly with water pollution. Stevenson (1984) suggests that changes in species diversity, rather than the diversity value, may be useful indicators of changes in water quality.

Diatom communities during the dry season were less diverse as showed in the low generic richness and low Shannon Diversity Index. The diatoms identified were moderately tolerant to organic pollution indicative of intermediate nutrient inputs. Clean waters have relatively low populations of diverse diatom species but as water becomes polluted, the diversity of diatoms decreases, but the population of pollution tolerant types increases (Person 1989). Diatom communities were exposed to increased siltation levels, particularly in STN02 and STN03, as reflected in the Siltation Index. These stations are adjacent to unpaved roads and the disturbance caused by moving vehicles might have contributed to the silt input in these stations, especially that the sampling was conducted during the onset of rainy season. Also, in STN02 and STN03 and in STN04, the green – algae, *Stigeoclonium*, were observed albeit in moderate abundances. This alga is abundant in water with high levels of organic matter and consequently the stations where they observed were adjacent to residential areas, where domestic wastes could have potentially augmented the nutrient inputs (Person 1989). *Oscillatoria*, which was considered as one of the most tolerant algae to organic pollution was also recorded in minimal abundances.

Diversity index during wet season sampling was generally low for all the sampling station (<1) indicative of high stress. This was generally the same from what was computed during the dry season sampling in station STN01 and STN04 with slight high diversity values of 1.10 and 1.76 respectively indicating a moderate stress.

In terms of siltation index, station FW2 and FW3 recorded the highest computed values with 98% and 78%, respectively. Again, this was primarily due to high number of *Navicula* and *Niztschia* recorded in these two stations which is expected since these are the station exposed to high levels of siltation caused by run-off from the existing quarry site and soil erosion from unpaved roads which is more pronounced during the rainy season. In terms of pollution index, station FW2 was the most severely polluted portion with computed value of <1.50. Station 1, 3 and 5 has computed values that ranges from 2.01-2.50 indicating a moderate pollution. Station 4 scored the highest PI indicating a better water quality with no substantial level of pollutants. Comparing this result with the dry season sampling, pollution level in station 2 previously with 2.02 rating seemed to have increased while all the rest had a relatively similar pollution index value with >2.

Table 2-45. Comparison Between the Wet and Dry Season using Various Indices

Stations	Total Abundance		Richness		PTI		Siltation Index		Diversity	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
FW1	280	69,237	2	10	2.24	2.6	17.65	40.22	0.55	1.1
FW2	97,075	40,392	5	9	0.97	2.02	97.77	98.3	0.80	0.75
FW3	6,640	68,208	5	11	1.62	2.06	78.31	94.46	0.82	0.98
FW4	139,111	36,603	12	14	2.90	2.51	6.47	46.67	0.49	2.51
FW5	200	97,970	2	15	2.40	2.91	60	16.59	0.67	2.91

During the wet season sampling, the total periphyton abundance for all stations was 243,306 cells/ml which was lower than what was observed during the dry season sampling with 312,410 cells/m. The highest abundance and taxa richness were observed in station FW4 like what was observed in plankton community assessment. Sampling during dry season also indicated relative higher taxa richness in Stations 4 and 5. Periphyton density is generally highly variable and could changes drastically depending on the magnitude of physico-chemical change in water quality. Comparing the total density, it appears that there is no significant decrease in periphyton population since drastic changes could occur at several folds less in other areas. Taxa richness was however was generally low during the wet season sampling with numbers ranging from 2 to 12 compared to dry season sampling where taxa richness ranges from 9 to 15. High species richness is assumed to indicate high biotic integrity because many species are adapted to the conditions present in the habitat. Species richness is predicted to decrease with increasing pollution because many species are stressed. However, many habitats may be naturally stressed by low nutrients, low light, or other factors. Slight increases in nutrient enrichment can increase species richness in headwater and naturally unproductive, nutrient-poor streams (Bahls et al. 1993).

Macroinvertebrates (Epibenthic Fauna)

Macroinvertebrates are small (200 µm to 500 µm) animals without backbones that live among and within the sediments and stones on the bottom of streams, rivers, and lakes. They spend all or part of their life cycle in or on the bottom of these waterways (Rosenberg and Resh 1993). Generally, macroinvertebrate communities include insect larvae, crustaceans, mollusks and gastropods.

Epibenthic fauna (macro-invertebrates or macrobenthos) serves several ecosystem roles at various levels of the food chain, ranging from consumers of plant material to prey for fish. Due to their filter-feeding nature, macro-invertebrates are good indicators of environmental conditions over time and can be used as indicators of water quality and the degradation of the aquatic environment. Benthic or bottom dwelling animals constitute a major part of the diet of many benthic and bottom dwelling fishes and crustaceans. Many of the bivalves in riverine and estuarine systems are also edible invertebrates collected for food and sustenance trade.

Macroinvertebrate communities during the dry season were composed of 18 taxa belonging to ten orders. The assemblage was dominated by insect (i. e mayflies, stoneflies, caddisflies, and dragonflies) larvae of which the most dominant were the EPT consisting around 85 % of the sampled population. Of the 85 %, around 64 % were contributed by the caddisfly from family, Hydropsychidae.

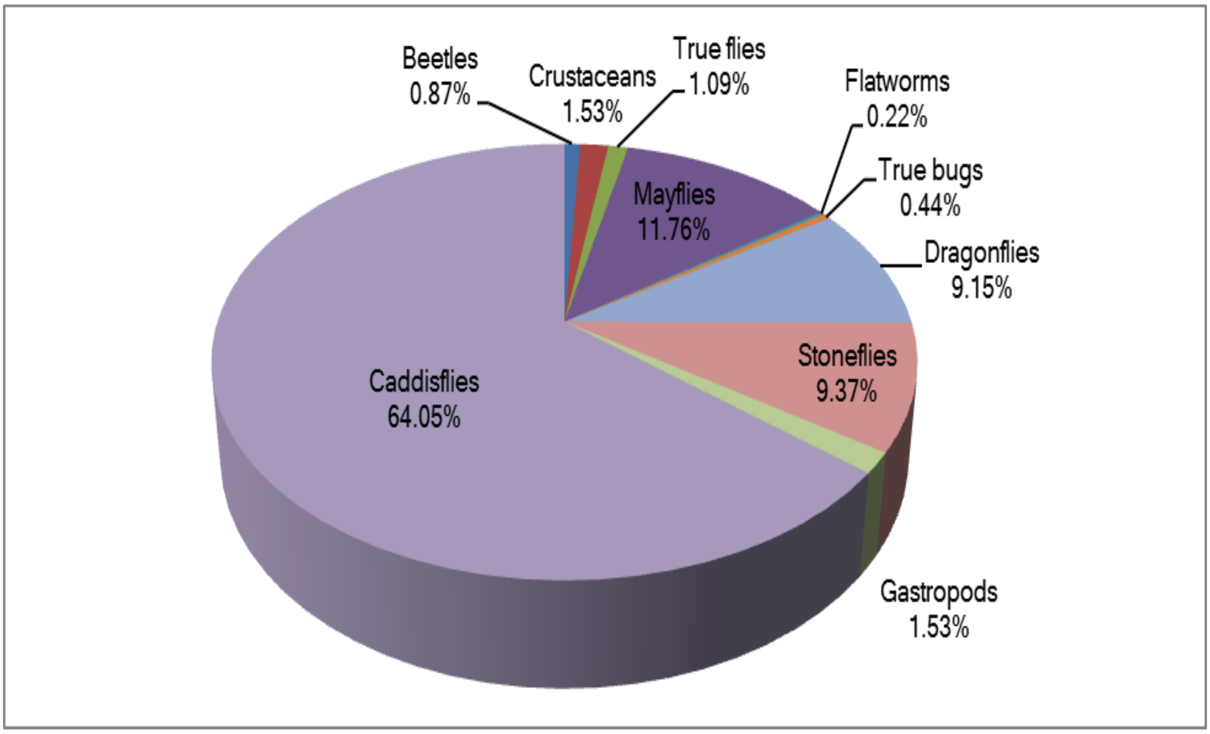


Figure 2-68. Percent Composition of Macroinvertebrates, Dry Season

During the wet season, a total of 212 individuals belonging to eleven (11) families were recorded during the August 23, 2017 survey in Maaslum River representing the wet season sampling. The macro-benthos recorded in this survey belongs to four (4) major phyla i.e. Chordata, Arthropoda, Annelida and Mollusca (Figure 2-69). Among these, the phylum chordata accounted for 34% of the total macro-invertebrates' community, followed by Arthropoda with 32%, Mollusca with 30% and Annelida with 4%. The only representative of the phylum chordata which was the family Gobiidae were the most abundant particularly in station B5. Among the arthropods, the family Libullidae (dragonflies) constituted for 11.32% of the total macrobenthos count. For the mollusks group, the bivalve belonging to family Corbiculidae recorded the highest relative abundance with 15%. The most family rich phyla were Arthropoda with eight (8) families recorded in all sampling sites.

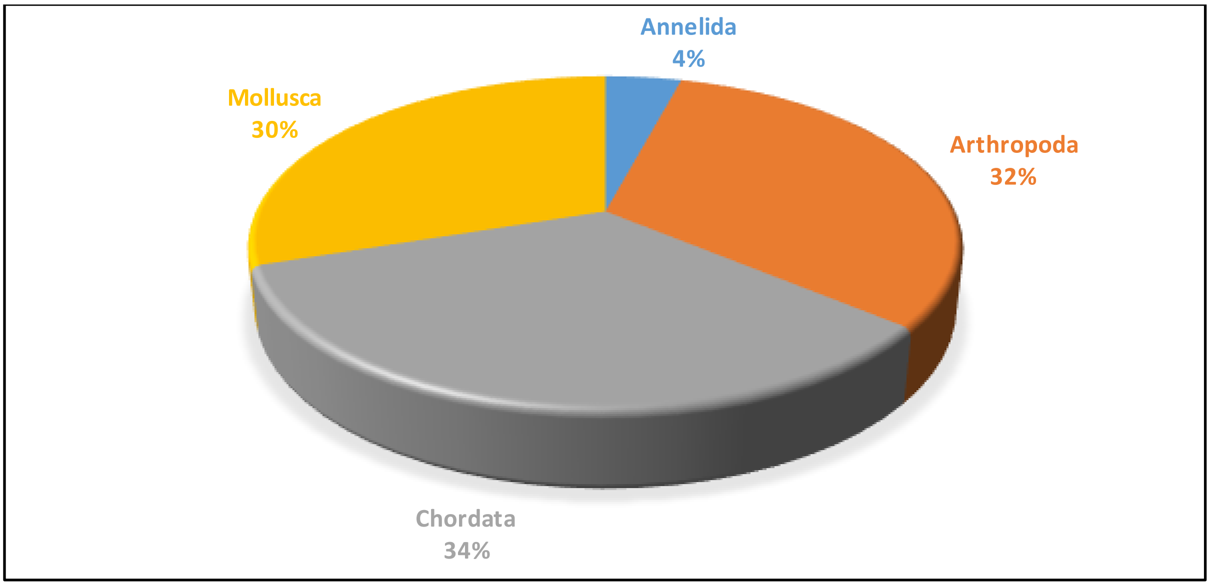


Figure 2-69. Percent Composition of Major Macrobenthos Groups, Wet Season

Macro Invertebrates Total Abundance

Total abundance of macroinvertebrate communities during dry season was 459 individuals with relatively high abundances in FW2 and FW3. These stations have riffle segments where water flow is agitated by rocks and characterized by shallow depths with fast turbulent water. The rocky bottoms provide protection from predators, food deposition, and shelters while the turbulence and stream flow results to high dissolved oxygen concentration, which provides suitable conditions for macroinvertebrates to thrive. Macroinvertebrate abundance was decreasing with increasing distance from the project site. This can be attributed to the shift in habitat type from riffles in the upstream segment of Maaslum River to runs in the downstream segment. Current is too slow in run habitats resulting to stagnant water with low aeration.

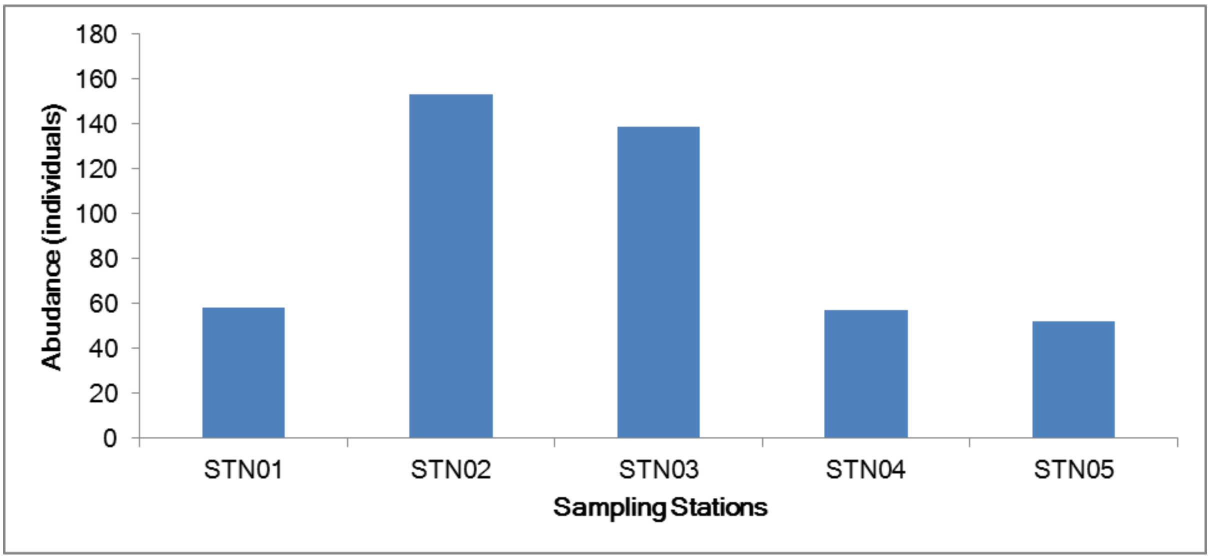


Figure 2-70. Spatial Distribution of Macroinvertebrate Abundance

Ephemeroptera (mayflies), *Plectoptera* (stoneflies), and *Trichoptera* (caddisflies) are considered important taxonomic groups in river systems as they primarily thrive in relatively clean and well oxygenated waters; thus, their abundance are good indicators of water quality (Stoyanova et al. 2014). Percent EPT (70 % to 90 %) in all stations were indicative of excellent water quality. Based on this index a water body is in excellent status if the % EPT is more than 27 % of the total population identified. EPT index was further supported by HBI values which showed that a large proportion of the macroinvertebrate communities are either intermediate or less tolerant to organic pollution. HBI values in FW1 to FW4 were indicative of non – impacted (0 – 4.5) stations while HBI value in FW5 was of slightly impacted station (4.51 – 6.50). Only three (3) taxa were identified in STN05, mayflies, chironomids, and gastropods, which have tolerance values indicative of organisms with intermediate tolerance to organic pollution. Although mayflies are considered as clean – water taxa, they can also be found in standing water with an average oxygen supply. Mayfly nymphs tend to be grazers, feeding on algae or detritus (Peckarsky et al. 1990) which might explain their high abundance in FW5 where periphyton abundance was highest.

Table 2-46. Macro Invertebrates Composition and Abundance, Dry Season

Macroinvertebrate Taxa	Stations					Mean
	STN01	STN02	STN03	STN04	STN05	
	Upstream of Quarry Site Brgy. Maaslum	Brgy. Maaslum	Brgy. Maaslum	Brgy. Gomentoc	Brgy. Poblacion	
Arthropoda	**58.0**	**153.0**	**139.0**	**51.0**	**50.0**	**90.2**
Coleoptera	-	-	-	**4.0**	-	**0.8**
Insecta	-	-	-	4.0	-	0.8
Dytiscidae	-	-	-	**2.0**	-	**0.4**
predaceous diving beetles	-	-	-	2.0	-	0.4
Hydrophilidae	-	-	-	**1.0**	-	**0.2**
water scavenger beetles	-	-	-	1.0	-	0.2
Psephenidae	-	-	-	**1.0**	-	**0.2**
water penny beetles	-	-	-	1.0	-	0.2
Decapoda	**6.0**	-	-	-	**1.0**	**1.4**
Crustacea	6.0	-	-	-	1.0	1.4
Gastropods	-	-	-	-	**1.0**	**0.2**
shrimps	-	-	-	-	1.0	0.2
Potamidae	**6.0**	-	-	-	-	**1.2**
freshwater crab	6.0	-	-	-	-	1.2
Diptera	**1.0**	-	-	**2.0**	**2.0**	**1.0**
Insecta	1.0	-	-	2.0	2.0	1.0
Chironomidae	-	-	-	-	**2.0**	**0.4**
non - biting midges	-	-	-	-	2.0	0.4
Syrphidae	**1.0**	-	-	-	-	**0.2**
rat - tailed maggot	1.0	-	-	-	-	0.2
Tipulidae	-	-	-	**2.0**	-	**0.4**
crane flies	-	-	-	2.0	-	0.4
Ephemeroptera	-	-	-	**7.0**	**47.0**	**10.8**
Insecta	-	-	-	7.0	47.0	10.8
Baetidae	-	-	-	**7.0**	**47.0**	**10.8**
minnow mayfly	-	-	-	7.0	47.0	10.8
Hemiptera	-	-	-	**2.0**	-	**0.4**
Insecta	-	-	-	2.0	-	0.4
Corixidae	-	-	-	**1.0**	-	**0.2**

Macroinvertebrate Taxa	Stations					Mean
	STN01	STN02	STN03	STN04	STN05	
	Upstream of Quarry Site Brgy. Maaslum	Brgy. Maaslum	Brgy. Maaslum	Brgy. Gomentoc	Brgy. Poblacion	
water boatman	-	-	-	1.0	-	0.2
Gerridae	**-**	**-**	**-**	**1.0**	**-**	**0.2**
water strider	-	-	-	1.0	-	0.2
Odonata	**1.0**	**21.0**	**18.0**	**2.0**	**-**	**8.4**
Insecta	1.0	21.0	18.0	2.0	-	8.4
Coenagrionidae	**-**	**-**	**-**	**2.0**	**-**	**0.4**
narrow - winged damselfly	-	-	-	2.0	-	0.4
nymph	**1.0**	**21.0**	**17.0**	**-**	**-**	**7.8**
dragonfly	1.0	21.0	17.0	-	-	7.8
pupa	**-**	**-**	**1.0**	**-**	**-**	**0.2**
dragonfly	-	-	1.0	-	-	0.2
Plecoptera	**19.0**	**11.0**	**13.0**	**-**	**-**	**8.6**
Insecta	19.0	11.0	13.0	-	-	8.6
Perlodidae	**19.0**	**11.0**	**13.0**	**-**	**-**	**8.6**
perlodid stoneflies	19.0	11.0	13.0	-	-	43.0
Trichoptera	**31.0**	**121.0**	**108.0**	**34.0**	**-**	**58.8**
Insecta	31.0	121.0	108.0	34.0	-	58.8
Hydropsychidae	**31.0**	**121.0**	**108.0**	**34.0**	**-**	**58.8**
net - spinning caddisfly	31.0	121.0	108.0	34.0	-	58.8
Mollusca	**-**	**-**	**-**	**5.0**	**2.0**	**1.4**
Prosobranchia	**-**	**-**	**-**	**5.0**	**2.0**	**1.4**
Gastropoda	-	-	-	5.0	2.0	1.4
Gastropods	**-**	**-**	**-**	**4.0**	**2.0**	**1.2**
right - gilled snail	-	-	-	4.0	2.0	1.2
Physidae	**-**	**-**	**-**	**1.0**	**-**	**0.2**
left - gilled snail	-	-	-	1.0	-	0.2
Platyhelminthes	**-**	**-**	**-**	**1.0**	**-**	**0.2**
Flatworms	**-**	**-**	**-**	**1.0**	**-**	**0.2**
Turbellaria	-	-	-	1.0	-	**0.2**
Flatworms	**-**	**-**	**-**	**1.0**	**-**	**0.2**
flatworm	-	-	-	1.0	-	0.2
Grand Total	**58.0**	**153.0**	**139.0**	**57.0**	**52.0**	**91.8**

In this survey during wet season, there were two (2) taxa that belonged to category 1, seven (7) for category 2 and four (4) for category 3. Vertebrate like gobiidae were still recorded as part of macrobenthos community since they are bio-indicators of freshwater ecosystem. The highest number of category 1 taxa was observed in Station 4 in Gomentoc River primarily attributed to plecopteran and ephemeropterans. They are considered as pollution sensitive taxa that require higher DO, neutral pH and cold water. It is important to note that the amphipod belonging to family Gammariidae are recorded in Station 4. Amphipods are also considered as sensitive group to pollution. The presence of amphipod and high number of category 1 macroinvertebrates in Gomentoc river (Station 4) indicates that is has better water quality The upstream station (FW1) of Maaslum River had the most number of category 2 taxa but the midstream and downstream station did showed the occurrence of category 1 and 2 macroivertebrates during the wet season sampling. Instead, low counts of category 3 were recorded in these stations. Macroinvertebrates belonging to category 2 are somewhat pollution tolerant but category 3 macroinverteb rates are the most pollution tolerant species that can tolerate low dissolved oxygen, unstable pH and warmer water.

Although no macroinvertebrates in Station 5, it harbors a several mudskippers which is a juvenile form of an estuarine fish that has considerable tolerance to environmental stressors, organic and inorganic contaminants.

Table 2-47. Macrobenthos Composition, Abundance and Diversity, Wet Season

Taxa	Stations					Grand Total	Relative Abundance
	B1	B2	B3	B4	B5		
Annelida		4	3			7	3.30
Oligochaeta		4	3			7	3.30
Lumbricullida		4	3			7	3.30
Lumbricullidae		4	3			7	3.30
Earthworm		4	3			7	3.30
Arthropoda	19	2	6	61		88	41.51
Insecta	19	2	6	53		80	37.74
Coleoptera	5					5	2.36
Gyrinidae	5					5	2.36
Unknown	5					5	2.36
Ephemeroptera				21		21	9.91
Baetidae				21		21	9.91
Minnow mayfly				21		21	9.91
Hemiptera	14		3			17	8.02
Gerridae	11		3			14	6.60
Unknown	11		3			14	6.60
Veliidae	3					3	1.42
Water crickets	3					3	1.42
Odonodata		2	3	19		24	11.32
Libellulidae		2		6		8	3.77
Dragonfly		2		6		8	3.77
Zygoptera			3	13		16	7.55
Damselfly			3	13		16	7.55
Plecoptera				13		13	6.13
Periotidae				13		13	6.13
Perlodid stoneflies				13		13	6.13
Malacostraca				8		8	3.77
Amphipods				8		8	3.77
Gammaridae				8		8	3.77
Unknown				8		8	3.77
Chordata					57	57	26.89
Osteichthyes					57	57	26.89
Percifprmis					57	57	26.89
Gobiidae					57	57	26.89
Muskipper					57	57	26.89
Mollusca			5	33	22	60	28.30
Bivlavia			5	26		31	14.62
Veneroidea			5	26		31	14.62
Corbiculidae			5	26		31	14.62
Corbicula			5	26		31	14.62
Gastropoda				7	22	29	13.68
Caenogastropoda				7		7	3.30
Thiaridae				7		7	3.30
Melaniodes				4		4	1.89
Thiara				3		3	1.42
Cycloneritimorpha					9	9	4.25
Neritidae					9	9	4.25

Taxa	Stations					Grand Total	Relative Abundance
	B1	B2	B3	B4	B5		
Clithon					5	5	2.36
Nerita sp.					4	4	1.89
Neogastropoda					11	11	5.19
Nassaridae					11	11	5.19
Nassarius					11	11	5.19
Pulmonata					2	2	0.94
Ellobiidae					2	2	0.94
Ellobius					2	2	0.94
Grand Total	19	6	14	94	79	212	100.00
Richness	2	2	4	8	5		
Evenness	0.63	0.92	0.98	0.9	0.6		
Diversity	0.44	0.64	1.4	1.9	0.93		
% EPT	0	0	0	36	0		
Modified Hilsenhoff Biotic Index	1.05	6.33	3.43	3.61	0		

Table 2-48. List of Macrobenthos, Wet Season

Phyla	Class	Order	Family	Scientific name/ Common name	Category
Annelida	Oligochaeta	Lumbricullida	Lumbricullidae	Earthworm	3
Arthropoda	Insecta	Coleoptera	Gyrinidae	Whirlligig beetle	2
			Veliidae	Water crickets	2
			Gerridae	Unknown	2
		Odonodata	Zygoptera	Damselfly	2
			Libellulidae	Dragonfly	2
			Zygoptera	Damselfly	2
		Ephemeroptera	Baetidae	Minnow Mayfly	1
		Plecoptera	Periotidae	Perlodid stoneflies	1
	Malacostraca	Amphipods	Gammaridae	Unknown	2
Chordata	Osteichthyes	Percifprmis	Gobiidae	Muskipper	-
Mollusca	Bivlavia	Veneroidea	Corbiculidae	Corbicula sp,	3
	Gastropoda	Caenogastropoda	Thiaridae	Melaniodes sp.	3
				Thiara sp.	3
		Cycloneritimorpha	Neritidae	Clithon sp.	-
				Nerita sp.	-
		Pulmonata	Ellobiidae	Ellobius sp.	-
		Neogastropoda	Nassaridae	Nassarius sp.	-

Category 1 – pollution sensitive organisms; found in good water quality

Category 2 – can exist in wide range of water quality conditions; generally, found in moderate water quality

Category 3 – can exist in wide range of water quality; highly tolerant to poor water

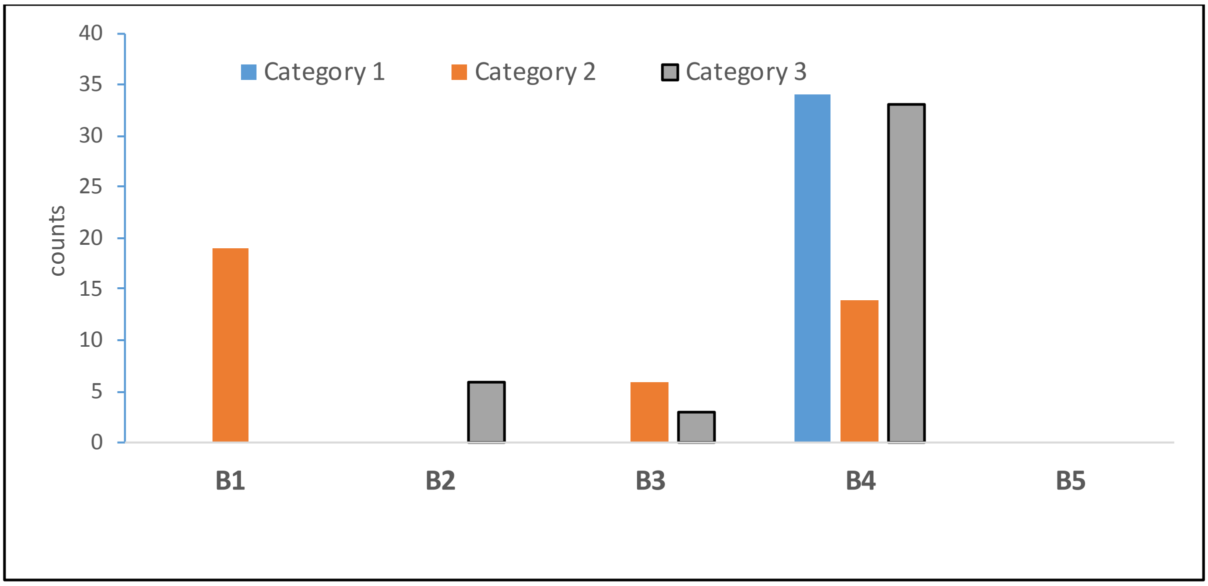


Figure 2-71. Occurrence of Three Categories of Macro-invertebrates in Maaslum River

Macroinvertebrates Indices

The four (4) indices computed (richness index, diversity index and percent EPT (Ephemeroptera-Plecoptera-Tricoptera) modified Hilsenhoff Biotic index) generally gave better information about the environmental conditions under which the organisms lived than a consideration of the individual taxa alone. Taxa richness is the total number of distinct taxa in a sample. It reflects the health of the community through measurement of the variety of taxa present which generally increases with increasing water quality (Plafkin et al., 1989). Shannon – Weiner Index (H') accounts for both abundance and evenness of the taxa present in a community. It is expected to decrease with increasing disturbances (Plafkin et al, 1989). The resulting value is generally between 1.5 – 3.5 and exceeds 4.5 very rarely. The values above 3.0 indicate that the habitat structure is stable and balanced while values lower than 1.0 indicates pollution and degradation of habitat structure (Goncalves and Menezes, 2011).

Table 2-49. Evaluation of Water Quality Using Modified Hilsenhoff Biotic Index (Hilsengoff, 1987)

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

Table 2-48 shows the comparison of the computed indices of the wet season survey from the dry season. In terms of abundance, an overall decrease was observed particularly in Stations 1, 2, 3 located within the proposed project site. Number of taxa has also slight decreased but what is more drastic the is the disappearance of EPT recorded in in these stations as compared to the dry sampling where more than 80% was still recorded. Several factors could be attributed to the absence of this pollution sensitive taxa. Although, it early to assume that pollution has resulted to disappearance of these taxa since midstream station of Maaslum River (FW2) has significant organic pollution as reflected by its modified Hillsenhoff index of 6.33. Other reason could be the timing of the sampling since a heavy rain occurred a day before the sampling resulting to turbid water from the on-going quarry operating negatively affecting these taxa.

Table 2-50. Comparison of Wet and Dry Season Sampling using the Indices

Abundance		Number of Taxa		% EPT		Modified Hilsenhoff Biotic Index (HBI)	
Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
58	19	5	2	86.21	0	3.1	1.05
153	4	3	2	86.27	0	4.41	6.33
139	19	4	4	87.05	0	4.33	3.43
57	48	11	8	71.93	36	4.44	3.61
52	79	3	5	90.38	0	5.1	0

Fisheries Resources

The presence of species of fish was detected in only two stations i.e. station FW4 and station FW5 where species richness and abundance were extremely low. Neither fish nor fishers were encountered in all of the Maaslum river and, but key informants interviewed in STO4, tributary of Maaslum river located in in Brgy. Gometoc revealed the existence of few fisheries resources. The most abundant catch in this river were usually *Oreochromis (Tilapia)* where they sometime catch more than a kilo. The absence of fish and crustacean species in stations near the project site only confirm findings in the plankton survey where Maaslum River has considerably poor productivity due to the extremely intense sedimentation. Basically, the result of the fisheries profile assessment was similar to previously conducted during the dry season.

Table 2-51. Diversity of Finfish and Crustaceans Existing in Maaslum River and Tributary

Family	Scientific Name	Local Name
Pelodiscus sp.	*Pelodiscus sinensis*	Salimao
Cichlidae	*Oreochromis sp.*	Tilapia
Portunidae	*Scylla serrata*	Alimgao
Paneneidae	*Macrobrachium rosenbergii*	Ulang
Cyprinidae	*Barbodes sp.*	Carpa
Gobiidae	*Glosogobius sp.*	Biya
Claridae	*Clarias sp.*	Pantat
Anguillidae	*Anguilla marmorata*	Igat/Kasili

Summary of Endemicity/Conservation Status

The absence of significant plankton and macro-invertebrate diversity in all of the river systems investigated signify a poor biological environment and any further threats to the integrity of the said bodies of water is insignificant as there are minimal populations of fish and shellfish whose growth, reproduction and recruitment can be threatened in Maaslum River. Prevention of possible threat should be emphasized in the one of the tributaries located in Brgy. Gomentoc which was the only freshwater body in the area that is still in relatively good condition and is being used for domestic uses. The freshwater prawn (Ulang) documented through the key informants in this tributary is of high conservation value, although they are not reported as endemic, threatened and endangered. The Chinese softshell turtle, although invasive is another species that needs to have conservation attention since it is reported to be a vulnerable organism. If propagated to a viable population, this species is of important commercial value for food and trade. Endemic mudfishes and catfishes were not reported to occur in the river system.

Abundance of Ecologically and Economically Important Species

The tilapia, ulang, carpa, igat, pantat as well as to species of macro-invertebrate shellfish existing in the tributary of Maaslum river are valuable food fishes but most are of juvenile sizes, indicating growth overfishing. The low species density and abundance is indicative of a deteriorating habitat condition. This has caused the absence of standing stocks of fish of any species. Similarly, the low number of plankton species and taxa identified in the plankton surveys is indicative of low diversity and unfavorable environmental conditions.

Presence of Pollution Indicators

There are no species of fish and shellfish that can be employed as bio-indicators of biotoxin pollution.

On the other hand, plankton blooms are used as indicators of hyper-organic nutrient loading and extreme pollution leading to episodes of oxygen depletion and fish kills. The pollution tolerant genera observed in this survey include *Oscillatoria, Synedra, Navicula, Nitzschia* and *Euglena*. Blooms of these genera have been recorded to block canals and clog filters especially in water treatment facilities and small riparian systems. However, the present plankton survey did not reveal the presence of any of the HAB-causing species in excessive densities and plankton abundance was catalogued as 'poor'. Drawing from overall diversity, richness and total abundance, the Maaslum River has very poor biodiversity and species richness with presence of pollution tolerant genera like *Oscillatoria* indicating a highly polluted river. The diatom *Fragillaria*, on the other hand, forms an important component of the food chain especially in the production of primary organic material. Excessive diatom blooms, however, are known to cause euthrophic conditions and the current condition of the Maaslum River can trigger such blooms. Similarly, it is important to note that zooplankton community in seven sampling stations revealed only six taxa, indicating low abundance and diversity. The potential threat/impacts of additional anthropogenic pollution would be insignificant.

Epibenthic fauna (macroinvertebrates or macrobenthos), on the other hand, serve several ecosystem roles at various levels of the food chain, ranging from consumers of plant material to prey for fish. Macro-invertebrates are good integrators of environmental conditions over time and can be used as indicators of heavy metal pollution, especially sessile, filter-feeding macro-invertebrates. However, no significant population of bivalves have been observed in the Maaslum and its tributary.

Threat to Existence and/or Loss of Important Local Species and Habitat

Result from indices computed of the plankton, periphyton and macrobenthos obtained from the survey of the five stations at the vicinity of the project site suggest, the major river systems around the project site are already unsuitable for survival of aquatic biota in Maaslum River. However, one of its tributaries located in Brgy. Gomentoc, although relatively far from the project site would still need to be not to be protected to prevent degradation in the long run since it is still connected to the project site. Along this line, it is important that protection of the integrity, and in fact promotion of improvement and maintenance of its water quality, be pursued.

Sediments carried down from soil erosion and earth moving due to construction-related activities such as land clearing activities and stockpiles may end up as runoff to nearby sections of Maaslum River especially during storm and heavy rains. This may adversely cause water turbidity and stream flow obstruction and affect plankton and the remaining macrobenthos fauna. Sediment erosion in freshwater bodies can cause localized mortality of aquatic larval forms of bivalves and gastropods, as well as impair nesting grounds of Tilapia. Siltation may increase water turbidity, resulting in decreased light penetration and a decrease in photosynthetic function of primary producers such as phytoplankton and benthic algae.

Threat to Abundance, Frequency and Distribution of Species

Similar to above – discussed potential impacts; threats to abundance, frequency and distribution of species were siltation and organic pollution. As aforementioned, the stations that are most likely to be affected by additional silt input are the more upstream stations (FW1, FW2 and FW3) but currently no linear correlation was associated between the current operations of the project and abundances of periphyton and macroinvertebrates. So, it is probable that the potential effect of additional silt and organic input will only affect the assemblage or the composition and not the abundance and distribution of organisms. However, as discussed in this assessment, abundance of organisms was most likely influence by habitat type and alteration of habitat type due to continuous silt deposition and chronic exposure to organic pollution might potentially alter periphyton and macroinvertebrate abundance in FW1, FW2 and FW3.

Impacts and Mitigating Measures for the Water Environment

Possible impacts of the proposed project on the water environment are as follows:

- May cause drawdown of ground water levels in immediately adjacent areas, where an aquifer may be located, to the quarry site due to inflow of water to the quarry pit.
- Transport of sediments into nearby surface water bodies during the construction and operation phases;
- Polluted water containing minerals and heavy metals may result from contact of ground water and/or rainwater with freshly blasted ores; Water contamination from chemicals/reagents used in the assay laboratory; and
- Hydrocarbon leaks and spills from vehicles and heavy equipment, fuel and oil tanks and used oil storage may contaminate groundwater and nearby surface water bodies.

To minimize or prevent degradation of the Maaslum River and its tributaries, the following measures will be adopted:

a) Creation of drainage systems which will include siltation ponds, stabilization of gullies and construction of run-off weirs at desirable distances along and within the existing gullies will be instituted in order to prevent sediment streams from reaching any freshwater river systems;

b) No part of the river or tributary will be blocked, and the project will ensure fluid discharge along the intake point;
c) Construction stockpiles shall be covered and rigidly bundled;
d) Vehicles carrying construction materials shall be covered and speed limits will be imposed.
e) Drainage canals shall be engineered to trap and prevent sediment from being washed into nearby freshwater bodies of water, especially the Maaslum river and its tributaries
f) A sound wastewater and solid waste management plan will be implemented and strictly enforced as mitigation to potential waste disturbances.
g) Regular *in-situ* monitoring of water quality and aquatic fauna will be conducted.

5. Marine Ecology

This marine ecology resource baseline study includes phytoplankton and zooplankton monitoring survey, coral reef survey and seagrass and mangrove community survey. This also includes securing of secondary information for season variations in the area.

Annex 16 is the summary of baseline assessment of coastal and marine habitats within two (2)-kilometer radii from the mouth of Tampocon River. The baseline assessment was conducted to characterize habitat types, diversity, spatial distributions and current condition of coastal habitats and resources in the area. Employing standard scientific assessment tools, the marine survey team conducted in-situ surveys of coral reefs, seagrass beds, mangrove forests, and census of reef-associated fish assemblages in the area.

The survey team eventually established ten (10) manta tow survey stations, four (4) coral reef line intercept stations, and two (2) seagrass assessment areas.

The survey and profiling covered a stretch of coastal water almost 18 kilometers long following the reef isobath in stations surveyed.

Table 2-52. Sampling Coordinates of Marine Study

Sampling Stations	Coordinates
CR1-Brgy. Tampocon I, Negros Oriental	9°50'38.00"N, 123° 8'24.00"E
CR2 -Brgy. Tampocon I, Negros Oriental	9°50'44.80"N, 123° 8'20.00"E
CR3 -Brgy. Tampocon II, Negros Oriental	9°51'15.50"N, 123° 8'59.20"E
CR4 -Brgy. Tampocon II, Negros Oriental	9°51'22.40"N, 123° 9'4.10"E
SG1 -Brgy. Tampocon I, Negros Oriental	9°50'32.00"N, 123° 8'22.00"E
SG2 – Brgy. Tampocon II, Negros Oriental	9°51'2.00"N, 123° 8'37.00"E
M1 - Brgy. Tampocon I, Negros Oriental	9°50'32.00"N, 123° 8'18.00"E
M2 - Brgy. Tampocon II, Negros Oriental	9°51'17.00"N, 123° 8'52.00"E
PL - Brgy. Tampocon II, Negros Oriental	9°50'54.85"N, 123° 8'29.83"E

Findings of the Study

All throughout the conduct of the monitoring, the weather was favorable. Wind speed were between 6-9km/h, with average water temperature of 28°C and underwater visibility ranged from 6-10 feet.

Results of the survey showed FAIR coral cover at 27%. Survey site designated as CR4 showed the highest at 30%, followed with CR3 at 28%, then CR1 and CR2 at 27% and 25% respectively. Branching corals were mostly observed across all survey sites and these are *Acropora sp*. which literally means a porous stem or branch. While common branching corals observe on site was staghorn corals. These corals are among the fastest growing corals on reefs are excellent reef-builders. This coral grows in shrub-lie clumps and provides shelter for a variety of small fish. Branching corals was highest at CR3 monitoring site. On the average branching corals was accounted at 11.5% hard coral cover. Following branching corals, was massive, encrusting at 4% and 3% respectively. Submassive and soft corals picks up next at 2.5%. Foliose corals came next at 1.5%, while tabulate followed at 1% and lastly plate-like corals at 0.5% respectively.

A total of 19 fish families with 3,855 fish individuals accounted for in this survey period. Majority of fish individuals were major species at forty-seven percent (47%). This was followed with target fish species at forty-four percent (44%). Indicator species was observed at nine percent (9%). Spotted ghost pipe fish were identified at survey area CR3. Major species are ecologically important species that occupy a unique niches and function as important trophic links. These fish are often the numerically dominant and most visually obvious group.

Seagrass meadown in the coastal areas of Ayungon showed distribution of six (6) seagrass species encountered. Average mean cover is at 37% which can be categorized at FAIR condition. *Halophila ovalis* was observed the highest mean cover at 50%. Followed with *Syringodium isoetifolium* at 45% mean cover. Then *Halodule pinifolia* followed next at 40% mean cover. *Halodule uninervis* is at 30% then followed with *Thalassia hemprichii* AT 33%. Lastly, *Cymodocea serrulate* is at 18%

The average mean density of phytoplankton observed in all monitoring sites was at 12,883 cells/ m3 while zooplankton was at 24,032 cells/m3). This density signifies a healthy microalgae ecosystem in the area. Showing results in each monitoring stations, monitoring station CR1 showed is at 11,212 cells/m3 of phytoplankton and 26,110 cells/m3 zooplankton, CR2 showed 16,252 cells/m3 phytoplankton and 29,881 cells/m3 zooplankton. Moreover, CR3 is at 13,212 cells/m3 phytoplankton 25,181 cells/m3 zooplankton. Survey station CR4 phytoplankton 12,215 23, 991 and cells/m3 zooplankton while CR5 11,523 cells/m3 phytoplankton and 14,996 cells/m3 zooplankton.

Plankton composition diversity was primarily composed of 23 common genera across all survey station. Top three most frequent phytoplankton recorded were *Ceratium sp* at nineteen percent (19%), followed with *Chaetoceros sp* at sixteen percent (16%). This was then followed with and *Coscinodiscus sp* and *Noctiluca sp.* at twelve percent (12%) respectively.

Meanwhile, for zooplankton species, *Copepods* was observed the highest at twenty-three percent (23%) followed with *Bivalvia sp.* at thirteen percent (13%), then *Mollusca sp* at twelve percent (12%) respectively.

Three (3) species of true mangrove were identified representing old growth and saplings. These are pagatpat (*Sonneratia alba*), miapi (*Avicennia marina*), and bakhaw (*Rhizophora mucronata*).

The mangrove habitat serves as coastal protection, fish nursery and source of nutrient exchange supporting the local seagrass ecosystem down to the coral habitat. The area may be proposed for mangrove reforestation or protection to further support and enhance fish productivity on its surrounding area.

C. Air

1. Meteorology/Climatology

Change in Local Micro-Climate

Monthly Average Rainfall and Temperature of the Area

The graph below specifically represents the rainfall in terms of days rains occurred as well as the total volume per month for the Municipality of Ayungon, Negros Oriental. The graph indicates that the occurrence of high volume is in the months of June, July and October of 2016. These months are also the time farmers plant their crops. Typhoons also strike during these months. In May, June, July, August, September and October, the wind is south westerly and in the months of November, December, January, February, March and April, the wind direction is north easterly. Rainfall is also affected by the wind velocity and direction. During the dry season, there are more rain days but of lesser volume which is prominent in the months of January, February and March.

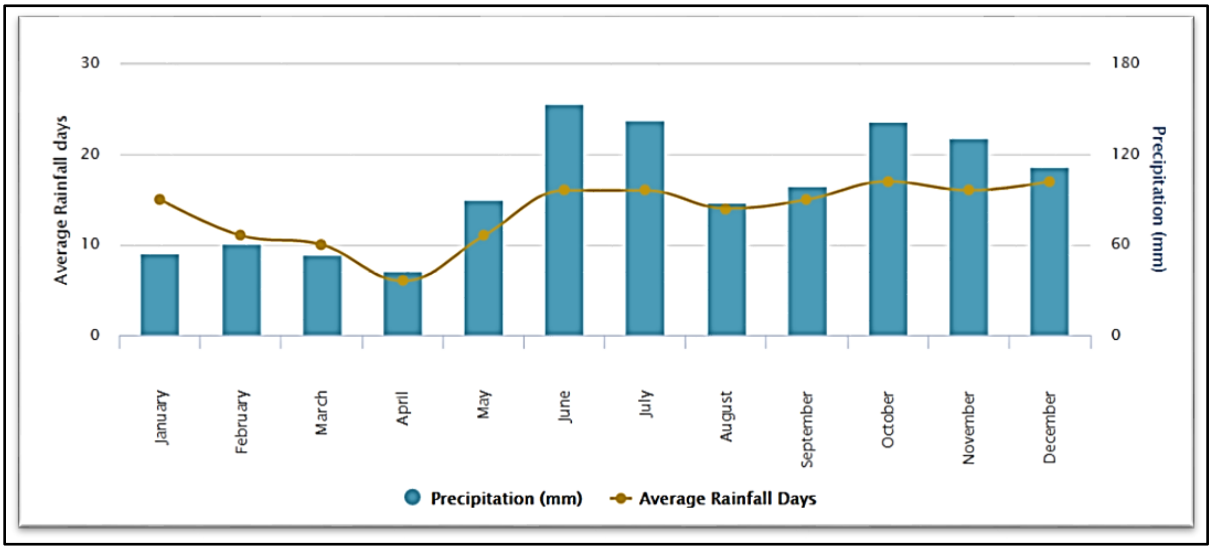


Figure 2-72. Average Monthly Rainfall in Ayungon
Source: Dumaguete Airport Authority (DAA)

The lowest average monthly temperature in the Ayungon area occurs in the months of July, August, September, October, January and February. In July to October, the rainy season is at its peak and in January and February, the low temperature is caused by the Siberian winds due to the melting of the ice in the northern hemisphere. The high temperature occurred during the rainy days due to the high atmospheric humidity. In the Ayungon area, the relative humidity is 78%.

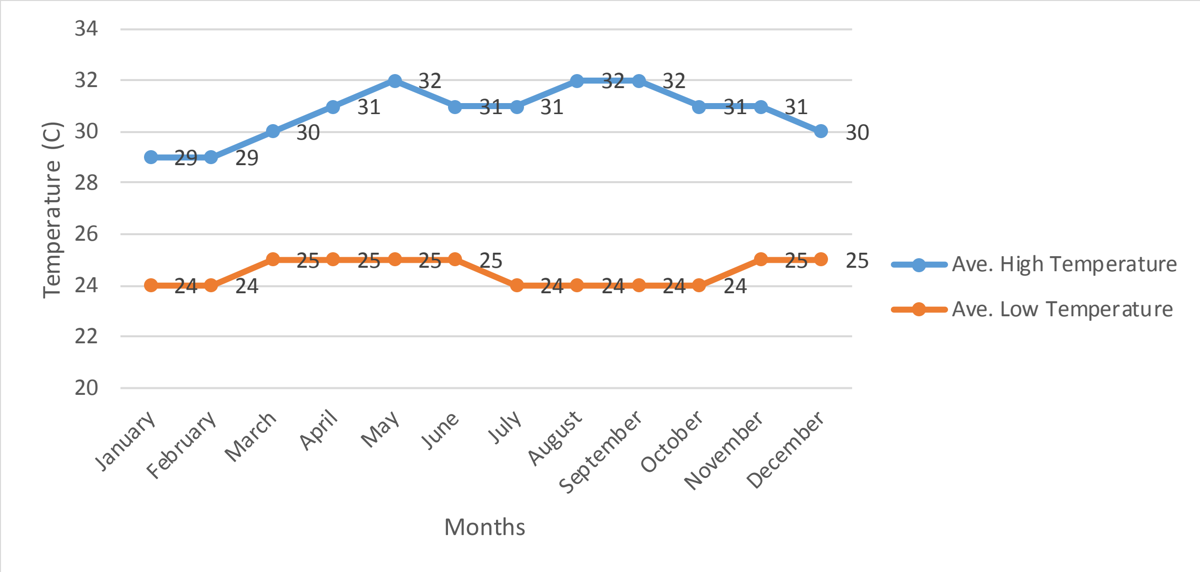


Figure 2-73. Average Monthly Temperature
Source: Dumaguete Airport Authority (DAA)

Windrose Diagram

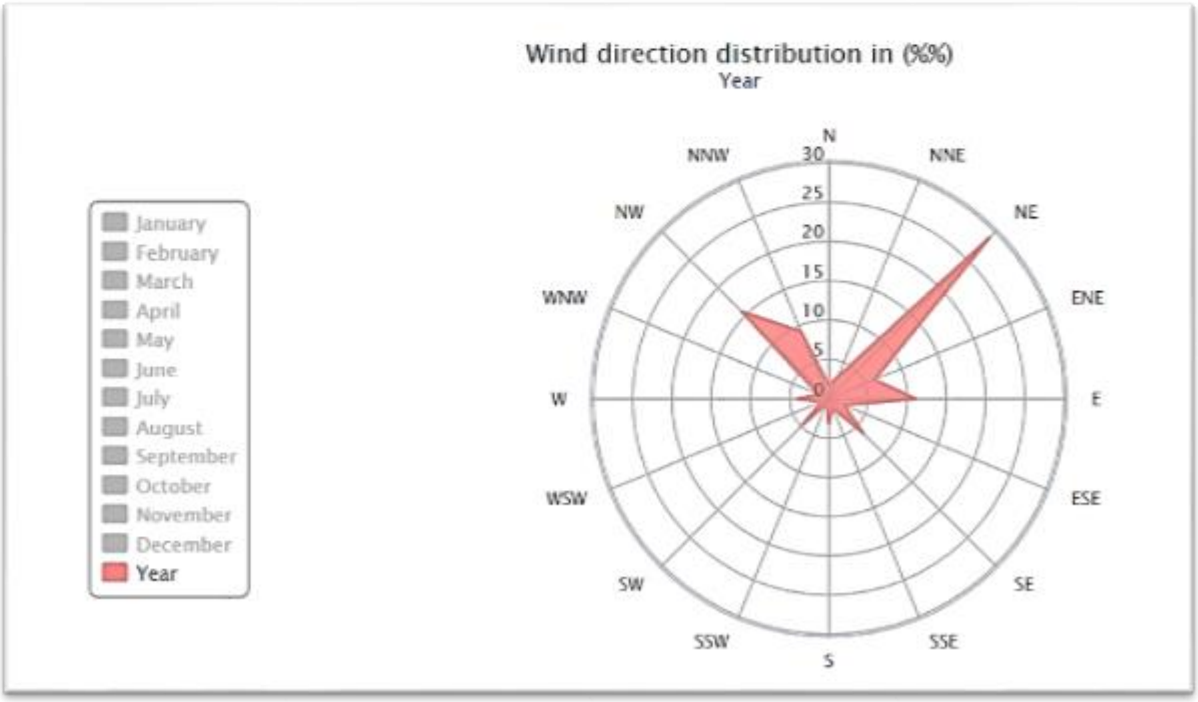


Figure 2-74. Wind Direction

The wind rose was sourced from the data gathered by the Dumaguete Airport, being the best institution with weather instruments and complete data near the Municipality of Ayungon. The wind rose showed that the wind is stronger and occurs mostly from the north east but least from the southeast. This wind rose is affected by the mountain range between Negros Oriental and Negros Occidental, the Tañon Strait, and the mountains in Cebu.

Frequency of Tropical Cyclones

Based on the Philippine Vulnerability to Environmental Disasters, the Project Site is in a low hit area.

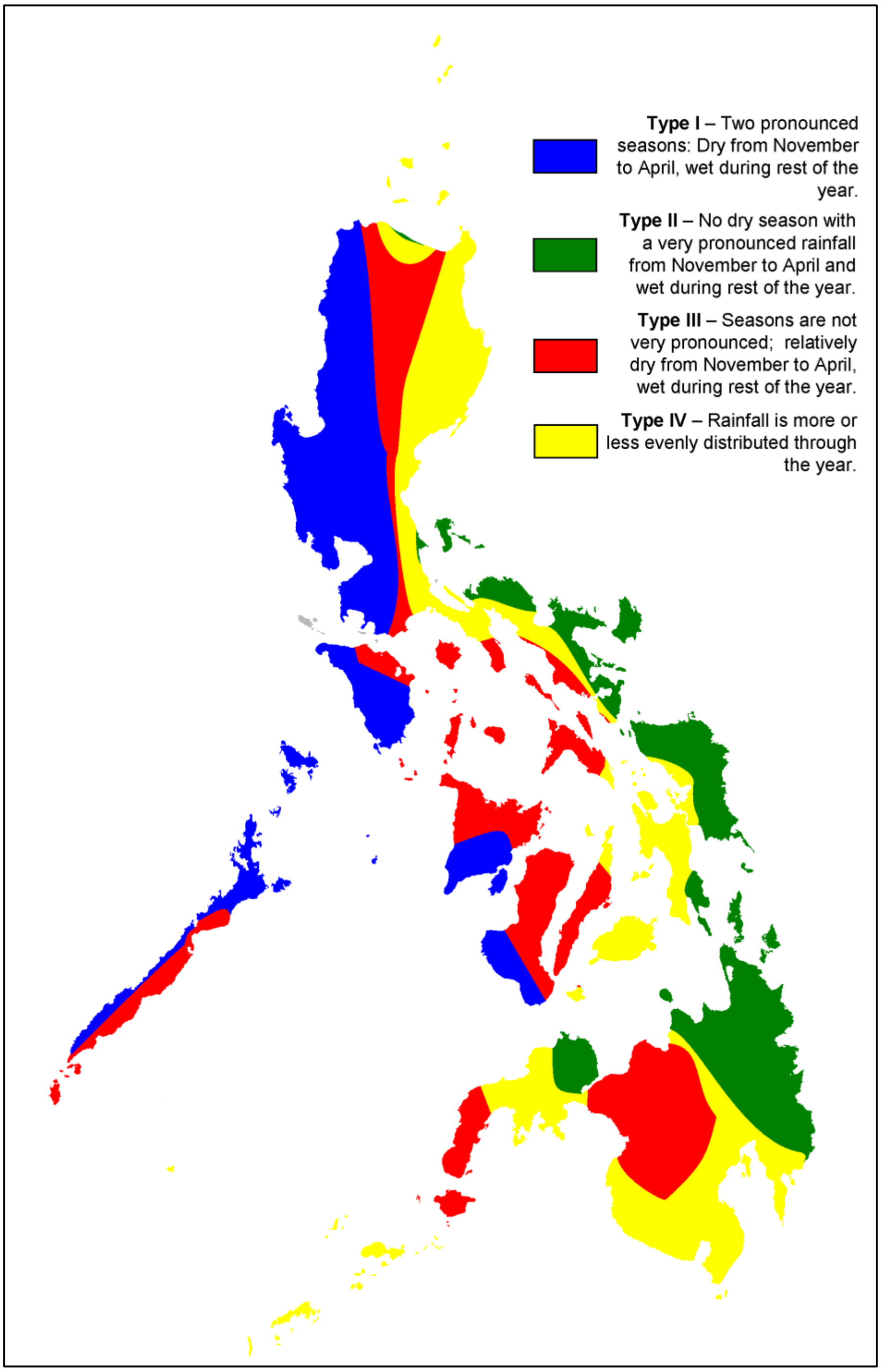


Figure 2-75 Climate Map of the Philippines *(Source: PAGASA)*

Greenhouse Gas Estimates (GHG Mitigation Potential)

Sources of greenhouse gases from the quarry project are CO_2 and nitrous oxides gases from fuel combustion in quarry equipment and motor vehicles. Greenhouse gas emissions from the said sources are very minimal and its contribution to climate change could be considered negligible. As such, evaluation of greenhouse gas contribution to climate change for this project is considered not necessary. As noted in the scoping guidelines, the said evaluation is "applicable only for projects with significant GHG emissions."

Nevertheless, HRDC will continue the implementation of greening program to serve as carbon sink, primarily to help offset the impact of greenhouse gas emissions from the operations of quarry.

As the GHG emissions is negligible, there is no need to monitor for these substances.

Table 2-53. Greenhouse Gas (GHG) Emission Estimates

VOC	CO	NOX	SO2	PM10
0.037 ug/Ncm	1.377 ug/Ncm	0.28 ug/Ncm	0.000607 ug/Ncm	22.236 ug/Ncm
0.185 ug/Ncm	6.885 ug/Ncm	1.4 ug/Ncm	0.003035 ug/Ncm	111.18 ug/Ncm

2. Air Quality and Noise

The methods of sampling and analysis of TSP, PM10, PM2.5, SO2, NO2, CO, and total VOCs for the ambient air quality monitoring were based on the DENR standards. For the trace metals (Hg, Pb, Cd, As and Cr), these are not required in the ECC and thus are not included in the monitoring.

Table 2-54. Methods of Ambient Air Sampling and Analysis

Parameters	Sampling Method
Total Suspended Particulates (TSP)	High Volume – Gravimetric Method
Particulate Matter less than 10 microns (PM_{10})	High Volume – Gravimetric Method
Particulate Matter less than 2.5 microns (PM_{10})	Low Volume – Gravimetric Method
Sulfur dioxide (SO_2)	Bubbler – Pararosaniline Method
Nitrogen dioxide (NO_2)	Bubbler – Griess – Saltzman Reaction Method
Carbon monoxide (CO)	Gas Analyzer – Direct Reading
Total Volatile Organic Compound (VOCs)	Gas Analyzer – Direct Reading

Total Suspended Particulates

Sampling of TSP was carried out by using a high-volume sampler. Ambient air was drawn into a covered housing and through a collecting medium of a pre-weighed glass microfiber filter paper at a controlled flow rate over the specified sampling period. The filter paper with retained particles was recovered after sampling and desiccated for 24 hours in the laboratory followed by accurate weighing (gravimetric method) using a calibrated mass balance. The net weight (mass gain) from the initial and final masses of the filter paper corresponds to the total amount of particulates collected. The concentration of TSP in ambient air was determined from the ratio of total mass of particulates collected and the total normal volume of air sampled (total volume of air sampled corrected to normal conditions of 25 °C and 760 mm Hg).

Particulate Matter less than 10 microns

Sampling of PM10 was carried out by using a high volume PM10 sampler. Ambient air was drawn at a controlled flow rate into a specially shaped cyclone inlet where the larger particulates are initially separated from PM10 size range. Each size fraction in the PM10 size range is then collected on a pre-weighed glass microfiber filter over the specified sampling period. The filter paper with retained particles was recovered after sampling and desiccated for 24 hours in the laboratory followed by accurate weighing using a calibrated mass balance. The net weight (mass gain) from the initial and final masses of the filter paper corresponds to the amount of PM10 collected. The concentration of PM10 in ambient air was determined from the ratio of total mass of PM10 collected and the total normal volume of air sampled.

Particulate Matter less than 2.5 microns

Sampling of PM2.5 was carried out by using a low volume sampler. Ambient air was drawn at a controlled flow rate through an inertial particle size separator (impactor) where the suspended particulate matter in the PM2.5 size range is separated for collection on a pre-weighed glass-fiber filter paper over the specified sampling period. The filter paper with retained particles was recovered after sampling and desiccated for 24 hours in the laboratory followed by accurate weighing using a calibrated analytical balance. The net weight (mass gain) from the initial and final masses of the filter paper corresponds to the amount of PM2.5 collected. The concentration of PM2.5 in ambient air was determined from the ratio of total mass of PM2.5 collected and the total normal volume of air sampled.

Sulfur Dioxide

Sulfur dioxide in the ambient air was sampled using a handy gas sampler by aspirating air at a controlled flowrate into a solution of 0.04 M sodium tetrachloromercurate (TCM) through a glass midget impinger over the specified sampling period. The solution was then treated in the laboratory with formaldehyde and with a specially purified acid-bleached pararosaniline to form an intensely colored pararosaniline methyl sulfonic acid. The color intensity was measured spectrophotometrically at 548 nm and is directly related to the amount of SO2 collected. SO2 concentration was determined from the difference between the absorbance of the sample and blank, multiplied by the calibration factor, and divided by the total normal volume of air sampled.

Nitrogen Dioxide

Nitrogen dioxide in the ambient air was determined using Griess-Saltzman Reaction Method. Air was drawn using a handy gas sampler at a controlled flowrate into an azo dye forming reagent through a glass midget impinger over a specified sampling period. The absorption reaction produces a stable red-violet color. The color intensity was read by a spectrophotometer in a laboratory at 550 nm and is directly related to the amount of NO2 collected. NO2 concentration was determined from the difference between the absorbance of the sample and blank, multiplied by the calibration factor, and divided by the total normal volume of air sampled.

Carbon Monoxide

Carbon monoxide in air was measured by a direct-reading gas analyzer equipped with a special sensor for CO. The average value obtained during monitoring was recorded. The minimum detection limit for CO is 1.0 ppm.

Total Volatile Organic Compounds

Total VOCs was determined using a direct-reading photoionization detector. It has an electrodeless 10.6 eV ultraviolet lamp that ionizes chemicals with ionization potentials below 10.6 eV and thereby measure their concentrations in parts per million. The average value of total VOCs obtained during monitoring was recorded. The detection limit for total VOCs is 0.1 ppm.

Sampling Schedule, Locations and Coordinates

In compliance with the requirements of DENR-EMB Central Office, sampling activity for ambient air and noise quality monitoring was conducted in two (2) different seasons – wet and dry season- in order to monitor and identify the effects of the Project operations to the surrounding environment and vice-versa.

Dry season sampling was conducted on November 29-30, 2016 while wet season sampling was done on August 24-25, 2017. The sampling was conducted in five (5) different locations, within and outside the Project Site. The table below shows the coordinates of the sampling stations while Figure 2-77 shows the sampling map of the baseline activity.

Table 2-55. Sampling Coordinates of AAQM

Sampling Stations	Coordinates
A1 – Quarry Gate Entrance	09°51’29.6” N / 123°04’37.3” E
A2 – Sitio Binatca, Brgy. Maaslum, Basketball Court	09°51’22.5” N / 123°05’07.4” E
A3 - Sitio Sacsac, Brgy. Gomentoc	09°51’12.2” N / 123°07’37.9” E
A4 – Sitio Looc, Brgy. Tampocon 1	09°50’39.6” N / 123°08’07.6” E
A24-5 – Front of Maaslum Barangay Hall	09°51’31.5” N / 123°05’39.0” E

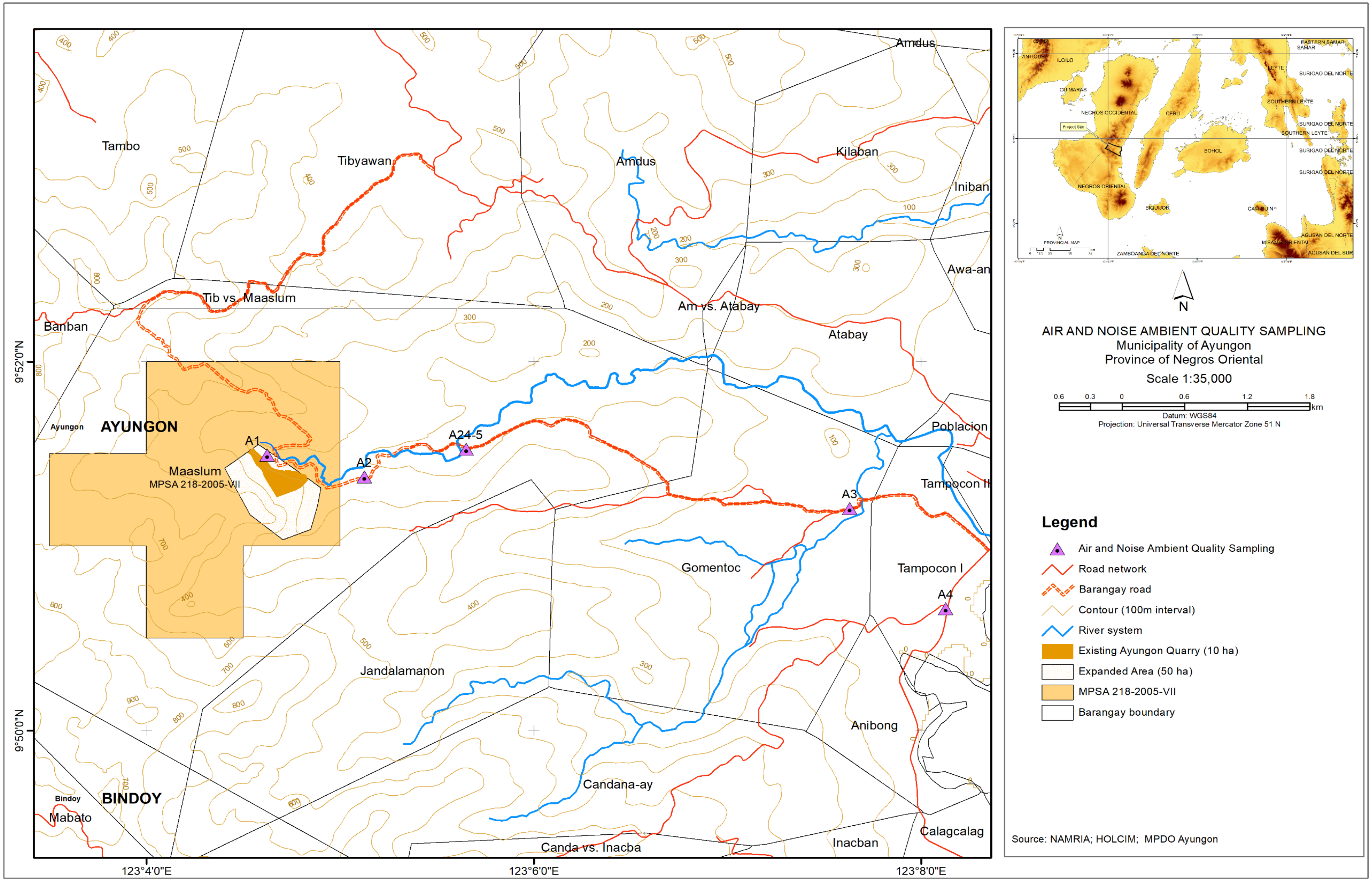


Figure 2-76. Ambient Air and Noise Quality Sampling Stations *(Source: NAMRIA, HOLCIM, MPDO-Ayungon)*

Degradation of Air Quality

One (1) Hour Ambient Air Quality Monitoring

Four (4) designated sampling stations were assessed with TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and total VOCs. The pollutant concentrations, as presented in Table 2-54, complied with the DENR National Ambient Air Quality Standards (NAAQS) for Source Specific Air Pollutants of 300 µg/Ncm for TSP, 200 µg/Ncm for PM_{10}, 340 µg/Ncm for SO_2, and 260 µg/Ncm for NO_2; and with the DENR National Ambient Air Quality Guideline Values (NAAQGV) for Criteria Pollutants of 30 ppm for CO – all were based on 60 minutes averaging time. However, there are no established DENR standards for PM_{25} and total VOCs for 60 minutes of monitoring. ***Annex 7*** *shows the Results of Ambient Air Quality and Noise Monitoring.*

Based on the report of the actual sampling done by a hired monitoring team, the result showed that at all times, are all within the DENR standards for light industrial area. Considering that the road is used specifically, for the transport of an industrial output; there is no specific land use classification of the area; there is no noise ordinance promulgated and the project is endorsed by the local government of, Ayungon, Negros Oriental, the standard used for industrial road. It must be noted that the operation is being conducted only during morning and daytime only, to protect the nearby residents of noise during their time of sleep.

On the other hand, it is noticeable that there is a slight increase in the Total Suspended Particles (TSP) during dry season sampling due to dust brought by strong wind or moving vehicles. Aside from TSP, which is still below the DENR Standard, no other parameters have observable increase identified.

24-hours Ambient Air Quality Monitoring

One (1) designated sampling stations were assessed with TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and total VOCs. The pollutant concentrations, as presented in Table 2-55 and Table 2-56, complied with the DENR National Ambient Air Quality Guideline Values (NAAQGV) for Criteria Pollutants of 230 µg/Ncm for TSP, 150 µg/Ncm for PM_{10}, 50µg/Ncm for $PM_{2.5}$, 180 µg/Ncm for SO_2, and 150 µg/Ncm for NO_2 based on 24 hours averaging time; and 9 ppm for CO based on 8 hours averaging time. However, there is no established DENR standard for total VOCs for 24 hours of monitoring. ***Annex 7*** *shows the Results of Ambient Air Quality and Noise Monitoring.*

Same as to the One (1)-hour Ambient Quality monitoring, the 24-hour Ambient Air Quality Monitoring results shows that there is no significant increase in the concentrations of the identified parameters in different sampling locations that may be contributed to the operation of the Project.

Sampling for Hg, Pb, Cd, AS, Cr

The sampling for air parameters which cover Hg, Pb, Cd, As and Cr was not done since the project is a simple quarry operation of cutting and grabbing of silica material and does not entail the production of effluents and pollutants containing Hg, Pb, Cd, As and Cr.

Increase in Ambient Noise Level

A direct-reading sound level meter (in A-weighing mode) was used to collect noise level data at each sampling station. A-weighted (dBA) scale was selected as required by the 1978 NPCC and the 1980 NPCC standards were also based on the same weighting network. A weighting network most closely approximates the response of ear to various sound frequencies.

The procedure used followed that of Wilson (1989), in which at least a total of fifty (50) readings were recorded in order to increase confidence limits of the data. Procedures outlined by Wilson (1989) were adopted in the monitoring of intervals, duration of samplings, size of data needed, and methods of noise level analysis were not specified in the 1978 NPCC.

According to the provision provided in the NPCC Memorandum Circular 002 (1980), the arithmetic median of seven maximum-recorded noise levels is regarded as the noise level comparable to the standard. The 24-hous ambient noise level monitoring data were collected between four periods with the inclusive times as seen in the table below. Field observations during the monitoring were also noted to identify the primary sources of noise in each area.

Table 2-56. Noise Monitoring Periods

Periods	Time
Morning	5:00AM-9:00AM
Daytime	9:00AM-6:00PM
Evening	6:00PM-10:00PM
Nighttime	10:00PM-5:00AM

Based on the results of the Ambient Noise Level Monitoring shown in Table 2-56 the Project has no significant effect on the Noise Levels that may adversely affect the nearby communities. Causes of the increase in noise identified during the sampling were due to natural sources, like birds and insects, and vehicular noises coming from motorcycles and others. ***Annex 7*** *shows the Results of Ambient Air Quality and Noise Monitoring.*

Geotagged Areas of Air Pollution Sources

Figure 2-77 shows the location of air pollution sources in the quarry area.

Table 2-57. One (1) Hour Ambient Air Quality Monitoring Results for Wet and Dry Season

Station	Location	Date and Time of Sampling	TSP (µg/Ncm)		PM_{10}(µg/Ncm)		$PM_{2.5}$(µg/Ncm)		SO_2 (µg/Ncm)		NO_2 (µg/Ncm)		VOCs (µg/Ncm)		CO	
			Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
A1	Quarry Gate Entrance	Dry: Nov. 29, 2016 1003H-1103H Wet: Aug. 24, 2017 1005H-1105H	155.5	<1.8	87.6	<1.8	<17.9	1.4	<0.5	5.0	4.4	1.9	<0.1	<1.0	<1.0	<1.0
A2	Sitio Binatca, Brgy. Maaslum, Basketball Court	Dry: Nov. 30, 2016 1225H-1325H Wet: Aug. 24, 2017 1125H-1225H	65.7	<1.8	<1.8	<1.8	<17.7	1.4	<0.5	5.0	5.3	1.9	<0.1	<1.0	<1.0	<1.0
A3	Sitio Sacsac, Brgy. Gomentoc	Dry: Nov. 30, 2016 1420H-1520H Wet: Aug. 24, 2017 1250H-1350H	194.7	5.2	60.3	<1.7	<17.2	0.7	31.8	7.3	3.0	<0.7	<0.1	<1.0	1.0	<1.0
A4	Sitio Looc, Brgy. Tampocon 1	Dry: Nov. 30, 2016 1055H-1155H Wet: Aug. 24, 2017 1405H-1505H	245.4	<1.7	43.2	<1.7	<17.3	<0.2	6.4	8.4	1.7	<0.7	<1.0	<1.0	1.0	<1.0
DENR National Ambient Air Quality Standards *(60 Minutes Averaging Time)*			300		200		None		340		260		None		30	

Note: The detection limit value of the parameters was used for the computation of non-detected concentrations. The gas analyzer was calibrated to read total VOCs in isobutylene equivalents. (Minimum detection limit is 0.1 ppm using a 10.6 eV lamp).

Table 2-58. 24-Hour Ambient Air Quality Monitoring Results for Wet and Dry Season

Station	Location	Date and Time of Sampling (Dry, Wet)	TSP (µg/Ncm)		PM_{10} (µg/Ncm)		$PM_{2.5}$ (µg/Ncm)		SO_2 (µg/Ncm)		NO_2 (µg/Ncm)		VOCs (µg/Ncm)	
			Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
A24-5	Front of Maaslum Barangay Hall	Dry: Nov. 29-30, 2016 1205H-1205H Wet: Aug. 23-24,2017 0940H-0940H	27.1	17.3	7.3	2.4	6.6	0.4	1.5	3.7	0.7	1.7	<0.1	<1.0
DENR National Ambient Air Quality Standards *(24-hour Averaging Time)*			230		150		50		180		150		None	

Notes: The detection limit value of the parameters was used for the computation of non-detected concentrations. The gas analyzer was calibrated to read total VOCs in isobutylene equivalents. (Minimum detection limit is 0.1 ppm using a 10.6 eV lamp)

Table 2-59. 24-Hour Ambient Air Quality Monitoring Results (ppm) for Wet and Dry Season

Station	Location	Date and Time of Sampling (Dry, Wet)	8-Hours Monitoring Period	CO	
				Dry	Wet
A24-5	Front of Maaslum Barangay Hall	Dry: Nov. 29-30, 2016 Wet: Aug. 23-24, 2017	Dry: 1205H - 2005H Wet: 0940H-1740H	<1.0	<1.0
			Dry: 2005H – 0405H Wet: 1740H-0140H	<1.0	<1.0
			Dry: 0405H - 1205H Wet: 0140H-0940H	<1.0	<1.0
DENR National Ambient Air Quality Standards *(24-hours Averaging Time)*				9	

Note: Detection limit for CO is 1.0 ppm.

Table 2-60. Ambient Noise Level Monitoring Results (dBA) for Wet and Dry Season

Station	Location	Date/Time (Dry, Wet)	Period	Noise Level		NPCC Standard	Source
				Dry	Wet		
N1	Quarry Gate Entrance	Dry: Nov. 29, 2016 0948H-0958H Wet: Aug. 24, 2017 1105H-1115H	Daytime	56	57	70	Heavy vehicles Chirping birds

Station	Location	Date/Time (Dry, Wet)	Period	Noise Level		NPCC Standard	Source
				Dry	Wet		
N2	Sitio Binatca, Brgy. Maaslum, Basketball Court	Dry: Nov. 29, 2016 1030H-1040H Wet: Aug. 24, 2017 1225H-1235H	Daytime	60	58	55	Heavy and light vehicles Passing motorcycle and children playing nearby
N3	Sitio Sacsac, Brgy. Gomentoc	Dry: Nov. 29, 2016 1015H-1025H Wet: Aug. 24, 2017 1350H-1400H	Daytime	60	55	55	Heavy and light vehicles Passing motorcycle
N4	Sitio Looc, Brgy. Tampocon 1	Dry: Nov. 29, 2016 1105H-1115H Wet: Aug. 24, 2017 1505H-1515H	Daytime	58	55	55	Heavy and light vehicles Passing vehicle nearby
N24-5	Front of Maaslum Barangay Hall	Dry: Nov. 30, 2016 0821H-0831H Wet: Aug. 24, 2017 0820H-0830H	Morning	52	57	50	Light vehicles Chirping birds, passing motorcycle
		Dry: Nov. 29, 2016 1008H-1018H Wet: Aug. 23, 2017 0930H-0940H	Daytime	59	50	55	People playing basketball, heavy and light vehicles Passing motorcycle
		Dry: Nov. 29, 2016 2028H-2038H Wet:	Evening	49	48	50	Insects Chirring insects, passing motorcycle

Station	Location	Date/Time (Dry, Wet)	Period	Noise Level		NPCC Standard	Source
				Dry	Wet		
		Aug. 23, 2017 1815H-1825H					
		Dry: Nov. 29, 2016 2324H-2334H Wet: Aug. 23, 2017 2210H-2220H	Nighttime	45	40	45	Insects Chirring Insects

Figure 2-77. Geotagged Location of Air Pollution Sources in the Quarry Area

D. People/ Community

1. Demographic Profile

Land Area

The Municipality of Ayungon has a total land area of 43,568 hectares, of which, 15,400 hectares are within municipal waters.

The land use pattern of Ayungon is typical of most municipalities in the Province of Negros Oriental, which is characterized by the predominance of agricultural lands and grasslands/shrubs indicating a rural environment. The designated urban area in the municipality of Ayungon is the entire barangay Poblacion, which is defined by the following boundaries: by the barangay boundary of Poblacion and Tampocon (south); by the barangay boundary of Poblacion and Awa-an (north); the barangay boundary of Poblacion and Atabai (west) and the barangay of Poblacion and Tańon Strait (east).

The total land area of the three (3) impact areas is 3,357 hectares. A walk through in the barangays revealed that all three (3) barangays are agriculturally based. Brgy. Maaslum is coconut-based with few patches of rice lands. These rice lands are irrigated. Irrigation canals were provided by the National Irrigation Administration (NIA).

In addition to coconut, most the residents plant banana which are sold during market days in the poblacion. According to the barangay officials and as stated in its barangay profile, the land use of Brgy. Maaslum is as follows:

- Forest – 10%
- Agricultural – 40%
- Residential – 30%
- Quarry – 20%

Brgy. Gomentoc and Tampocon I, on the other hand, are rice producing. Brgy. Gomentoc is one of the 13 barangays covered by the Comprehensive Agrarian Reform Program (CARP) in Ayungon. Around 280 hectares or 35% of its total land area is planted to palay and coconut. The farmlands are irrigated. A large portion of the agricultural land in Brgy. Gomentoc is planted to mangoes, coconut, and banana.

Population

In 2015, the Municipality of Ayungon, Negros Oriental had a total population of 46,303 (Philippines Statistical Office). Out of the 24 barangays, five (5) are urban and the rest are rural. The least populated is Brgy. Kilaban with a population of 819 while the most populated is Brgy. Tambo with a total population of 3,940.

Table 2-61. Ayungon Population, 2015

Barangay	Population	Percentage	Rank*
A. Urban			
1. Anibong	2,047	4.4%	15th
2. Awa-an	2,870	6.2%	21st
3. Tampocon I	2,061	4.5%	16th
4. Tampocon II	2,165	4.7%	18th
5. Poblacion	2,025	4.4%	14th
Sub-total	11,168		
B. Rural			
1. Amdus	1,160	2.5%	4th
2. Jandalamanon	1,148	2.5%	3rd
3. Atabay	1,274	2.8%	6th
4. Ban-ban	2,603	5.6%	19th
5. Calagcalag	1,764	3.8%	12th
6. Candana-ay	1,349	2.9%	7th
7. Carol-an	2,928	6.3%	22nd
8. Gomentoc	2,159	4.7%	17th
9. Inacban	1,376	3.0%	8th
10. Iniban	1,390	3.0%	9th
11. Kilaban	819	1.8%	1st
12. Lamigan	897	1.9%	2nd
13. Maaslum	1,721	3.7%	11th
14. Mabato	3,385	7.3%	23rd
15. Manogtong	1,500	3.2%	10th
16. Nabhang	1,189	2.6%	5th
17.Tambo	3,940	8.5%	24th
18.Tibyawan	1,808	3.9%	13th
19. Tiguib	2,725	5.9%	20th
Sub-total	35,135		
Total	**46,303**	**100.0%**	

Source: CLUP 2020-2029

Of the 24 barangays, three (3) barangays are directly affected by the project. These are: Barangay Maaslum, where the quarry site is found; Barangay Gomentoc, which is an adjacent barangay and its road leads to Brgy. Maaslum; and, Barangay Tampocon 1, whose road also leads to Brgy. Maaslum which is the quarry site. All barangays are in the Municipality of Ayungon, in Negros Oriental.

Based on the 2015 Philippine Statistics Authority (PSA) data, Barangays Maaslum, Gomentoc, and Tampocon 1 have a total population of 5,941 which is 12.83% of the total population of the Municipality. Maaslum is ranked 11th in terms of its contribution to the total population of the Municipality while Gomentoc and Tampocon I ranked 17th and 16th, respectively.

Population Growth

The population of Ayungon, Negros Oriental increased by 14% or from 40,744 in 2004 to 46, 303 in 2015. This translates to an average annual growth rate of Ayungon of 1.27%. Table 2-61 below shows the population of Ayungon in 2004 and in 2015 and the corresponding increases in population from 2004 to 2015.

As far as the impact barangays are concerned, Barangay Maaslum in 2004 was only 1,268 in terms of population but over the years exhibited a growth rate of 2.4% with an increased population of 1,721 in 2015. Barangay Gomentoc manifested a 1.6% growth rate showing an increase in population from 1,739 to 2,159 in years 2004 and 2015, respectively. For barangay Tampocon I, a growth rate of 0.8% was reported resulting to a change in its population from 1,846 to 2,061 during 2004 to 2015 respectively.

Table 2-62. Population of Ayungon, 2004 vs 2015

Barangay	Population				
	2004	2015	Inc/Dec	Percent	Annual Rate
A. Urban					
1. Anibong	1,701	2,047	346	20%	1.4%
2. Awa-an	2,062	2,870	808	39%	2.6%
3. Tampocon I	1,846	2,061	215	12%	0.8%
4. Tampocon II	1,544	2,165	621	40%	2.7%
5. Poblacion	1,648	2,025	377	23%	1.5%
Sub-total	**8,801**	**11,168**			
B. Rural					
1. Amdus	2,022	1,160	-862	-43%	-2.8%
2. Jandalamanon	1,351	1,148	-203	-15%	-1.0%
3. Atabay	1,137	1,274	137	12%	0.8%
4. Ban-ban	2,216	2,603	387	17%	1.2%
5. Calagcalag	1,622	1,764	142	9%	0.6%
6. Candana-ay	1,011	1,349	338	33%	2.2%
7. Carol-an	3,245	2,928	-317	-10%	-0.7%
8. Gomentoc	1,739	2,159	420	24%	1.6%
9. Inacban	1,557	1,376	-181	-12%	-0.8%
10. Iniban	1,149	1,390	241	21%	1.4%
11. Kilaban	856	819	-37	-4%	-0.3%
12. Lamigan	976	897	-79	-8%	-0.5%
13. Maaslum	1,268	1,721	453	36%	2.4%
14. Mabato	2,162	3,385	1,223	57%	3.8%
15. Manogtong	1,140	1,500	360	32%	2.1%
16. Nabhang	1,522	1,189	-333	-22%	-1.5%
17.Tambo	2,875	3,940	1,065	37%	2.5%
18.Tibyawan	1,780	1,808	28	2%	0.1%
19. Tiguib	2,315	2,725	410	18%	1.2%
Sub-total	***31,943***	***35,135***			
Total	**40,744**	**46,303**		13%	0.9%

Source: PSA

The Philippines Statistics Authority (PSA) reported that the Philippine population increased by 1.72% annually, on average, during the period 2010 to 2015. By comparison, the rate at which the country's population grew during the period 2000 to 2010 was higher at 1.90%.

The Negros Island Region (NIR) increased by 0.98% annually, on average, during the period 2010 to 2015. By comparison, the rate at which the region's population grew during the period 2000 to 2010 was higher at 1.27%.

The population of Negros Oriental grew faster than that of Negros Occidental (excluding Bacolod City) with an average annual population growth rate (PGR) of 0.99% during the period 2010 to 2015. Negros Occidental (excluding Bacolod City) posted a PGR of 0.79%.

Population Density

Based on the 2015 data of the Municipal Planning Development Office, the population density in Brgy. Tampocon I was 8.59 persons per hectare, in Brgy. Gomentoc 2.35 persons per hectare and in Brgy. Maaslum 0.84 person per hectare which are all considered to be low density areas.

This is the same for all the barangays in the Municipality of Ayungon whether urban or rural. The average built-up density in the urban areas is six (6) persons per hectare while the average built-up density in rural areas is 3.06 persons per hectare.

Table 2-63. Population Density of Ayungon per Barangay as of 2015

Barangay	Population	Gross Area	Population Density
Amdus	1,160	1,219.00	0.95
Anibong	2,047	520.00	3.94
Atabay	1,274	483.00	2.64
Awa-an	2,870	260.00	11.04
Banban	2,603	2,608.00	1.00
Calagcalag	1,764	510.00	3.46
Candana-ay	1,349	1,116.00	1.21
Carol-an	2,928	5,598.00	0.52
Gomentoc	2,159	920.00	2.35
Inacban	1,376	299.00	4.60
Iniban	1,390	334.00	4.16
Jandalamanon	1,148	559.00	2.05
Kilaban	819	448.00	1.68
Lamigan	897	1,490	0.60
Maaslum	1,721	2,049.00	0.84
Mabato	3,385	2,981.00	1.14
Manogtong	1,500	745.00	2.01
Nabhang	1,189	1,714.00	0.69
Poblacion	2,025	108.00	18.75
Tambo	3,940	1,602.00	2.45
Tampocon I	2,061	240.00	8.59
Tampocon II	2,165	88.00	24.60
Tibyawan	1,808	1,490	1.21
Tiguib	2,725	745.00	3.66
Total	46,303	26.168	1.64

Source: MPDO

Number and Size of Household

The average household size in Ayungon is four (4). According to those who attended the focused group discussions (FGDs), the number of children per household ranged from 2 to as much as 13.

The total number of households in the three (3) impact areas is 1.401. Table 2-63 shows that of the three (3) direct impact areas (DIA), Brgy. Maaslum, which has the biggest area at 2,049 hectares has the least number of households at 379. This is understandable considering that Brgy. Maaslum is farthest from the Poblacion and is mountainous in terms of topography.

Table 2-64. Household Population and Average Household Size

Barangay	Population	Number of Households	Average Household Size
Amdus	1,160	288	4.03
Anibong	2,047	479	4.27
Atabay	1,274	291	4.38
Awa-an	2,870	731	3.93
Banban	2,603	570	4.57
Calagcalag	1,764	405	4.36
Candana-ay	1,349	245	5.51
Carol-an	2,928	655	4.47
Gomentoc	2,159	506	4.27
Inacban	1,376	303	4.54
Iniban	1,390	359	3.87
Jandalamanon	1,148	263	4.37
Kilaban	819	166	4.93
Lamigan	897	203	4.42
Maaslum	1,721	379	4.54
Mabato	3,385	699	4.84
Manogtong	1,500	283	5.30
Nabhang	1,189	280	4.25
Poblacion	2,025	493	4.11
Tambo	3,940	887	4.44
Tampocon I	2,061	516	3.99
Tampocon II	2,165	511	4.24
Tibyawan	1,808	403	4.49
Tiguib	2,725	658	4.14
Total	46,303	10,573	4.38

Source: CLUP 2020-2029

Gender and Age Profile

Based on the Comprehensive Land Use Plan (CLUP) prepared by the local government unit (LGU) of Ayungon, men outnumber women in all age groups by approximately 1.04%. Table 2-65 below shows the number of women and men by age group.

Table 2-65. Gender Distribution by Age Group, 2015

Age group	Male	Female	Total
Under 1	532	520	1052
1-4	2185	1963	4149
5-9	2686	2671	5357
10-14	2706	2493	5199
15-19	2505	2235	4740
20-24	2077	1924	4001
25-29	1783	1575	3358
30-34	1505	1254	2759
35-39	1307	1151	2458
40-44	1285	1209	2495
45-49	1157	1256	2413
50-54	1094	1100	2194
55-59	885	938	1823
60-64	754	795	1559
65-69	493	567	1060
70-74	357	401	758
75-79	186	297	483
80 and over	160	285	445
Total	23,669	22,634	46,303

Source: PSA

Ayungon has a relatively young population. The total number of people below 15 years old is 14,706; while the total population of 65 years and above is only 2,746. And when computed, the total population of the residents with ages ranging from 15-64 years old is 27800. The young dependency ratio is computed to be 34.03%. The old dependency ratio on the other hand is 5.93%. When computed, the total dependency ratio is 39.96%. This means that 39.96% of the total population is dependent upon the 60.57% of working population.

Literacy Rate / Profile of Educational Attainment

The literacy rates of both male and female are almost equal in Ayungon. However, Table 2-66 below shows that there is a wide gap in the literacy rate between the rural and urban areas. In the rural area, the literacy rate is 80% while literacy rate in urban areas is 97%.

Table 2-66. Literacy Rate by Gender in Ayungon

Description		Sex		Total
		Male	Female	
TOTAL	Total	13,010	12,964	25,974
	Literate	10,340	10,430	20,770
	%	79%	80%	80%
	Illiterate	2,670	2,534	5,204
	%	21%	20%	20%
Urban	Total	693	693	1,386
	Literate	670	669	1,339
	%	97%	97%	97%
	Illiterate	23	24	47
	%	3%	3%	3%
Rural	Total	12,317	12,271	24,588

Description		Sex		Total
		Male	Female	
	Literate	9,670	9,761	19,431
	%	79%	80%	79%
	Illiterate	2,647	2,510	5,157
	%	21%	20%	21%

Source: CLUP 2020-2029

Based on records of the Department of Education (DepED), the school going age population steadily declines from the time the school aged children enter primary school. Table 2-67 below shows that of the 37.27% who have entered primary education only 13.80% reach the intermediate levels.

Table 2-67. School-Going Age Population

School Level	Population	Percentage
Primary		
All Ages	6,945	37.27%
6	1,699	9.12%
7	1,444	7.75%
8	1,428	7.76%
9	1,068	5.73%
10	1,306	7%
Intermediate		
All Ages	2,571	13.80%
11	1,409	7.56%
12	1,162	6.23%
Secondary		
All Ages	4,791	25.72%
13	1,469	7.88%
14	1,271	6.82%
15	1,101	5.91%
16	950	5.09%
Tertiary		
All Ages	4,325	23.21%
17	1,261	6.77%
18	1,120	6%
19	964	5.17%
20	848	4.55%
21	132	0.71%
TOTAL	**18,632**	**100%**

Source: CLUP 2020-2029

In the project direct impact areas, Brgys. Maaslum, Gomentoc, and Tampocon I have complete elementary education and day care centers. After graduation, most of these pupils would transfer to the nearest barangay to attend junior high school which is about nine (9) kilometers from Brgy. Maaslum; 5 km from Brgy. Gomentoc; and 2-3 km from Brgy. Tampocon I. Because of the distance of these high schools from these barangays, only around 50% of the total student population continue to study junior and senior high school.

Displacement of Settlers

Displacement/Disturbance of Properties

There is no major infrastructure within the MPSA area except for the unpaved barangay road that ends in the quarry site. There is also no infrastructure within the quarry site except for a small guard outpost. Residential houses and farmlands are located at northern side of Maaslum River, north of the quarry site. HAZ has no plan of building any major infrastructure in the Project Area.

A map of the MPSA area indicates that no households and structures will be affected by the expansion of the quarry project.

Likewise, no disturbance of the property under expansion is expected. If ever, forest and vegetation covers will be affected. Mini-reforestation zones will be established within and immediately outside the 10-hectare project site for progressive "re-greening" or assisted natural regeneration to start tree stands or increase present tree density in areas not needed by the proponent for actual mining.

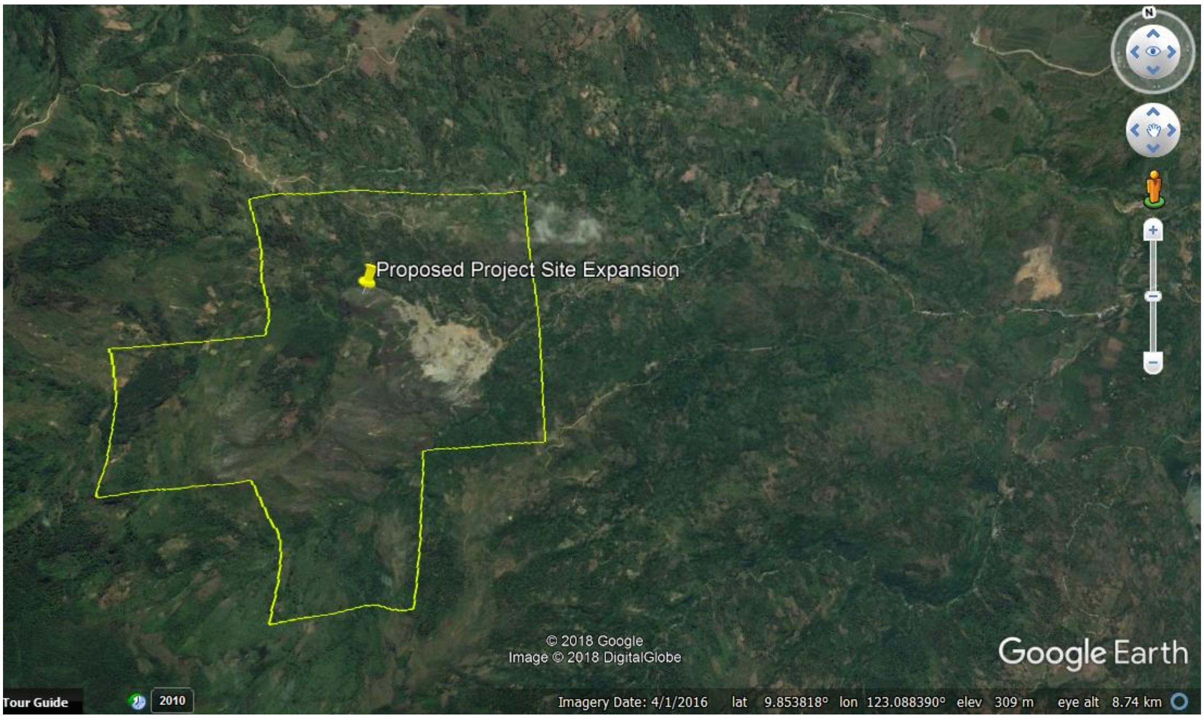


Figure 2-78. A Google Imagery showing that there are no Affected Households and Structures in the Project Site Expansion

North, east and west of the present quarry site are used for agricultural and pastureland while south of the quarry is generally forestland. The MPSA area has been classified by the Municipality of Ayungon as a quarries and mineral deposit area.

Change/Conflict in Land Ownership

There will be no change / conflict in land ownership. The project is within the MPSA granted by the DENR to the Heirs of Arturo Zayco covering an area of 505.4626 hectares. An MPSA is granted to entities who aspire to undertake activities acceptable to the DENR and become stewards of public lands and the environment. Being public land classified for quarry and mineral extraction purposes, there is no foreseen land conflict in land ownership.

Change/Conflict Right of Way

Barangay roads leading to the project are present. Roads to be constructed inside the project area will not affect any right-of-way.

Impact on Public Access

The project will in no way affect public access since the area where the silica quarry will be operated has no access road from Brgy. Maaslum to its neighboring barangays.

Impact of In-migration Patterns as a Result of Project Implementation

The rate of in-migration in Ayungon is negligible at 1.14% owing mostly to residents marrying outsiders and settling in Ayungon.

Table 2-68. In-Migration Pattern in Ayungon

Sex and Present Residence	Household Population 5 Yrs. Old and Over	Place of Residence									
		Same Municipality		Other City/Municipality Same Province		Other Provinces		Foreign Country		Unknown	
		No.	%	No.	%	No.	%	No.	%	No.	%
Both Sexes	39,955	38,816	97.15	358	1.04	455	1.14	4	0.01	192	0.48
Male	20,205	19,607	97.04	183	1.29	238	1.18	2	0.01	95	0.47
Female	19,750	19,209	97.26	175	1.24	205	1.04	2	0.01	89	0.45

Source: Census Population Housing National Statistics Office 2000

Proliferation of Informal Settlers

There are no recorded informal settler families (ISFs) found in the direct impact areas. Most of the farmers in Brgys. Gomentoc, Maaslum, and Tampocon 1 have private agricultural lands of their own.

It was learned during the FGDs that a number of residents are employed by Holcim Resources Development Corporation (HRDC) who are from Ayungon and live in adjacent barangays.

Any increase in the number of employees that will be required by the expansion of the quarry site will only mean attracting other residents of other barangays of Ayungon and will not attract the presence of informal settlers.

In 2018, there are households that have been recorded to proliferate in barangays Poblacion and Tampocon II as shown in the table below but none in barangays Gomentoc, Maaslum and Tampocon I.

Table 2-69. Informal Settlement Areas, 2018

Barangay	Name of settlement	Area (ha)	Land ownership	Zoning classification	Programs	Agency	Number of households
Poblacion	Little Tondo	0.005	Private	Residential	Livelihood, health	LGU	22

Tampocon II	Expendables	1.000	Private/public	Agricultural, Residential	Livelihood, health	LGU	26

Source: CLUP 2020-2029

Cultural/Lifestyle Change

Ayungon is a typical rural community in Negros Oriental.

It is said that the term Ayungon is derived from the name of a deaf man, “Ayung,” who cut down a “dungon” tree. Old municipal profiles refer to Ayungon as Todos los Santos though there are no legends to explain that Hispanic name, just as there are no tales elaborating on the ruins of apparently Hispanic fortifications on the Tampocon II shoreline, perhaps because Ayungon’s colonial past was not entirely its own: for many years it was a mere barrio of Tayasan, until 1924 when Governor General Leonard Wood came to establish Ayungon as a full-fledged municipality (Ayungon website).

Ayungon’s historical and tourist potentials include the Spanish Fort, Pagsalsalan Falls, Sook 3-stair Falls, CVRP Training Center, Mantalip Fish Sanctuary (Scuba Diving), Iniban Fish Sanctuary, Communal Forest, Mt. Kwisaw (far Mountain Climbers/Bikers), Banban Rice Fields (Agriculture). (Ayungon website)

To date, there have been no reported indigenous peoples (IP) in Ayungon and more particularly in the three (3) barangay impact areas.

Impacts on Physical, Cultural Resources

The existence of the silica quarry over the last 10-20 years has not affected the culture or lifestyle living in the municipality. Likewise, no archaeologic, paleontogic, historical, religious, aesthetic or cultural significance will be affected.

Through the project and in close coordination with the local government of Ayungon, efforts will be undertaken to preserve its local forest which one of the remaining three virgin forests found in Negros Island. The proponent will likewise assist in the preservation of the Nabingka Caves, vast areas of mangrove forest, the cool water of Maaslum Falls, and the Ayungon Peoples Park (Figure 2-78).

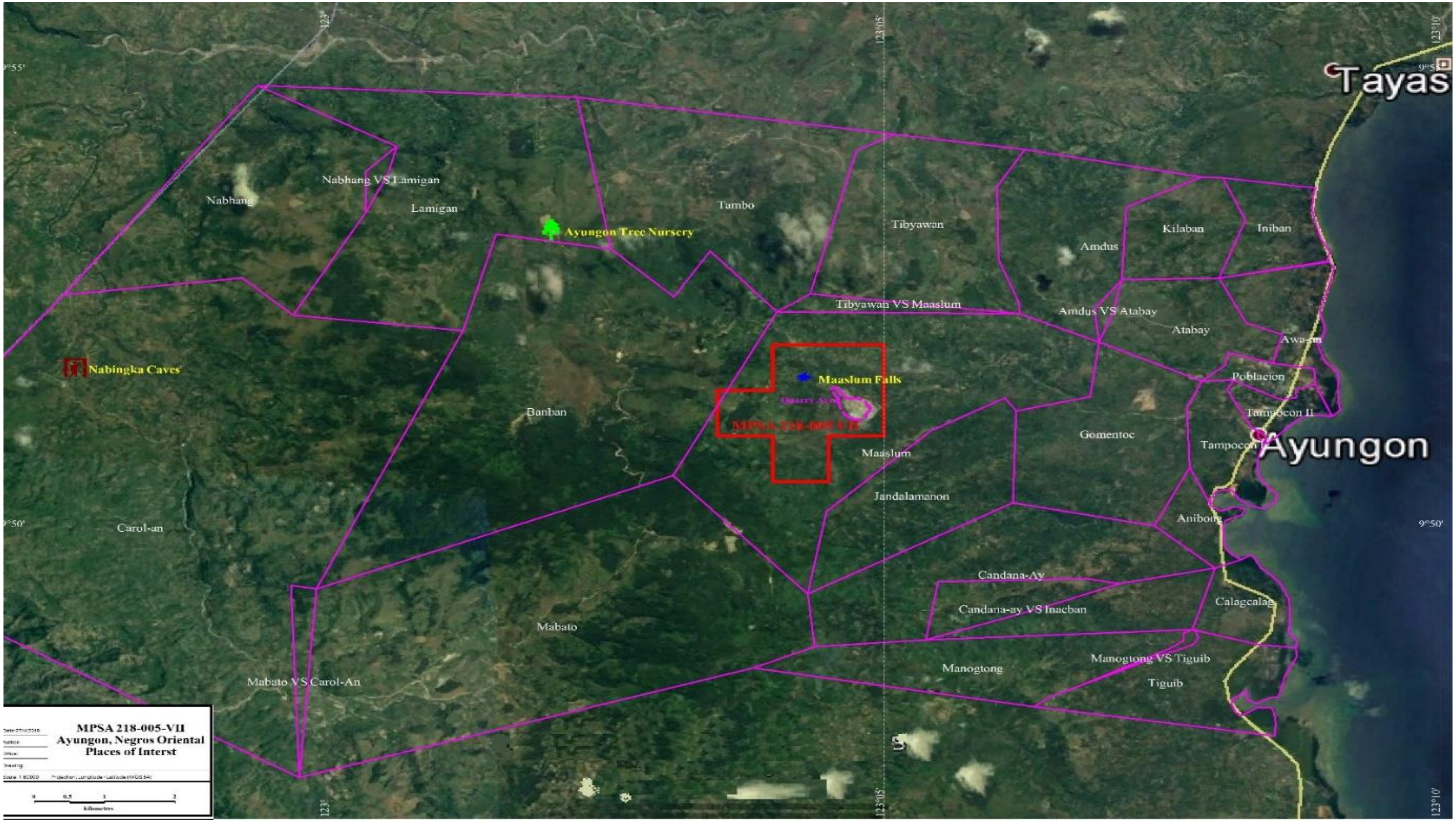


Figure 2-79. Ayungon Places of Interest

Threat to Delivery of Basic Services/Resource Competition

Food Security

The economy of the Municipality of Ayungon depends largely on agriculture. Hence. Its population is largely dependent on agricultural products as their main source of income or livelihood. In 2012, data from the Department of Agriculture (DA) showed that of the 28,168 hectares of Ayungon, 11,167 ha or 20% of the total land area of Ayungon is devoted to agriculture. Table 2-70 shows that coconut, rice, and corn are the major crops in Ayungon.

Table 2-70. Agricultural Crop Areas vs Total land area of Ayungon, 2016

Major Crops	Area	Volume of Production MMT	% of Total Agricultural Area Devoted to Crop Production	% of Municipal Area
1. Rice	2903	13583	18	10
2. Corn	4570	4786	29	16
3. Banana	723	3103	5	3
4. Coconut	4232	8135.15	26	15
5. Mango	147.5	2210.9	0.9	0.5
6. Sugarcane	2528	90817	16	9
7. Vegetables	902	412	6	3
Total	**16005.5**		**100**	**56.5**

Source: CLUP 2020-2029

As part of the agricultural economy of Ayungon, a large majority of the population is into livestock and poultry farming although backyard in nature. Table 2-71 shows the various livestock raised by the three impact barangays of Gomentoc, Maaslum and Tampocon I.

Table 2-71. Existing Livestock and Poultry Farms, Year 2015

Type	Barangay	Area (ha)	No. of heads	Production classification	Production		Product market
					Volume (per head)	Value (PhP)	
Cattle	Gomentoc	154	154	Backyard	154	1,540,000	Local
	Maaslum	221	221	Backyard	221	2,210,000	Local
	Tampocon I	80	80	Backyard	80	800,000	Local
Carabao	Gomentoc	143	143	backyard	143	1,430,000	Local
	Maaslum	144	144	Backyard	144	1,440,000	Local
	Tampocon I	27	27	Backyard	27	270,000	Local
Goat	Gomentoc	162	162	Backyard	162	129,600	Local
	Maaslum	574	574	Backyard	574	459,000	Local
	Tampocon I	200	200	Backyard	200	160,000	Local
Horse	Maaslum	10	10	Backyard	10	100,000	Local
Poultry							
Chicken	Gomentoc	1025	1025	Backyard	1025	123,000	Local
	Maaslum	1292	1292	Backyard	1292	155,040	Local

	Tampocon I	500	500	Backyard	500	60,000	Local
Duck	Gomentoc	1650	1650	Backyard	1650	165,000	Local
	Tampocon I	321	321	Backyard	321	32,100	Local

Source: Municipal Agricultural Office, 2018

Social Services

Water Supply

The Ayungon Water District Office (Ay-WD) provides water to the municipality. At present, the Ayungon Water District utilizes nine (9) springs as its source of water situated. These springs are found in Jandalamanon, Kansalanga, Anis-is, Palao, Amdus, Maiti, Mabais, Kanlukduhan and Batuan and three reservoirs situated at Tampocon I, Amdus and Buenavista.

A water pump has been installed in Brgy. Tiguib where the Ayungon Water District entered into a Memorandum of Agreement (MOA) with the landowner and pays Php3.00 per cubic meter of water extracted from the well. The pump operates three (3) hours in the morning (5:00-8:00 am) and 3 hours in the afternoon (5:00-8:00 pm) to boost the supply of water to the concessionaires of Tiguib & Calagcalag during peak hours.

The Ayungon Water District has the lowest rate of water compared to the rest of the water districts in Negros Oriental.

Power Supply / Electricity

The Negros Oriental Electric Cooperative I (NORECO) supplies electricity to all 24 barangays of Ayungon. The electricity supplied by NORECO I is generated from the geothermal plant in Municipality of Valencia Negros Oriental.

Communication

The Municipality of Ayungon has no TV and radio stations. TV channels are provided by the Fil Products Cable. There are three (3) internet cafes all located in the Poblacion area. The Postal services is provided by the Philippine Postal Corporation located at the Municipal Hall.

Smart, Sun and Globe have established cell sites in Ayungon. The services offered by the local public telecommunication office and the Bureau of Telecommunication are telegram, telex and telegraphic transfer using a MORE-100 capacity machine. It has two (2) telex machines and three (3) telegraph units used for telegraphic transfer. Broadcast Media is received from FM and AM stations that are situated in Cebu, Dumaguete and Bais City.

Educational Facilities

There are two (2) elementary schools in Barangay Gomentoc and one (1) elementary school in Barangay Maaslum. In Barangay Tampocon I, there are one (1) elementary and one (1) high school. Table 2-71 below shows the list of elementary and high schools in the municipality of Ayungon. The following indicates the condition of present facilities: G= Good (Well-Maintained), C= Critical (Requiring Priority Action), P = Poor (Needs Improvement), N = No such facility.

An assessment of the current project site and its expansion area will not contribute to a threat in the delivery of basic services and resource competition. Settlements are not expected to rise inside the project site are not expected to be formed immediately outside of the project sites. Please refer to the discussions in Section 4 of this report for the types of social services being provided, e.g., water supply, power, communications, education, etc.

Table 2-72. School Facilities in Ayungon

School	Location (Brgy.)	Area Occupied (Ha)	Type		Facilities and Condition						
			Public	Private	Lab.	Shop	Library	Clinic	Comfort Room	Playground	Others (Specify)
Elementary											
1. Amdus E/S	Amdus	0.500 has	/	-	N	N	C	N	G	N	G
2. Anibong E/S	Anibong	0.500 has	/	-	N	N	C	N	G	N	G
3. Buenavista E/S	Atabay	0.500 has	/	-	N	N	C	N	G	N	G
4. Awa-an E/S	Awa-an	0.500 has	/	-	N	N	C	N	G	N	G
5. Banban E/S	Banban	0.500 has	/	-	N	N	C	N	G	N	G
6. Libtacon P/S		0.300 has	/	-	N	N	C	N	G	N	G
7. Calagcalag E/S	Calagcalag	1.000 has	/	-	N	N	C	N	G	N	G
8. Candana-ay E/S	Candana-ay	0.500 has	/	-	N	N	C	N	G	N	G
9. Carol-an E/S	Carol-an	0.500 has	/	-	N	N	C	N	G	N	G
10. Nabalian E/S		0.400 has	/	-	N	N	C	N	G	N	G
11. Talanyog E/S		0.500 has	/	-	N	N	C	N	G	N	G
12. Gomentoc E/S	Gomentoc	1.000 has	/	-	N	N	C	N	G	N	G
13. Calukdan E/S		0.500 has	/	-	N	N	C	N	G	N	G
14. Inacban E/S	Inacban	0.500 has	/	-	N	N	C	N	G	N	G
15. Jandalamanon E/S	Jandalamanon	0.500 has	/	-	N	N	C	N	G	N	G
16. Kilaban E/S	Kilaban	0.500 has	/	-	N	N	C	N	G	N	G
17. Lamigan E/S	Lamigan	0.500 has	/	-	N	N	C	N	G	N	G
18. Maaslum E/S	Maaslum	0.500 has	/	-	N	N	C	N	G	N	G
19. Mabato E/S	Mabato	1.000 has	/	-	N	N	C	N	G	N	G
20. So-ok E/S		0.500 has	/	-	N	N	C	N	G	N	G
21. Manogtong E/S	Manogtong	0.500 has	/	-	N	N	C	N	G	N	G
22. Nabhang E/S	Nabhang	1.000 has	/	-	N	N	C	N	G	N	G
23. Ayungon E/S	Poblacion	1.500 has	/	-	N	C	C	N	G	N	G
24. Tiguib E/S	Tiguib										
25. Tomampon E/S	Tiguib										
26. Tambo E/S	Tambo	1.000 has	/	-	N	N	C	N	G	N	G
27. Tampocon I E/S	Tampocon I	1.000 has	/								
28. Tampocon II E/S	Tampocon II	1.000 has	/								
29. Iniban E/S	Iniban	1.000 has	/								
30. Tibyawan E/S	Tibyawan	1.000 has	/								
31. Duli-duli E/S		1.000 has	/								

School	Location (Brgy.)	Area Occupied (Ha)	Type		Facilities and Condition						
			Public	Private	Lab.	Shop	Library	Clinic	Comfort Room	Playground	Others (Specify)
Secondary											
1. ANHS	Tampocon I	2.000 has	/	-	N	N	C	G	G	N	G
2. TNHS	Tambo	0.500 has	/	-	N	N	C	G	G	N	G
3. ASHS	Tampocon II	0.500 has	/	-	N	N	C	G	G	N	G
4. NA	Tampocon II	1.000 has		/	N	N	C	G	G	N	G
5. MNHS	Carol-an	0.500 has	/	-	N	N	C	G	G	N	G
6. CNHS	Mabato	0.500 has	/	-	N	N	C	G	G	N	G

Source: CLUP 2020-2029

Peace and Order

Protective service is the maintenance of peace and order, which includes crime-prevention anti-insurgency campaign drug prevention, enforcement of local and national laws, rules and regulation; fire protection and jail management or penology.

Although a state function, this is a responsibility of the National Government, certain functions, however, were devolved to the local government units. Those devolved functions are:

- Provisions of sites for police, fire stations and sub-stations.
- Site for Municipal Jail
- Support for police and fire prevention facilities.

Table 2-73. Protective Services by Facilities and Equipment

Type of Service	Location	Area (sq.m.)	Number of Personnel	Personnel to Population Ratio	Facilities/ Equipment		Condition
					Vehicle	Others	
Public Force Headquarter	Poblacion	500	46	1:1,940	Patrol Car	-	Good
Traffic Outpost	Poblacion	6	8	-	-	-	-
Fire Protection Headquarter	Poblacion	500	16	1:3,395	Fire Truck	-	Good
Civilian Volunteer	24 barangays	-	52	-	-	-	-
Tanod	24 barangays	-	332	-	-	-	-
Traffic	Poblacion	-	8	-	-	-	-
Auxiliary	None	None	None	None	None	None	None
Disaster	24 barangays	400	50	-	-	-	-
Brigade Military Camp	24 barangays	400	144	-	-	-	-
Outpost in the Municipality and immediate vicinity	Amduls	549	28	-	-	-	-

Source: Fire Department, 2012

In general, Ayungon is a peaceful community. The greatest number of crimes committed in the Municipality from 2014 to 2018 are illegal gambling and physical injuries, followed by homicides as presented in Table 2-74. The local PNP are performing well and is a current awardee for outstanding Municipal PNP Station in the Province.

The crimes committed by children (below 18 years old) which had been reported and documented over the past five (5) years were only two (2) incidences of trespassing and two (2) cases of violation of RA 8262, which defines violence against women and their children. These incidences happened in 2014 and 2015 and there were no reported incidences in years 2016-2018.

Fire incidence that occurred in the municipality in the last five (5) years; totals 35, or an average of seven (7) per year. Most of them are accidental and minor incidence.

Table 2-74. Crime Incidence by Barangay for Adults for the Past Five Years

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
Amdus	Murder	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	2	-	-	-	-	-	1	1	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	Rape	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	3	1	1	1	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 705	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9262	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9344/ CICL	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 7610	2	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Anibong	Murder	3	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-
	Homicide	3	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-
	Physical Injuries	3	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-
	Theft	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	3	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-

Barangay	Type of Crime	Overall Total	2014 Total	2014 Cases Solved	2014 Offender Male	2014 Offender Female	2014 Offender Unidentified	2015 Total	2015 Cases Solved	2015 Offender Male	2015 Offender Female	2015 Offender Unidentified	2016 Total	2016 Cases Solved	2016 Offender Male	2016 Offender Female	2016 Offender Unidentified	2017 Total	2017 Cases Solved	2017 Offender Male	2017 Offender Female	2017 Offender Unidentified	2018 Total	2018 Cases Solved	2018 Offender Male	2018 Offender Female	2018 Offender Unidentified
	RIR Physical Injuries	8	5	4	4	1	-	1	1	1	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Damage to Property	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Acts of Lasciviousness	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Assault/ Resistance to Authority	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Arson	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Threat/ Coercion	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Violation of P.D. 1602/ R.A. 9287	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-
	Violation of R.A. 9165	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	-
	Violation of R.A. 9344/ CICL	2	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atabay	Murder	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	3	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Rape	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Theft	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	RIR Homicide	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Damage to Property		1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 10591/ 8294	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	-	-
	Violation of R.A. 9165	3	-	-	-	-	-	-	-	-	-	-	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Awa-an	Murder	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Physical Injuries	6	-	-	-	-	-	1	-	-	1	-	1	1	1	-	-	2	2	2	-	-	2	1	2	-	-
	Rape	2	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Theft	3	3	1	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Robbery	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
	RIR Homicide	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	14	5	5	5	-	-	2	2	2	-	-	5	4	3	1	1	2	1	2	-	-	-	-	-	-	-
	RIR Damage to Property	3	3	2	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 7610	3	1	-	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Violation of R.A. 9165	2	-	-	-	-	-	1	1	-	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Violation of R.A. 9262	2	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 10591/ 8294	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 9344/ CICL	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Banban	Murder	2	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	1	-	-	-	1
	Homicide	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	4	-	-	-	-	-	3	1	2	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9344/CICL	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Calagcalag	Physical Injuries	2	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rape	2	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1	1	-	-	-	-	-	-	-
	Theft	4	2	-	-	-	2	2	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	4	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	2	2	2	-	-
	RIR Physical Injuries	2	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Damage to Property	4	2	1	1	-	1	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Estafa	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Swindling	3	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	1	-
	Threat/ Concern	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9165	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 7610	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of P.D. 1602/ R.A. 9287	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	2	11	2	-	1	1	1	-	-
Candana-ay	Physical Injuries	2	-	-	-	-	-	1	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 1602/ R.A. 9287	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
	Violation of P.D. 705	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	2	1	-
Carol-an	Murder	3	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1	1	-	-	1	1	1	-	-
	Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Physical Injuries	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Rape	3	-	-	-	-	-	2	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
Gomentoc	Murder	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Homicide	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1	1	-	-
	Rape	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Cattle Rustling	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	2	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Threat/ Coercion	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trespassing	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 7610	2	1	-	-	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 8353	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9262	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 1602/ R.A. 9287	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	Violation of P.D. 705	3	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	-	-
Inacban	Theft	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Acts of Lasciviousness	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 7610	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9262	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Violation of P.D. 1602/ R.A. 9287	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iniban	Physical Injuries	3	1	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	1	1	1	-	-
	Rape	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	11	4	4	4	-	-	6	5	5	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Damage to Property	2	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Assault/ Resistance to Authority	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Threat/ Coercion	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Acts of Lasciviousness	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jandalamanon	Murder	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Homicide	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	4	-	-	-	-	-	2	1	2	-	-	1	1	1	-	-	1	-	1	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Acts of Lasciviousness	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9165	2	-	-	-	-	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 1602/R.A. 9287	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
Kilaban	Physical Injuries	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Carnapping	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Violation of P.D. 1602/ R.A. 9287	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
Lamigan	Violation of R.A. 9262	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Violation of R.A. 7610	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Maaslum	Physical Injuries	4	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Rape	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Robbery	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	RIR Physical Injuries	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Violation of P.D. 1602/R.A. 9287	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-
	Violation of R.A. 10591/ 8294	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 705	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	-	-
	Violation of R.A. 7610	5	2	-	1	-	1	1	-	1	-	-	-	-	-	-	-	1	1	1	-	-	1	-	1	-	-
Mabato	Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Physical Injuries	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
	Carnapping	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattle Rustling	2	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rape	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Alarm and Scandal	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Threat/ Coercion	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Violation of R.A. 10591/8294	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Manogtong	Physical Injuries	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nabhang	Violation of R.A. 7610	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9262	2	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of P.D. 705	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Poblacion	Murder	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	Physical Injuries	5	-	-	-	-	-	1	-	-	-	1	1	-	1	-	-	-	-	-	-	-	3	2	3	-	-
	Robbery	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	7	4	1	1	-	3	3	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	RIR Physical Injuries	27	7	5	5	-	2	14	11	11	-	3	5	5	5	-	-	-	-	-	-	-	1	1	1	-	-
	RIR Damage to Property	11	4	4	4	-	-	4	4	4	-	-	1	1	1	-	-	-	-	-	-	-	2	1	2	-	-
	Alarm and Scandal	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Estafa	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Slight Physical Injuries	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Threat/ Coercion	2	1	-	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Trespassing	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Assault/ Resistance to Authority	2	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9344/ CICL	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 1602/ R.A. 9287	15	2	2	2	-	-	1	-	-	-	1	-	-	-	-	-	4	1	3	1	-	8	1	8	-	-
	Violation of R.A. 7610	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	1	-	-
	Violation of P.D. 705	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Violation of R.A. 9262	3	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	1	-	1	-	-
	Violation of R.A. 10591/8294	3	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 9165	4	1	1	1	-	-	2	1	2	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Tambo	Murder	2	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Physical Injuries	6	1	-	1	-	-	3	-	3	-	-	-	-	-	-	-	2	1	1	-	-	-	-	-	-	-
	Rape	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	4	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	RIR Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	RIR Physical Injuries	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Acts of Lasciviousness	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Assault/ Resistance to Authority	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Threat/ Coercion	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Violation of P.D. 1602/ R.A. 9287	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	Violation of R.A. 9262	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 10591/8294	2	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Tampocon I	Homicide	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	10	1	-	1	-	-	4	1	3	1	-	2	-	2	-	-	1	-	1	-	-	2	-	-	2	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Rape	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	1	-	-	-	-	-	-
	Robbery	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	9	4	-	3	-	1	4	1	2	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
	RIR Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	RIR Physical Injuries	24	4	3	3	-	1	12	10	9	1	2	4	4	3	1	-	3	2	3	-	-	1	-	1	-	-
	RIR Damage to Property	9	5	5	5	-	-	4	3	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Estafa	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 7610	1	-	-	-	-	-	-	-	-	-	-	-	-	-		-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 9208	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of P.D. 1602/ R.A. 9287	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	4	-	4	-	-
	Violation of R.A. 10591/8294	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
	Violation of R.A 9165	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	-	-
	Violation of R.A. 9262	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tambo	Murder	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	-
	Physical Injuries	5	1	-	1	-	-	1	-	1	-	-	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Robbery	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Theft	2	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Physical Injuries	15	4	3	4	-	-	7	5	4	1	2	2	-	2	-	-	-	-	-	-	-	2	2	2	-	-
	RIR Damage to Property	8	4	3	3	-	1	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Alarm and Scandal	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Arson	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Oral Defamation	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-
	Perjury	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
	Threat/ Coercion	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-
	Violation of R.A. 7610	2	1	1	1	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9262	3	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 10591/8294	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 8040/ R.A. 10593	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	1	-	-	-	-	-	-
	Violation of R.A. 9165	8	3	2	3	-	-	1	1	1	-	-	1	1	1	-	-	1	1	1	-	-	2	2	2	-	-
Tibyawan	Murder	2	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender			Total	Cases Solved	Offender		
					Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified			Male	Female	Unidentified
	Homicide	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
	Cattle Rustling	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Physical Injuries	3	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-
	Robbery	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Theft	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	2	1	-	-	-	-	-	-
	RIR Damage to Property	2	-	-	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
	Alarm to Scandal	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Arson	2	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 9262	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 9344/CICL	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tiguib	Physical Injuries	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	1	-
	RIR Homicide	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-
	RIR Physical Injuries	8	4	4	3	1	-	2	2	2	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
	RIR Damage to Property	4	-	-	-	-	-	3	3	3	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-

Barangay	Type of Crime	Overall Total	2014					2015					2016					2017					2018				
					Offender					Offender					Offender					Offender					Offender		
			Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified	Total	Cases Solved	Male	Female	Unidentified
	Assault/ Resistance to Authority	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
	Violation of R.A. 7610	2	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A 9165	2	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	1	-	-	-	-	-	-	-
	Violation of R.A. 9262	4	-	-	-	-	-	1	-	1	-	-	1	-	1	-	-	2	2	2	-	-	-	-	-	-	-
	Violation of R.A. 10591/8294	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of R.A. 8040/R.A. 10593	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	2	2	-	-	-	-	-	-
	TOTAL	541	133	79	111	3	19	138	82	108	7	23	83	59	77	2	4	92	51	77	9	6	95	43	81	11	3

Table 2-75. Crime Incidence by Barangay for Children (below 18 years old) in Conflict with the Law for the Past Five Years

Barangay	Type of Crime	2014				2015				2016				2017				2018			
		Total	Cases Solved	Offender		Total	Cases Solved	Offender		Total	Cases Solved	Offender		Total	Cases Solved	Offender		Total	Cases Solved	Offender	
				Male	Female			Male	Female			Male	Female			Male	Female			Male	Female
Poblacion	RA 9262	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Tiguib	Trespassing	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL		2	-	-	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Municipal Social Welfare and Development Office, 2018

Sports and Recreational Facilities

The Municipality of Ayungon has a gymnasium covering 1622.5 sqm for public purposes located at Brgy. Poblacion. The gymnasium is used to stage basketball tournaments and like. The three (3) impact barangays all have sports facilities, publicly owned and considered to be in fair physical condition.

Recreational facilities on the other hand include the CVRP Training Center, Mantalip Fish Sanctuary (Scuba Diving), Iniban Fish Sanctuary, Communal Forest, Mt. Kwisaw (far Mountain Climbers/Bikers), Banban Rice Fields (Agriculture).

Table 2-76. Existing Sports and Recreational Facilities, 2015

Barangay	Type of Facility	Lot Area (sq m)	Ownership	Physical Condition of Facility
Gomentoc	Sports	1,146.67	Public	Fair
Maaslum	Sports	965.41	Public	Fair
Tampocon I	Sports	10,582.00	Public	Fair

Source: Municipal Planning and Development Office, 2015

Inventory of tourism support facilities and services

There are tourism support facilities which have been identified for the existing tourism establishments. It is worthy to note that these tourism establishments have accommodation facilities, communication facilities but no restaurant or eating facility except for Romeo's Diner. All the establishments cater to the local tourists.

Table 2-77. Inventory of Tourism Support Facilities

Name of Tourism Establishment	Facilities Present			No. of Employees	Markets Covered
	Accommodation Facilities	Communication Facilities	Restaurants and Eating Facilities		
Shunichi Inn	✓	✓	X	3	Local
Gemini resort	✓	✓	X	2	Local
Coral Strand House	✓	✓	X	2	Local
Dungguanan Beach Inn	✓	✓	X	3	Local
Historillo's Lodging House	✓	✓	X	2	Local
Pondside Inn	✓	✓	X	2	Local
Traveller's Inn	✓	✓	X	2	Local
Narbebic Beach House	✓	✓	X	2	Local
Beach A Holic	✓	✓	X	3	Local
Romeo's Diner	✓	✓	✓	4	Local

Source: Municipal Tourism Unit, 2018

Threat to Public Health and Safety

Table 2-78 shows that over the years 2011 to 2015, on a municipal level, severe viral infection (1,725 cases) was the leading illness while acute respiratory infection without pneumonia was number two. However, this latter sickness was not observed in years 2014-2015 which was the same for pneumonia which came in third with 758 cases followed by nasopharyngitis (677 cases), urinary tract infection (547 cases) and pulmonary tuberculosis (545 cases).

The most common illnesses for Ayungon in 2015 were severe viral infection or influenza (459 incidences), nasopharyngitis or upper respiratory infection/rhinitis (244 cases), PCAP or community acquired pneumonia (190 incidences), pulmonary tuberculosis (128 incidences) and urinary tract infection (126 cases).

It should be noted that the most common illnesses are associated with the respiratory system such as severe viral infection, pneumonia, nasopharyngitis and pulmonary tuberculosis. It is also worthy to note that even if pneumonia was not reported in years 2014 to 2015, community acquired pneumonia was documented in 2015 as a cause of death.

On the other hand, the leading causes of death in 2015 were pneumonia (31.82%) and cancer (20.13%) as shown in Table 2-79. Over the years, from 2011-2015, the high incidence of pneumonia as a cause of death has been consistently reported.

Based on the results of the public scoping in 2016, the residents in the community complained about the dust coming from the dump trucks which was perceived to have greatly affected their health. This can be corroborated with the reports that the most common ailments in the impact barangays are related to the upper respiratory system such as cough, colds, asthma and tuberculosis. These reported ailments could also have led to the deaths in the respective barangays. Most of these common causes of death and illnesses which are respiratory related were both reported in the municipal and barangay levels. It is thus implied that there is a contributing factor in the air that might have triggered these illnesses and deaths.

The most common causes of morbidity and mortality clearly show the relationship of the two. The prevalent sickness in the community when not properly or immediately addressed/r treated becomes the cause of death. There was mention by the barangay residents when the impact study was conducted that medicines though provided under the SDMP health projects were quite insufficient.

While it has been established that pneumonia is caused by virus, bacteria or fungi, nasopharyngitis by virus or bacteria and pulmonary tuberculosis by bacteria, there are medical studies asserting that soil dust contains organic compounds and metals and is impressive on the incidence of respiratory diseases. Breathing air containing dust overtime can cause pathological changes in the lungs. In addition, the effect of silica, cotton, wool, weaving mills, coal mine is known to contribute to the incidence of respiratory diseases. (www.ncbi.nlm.nih.gov).

Therefore, the company, whose business is on the extraction of silica from Barangay Maaslum and uses the roads of Gomentoc and Tampocon I, should take extra care in their operation. The mining and transporting of silica must not contribute further to the present state of health of the municipality and the direct impact barangays.

The mitigation of dusts particles in the atmosphere can be minimized if not totally eliminated by the company, through regular sprinkling of the roads traversed most especially during summer or dry periods. Furthermore, the trucks carrying the quarried silica should be tightly covered before transporting the said product. The speed limit and load of the trucks should likewise be monitored to eliminate or contain fugitive dust particles. Likewise, buffer zones in the periphery of the mining area and along the transport road should be established. This could be attained by planting trees to filter the dust as well as minimize the possibility of noise occurrence during quarrying and transporting of silica.

Aside from these measures, regular monitoring of the state of health of the residents should be conducted through medical missions and barangay health monitoring. The support of the company in terms of medicines, medical supplies and equipment for use in the barangay health centers should be consistently undertaken. Continuous IEC activities pertaining to health and safety should be religiously implemented by the company in collaboration with the municipal and barangay health workers.

Table 2-78. Leading Causes of Morbidity (Sickness) for the Past Five (5) Years

Causes	Year				
	2011	2012	2013	2014	2015
1. Acute Respiratory Infection w/o Pneumonia	444	419	223	0	0
2. Severe Viral Infection	311	251	382	322	459
3. Pneumonia	233	279	246	0	0
4. Bronchitis Acute	232	71	68	95	0
5. Pulmonary Tuberculosis	118	104	84	111	128
6. Dermatitis	113	0	0	82	101
7. Urinary Tract Infection	112	114	121	74	126
8. Asthmatic Bronchitis	80	0	79	79	0
9. Diarrhea	69	0	0	0	0
10. Hypertension Essential	0	115	135	146	0
11. Wound (All type)	0	95	0	0	0
12. Nasopharyngitis	0	0	150	283	244
13. Osteoarthritis	0	0	82	112	103
14. CAP, low risk	0	0	0	153	0
15. Functional Dyspepsia	0	0	0	0	110
16. PCAP	0	0	0	0	190
17. Hypertension, Essential 2	0	0	0	0	146
18. URTI	0	0	0	0	118
19. Dyspepsia	0	0	0	0	110
TOTAL	**1,712**	**1,448**	**1,570**	**1,457**	**1,835**

Source: CLUP 2020-2029

Table 2-79. Ten Leading Causes of Mortality (Death) for the Past Five (5) Years

Causes	Municipal																			
	2011				2012				2013				2014				2015			
	M	F	Total	%	M	F	Total	%	M	F	Total	%	M	F	Total	%	M	F	Total	%
1. Cancer	18	9	27	24.32	11	9	20	13.79	15	8	23	16.55	19	4	23	18.55	15	16	31	20.13
2. Myocardial Infection	9	5	14	12.61	12	10	22	15.17	8	2	10	7.19			0	0.00	10	13	23	14.94
3. Pneumonia	7	6	13	11.71	7	9	16	11.03	13	19	32	23.02	17	24	41	33.06	20	29	49	31.82
4. Multiple Organ Failure 2° to Malnutrition & Dehydration	2	11	13	11.71	5	10	15	10.34	4	3	7	5.04	0	0	0	0.00	0	0	0	0.00
5. CVA	6	5	11	9.91	7	9	16	11.03	11	2	13	9.35	0	0	0	0.00	0	0	0	0.00
6. Chronic Obstructive Pulmonary Disease	4	3	7	6.31	2	7	9	6.21	9	5	14	10.07	6	3	9	7.26	3	3	6	3.90
7. Haemorrhagic Shock	6	1	7	6.31	0	0	0	0.00	7	2	9	6.47	7	1	8	6.45	0	0	0	0.00
8. Congestive Heart Failure	4	3	7	6.31	7	6	13	8.97	0	0	0	0.00	5	2	7	5.65	6	3	9	5.84
9. Hypertension	4	2	6	5.41	9	4	13	8.97	10	5	15	10.79	0	0	0	0.00	0	0	0	0.00
10. Renal Disease	3	3	6	5.41	5	4	9	6.21	5	1	6	4.32	0	0	0	0.00	4	4	8	5.19
11. Cerebral haemorrhage	0	0	0	0.00	10	2	12	8.28	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
12. PTB	0	0	0	0.00	0	0	0	0.00	5	5	10	7.19	4	2	6	4.84	7	1	8	5.19
13. Cardiovascular Disease	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	8	4	12	9.68	5	6	11	7.14
14. Bleeding peptic Ulcer	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	4	2	6	4.84	3	2	5	3.25
15. Pulmonary Disease	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
16. Acute Myocardial Infarction	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	4	4	8	6.45	0	0	0	0.00
17. Cerebral Haemorrhage 2° to Multiple Skull Fracture	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	2	2	4	3.23	0	0	0	0.00
18. PTB, Bacteriology Confirmed	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00	2	2	4	2.60
TOTAL	63	48	111	100.0	75	70	145	100.0	87	52	139	100.0	76	48	124	100.0	74	79	154	100.0

Source: CLUP 2020-2029

Health Services

Ayungon has twenty-three (23) Barangay Health Stations and one (1) main Health Center at Barangay Poblacion. A health service also is complemented by a private medical clinic and one (1) private dental clinic.

Sanitation

Table 2-79 below shows that 35% of the total households in Ayungon have water sealed sewers and septic tanks that are exclusively used by the family members. 51% of the households have water sealed and other depositories and are used exclusively by the household members. Despite this, a significant 13.5% of the total households have no toilets and 13.5% discharge their wastes in open pits.

Table 2-80. Types of Toilets

Barangay	Sanitary			Unsanitary		
	Own Flush	Closed Pit Latrine	Total	Open Pit Latrine	No facility	Total
Amdus	119	82	195	81	21	102
Anibong	130	98	228	34	130	164
Atabay	91	55	146	58	8	66
Awa-an	403	30	433	2	13	15
Banban	174	129	303	61	27	88
Calagcalag	219	34	253	78	41	119
Candana-ay	298	77	375	22	10	32
Carol-an	200	88	288	99	69	168
Gomentoc	128	97	225	22	126	148
Inacban	151	81	232	2	34	35
Iniban	103	69	172	39	12	51
Jandalamanon	83	37	120	18	42	60
Kilaban	50	33	83	50	8	58
Lamigan	36	17	53	51	26	77
Maaslum	112	81	193	92	60	152
Mabato	203	236	439	99	79	178
Manogtong	119	91	210	57	40	97
Nabhang	81	61	342	30	60	90
Poblacion	311	0	311	0	12	12
Tambo	256	138	394	42	118	160
Tampocon I	267	17	284	0	50	50
Tampocon II	405	98	501	0	41	41
Tibyawan	95	71	166	30	24	54
Tiguib	206	68	274	142	51	193
Total	**4232**	**1788**	**6020**	**1109**	**1102**	**211**
%	*51*	*22*	*73*	*13.5*	*13.5*	*27*

Source: CLUP 2020-2029

Generation of Local Benefits from the Project

Food Security/ Main Sources of Income / Livelihood

"Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization).

In Ayungon, 4,433 hectares or 82% of the 5,301 hectares of alienable and disposable (A&D) land is devoted to agriculture which is the source of food of its constituency. Most of the residents in Ayungon are engaged in fishing or farming. There are no recorded poultry and swine farms in the area, although all households are into backyard swine and poultry production.

In addition to farming, fishing is also a source of income of residents in Brgy. Tampocon I but not fishing from the Maaslum River or its tributaries which are far from the project site. To reiterate the findings of this report on the section on Fisheries Resources (4.9.1.1.1)," *neither fish nor fishers were encountered in all of the Maaslum river and, but key informants interviewed in STO4, tributary of Maaslum river located in in Brgy. Gometoc revealed the existence of few fisheries resources. The most abundant catch in this river were usually Oreochromis (Tilapia) where they sometime catch more than a kilo*."

Table 2-81. Agricultural Crop Area and Production, 2016

Major crops	Area	Volume of Production MMT
1. Rice	2,903.0	13,583.00
2. Corn	4,570.0	4,786.00
3. Banana	723.0	3,103.00
4. Coconut	4,232.0	8,135.15
5. Mango	147.5	2,210.90
6. Sugarcane	2,528.0	90,817.00
7. Vegetables	902.0	412.00

Source: Municipal Agriculture's Office, 2016

Table 2-82. Comparative Area Utilization of Significant Agricultural Activities

Activities	2016	
	Area (has)	%
Crop production	7701.00	43
Livestock/poultry	10,202.27	57
Fishing	91.80	1
Total	**17,995.50**	**100**

Source: MAO 2016

Table 2-83. Existing Livestock and Poultry Farms in the Impact Barangays, 2015

Type	Barangay	Area (ha)	No. of Heads	Production Classification	Production		Product Market
					Volume (per head)	Value (PhP)	
Cattle	Gomentoc	154	154	Backyard	154	1,540,000	Local
	Maaslum	221	221	Backyard	221	2,210,000	Local
	Tampocon I	80	80	Backyard	80	800,000	Local
Carabao	Gomentoc	143	143	backyard	143	1,430,000	Local
	Maaslum	144	144	Backyard	144	1,440,000	Local
	Tampocon I	27	27	Backyard	27	270,000	Local

Goat	Gomentoc	162	162	Backyard	162	129,600	Local
	Maaslum	574	574	Backyard	574	459,000	Local
	Tampocon I	200	200	Backyard	200	160,000	Local
Horse	Maaslum	10	10	Backyard	10	100,000	Local
Poultry							
Chicken	Gomentoc	1,025	1,025	Backyard	1,025	123,000	Local
	Maaslum	1,292	1,292	Backyard	1,292	155,040	Local
	Tampocon I	500	500	Backyard	500	60,000	Local
Duck	Gomentoc	1,650	1,650	Backyard	1,650	165,000	Local
	Tampocon I	321	321	Backyard	321	32,100	Local

Source: Municipal Agricultural Office, 2016

Fishing as a source of income of residents of Ayungon come from fishponds. There are also a number of fishponds found in Tampocon I which is the source of employment of the residents in Tampocon I as shown in the Table 2-84 below.

Table 2-84. Existing Fishing Grounds and Aquaculture Production, 2015

Fishing Grounds	Barangays	Production		Production Market	
		Volume	Value	Local	Export
Marine					
Sea	(7 coastal barangays)				
	Iniban	1,480	148,000	/	X
	Awa-an	2,880	283,000	/	X
	Tampocon I	3,230	323,000	/	X
	Tampocon II	5,830	583,000	/	X
	Anibong	5,450	545,000	/	X
	Calagcalag	1,300	130,000	/	X
	Tiguib	2,050	2,015,000	/	X
Fishpond/cages	Tiguib	500	40,000	/	X
	Poblacion	1,000	100,000	/	X

Source: Municipal Agriculture's Office

<u>Inventory of commercial establishments</u>

Despite the seeming abundance of sources of income, Ayungon in 2012 was identified to be poorest municipality in Central Visayas with a poverty incidence rate of 51.3%. The proposed project is expected to raise the level income of at least 20% of those belonging to the 51.3% poorest of the poor in Ayungon.

The municipality is characterized by a rural economy. Within the planning period it is difficult for the Municipality to engage in higher level of commercial activities, much less industrial and tourism ventures.

The municipality, however, may prepare itself for future commercial, industrial and tourism development; through an increase basic service facility, increased production of raw materials and massive housing projects in order to sustain a proposed commercial and industrial development. Along this line, the major types of business or trades and other commercial support facilities established at the municipality shall depend largely on the level of development and the presence of opportunities and incentives for the establishment of business that are private sector led.

The Municipality has a total of 923 commercial establishments in 2018, covering an area of around 21.316 hectares. This is only about 0.01% of the municipality total land area. Around 79% of these establishments are sari-sari stores, retails and general merchandise.

Table 2-85. Inventory of Commercial Establishment by Economic Activities

Economic Activities	2018	
	No. of Establishments	No. of Employment
Wholesale and retail trade	731	967
Hotel and Restaurants,	1	4
Transport & Storage Communication	111	115
Financial Intermediation	13	46
Real Estate Renting and Business Activities	23	38
Education	3	85
Other community, social and personal service activities	41	130
Total	923	1,299

Source: CLUP, 2020-2029

Banking and Financial Institution

There are no commercial banks present in Ayungon. The nearest banking and financial institution are in Dumaguete City. The banking and financial institutions status of Ayungon is shown below.

Table 2-86. Number of Banking/ Financial Institution

Number of Universal/ Commercial Banks	0
Number of Thrift/ Savings Banks	0
Number of Rural Banks	0
Number of Finance Cooperatives	5
Number of Savings and Loans Associations with Quasi Banking Functions	0
Number of Pawnshops	4
Number of Money Changers/ Foreign Exchange	2
Number of Remittance Centers	4
Number of Microfinance	4

Source: CLUP 2020-2029

Employment

In 2015, there were 8,858 unemployed persons. This is around 31.9% of the total population of 27,800. There are more unemployed women than men and these are found mostly in the rural areas.

It was learned during the FGDs that a number of residents are employed by Holcim Resources Development Corporation (HRDC) in the quarry site. In Brgy. Maaslum, 10 security guards are employed by HRDC while three (3) from Brgy. Gomentoc work as drivers for Silica Resources Corp (SI). SI was contracted by HRDC for its hauling services. Others are employed by the Goodyield Resources and Development, Inc. (GRDI).

Most of the women in the three barangays are unemployed. A few have their own backyard piggery. Some families attend to their goats and native chickens. Only a handful have cattle.

Table 2-87. Population in the Labor Force, 2015

Sex	Population 15 Years and Over	Employed	%	Unemployed	%
Male	14,363	12,528	87.2	1,835	12.8
Female	13,437	6,414	47.7	7,023	52.3
Total	**27,800**	**18,942**	**68.1**	**8,858**	**31.9**

Source: Philippine Statistics Authority

In 2018, 90% of those employed performed tertiary economic activities of wholesale/retail, transport, financial intermediation, education and other community, social and personal services. On the other hand, the primary economic activity of agriculture/fishing/forestry, mining and quarrying consisted only 8% of those employed. Lastly, secondary economic activities of manufacturing and electricity, gas and water supply made up the lowest employed group at 3%.

Table 2-88. Employment by Type of Economic Group, 2018

Economic Activity	Number	%
Primary		
- Agriculture, hunting and forestry, fishing	80	68
- Mining and quarrying	38	32
Total	118	8
- Secondary		
- Manufacturing	24	55
- Electricity, gas and water supply	20	45
Total	44	3
Tertiary		
- Wholesale and retail trade/repair of motor vehicles, motorcycles, persona and household good	967	70
- Hotels/ restaurants	4	0
- Transport, storage and communication	115	8
- Financial intermediation	46	3
- Real estate, renting and business activities	38	3
- Education	85	6
- Other community, social and personal services activities	130	10
Total	1,385	90
Grand total	**1,547**	**100**

Source: CLUP 2020-2029

Increased revenue of LGUs

Excise taxes and occupation fees

Under the new tax system, mining companies that extract metallic or non-metallic minerals are subject to a 4% excise tax based on the actual market value of the annual gross output thereof at the time of removal.

Occupation fees shall be paid on the date the exploration permit/mineral agreement/FTAA is registered with the appropriate office and on the same date every year thereafter. It shall be paid to the Treasurer of the municipality where the mining area is located.

The allocation of occupation fees collected is as follows: 30% of all occupation fees collected from on shore mining areas shall accrue to the province and seventy percent (70%) to the municipality where the mining area is located, for chartered cities, the full amount shall accrue to the city concerned.

It can be gleaned from the table that excise tax and occupation fees have been paid by the company to the local government. In 2015, the total fees and taxes paid was P399,941.66 while P761,902.14 was paid the following year. In 2017, the total amount paid was P664,227.59. In 2018, an increase to P1,430,712.94 was paid in excise taxes only. The occupation fee was still not included.

Table 2-89. Excise Tax and Occupational Fees

Taxes and Fees	Year					
	2013	2014	2015	2016	2017	2018
Excise tax			361,991.66	723,952.14	626,277.59	1,430,712.94
Occupation fee	47,437.50	37,950	37,950.00	37,950.00	37,950.00	
Total	**47,437.50**	**37,950**	**399,941.66**	**761,902.14**	**664,227.59**	**1,430,712.94**

With the expansion of the project, excise taxes due the barangays are expected to increase. In consonance with the Local Government Code of 1992 (LGC), LGUs have a share of forty percent (40%) of the gross collection derived by the National Government from mining taxes, royalties and other such taxes, fees or charges from mining operations in addition to the occupational fees (30% to the Province and 70% to the Municipalities concerned).

Likewise, with the project, it is expected that business or commercial establishments will increase.

With the expected closure of the project in 10-20 years, the increase in business establishments is expected to have increased by 30% which will somehow replace the loss of revenues generated from the taxes paid by the proponent. Also, since it is expected that during the life of the project, progressive rehabilitation and reforestation of mined out areas are implemented, the re-vegetated and reforested areas could serve as an eco-tourism site which will be income generating for both the LGU and the communities surrounding the project site.

Increased business opportunities and associated economic activities

Through the Social Development Projects that will be implemented by the project, livelihood activities will be given to the barangays that will be directly affected by the project. Women will be the priority beneficiaries of the project. Based on the initial meetings with the women groups in the barangays, they seek expansion of their existing income generating activities particularly livestock, e.g., pigs, goats, native chickens and cattle. Women in the community will be organized, trained on developing livelihood projects that will look into the commodity value chain.

As mentioned earlier, the rate of in-migration in Ayungon is negligible at 1.14%. Hence, competition on economic opportunities between insiders and outsiders is not expected.

Enhancement of employment and livelihood opportunities

Through this project, more residents of Ayungon will be employed by Holcim Resources Development Corporation (HRDC) in the quarry site. Currently, 10 residents from Brgy. Maaslum and three (3) from Brgy. Gomentoc are employed by HRDC and Silica Resources Corp (SI). SI was contracted by HRDC for its hauling services. Others are employed by the Goodyield Resources and Development, Inc. (GRDI).

It has been the priority of the proponent to prioritize the hiring local residents from the three (3) barangays provided that the applicants' competencies fit the requirements of the job. Majority of the technical skills requirement such as the maintenance and production technicians, and operators are supplied locally. Engineering and other professional skills are sourced by standard hiring procedures with nationwide job notification.

Regarding the aspect of gender preference for job positions, all job positions are open to either men or women, provided they are qualified for the job requirements. Based on the actual manpower composition, the number of men occupying positions in the Project far outweighs the number of women.

In the absence of qualified personnel, efforts will be made on the capacity building for women workers aligned with Republic Act 9710, an Act Providing for the Magna Carta of Women.

The proposed projects to be implemented to increase employment and economic activities which will be included in the proponent's Social Development and Management Program (SDMP). Republic Act (RA) 7942, known as the Mining Act of 1995, and its Implementing Rules, i.e., the Department of Environment and Natural Resources' (DENR) Department Administrative Order (DAO) No. 2010-21, and DAO 2012-17 require mining companies to develop a Social Development and Management Program (SDMP) to ensure that negative social impacts are mitigated at all level of mining operations, i.e. from inception to post-termination.

Traffic Congestion

Based on the CLUP of Ayungon, its existing urban road length is 21 km. This length includes the national highway, municipal streets and barangay roads within the proposed central business district.

Overall, the municipality has a total of 133.38 km of road network. 16.95 km of which is concrete, 3.4 km asphalt, and 104.78 kilometers are gravel. 7.52 km is earth filled.

There are five (5) bridges in the area, all within the national highways and are made of concrete. The hinterlands have 6 bridges, 4 of which are concrete and 2 are wooden.

The Municipality has no bus and jeepney terminal. Its transportation for hire vehicles is parking at the unauthorized municipal park. A one (1) hectare Bus-Jeepney Terminal is already needed by the Municipality.

Traffic congestion due to the use of trucks in transporting the silica is not expected since as practiced, the hauling of silica and transporting thereof is scheduled by Holcim.

3. Environmental Management Plan

The Environmental Management Plan (EMP) is formulated to minimize the potential adverse impacts while enhancing the beneficial effects of implementation of the project. This EMP, as summarized in shall serve as the implementing guideline to ensure that environmental requirements are met during the project implementation and should serve as basis for the preparation of the revised EPEP. Programs indicated can be updated during the monitoring of the perceived project impacts.

The size of the project for MPSA 218-2005-VII and the magnitude of impacts were considered in the impact management plan. The size of the project and the volume of extraction indicate that the compliance with EMP has been mostly done through visual observations. This manner of observation indicated that there were no visible violations in the prescribed environmental performance criteria and exceedances over any applicable environmental standards as indicated in ECC 701-08-23-0135303 (for 10 hectares).

In case of unacceptable deterioration or degradation of vulnerable environmental media or adverse health and welfare impacts to human receptors, appropriate and effective environmental impact actions or mitigation measures would have been made. In the case of the project’s expansion, more appropriate and effective environmental impact remedial actions in case of exceedances will be implemented complaints receiving set-up has been in place to ensure that procedures or protocols are in place for a case investigation, implementation of corrective measures and the communication with the complainant or the public are documented.

Land Resources

The perceived impacts on land include, among others, changes in natural topography/slope; vegetation removal; loss of topsoil; and soil compaction and erosion. To address such, thorough geotechnical site investigation and implementation of appropriate and site-specific engineering measures (i.e. maintenance of specific slope and height of stockpiles) are being carried out. Rehabilitation works, which include revegetation or reforestation of disturbed areas, are also being implemented.

Water Resources

The impacts of the proposed project on water resources are on alteration of water quality. Identified mitigation and control measures are proper planning, sound engineering practices, installation of pollution control devices (e.g. provision of proper drainage, silt traps, settling ponds, etc.), and proper handling of solid and hazardous wastes. These identified measures are being implemented.

Air Quality

Identified mitigating and control measures for possible adverse effects on air and noise quality include implementation of established procedures (i.e. setting of speed limits, scheduling of activities, etc.); regular water sprinkling; covering hauling trucks with tarpaulin or canvass during transport; and proper maintenance of heavy equipment and pollution control devices. These measures are consistently being implemented.

People/ Community

Significant social impacts include psychosocial impacts and influx of migrants. Identified mitigating measures include the continued implementation of the different programs such as the IEC, SDMP, and the established safety, health and environmental programs/procedures. These measures were actively implemented by the HRDC.

Table 3-1 below shows the Impact Management Plan (IMP) for the proposed expansion.

Table 3-1. Impact Management Plan

Project Phase/ Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
I. DEVELOPMENT/ CONSTRUCTION PHASE 1. Site Preparation, Establishment of Haul Roads, Topsoil Stockpiling	A. The Land	• Loss of topsoil due to ground/site preparation activities • Induced landslides and mass wasting due to activities on high angle slopes.	• Mix the stockpiled topsoil layer with limestone gravel and re-spread in disturbed areas/quarried out areas to prevent erosion and allow reestablishment of vegetation • Conserve and stockpile removed topsoil in a predetermined area to be used later in rehabilitation and backfilling activities • Grade the topsoil stockpile to a stable relief on flat ground lined out with retaining rocks to prevent it eroding out when it rains. • Continue to implement established safe working slopes. A slope angle of 40 degrees is the safe working slope for the project. This was the minimum stable slope angle from the Engineering Geologic Investigation of Ayungon Silica Quarry by Cabria et. al. in 2012	Quarry Operations Manager	Included in project cost	Included in EPEP
	A. The Land (Flora and Fauna)	• Reduction of vegetative cover; fauna disturbance and/or displacement	• Replant the surrounding area after construction, preferably with indigenous plants from the site • Keep to a minimum vegetation removal, ensuring that only necessary/planned clearings are undertaken • Replace with the same species, preferably with nursery-raised seedlings, tree and other plant species that are removed during site preparation • Utilize felled trees as construction materials at the site; cleared vegetation parts as compost materials to fertilize seedlings in the nursery and during seedling out planting and field maintenance. • Establish voluntary conservation zones and biological corridors within the Project area	Quarry Operations Manager	Included in project cost	Included in EPEP
	B. The Water (Groundwater Flow)	• Inflow of groundwater to excavated areas could result to drawdown in ground water levels • Reduction in the spring discharge and ground water baseflow components of the streamflow of nearby water catchments • Depletion of ground water flow which affects to the distribution and availability of surface flow • Affect its potential use as a drinking water or irrigation source	• Replace and relocate downstream affected existing ground water wells with new ones if significant loss of water yield is experienced • Provision of shallow ground water wells when necessary	Quarry Operations Manager	Included in project cost	Included in EPEP
	B. The Water (Groundwater Quality)	• Contamination with biological agents (e.g. fecal coliforms) from domestic and animal wastes carried by runoffs • Contamination with oil and grease from hydrocarbon leaks and spills from vehicles and heavy equipment, fuel and oil storage	• Provide access roads with drainage system to contain and limit run offs • Progressive rehabilitation and revegetation of mined out quarries and planting barren lots to prevent soil erosion • Proper management of domestic solid and liquid wastes (provision of enough toilets with appropriate septic tanks for workers); • Training for workers good housekeeping practices; • Motorpool, fuel and oil storage and maintenance areas are provided with impervious surface and well-maintained oil-water separator facility	Quarry Operations Manager	Included in project cost	Included in EPEP

	B. The Water (Surface Water Quality)	• Siltation and organic loading of streams from erosion of exposed soil and overburden materials; • Contamination with oil and grease from hydrocarbon leaks, spills from vehicles, heavy equipment. • Increased susceptibility to contaminated water and water borne diseases • Decrease water quality due to washing of equipment and leakage and spills from discharge from worker camps to the water resources. • Acceleration of the aging process of surface water ecosystem which can lead to an imbalance in the nutrient and material cycling process.	• Continue to implement sediment and erosion control plan *(Please see Annex 28)* • Regular maintenance of drainage systems along access roads to contain and limit downstream runoffs from quarries and roads • Proper piling and management of quarry overburden; • Continue to implement progressive rehabilitation and reforestation of mined out areas to lessen the impacts of soil erosion; revegetate exposed plots and areas • Strict implementation of sanitary practices among workers; provision of adequate toilet facilities with proper septic tanks; • Continue to implement proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal); • Continue to train and orient all workers on proper waste management, good housekeeping, and proper chemical handling • Regular monitoring of water quality in water quality monitoring stations; • Proper storage provisions for fuel oil, used oil and other oily wastes; provide fuel oil storage tanks with appropriate bunding with concrete/impervious flooring • Motorpool, fuel and oil storage and maintenance areas are provided with oil and water separator facility. • Regular water testing	Quarry Operations Manager	Included in project cost	Included in EPEP
	C. The Air (Air Quality)	• Air pollution due to fugitive dust from ground clearing operations.	• Proper maintenance of quarry equipments to reduce air emissions. • Buffer zone of different species combination of plants including shrubs, small and medium sized trees should be established around the quarry sites. At least 20-meter buffer zone width is recommended. High density planting should be employed to assure capture of dust particulates around the extraction sites. • Regular water spraying in areas where land development activities are concentrated. • Replacement of vegetation in non-structure areas. • Compact exposed soil • Cover with tarpaulin trucks loaded with construction materials, which may give off airborne dusts • Immediate hauling of spoils and wastes • Strictly implement vehicle speed limits • Install off-site ambient air quality monitors	Quarry Operations Manager	Included in project cost	Included in EPEP
		• Air pollution due to SOx, NOx, TSP and PM_{10} emissions from heavy equipment and vehicles	• Regular maintenance of heavy equipment and motor vehicles. • Install off-site ambient air quality monitors	Quarry Operations Manager		Included in EPEP
	C. The Air (Sound Levels)	• Noise from construction activities	• Regular maintenance of motor vehicle mufflers • Provide noisy, stationary vibrating equipment with barriers and shielding • Provide workers with free hearing PPE's (e.g. ear mufflers, ear plugs) • Schedule "*noisy*" activities during daytime	Quarry Operations Manager	Part of Contractor's services	Included in EPEP,

	D. The People (People/ Community)	<u>Psycho-social</u> • Fear of air and noise pollution due to quarrying activities • Fear of landslides and flooding due to quarrying activities	• IEC on the nature and operation of the quarry project and mitigating measures • Orientation and training of affected residents on Disaster Risk Reduction Management, particularly on landslides and flooding	Barangay Envi Com and BDRRMC;	Included in project cost	Included in EPEP, SDMP
		<u>Economic</u> • Generation of employment • Generation of livelihood opportunities	• Local hiring priority for qualified barangay residents (LGU R.A. 7160) • Barangay consultation on job requirements and qualification • Training to upgrade skills of local residents who can be hired by the Project	Quarry Operations Manager Barangay LGU; TESDA/TLRC	Included in project cost	SDMP
		<u>Health and Safety</u> • Entry of migrant workers with families may result to health problems due to diseases; overuse of public utilities/services; competition for resources; social conflicts; peace and order; increase in pollution • Increase in traffic volume causing air and noise pollution	• Health certificate for workers prior to hiring into the project • Partner with the LGU on the implementation of the Social Development Program • Management of entry of migrant workers • Increase and train Barangay tanods to be deployed in areas where migrant workers reside • Implementation of a Traffic Management Plan • IEC on proper scheduling of quarry vehicle operations (avoid late hours) • Water sprinkling of dusty roads during dry seasons	Human Resource Officer CSR Officer Admin. Officer	Included in project cost	SDMP
		<u>Peace and Order</u> • Population congestion, peace and order problems and security breaches	• Coordination with the Barangay LGU to control of the entry of outsiders and to manage peace and order problems	Quarry Operations Manager	Included in project cost	SDMP
		<u>Cultural and Historical</u> • Possible unearthing of historical artifacts and/or fossil remains	• Safeguard possible archaeological site and immediately inform the National Museum in case of finds	Quarry Operations Manager National Museum	Included in project cost	SDMP
II. OPERATION PHASE 1. Quarrying Operations	A. The Land	• Landslides and mass wasting maybe induced by activities at high angle slopes	• Grade stockpile to a stable relief • Implement established safe working slopes • Install landslide control structures	Quarry Operations Manager	Included in project cost	Included in EPEP
		<u>Flooding Potential</u> • Potential for downstream flooding	• Flood management schemes • Rainwater reservoir constructed and maintained according to design by a structural engineer, taking into account peak flood regimes	Quarry Operations Manager	Included in project cost	Included in EPEP
		• Contamination of soil from diesel, motorpool	• Continue to implement procedures for proper handling, storage, disposal and transport of hazardous materials (e.g. diesel, motor oil, used batteries, used oil, etc.); • Continue use and maintenance of pollution control devices; • Continue training of all involved personnel and contractors; and • Continue to implement emergency containment and clean-up program to handle oil and other hazardous material spills.	Quarry Operations Manager	Included in the project cost	Included in EPEP
	B. The Water (Surface Hydrology and Hydrogeology)	• Siltation from increased erosion, surface runoff and down slope sedimentation • Decline in river carrying capacity due to siltation • Lowering of groundwater table	• Properly installed and maintained erosion/ sedimentation controls: • Rainwater and runoff collecting systems at the toe of work areas; • "Vengineering" (i.e. planting of vegetation with high rainfall intercepting capacity and high transpiration rates); • Drainage systems in access roads;	Quarry Operations Manager	Included in the project cost	Included in EPEP

			• Strengthened water monitoring system (i.e. install water meters at source points; keeping a daily record of water extraction and consumption). • Development of rainwater impoundment facilities in abandoned quarry areas			
	B. The Water (Groundwater Quality)	• Contamination with biological agents (e.g. fecal coliforms) from domestic and animal wastes carried by runoffs • Contamination with oil and grease from hydrocarbon leaks and spills	• Provide access roads with drainage system to contain and limit run offs • Progressive rehabilitation and revegetation of mined out quarries and planting barren lots to prevent soil erosion • Proper management of domestic solid and liquid wastes (provision of enough toilets with appropriate septic tanks for workers); • Training for workers good housekeeping practices; • Motorpool, fuel and oil storage and maintenance areas are provided with impervious surface and well-maintained oil-water separator facility.	Quarry Operations Manager	Included in project cost	AEPEP
	B. The Water (Surface Water Quality)	• Siltation and organic loading of streams from erosion of exposed soil and overburden materials; • Contamination with oil and grease from hydrocarbon leaks, spills from vehicles, heavy equipment, fuel and oil storage, motorpool • Increased susceptibility to contaminated water and water borne diseases • Decrease water quality due to washing of equipment and leakage and spills from carried by runoff to the water resources. • Acceleration of the aging process of surface water ecosystem which can lead to an imbalance in the nutrient and material cycling process.	• Continue to implement sediment and erosion control plan • Regular maintenance of drainage systems along access roads to contain and limit downstream runoffs from quarries and roads • Proper piling and management of quarry overburden; • Continue to implement progressive rehabilitation and reforestation of mined out areas to lessen the impacts of soil erosion; revegetate exposed plots and areas • Strict implementation of sanitary practices among workers; provision of adequate toilet facilities with proper septic tanks; • Continue to implement proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal); • Continue to train and orient all workers on proper waste management, good housekeeping, and proper chemical handling • Regular monitoring of water quality in water quality monitoring stations; • Proper storage provisions for fuel oil, used oil and other oily wastes; provide fuel oil storage tanks with appropriate bunding with concrete/impervious flooring • Motorpool, fuel and oil storage and maintenance areas are provided with oil and water separator facility. • Regular water testing	Quarry Operations Manager	PhP 2,174,738.17	Included in EPEP, SHP
	C. The Air (Ambient Air Quality)	• Fugitive particulate pollution	• Water spraying of tires before leaving the site. • Regular water spraying in roads that will be used for transporting stockpiles. • Trucks loaded with ores will be covered with tarpaulin. • Proper operation and maintenance of appropriate air pollution control devices in heavy equipment and vehicles • Provide adequate and appropriate PPEs for workers free of charge • Water spraying of exposed dusty areas during high winds • Optimize active extraction areas at the quarry	Quarry Operations Manager	PhP 4,380,000	Included in EPEP, SHP

			• Control options for stockpile wind erosion – 50% reduction from water sprays – 30% reduction from wind breaks and rock armor • 40% reduction from vegetation (exposed surfaces)			
		• Fugitive particulate pollution from quarry haul roads	• Vehicle restrictions that limit the speed, weight or number of vehicles on the road. • Surface improvement by (a) paving or (b) adding gravel or other surfacing materials • Surface treatment such as water sprinkling	Quarry Operations Manager	Included in project cost	Included in EPEP
		• Air pollution in terms of SOx, NOx, TSP and PM_{10} from heavy quarry equipment and motor vehicles	• Continue to implement appropriate maintenance program for quarry equipment and vehicles, including emissions testing	Quarry Operations Manager	Included in project cost	Included in EPEP
		• Very minimal contribution to climate change due to CO_2 gas emissions from fuel combustion in quarry equipment and motor vehicles	• Continue implementation of greening program and reforestation to serve as carbon sink, primarily to help offset the impact of greenhouse gas emissions from the operations of vehicle	Quarry Operations Manager	Included in project cost	Included in EPEP
	C. The Air (Ambient Sound Levels)	• Generation of noise from quarrying equipment and activities	• Incorporate noise criteria in the specifications and selection of equipment • Regularly maintain quarry vehicles and equipment; • Provide free hearing PPE's (ear plugs, mufflers) to workers as appropriate; and • Plant appropriate vegetation as noise buffer	Quarry Operations Manager	Part of Contractor's cost	Included in EPEP, SHP
	D. The People (People/ Community)	• Safety and health risks to workers from domestic solid and liquid wastes (from guard post)	• Continue to implement procedures for proper handling, storage, disposal and transport of hazardous materials • Continue to provide appropriate free PPE's • Continue to implement proper housekeeping • Continue to implement established domestic waste handling and disposal; • Continue to provide workers with enough and well-maintained sanitary facilities (toilets, washrooms, etc.); • Segregate, collect and dispose combustible materials (e.g. plastics) through the recovery facility	Quarry Operations Manager	Included in FMRDP	Included in EPEP, SHP
		<u>Economic</u> • Local government generation of revenues from taxes, permits and LGU share in the quarrying of limestone • Taxes paid locally and shared by municipality and barangays • Generation of employment • Generation of livelihood opportunities (e.g. food stalls, variety stores and other services) • Problems of congestion, peace and order and security breaches	• Benefits from development programs through *Social Development Management Plan* (equivalent to 1.5% of operating costs) • Excise Tax: 60% goes to national government; 40%, to the local government (20% for host Provinces; 45% for host Municipalities; 35% for host Barangays) • Real Property Tax to province and municipalities • IEC on nature of jobs the proponents • Coordination on job requirements and qualifications • Local hiring priority for qualified barangay residents • Skills training to upgrade local skills of residents • Coordination with the Barangay LGU to ensure authorized establishments and control of unauthorized entry of outsiders as well as the management of waste	Quarry Operations Manager; Barangay LGU	Included in project cost	Included in EPEP, SDMP,
		<u>Health & Safety</u> • Diseases due influx of migrants and overuse of public utilities /services; • Increased competition for resources, • social conflicts, peace and order problems, • increase in solid and liquid wastes pollution • Increase in traffic volume causing air and noise pollution	• Management of entry of migrant workers. • Tap the auxiliary services of barangay tanods; provide trainings if needed • Health certificate for workers prior to hiring into the project. • Continue to partner with the LGU in implementing the *Social Development and Mgt. Program*	Quarry Operations Manager	Included in project cost	Included in SDMP

			• IEC on proper scheduling of quarry vehicle and delivery trucks operations (avoid late hours). • Proper management of traffic (quarry vehicles, delivery trucks and visitors) within the quarry area • Water spraying of roads during dry seasons			
		Climate Change Impact of Climate Change: La Niña and El Niño phenomena and possible consequential disasters	• Assist impact barangays on gender sensitive capability building on Disaster Risk Reduction and Management; • Continue IEC on the project's mitigating measures to protect water aquifers; identification of areas most vulnerable to natural hazards; and on strengthening the protection of ecosystems	Quarry Operations Manager BDRMMC	Included in project cost	Included in EPEP
III. ABANDONMENT PHASE 1. Decommissioning of Equipment, Rehabilitation of Disturbed Areas, Dismantling of Structures	A. The Land	• Permanent land use change in areas occupied by the quarry and its facilities	• Rehabilitate quarry areas based on agreed upon final land use plan and design upon abandonment; • Ensure that the final perimeter and cover of the quarry area will have an undulating profile to facilitate drainage and future land use	Quarry Operations Manager	Included in FMRDP	Included in FMRDP
	B. The Water	• Failure of rainwater reservoirs • Flooding of areas downstream of the quarry	• Monitor structural integrity of the reservoirs for the duration of operation and beyond project closure; • Develop an Emergency Response Plan to handle possible water reservoir failure accidents. • Identify vulnerable areas and possible scenarios of flooding and the necessary preventive measures	Quarry Operations Manager	Included in FMRDP	Included in FMRDP
	C. The Air (Ambient Air Quality)	• Air pollution due to fugitive dust	• Regular water spraying in areas where dismantling activities are concentrated • Replacement of vegetation in non-structure areas. • Compact exposed soil • Cover with tarpaulin trucks loaded with debris • Impose vehicle speed restrictions	Quarry Operations Manager	Included in FMRDP	Included in FMRDP
	D. The People (People/ Community)	• Loss of LGU revenues from proponent's taxes, permits and share when mining operations ceases	• Timely announcement and preparation of decommissioning/ abandonment	Quarry Operations Manager	No contribution for the total FMRDP cost but to be included in CSR projects	Included in FMRDP
		• Cumulative health impacts on the community brought about by air pollution and contaminated water	• Conduct barangay-wide medical check-up and compare results during the construction phase and before decommissioning	Quarry Operations Manager	No contribution for the total FMRDP cost but to be included in CSR projects	Included in FMRDP

4. Environmental Risk Assessment and Management

A. Introduction

This Environmental Risk Assessment (ERA) was prepared for the proposed Expansion of Silica Quarry of the Heirs of Arturo Zayco (HAZ) under MPSA 218-2005-VII, which is in Brgy. Barangay Maaslum, Municipality of Ayungon, Negros Oriental.

1. Objective of the ERA

This ERA aims to identify and analyze the hazards and assess the risks associated with the proposed project. It includes characterization of consequences for identified potential hazards in terms of loss of human lives or injuries, damage to or loss of assets and environmental risks.

2. Scope and Limitations of the ERA

This ERA deals with the analysis of the various potential safety (fire, explosion, toxicity) and physical hazards related with the proposed expansion of the silica quarry project of the HAZ. This ERA complies with the requirements of the Procedural Guidelines for Scoping of Environmental Risk Assessment (Annex 2-7e of the Revised Procedural Manual of DAO 03-30) and focuses on safety risks, which are characterized by low probability, high consequence, accidental nature and acute effects" (EMB-EIAMD, 2007).

This ERA does not delve deeply into geological, geo-technical and structural risks, as these issues are tackled in the separate Engineering Geological and Geohazard Assessment Report (EGGAR). It also does not include environmental impacts from normal and other planned operations, which are discussed in detail in the main EPRMP Report.

3. ERA Framework

The Procedural Manual for DAO 2003-30 (Annex 2-7e) defines environmental risk assessment as "the use of universally accepted and scientific methods to assess the risks associated with a project. Risk is defined as a measure of potential human injury, death, economic loss, or environmental damage. It is determined based on the probability (likelihood) of the loss, injury/ death or damage occurring and the severity (magnitude) of the loss, injury/death or damage if it occurs. In simple terms, risk involves two measurable parameters: severity and probability.

The general ERA process is illustrated in Figure 4-1. The various elements/steps in the risk assessment procedure are elaborated in the succeeding sections.

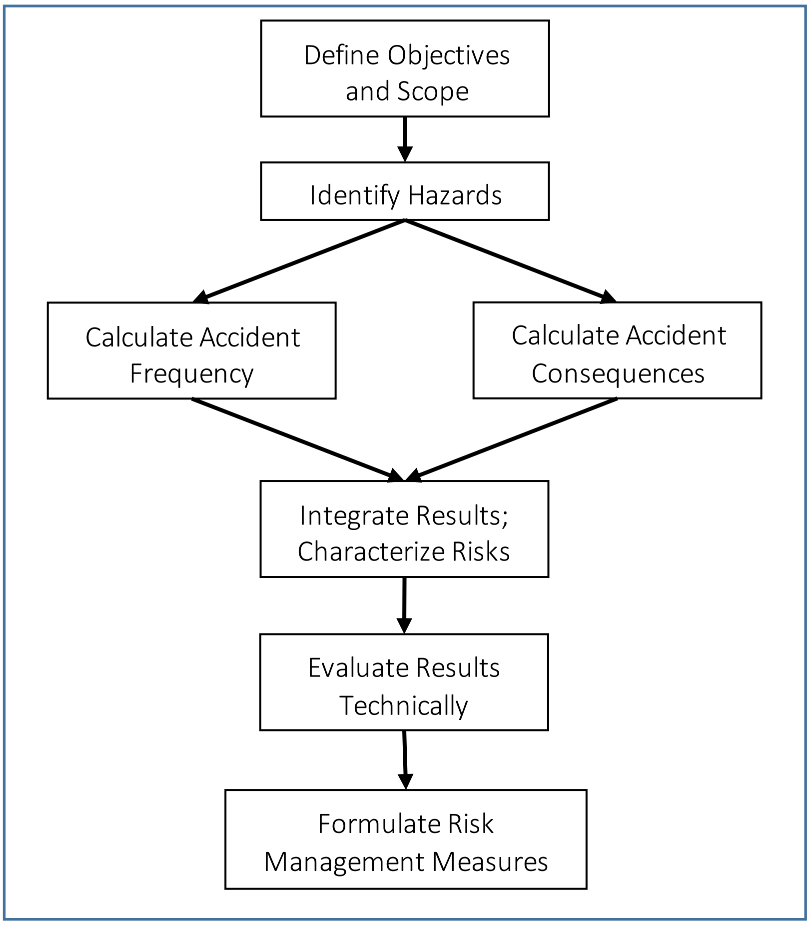


Figure 4-1. The Risk Assessment Procedure

B. Risk Screening of Hazardous Substances

A risk screening procedure was undertaken to determine the type of environmental risk assessment to be undertaken and to prioritize the environmental risks presented by the various hazardous substances and activities. The criteria and process used in risk screening was based on *Annex 2-7e (Guidelines for the Conduct of Environmental Risk Assessment) of the Revised Procedural Manual of DAO 2003-30.*

The screening criteria for hazardous substances are (1) inherent hazardous characteristics of the substance and (2) maximum inventory involved. After classifying the substances according to defined categories (i.e. flammable, oxidizing, toxic, etc.), their respective maximum inventories were compared to DENR's threshold inventory levels (Levels 1 and 2), which are defined in the *Revised DAO 2003-30* guideline. A facility that will manufacture, process or store any hazardous substance in excess of DENR's Threshold Inventory Level 2 is required to undertake a quantitative risk assessment. Those with any hazardous substance exceeding Level 1 threshold inventory but below Level 2 threshold inventory is required to undertake Hazard Analysis Study, and Emergency/Contingency Plan based on the study and worst-case scenario.

Fuel oil (diesel) is the only bulk hazardous material (flammable) that is stored at the project site. It is contained in one (1) horizontal tank with maximum capacity of approximately 28 m3 or 19.8 metric tons. There is also a standby diesel tanker of approximately the same volume. As such, maximum stored fuel oil at the site is only approximately 40 MT, an amount that is way below DENR's Threshold Inventory Level 1, which is 5000 MT for flammables. There is no plan to put up additional storage facilities for diesel. Based on this data, the "q/Q" value is below unity (1) even for Level 1 Threshold Inventory.

Figure 4-2 below shows the result of the risk screening process done.

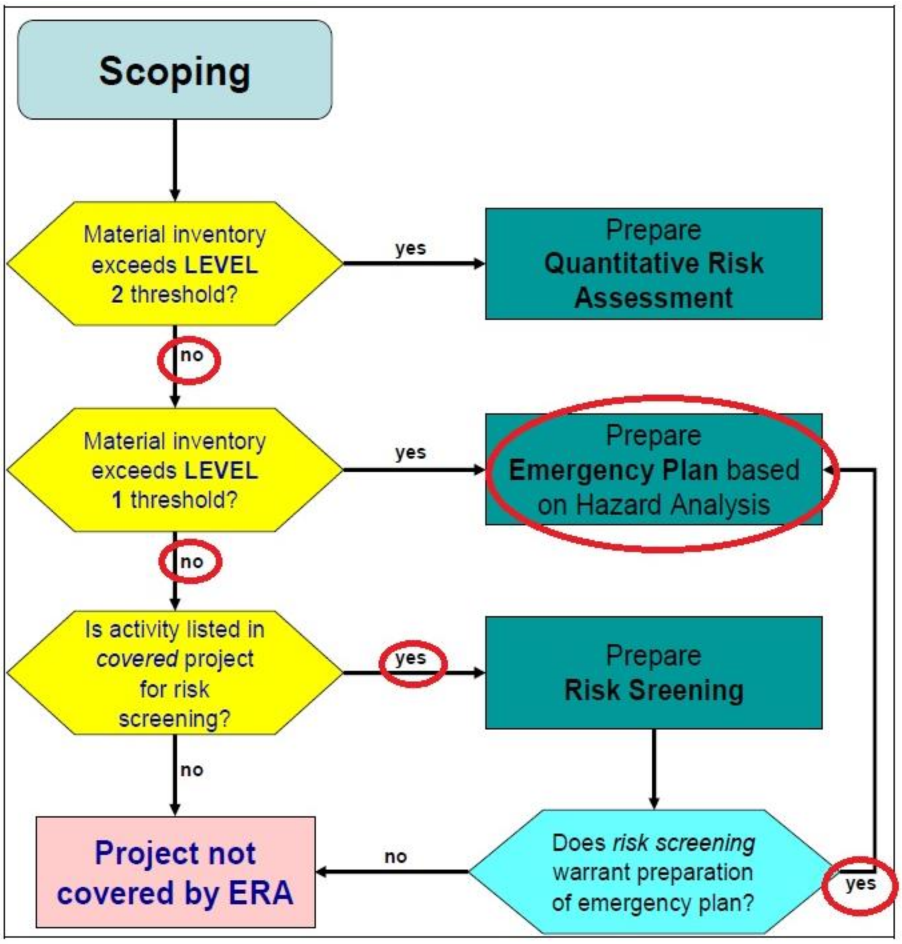


Figure 4-2. Result of Risk Screening Process

C. Hazard Identification

The various hazardous activities, conditions and substances associated with the proposed expansion of the silica quarry project of the HAZ were identified and reviewed. These includes all hazards, both physical and chemical, that could result to injury to or fatality of silica quarry and associated workers and the general public, particularly those in the vicinity of the quarry and/or along the transport route of the ores. Included in the analysis are various natural factors that may cause failure of structures (i.e. earthquakes, extreme weather events) and external factors such as sabotage and terrorism. Also identified were hazards associated with occupational health and safety and environmental factors such as climate change.

Chemical hazards were also identified, particularly those that has the potential to cause fire, explosion and toxic releases. Identification of all hazardous substances to be used, handled and stored during the various project phases was conducted. The potential of each substance to pose hazards to the environment, the public and the facility was analyzed based on review of its intrinsic physical, chemical and hazard characteristics. Risk screening was done according to the process and criteria described in the Revised Procedural Manual of DAO 2003-30: Guidelines for the Conduct of Environmental Risk Assessment, particularly Annex 2-7e.

Table 4-1 lists the identified hazards associated with the project during construction and operation, including occupational health and safety, natural hazards and climate change and external factors. A total of 42 hazards were identified, which were assessed in the succeeding sections of the ERA Report.

Table 4-1. Hazards List and Risk Characterization of the Proposed Expansion of the Silica Quarry Project of HAZ in Ayungon

HN	Activity/ Condition	Hazard	Initiating/Contributing Factors	At Risk Sectors	C	F	Risk*
A.	Construction Phase						
1	Clearing of existing vegetation	• Being struck by felled trees, debris and equipment part	• Human error; equipment failure; communication failure; non-adherence to SOPs	• Clearing team	3	2	6
2	Clearing of existing vegetation	• Vibration and noise from power saws and other equipment	• Inadequate vehicular/ equipment maintenance	• Clearing team	3	3	9
3	Clearing of existing vegetation	• Vehicular and/or equipment accidents (overturning, fall from heights, etc.)	• Adverse weather conditions • Inherently steep slopes • Unsafe practices • Inadequate vehicular/ equipment maintenance	• Clearing team • Company assets	4	3	12
4	Stripping and stockpiling of quarry overburden	• Landslides and rock falls	• Heavy rains, typhoons, earthquakes, defective engineering design; • Area is classified by MGB as "highly susceptible to landslides"	• Quarry workers • Neighboring communities	5	3	15
5	Stripping and stockpiling of quarry overburden	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• Inadequate equipment/ vehicle maintenance; human errors (failure to follow protocols, etc.)	• Equipment operators and drivers	4	3	12
6	Stripping and stockpiling of quarry overburden	• Sediment-laden runoffs from overburden stockpiles could contribute to surface water siltation and possible contamination with toxic heavy metals and minerals (eg. Cr, Pb, Fe, Al, Mg, Mn, etc)	• Inadequate/inappro-priate berms • Failure to stabilize overburden stockpiles • Heavy rains	• Surface water bodies and adjacent lands • General public	3	3	9
7	Bench Development	• Landslides and rock falls	• Heavy rains, typhoons, earthquakes, defective engineering design; • Area is classified as "highly susceptible to landslides"	• Quarry workers • Surrounding communities	5	3	15
8	Bench Development	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• Inadequate equipment/ vehicular maintenance; human errors (failure to follow protocols, etc.)	• Equipment operators and spotters • Quarry workers	4	3	12

HN	Activity/ Condition	Hazard	Initiating/Contributing Factors	At Risk Sectors	C	F	Risk*
B.	Operation Phase						
9	Ripping, drilling and/or breaking of silica ores	• Landslides and rock falls	• Most areas of the quarry site have very steep slopes; • Area is classified by MGB as "highly susceptible to landslides" • Prolonged and heavy rains; strong winds	• Quarry workers and equipment operators • Neighboring communities	5	3	15
10	Ripping, drilling and/or breaking of silica ores	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• Inadequate equipment/vehicular maintenance • Human error • Non-adherence with SOPs	• Equipment operators; vehicle drivers	4	3	12
11	Ripping, drilling and/or breaking of silica ores	• Generation of and exposure of people to respirable crystalline silica (RCS) that could lead to or predispose to respiratory (e.g. silicosis, cancer, TB), renal diseases and/or possibly cancer	• Inadequate PPE, inadequate/absence of protective barriers	• Quarry workers; equipment operators; vehicle drivers	3	4	12
12	Ripping, drilling and/or breaking of silica materials	• Harmful noise levels could lead to hearing impairment	• Inadequate maintenance of equipment • Inadequate hearing PPEs	• Same as above	3	3	9
13	Ripping, drilling and/or breaking of silica materials	• High impact vibration from drilling and other equipment can predispose to musculoskeletal and nervous system disorders (eg. Hand-Arm vibration Syndrome or HAVS)	• Inadequate equipment/vehicular maintenance • Prolonged exposure to vibration	• Equipment operators; vehicle drivers	3	3	9
14	Ripping, drilling and/or breaking of silica materials	• Fall from the edge of a bench	• Working at heights and very steep slopes	• Quarry workers	4	3	12
15	Ripping, drilling and/or breaking of silica materials	• Being struck by falling rocks/debris at the foot of a face	• Human error; unsafe practices; inadequate training of workers	• Quarry workers	4	3	12
16	Ripping, drilling and/or breaking of silica materials	• Being struck by or caught in a moving part of quarry equipment	• Same as above • Unguarded equipment moving parts	• Quarry workers	3	3	9

HN	Activity/ Condition	Hazard	Initiating/Contributing Factors	At Risk Sectors	C	F	Risk*
17	Pushing and stockpiling of quarried silica materials	• Equipment accident (fall from edge of a bench, being hit by falling rocks, etc.)	• Very steep slopes • Human error • Failure to follow protocols • Unsafe practices	• Equipment operators • Quarry workers	4	3	12
18	Crushing of coarse grained silica ores	• Generation of RCS that could expose and predispose people to silicosis, respiratory, renal diseases and possibly cancer	• No or inadequate respiratory PPE • Inadequate dust mitigation and control measures	• Workers at and the vicinity of crushers	3	4	12
19	Crushing of coarse-grained silica ores	• Harmful noise levels	• Non-wearing of ear protection PPEs in noisy zones (eg. Near crushers, etc)	• Same as above	3	3	9
20	Crushing of coarse grained silica ores	• Fugitive rock and/or debris projectiles	• Inadequate machinery guards	• Same as above	2	3	6
21	Crushing of coarse grained silica ores	• Contact of body parts with moving equipment parts	• Inadequate machinery guards	• Same as above	2	3	6
22	Hauling and transport of silica materials	• Generation of airborne dusts from dirt roads and from silica materials being hauled	• Unpaved roads • Dry road conditions • Exposed ore loads	• Hauling truck drivers and helpers • Communities at the vicinity of haul roads	3	3	9
23	Hauling and transport of silica materials	• Noise from haul trucks could cause disturbance to communities along the haul route	• Inadequate vehicle maintenance • Failure to follow delivery schedules	• Same as above	3	3	9
24	Hauling and transport of silica materials	• Vehicular accidents at the quarry site (fall from edge of bench, collision with other vehicles/equipment or structures, overturning, etc.)	• Inadequate vehicle maintenance • Unsafe driving practices • Inadequate training of drivers	• Vehicle drivers, helpers and other Quarry workers	4	3	12
25	Hauling and transport of silica materials	• Traffic accidents (collision with other vehicles, hitting pedestrians and/or animals, others)	• Same as above • Unsafe road conditions	• Vehicle drivers and helpers, other commuters, pedestrians and residents along the haul roads	4	3	12
27	Storage and Use of Flammables (fuel oil)	• Pool/ jet fires	• Damage to fuel container or spillage of fuel/ chemicals during storage and use	• Workers • Assets • Environment	3	2	6

HN	Activity/ Condition	Hazard	Initiating/Contributing Factors	At Risk Sectors	C	F	Risk*
			• Inadequate maintenance of storage tanks/ containers, loading arm or pipe system				
28	Storage and Use of Flammables (fuel oil, lubricants)	• Generation of harmful combustion products (particulates, SO_x, NO_x, ozone, etc)	• Uncontrolled fires	• Workers • Neighboring communities	2	2	4
29	Storage and Use of Flammables (fuel oil, lubricants)	• Spills causing soil and/or water contamination	• Failure to install mitigating barriers and other measures (eg. concrete flooring • Failure to implement clean up procedures	• Environment • General public	3	3	9
30	Storage and disposal of hazardous wastes (used oil, lubes, etc.)	• Spillage and subsequent contamination of soil and nearby water bodies with harmful chemical components	• Improper storage and/or disposal of waste fuel oil and chemicals	• Environment, general public	3	3	9
31	Storage and disposal of hazardous wastes (used oil, lubes, etc.)	• Exposure of people to toxic components	• Unsafe practices (e.g. washing of hands with fuel oil, unprotected handling of chemicals, smoking or eating while handling chemicals, etc) • Improper hazardous waste disposal (non-compliance with RA 6969)	• Workers, general public	3	3	9
32	Settling Ponds	• Breaching of settling ponds could lead to flash floods, siltation and possible contamination with heavy metals and minerals (Cr, Pb, Fe, Mn, Mg, of surface waters and nearby lands	• Inclement weather conditions • Earthquakes • Faulty engineering design • Inadequte maintenance of drainage canals and the settling pond system	• Surface waters and adjoining lands • Aquatic ecological entities • Surrounding communities	4	3	12
33	Ergonomic issues (heavy lifting, prolonged standing, repetitive movement,	• Ergonomic hazards that may lead to bodily injuries and stress	• Inappropriate body mechanics while performing activities • Inadequate rest periods • Tasks performed exceed recommended limits (eg. too heavy lifted loads, etc.)	• Workers	2	3	6

HN	Activity/ Condition	Hazard	Initiating/Contributing Factors	At Risk Sectors	C	F	Risk*
	awkward postures, etc.)						
C.	Natural Events, Climate Change Factors and Terrorism						
34	Earthquakes	• Landslides and damage to structures and equipment with injuries/fatality to people	• Areas with steep slopes and susceptible to erosion	• Workers and other persons at the site • Assets • Ecology	5	3	15
35	Increased frequency and intensity of tropical cyclones	• Landslides and rock falls • Flooding of low lying areas • Damage to buildings and equipment • Injury or fatality from falling trees, debris, rock fragments projectiles, and equipment parts	• Area classified as highly susceptible to landslides • poor engineering design; poor maintenance of structures; defective warning systems; infrastructures along riverbanks and flood plains	• Workers; contractors; nearby communities esp. along river/stream banks	5	3	15
36	Increased intensity and frequency of rains during rainy season	• Same as above	• Same as above	• Same as above	5	3	15
37	Drier dry seasons and increased ambient temperatures	• Fire incidents; • Increased airborne dusts; • Drying water reservoirs and sources	• Presence of ignition sources near storage tanks/containers • Indiscriminate disposal of live cigarette butts • Inadequate dust suppression system; earthworks; • forest/ vegetation denudation; disturbance of existing water sources (springs, rivers, streams)	• Workers, contractors, nearby communities, enviroment	3	4	12
38	External Threats/ Terrorism	• Terroristic attacks and/or sabotage of quarry facilities	• Major damage to equipment and facilities • Fatalities/ injuries to people	• Workers • General Public • Assets	4	3	12

Legends: HN = hazard Number; C = Consequence; F = Frequency
* [red] -- High Risk; [yellow] -- Medium Risk

D. Severity Analysis

Consequence severity analysis involved the qualitative description of possible impacts on people, assets and the environment in case of occurrence of accidents or incidents due to the identified hazards. Accident or consequence is graded according to a Consequence Severity Rating Chart as shown in Table 4-2. The rating ranges from 1 to 5, with rating 1 being the lowest consequence and 5 as the highest consequence severity.

Table 4-2. The Consequence Severity Rating Chart Used in Consequence Analysis

Rating	Description	Consequence/Impact	
		On-site Health and Safety	Environment and Community
1	Very low	Self-administered first aid treatment; No specific treatment	No community complaints; no corrective actions required; No breach of regulations
2	Low	First Aid treatment injury	Impacts confined to site; corrective actions required; no breach of regulations
3	Moderate	Medical treatment injury; possible loss time injury	Off-site environmental/ community damage could easily be contained or prevented; breach of regulations
4	High	Injuries require hospitalization	May result to uncontained environmental or community damage; multiple community complaints; may result to civil prosecution
5	Very High	Fatalities; Permanent disabilities	Long term environmental damage; May result to criminal prosecution

E. Probability/Frequency Analysis

Probability/frequency analysis of accidents or incidents due to realization of project hazards were described using a Probability of Occurrence Rating Chart as shown in Table 4-3. Probability (frequency) were assigned with values ranging from 1 to 5, with the value of 1 corresponding to the lowest probability value and 5 having the highest probability value.

Table 4-3. The Probability of Occurrence Rating Chart Used in Consequence Analysis

Rating	Description	Explanation
1	Rare	Might occur at some time in exceptional circumstances
2	Unlikely	Could occur at some time although unlikely
3	Possible	Might occur at some time
4	Likely	Will probably occur, has happened
5	Almost Certain	Expected to occur, quite common

F. Accident Severity and Frequency Statistics for the Surface Mining Industry

The application of the Consequence Severity Rating Chart (Table 4-2) and the Probability of Occurrence Rating Chart (Table 4-3) for this ERA was primarily based on existing statistics for the surface mining industry, the sand and gravel industry in particular. Due to paucity of statistical data on surface mining accidents and incidents in the Philippines, data were derived from the Center for Disease Control and Prevention (CDC) of the National Institute for Occupational Safety and Health (NIOSH), which keeps a database of mining accidents/incidents and the resulting fatalities and non-fatal injuries for the mining industry of the USA. Data used were from the years 1983 to 2018, as these are the available statistical data from the *NIOSH Mining* website. For the Philippine mining context, data from sources such as news articles on surface mining accidents/disasters were reviewed. These data were used in the analysis of what surface mining accidents/disasters had occurred recently and what were the toll of these accidents.

Base on the NIOSH-derived data, strip mine and quarries reported 50% of the total injuries recorded for the mining industry for the period 2003-2007. Sand and gravel operation, wherein silica mining may be classified under, ranks third in injury rates (16.5%) among surface mining operations, with incidence rate of 3.5 injuries per 100 full-time equivalent miners per year (Coleman). The number and percentage of occupational fatalities by accident class for surface gravel and sand surface mining for the period 1983-2018 are shown in Table _ below. Powered haulage, which includes transportation and hauling events, tops the fatality rate at 39.9%. This data is supported by a report by the U.S. Department of Health and Human Services (2000), stating that transportation events compose the biggest proportion of fatal injuries in both the mining and all industries. In the mining industry, it comprises the largest proportion of fatalities except for coal mining (U.S. Department of Health and Human Services, 2000).

Table 4-4. Percentage **of occupational fatalities by accident class at sand & gravel surface mining operations in the U.S., 1983 - 2018 (N=276)**Invalid source specified.

Accident Class	Fatalities	%
Powered haulage	110	39.9
Machinery	51	18.5
Electrical	26	9.4
Falling, rolling or sliding rock or material	24	8.7
Slip or fall of person	22	8.0
Unknown or NEC	18	6.5
Exploding vessels under pressure	5	1.8
Fall of ground (from in place)	5	1.8
Handling materials	4	1.4
Ignition/ explosion of gas/ dust	4	1.4
Hand tools	3	1.1
Non-powered haulage	2	0.7
Inundation	2	0.71
Total	276	100

The CDC-NIOSH Mining data showed that for the period 1983-2018, the fatality rates (per 100,000 full-time equivalent employees) in surface mining operations in the U.S.A. ranged from 7.03 (2015) to 36.99 (1984) fatalities per 100,000 full-time equivalent employees (FTE). The average fatality rate per year was 19.7 fatalities per 100,000 FTE. Full-time equivalent (FTE) employees is computed using reported hours worked with 2,000 hours = 1 FTE (CDC-NIOSH, 2019).

In the context of Philippine mining situation, data on surface mining-associated accidents and disasters could be helpful on deciding on the severity ratings of some types of surface mining accidents. Most surface mining-related accidents that involved multiple fatalities were associated with landslides coupled with the occurrence of natural events such as strong typhoons, prolonged rains or earthquakes involving a surface mining site (Mayuga, 2018) (Michael Bueza. Sept. 22, 2018) **Invalid source specified.** (Dumlao-Abadilla, 2015).

G. Risk Characterization

Risk characterization involved the integration of the results of the consequence severity analysis and consequence probability analysis. For purposes of risk prioritization, indicative risk (IR) values were computed for each of the identified hazard by getting the product of the severity rating and probability rating values from Table 4-2 and Table 4-3, respectively. Table 4-5 shows the resulting risk matrix.

Table 4-5. Risk Matrix

Qualitative Risk Matrix			Probability/Frequency				
			1	2	3	4	5
			Rare	Unlikely	Possible	Likely	Almost Certain
Consequence/ Impact	5	Very High	5	10	15	20	25
	4	High	4	8	12	16	20
	3	Moderate	3	6	9	12	15
	2	Low	2	4	6	8	10
	1	Very Low	1	2	3	4	5

Low Risk — Medium Risk — High Risk

As shown in Table 4-1, the identified hazards associated with the proposed expansion of the silica quarry project of HAZ has the potential to result either to medium risks (36 of the 42 identified hazards) or high risks (6 of the 42 identified hazards).

The potential for the occurrence of landslides and rockfalls at the project site was classified as a high-risk hazard based on the methodology employed with potential consequence, at worst case, of multiple fatalities, damage to assets and damage to ecological entities.

1. Risk of Landslides and Rock Falls

Landslides and rock falls are high risk hazards that may result from earthquakes; earthworks during overburden stripping/stockpiling, ripping/drilling of silica ores; and climate-change instigated weather anomalies (increased frequency and intensity of tropical cyclones; increased frequency and intensity of precipitation). The mining area is classified by MGB as "highly susceptible" to landslides and rockfalls, with characteristic steep slopes. Other factors that may contribute to the realization of the hazard are heavy and/or prolonged rains and typhoons, defective/inadequate slope stabilization engineering and maintenance, and ground vibration from blast overpressures.

The worst-case consequence of slope failure is multiple fatalities and injuries, damage to assets and properties, and possible damage to ecological entities. If the landslide and rockfalls should result to damming/obstruction of river flows, downstream flash flooding could result upon breaching of the dam/obstruction, especially in the event of extreme rainfall. Six (6) activities/events that can lead to landslides and rockfalls are shown in Figure 4-3.

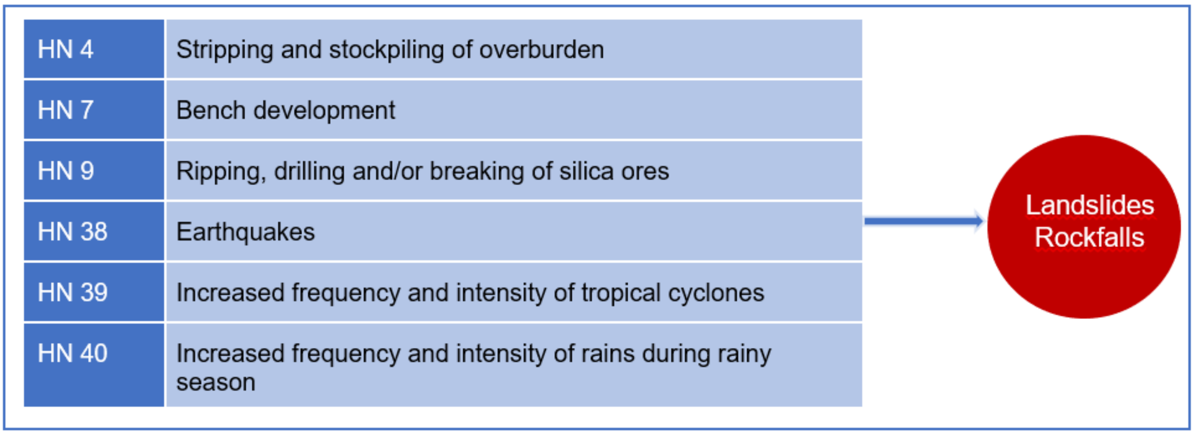


Figure 4-3. Activities and events that may lead to landslide and rockfall incidents

2. Flooding of Low-lying Areas during Heavy and/or Prolonged Rains

Flooding of low-lying areas can be a consequence of extreme tropical cyclones and heavy/prolonged and rains. The stripping of vegetation and changes in topography as a prerequisite of silica mining could contribute to this hazard. Accidental breaching of siltation ponds and drainage systems following extreme rainfall events may also result to flash flooding of downstream low-lying areas.

3. Risk of Vehicular and Equipment Accidents

Vehicular and Equipment accidents are medium risk hazards that could result to injuries and possible fatalities, particularly of the vehicle/ equipment drivers and operators at the site and other road users offsite. Contributing factors may include the following: adverse weather conditions, inherently steep slopes, inadequate vehicle/equipment maintenance, unsafe practices, failure to follow protocols/SOPs and traffic accidents, and unsafe road conditions.

Associated activities that could lead to the risk of vehicular/equipment accidents are shown in Figure 4-4.

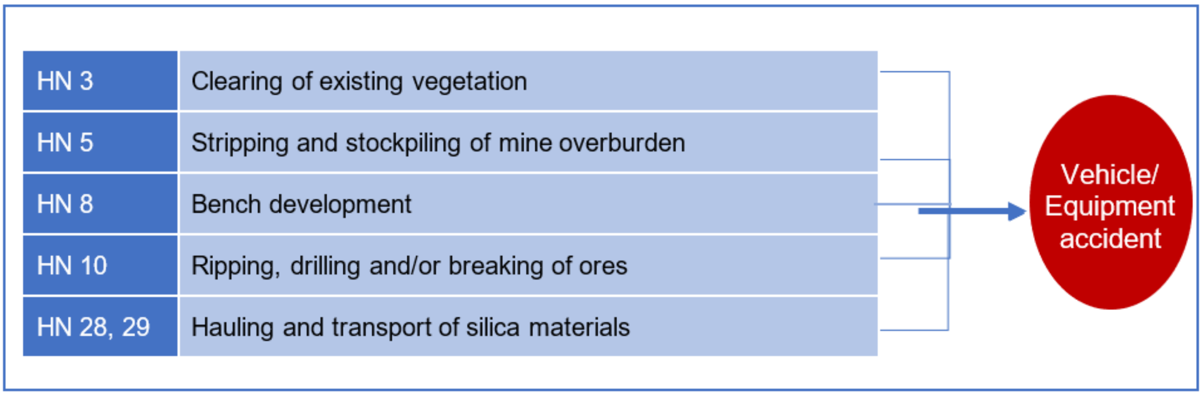


Figure 4-4. Activities associated with risks of Vehicular/Equipment accidents

4. Generation of Respirable Crystalline Silica (RCS)

Crystalline silica is also known as quartz, silicon dioxide, cristobalite, tridymite, silica sand or sand. Its chemical formula SiO_2. The respirable component (PM4) is hazardous to health and is responsible for the development of a lung disease known as silicosis, a form of pneumoconiosis. Respirable crystalline silica (RCS) dust can be released into the atmosphere from cutting, grinding, drilling, crushing, sanding, transporting or fragmenting apart crystalline silica-containing materials, such as silica ores. Any activity that create friction on and movement of crystalline silica-bearing materials has the potential to release respirable components. In relation to the project, such activities are shown in Figure 4-5 below.

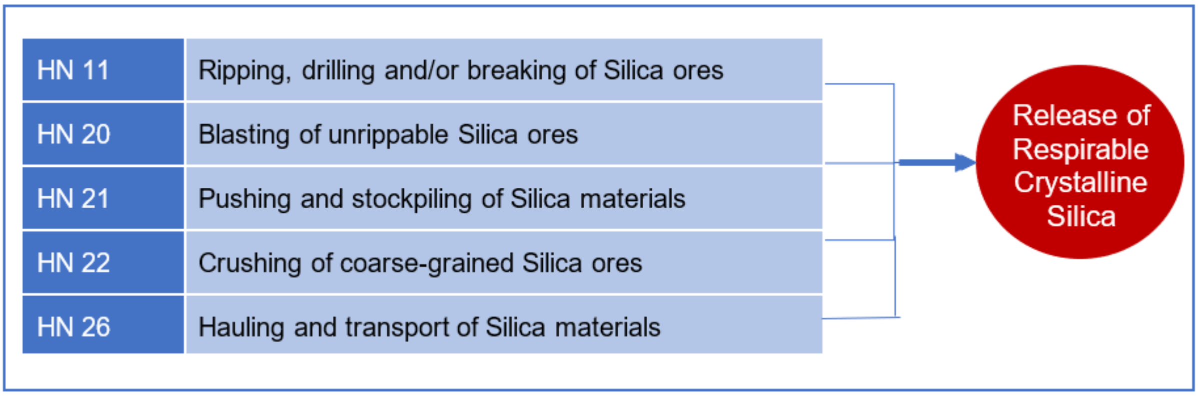


Figure 4-5. Activities associated with the risk of releasing respirable crystalline silica

Inhalation of respirable crystalline silica is implicated in the development of a respiratory disease known as silicosis. The deposition of respirable silica in the lung tissues can predispose a person to the development of other respiratory diseases like bronchitis, tuberculosis, lung cancer, and renal disease. Caused by the inhalation, retention, and pulmonary reaction to the crystalline silica, silicosis is a fibrosing disease of the lungs. Upon being symptomatic, the primary manifestation is usually difficult or labored breathing and/or shortness of breath (dyspnea). In the absence of other respiratory diseases, shortness of breath may not be noted in the early stages of the disease. The disease may be first detected through an abnormal chest X-Ray. The manifestation of dyspnea may be an indication of the development of pulmonary complications such as tuberculosis, airways obstruction, progressive massive fibrosis (PMF), or cor pulmonale (enlargement of the right side of the heart). Productive cough is often a symptom. An exposed worker may develop either one of the following three types of silicosis, depending on the level of exposure to airborne crystalline silica:

a) **Chronic Silicosis:** Oftentimes develop after 10 or more years of exposure to relatively low concentrations of respirable crystalline silica. The silica dust produces swellings in the lungs and lymph nodes of the chest. Troubled breathing, similar to that in chronic obstructive pulmonary disease, is the primary symptom;
b) **Accelerated Silicosis:** The occurrence of swellings in the lungs and symptoms is faster than in chronic silicosis. It usually develops 5 to 10 years after initial exposure; or
c) **Acute Silicosis:** A consequence of exposure to high concentrations of respirable crystalline silica, its symptoms manifest within a period of a few weeks to 5 years after the first exposure. Its manifests as severe shortness of breath and low blood oxygen levels resulting from a very inflamed lungs that may fill with fluid **Invalid source specified.**.

To prevent the development of silicosis in miners, the Mine Safety and Health Administration (MSHA) of the US Dept. of Labor has developed a Permissible Exposure Limit (PEL) to respirable crystalline silica (RCS). When RCS is greater than 1% in the respirable dust sample, the PEL is calculated by dividing 10 mg/m3 by the sum of the percent quartz plus 2. For instance, if a dust sample contains 8% quartz, the PEL would be equal to 1 mg/m3 (i.e., 10 ÷ (8 + 2)). The upper limit of exposure to RCS is set at 100 µg/m3 **Invalid source specified.**.

5. Failure of Settling Pond Structures

The project has several existing settling ponds and plans to construct additional ones to receive surface run offs. Failure of settling pond structures (walls/containment) can result to flash flooding and mass release of sediments that may be heavily tainted with heavy metals and minerals. Factors which may contribute to structural failure, such as breaching of containment, are natural hazards like strong earthquakes, prolonged heavy rains, strong typhoons, faulty engineering design, and sabotage.

Mass release of sediments and flash flooding can result to fatalities, injuries, heavy siltation of affected surface water systems, and destruction and contamination (with heavy metals and minerals) of affected terrestrial and aquatic environments.

Contamination of Surface Waters and Soil with Heavy Metals and Minerals

Mining activities may increase the loads of heavy metals and other hazardous minerals in the vicinity and at the site through release and exposure of these substances in the process of mining. Pertinent activities include excavation, drilling, crushing, stockpiling and transport. Run offs from mine overburden and wastes may scavenge and carry heavy metals and minerals. Sample cores and surface soil samples from the area showed the following heavy metals as components: aluminum, iron, magnesium, manganese, copper and arsenic. Recently obtained surface soil samples from the area showed acceptable levels of lead and arsenic. Chromium, mercury and cadmium from the said samples were below detection limits. Surface water samples from several sampling stations at the site, however, showed high concentration of Chromium (VI) during the dry season sampling that may be attributed to the presence of sulfur vents in the area. It may therefore be expected that the settling pond sediment and water columns may also contain high Chromium (VI) concentration.

The toxicological hazards of these substances are summarized in Table 4-5. The toxicological character of the identified heavy metals and minerals are subsequently discussed.

Table 4-6. Relevant heavy metals and their significance

Substance	Effects and Significance
Iron (Fe)	Essential nutrient; damages fixtures by staining; partly responsible for acid mine drainage
Chromium (Cr)	Essential as Cr(III), toxic as Cr(VI)
Arsenic (As)	Toxic, possibly carcinogenic
Copper (Cu)	Essential trace element; toxic to humans, plants and algae at higher levels
Lead (Pb)	Toxic, harmful to humans and animals, carcinogenic
Manganese (Mn)	Toxic to plants, damages fixtures by staining

Lead (Pb)

Though well within acceptable limits for surface soil, lead was found in two out of three surface soil samples. The typical mean Pb concentration for surface soils worldwide averages 32 mg/kg and ranges from 10-67 mg/kg. Surface soil samples from two sampling stations in the area showed 13 and 11 mg/kg Pb content, respectively. Sources of lead may be geogenic or anthropogenic. Anthropogenic sources include pesticides, agricultural inputs, fuel combustion, coal-fired power plant emissions, waste batteries and paints.

If absorbed into the body, lead can be toxic and has potential for carcinogenicity. With inhalation and ingestion as two routes of exposure, lead accumulates in body organs, which may lead to poisoning or even death. Lead can affect the central nervous system (CNS), the gastrointestinal tract, the bones, and the kidneys. In children, it can lead to risks of impaired development. Lower IQ, shortened attention span, hyperactivity and mental retardation. In adults, lead poisoning may manifest as decreased reaction time, loss of memory, nausea, insomnia, anorexia and joint weakness.

Iron (Fe)

Elemental and iron compounds are usual components of mining wastes. Iron is an essential element to human and animal metabolism in trace amounts. In excess, it can exert toxic effects and environmental impacts.

Chromium (Cr)

The process of mining may facilitate the release of chromium to the environment. Relevant to the site, Chromium, particularly Chromium (VI), may come from the surface and spring waters that drain the area. The high concentration of Cr (VI) in the waters may be attributed to the presence of sulfur vents. Chromium in trace amounts is an essential element of human and animal nutrition. It is important in glucose and fat metabolism. Trivalent Cr is the nutritionally useful form while the hexavalent from, Cr (VI), is toxic and mutagenic. The biotoxicity of chromate is mostly a function of its ability to cross biological membranes and its powerful oxidizing capabilities. Cr (VI) compounds can be absorbed by humans through inhalation, dermal contact, and ingestion. Excessive Cr exposure can result to ulceration and perforation of the nasal septum, respiratory cancer, skin ulceration, contact dermatitis, and in the event of ingestion, kidney damage. It can also cause damage to various proteins and nucleic acids, which can lead to mutation and carcinogenesis (Lewis and Bianchi, 1982).

Arsenic (As)

Arsenic may form part of the mining overburden and ore wastes. Arsenic is a general cytotoxicant which can elicit injury to most cells and organ systems. It chelates with alpha-lipoic acid, disrupting energy production from the Kreb Cycle. Alpha-lipoic acid is an essential co-factor for pyruvate dehydrogenase, an enzyme required in the Kreb Cycle. Arsenic is mostly in the form of arsenate in the biological system. It mimics the phosphate oxyanion in cells. "Substitution" of phosphate by arsenate effectively disrupts a variety of metabolic reactions, resulting in the inhibition of ATP formation. The general effect is toxicity to the cells (Chang and Cockerham, 1994).

Manganese (Mn)

Manganese may also constitute one of the heavy metal wastes of mining. This metal is neurotoxic and could induce Parkinson-like syndromes and degeneration of the caudate nucleus, basal ganglia, and substancia nigra (Chang and Cockerham, 1994).

6. Occupational Hazards

As shown in Table 4-1, occupational hazards associated with various project activities include the following: harmful noise levels; repeated exposure to harmful vibration; exposure to respirable crystalline silica; working at heights; working and/or operating vehicles/equipment at very steep slopes; mechanical impacts from falling trees, rocks, etc; possible exposure to blast overpressures; possible contact with moving machinery parts; and ergonomic hazards (heavy lifting, prolonged standing, awkward postures, repetitive movement, etc.).

H. Safety Performance

Table 4-7 below shows the annual safety statistics for the existing Ayungon silica project for the period 2015-2018. The safety statistics for the silica mining project show that for the said period there was only two (2) NLTA and no LTA that occurred. The two NLTA occurred 2015. The yearly total manhours worked ranged from 69,699 hours in 2015 to 151,489 hours in 2018. Total manhours worked for the period is 446,997 hours. Because of no LTAs for the whole period, both the annual Disabling Injury Severity Rate (DISR) and the annual Disabling Injury Frequency Rate (DIFR) were nil for the whole period. Based on these safety statistics, it could be said that the safety performance of the Silica Quarry Project of the HAZ in Ayungon is commendable.

Table 4-7. Safety Statistics for the Period Fiscal Years 2015-2018

Parameter	Fiscal Year			
	2015	2016	2017	2018
No Lost Time Accident (NLTA)	2	0	0	0

Parameter	Fiscal Year			
	2015	2016	2017	2018
Lost Time Accident (LTA)				
- Non-Fatal (NF)	0	0	0	0
- Fatal (F)	0	0	0	0
Total Days Lost	0	0	0	0
Total Manpower		69	79	81
Total Manhours (annual)	69,639	93,049	132,820	151,489
DISR	0	0	0	0
DIFR	0	0	0	0

Legends: DIFR = Disabling Injury Frequency Rate (lost time injuries per million manhours);
DISR = Disabling Injury Severity Rate (days lost per million manhours)

I. Risk Management

The risk assessment conducted showed that potential inherent (unmitigated) risks from the proposed expansion of the Silica Quarry Project of HAZ in Ayungon ranges from medium to high risks. High risks must be prevented and/or controlled with application of appropriate mitigation measures. These must be reduced to at least Medium Risk before work commences. Medium risks, on the other hand, should be carefully evaluated and reduced to as low as reasonably practicable (ALARP) within a defined period. Reasonable in this context means a balance between the benefits of increased safety, environmental protection or lives saved and the costs involved in the process of risk reduction.

1. High Potential for Landslides and Rockfalls

Classified as a high-risk hazard, the potential for landslides and rockfalls is due to the inherent characteristics of the area (classified by MGB as highly susceptible to landslides and rockfalls) and the nature of activities to be undertaken. To address these hazards, the Project management implements and plans to continue to implement the following measures:

- Strict implementation of a benching design: Bench development involves the construction of access roads and ramps to reach higher grounds and the eventual shaping-up of quarry benches for slope stability. Benches shall be developed according to a specific engineering design oriented towards slope stability and control of erosion;
- Install slope stabilization structures where necessary, such as application of filter matting and vegetation planting along berms;
- Construction of a system of drainage canals and siltation ponds to control the flow of water that could trigger soil erosion and landslides;
- Silica stockpiles at the site would be limited to a week's inventory;
- Prompt scaling down of all overhangs and loose rock masses suspected of falling on pit walls and extraction faces;
- Grading the topsoil and overburden stockpile to a stable relief;
- Use of quarry wastes and overburden as backfill;
- Proper siting of new overburden/waste storage facility; and
- Progressive rehabilitation and reforestation of inactive and abandoned quarry sites.

The following mitigating measures are recommended:

- Ensure regular inspections and proper maintenance of containment berms; and

- Conduct regular orientation and drills of workers on emergency response in case of landslides and other accidents (the subject of "Landslides" is part of the existing Emergency Prevention and Response Plan).
- Recommendations are contained in Table 4-7.

2. Flooding of Low-lying Areas during Heavy and/or Prolonged Rains

The following measures are being implemented or are to be implemented:

- Construction of a system of drainage canals and siltation ponds to control the flow of water;
- Regular and periodic cleaning/dredging of settling ponds through bailing out the accumulated silt materials as soon as they near critical level;
- Limiting the footprint of quarry sites
- Progressive reforestation of areas not needed by the proponent for actual quarrying;
- Progressive rehabilitation and reforestation of inactive and abandoned quarry sites

3. Occupational Hazards

To prevent occupational injuries from accidents and untoward incidents, the management of the Ayungon Silica Quarry Project of the Heirs-of-Arturo Zayco will both observe and strictly enforce the applicable quarry safety rules and regulations prescribed by the Philippine Mining Laws, particularly those provided for in the DENR Mine Administrative Order No. MRD – 51. Accordingly, an annual safety and health program has been formulated and installed in compliance with the regulations. Training of proponent's employees on safe quarrying practices will continue to be conducted. Among the pertinent safety precautions that will be observed and enforced are the following:

a) Provision of hard hats and safety shoes to all quarry workers;
b) Scaling down of all overhangs and loose rock masses that have high potential of falling on pit walls and extraction faces;
c) Provisions of spotters to continuously guide heavy mining equipment and mobile units in maneuvering and operating within the active quarry zones;
d) Prohibiting mining personnel from working directly below unstable slopes;
e) Prohibiting children, passerby and outsiders from loitering or staying around the project site;
f) Providing supports to reinforce pit walls/faces suspected of pending collapse;
g) Proper maintenance and servicing of all mining equipment;
h) Provision of First-Aid kit onsite;
i) Provision of adequate lightning facilities when operating during nighttime; and
j) Periodic briefing of quarry personnel on mine safe operating practices.

4. Particular Hazards and Mitigation

Recommendations to mitigate and manage identified hazards are listed in Table 4-7.

Table 4-8. Identified Hazards and Risks and Corresponding Recommended Mitigating Measures for the Proposed Expansion of the Silica Quarry Project of HAZ

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
1	Clearing of existing vegetation	• Being struck by felled trees, debris and equipment part	• Adopt and implement the safest methods/ technology. • Ensure that persons doing specialized tasks (eg. Tree felling) are fully trained. • Use of well-maintained equipment. • Ensure use of personal protection gears
2	Clearing of existing vegetation	• Vibration and noise from power saws and other equipment	• Regular and timely maintece of equipment • Provide ear protection and vibration protective PPEs to workers
3	Clearing of existing vegetation	• Vehicular and/or equipment accidents (overturning, fall from heights, etc.)	• Use of well-maintained and suitable equipment and vehicles. • Use of properly trained crew and operators, especially drivers of large equipment like bulldozers and backhoes.
4	Stripping and stockpiling of quarry overburden	• Landslides and rock falls	• Ensure regular inspections and proper maintenance of containment berms. • Batter off final waste dump slope to atmost 20 degrees. • Use wastes and overburden as backfill. • Ensure implementation of rehabilitation plan on waste dumps. • Ensure proper siting of the overburden/waste storage facility.
5	Stripping and stockpiling of quarry overburden	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• Avoid operation during inclement weather. • Maintain proper security and cordon off hazardous areas. • Ensure good maintenance and regular testing vehicles, especially of brakes. • Adequate training of operators and drivers. • Provide spotters to guide heavy mining equipment and mobile units in maneuvering and operating within the quarry zones and destination; • Driver/operator cabs are protected from dusts and heat. • Restrict access to vehicles
6	Stripping and stockpiling of quarry overburden	• Sediment-laden runoffs from overburden stockpiles could contribute to surface water siltation and possible contamination with toxic heavy metals and minerals (eg. Cr, Pb, Fe, Al, Mg, Mn, etc)	• Construct and maintain networks of drainage canals and settling ponds • Progressive rehabilitation and reforestation of abandoned quarries, inactive quarries and idle lands • Stabilize overburden stockpiles to a stable relief • Batter off final waste dump slope to atmost 20 degrees and plant with sediment holding vegetation cover
7	Bench Development	• Landslides and rock falls	• Implement proper design and procedure in bench development • Install slope stabilization structures where necessary (eg. application of filter matting, vegetation planting along berms)

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
			• Construction and maintenance of a system of drainage canals and siltation ponds • Scale down of all overhangs and loose rock masses suspected of falling down on pit walls and extraction faces • Grading the topsoil and overburden stockpile to a stable relief • Use of quarry wastes and overburden as backfill • Proper siting of new overburden/waste storage facility; and • Progressive rehabilitation and reforestation of inactive and abandoned quarry sites. • Regular inspections and proper maintenance of containment berms; and • Regular orientation and drills of workers on emergency response in case of landslides and other accidents • Proper siting of the overburden/waste storage facility
8	Bench Development	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• As in #HN 5
9	Ripping, drilling and/or breaking of silica ores	• Landslides and rock falls	• As in #HN 7
10	Ripping, drilling and/or breaking of silica ores	• Equipment/vehicular accidents (fall from steep slopes, being hit by rocks and debris, collisions, etc.)	• As in #HN 5
11	Ripping, drilling and/or breaking of silica ores	• Generation of and exposure of people to fine silica dusts that could lead to or predispose to respiratory (e.g. silicosis, cancer, TB), dermal and/or kidney diseases and/or possibly cancer	• Ensure use of appropriate personal protection equipment. • Use of appropriate equipment and vehicles with protective operator cabin. • Pre-employment and free annual medical examination of all workers, including chest X-rays.
12	Ripping, drilling and/or breaking of silica materials	• Harmful noise levels could lead to hearing impairment	• Ensure good maintenance and regular testing vehicles and equipment. • Provide adequate hearing protective PPEs to workers free of charge
13	Ripping, drilling and/or breaking of silica	• High impact vibration from drilling and other equipment can	• Ensure good maintenance and regular testing vehicles and equipment.

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
	materials	predispose to musculoskeletal and nervous system disorders (eg. Hand-Arm vibration Syndrome or HAVS)	• Provide vibration protective gears like hand/arm support for critical operations like drilling and ore breaking. • Operator rotation to reduce exposure to vibration.
14	Ripping, drilling and/or breaking of silica materials	• Fall from the edge of a bench, ravines	• Training • Safety barriers and signages • PPE - hard hats, safety harness
15	Ripping, drilling and/or breaking of silica materials	• Being struck by falling rocks/debris at the foot of a face	• Prompt scaling down of all overhangs and loose rock masses near pit walls and extraction faces • PPE-hard hats, safety shoes
16	Ripping, drilling and/or breaking of silica materials	• Being struck by or caught in a moving part of quarry equipment	• Training of workers • Proper selection of equipment, noting presence of guards • Install/replace all guarding mechanism on equipment/ machines
17	Pushing and stockpiling of quarried silica materials	• Equipment accident (fall from edge of a bench, being hit by falling rocks, etc.)	• As in #HN 5
18	Crushing of coarse grained silica ores	• Generation of fine and respirable crystalline silica dusts that could expose and predispose people to silicosis, respiratory, dermal and kidney diseases and possibly cancer	• As in #HN 11
19	Crushing of coarse-grained silica ores	• Harmful noise levels	• Provide workers with ear protective PPE • Include hearing tests for pre-employment and annual medical examination of workers
20	Crushing of coarse grained silica ores	• Fugitive rock and/or debris projectiles	• Provide machinery guards and protective curtains, as necessary • Regular and adequate equipment maintenance • Provide workers in the vicinity of the crushing area with adequate PPEs (eg. hard hat, safety shoes, goggles, dust mask, gloves)
21	Crushing of coarse grained silica ores	• Contact of body parts with moving equipment parts	• Install and/or replace machine guards as necessary

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
22	Hauling and transport of silica materials	• Generation of airborne dusts from dirt roads and from silica materials being hauled	• Regular and adequate water sprinkling of haul dirt roads • Adequate cover over the materials being transported
23	Hauling and transport of silica materials	• Noise from haul trucks could cause disturbance to communities along the haul route	• Observance of hauling/transport schedules, whicch takes into account the welfare of the public (eg. no transport during night time)
24	Hauling and transport of silica materials	• Vehicular accidents at the quarry site (fall from edge of bench, collision with other vehicles/equipment or structures, overturning, etc.)	• As in #HN 5
25	Hauling and transport of silica materials	• Traffic accidents (collision with other vehicles, hitting pedestrians and/or animals, others)	• Adequate training of drivers • Adequate vehicle maintenance • Regular performance review and implementation of corrective measures
27	Storage and Use of Flammables (fuel oil)	• Pool/ jet fires	• Remove/reduce ignition sources in the area. • Ensure regular inspection and maintenance of bund containment (bund capacity should at least be 110% of the tank's capacity). • Ensure regular inspection and maintenance of tanks, pipings, hoses, valves, gauges and other accessories. • Maintain a safety radius or buffer zone around the facility. • Ensure provision of fire control devices and systems. • Ensure strict adherence to Emergency Preparedness and Response and Plan (EPRP) • Ensure maintainance of properly functioning fire trucks, fire extinguishers and other fire fighting equipment.
28	Storage and Use of Flammables (fuel oil, lubricants)	• Generation of harmful combustion products (particulates, SO_x, NO_x, ozone, etc)	• Same as above
29	Storage and Use of Flammables (fuel oil, lubricants)	• Spills causing soil and/or water contamination	• Same as above

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
30	Storage and disposal of hazardous wastes (used oil, lubes, etc.)	• Spillage and subsequent contamination of soil and nearby water bodies with harmful chemical components	• Implement the provisions of RA 6969 on the storage and disposal of hazardous wastes • Contract out to accredited waste transporters and treaters for the disposal of hazardous wastes • Training and education of workers on the proper handling, storage and disposal of hazardous materials and wastes
31	Storage and disposal of hazardous wastes (used oil, lubes, etc.)	• Exposure of people to toxic components	• Same as above
32	Settling Ponds	• Breaching of settling ponds could lead to flash floods, siltation and possible contamination with heavy metals and minerals (Cr, Pb, Fe, Mn, Mg, of surface waters and nearby lands	• Ensure appropriate siting, design and construction of settling pond and related facilities. • Ensure regular, as well as emergency inspections and monitoring of structures • Ensure proper and regular maintenance of the facility, including sediment dredging when critical levels are reached • Security measures to prevent sabotage of infrastructures.
33	Ergonomic issues (heavy lifting, prolonged standing, repetitive movement, awkward postures, etc.)	• Ergonomic hazards that may lead to bodily injuries and stress	• Training of workers on proper body mechanics in performing various tasks • Job rotation to reduce exposure to very stressful tasks • Provide workers with adequate break times
34	Earthquakes	• Landslides and rockfalls • Damage to structures and equipment • Injuries/fatality to people	• Formulate and implement an earthquake response plan that includes the following: monitoring and warning system; system of communication within and outside the mine site; SOPs for all personnel, workers and contractors; and evacuation plan. • Conduct regular and timely orientation and drills of all personnel, workers, contractors, as well as nearby communities, on the earthquake/tsunami emergency response plan and procedures. • Ensure regular and timely inspections and monitoring of all buildings and infrastructures within the mine site. • Ensure proper zoning and location, as well as good engineering, of buildings and other infrastructures.
35	Increased frequency and intensity of tropical cyclones	• Landslides and rock falls • Flooding of low lying areas	• Regular review of the Project's ERPP • Strict implementation of and compliance with the safety and health program, especially the EPRP.

HN	Activity/ Condition	Hazard	Recommended Mitigating Measures
		• Damage to buildings and equipment • Injury or fatality from falling trees, debris, rock fragments projectiles, and equipment parts	• Regular and timely inspections and monitoring of containment dikes, retaining walls, and other retaining structures. • Orient all personnel, workers and contractors of the EPRP • Regular conduct of emergency drills for situations such as fires, flooding and earthquakes. • Education/ information campaigns on climate change, its impacts and appropriate responses to mitigate impacts (tailored to the specific condtion in the area).
36	Increased intensity and frequency of rains during rainy season	• Same as above	
37	Drier dry seasons and increased ambient temperatures	• Fire incidents; • Increased airborne dusts; • Drying of water reservoirs and sources • Increase in heat related diseases such as heat strokes, heat rashes, etc.	• Continue to implement progressive rehabilitation and reforestation program of mined-out areas and other denuded areas. • Implement fire prevention and control measures and protocols. • Implement dust suppression measures such as regular and adequate water sprinkling on dirt haul roads, overburden stockpiles • Provide adequate cover over silica stockpiles and during transport • Provide workers with dust protection PPEs such as dust mask/respirators, eye goggles.
38	External Threats/ Terrorism	• Terroristic attacks and/or sabotage of quarry facilities	• Fencing and security barriers of critical equipment • Proper deployment of security personnel • Monitor for security announcement/advice from government's national/regional/ local security agency • Establish good public relations with the surrounding communities

J. Environmental Risk Mitigation: Assessment and Enhancement

Mitigating measures to address the hazards of landslides or slope/ground failure, siltation of rivers and downstream areas, degradation of water quality, and potential health impacts of silica in the 10-hectare silica quarry of HAZ has been identified and adequately implemented. To address the hazard of siltation and water quality degradation, the project has implemented an appropriate quarry design that involves benching; it has put up a three-stage siltation pond system with water capacity of 5,000 m^3; it regularly desilted the siltation ponds, and it has started to implement a progressive rehabilitation and reforestation program, among others. To address the hazard of landslides, it implemented measures as identified in the Section on ***High Potential for Landslides and Rockfalls***.

To address the hazards of vehicular/equipment and road accidents, it implemented measures as identified in Table 4-7. Health hazards from airborne dusts were mitigated through regular sprinkling with water exposed and dusty areas such as hauling roads, excavation faces and quarry pits during the dry season.

The types of hazards associated with the 10-hectare silica quarry operation are basically the same as those in the expanded 50-hectare quarry silica operation. As such, the type of mitigating measures used for each particular hazard associated with the 10-hectare quarry will basically be the same measures that will be employed in the expanded quarry operation. However, implementation of said measures will be intensified and expanded. The mitigating measures will be implemented in a wider scope and scale.

Siltation Hazards. As a case in point, in anticipation of expanded operation and added risk of siltation to rivers, irrigation canals and downstream areas, an additional two-stage siltation traps and one siltation pond and drainage systems were recently built, in addition to the three-stage siltation pond that was built for the existing 10-hectare quarry. Regular desilting of the siltation traps and ponds will continue to be carried out. Table 4.9 shows the location and specifications of the new siltation traps and ponds. More siltation ponds may be constructed if the existing ones prove to be inadequate.

Table 4-9. The newly built 2-stage siltation traps and one primary siltation pond: location, area and holding capacities.

NEW CONSTRUCTION : 2-Stages Silt Traps and 1 Primary Siltation Pond										
							AREA		**Holding Capacity**	
		NORTHINGS	EASTINGS	LINE	DISTANCE				**Water Level**	**Silt Level**
PRIMARY SILT TRAPS (PST)	PST-1	9°51'20.87"N	123° 4'45.92"E	PST 1-2	25	MTS	1,342	SQ.M.	B+330 - B+320	B+328 - B+320
	PST-2	9°51'20.36"N	123° 4'45.29"E	PST 2-3	42.34	MTS			Depth = 10mts	Depth = 8mts
	PST-3	9°51'21.41"N	123° 4'44.40"E	PST 3-4	27.5	MTS			Silt holding Cap. = 6,710 LCM	
	PST-4	9°51'21.94"N	123° 4'45.09"E	PST 4-1	41.31	MTS			**Desilt every (Days)**	**43**
		NORTHINGS	EASTINGS	LINE	DISTANCE		AREA		**Water Level**	
SECONDARY SILT TRAPS (CST)	SST-1	9°51'22.02"N	123° 4'44.76"E	SST 1-2	25.79	MTS	1,207	SQ.M.	**B+319 - B+314**	**B+318 - B+314**
	SST-2	9°51'21.49"N	123° 4'44.07"E	SST 2-3	25.84	MTS			Depth = 5 mts	Depth = 4mts
	SST-3	9°51'21.23"N	123° 4'43.24"E	SST 3-4	48.37	MTS			Silt holding Cap. = 4,828LCM	
	SST-4	9°51'22.70"N	123° 4'42.80"E	SST 4-5	35.32	MTS			**Desilt every (Days)**	**46**
	SST-5	9°51'22.28"N	123° 4'43.88"E	SST 5-1	28.42	MTS				
		NORTHINGS	EASTINGS	LINE	DISTANCE		AREA		**Water Level**	
PRIMARY SILT PONDS (PSP)	PSP-1	9°51'29.20"N	123° 4'37.19"E	PSP 1-2	30	MTS	379	SQ.M.	**B+300 - B+295**	**B+318 - B+314**
	PSP-2	9°51'29.32"N	123° 4'36.23"E	PSP 2-3	12	MTS			Depth = 5 mts	Depth = 4mts
	PSP-3	9°51'29.72"N	123° 4'36.34"E	PSP 3-4	30	MTS			Silt holding Cap. = 1,516LCM	
	PSP-4	9°51'29.55"N	123° 4'37.26"E	PSP 4-1	12	MTS			**Desilt every (Days)**	**29**

Health Hazards from Airborne Dusts. An expanded area of operation can likewise increase health risks from airborne dusts that may contain fine silica dusts due to greater exposed open areas and greater frequency of ore hauling operation. To respond to this, an additional water truck unit has been added to the existing one water truck unit that is used to periodically wet potential sources of airborne dusts such as haul roads, quarry pits, excavation faces and spoil stockpiles especially during the dry season. The practice of minimized site clearing for mining coupled with progressive rehabilitation and reforestation will help reduce airborne dusts and will continue to be pursued. In anticipation of greater area for reforestation, the HAZ will start to establish its own nursery for forest tree seedlings and other plants.

Hazards from Landslides, Mudslides and Rockfalls. As discussed in the Section on Geology, the area is not prone to mudslides. It is however classified as highly prone to landslides. Risks from landslides and rockfalls may increase with the expansion of mining area operation due to the increased disturbed area. The existing mitigating measures will be pursued in a wider scale, in all area of operation. These mitigating measures are as discussed in Section on **High Potential for Landslides and Rockfalls.** Additionally, as described in the company's AEPEP for 2019, a daily landform monitoring protocol will be implemented in order to detect signs of impending slope/ground failure, thoroughly assess such signs if found, and to implement appropriate actions as necessary.

The Supervisor is responsible for the daily surveillance of local topography especially at the vicinity of the primary extraction zone. Adverse and abrupt changes in surface topography such as sloughing, en-echelon cracks, gullies and erosion may indicate an impending ground/slope failure and should be thoroughly assessed to serve as basis for mitigation and appropriate action, which may be in the form of redesigning of mining system, suspension of work, or transfer of excavation site. Quarry workers and potentially affected communities should be properly informed of impending slope/ground failure that may affect them. The regular visual monitoring will also include observations on the stability of stockpiles, integrity of the pits, extraction faces and conditions of the area drainage system.

Road Accident Hazards. The risk from road accidents increases with the number of vehicles plying the route. The expansion of the project area from 10 hectares to 50 hectares is expected to increase the volume of ores to be hauled/transported from the project site to the ports. As such, frequency of ore haulage and greater vehicular accident risk may be expected on the route to be taken by the hauling trucks. The vehicular accident mitigating measures shown in Table 4-7, are already being implemented by HAZ. These measures are recommended to be further pursued with the project expansion. Newly hired drivers, operators and spotters should be thoroughly oriented and trained on safety procedures and protocols while existing ones should be regularly refreshed with safety procedures and protocols.

5. Social Development and Management Program / Information, Education and Communication

A. Social Development and Management Program (SDMP)

1. Review of the 2011-2019 SDMP

In 2011, the only SDMP project that was implemented was the construction of two (2) spillways amounting to P250,000.00. Holcim provided the construction materials, aggregates, cement and in part labor. The other materials and labor were provided by the local government of Ayungon. The other areas of concern such as health, education, livelihood and socio-cultural activities were not given focus as shown in Table 5-1.

The same table shows that in year 2012, there were more projects implemented in the three direct impact barangays. The purchase of medicines, development of a water system, road concreting, purchase of a mini-bus, procurement of IEC equipment and the expansion of a health center were the projects pursued. The total budget incurred for the said year totaled to P1,750,000.00. It should be noted that the activities centered on health and infrastructure, the areas of concern overlooked were education, livelihood and socio-cultural.

In the succeeding year, 2013, only the establishment of infrastructure/facilities and purchase of water tanks and medical equipment were done. Carrying out these activities had a subsequent expenditure of P457,736.83. The highest allotment was given to barangay Maaslum for the construction of the community center and fencing of the community plaza.

Again in 2014, health and infrastructure projects comprised the projects for the development of the communities. The funds spent to carry out the said projects was P255,763.50. Purchase of medicines for barangay Tampocon 1 residents in the amount of P60,000.00 was implemented while construction of a foot trail in barangay Gomentoc and foot bridge in barangay Maaslum were accomplished.

For year 2015, only projects related to infrastructure or public utilities such as the construction of secondary electrical lines in barangay Gomentoc for P124,000.00, construction of the barangay Maaslum plaza stage and multipurpose hall and the expansion of the multipurpose hall in barangay Tampocon 1 were undertaken.

The purchase of a mobile rice mill machine was done in 2016 to benefit the farmers of barangay Gomentoc. The construction of the multi-purpose hall (Phase 2) in barangay Maaslum and the maintenance and rehabilitation of streetlights in barangay Tampocon 1 were implemented which benefitted the residents of the said villages.

Health and infrastructure concerns were addressed in 2017 by purchasing a service vehicle for the patients in barangay Tampocon 1, constructing a foot bridge in Maaslum and road widening of a farm to market road in Gomentoc. These accomplishments were a big help to the sick residents and farmers/traders of crops raised in the said community.

SDMP activities in 2018 in the direct impact barangays concentrated on livelihood such as cattle fattening in barangay Gometoc while education concerns were addressed through the construction of a school feeding facility and maintenance of the school service in barangay Maaslum. The concern on infrastructure was addressed through the maintenance and rehabilitation of streetlights in the same barangay.

For 2019, the livelihood activities implemented were the cattle fattening project in barangay Gometoc and the purchase of a portable rice mill for barangay Maaslum. Road repair was the activity undertaken for barangay Tampocon 1.

In the SDMP projects and activities that the company and the community embarked on from 2011 to 2019 highly focused on infrastructure and to a lesser degree on livelihood and health.

The support to education and socio-cultural activities was taken cared by the Corporate Social Responsibility (CSR) funds of the company.

Table 5-1. Projects and Activities Implemented Under the SDMP 2011-2019

Year	Concern	Barangay	Beneficiaries	Budget
2011				
	Health	-	-	-
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure • Construction of 2 spillways	Maaslum	Residents of barangay Maaslum	P250,000.00
	Socio-cultural	-	-	-
	Sub-Total	**-**	**-**	**P250,000.00**
2012				
	Health			
	• Purchase of medicines	Gomentoc	Residents of barangay Gomentoc	P10,000.00
	• Purchase of medicines	Tampocon 1	Residents of barangay Tampocon 1	P20,000.00
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure			
	• Water development (setting water tank and distribution of water supply)	Gomentoc	Residents of barangay Gomentoc	P50,000.00
	• Transportation service – minibus	Maaslum	Residents of barangay Maaslum	P1,600,000.00
	• Procurement of IEC equipment	Tampocon 1	Residents of barangay Tampocon 1	P10,000.00
	• Expansion of health center	Tampocon 1	Residents of barangay Tampocon 1	P60,000.00
	Socio-cultural	-	-	-
	Sub-Total			**P1,750,000.00**
2013				
	Health	-	-	-
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure			

Year	Concern	Barangay	Beneficiaries	Budget
	• Electrification project-construction of secondary electrical line	Gomentoc	Residents of barangay Gomentoc	P120,000.00
	• Community center	Maaslum	Residents of barangay Maaslum	P99,999.83
	• Construction of fence for community plaza (materials)	Maaslum	Residents of barangay Maaslum	P96,377.00
	• Purchase of water tanks for the development of water source	Gomentoc	Residents of barangay Gomentoc	P51,360.00
	• Procurement of medical equipment	Tampocon 1	Residents of barangay Tampocon 1	P90,000.00
	Socio-cultural	-	-	-
	Sub-Total			**P457,736.83**
2014				
	Health			
	• Purchase of medicines	Tampocon 1	Residents of barangay Tampocon 1	P60,000.00
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure			
	• Construction of foot trail so sitio Sacsac	Gomentoc	Residents of barangay Gomentoc	P90,000.00
	• Construction of foot bridge (materials)	Maaslum	Residents of barangay Maaslum	P105,763.50
	Socio-cultural	-	-	-
	Sub-Total			**P255,763.50**
2015				
	Health	-	-	-
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure	-	-	-
	• Electrification Project-construction of secondary electrical line going to sitio Canlukduhan	Gomentoc	Residents of barangay Gomentoc	P124,000.00
	• Construction of barangay plaza stage	Maaslum	Residents of barangay Maaslum	P153,148.00
	• Construction of multi-purpose building	Maaslum	Residents of barangay Maaslum	P155,852.00
	• Expansion of multipurpose hall	Tampocon 1	Residents of barangay Tampocon 1	P185,000.00
	Socio-cultural	-	-	-
	Sub-Total			**P618,000.00**
2016				
	Health	-	-	-
	Education	-	-	-
	Livelihood			
	• Purchase of Mobile Rice mill machine	Gomentoc	Farmers of barangay Gomentoc	P154,395.00
	Infrastructure			
	• Construction of multi-purpose Hall (Phase 2)	Maaslum	Residents of barangay Masslum	P385,987.00

Year	Concern	Barangay	Beneficiaries	Budget
	• Maintenance of and rehabilitation of streetlights	Tampocon 1	Residents of barangay Tampocon 1	P231,592.00
	Socio-cultural	-	-	-
	Sub-Total			**P771,974.00**
2017				
	Health			
	• Purchase of service vehicle for patients	Tampocon 1	Residents of barangay Tampocon 1	P231,592.00
	Education	-	-	-
	Livelihood	-	-	-
	Infrastructure			
	• Barangay road widening (Phase 1) farm to market road at sitio lower Danao	Gomentoc	Farmers/ traders of farm produce	P154,395.00
	• Construction of foot bridges for Mambago and sitio Ilaya	Maaslum	Residents of barangay Maaslum	P385,987.00
	Socio-cultural	-	-	-
	Sub-Total			**P771,974.00**
2018				
	Health	-	-	-
	Education			
	• Renovation of school feeding facility	Masslum	Maaslum elementary school	P100,000.00
	• School bus maintenance	Maaslum	Maaslum high school students	P20,000.00
	Livelihood			
	• Cattle fattening project	Gomentoc	Farmers/traders of farm produce	P154,395.00
	Infrastructure			
	• Maintenance and rehabilitation of streetlights	Maaslum	Residents of barangay Maaslum	P265,987.00
	Socio-cultural	-	-	-
	Sub-Total			**P540,382.00**
2019				
	Health	-	-	-
	Education	-	-	-
	Livelihood			
	• Purchase of portable feed mill	Maaslum	Residents of barangay Maaslum	P385,987.00
	• Cattle fattening project	Gomentoc	Farmers/traders of farm produce	P154,395.00
	Infrastructure			
	• Road repair	Tampocon 1	Residents of barangay Tampocon 1	P231,592.50
	Socio-cultural	-	-	-
	Sub-Total			**P771,974.50**
Grand Total				**P6,187,804.83**

2. Summary of SDMP expenditures by year (2011-2019)

Table 5-2 shows that of the total SDMP funds for the development of host and neighboring communities (DHNC) over the years 2011-2019 amounted to P6,187,804.83 or on the average P687,533.00 per year. The allotment of these funds in relation to the areas of concern was highly concentrated on the construction and maintenance of public utilities like roads, foot bridges, foot trails, community centers, streetlights and the development of water systems. The total funds apportioned to this was P4,897,040.83 or 79%. The second item that was given 14% of the funds was for the development of livelihood opportunities at P849,172.00 followed by health to which was delegated with P321,592 or 5% of the total expenditure. The least participation was on the area of education, which was given only P120,000.00 or 2% of the fund resources. Nothing was appropriated in support of the socio-cultural activities of the communities.

On a per year basis, the same table shows that there are certain periods that all the SDMP allotment was spent on infrastructure such as in 2011, 2013 and 2015. It was in 2016 when 20% of the annual allotment was given to livelihood projects.

Table 5-2. Summary of SDMP/DHNC Expenditure by Year, 2011-2019

Year	Total expenditure for the DHNC	Percentage	Health	%	Education	%	Livelihood	%	Infrastructure	%	Socio-cultural	%
2011	P250,000.00	4.04%	-	-	-	-	-	-	P250,000.00	100%	-	-
2012	P1,750,000.00	28.28%	P30,000.00	2%					P1,720,000.00	98%	-	-
2013	P457,736.83	7.39%	-	-	-	-	-	-	P457,736.83	100%	-	-
2014	P255,763.50	4.13%	P60,000.00	23%					P195,763.50	77%	-	-
2015	P618,000.00	9.98%	-	-	-	-	-	-	P618,000.00	100%	-	-
2016	P771,974.00	12.47%	-	-		-	P154,395.00	20%	P617,579.00	80%	-	-
2017	P771,974.00	12.47%	P231,592.00	30%	-	-	-	-	P540,382.00	70%	-	-
2018	P540,382.00	8.73%	-	-	P120,000.00	22%	P154,395.00	29%	P265,987.00	49%	-	-
2019	P771,974.50	12.47%	-	-	-	-	P540,382.00	70%	P231,592.50	30%	-	-
Total	P6,187,804.83	100%	P321,592.00	5%	P120,000.00	2%	P849,172.00	14%	P4,897,040.83	79%	0	0%

3. Summary of SDMP funds allocation per barangay, 2011-2019

On a per barangay basis, the table below shows that from the period 2011 to 2019, P4,005,087.83 or 65% of the SDMP funds was appropriated to barangay Maaslum while 17% or P1,062,940.00 was allocated to barangay Gomentoc and 18% or P1,119,776.00 to barangay Tampocon 1. The data indicates that more socio-development projects of more importance and of higher priority were identified and implemented in barangay Maaslum.

It can also be be seen from the table that there were three hundred ninety-five (395), one hundred twenty (120) and one hundred (100) families and households directly benefitted from the SDMP projects in Barangays Maaslum, Gomentoc and Tampocon I, respectively.

Table 5-3. Summary of SDMP Funds Allocation per Barangay, 2011-2019

Barangay	Allocation	%	Number of Direct Beneficiaries*
Maaslum	P4,005,087.83	65	395 households
Gomentoc	P1,062,940.00	17	120 families
Tampocon 1	P1,119,776.00	18	100 households
Total	**P6,187,804.83**	**100**	

It should be noted that there are likewise other indirect beneficiaries who were able to take advantage of the gains provided to the direct beneficiaries. For example, the footbridge that was constructed using SDMP funds was originally for foot passage but when renovated was able to accommodate motorcycles. This implies that more people, including those not necessarily from the locality were able to reach their destinations in less time. Furthermore, access to electricity to more households provided additional income opportunities (i.e., ice and ice candy sales, etc.) and less spoilage through refrigeration to the direct and indirect beneficiaries of the SDMP projects.

4. SDMP Project Impacts

The impacts presented in Table 5-4 as mentioned in the Social Impact Assessment made in 2016 indicate that the identified and implemented SDMP projects addressed the needs and concerns existing in the communities. The residents were very satisfied with the said projects giving credit to Holcim for its contribution in improving the barangay conditions.

Even the electrification project in Barangay Gomentoc in 2013 generated positive results not only in the provision of adequate power supply but also in providing an additional source of income to the barangay residents. They were able to sell frozen/chilled products such as ice candy, ice water and cold drinks. The education of the students was likewise enhanced by way of access to IT gadgets/equipment used in researching information needed in home assignments and school projects. The residents were also kept abreast with the news and what was happening in other areas since they now have electricity-powered gadgets and radio. Social activities were also enriched by having gatherings made lively with karaoke singing.

The improvement of roads, foot trails and foot bridges enabled the residents especially school children to safely reach their classrooms during monsoon months. The cementing and widening of roads presented to farmers and traders of agricultural products more opportunities in saving on time and gaining more profit in transporting their goods to the market. Residents in the community who were hired during the construction of the projects obtained additional income.

The development of the water facilities provided not only a reliable water supply but ensured a healthy and sanitary home environment for the residents. The time saved in fetching water from a distant source also provided the residents more time to perform other productive activities.

The rehabilitation of streetlights likewise had a big impact on the communities as the residents can walk even at night feeling safe and secure on the well-lit streets in the barangay.

The provision of medicines was seen by the community members as giving them a respite from their problem of not being able to access even cheap medicines. Common illnesses were treated immediately though the medicines provided were considered as inadequate for their needs. In addition, the acquisition of a service vehicle to transport the sick to hospitals was considered by the residents as very helpful to them.

The construction/renovation of other barangay facilities such as the stage improvement, multi-purpose hall rehabilitation, and others likewise made the residents secure that they can hold their community activities in a place which is presentable and safe.

The purchase of a mini-school bus was a big help because students did not need to spend transportation money going to and from school. In addition, the danger of these students hitching a ride with the silica haulers/trucks was prevented. However, because of the increase in student population in the most recent years, some students cannot be accommodated thus, a fare of P80 per student per day was incurred.

The implementation of some livelihood projects like the acquisition of a mobile rice mill which started for Gomentoc in 2016 and 2019 for Maaslum, in addition to cattle fattening in Gomentoc (2018 and 2019), provided an alternative source of livelihood to the residents. However, an assessment of the success and sustainability of these projects must be done to make sure that these provided a regular stream of income to the community and to determine the degree and magnitude of impacts these have created.

Table 5-4. Impacts of SDMP projects/Activities Implemented in Years 2012-2019

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
Maaslum	Road construction (P250,000.00)	2011	• Prior to the implementation of the project, the residents had problems relative to their safety due to excessive rain and flooding that endangered their lives. • Agricultural products like copra and bananas could not be transported from the barangay to the marketplace • Pupils/students could not attend classes and livelihood opportunities were lost due to poor road condition.	• Agricultural products can now be easily transported to the marketplace. • Pedestrians and motorists can pass through the spillways. • Children are regularly present in their classes except on extremely stormy weather. • During emergency cases, the spillways are felt by the residents as a safe and an important passageway for people, animals, products and others.	• Residents and technical working group expressed that they are extremely satisfied • Project has given so much economic benefits to the residents • Previous problems greatly solved. • Holcim's contribution seen as excellent contribution in improving the residents' economic lives.
Maaslum	Mini-bus school service (P1,600,000.00)	2012	• Students have to walk starting at 5 -7 am to attend school and 5-7pm to reach their homes • More often than not, if they do not walk, they hitch a ride with the silica haulers which is dangerous • Difficulty of residents in reaching the town proper, especially the hospital in emergency cases.	• Minibus was a big help because students did not need to spend transport money in going to and from school • The minibus provided free transportation • During emergency cases, the residents can be transported from the barangay to the nearest hospital • Due to the increase in student population in the recent years, some students cannot be accommodated and thus spent P80 per day for fare.	• The technical working group was only moderately satisfied compared to the household members who were extremely satisfied. • The previous problem was moderately solved according to the technical working group while the residents felt that the problem was greatly solved. • Holcim contribution according to the technical working group was good while the households felt that Holcim had an excellent contribution in improving the lives in the barangay.
Maaslum	Community center Holcim - P 99,999.83 LGU Ayungon – P30,000.00	2013	• The plaza was open without fencing • Stray animals roamed freely in the area	• Fencing somehow solved the problem • Clean plaza • Safe for children to play	• The household members are extremely satisfied

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
			• Other animals were purposely tied and left in the area to graze • Altercations and discussions among residents about the animal waste left in the plaza area	• Plaza can be used in drying rice and other crops such as chopped cassava • Sports activities and other recreational undertakings held in plaza • Heated discussion over the condition of the plaza has been avoided.	• Holcim contribution seen as an excellent contribution in improving the barangay.
Maaslum	Construction of fence for community plaza (P96,377.00)	2013	• Open community plaza	• Provided security to town plaza against vagrants and other unwanted elements	• Residents very satisfied with the fence
Maaslum	Purchase of water tanks for the development of water source (P51,360.00)	2013	• Limited access to water	• Provided a stable source of water supply	• Very satisfied with more access to a reliable water source
Maaslum	Foot bridge (P105,763.50)	2014	• Difficulty on the part of the students to go to school and come back whenever flooding occurred. • Residents' means of livelihood was affected because transport of agricultural products to the market was difficult	• The construction of the sitio Ilawod footbridge ensures the safety of the school children during the rainy season • Students are seldom absent from school • The footbridge is not only passable by foot. It is wide, sturdy and stable enough that it can also accommodate motorcycles with passengers.	• Problem is highly solved • Households are extremely satisfied • Holcim contributed much in improving the barangay
Maaslum	Construction of the plaza stage (P153,148.00)	2015	• The old stage was damaged by a 6.9 magnitude earthquake • Barangay gatherings used to be held in the area • Activities were constructed elsewhere when the stage was destroyed	• The stage is now serving the needs of the barangay • Cultural development, feeding programs, • Assemblies, pageants, and other activities are held on the newly constructed stage	• Both households and technical working group agreed that they are extremely satisfied by the completion of the project • Holcim has done an excellent contribution in improving the barangay

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
Maaslum	Construction of multi-purpose building (P155,852.00)	2015	• No venue to hold public events or recreational /sports activities	• Provided a venue to hold community events	• Very satisfied with the multi-purpose building
Maaslum	Construction of multi-purpose hall – Phase 2 (P385,987.00)	2016	• Unfinished multi-purpose hall	• Provided a venue for a better and complete venue to hold community activities	• Very satisfied with a finished multi-purpose hall
Maaslum	Construction of foot bridges for Mumbago and Ilaya (P385,987.00)	2017	• Difficulty in traversing the slopes of the higher elevation in the barangay	• Provided a more established and secure means to travel especially during rainy season	• Highly satisfied with a more secure and stable way to traverse the hilly slopes going to various places
Maaslum	Renovation of school feeding facility (P100,000.00)	2018	• Dilapidated school feeding facility	• Provided a more secure place for school children to enjoy their meals/snacks	• Very satisfied with a more functional feeding facility
Maaslum	School bus maintenance (P20,000.00)	2018	• No funds for the maintenance of school bus	• Maintained the school bus for a more reliable transport service for school children and teachers	• Very satisfied with the upkeep of the school bus
Maaslum	Maintenance and rehabilitation of streetlights (P265,987.00)	2018	• Non-functioning of some streetlights	• Provided a more secure and safe walk on the streets especially at night through a well-lit thoroughfare	• Very satisfied as residents can walk at night knowing they are safe on the streets
Maaslum	Purchase of portable feed mill (P385,987.00)	2019	• Limited sources of alternative income	• Savings on transporting rice to be milled as the portable feed mill gives more access to residents near their residences	• Very satisfied with the savings made on transportation cost and easier access to a rice mill
Gomentoc	Purchase of medicines (P10,000.00)	2012	• Colds cough, flu hardly treated due to poor access to medicines • Limited medicines for emergency cases • Provision of medicines on first come first serve basis • The barangay has an allocation of P10,000 per year but this was not sufficient • Many residents cannot afford to buy even cheap medicines	• Common illnesses were treated immediately • Medicines were all distributed even if considered to be insufficient	• Residents very satisfied • Holcim contribution seen as very good contribution in improving barangay • Previous problem moderately solved

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
Gomentoc	Water development (P50,000.00)	2012	• Many incidences of diarrhea and water-related illnesses (sitio Danao) • No safe source of drinking water • Residents get their drinking water from open wells • Residents had to carry 20-liter containers uphill and downhill for about ½ km • Pupils would attend classes even without bathing considered as unhealthy practice • Only residents of sitio Danao benefitted	• Diarrhea and other water-related illnesses decreased • Connected households have safe water supply for drinking and other household purposes • Total households =70 • Pupils now attend classes clean and well-groomed • Time spent in fetching water was lessened and can have more time doing productive activities • Water fees collected – minimum rate at P95/mo • Beyond 10 cu m. P6.50 per cu m	• Residents extremely satisfied • Holcim contribution seen as very good in improving lives • Previous problem moderately satisfied
Gomentoc	Road concreting		• Municipal road flooded during rainy season • The foot bridge was used to get to the other side of the road • People and even motorcycles had difficulty in passing through the approach especially after a rain • School enrollment has decreased from 300 to 269 due to poor road condition and unsafe river crossing during rainy season	• The cemented approach to the footbridge made the residents and "traders" passage convenient and safe • Easier and faster transport of farm produce to market • Motorcycles can pass through the foot bridge • Some residents who were employed in constructing the project earned additional income	• Residents are very satisfied • Holcim contribution seen as excellent contribution in improving the barangay • Previous problem was highly solved
Gomentoc	Electrification project (construction of secondary electrical line (P120,000.00)	2013	• Pupils could not study well at night • Residents had poor communication capabilities and not kept abreast of what what was happening in the outside world • Residents were not abreast with the coming typhoons and other calamities • Household incomes depended mostly on agriculture	• 150 hh were benefitted • Students' performance in school improved • Residents have access to news, market and farm updates • Households have other income by having a store or by selling ice candy, ice water, cold drinks, etc. • Households can stock more food and medicines for future use	• Residents are extremely satisfied • Holcim contribution is seen as an excellent contribution in improving the barangay • Previous problem highly solved

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
			• Food and medicines could not be kept long	• Some residents have improved their lifestyle or quality of life by use of cellphones, laptops and other ICT equipment whether for business, social or educational purposes • Social activities are improved and enlivened by making possible the use of varied household appliances like karaoke, components, etc.	
Gomentoc	Purchase of water tank for the development of water source (P51,360.00)	2013	• Limited access to safe water	• Provided a more stable source of safe/clean water	• Residents very satisfied
Gomentoc	Construction of foot trail to sitio Sacsac (P90,000.00)	2014	• Almost not passable foot trail during rainy season for people and motorcycles • Foot trail land slide prone • Foot trail partially damaged by typhoon thus needs repair • Passage on the foot trail was inconvenient and unsafe without gravelling and the approach to the connecting foot bridge being cemented • Difficult to transport patients from interior barangays for treatment • School enrollment decreased from 300 to 269 due to poor road condition and unsafe river crossing	• Foot trail was improved after gravelling making passage more convenient and safer • Farm products and inputs are transported to market faster and easier • Quicker and safer transport of patients from interior areas • Faster, easier and safer travels/walks of people to and from school during rainy season	• Residents are very satisfied with the project • Holcim contribution is seen as an excellent contribution in improving the barangay • Previous problem highly solved
Gomentoc	Electrification project- construction of secondary electrical line going to sitio (P599,819.00) Holcim – P124,819.13	2015	• Students could not study well at night • Residents had poor communication capabilities and	• 30 households are benefitted • Pupils' and students' performance improved through - sourced educational assistance	• Residents are extremely satisfied with the project • The Holcim contribution is seen as an excellent contribution in improving the barangay

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
	LGU Ayungon - P475,000.00		were not abreast with what was happening in the outside world • Household income depended mostly on agriculture • Food and medicines could not be kept long	• Residents have access to news and market/farm updates • Households can have other sources of income by selling ice candy. Iced water, etc. • Households can stock more food and medicines for future use • Some residents have improved their lifestyle or quality of life with the use of cell phones, laptops and other ICT equipment whether for business, social or educational purposes • Social activities are improved and enlivened by making possible the use of varied household appliances like karaoke, components, etc.	• Previous problem highly solved
Gomentoc	Purchase of mobile rice mill machine (P154,395.00)	2016	• Residents did not have an alternative source of income	• The residents saved some amount in terms of transporting the rice to be milled to milling stations • Source of alternative income	• Residents satisfied to have a more accessible rice mill
Gomentoc	Barangay road widening (Phase 1) farm to market road at sitio lower Danao(P154,395.00)	2017	• Difficulty in transporting agricultural produce to market	• Ease and comfort in transporting farm produce to market • Saved time in transporting farm produce to markets hence obtaining higher prices due to the freshness of the produce • Less spoilage/ wastage	• The farmers were highly satisfied with the project.
Gomentoc	Cattle fattening project (P154,395.00)	2018	• Limited alternative source of livelihood	• Additional source of income	• Satisfied with the alternative income source
Gomentoc	Cattle fattening Project (P154,395.00)	2019	• Limited alternative source of livelihood	• Additional source of livelihood	• Satisfied with the alternative income source

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
Tampocon 1	Purchase medicines (P20,000.00)	2012	• Basic over the counter medicines for common illnesses were not enough for the residents of the barangay • Very limited prescription drugs • The residents had to go to the municipal health center and DSWD in order to access basic medicines for common illnesses	• Most residents were able to access basic medicines for common illnesses • Some anti-biotics and other prescription drugs were available but not enough • The students were able to save money in going to the municipal health center and DSWD	• Barangay officials were very satisfied • Residents were extremely satisfied • Holcim contribution is very good in improving the lives in the barangay
Tampocon 1	Procurement of IEC equipment (P10,000.00)	2012	• Most pre-schoolers did not have access to materials for their development • No bulletin boards to post announcements	• Pre-school children can get hold of toys, books and some reading materials • Residents are now updated on the events of the barangay	• Barangay officials very satisfied • Residents are extremely satisfied with Holcim's contribution
Tampocon 1	Expansion of health center (P60,000.00)	2012	• The health center was too small and can serve at most two deliveries with accommodation	• The DOH gave an additional room in the health center. Residents from the barangay as well as some residents from nearby barangays were served	• Barangay officials were very satisfied • Residents are extremely satisfied with Holcim's contribution to improving the lives of the barangay
Tampocon 1	Procurement of medical equipment (P90,000.00)	2013	• There was very few medical equipment available at the health center to the point that very few people can be served	• More patients have access to simple medical care	• The barangay officials were very satisfied • Residents were extremely satisfied
Tampocon 1	Purchase of medicine for indigents Holcim- P60,000.00 LGU – P10,000.00	2014	• Not all sick residents were able to access to basic medical treatment • Medicines were not enough to cater to the needs of residents. Most antibiotics were not available thus the residents have to purchase such.	• The budget for the purchase of medicines have increased thus more people have access to over the counter medicines • Some antibiotics can be availed	• Barangay officials are very satisfied • Respondents extremely satisfied and pointed out that the contribution of Holcim is a great help them
Tampocon 1	Expansion of multi-purpose hall	2015	• The multi-purpose Hall was too small to accommodate all barangay transactions. Barangay sessions are	• The multi-purpose hall is now bigger for the barangay.	• Barangay officials are extremely satisfied. • Residents extremely satisified

Barangay	Project	Year	Before Project	Impacts	Level of Beneficiary Satisfaction
	Holcim – P 185,000.00 LGU – P55,500.00		often times disturbed by the noise created by the residents who buy residence certificates in the office and no privacy in settling of some disputes	• The session hall is now well arranged. The barangay captain has his own office and residents can freely see and talk with the baranfay captain without disturbing other offices.	• This contribution of Holcim has boosted the morale of the barangay officials.
Tampocon 1	Maintenance and rehabilitation of streetlights (P231,592.00)	2016	• Non-functioning streetlights	• Provided a more secure and safe walk on the streets especially at night through a well-lit thoroughfare	• Very satisfied
Tampocon 1	Purchase of service vehicle for patients (P231,592.00)	2017	• Difficulty in transporting sick residents to hospitals	• Provided a safe, comfortable and reliable vehicle to transport ill residents	• Very satisfied with a reliable transportation service
Tampocon 1	Road repair (P231,592.50)	2019	• Difficulty in traversing roads during rainy season	• A more comfortable travel with the repairs made	• Very satisfied with the comfort provided and time saved during travels along the repaired roads

5. Social Development Framework, Year 2020-2025

The Social Development and Management Program (SDMP) under Republic Act No. 7942 (Philippine Mining Act of 1995) provides that contractors shall assist in the development of their mining communities, the promotion of the general welfare of the communities' inhabitants and the development of science and mining technology. Chapter XIV of DAO 2010-21 - the consolidated DENR Administrative Order for the Implementing Rules and Regulations (IRR) of R.A. 7942, requires for the development of community, mining technology and geosciences and further specified the IRR of the SDMP for mining projects. Executive Order (EO) No. 443 or the Comprehensive and Integrated Delivery of Social Services (CIDSS) further demands that the community's minimum basic needs should be delivered. As such, the formulation and implementation of Social Development and Management Program (SDMP) was required from the locally operating mining companies. SDMP is a comprehensive five-year plan of the Contractor/Permit Holder/Lessee authorized to conduct mining and milling operations towards the sustained improvement in the living standards of the host and neighboring communities by creating a responsible, self-reliant and source-based communities capable of developing, implementing, and managing community development activities, projects and programs in a manner consistent with the principle of people empowerment. It is a tool for the development and implementation of community activities/projects/programs in consultation and in partnership with the host and neighboring communities[6]. SDMP's objectives are:

- To meet the minimum basic needs of the mining communities and enhance human welfare and prevent/reduce social ills;
- To optimize the advancement of human resources which includes grassroots development and people empowerment to attain a self-help, self-reliant and self-managed community; and
- To provide opportunities for a self-sustained livelihood thus decreasing dependency on the benefits derived from the mining companies.

DAO 2010-21 also increased the amount for SDMP and IEC from 1% direct mining and milling cost (DMMC) to 1.5% of the Operating Cost. This will mean a significant increase in the funds for community development, IEC and research activities that will be allocated by the mining companies.

The funds for the implementation of the SDMP will be provided by the Contractor/Permit Holder/Lessee with an allotment of a minimum of 1.5% of the total operating cost annually, of which 75% shall be appropriated to implement the SDMP, 15% for the IEC, as well as the corresponding manpower training and development and 10% for the development of mining technology and geosciences.

The amount of funds generated from the mining activities of HAZ over the past years (2011-2019) was very minimal to implement high impact projects. Nevertheless, the company together with the community exerted efforts in identifying and implementing programs and activities that created significant impact on the community.

Therefore, with the proposed expansion project, the volume of production from mining will increase from 125,316,84 MTPY of silica to 625,000 MTPY of silica. Given these figures, it is foreseen that the funds to be allocated for the implementation of the Social Development and Management Program (SDMP) programs and activities will increase upon approval of the expansion. Thus, the increase in appropriation will be able to fund more projects that will address the immediate needs of the community.

It is in this context that the SDMP Framework for 2020-2025 has been formulated and presented in Table 5-5.

In relation to the concern on health, the three direct impact barangays – Maaslum, Gomentoc and Tampocon 1 – the common ailments that beset the communities are cough and colds, asthma and tuberculosis. Being a mining project that excavates and moves the soil, dust particles are dispersed into the air which tend to get into the air passages of the residents. The conduct of medical missions is recommended as an activity under the SDMP in the coming years. Furthermore, the enhancement of local health facilities through the provision of medical equipment and apparatus is also seen as a move to better monitor the state of health of the residents. Lastly, the conduct of regular monitoring on the workers and residents of the community for silicosis or lung fibrosis caused by the inhalation of dust containing silica shall be provided. The literacy rate in Ayungon, as mentioned in the 2012 CLUP is 97% in urban areas compared to 79% in rural communities. Based on the 2015 PSA data, Tampocon 1 is an urban barangay while Maaslum and Gomentoc are classified as rural barangays. In the past SDMP projects, education was allotted 2% from the total SDMP funds. It is understandable that there were projects and activities that were funded through the CSR. However, for the coming SDMP projects (2020-2025), education projects must likewise be given priority considering the state of literacy of the barangays. The education programs that shall be pursued under the SDMP are the upgrading of school facilities like libraries and other amenities. In addition, scholarship grants or support to elementary, high school and college students in terms of school supplies and allowances shall be undertaken for these children to have access to an enhanced quality of education. The support of the company to the “Brigada Eskwela” shows that they are partners in providing to school children the requisites of a good learning environment through safe and clean schools. This activity shall be sustained by the company.

The livelihood aspect of the SDMP which was given only 14% of the total SDMP funds in the past years shall now be given focus by providing trainings on skills and capability enhancement of the residents who are willing to implement livelihood projects. Furthermore, an assessment and identification of potential livelihood alternatives shall be done by the barangay officials and its residents together with representatives of the various sectors of the community. This shall be done to prioritize projects and identify the needed skills and knowledge, available resources and support mechanisms to be able to pursue the identified livelihood. In addition, the basic knowledge in managing small businesses and determining the costs and returns of these shall be imparted to the community.

The improvement of infrastructure shall likewise be implemented but to a regulated level since it was already provided with 79% of the past SDMP funds. Nevertheless, upgrading and maintenance of community facilities shall still be undertaken. The addition, more trucks to water the roads and prevent the dispersion of dust particles must be pursued to solve some of the health issues in the affected barangays.

The improvement of the environment shall be done by planting of trees in buffer zones to mitigate the presence of dust and occurrence of noise during mining activities and transport of mined products by trucks. In addition, these trees will serve as soil cover to absorb and slow down surface run-off during heavy rains.

Trainings on first aid and disaster preparedness shall be done together with the provision of simple tools such as whistles and empty bottles to alert the community during disasters and calamities.

The company shall, through the CSR funds, continue to support the socio-cultural and religious activities in the barangay, such as fiestas and foundation day.

Table 5-5. Social Development and Management Program Framework 2020-2025

Concern/Program/ Project/Activity (PPA)	Responsible Community Member/Beneficiary	Government Agency/Non-Government Agency and Services	Proponent	Indicative Timeline	Sources of Funds
Health • Conduct of regular medical and dental missions with medicine provision • Enhancement of local health facilities	• Barangay kagawad for health/BHWs of barangays Maaslum, Gomentoc and Tampocon 1	• MHO/DOH • BHWs	HAZ Community Relations Officer	Operation	Holcim SDMP
Education • Upgrading of elementary school libraries/ facilities • Scholarship grants/support to high school and college students (supplies and allowances) • Support to "Brigada Eskwela"	• Barangay kagawad on education • Barangays Maaslum, Gomentoc and Tampocon 1	• DepEd • Barangay public schools	HAZ Community Relations Officer	Operation	LGU Holcim SDMP CSR
Livelihood • Skills and capability enhancement on basic business management, identification of appropriate livelihood option based on availability of raw materials, skills, support mechanisms (such as markets, infrastructure, technologies, storage, credit, etc.)	• Barangay Kagawad on livelihood • Barangays Maaslum, Gomentoc and Tompocon 1	• LGU • TESDA • DTI • DPWH	HAZ Community Relations Officer	Operation	Holcim SDMP
Infrastructure • Upgrading of community facilities/ infrastructure • Acquisition of trucks to water the roads traversed by silica hauling trucks	• Barangay kagawad on infrastructure and public utilities and services • Barangays Maaslum, Gomentoc and Tampocon 1	• DPWH • LGU	HAZ Community Relations Officer	Operation	LGU Holcim SDMP

Concern/Program/ Project/Activity (PPA)	Responsible Community Member/Beneficiary	Government Agency/Non-Government Agency and Services	Proponent	Indicative Timeline	Sources of Funds
Environmental enhancement program • Tree planting in buffer zone areas (dust and noise filters) • Active community participation in the conduct of MMT	• Barangay Kagawad on Environment • Barangays Maaslum, Gomentoc and Tampocon 1	• ENRO/DENR	HAZ Community Relations Officer	Operation	Holcim CSR
Socio-cultural • Support to barangay foundation and fiestas • Support to other spiritual activities	• Barangay Kagawad on Socio-cultural Affairs • Barangays Maaslum, Gomentoc and Tampocon 1	• LGU • Religious leaders of various denomination • DoT	HAZ Community Relations Officer	Operation	Holcim CSR
Disaster and Risk Preparedness • Trainings on first aid /disaster and risk preparedness for students and households	• Barangay Kagawad on DRRM Barangays Maaslum, Gomentoc and Tampocon 1	• LGU • DILG	HAZ Community Relations Officer	Operation	SDMP/ CSR funds

B. Information, Education and Communication

An Information, Education and Communication Program is a valued tool not only in terms of building good relationship with a company's partner barangays but also as a mechanism in disseminating information about the company and the project, EIA/research findings, project benefits and unfavorable impacts, mitigating measures, monitoring guidelines and company procedures and regulations.

There are various strategies or ways by which information can be circulated. This may come in the form of radio broadcast, print ads, newsletter and flyers. The conduct of meetings and consultations are also means of making people aware of what is going on in its immediate and neighboring environment. Periodic reviews of the effectiveness of the various extension strategies must also be held so that financial resources are not misused or allocated on ineffective IEC strategies.

The determination to sustain IEC approaches assures the communities of being abreast on the present situation and updates about concerns, issues and resolutions in their barangays. The cost of carrying out these activities are based on the expenditure on radio airtime, expenses on IEC materials, number of participants to meetings/consultations/workshops, venues where the meetings are held, cost of meals and snacks and other incidental expenses in the implementation of the activities.

Since 2012, the company has implemented various IEC activities such as:

- Community consultations/meetings with the Barangay Development Council of the three affected barangays
- Conduct of annual SDMP planning
- Participation in radio programs
- Orientation of barangay workers and others

The table below presents the various IEC approaches that shall be undertaken to ensure that pieces of information relative to the operation, activities and accomplishments of the company are disseminated to the appropriate stakeholders.

To circulate information such as reports on findings of surveys and studies done in the area, completed/on-going and future activities of the company, procedures with regards to requests from the company and other matters, environmental monitoring guidelines/parameters and disaster management, the company shall adopt appropriate IEC strategies. These include the use of flyers, focus group discussions, radio broadcast, consultations/ meetings, site tours and DRRM seminars. The funds to be allocated will depend on the cost of radio spots, flyers/IEC materials and number of participants per seminar/meeting.

Bulong-pulongs or small meetings in the community shall be conducted to keep both the people and company well-informed on the current status of the environment and socio-economic and political dynamics going on in the communities.

The setting up of billboards shall be tapped to make people, not only from the communities, conscious of SDMP accomplishments and contributions of the company to the communities.

Table 5-6. Information, Education and Communication Plan

Target Sector	Major Topics of Concern in Relation to Project	IEC Scheme/ Strategy/Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
Households and LGU officials of Direct impact barangays, Students, POs, NGOs	Project activities • Findings of surveys and studies conducted in the area • Monitoring guidelines/parameters • company procedures with regards to requests from community members and other concerns DRRM seminars/ forum/ trainings to focus on the relationship of mining and potential disasters: • disaster preparedness • increased level of awareness and enhanced capacity • local community ways and means of communicating to residents of impending disaster	• Individual and group methods • Multi-media	• Flyers • Focus group discussion • Radio broadcast • Consultations • Hand-outs • Site tours • DRRM Seminars/ forum	Operation	Based on cost of: - Radio broadcast time - Cost of flyers/IEC materials - Number of participants and Venue
Barangay residents Barangay council POs	Bulong-pulong	Group method	• Consultation/meetings • Focus group discussion	Operation	P5,000 per meeting
Direct and indirect impact communities	Information billboards located in strategic places	Print media	Billboard	Operation	P10,000/billboard

6. Environmental Compliance Monitoring

This section presents the proposed framework for compliance monitoring of the project, which includes, among others, the environmental parameters necessary to monitor the identified key environmental impacts of the HRDC quarry project.

A. Status of Compliance with ECC Conditions

Compliance Monitoring

The latest available MMT *Compliance Monitoring Reports* (MMT-CMR), which covers the first and second quarters of 2016 and 2017 of the 10-has quarry operations, are appended in **Annex 10** of this document. The compliances of the existing quarry component/project are being regularly implemented and monitored by the Pollution Control Officer (PCO). The PCO is a duly accredited by regional EMB-DENR.

The MMT-CMRs for the 1st and 2nd quarters of 2016 and 2017 show that the small quarry operation is compliant with EMB-DENR's requirements based on conditions of ECC No. 0701-08-23-0135-303-A.

Quarterly Self-Monitoring

Based on the Self-Monitoring Reports for the first and second quarters of 2017, HRDC has complied the conditions of the ECC which include the following:

Table 6-1. Compliance Monitoring on ECC Conditions, 2016-2017

ECC Conditions	Status of Compliance for 2016-2017	Actions Taken
The ECC is valid within the period of validity or the small-scale quarry permit (SSQP) issued by the LGU. Upon expiry, extension of the said certificate can be determined only by EMB Region 7.	Complied	A third-party contractor is being tapped to take charge in the preparation of application documents for ECC of MPSA's partial declaration.
Meridional block dominated as Dini Mining Claim covered by Mining Lease Contract No. MRD-138 covering a total land area of 10 has with corner 1 having a geographical coordinate of 9°51'30" north latitude and 123°04'42.31" east longitude located at Barangay Maaslum, Ayungon, Negros Oriental.	Complied	Quarry operation is confined in the appropriate area.
The project proponent shall be responsible in implementing the mine operation and safety plan, mine quarry development and rehabilitation plan like vegetative and structural rehabilitation, subject to compliance monitoring to be conducted by ENRO of the LGU. Proponent may see	Complied	Plans and reportorial requirements are being complied.

ECC Conditions	Status of Compliance for 2016-2017	Actions Taken
assistance from the Provincial Mining and Regulatory Board (PMRB). Likewise, proponent shall be responsible to any environmental effect and damages incurred to the environment arising from the project implementation.		
Prior to operation, a Rehabilitation Cash Fund (RCF) in the amount of PhP 10,000.00 shall be allotted by the proponent to ensure that rehabilitation, cleanup and other related activities shall be implemented. Said RCF shall be managed by the concerned LGU. In no case shall the project be abandoned without rehabilitation by the proponent or concerned LGU.	Complied	Sufficient fund was allocated for the rehabilitation/ reforestation project of the company.
The ECC is issued as one of the requirements for any permit issuances by other concerned government agencies and shall not be construed as business permit or any other city/ municipal permits.	Complied	Permits were secured from concerned government agencies.
Annual extraction, by means of mechanized equipment, shall not exceed 50,000 cu m and should be confined inside the meridional block denominated as the Dini Mining Claim covered by the Mining Lease Contract No MRD-138 covering a total land area of 10 has with corner 1 having a geographical coordinates of 9°51'30" north latitude and 123°04'42.31" east longitude located at Barangay Maaslum, Ayungon, Negros Oriental.	Complied	Extraction was confined within the approved area.
Quarry operations shall be in accordance to the submitted Environmental Management Plan. This plan shall be posted the project site to ensure that persons responsible for the day to day operations are familiar with it and be guided in its implementation.	Complied	EMP is being implemented by the company.
A quarterly report should be submitted to this office for updating the implementation of all these submitted plans. The report should also include pictures showing proof of compliance, resolutions of complaints and corrective action required to make the project safe and other matters as determined by the EMB Region 7.	Complied	Periodic reports are submitted.
The proponent shall be responsible to any adverse effects due to its operation	Complied	Mitigating measures are being implemented to maintain air

ECC Conditions	Status of Compliance for 2016-2017	Actions Taken
on the water and air quality of the environment within its operating area pursuant to PD 984 and RA 8749 and their respective IRR.		quality and prevent siltation of bodies of water.
This ECC shall be allowed to be amended, suspended or cancelled if there is valid complaint from any of the legitimate stakeholders of the project.	Complied	No complaint received.
That any false information or misrepresentation in the submitted documents will be ground for the automatic revocation of the ECC.		
Compliance to the provisions for the ECC shall be borne by the proponent and to the contractor if the project is contracted. Moreover, if there will be transfer of ownership of the project is compliance shall be the sole responsibility of the new owner.	Complied	Compliance of the company is being monitored by the designated MMT.
This ECC is effective only once all other required permits, clearances and/ or certificates from other concerned agencies, such as business permit, quarry permit and zoning ordinances have been issued to the proponent.	Complied	Operations is covered with the requirement permits.
Non-compliance with any of the above stipulations will be sufficient for the suspension or cancellation of this certificate and/ or imposition of a fine in an amount not to exceed PhP 50,000 for every violation thereof, at the discretion of this office (Section 9 of PD 1586).		

Please see **Annex 10** for copies of the first and second quarter SMRs for 2016-2017.

Relative to the environmental management plan/ program, the HRDC has implemented the identified enhancement/ mitigation measures as follows:

Table 6-2. Quarterly Self-Monitoring Compliance on ECC Conditions, 2016-2017

Enhancement/ Mitigation Measures	Status of Compliance, 2016-2017	Actions Taken, 2016-2017
1. Water quality surveillance	Complied	Visual observation and construction of settling pond. To apply water discharge permit
2, Landform observation	Complied	Visual monitoring
3. Noise impact monitoring	Complied	Periodic maintenance of heavy equipment used in the operation
4. Reforestation progress determination	Complied	Replanting to increase average survival rate.
5. Dust emission and air quality monitoring	Complied	2 units of water trucks are deployed to conduct water sprinkling on haulage road to suppress dust emission during dry season.

B. Environmental Performance

The proponent has complied with the various requirements of the Mines and Geosciences Bureau and the Environmental Management Bureau as stated in its ECC for the 10 hectares quarry site.

The various documents for environmental performance include its submission and adherence to the requirements of its Annual Social Development and Management Program for 2016 (ASDM) and Annual Environmental Protection and Enhancement Program for year 2016 for the Partial Declaration of Mining Project Feasibility for the Silica Quarry Project. The ASDM and EPEP will be revised once a new ECC is issued that will cover the entire project area. HAZ likewise is preparing a Mine Rehabilitation Plan with the approval of the Declaration of Mining Project Feasibility on the Project Area (DMPFA).

HRDC-HAZ has completed reforesting the 100 hectares of area assigned for reforestation by the Municipal CENRO of Ayungon in compliance with the provisions of the ECC No. 070108-23 0135 303-A of the PDMPF. It is expected that a new and bigger area will be designated for reforestation with the new ECC and DMPFA in which HAZ will be more than happy to comply.

Results of the Compliance Monitoring and Verification Reports by the MMT (MMT-CMVRs) for the first two (2) quarters of 2016-2017 are attached as **Annex 10** of this document. A discussion on the compliance monitoring can also be gleaned in Section 3 of this document.

Flora and Fauna

To promote the provision of habitat and increase biodiversity in the project site, the project has established 10 hectares of tree plantation for 2015 using a total of 23,943 seedlings and maintenance ring weeding for 11,110 seedlings.

In partnership with the National Greening Program, have established a total of 100 hectares of tree planting. As of 2017, produced a total of 150,913 seedlings with ring weeding and maintenance for 235,531 seedlings.

To ensure the success of the tree planting activity, the project has replanted seedlings totalling 39,398.

As part of its community development activities, the project has also provided a barangay nursery to barangay Maaslum for additional tree planting projects.

Quarry Performance

Base on the latest available MMT Compliance Monitoring Reports (MMT-CMR), which covers the first and second quarters of 2016 and 2017 of the 10-has quarry operations, the quarry operation has complied with EMB-DENR's requirements based on conditions of ECC No. 0701-08-23-0135-303-A.

The compliances of the existing quarry component/project are being regularly implemented and monitored by the Pollution Control Officer (PCO). The PCO is a duly accredited by regional EMB-

DENR. The mine operation and safety plan, mine quarry development and rehabilitation plan like vegetative and structural rehabilitation are being complied by the project proponent. Quarry operations are in accordance to the submitted environmental Management Plan.

Socioeconomics

Based on the available MMT reports from 2011 - 2015, the SDMP projects as proposed were implemented and will be continued to be implemented as follows:

SDMP Projects

- Spillway Construction
- Community Service Vehicle
- Community Water Development
- Electrification of Sitio Pinyahan and Canlukduhan
- Improvement of Bgy. Maaslum Community Plaza
- Purchase of Medical Equipment
- Construction of Footbridge
- Purchase of Medicines
- Construction of Foot Trail
- Improvement of Multipurpose Halls

IEC

- MGB Radio Program
- MGB Newsletter
- Community Consultations
- Development of Mining Technology
- Mabinay Geohazard Mapping and Assessment
- On-the-Job Training of NORSU BS Geology Students

Other Initiatives

- Relief Operations during 2012 Earthquake
- Foster A Child's Education (FACE)

Water

Based on the available MMT Compliance Monitoring Reports (MMT-CMR) from 2014 to 2017, the project has complied with EMB-DENR's requirements based on conditions of ECC No. 0701-08-23-0135-303-A. Previous water sampling results passed tthe set standards based on DAO 90-35 in terms of pH, temperature, TSS and Chlorine. The results of the water quality done in this report was within the set standards except for pH, TSS, BOD, Chromium, and Iron. The results of the company's water monitoring are well within the standards and confirms that the silica mining activity does not have an impact on the water quality in the area.

The company has regularly submitted the compliance monitoring reports including water quality assessment to the DENR-EMB in compliance to the recommendation of the MMT monitoring. Water quality assessment are regularly monitored once every quarter given the established sampling monitoring stations.

Air

Performance could not be determined for air due to the absence of air quality data from the previous ECC.

C. Self-Monitoring Plan

Environmental Monitoring Stations

The sampling stations for the expansion site will be different considering that the previous area will no longer be utilized. The expansion site will be a new mining area and will follow the sampling stations considered in the baseline study.

Environmental Monitoring Plan

As required by DENR Memorandum Circular No. 2010-14 and RPM for DAO 2003-30, and as a pro-active tool in minimizing/eliminating adverse project consequences to the environment, an "Environmental Quality Performance Level" (EQPL) has been identified for each critical parameter associated with identified significant project impacts. The limit level shall be the regulated threshold of pollutant (standard that must not be exceeded) while the action level is set lower than the limit level wherein management measures must be implemented so as not to reach the regulated threshold.

The following mechanisms and monitoring schemes are also discussed:

- Environmental Monitoring Plan;
- Multi-sectoral Monitoring Framework; and
- Environmental Guarantee and Monitoring Fund Commitment.

The EQPLs presented below for the Environmental Self-Monitoring Plan is only applicable to Effluent and Emissions regulations. The EQPLs in the table below were initially assigned the following values:

- Alert: 70% of the limit
- Action: 80% of the limit
- Limit: 90% of DENR standard value

These EQPLs are initial values. Final thresholds for management limits, action, and alert levels will be determined from monitoring data and concurred by the MMT members, EMB, and HRDC.

The salient point of the said table is that Alert and Action EQPLs were only assigned to parameters that can be controlled by the project during construction and operation phases.

Table 6-3. Environmental Monitoring Plan (EMoP) with Environmental Performance Quality Levels (EGPLs)

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
I. Development/Construction Phase													
Site preparation (clearing, grubbing and stripping of topsoil) Construction of mine facilities/ haul roads, Stockpiling of topsoil)	Land: Loss of biodiversity	Terrestrial biology: Biodiversity indices Species richness and abundance Rehabilitation works	Sampling Interviews transects	Semiannual	Baseline sampling stations	Proponent through MEPEO;	150,000.00/monitoring	Equitability Index = 0.6	Equitability Index = 0.5	Equitability Index = 0.4	Replanting of the surrounding area after construction, preferably with indigenous, nursery-raised plants from the area; Vegetation removal will still be kept at minimum; Establish voluntary conservation zones and biological corridors within the Project area.		
	Water: Siltation; Contamination from petroleum spillage and domestic sewage	pH, temp, DO, BOD, Total coliform, oil and grease	In-situ Grab sampling Laboratory analysis for BOD, total coliforms, O&G, TSS pH, Temp, DO: direct measurement using portable pH/Temp/DO meters	Quarterly	Baseline sampling stations	Proponent through MEPEO;	100,000.00/monitoring		BOD = 45 mg/L Oil and grease = 0.8 mg/L Total coliform = 800 MPN/100 ml TSS=50 mg/L	BOD = 50 mg/L Oil and grease = 1 mg/L Total coliforms = 1000 MPN/100 ml TSS=70 mg/L	**Alert:** Identify pollutant source (construction activity, facility, or equipment) **Action:** Implement appropriate corrective action at identified pollutant source **Limit:** Temporary stoppage of identified construction activity or equipment		
	Air pollution in receptor areas	TSP	(S) 24 hr. High Volume- (A) Gravimetric USEPA 40 CFR, Part 50	Monthly	Existing stations AQ1 and AQ2	Proponent through MEPEO;	To be determined	161 ug/ncm	184 ug/ncm	230 ug/ncm	-do-	-do-	-do-
		PM-10	(S) 24 hr. High Volume- (A) Gravimetric USEPA 40 CFR, Part 50	Monthly	Existing stations AQ1 and AQ2	Proponent through MEPEO;	To be determined	105 ug/ncm	120 ug/ncm	150 ug/ncm	-do-	-do-	-do-
		SO_2	(S) 24-hr Gas Bubbler (A) Pararosaniline Method (West and Gaeke Method	Quarterly	Existing stations AQ1 and AQ2	Proponent through MEPEO;	To be determined	126 ug/ncm	144 ug/ncm	180 ug/ncm	-do-	-do-	-do-
		NO_2	(S) 24-hr Gas Bubbler (A) GriessSaltzman or Chemilu-minescence Method	Quarterly	Existing stations AQ1 and AQ2	Proponent through MEPEO;	To be determined	105 ug/ncm	120 ug/ncm	150 ug/ncm	-do-	-do-	-do-
	Noise generation in receptor areas	Sound levels	24- hr. sound measurements	Weekly	Existing stations AQ1 and	HRDC PCO; Contractor	To be determined	(a)	(b)	(c)	**Alert:** -Identification of possible source of noise		

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
			using handheld sound meters		AQ2						-Provision of ear plugs **Action:** -Corrective action on noise equipment source -Rescheduling of "noisy activities" **Limit:** Reduce use of noisy equipment		
	<u>Psycho-social:</u> Fear of air and noise pollution; Fear of landslides and flooding	IEC conducted Conduct of training on DRRM specifically, on landslides and flooding	FGDs, KIIs, household survey (when necessary), examination of official records and documentation	Annual	Impact communities	Proponent through CRO	150,000.00/monitoring	Manifestations/ observations during monitoring activities	Incident Report	Complaint Received	**Alert:** Implement measures to arrest possible occurrence of negative impact **Action:** - Verify and validate report; Implement measures to arrest negative impact **Limit:** Investigate. Take action based on the result of investigation - Assess the degree of impact - Implement measures to mitigate negative impact - Provide necessary assistance to the community		
	<u>Economic</u> Generation of employment and livelihood opportunities	Compliance on the prioritization of hiring of qualified barangay residents by Contractors Conducted Barangay Consultation on job requirements and qualification Conduct of training to upgrade local skills of residents	FGDs, KIIs, household survey (when necessary) examination of official records and documentation	Annual	Impact communities	Proponent through CRO	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-
	<u>Health and Safety</u> Entry of migrant workers with families which might cause health problems,	Inventory of migrant workers No. of residents serviced by the Company Clinic	FGDs, KIIs, household survey (when necessary) examination of	Quarterly/ Annual	Impact communities	Proponent through CRO	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	availability of resources and services, social conflicts, peace and order, and increased solid and liquid wastes; Increase in traffic flow causing air (dust) and noise pollution	Implementation of the Social Development Program Crime Rate Implementation of SWM Program Air and noise monitoring	official records and documentation										
	<u>Peace and Order</u> Economic activities and other services near the quarrying area might cause problems of congestion, peace and order and security breaches	Crime Rate	FGDs, KIIs, household survey (when necessary) examination of official records and documentation	Quarterly/ Annual	Impact communities	Proponent through CRO	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-
	<u>Cultural and Historical</u> Possible unearthing of historical artifacts and/or fossil remains	Found artifacts and/or fossil remains	Examination of official records and documentation	As needed	Construction and Quarry Area	Proponent through CRO	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-
II. Operation Phase													
	<u>Groundwater quality</u>: • Contamination with biological agents (e.g. fecal coliforms) • Contamination with oil and grease from hydrocarbon leaks and spills	Temperature	Grab sampling method from existing water wells; laboratory analysis using methods approved by EMB for BOD, TSS, Oil & Grease, Total Coliforms, heavy metals such as Cr+6 Temp, DO, pH: Direct measurement using portable Temp/DO/pH meter	Annual	Selected baseline sampling stations	Proponent through MEPEO;	150,000.00/monitoring				**Alert:** -Identify source of pollutant -Evaluate plant process that emits the pollutant -Monitor levels at stations **Action:** -Corrective action on plant process that emits the pollutant, -Conduct monitoring after corrective action **Limit:** Detailed evaluation of exceedance at the station		
		DO						DO = 494 %satn mg/L	DO = 564 %satn mg/L	DO = 705 %satn mg/L			
		pH						6.7-8.3	6.2-8.8	6.0-8.5			
		BOD						BOD = 0.7 mg/L	BOD = 0.8 mg/L	BOD = 1 mg/L			
		TSS						TSS=17.5 mg/L	TSS=20 mg/L	TSS=25 mg/L			
		TDS						TDS = 350 mg/L	TDS = 400 mg/L	TDS = 500 mg/L			
		Oil and Grease						Oil and grease = 0 mg/L	Oil and grease = 0 mg/L	Oil and grease = 0 mg/L			
		Total Coliform						Total coliforms = <0.77 MPN/100 ml	Total coliforms = <0.88 MPN/100 ml	Total coliforms = <1.1 MPN/100 ml			
		Heavy Metals (Cr^{+6}, Pb, Cd, Hg, As-mg/L)						Not more than: Cr+6: 0.0504 Pb: 0.0063 Cd: 0.00189 Hg: 0.00063 As: 0.0315	Not more than: Cr+6: 0.0576 Pb: 0.0072 Cd: 0.00216 Hg: 0.00072 As:0.036	Not more than: Cr+6: 0.072 Pb: 0.009 Cd: 0.0027 Hg: 0.0009 As:0.045			
Quarry Activities Diesel storage and motorpool	<u>Surface Water Quality</u>: • Siltation • Contamination with biological agents such as fecal coliforms • Contamination with oil and grease from	Temperature	Grab sampling method from existing water wells; laboratory analysis using methods approved by EMB for BOD, TSS, Oil &	Monthly	Baseline sampling stations	Proponent through MEPEO;	150,000.00/monitoring	Not more than 2.1°C rise	Not more than 2.4°C rise	Not more than 3.0°C rise	**Alert:** -Identify source of pollutant -Evaluate plant process that emits the pollutant -Monitor levels at stations **Action:**		
		DO						DO = 494 %satn mg/L	DO = 564 %satn mg/L	DO = 705 %satn mg/L			
		pH						pH= 6.7-8.3	pH= 6.2-8.8	pH=6.0-8.5			
		BOD						BOD = 3.5 mg/L	BOD = 4 mg/L	BOD = 5 mg/L			
		TSS						TSS=35 mg/L	TSS=40 mg/L	TSS=50 mg/L			

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Domestic and Liquid wastes from admin offices, workers' barracks	hydrocarbon leaks, spills	Oil and Grease	Grease, Total Coliforms, heavy metals Temp, DO, pH: Direct measurement using portable Temp/DO/pH meter					Oil and grease = 0.7 mg/L	Oil and grease = 0.8 mg/L	Oil and grease = 1 mg/L	-Corrective action on plant process that emits the pollutant, -Conduct monitoring after corrective action **Limit:** Detailed evaluation of exceedance at the station		
		Total Coliform						Total coliforms = 7,004 MPN/100 ml	Total coliforms = 800 MPN/100 ml	Total coliforms = 1000 MPN/100 ml			
		Heavy Metals (Cr^{+6}, Pb, Cd, Hg, As-mg/L)						Not more than: Cr+6: 0.063 Pb: 0.0315 Cd: 0.0063 Hg: 0.0315 As:0.0315	Not more than: Cr+6: 0.072 Pb: 0.036 Cd: 0.0072 Hg: 0.036 As: 0.036	Not more than: Cr+6: 0.09 Pb: 0.045 Cd: 0.009 Hg: 0.045 As: 0.045			
	Land	Housekeeping	Observations records	Quarterly	Applicable areas	Proponent through MEPEO;	25,000.00/ monitoring	Manifestations/ observations during monitoring activities	Incident Report		Implementation of 5S of housekeeping		
	Loss of biodiversity	Biodiversity indices Species richness and abundance Rehabilitation works	Sampling Interviews transects	Semiannual	Baseline sampling stations	Proponent through MEPEO;	150,000.00/monitoring	Equitability Index = 0.6	Equitability Index = 0.5	Equitability Index = 0.4	Replanting of the surrounding area after construction, preferably with indigenous. nursery-raised plants from the area Vegetation removal will still be kept at minimum Establish voluntary conservation zones and biological corridors within the Project area		
	Air pollution in receptor areas	TSP	(S) 24 hr. High Volume- (A) Gravimetric USEPA 40 CFR, Part 50	Minimum of twelve sampling days per quarter or forty-eight sampling days each year.	Existing stations in vicinity of quarries	MEPEO;	To be determined	161	184	230	**Alert:** -Identify source of pollutant -Evaluate plant process that emits the pollutant -Monitor ambient levels at stations -Conduct air dispersion modeling **Action:** -Corrective action on plant process that emits the pollutant, -Conduct monitoring after corrective action **Limit:** Detailed evaluation of exceedance at the station		
		PM10	(S) 24 hr. High Volume- (A)	Minimum of twelve sampling days per quarter	Existing stations in	Proponent through MEPEO;	To be determined	105	120	150	-do-	-do-	-do-

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
			Gravimetric USEPA 40 CFR, Part 50	or forty-eight sampling days each year.	Vicinity of quarries								
		SO_2	(S) 24-hr Gas Bubbler (A) Pararosaniline Method (West and Gaeke Method	Minimum of twelve sampling days per quarter or forty-eight sampling days each year.	Existing stations in Vicinity of quarries	Proponent through MEPEO;	To be determined	126	144	180	-do-	-do-	-do-
		NO_2	(S) 24-hr Gas Bubbler (A) GriessSaltzman or Chemilu minescence Method	Minimum of twelve sampling days per quarter or forty-eight sampling days each year.	Existing stations in Vicinity of quarries	Proponent through MEPEO;	To be determined	105	120	150	-do-	-do-	-do-
	Noise generation in receptor areas	Sound levels	24 hr. sound measurements using handheld sound meter	Monthly	Existing stations in Vicinity of quarries	Proponent through MEPEO;	To be determined	(a)	(b)	(c)	Alert: -Identification of possible source of noise -Check buffer zones and noise attenuation measures - Conduct noise modeling Action: -Corrective action on noise equipment source -Conduct monitoring after corrective action Limit: Detailed evaluation of exceedance at the station		
	People/Community: Influx of migrant workers with families may cause health problems due to diseases, overuse of public utilities /services, competition for resources, social conflicts, peace and order problems; increase in pollution due to solid and liquid wastes Long term monitoring of silicosis on the workers and	Inventory of migrant workers Implementation of the Social Development Program Crime rate	FGDs, KIIs, household survey (when necessary) examination of official records and documentation	Quarterly/ Annual	Impact communities	CRO	50,000/monitoring	Manifestations / observations during monitoring activities	Incident Report	Complaint Received	Alert: Implement measures to arrest possible occurrence of negative impact Action: - Verify and validate report - Implement measures to arrest negative impacts Limit: - Investigate - Take action based on the result of investigation - Assess the degree of impacts - Implement measures to mitigate negative impacts		

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	community in coordinated with municipal health officer. Increase in traffic flow causing air (dust) and noise pollution										- Provide necessary assistance to the community		
	People/Community: Community benefits	Employment, Tax revenues to LGUs, community projects initiated by the proponent, other benefits of the community from the project	FGDs, KIIs, household survey (when necessary) examination of official record (e.g. revenue reports)	Annual	Project affected barangay	Proponent through CRO;	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-
	<u>Climate Change</u> Impact of Climate Change: La Niña and El Niño phenomenon and possible consequential disasters	Trainings and IEC conducted	FGDs, KIIs, household survey (when necessary) examination of official records and documentation	Quarterly/ Annual	Impact communities	Proponent through CRO	150,000.00/monitoring	-do-	-do-	-do-	-do-	-do-	-do-
III. Abandonment Phase													
Decommissioning of equipment Rehabilitation of disturbed areas Dismantling of structures	**Land:** Decrease in diversity and abundance	Terrestrial biology Biodiversity indices, species richness and abundance	Sampling and interviews Site observation and documentation Transect survey, mist netting and cage trapping	Duration is for 2 years after the cease of operation following a semiannual monitoring pattern	Baseline sampling stations	Proponent through MEPEO;		Vegetation cover decreases by 10%	Vegetation cover decreases by 20%	Vegetation cover decreases by 25%	Implementation of FMRDP and appropriate planting and replanting schemes		
	People/ Community: Safety issue	To be identified in the FMRDP	Based on Methodology in FMRDP		Site location auxiliary facilities	Proponent through MEPEO and CRO;		Manifestations/ observations during monitoring activities	Incident Report		Implementation of SHP during decommissioning activities Provision of PPEs		
	Water: Water quality **People/ Community:** Health Hazard	Based on the result of the Environmental Site Assessment (ESA) that will be conducted prior to abandonment	Based on the recommendation of the ESA that will be conducted prior to abandonment			Proponent thru MEPEO;		Will be based on the recommendation of the ESA that will be conducted prior to abandonment			All the impoundment structures will be designed considering seismic and structural parameters Structural integrity will be monitored for the duration of operation of these facilities and beyond mine closure An Emergency Response Plan will be developed to handle possible occurrence		

Key Environmental Aspect per Project Phase	Potential Impact Per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Estimated Cost (Php)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
											of water reservoir failure and downstream flooding. Identify vulnerable areas and possible scenarios of flooding (i.e. its extent and its duration), and the necessary preventive measures Recyclable materials will be sold to recyclers. Residual wastes will be hand over to the municipal garbage collectors. Hazardous waste will be transported to accredited disposal Companies		
	People/Community: Termination of LGU revenues from taxes, permits and share when mining operations ceases	As discussed in the FMRDP	Based on Methodology in FMRDP					Manifestations/ observations during monitoring activities	Incident Report	Complaint Received	**Alert:** Implement measures to arrest possible occurrence of negative impact **Action:** - Verify and validate report - Implement measures to arrest negative impact **Limit:** - Investigate - Take action based on the result of investigation - Assess the degree of impact - Implement measures to mitigate negative impact - Provide necessary assistance to the community		

D. Multi-Sectoral Monitoring Framework

In order that all stakeholders are involved in the monitoring and evaluation at the pre-construction, construction, operations, and post-operations stages of the proposed expansion of the silica quarry project of the HAZ, a multi-sectoral monitoring framework needs to be established first to see to it that resources are effectively and efficiently used for the generation of expected project outputs and the achievement of immediate and long term objectives. From this framework an MSMF system will be developed that will endeavor to continuously gather vital and relevant information on the overall performance of the project and at the same time enable the objective review and assessment of work to improve project actions in the future.

MSMF Objectives

The primary objective of the proposed MSMF is to involve all stakeholders to measure and assess silica project's overall performance relative to agreed or targeted project outputs and results as designed. More specifically:

- Measure the physical and financial performance of the project relative to allocated inputs, resources, project implementation activities and targets;
- Identify and resolve in a timely fashion critical issues and concerns that might hamper the achievement of project outputs, outcomes and impacts;
- Enable the early identification and reporting of implementation problems which would necessitate a revision in the project design/framework;
- Determine indications of achievement of desired project benefits and impacts; and
- Assess the effects of the development intervention on the beneficiaries and the project areas.

Developing the MSF Framework

In designing the MSMF Framework, the following activities need to be conducted:

A. Formulation of Multi-Sectoral Monitoring Team composed among others of the following:
   - LGU municipal mayor or representative (MPDO or Municipal Engineer);
   - Holcim Phil manager or representative;
   - Holcim Community Relations Officer;
   - HAZ representative;
   - Barangay Chairperson +1;
   - NGO / Coop / PO chairperson or representative;
   - DENR;
   - MGB; and
   - Other NGAs (DA, DTI, DOST, etc.)

B. Preliminary activities of the MSMF
   - Preparation and finalization of logical framework;
   - Issuance of administrative orders re membership to the MSMT.

The MSMF shall be based on the guidelines or requirements of the Revised Procedural Manual for DAO No. 2003-30, DAO 2017-15. As representative of the Regional Executive Director pursuant to DAO 2018-18, the CENRO will be included in the MMT. The MMT shall be organized based on the provisions set forth in DAO 15-02 and DAO 2018-18.

The MMT shall be organized, as stipulated in the Philippine Environmental Impact Statement System (PEISS), to encourage public participation, promote greater stakeholder vigilance and provide appropriate check and balance mechanisms in the monitoring of project implementation. The MMT is recommendatory to EMB/MGB and have the primary responsibility of validation of proponent's environmental performance with the following specific functions:

- Monitor, assess and validate the project's compliance as stated in the EIA Report, ECC, EPEP and other relevant environmental standards;
- Set up project specific environmental standards in accordance with environmental standards identified above;
- Validate proponent's conduct of self-monitoring;
- Prepare members of the MMT to handle monitoring activities through proper trainings;
- Management and disposition of complaints formally filed against the project proponent and its contractors;
- Prepare, integrate and disseminate simplified validation reports to community stakeholders;
- Fiduciary management of funds allocated for the above purposes; and
- Make regular and timely submission of MMT Reports based on the EMB-prescribed format.

Developing the MSMF and Evaluation System

Immediately after the development of the MSM Framework, the MSMT will develop the project's M&E system that will investigate the following:

- Impact and benefits the project is designed to achieve;
- Inputs and outputs the development intervention will intend to deliver to enable the achievement of project benefits and impacts; and
- Project activities which will serve as basis for the preparation of the annual work plan.

The M&E system shall include the following:

A. Progress Monitoring

Initially, the Project will focus its attention in the conduct of project progress monitoring or the monitoring of accomplishments of activities during construction and operations, including the generation of physical outputs derived from the implementation of project activities. This system shall consist of two major sub-systems, the Input Monitoring, and the Output Monitoring. Input Monitoring would involve the documentation of the utilization of resources available for the project. Examples of project inputs/resources would include money/project funds, equipment, technology, and human expertise.

Output monitoring comprises of activities involving the close documentation of the physical and tangible goods and services to be delivered by the project. To enable the project to effectively monitor the delivery of agreed project outputs, several monitoring forms will be developed tracking down the development and finalization of specific projects from project development to successful construction of infrastructure facilities and undertaking of capacity building activities.

The MSMT is expected to generate the following deliverables:

Table 6-4. MSMT Deliverables

Progress Reports	Brief Description	Target Audience
Monthly Progress Report	Highlights the accomplishment of the project relative to monthly targets. Identify issues and recommended actions	HRDC HAZ
Quarterly Progress Report	Outlines the project's cumulative accomplishment for the quarter. Implementation issues and actions taken are also discussed.	LGU of Ayungon HRDC HAZ
Annual Progress Report	Presents a summary of the project's annual cumulative accomplishment.	LGU of Ayungon HRDC HAZ DENR and other NGAs
Project Completion Report	Evaluates the overall performance of the project relative to achievement of project goal and objectives.	LGU of Ayungon HRDC HAZ DENR and other NGAs

B. Progress Evaluation

In addition to monitoring, project evaluation is necessary. The main purpose of undertaking this system is to enable project actors and stakeholders to assess the overall performance of the project. Also, this system shall endeavor to identify and assess the immediate and direct benefits generated by the Project to target beneficiaries.

Table 6-5. MSMT Timetable

Workplan/Timetable	Year 1												Year 2												Year 3											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
I. Developing the MSM Framework and System																																				
A. Formation of the Multi-Sectoral Monitoring Team (MMT)			■																																	
B. Preparation of a project Logical Framework			■																																	
C. Preparation of an MSM Framework				■																																
D. Preparation of an MSM System				■																																
II. Project Monitoring																																				
A. Team Meetings				■		■		■		■		■		■		■		■		■		■		■		■		■		■		■		■		■
B. Monitoring Visits					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
C. Report Writing (Narrative & Financial)																																				
- Monthly Reports					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
- Quarterly Reports									■						■			■			■						■			■			■			
- Annual Reports												■												■												
- Project Completion Report																																				■
D. Evaluation																																				
- Conduct of midterm review																			■																	
- Conduct of annual project review and project planning												■																								
- Conduct of project evaluation																															■					

E. Environmental Guarantee and Monitoring Fund Commitments

For mining projects, the environmental guarantee and monitoring fund commitments are implemented through the *Contingent Liability and Rehabilitation Fund* (CLRF) and the fund allocated for *Social Development and Management Program* (SDMP), as provided for under DAO No. 2010-21, together with the *Environmental Trust Fund* (ETF). These funds are established in lieu of the Environmental Guarantee Fund (EGF) and Environmental Monitoring Fund (EMF), as provided for under DAO No. 2003-30 (Section 4.d., DAO No. 2015-02).

Legal Basis

The following DENR Administrative Orders (DAOs) constitute the legal bases for the environmental guarantee and monitoring fund mechanisms:

a) DAO No. 2005-07 (Amendment to Chapter XVIII of DAO No. 96-40, as amended, Providing for the Establishment of A Final Mine Rehabilitation and Decommissioning Fund);
b) Chapter XVIII (Contingent Liability Rehabilitation Fund) of DAO No. 2010-21 ("Revised Implementing Rules and Regulations of R.A. 7942, otherwise known as the Philippine Mining Act of 1995"); and
c) DAO No. 2015-02 (Harmonization of the Implementation of the Philippine Environmental Impact Statement System and the Philippine Mining Act of 1995 in Relation to Mining Projects).

DAO No. 2005-07 and DAO No. 2010-21 required the establishment of environmental guarantee fund mechanism known as Contingent Liability Rehabilitation Fund (CLRF). DAO No. 2005-07 amended the provisions in Chapter XVIII of DAO No. 96-40 and provided the basis for the establishment of a *Final Mine Rehabilitation and Decommissioning Fund* (FMR/DF) as part of the CLRF.

DAO No. 2015-02 aims to harmonize compliance, monitoring and reporting systems, and funding mechanisms in accordance with the PEISS and Mining Act Requirements. Section 4.d of the DAO states that "The CLRF and the fund allocated for *Social Development and Management Program* (SDMP), as provided for under DAO No. 2010-21, together with an ETF (*Environmental Trust Fund*), shall be established in lieu of the EGF (Environmental Guarantee Fund) and Environmental Monitoring Fund (EMF), as provided for under DAO No. 2003-30".

Environmental Guarantee and Monitoring Fund Mechanism

The various environmental guarantee and monitoring fund mechanisms are shown in the figure below.

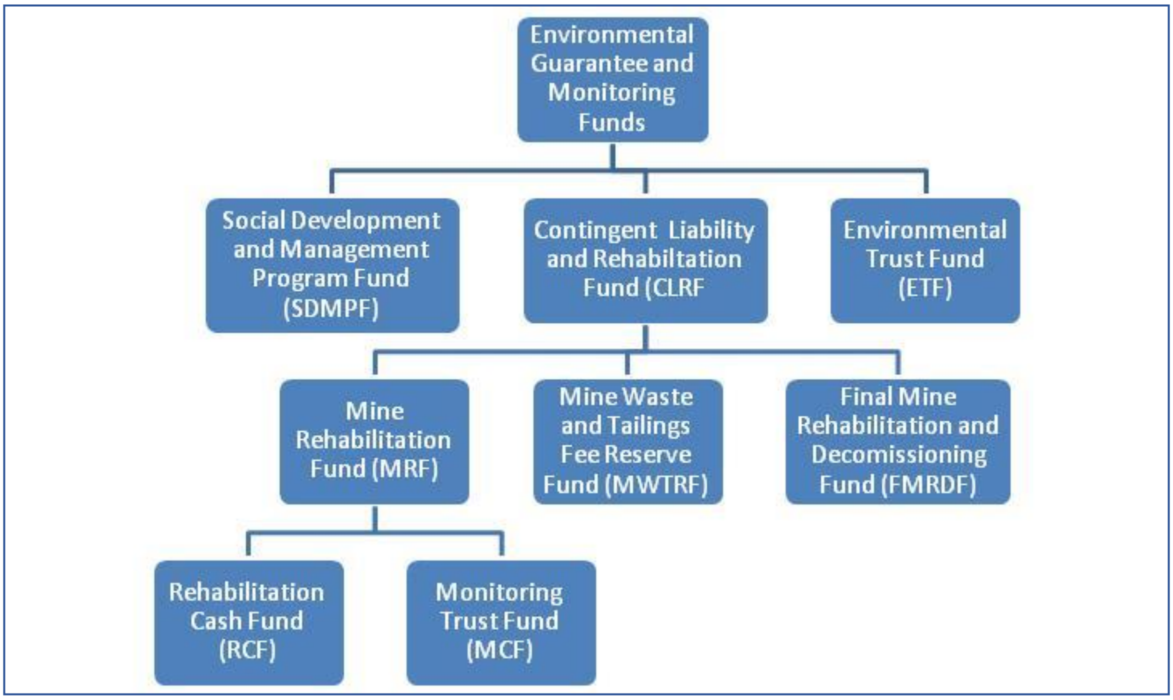


Figure 6-1. Components of the Environmental Guarantee and Monitoring Funds

Contingent Liability and Rehabilitation Fund (CLRF)

This CLRF is an environmental guarantee fund mechanism that aims "to ensure the just and timely compensation for damages and progressive and sustainable rehabilitation for any adverse effect a mining operation or activity may cause" (Section 180, Chapter XVII of DAO No. 2010-21). It is composed of three (3) fund mechanisms, namely: Mine Rehabilitation Fund (MRF), Mine Waste and Tailing Fees Reserve Fund (MWTFRF), and Final Mine Rehabilitation and/or Decommissioning Fund (FMR/DF).

Mine Rehabilitation Fund (MRF)

The MRF is established and maintained by each operating mine as a reasonable environmental deposit to ensure the availability of funds for the satisfactory compliance with the commitments and performance of the activities stipulated in the EPEP/Annual EPEP and this comes in two (2) forms: the Monitoring Trust Fund (MTF) and the Rehabilitation Cash Fund (RCF).

The MTF covers the maintenance and other operating budget for the transportation and travel expenses, cost of laboratory analysis, and other reasonable expenses incurred by the multi-partite monitoring team (MMT). The required MTF amount is to be determined by the MRF Committee and should not be less than PhP 150,000.00 in cash, which is replenished every quarter.

The Rehabilitation Cash Fund (RCF) is used to ensure compliance with the approved rehabilitation activities and schedules for specific mining phase including research, as defined in the EPEP/AEPEP. Its amount is equivalent to ten per cent (10%) of the total amount needed to implement the EPEP or PhP 5 Million, whichever is lower.

Final Mine Rehabilitation and Decommissioning Fund (FMRDF)

The FMRDF is the cost used to implement the final mine rehabilitation and decommissioning plan which is after the life of the mine. According to *Section 187-B of DAO No. 2010-21*, an FMRDF "shall be established by each operating Contractor/Permit Holder to ensure that the full cost of the approved FMR/DP is accrued before the end of the operating life of the mine. The FMRDF shall be deposited as a trust fund in a Government depository bank and shall be used solely for the implementation of the approved FMR/DP".

The annual FMRDF cash provisions are computed based on the following formula:

Annual Provision = Cost of Implementing the Approved FMR/DP x Percentage Required Per Table 1

Mine Waste and Tailings Fee Reserve Fund (MWTFRF)

Each mining operating contractor/lessee/permit holder is required to pay *Mine Waste and Tailings (MWT)* fees semi-annually. The MWT fees are based on the amounts of mine waste and mill tailings generated for the said period. The fees will accrue to a MWT Reserve Fund and shall be deposited in a Government depository bank to be used for payment of compensation for damages caused by mining pollution. The fund may also be utilized for research projects duly approved by the CLRF Steering Committee. Computation of the MWT fees is based on the following formula:

Mine Waste and Tailings Fee = P0.05/MT of mine waste produced and P0.10/MT of mill tailings generated from the mining operations

Payment of MWT fees may be waived if the mine wastes and mill tailings are utilized in a manner as described in *Section 190 (Mine Waste and Tailings Fees)* of DAO No. 2010-21.

Funds for Development of Mining Communities, Mining Technology and Geosciences

According to *Section 134, Chapter XIV OF DAO 2010-21*, a mining Contractor/Permit Holder/Lessee should allot annually a minimum of one and a half percent (1.50%) of the operating costs to fund programs/projects and activities for the *Social Development and Management Program (SDMP), Program for the Development of Mining Technology and Geosciences (PDMTGS),* and for *IEC Program* on public awareness and understanding of responsible mining and geosciences.

Allocation of the said 1.5% of operating costs shall be as follows:

- 1.125% (75% of 1.50%) shall be apportioned to implement the SDMP;
- 0.150% (10% of 1.50%) for the implementation of Program for the Development of Mining Technology and Geosciences; and
- 0.225% (15% of 1.50%) for the implementation of IEC Program

"Any unspent amount and/or savings, for any given year, allotted for the implementation of the various programs shall be added to the succeeding year's allotment and may be re-programmed after consultations with host and neighboring communities" (DAO No. 2010-21, p. 81-82).

Environmental Trust Fund (ETF)

ETF is used for payment of mining-related compensable damages other than those caused by mine wastes and tailings and should be at least Php 50,000.00. The ETF may be in the form of insurance, letters of credits, trust fund or other financial instruments and similar guarantee instruments. There is no explicit provision for valuation of potential impact in DAO 2003-30 to determine the amount to be set up. The amount to be allocated shall be determined through negotiations between the proponent and the EMB (CO/RO).

7. Decommissioning/ Abandonment/ Rehabilitation Policy

As with the end of every industry, the closure of the Project can affect the host community, create loss/decrease in taxes, loss of employment, income and/or business opportunities derived from the project. In view of these, the Proponent adopted an abandonment/rehabilitation strategy that can be used in mitigating the effects of the abandonment/decommissioning activities of the project

The following objectives were considered in the formulation of the plan:

a. Rehabilitate the disturbed areas to a condition that is beneficial to the environment and conforms to the land use plan of the municipality and/or province that is mutually concurred by the community, government agencies, and the company;
b. Manage and control off-site contamination by fortifying environmental control structures and implementation of appropriate rehabilitation methods;
c. Remove and disband unnecessary Project facilities and equipment used in the operation;
d. Conduct a comprehensive management and monitoring of rehabilitated areas until such time that the area is sustaining and is biologically and physically acceptable with the preferred final land-use; and
e. Monitor SDMP implementations and implement post-capacity training on the alternative skills and livelihood opportunities that were initiated during the onset of the Project's operation.

A. Decommissioning Plan

To carry out the transitional stage between cessation of operation and actual closure, Proponent plans to employ the following strategies:

Table 7-1. Decommissioning Strategy

Decommissioning Strategy	Timeframe
Mobilization of the Closure Team. Start of IEC Campaign as part of social preparation, creation of Mine Closure ComRel Plan, performance evaluation of the last 5-year SDMP and consultation for the final review of the FMRDP	Closure Planning. Three (3) years before closure
Inventory of all equipment and facilities by the Closure Team.	Part of Closure Planning Within two (2) years before Closure
Assessment of the conditions of equipment and facilities and extent of revegetation activities by the Closure Team.	Part of Closure Planning Within 2 years before Closure
Planning and review of decommissioning procedures vis-àvis the standard operating procedures. Coordination with contractors.	Part of Closure Planning Within one (1) year before Closure

Decommissioning Strategy	Timeframe
Cross matching of company personnel and residents with the decommissioning tasks. Trainings/seminars will be provided as the need arises. Consultation with stakeholders. Strengthening of IEC Campaign as part of social preparation.	Part of Closure Planning Within 1 year before Closure
Decommissioning of equipment and facilities.	Decommissioning and Rehabilitation Phase Within 6 months after closure
Post assessment by the Closure Team on the decommissioned equipment and facilities.	Decommissioning and Rehabilitation Phase Within and after 1 year of closure
Rehabilitation of the decommissioned project component.	Decommissioning and Rehabilitation Phase Within and after 2 year of closure

A Closure Team will be established to oversee the implementation of the abovementioned decommissioning strategies. This team, to be headed by the Resident Manager, will be composed of the various department heads and personnel working under the safety and health, environment, and social departments.

B. Final Mine Rehabilitation Plan

The rehabilitation strategies that will be utilized will depend on the final land use that will be consented and concurred with the project stakeholders. Nonetheless and upon completion of the dismantling and/or decommissioning of structures/facilities/equipment, the company foresees to clear and revegetate all disturbed areas.

Basic strategies, such as the following, will be employed during the rehabilitation plan to achieve the final land use and to control erosion and sedimentation prior to revegetation:

- Proper closure of quarry areas;
- Reshaping of the disturbed area to make it suitable for the desired final land use;
- Spreading of topsoil on the affected areas and ensure that it is capable of supporting plant growth;
- Introduction of self-sustaining vegetation consistent with the final land use;
- Construction/maintenance of drainage system;
- Maintenance of nursery to meet the rehabilitation requirements; and
- Monitor and manage rehabilitate areas.

The project has prepared a Mine Rehabilitation and Decommissioning Plan (MRDP) found in **Annex 14**. This will be submitted for approval upon the decommissioning of the current mine site.

C. Social Plan

The Social Plan maps-out the welfare of the workers and the impact communities during the closure process.

Retrenchment Packages

For this, the proponent will comply with at least the minimum requirement of the Philippine Labor Code, specifically, that indicated in Article 283 which provides the required retrenchment package in cases of closures or cessation of operation not due to serious business losses or financial difficulties. Written notice to the employees and the Department of Labor and Employment will also be made at least one (1) month prior to the intended date of retrenchment.

Labor Support Policies and Programs

The company will provide a wide range of placement services to its personnel to allow their transition towards alternative jobs or in becoming self-employed. These services can be through the following:

Job Search

Information on job-openings will be announced and job fairs will be conducted. The Human Resources/Administrative Office will facilitate job matching on the available job openings in the market.

Skills Training and Education Program

To help improve the employability potential of workers who are due to be separated because of project decommissioning, Proponent may provide or sponsor job-related courses/trainings that are focused towards finding an alternative employment. Such training may include office skills to artisan multi-skills training, computer technology, etc. Coordination with TESDA may be conducted.

Enterprise Awareness

Trainings on entrepreneurial skills development will also be implemented and opportunities for livelihood endeavors will be presented.

Counselling

The Company will inform the workers on the status of operation and prepare them psychologically on the planned mine closure. Counselling for workers to be retrenched and their families will be conducted.

Transfer of Social Assets

Any material from removed facilities and structures that have no value for the Company but may have value or use for the localities will be given and distributed for whatever purpose it may serve to them. Nevertheless, the transfer of social assets and services will depend on the outcome of the consultation with the stakeholders in the future.

D. Maintenance and Monitoring Plan

Maintenance and Monitoring Program and Procedures

The Closure Team, spearheaded by the environmental, community relations, safety and health members, shall implement the maintenance and monitoring plans pertinent to the decommissioning and rehabilitation activities. It is worth noting that this said monitoring is in addition to the monitoring and/or audit that will be conducted by the Mine Rehabilitation Fund Committee (MRFC) through the MMT, the Contingent Liability Rehabilitation Fund Steering Committee (CLRFSC) and the MGB.

Moreover, and in compliance with regulations, the Company will submit a progress report containing details of full, partial, and on-going activities relative to the implementation of the FMRDP. This report will be submitted to the MRFC for review and evaluation within thirty (30) days from the end of the term of the preceding work and financial plan. The results of the review and evaluation shall be integrated in the succeeding year's work and financial plan[7].

The more detailed and applicable maintenance and monitoring plans will be prepared/formulated two (2) years prior to closure by the Closure Team, in coordination with the MMT. In doing such, a realistic plan based on actual scenario can be made.

Long Term Management and Maintenance

Upon completion of the FMR/DP implementation and assessment of the company that the objectives of project closure have been achieved, the company will prepare and submit a Final Rehabilitation Report with third party Environmental Audit (FRR with EA) for pre-evaluation by the MRF Committee and final approval by the CLRF Steering Committee.

The MRFC and CLRFSC, after due review and evaluation of the FRR with EA, may issue a Certificate of Final Relinquishment to the company signifying approval of the FRR with EA and freeing the Company from any further obligations insofar as the rehabilitated area/s are concerned.

Nonetheless, if residual care is still needed, the company will submit a Site Management Plan detailing how the identified residual rehabilitation commitments are to be managed along with the corresponding funding requirement.

8. Institutional Plan for EMP Implementation

The project's expansion shall include an accredited Pollution Control Officer and Environment and Health Safety Officer from Holcim to ensure that the EMP and EMoP are strictly followed and implemented. The contractor in place shall also provide its own accredited Pollution Control Officer

[7]Section 187-D of DAO No. 2010-21

to ensure the compliance with all existing environment laws and policies and the implementation of the Environment Management Plan and Environmental Monitoring Plan.

Annex 6 presents the Operating Agreement between the Heirs of Arturo Zayco, represented by Alfredo F. San Miguel Jr., and Holcim Resources and Development Corporation. This was constituted in order to set out their respective rights and obligations for the exclusive exploration, development, and exploitation of the silica resources found in the Property. It was restated and/or further amended from the Original Agreement.

Annex 19 presents the Service Agreement between Holcim Mining Development Corporation, and SI Resources Corporation. This indicates the obligations and the terms of conditions set out in HMDC's Purchase Order.

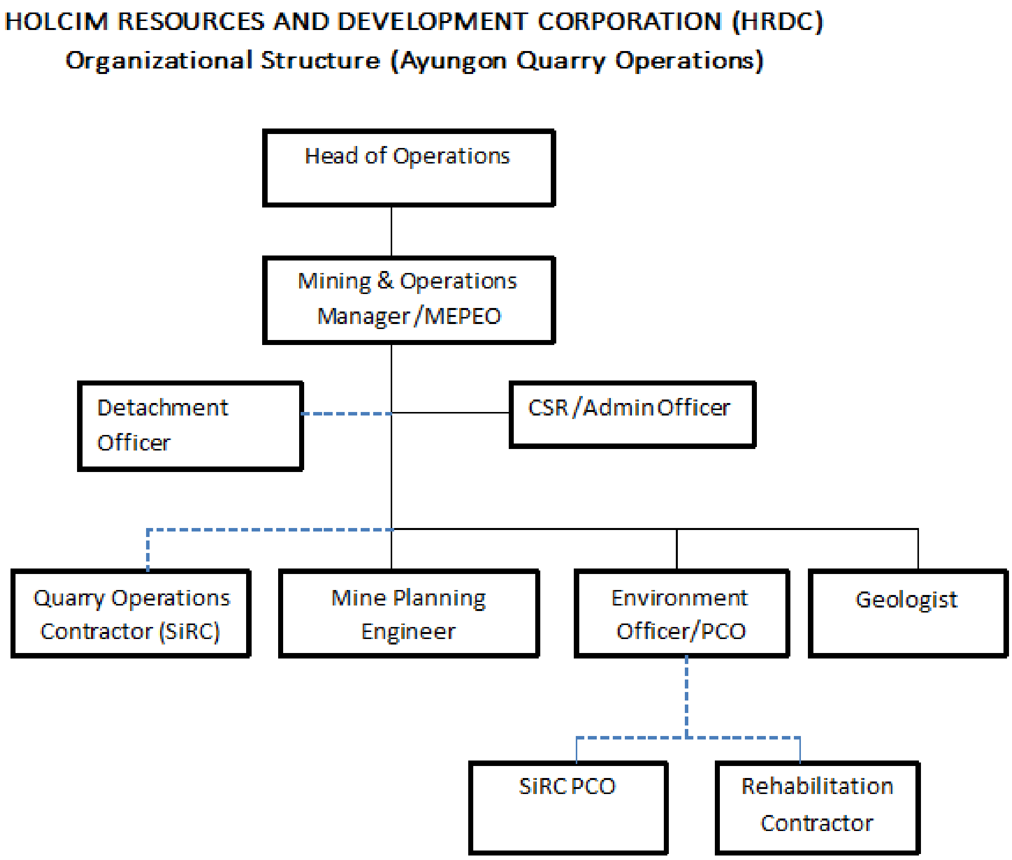


Figure 8-1. Holcim Resources and Development Corporation (HRDC)

<u>Holcim Resources and Development Corporation (HRDC) Community Grievance Redress Mechanism</u>

Holcim, as a company, follows a Community Grievance redress mechanism. The Community Grievance Redress Mechanism (GRM) for the Holcim Resources and Development Corporation (HRDC) is based on certain process which is as follows:

1. Community grievances or concerns shall be properly documented through the submission of a formal letter of the concerned individuals to Holcim Resources and Development Corporation (HRDC) in Ayungon Negros Oriental. The Corporate Social Responsibility Officer (CSRO) shall formally receive all Community Grievance Letters (CGLs) with corresponding received stamp and shall be properly recorded in the Community Grievance Logbook.
2. All received CGLs shall be documented by the CSRO through the use of Community Grievance form.
3. All received CGLs shall be evaluated and categorized by the CSRO based on the following:
    a. SDMP PPAs
    b. Environmental concerns
    c. Health and safety concerns
    d. Cultural concerns
    e. Security
    f. Human rights
    g. SI Resources Corporation
4. All evaluated CGLs shall be properly endorsed by the CSRO through the use of a transmittal form (TF) to the concerned department.
5. The concerned department shall conduct assessment and investigation immediately upon the received CGL and document results of assessment and investigation through the submission of a formal written report to the Mining and Operations Manager for review and approval, Final written report shall be submitted to copy furnish the CSRO.
6. The CRSO shall inform the community of company's response to community concerns and issues upon approval from the Mining and Operations Manager.
7. All completed community concerns shall be properly signed off.

9. References

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10. Annexes

Annex 1 Sworn Statement of Accountability of the Preparer

Annex 2 Sworn Statement of Accountability of the Proponent

Annex 3 Environmental Compliance Certificate

Annex 4 Mine Production Sharing Agreement

Annex 5 Deed of Assignment

Annex 6 Operating Agreement of HRDC and HAZ

Annex 7 Ambient Air Quality Monitoring Results

Annex 8 Surface Water Quality and Ground Water Quality Monitoring Results

Annex 9 Soil Quality Results (Dry and Wet Season)

Annex 10 Multi-Partite Monitoring Team & Self-Monitoring Report and Compliance Monitoring Reports

Annex 11 Annual Social Development and Management Program Accomplishment

Annex 12 2016 and 2018 Public Scoping

Annex 13 Project Environmental Monitoring and Audit Prioritization Scheme

Annex 14 Mine Rehabilitation and Decommissioning Plan

Annex 15 Notice of Approval of the Partial Declaration of Mining Project Feasibility

Annex 16 Marine Study Report

Annex 17 2016 and 2018 IEC Results

Annex 18 2016 Annual Environmental Protection and Enhancement Program

Annex 19 HMDC Service Agreement with Silica Resources

Annex 20 Latest Photos of the Project Site

Annex 21 2019 Annual Environmental Protection and Enhancement Program

Annex 22 COA approved AEPEP

Annex 23 Final Mine Rehabilitation and Decommissioning Plan

Annex 24 HAZ Three Year Work Plan

Annex 25 Sediment Transport Modelling Report

Annex 26 Ayungon 35-Year Mining Development Plan

Annex 27 Growth and Survival Performance of Tree Plantations

Annex 28 Site Development Plan-Sand and Silt