ENVIRONMENTAL PERFORMANCE REPORT AND MANAGEMENT PLAN

Cement Finish Mill and Quarry Operation Project

Barangays Dunggoan, Cagat, Sandayong Norte, Binaliw and Malapoc in Danao City and Barangays Triumfo, Hagnaya and Dawis Sur in Carmen Municipality
Province of Cebu

REPUBLIC
A CRH-ABOITIZ COMPANY

Prepared by:

Mediatrix Business Consultancy

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ABBREVIATION

ANFO	Ammonium Nitrate Fuel Oil
CITES	Convention on International Trade in Endangered Wild Fauna and Flora Species
CLUP	Comprehensive Land Use Plan
CLRF	Contingent Liability and Rehabilitation Fund
CPDO	City Planning Development Office
CSR	Corporate Social Responsibility
DAO	DENR Administrative Order
DCS	Distributed Control System
DENR	Department of Environment and Natural Resources
DIA	Direct Impact Area
DPP	Disaster Preparedness Plan
ECC	Environmental Compliance Certificate
EIA	Environmental Impact Assessment

EMB	Environmental Management Bureau
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EPEP	Environmental Protection and Enhancement Program
EPRMP	Environmental Performance Report and Management Plan
EQPL	Environmental Quality Performance Level
ESA	Environmental Site Assessment
FMRDP	Final Mines Rehabilitation and Decommissioning Plan
IEC	Information, Education and Communication
IIA	Indirect Impact Area
IPCC	Intergovernmental Panel on Climate
IUCN	International Union for the Conservation of Nature
LGU	Local Government Unit
LRI	Lafarge Republic, Inc
LRIC	Lloyds Richfield Industrial Corporation
mamsl	Meters Above Mean Sea Level
MPSA	Mineral Production Sharing Agreement
MRF	Material Recovery Facility
NFPA	National Fire Protection Association
NWRB	National Water Resources Board
PEMAPS	Project Environmental Monitoring and Audit Prioritization Scheme
PGA	Peak Ground Acceleration
PM	Particulate Matter
PPE	Personal Protective Equipment
PTO	Permit to Operate
RCBM	Republic Cement and Building Materials, Inc.
SDP	Social Development Plan
TCT	Transfer Certificate of Title
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

A. PROJECT FACT SHEET

<table>
<tr><td>Project Name</td><td>Cement Finish Mill Plant and Quarry Operations Project</td></tr>
<tr><td>Project Location</td><td>Barangays Dunggoan, Cagat, Sandayong Norte, Binaliw, Malapoc and Quisol in Danao City, Cebu
Barangays Triumfo, Hagnaya, Dawis Sur, Dawis Norte, Baring, Ipil and Corte in Carmen Municipality, Cebu</td></tr>
<tr><td>Project Type</td><td>Quarry and Cement Manufacturing Plant</td></tr>
<tr><td>Project Area</td><td>Existing Project covered by ECC No. 9906-014-105:
<table>
<tr><th>Description</th><th>Area (ha)</th></tr>
<tr><td>Cement Finish Mill and Packhouse/Storage</td><td>10</td></tr>
<tr><td>Quarry Area</td><td>272</td></tr>
<tr><td>Area 1: Binaliw in Danao</td><td>121</td></tr>
<tr><td>Area 2: Sandayong Norte in Danao</td><td>30</td></tr>
<tr><td>Area 3: Triumpo in Carmen</td><td>81</td></tr>
<tr><td>Area 4: Sandayong Norte in Danao</td><td>30</td></tr>
<tr><td>Power Plant</td><td>1</td></tr>
<tr><td>Total</td><td>283</td></tr>
</table>
Proposed Project:
<table>
<tr><th>Description</th><th>Area (ha)</th></tr>
<tr><td>Cement Finish Mill and Packhouse/Storage</td><td>10</td></tr>
<tr><td>Quarry Area</td><td>1,355</td></tr>
<tr><td>Area 1: Dunggoan in Danao and Dawis Sur in Carmen</td><td>195</td></tr>
<tr><td>Area 2: Sandayong Norte, Cagat, Cambanay, Binaliw in Danao</td><td>710</td></tr>
<tr><td>Area 3: Triumpo, Hagnaya in Carmen</td><td>450</td></tr>
<tr><td>Total</td><td>1,365</td></tr>
</table></td></tr>
<tr><td>Project Capacity</td><td>Cement: 1,200,000 metric tons per year (MTPY)
Quarry:
500,000 MTPY of limestone
150,000 MTPY of pozzolan/shale</td></tr>
<tr><td>Project Description</td><td>The proposed project will involve a Cement Finish Mill with a downgrade capacity from 2,500,000 MTPY (covered by ECC No. 9906-014-105) to 1,200,000 MTPY and Quarry Operations with a capacity of 500,000 MTPY for limestone and 150,000 MTPY for siliceous materials (pozzolan/shale).</td></tr>
<tr><td>Project Components</td><td>The old project covered by the ECC Reference No. 9906-014-105 is a full cement manufacturing plant which starts from quarrying of raw materials, raw materials grinding, clinkering, finish milling, packing and powerplant. Whilst the proposed project involves quarrying of limestone and pozzolan/shale, finish milling and dispatch. The Kiln line was already demolished. The power plant facility is still existing, but the equipment is not operational anymore. RCBM has no plan to revive the power plant operation in this project. Moreover, the proposed project will not involve construction of new facilities. Only upgrade and improvement of the facilities will be undertaken. Provide below is the existing and proposed changes of the project in terms of components, rate and status.
<table>
<tr><th>Components</th><th>Capacity/Rate</th><th>Status</th></tr>
<tr><td colspan="3">Quarrying</td></tr>
<tr><td>• MPSA</td><td>MPSA-132-99-VII
Area 1: 121 ha
Area 2: 30 ha
Area 3: 81 ha</td><td>Same MPSA-132-99-VII
Area 1: 195 ha
Area 2: 710 ha
Area 3: 450 ha</td></tr>
</table></td></tr>
</table>

	Area 4: 30 ha	
Components	**Capacity/Rate**	**Status**
Pyroline		
• Kiln and Cooler	2.5 MMTPY	No more pyroline operation (Already demolished)
Cement Raw Material Storage		
• Material Storage 1	73,000 T	Existing; no change
• Material Storage 2	39,000 T	Existing; no change
Cement Finish Mill Plant		
• Ball Mill	80-136 TPH	Existing; no change
• Mill Discharge Airslide	150 TPH	Existing; no change
• Mill Bucket Elevators 1 and 2	150 TPH	Existing; no change
• Fly Ash Silo	200 T	Existing; no change
• Air Separator	80-150 TPH	Existing; no change
• Product Airslide	150 TPH	Existing; no change
• Hot Gas Generator	200kg/h fuel consumption	Existing; no change
• Compressors:		
GA45	160 kW	Existing; no change
GA75	75 kW	Existing; no change
ZE160	45 kW	Existing; no change
ZE4	45 kW	Existing; no change
Packing, Bulk Loading, and Cement Silo (Dispatch)		
• Rotopacker	2,400 BPH (8 spouts)	Existing; no change
• Palletizing System	5 T	Existing; no change
• Bulk Loading Facility	80 TPH	Existing; no change
• Cement Silo	1,250 T	Existing; no change
Support Facilities		
• Power plant	70 MW	No more powerplant operation (Building is still existing but the equipment not anymore operational)
• Generator Set (Back-up)	800 kVA	Existing; no change
• Jetty (Wharf)	1.4MMT bulk cement / 0.7 MMT bag cement shipments	Existing; no change
• Fire Protection System	plantwide	Existing; no change
• Safety Devices	plantwide	Existing; no change
• Cement Warehouse 1	1,700 MT	Existing; no change
• Cement Warehouse 2	2,000 MT	Existing; no change

Existing ECC

ECC No. 931-07CE-051 issued on September 8, 1993 by DENR Region VII

- Proponent: Lloyd Richfield Industrial Corporation
- Project Name: Rehabilitation and Operation of its Cement Manufacturing Plant

ECC No. 9906-014-105 issued on September 26, 2002 by DENR Central Office
Proponent: Lloyds Richfield Industrial Corporation (LRIC)
Project Name: 2.5 MMPTY Cement Manufacturing Complex, Quarrying, Power Plant, Wharf and Other Facilities

Changed the proponents name from LRIC to RCBM on 07 July 2017.

Project/Investment Cost	Four Hundred Fourteen Million and Three Hundred Thousand Pesos (PhP414.3 Million)
Profile of the Proponent	
Name of Proponent	**Republic Cement and Building Materials, Inc. (RCBM)**
Address	Brgy. Dunggoan, Danao City, Cebu
Authorized Signatory/ Representative	**Mr. Fabian Baya** Plant Manager
Contact Details	Telephone No.: (032) 238 6596 Email Address: fabian.baya@republiccement.com
Profile of the Preparer	
EIA Preparer	**Mediatrix Business Consultancy**
Address	L29 Joy-Nostalg Center, 17 ADB Ave., Ortigas Center, Pasig City
Contact Person	**Matilde R. Jimenez-Fernando** General Manager
Contact Details	Telephone No.: (02) 689 7114 Mobile No.: +639175064499 Email Address: mrjfernando@mediatrixph.com; mediatrixbusinessconsultancy@gmail.com

B. EIA PROCESS DOCUMENTATION

EIA Team

The EIA Study was conducted by a multidisciplinary team of professional experts of Mediatrix Business Consultancy (Mediatrix), who have strong background in environmental assessments, in close coordination with the RCBM. The composition of the EIA Team is presented in **Table ES-1**. The sworn statements of accountability of RCBM and Mediatrix are presented in **Annex ES-1**.

Table ES-1: EIA Team Composition

EIA Team	Areas of Expertise	EMB Registry No.
Matilde J. Fernando	Team Leader, Socio-Economics and Legal Framework	IPCO-035
Reynaldo S. Tejada	Water and Air Module	IPCO-036
Hernani Bayani	Geology and Geohazard	IPCO-058
Juvinal Esteban	Socio-economics	IPCO-091
Kristina Orpia	Terrestrial Fauna	-
Alexis M. Fernando	Research and sampling	IPCO-034
Jessan Jello Bernales	Perception Survey	
For. Benjamin Cuevas	Terrestrial Ecology	IPCO-072

EIA Schedule

Mediatrix, together with the RCBM, proceeded on EIA planning, stakeholder profiling and conducted initial EIA processes. Public Scoping was held on January 23, 2014 at El Salvador Resort in Danao City, Cebu. The Technical Scoping was conducted on May 20, 2014 and based on the agreed scope of work, the collection of primary and secondary data was conducted. The EIA Scoping and Screening Form is attached in **Annex ES-2**.

Data collected were processed, analyzed and evaluated for impact assessment and formulation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP). The data and information were written into an Environmental Performance Report and Management Plan (EPRMP) and the final version of the EPRMP will be submitted to the EMB-Central Office for the application of an amended ECC.

EIA Study Area

The EIA study area for the project covers the 10 ha plant site and the 1,355 ha quarry area (Area 1: 195 ha; Area 2: 710 ha; and Area 3: 450 ha) at Barangays Dunggoan, Cagat, Sandayong Norte, Binaliw and Malapoc in Danao City and Barangays Triumfo, Hagnaya and Dawis Sur in Carmen Municipality in Cebu.

EIA Methodologies

The EIA for the proposed project conforms to the Revised Procedural Manual for DENR Administrative Order (DAO) 2003-30 and DAO 2017-15 in the conduct of the following activities, to wit: (i) Scoping, (ii) collection of primary and secondary data, (iii) identification/prediction/ assessment of environmental impacts, (iv) formulation of EMP, and (v) development of EMoP. **Table ES-2** presents the detailed EIA methodology per environment sector/component.

Table ES-2: EIA Methodology

EIA Study Module	Parameters/Scope	Baseline Sampling and Methodology
Land		
Geology/ Geomorphology, Pedology, Land Use & Classification	Reconnaissance, land use, land classification assessment, slope, soil types and classification, erosion	Secondary data, soil sampling and testing, review of geological reports and maps, soil site assessment
Terrestrial Biology – Wildlife and Vegetation	Plain description of the project site because of absence of flora and fauna environment	Plain description of the project site because of absence of flora and fauna environment
Water		
Hydrology/Hydrogeology	Regional hydrogeology, catchment and drainage system	Spring and well inventory, use of secondary data, water balance analysis, and groundwater recharge and production analysis, interviews
Water Quality Freshwater Ecology	Physico-chemical and bacteriological characteristics of rivers	Water sampling and laboratory analysis; use of secondary data
Air		
Air Quality	Ambient air quality and noise levels	Sampling and laboratory analysis
Meteorology/Climatology	Monthly average rainfall, climatological normal and extremes, wind rose diagrams, and frequency of tropical cyclones	Use and review of secondary data
Air Dispersion Modeling	Worst case scenario identification, use of meteorological data	Use of AUSPLUME Model
Climate Change		
Temperature change	Seasonal Temperature increase (in °C) in 2020 and 2050 under medium range emission scenario in Cebu Province Monthly Average Temperature without Climate Change Monthly Average Temperature with Climate Change (2006-2035)	Effects of Temperature Increase in the Project
Rainfall change	Seasonal rainfall change (in %) in 2020 and 2050 under medium range emission scenario in Cebu Province	Effects of change in rainfall pattern to the grinding plant project

EIA Study Module	Parameters/Scope	Baseline Sampling and Methodology
	Monthly Average Rainfall without Climate Change (1980-2010) Monthly Average Rainfall with Climate Change (2006-2035) Monthly Average Rainfall with Climate Change (2006-2065)	
Greenhouse Gas Assessment	CO_2, CH_4, and N_2O Emissions based on IPCC 2006 Guidelines and USEPA Procedure	CO_2 emission released from the exhaust tailpipe of trucks, heavy equipment, and other vehicles during operation
People		
Public health and Demography	Morbidity and mortality trends, Demographic data of impact area: • Number of households and household size • Land area • Population • Population density /growth • gender and age profile • literacy rate • profile of educational attainment	Interviews with key elected officials of the barangays (from barangay captains to councilors and the social welfare barangay officers/ barangay health workers); analysis of secondary health data; Use of secondary data from RHU and PSA; Interviews with the locals; household-level survey
Socio-economics	Socioeconomic data: Main sources of Income, Employment rate/ profile, sources of livelihood, Poverty incidence, commercial establishments and activities, banking and financial institutions	Perception surveys, Interviews with municipal and barangay officials; analysis of secondary data; analysis of survey results
Environmental Risk Assessment		
Risk Assessment	Safety risks and physical risks	Consequence and Frequency analyses to be undertaken using the methodology described in the Revised Procedural Manual for DAO 2003-30

Public Participation Activities

Pursuant to DAO 2003-30, MC 2010-14, and DAO 2017-15, RCBM has conducted a series of public participation activities through pre-scoping, Information, Education and Communication (IEC), public public scoping, and formal and informal discussions with the Barangay and Municipal Officials and residents of in Danao City and the municipality of Carmen from 2014 to present regarding the project.

Information, Education and Communication

The IEC activities presented in **Table ES-3** were conducted to provide updated information about the proposed project and encourage the concerned stakeholders to participate in the EIA process. IEC documents such as attendance, issues raised, and photos taken during the IEC are presented in **Annex ES-3**. **Table ES-4** presents the Summary of Issues and Concerns raised during the IECs Conducted.

The IEC Activities conducted were the following:

- Courtesy Calls and Consultations;
- Barangay Assembly
- Postings of Announcement in conspicuous areas

The content of the IEC Discussions and material were on the following:

- Company Introduction
- Project Concept
- Health, Safety & Environment
- Benefits to Host Communities

Table ES-3: IEC Conducted for the Proposed Project

Date/Time	Venue
November 3, 2019, 10:00 AM	Barangay Hall of Barangay Cagat, Danao City
November 3,2019, 10:00 AM	Barangay Hall of Barangay Cambanay, Danao City

Table ES-4: Summary of Issues and Concerns Raised during the IECs Conducted

Issue/Concern	Proponent's Response during the IEC
Kung ma-approve and proposed project sa planta ug mosugod na ang quarry sa among barangay kung mahimo ayohon una ang dalan kay ang dalan sa barangay dili intended para sa heavy equipment or vehicle.	
Pwede pod ba mi makapangayo ug multicab o dump truck para sa among basura?	Sa akong gi-share kaninyo, ang pagprovide ug multicab apil sa social development and mgt program alang sa brgy nga aduna kami operation. Kung panangutan nga madayon atong project diri sa brgy, aduna kitay SDMP ug kamo ang mag-identify sa priority nga project nga maapil nini

Perception Survey

The perception survey was conducted in May 2014 and on February 5-12, 2020, as presented in **Table ES-5**. A total of 2,775 households were randomly interviewed and surveyed.

Table ES-5: Details of Sample Size

City/Municipality	Barangay	Sample size	Date of Survey
Danao	Sandayong Norte	306	February 5 to 12, 2020
	Cagat	295	
	Cambanay	344	
	Dunggoan	534	May 2014
	Binaliw	331	
	SUBTOTAL	***1,810***	
Carmen	Dawis Sur	323	February 5 to 12, 2020
	Triumfo	319	
	Hagnaya	323	
	SUBTOTAL	***965***	
	OVERALL TOTAL	***2,775***	

Public Scoping

Two Public Scoping sessions were conducted. The first Public Scoping was conducted on January 23, 2014, 08:00AM in El Salvador Resort by Lafarge Republic, Inc. (former name of RCBM) and the second one was on November 15, 2019, 09:30AM in Carmen Activity Center, Nautical Highway, Carmen, Cebu. The first Public Scoping has a total of 28 attendees while 41 for the second Public Scoping. Provided in **Table ES-6** and **Table ES-**7 are the summary of issues and concerns raised during the public scoping sessions. Details of Public Participation are presented in **Annex ES-3**.

Table ES6: Summary of Issues and Concerns during Public Scoping Conducted by Lafarge Republic, Inc. on January 23, 2014

Issue/Concern	Proponent's Response during the Public Scoping
Dust during loading	LRI will conduct briefing with operators of payloader; implementation of conveying system is also an option that LRI will implement
Clinker spillages during delivery from Wharf to plant	LRI will meet with hauler contractors; LRI will also look at possible assignment of street sweepers; water sprinkling during hauling will also be looked at as alternative option of dust/spillage mitigation
Efficiency of Dust Collection	Efficiency is built-in in the automated system; LRI invites the participants for a plant visit to see and understand the process
Copy of minutes and presentation to the LGU	To be provided next week
How fast can conveying system be implemented?	Schedule is still being finalized by LRI.
Feedback mechanism; provide hotline numbers of mobile numbers to report violations or alleged violations of contractors especially the haulers;	Suggestion noted and LRI to Invite brgy officials during briefings with contractors in February to discuss concerns
Tree Planting in 44 hectares lacks protection of trees to grow and sustainable forest protection	LRI planted a total of 800 ha all over the Philippines; LRI has signed a MOA with DENR, Toledo, etc. on Tree growing; Annex B of the MOA was presented (attached in this ppt); meeting with parties involved to come up with plan on how to protect the forest after turn-over.
Illegal Tree Cutting	LRI will conduct information drive and Brgy. Dunggoan to pass a resolution regarding imposition of penalties to punish illegal tree cutting; cutting not allowed for regulated species (PENRO)
Livelihood and employment to avoid illegal tree cutting	LRI requested for the coordination of the Brgy.
Was MMT formed?	MMT was formed but did not officially convene. It is being revived.
Social Development for housewives	Programs to be proposed should be in coordination and aligned with Brgy. Dunggoan; accredit the NGO with the City and submit programs with the Barangay
Join the Brgy. Session schedule (every Thursday) to discuss the proposed SDP	LRI suggested for DACODEP to submit project feasibility and discuss with the barangay

Table ES7: Summary of Issues and Concerns during Public Scoping (25 November 2019)

Issue/Concern	Proponent's Response during the Public Scoping
Is road spraying not affecting or destroying the road	The Proponent responded that in order not to affect the quality of the road, water spraying should be done during cold time of the day like early morning or late afternoon.
How is Republic's pollution control system at the Plant	The Proponent responded that since dust is the main impact, Republic has installed 11 dust collectors. Todate, test results based on quarterly monitoring is compliant with DENR Standards as per RA 8749.
Is there burning involved in processing Limestone?	The Proponent responded that limestone is used as an additive to reduce clinker requirement.
Program for Senior Citizens	The Proponent responded that medical missions are currently conducted annually and most of the beneficiaries are Senior Citizens. Republic also provides

Issue/Concern	Proponent's Response during the Public Scoping
	medicines for hypertension. RCBM may consider continuously providing other program in the future intended for the Senior Citizens.
What is the assurance that quarry operations will not cause landslides	The Proponent responded that this concern will be covered by the geology and geohazard identification that will be conducted by the EIA Group's Geology Team.
Do you conduct water spraying?	The Proponent responded that controlled water spraying is one of the control measures in mitigating the road dust during raw material hauling.
How much is the increase in production	The Proponent responded that the proposed project capacity for cement production is 1,200,000 metric tons per year and the extraction/quarry capacity is 500,000 metric tons per year of limestone and 150,000 tons of shale and other siliceous materials.
How often will medical mission be implemented? Is hiring will also be considered for Carmen?	The Proponent responded that annually Republic Cement conducted medical mission. Currently, 80% of the manpower employed in Republic Cement are from Danao City and Carmen. In every job opportunities, residents from Danao and Carmen are given utmost priority.
Membership to MMT; Inclusion of Dawis Sur to MMT	The Proponent responded that the exiting MMT Membership was previously assigned by EMB and MGB. Once the ECC amendment is issued, Dawis Sur will definitely be a member being a host community.
Provision of MRF / shredder	The Proponent noted this request.

Review of Secondary Data

Socio-demographic and economic data were procured from pertinent documents from respective government institutions such as Municipal, City and Provincial LGUs, as well as online sources for background information. All sources were exhausted in the study.

C. EIA SUMMARY

Summary of Alternatives

There were no alternative site and technology considered for the project because the Cement Finish Mill Plant and Quarry Operations Project of RCBM in Barangay Dunggoan, Danao City, Cebu is already operational. Also, no other technology option, project operation and resources were considered because the Plant will use the existing equipment available and already installed at the Plant.

With this, there will be no more comparison of environmental impacts for each alternative since alternative itself is nil.

No Project Option

If the proposed project will not materialize, employment opportunities and social development such as livelihood projects, skills training, scholarship programs and medical assistance for the residents will not be realized. Also, the prospective LGU increase in revenue, multiplier effect of the project such as business opportunities, support to basic services like infrastructure and medical assistance and other opportunities for the community and LGU will likely lose when the project is not pursued.

The possibility of expanding and upgrading LGU's basic infrastructure services and facilities and strengthening of LGU's capacity in local governance, investment planning, revenue generation and project development and implementation will not also be realized. This may also include possibility of enhancing their capabilities for local leadership because the project may provide technical support and assistance to local leaders to training, seminars and workshops. All of these may be provided by the project thru its tax payments, permits and clearances and social development programs.

Another opportunity that the local government and the community may miss if the project will not be realized is the possibility of constructing additional infrastructure projects like roads and bridges, increasing school classrooms and improving school facilities and medical assistance such as provision of medicines, medical supplies and medical missions.

Summary of Existing Environmental Conditions Including Notifiable Changes vis-à-vis the Previous Baseline Conditions during the Previous EIA

In summary, the main impact for this project is the generation of dust by the cement plant and the generation of dust and noise by the quarry activities as well as movement of raw materials which can be mitigated as regularly practiced by RCBM. More importantly, among the main impacts of the project is the positive impact of community benefits under the SDMP, environmental protection under the EPEP and progressive rehabilitation under the FMRDP which are all religiously being implemented by RCBM.

Among the risks of the project is air emissions but this is continuously being mitigated using air pollution control devices such as bag filters as dust mitigation measure.

Table ES-8 presents the summary of key environmental impacts of the project and the corresponding management plan and mitigating measures.

Table ES-8: Summary of Environmental Management Plan

Activity	Impact	Mitigating Measure	Efficiency Of Measures
Site Preparation			
Vegetation clearing	Reduction of vegetation, fauna disturbance and/or displacement	• Limit site preparation within an area required by MGB to be open at one given time and keep to a minimum vegetation removal ensuring that only necessary/planned clearings are undertaken	100% replacement of removed vegetation with same species
		• Replace with the same species of seedlings, tree and other plant species that are removed during site preparation and development	
	Potential siltation of nearby bodies of water due to surface water run-off	• Provision of temporary bunds around the stockpiles of overburden wastes and drainage systems to convey the storm run-off to siltation ponds. Zero discharge of silt ponds.	100% conveyance of run-off water to siltation ponds
	Generation of dust from site/access road preparation	• Sprinkling of water at least once a day along the access road and project area	100% no generation of dust/compliance of TSP level
Quarry Operation			
Extraction and hauling of materials (Silica)	Siltation to streams due to erosion of exposed soil and Overburden materials	• Progressive rehabilitation and revegetation of mined out quarries and planting barren lots, with at least 200 endemic trees per year to prevent soil erosion.	100% No generation of silt
Crushing (sizing and sorting)		• Utilize the recovered topsoil for re-soiling or as soil cover on waste dumps and other disturbed areas for rehabilitation and revegetation. All stockpiles shall be maintained and managed below the angle of repose of 45%	No. sediments to streams and 100% compliance with RA9275

Materials (Silica) Transport		• Continue to implement sediment and erosion control plan	
		• Proper drainage design at the bench toes and access roads, to control the flow of run –off water, and divert it to series of 3 stage siltation ponds	
		• Rainwater and runoff collecting systems from crusher flatform shall be provided with primary and secondary silt traps	
	Generation domestic wastewater that may contaminate the soil and receiving body of water	• Provision of portalets (Note: at least one (1) portalet for 10 workers) with appropriate septic tanks for the workers. Wastes shall be collected by 3rd party hauler with valid permits/clearances	100% collection of wastewater
	Generation of solid wastes	• Proper management of domestic solid i.e. provision of Material Recovery Facility for proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal	100% compliance to RA9003
	Generation of hazardous wastes from waste oil/ grease and spills from the heavy equipment and vehicles	• Provision of 2,000 liter storage capacity provided with bund wall • Regular (2x a year) hauling of hazardous waste by DENR accredited transporter and treater	100% no oil spills and compliance to RA6969
	Generation of fugitive dust during the quarrying activities	• Regular water spraying of exposed dusty areas during high winds, and dry months. • Establishment 20-meter wide buffer zone of different species combination of plants including shrubs, small and medium sized trees should be established around the quarry sites, to contain dust	100% no dust be seen in the area
	Generation of noise from the quarrying activities	• Implement regular preventive maintenance to all vehicles/equipment and install mufflers	100% compliance to noise standards
	Fugitive particulate pollution	• Water spraying of transportation of tires of trucks before leaving the site • Utilize at least 1 water truck in water spraying unpaved haul roads for the whole 8 hours operation per day depending on weather condition • Strictly implement 30 kilometers per hour vehicle speed limits • Trucks loaded with ores will be covered to prevent fugitive dust	100% No dust be seen during transport of materials
Cement Mill operations	Contamination and improper management of hazardous waste	• Provision of Hazardous Waste area with proper labeling, segregation and storage of wastes • Management of transformer oil to prevent spills. Storage rooms should	100% Compliance to disposal of toxic and hazardous waste

	materials, e.g. transformer oil spill	have concrete containment. The transformer room/ area should also be designed to prevent accidental spills to contaminate soil in the area. The storage room also for used transformer oils should have containment - this is our Hazmat Storage Facility. • Transport, treatment and disposal of DENR accredited third party contractors • Provision of secondary containment for oil drums & diesel fuel tanks • Provision of oil skimmer for mechanical clean up in case of accidental spillage • Proper labelling of oil drums & diesel tanks	
	Possible increase in ambient concentration of PM10, CO2, CO, Sox and NOx	• Regular maintenance of equipment • Use of enclosures for equipment • Quarterly monitoring of the ambient air to ensure the project's operation is compliant with the Clean Air Act	100% Compliance to the standards of the Clean Air Act
	Degradation of air quality due to fugitive dusts from equipment and vehicles	• Strict implementation of speed limits in vehicles • Proper maintenance of equipment • Designation of no idling zone • Strict implementation of routine plant maintenance and good house keeping • Regular wet suppression or water spraying during dry weather condition of the access road • Regular maintenance of trucks to reduce or maintain tailpipe emissions	100% Compliance to the standards of the Clean Air Act
	Indoor Dust Pollution	• Provision of Control Ducting Facility to minimize fugitive dusts outside the building of cement mill operation	100% Compliance to the standards of the Clean Air Act
	Generation of Air Pollution from all sources	• Regular annual stack test monitoring	100% Compliance to the standards of the Clean Air Act
	Noise from equipment and vehicles	• Maintain appropriate measures and buffer zones along the entire periphery of the industrial complex with appropriate species/dense vegetation cover to enhance the condition of the ecosystem and to serve as noise, vibration and dust buffers; • Enclosure of facility • Defective equipment/parts with abnormal noise and/or vibration will be either repaired replaced; • All employees working on site will be provided with proper PPE especially ear protectors	100% Compliance to DENR Noise Standards

		• The Contractor shall at all times comply with all current statutory environmental legislation especially on noise.	
	Health and safety hazards	• Strict implementation of Health and Safety Policies at the Plant • Regular conduct of employee safety inspections and toolbox meetings • Regular APE and strict implementation on the use of PPEs • Regular conduct of First Aid Training • Provision of Fire Fighting System	100% Compliance to health and safety rules
	Traffic due to increase in number of trucks	• Allocation of open yards and spaces for stationing of the trucks and provide ample parking spaces • Adequate signages and proper scheduled hours for the truck and vehicles coming in and out • Assign traffic personnel to manage the traffic	100% Compliance to traffic rules and non-contribution to worst traffic situation

Status of EMF & EGF / CLRF implementation

For resource extractive projects where this project of RCBM falls, a financial mechanism called Contingent Liability and Rehabilitation Fund (CLRF) is established in lieu of the EMF and EGF. The CLRF is an environmental guarantee fund mechanism that ensures the just and timely compensation for damages and progressive and suitable rehabilitation for any adverse effect a mining operation or activity may cause. This fund is further broken down as follows:

- Environmental Trust Fund (ETF) which is divided into Rehabilitation Cash Fund (RCF) and Monitoring Trust Fund (MTF);
- Mine Rehabilitation Fund (MRF);
- Mine Waste Tailings Reserve Fund (MWTRF); and
- Final Mine Rehabilitation and Decommissioning Fund (FMRDF).

As per the Bank Account of RCBM as of 11/23/2020, follow are the funds' balance:

Run Date: 12-02-2020
Run Time: 11:47:28

DBP

TRUST SYSTEM
OUTSTANDING BALANCE OF INVESTMENT
As of November 30, 2020

CBN NUMBER 012546

T.O. In No.	Value Date	Cash Out	Gross Rate	Net of Tax	Coupon Rate	Full Term	Maturity Date	Sec Type	Face Value	Maturity Value	Maturity Value Net of Trust Fees
016-24 -012546 - RCBMI DANAO (FMRDF)											
00144082	11/23/20	1,070,931.74	1.350000%	1.080000%	0.000000%	60	01/22/21	SSA	1,070,931.74	1,072,859.42	1,071,966.98
TOTAL		1,070,931.74							1,070,931.74	1,072,859.42	1,071,966.98

1. PROJECT DESCRIPTION

Republic Cement and Building Materials, Inc. (RCBM), (formerly Lafarge Republic, Inc.), is a CRH-Aboitiz company. CRH is a leading player in building materials which has an established presence in the Philippines through RCBM. RCBM and its associated companies market cement products, both in bags and bulk, under three (3) main brands namely: Republic, Fortune and Mindanao. RCBM owns and operates five (5) integrated cement plants in luzon and mindanao, and a cement finish mill plant and quarry operation in Danao City, Cebu. RCBM's office is located at 18th Floor, Menarco Tower, Bonifacio Global City. RCBM was incorporated in May 1995 with the Securities and Exchange Commission (SEC) with Registration No. 9803 and its corporate term has been extended to May 3, 2055 by the SEC on February 3, 2005.

Driven by a customer focused approach, RCBM offers the construction industry and the general public innovative solutions bringing greater safety, comfort and quality to their everyday surroundings. In line with this, RCBM proposed to redesign the existing Cement Finish Mill Plant located in Barangay Dunggoan, Danao City, Cebu. RCBM intends to downgrade the full line cement manufacturing of the project to finish milling only.

The Cement Finish Mill Plant and Quarry Operation in Danao City was originated from the Lloyds Richfield Cement Manufacturing Complex (LRIC). On July 31, 2007, LRIC was absorbed by RCBM by virtue of Certificate of Filing of the Articles and Plan of Merger. The Cement Finish Mill Plant and Quarry Operation was issued an Environmental Compliance Certificate (ECC) with reference number 931-07CE-051 by the EMB-Central Office on September 8, 1993 and was amended by ECC Reference No. 9906-014-105 on September 26, 2002 (**Annex 1-1**).

On September 02, 2019, MGB sent its Letter of Approval to Republic Cement. Dispositive portion of which stated that:

> *"We note that the "Project Feasibility Study" of the project, which was submitted as one of the mandatory requirements for the application of the MPSA, covering the entire contract area under MPSA No. 132-99-VII was approved upon the issuance of the MPSA on May 20, 1999. The approval thereof shows that the project is technically and economically feasible rendering the MPSA directly under Operating Period, which allows RCBM to directly undertake the utilization and disposition of the minerals therein."*

With this, DMPF was no longer required from RCBM.

Annex 1-2 presents a copy of the Certificate of Incorporation of RCBM, while **Annex 1-3** presents a copy of the Change of Name of ECC Holder to RCBM. **Annex 1-4** provides the MGB Letter of Approval dated Sept. 02, 2019.

1.1 PROJECT LOCATION AND AREA

1.1.1 Description of the Project Area

The Cement Finish Mill Plant is located at 10 hectares (ha) lot in Barangay Dunggoan, Danao City, Cebu. On the other hand, the 1,355 ha Quarry Area is located in Barangays Dunggoan, Cagat, Sandayong Norte, Binaliw, Malapoc, and Quisol in Danao City; and Barangays Triumfo, Hagnaya, Dawis Sur, Dawis Norte, Baring, Ipil, and Corte in Carmen Municipality. The Cement Finish Mill Plant is located approximately 200 meters (m) from the Quarry Area. The summary of the exising and proposed area of the project is presented in **Table 1.1.1**.

Table 1.1.1: Summary of the Project Area

Description	Area (ha)
Existing Project covered by ECC No. 9906-014-105:	
Cement Finish Mill and Packhouse/Storage	**10**
Quarry Area	**272**
Area 1: Binaliw in Danao	121
Area 2: Sandayong Norte in Danao	30
Area 3: Triumpo in Carmen	81
Area 4: Sandayong Norte in Danao	30
Power Plant	**1**
Total	**283**
Proposed Project	
Cement Finish Mill and Packhouse/Storage	**10**
Quarry Area	**1,355**
Area 1: Dunggoan in Danao and Dawis Sur in Carmen	195
Area 2: Sandayong Norte, Cagat, Cambanay, Binaliw in Danao	710
Area 3: Triumpo, Hagnaya in Carmen	450
Total	**1,365**

The 10 ha lot where the Cement Finish Mill Plant is currently situated, is privately owned by RCBM and covered by the Transfer Certificate of Title (TCT) No. T-397 and 910. On the other hand, the Quarry Area with a total area of 1,355 ha is under the Mineral Production Sharing Agreement (MPSA) No. 132-99-VII covering a total area of 2,551 ha. MPSA No. 132-99-VII was entered into by and between the Government and RCBM on May 20, 1999 covering portion of the areas of Barangays Dunggoan, Cagat, Sandayong Norte, Binaliw, Malapoc, and Quisol in Danao City; and Barangays Triumfo, Hagnaya, Dawis Sur, Dawis Norte, Baring, Ipil, and Corte in Carmen Municipality. **Annex 1-5** presents the TCT of RCBM for the Cement Finish Mill Plant, while **Annex 2-1** presents the MPSA 132-99-VII for the Quarry Area.

Barangay Dunggoan is located in the northeastern part of Danao City, Cebu facing the Camotes Islands. It lies in the eastern coast between the municipalities of Compostela and Carmen, bounded on the west by the municipalities of Balamban, Asturias and Tuburan. It is 8.20 kilometers (km) from Carmen to the north; 96.0 km from Balamban (via Toledo City); 92.14 km from Asturias (via Lugo); 7.80 km from Compostela to the south; and 33.1 km from Cebu City. The project site is accessible to all types of vehicles. It can be access through the airport at Mactan Cebu International Airport, which services regular flights to and from Manila as well as to other islands of Mindanao and abroad. Other mode of access to the plant is through an existing pier of Republic Drydock, Danao City port and port of Carmen town, Cebu and vessels from other ports of Cebu City.

Table 1.1.1 presents the technical description and the geographical location of the project site, i.e. the cement finish mill and quarry sites while **Figure 1.1.1, Figure 1.1.2** and **Figure 1.1.3** show the location of the project site.

Table 1.1.2: Geographical Coordinates of the Project Site

Point	Coordinates	
	Latitude	Longitude
Cement Finish Mill Plant Site		
1	10°33'36.38" N	124°1'17.45" E
2	10°33'33.32" N	124°1'10.12" E
3	10°33'24.76" N	124°1'12.95" E
4	10°33'20.80" N	124°1'19.44" E
Limestone Quarry Active Area		
1	10˚33'35.327"	124˚00'56.667"
2	10˚33'29.486"	124˚01'05.232"
3	10˚33'24.600"	124˚01'00.949"

Point	Coordinates	
	Latitude	Longitude
4	10˚33'31.315"	124˚00'52.862"
Shale Quarry Active Area		
1	10˚32'49.833"	123˚59'49.540"
2	10˚32'50.300"	123˚59'52.063"
3	10˚32'46.307"	123˚59'52.237"
4	10˚32'47.285"	123˚59'50.064"

Table 1.1.3: Geographical Coordinates of Quarry Areas 1, 2 and 3

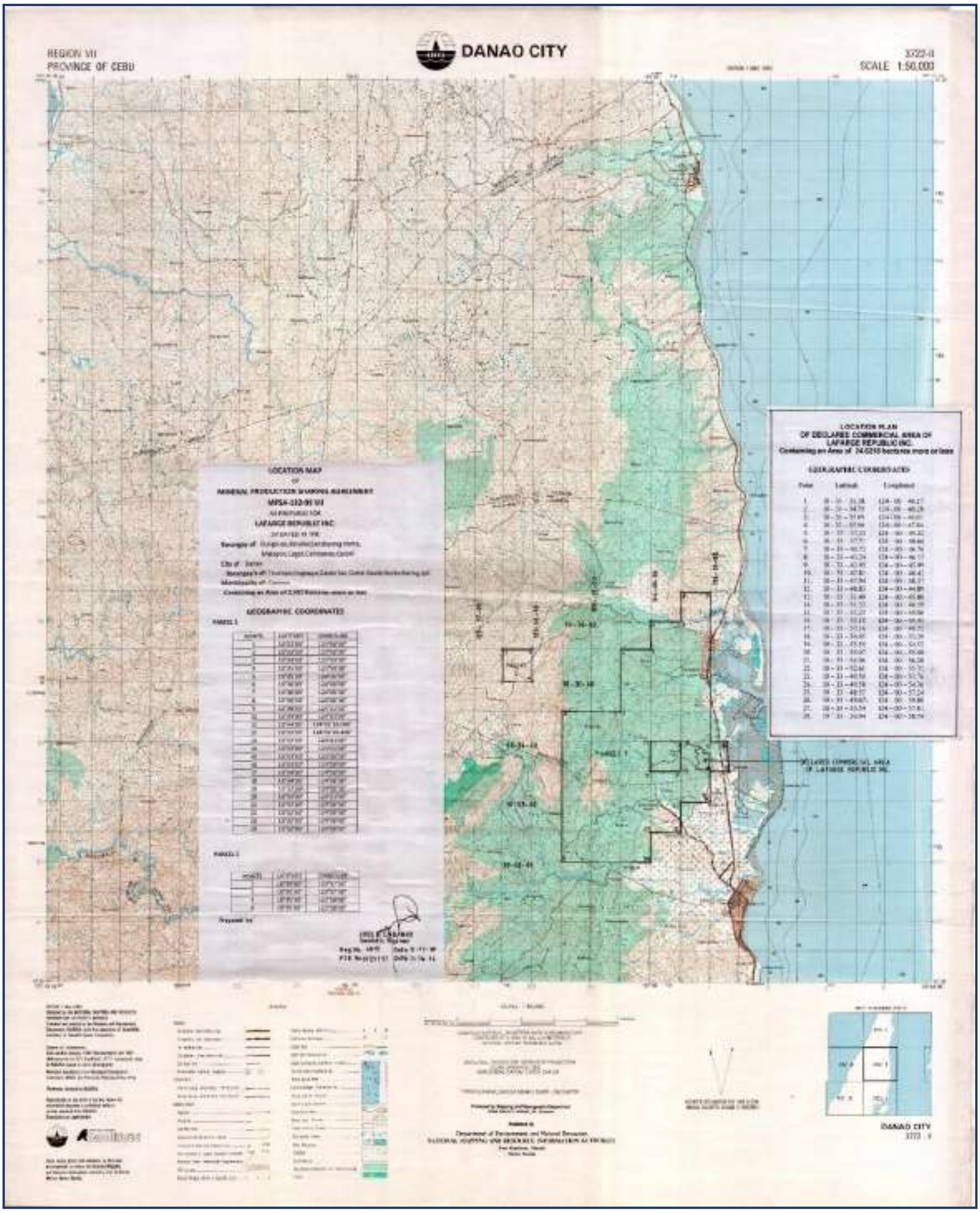
Name	Area (sq.m.)	Cor	WGS 84 (Google Earth)			
			x_wgs	Longitude	y_wgs	Latitude
Area 1	1947047.212	1	124.01812	124° 1'5.22"E	10.56872	10°34'7.39"N
Area 1	1947047.212	2	124.01812	124° 1'5.22"E	10.565506	10°33'55.82"N
Area 1	1947047.212	3	124.01914	124° 1'8.89"E	10.565506	10°33'55.82"N
Area 1	1947047.212	4	124.01889	124° 1'7.99"E	10.557173	10°33'25.82"N
Area 1	1947047.212	5	124.01812	124° 1'5.22"E	10.557173	10°33'25.82"N
Area 1	1947047.212	6	124.01812	124° 1'5.23"E	10.552062	10°33'7.42"N
Area 1	1947047.212	7	124.00666	124° 0'23.96"E	10.552767	10°33'9.96"N
Area 1	1947047.212	8	124.00673	124° 0'24.24"E	10.557173	10°33'25.82"N
Area 1	1947047.212	9	124.00979	124° 0'35.22"E	10.557173	10°33'25.82"N
Area 1	1947047.212	10	124.00978	124° 0'35.22"E	10.565505	10°33'55.82"N
Area 1	1947047.212	11	124.00976	124° 0'35.15"E	10.568901	10°34'8.05"N
Area 2	7096102.447	1	124.00145	124° 0'5.22"E	10.561794	10°33'42.46"N
Area 2	7096102.447	2	124.00145	124° 0'5.22"E	10.557172	10°33'25.82"N
Area 2	7096102.447	3	124.0026	124° 0'9.35"E	10.557172	10°33'25.82"N
Area 2	7096102.447	4	124.00297	124° 0'10.67"E	10.556124	10°33'22.05"N
Area 2	7096102.447	5	124.0037	124° 0'13.33"E	10.553379	10°33'12.17"N
Area 2	7096102.447	6	124.00379	124° 0'13.63"E	10.550829	10°33'2.98"N
Area 2	7096102.447	7	124.00491	124° 0'17.68"E	10.548689	10°32'55.28"N
Area 2	7096102.447	8	124.00754	124° 0'27.13"E	10.546888	10°32'48.80"N
Area 2	7096102.447	9	124.00979	124° 0'35.23"E	10.544826	10°32'41.38"N
Area 2	7096102.447	10	124.00979	124° 0'35.23"E	10.540507	10°32'25.83"N
Area 2	7096102.447	11	124.00145	124° 0'5.23"E	10.540507	10°32'25.83"N
Area 2	7096102.447	12	124.00145	124° 0'5.23"E	10.535771	10°32'8.78"N
Area 2	7096102.447	13	123.9987	123°59'55.31"E	10.537233	10°32'14.04"N
Area 2	7096102.447	14	123.98089	123°58'51.19"E	10.53979	10°32'23.24"N
Area 2	7096102.447	15	123.97833	123°58'41.97"E	10.54345	10°32'36.42"N
Area 2	7096102.447	16	123.97897	123°58'44.31"E	10.560657	10°33'38.37"N
Area 2	7096102.447	17	123.98723	123°59'14.02"E	10.55991	10°33'35.67"N
Area 2	7096102.447	18	123.99608	123°59'45.90"E	10.560649	10°33'38.33"N
Area 3	4485273.862	1	123.97645	123°58'35.22"E	10.573837	10°34'25.81"N
Area 3	4485273.862	2	123.99312	123°59'35.22"E	10.573838	10°34'25.82"N
Area 3	4485273.862	3	124.00482	124° 0'17.34"E	10.573872	10°34'25.94"N
Area 3	4485273.862	4	124.00634	124° 0'22.83"E	10.565505	10°33'55.82"N
Area 3	4485273.862	5	124.00145	124° 0'5.22"E	10.565505	10°33'55.82"N
Area 3	4485273.862	6	124.00145	124° 0'5.22"E	10.561794	10°33'42.46"N
Area 3	4485273.862	7	123.99608	123°59'45.90"E	10.560649	10°33'38.33"N
Area 3	4485273.862	8	123.98723	123°59'14.02"E	10.55991	10°33'35.67"N
Area 3	4485273.862	9	123.97897	123°58'44.31"E	10.560657	10°33'38.37"N
Area 3	4485273.862	10	123.97645	123°58'35.22"E	10.561984	10°33'43.14"N

Figure 1.1.1: Location Map

Current ECC Quarry Scope

Proposed Quarry Expansion

Figure 1.1.2: MPSA Map showing the Current ECC Scope and Proposed Area Coverage



Source: NAMRIA

Figure 1.1.3: Map of the MPSA Area

1.1.2 Impact Areas

The direct impact area (DIA) cover the 1,365 ha project site and the posible air receptor within 1 km due to the expected air emissions from finish mill and quarry operations. Similar receptors are the impact areas identiifed for socal development. On the other hand, the indirect impact area (IIA) cover the hauling route (National Highway) during operation of the project. The DIA and IIA of the project is shown in **Figure 1.1.4**.

Source: Google Earth Map

Figure 1.1.4: Impact Areas of the Project

1.2 PROJECT RATIONALE

RCBM intends to redesign the implementation of the existing Cement Finish Mill Plant due to the following reasons:

- Focus or limit the project on Limestone Quarrying, Material Storage, Cement Milling, Silos, and Packing;
- Meet the increasing market demand in general especially the demand for cement by the Philippine Government for its Build-Build-Build Projects; and
- Specifically, support and meet the fast-growing demand of urbanization in Cebu province that will also contribute to increased local employment and increased tax revenue for the host LGU.

1.3 PROJECT ALTERNATIVES

1.3.1 Site and Technology Selection

There were no alternative site and technology considered for the project because the Cement Finish Mill Plant and Quarry Operations Project of RCBM is already operational. Also, the primary consideration for the project site determination is the MPSA 132-99-VII where the quarry site is located.

Cement manufacturing operations of the RCBM Danao Plant employs the most efficient cement manufacturing technology, the dry process, with pre-heater and pre-calciner systems. A simple diagram of the cement process flow is shown in **Figure 1.3.1**.

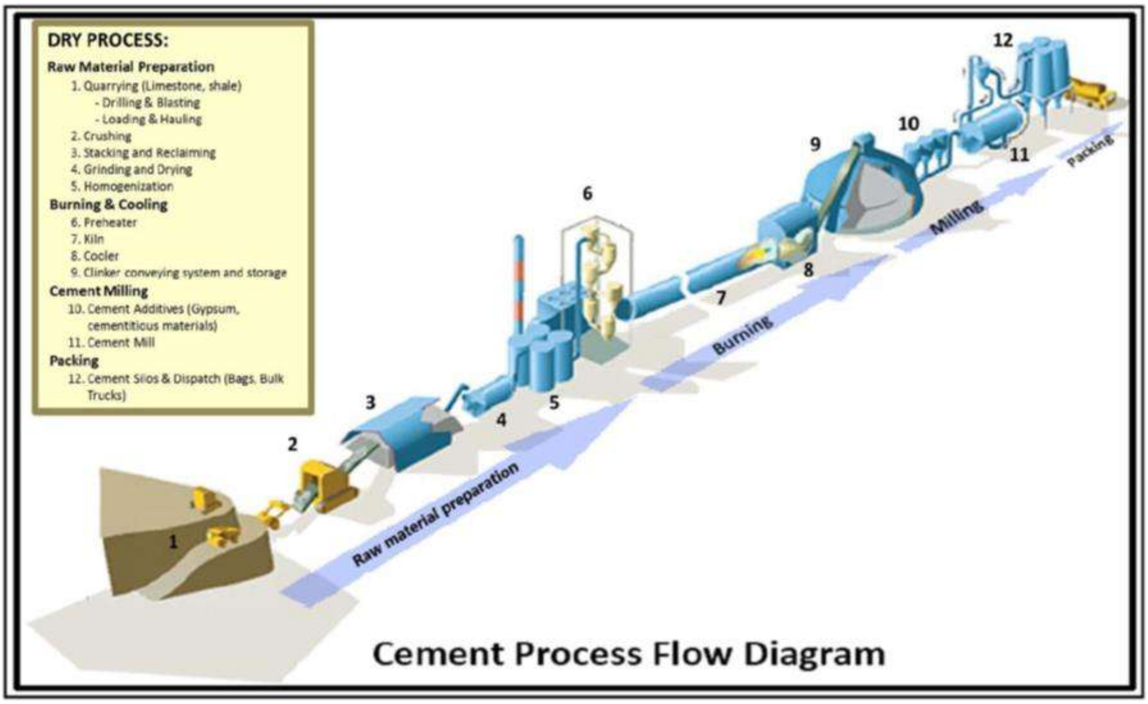


Figure 1.3.1: Cement Process Flow Diagram

Cement manufacturing is achieved through the four general processes of raw mix preparation, burning, milling and packing. For this amendment, the Danao Plant's project scope will be limited only to quarrying, milling, packing and dispatching.

1.3.1.1 Raw Mix Preparation

The raw mix preparation starts with the quarrying operations followed by crushing, stacking and reclaiming; grinding, drying, and homogenization of raw materials.

1.3.1.1.1 Quarrying

Material quarrying is the first stage of cement production. Limestone and shale are extracted from the quarry area. The area that is actively being quarried using open cast quarry.

Drilling and Blasting

The drilling and blasting are not done in the active quarry areas as limestone formation is soft enough and can be extracted using backhoe with breaker.

Loading and Hauling

Broken limestone and shale from blasting are loaded by hydraulic excavators, shovels, and wheel loaders to 50/60-tonner off-highway trucks. Each truck carries material directly to the crusher about 1km away using an access road that is within plant boundaries. Normally, two to three loading areas are active to be able to sustain crusher target throughout and target quality of limestone at the pre-homo stockpile.

1.3.1.1.2 Crushing, Stacking, and Reclaiming of Raw Materials

The raw material from the quarry is first crushed in a jaw crusher followed by an impact crusher to reduce particle size to below 50 mm. Crushed limestone is then conveyed to the storage area where other raw material additives such as shale, silica and iron are stacked in a longitudinal storage unit called a limestone storage stockpile. Materials are then extracted transversely by a reclaimer and conveyed to the raw mill bin for grinding. Each material has its own feeder to ensure the right amount is extracted from the stockpile.

1.3.1.2 Cement Milling

Clinker is then transported to Finish Mills.

As previously declared, this EPRMP focuses on cement finish mill and quarry and not the whole cement manufacturing operations.

The existing cement finish mill operations employs the most efficient technology with blending systems. The process only involves the grinding of Clinker materials for cement production and blending. With the Clinker being produced from other manufacturing sites, the process generally starts at grinding of the raw materials.

From the clinker storage, clinker is transferred to the clinker bin. It passes through the weigh feeder, which regulates its flow in proportion with the additive materials. At this stage, gypsum, pozzolan and limestone are added to the clinker and then fed to the finish grinding mills. Gypsum serves as a retarder in the too rapid setting or hardening of cement. Blended cement is pulverized in a closed circuit system in the finish mills to the desired fineness. Cement is then transported to cement silos then packed into bags by inline packers or loaded as bulk and bags are distributed either by land using forwarder trucks and bulk trucks or by sea using barges or bulk ships.

The facilities are environment-friendly and compliant with environmental standards. The cement line, crushing and cement production are highly automated for more efficient monitoring and maintenance. Storage facilities for crushed raw materials and finished products within the plant area are all enclosed or in silos. Dust management system is also being implemented to minimize dust particulates.

The clinker is being sourced from other RCBM Cement Plants and/or other third party sources.

1.3.2 No Project Option

Not continuing the project is not an option. If the project will not continue, the additional employment opportunities for qualified residents of the host Barangay Dunggoan and other barangays in Danao City as well as the social development for the community such as livelihood projects, skills training, scholarship programs and medical assistance will be lost. Also, the substantial increase in local taxes and revenues, multiplier effect of the project such as business opportunities, support to social services and other opportunities for the community and the local government unit (LGU) will also be foregone.

The possibility of expanding and upgrading LGU's basic infrastructure services and facilities and strengthening of LGU's capacity in city governance, investment planning, revenue generation and project development and implementation will not also be realized. This may also include possibility of enhancing their capabilities for local leadership because the project may provide technical support and assistance to local leaders to training, seminars and workshops. All of these may be provided by the project thru its tax payments, permits and clearances and Social Development and Management Program.

Another opportunity that the local government and the community may miss if the project will not be realized is the possibility of constructing additional infrastructure projects like roads and bridges, increasing school classrooms and improving school facilities and medical assistance such as provision of medicines, medical supplies and medical missions.

1.4 PROJECT COMPONENTS

The old project covered by the ECC Reference No. 9906-014-105 is a full cement manufacturing plant which starts from quarrying of raw materials, raw materials grinding, clinkering, finish milling, packing and powerplant. Whilst the proposed project is only finish milling and dispatch. The Kiln line was already demolished and the power plant facility is still existing, but the equipment is not operational anymore and there is no plan to revive the powerplant operation in this project.

The plant will be redesigned to be more efficient. Unlike a complete full scale cement operation which produces clinker using a kiln and require producing heat up to 1,000°C; the project of RCBM will only be operated as a cement grinding 'finish milling' facility. The main raw material is Clinker that will be mixed with other pozzolanic materials during the grinding process.

Table 1.4.1 presents the major component, support facilities, and pollution control devices of the project.

Table 1.4.1: Project Components

Components/ Facilities	Original		Proposed Downgrade	
	No. of Units	Specification	No. of Units	Specification
MAJOR COMPONENTS				
Quarry				
ECC Exisiting				
Limestone – Binaliw	1	121 ha	-	-
Limestone - Carcar	1	30 ha	-	-
Shale - Triumpo	1	81 ha	-	-
Shale - Sandayong	1	30 ha	-	-

Components/ Facilities	Original		Proposed Downgrade	
	No. of Units	Specification	No. of Units	Specification
New Proposed Expansion for Limestone, Shale & Other Siliceous Materials				
Dunggoan and Dawis Sur (Area 1)	-	-	1	195 ha
Triumpo and Hagnaya (Area 2)	-	-	1	450 ha
Sandayong Norte, Cagat,Cambanay, and Binaliw (Area 3)	-	-	1	710 ha
Pyroline				
Kiln & Cooler Line	1	2.5 MMTPY	-	-
Cement Raw Materials				
Material Storage 1	1	73,000 T	Same	Same
Material Storage 2	1	39,000 T	Same	Same
Overhead Crane	1	3.2 T	Same	Same
Clinker Weighfeeder	1	10-100 TPH	Same	Same
Gypsum Weighfeeder	1	1-10 TPH	Same	Same
Pozzolan Weighfeeder	1	3.5-35 TPH	Same	Same
Limestone Weighfeeder	1	2-20 TPH	Same	Same
Cement Finish Mill				
Ball Mill	1	80-136 TPH	Same	Same
Mill Discharge Airslide	2	150 TPH per unit	Same	Same
Mill Bucket Elevators 1 and 2	2	150 TPH per unit	Same	Same
Fly Ash Silo	2	200 Tons per unit	Same	Same
Air Separator	1	80-150 TPH	Same	Same
Product Airslide	1	150 TPH	Same	Same
Hot Gas Generator	1	350×10^4 kcal/H	Same	Same
Compressors:				
GA45	2	160 kW	Same	Same
GA75	1	75 kW	Same	Same
ZE160	1	45 kW	Same	Same
ZE4	1	45 kW	Same	Same
Packing, Bulk Loading & Cement Silo (Dispatch)				
Packhouse				
Rotopacker	1	2,400 BPH (8 spouts)	Same	Same
Palletizing System	4	5T per unit	Same	Same
Bulk Loading Facility	1	80 TPH	Same	Same
Cement Silo	4	1,250 T each	Same	Same
Silo Drag Chain	2	120 TPH per unit	Same	Same
Packhouse Bucket Elevators	2	120 TPH per unit	Same	Same
Vibrating Screens	2	2,400 bags/h	Same	Same
SUPPORT FACILITIES				
Powerplant	7	10MW	-	-
Genset	1	800 kVA	Same	Same
Fire Protection System	1	plantwide	Same	Same
Safety Devices	1	plantwide	Same	Same
Cement Warehouse 1	1	1,700 T	Same	Same
Cement Warehouse 2	1	2,000 T	Same	Same
POLLUTION CONTROL DEVICES				
Cement Mill Separator Dust Collector (Jet Pulse)	1	165,000 m^3/h	Same	Same
Cement Mill Main Dust Collector (Jet Pulse)	1	60,000 m^3/h	Same	Same
Weigh Feeder Dust Collector (Jet Pulse)	1	18,000 m^3/h	Same	Same
Packhouse Dust Collector (Jet Pulse)	2	20,000 m^3/h	Same	Same

Components/ Facilities	Original		Proposed Downgrade	
	No. of Units	Specification	No. of Units	Specification
Cement Silo Dust Collector (Jet Pulse)	2	9,600 m^3/h	Same	Same
Flyash Silo Dust Collector (Jet Pulse)	2	20 m^2 filter area	Same	Same
Bulk Loading Dust Collector (Jet Pulse)	1	2,300 m^3/h	Same	Same
Rotopacker Dust Collector (Jet Pulse)	1	18,000 m^3/h	Same	Same
Hazardous Waste Storage Facility	1	4mx6m estimated	1	14.5m x 9.6m
Material Recovery Facility	1	3mx5m estimated	1	4.5mx9.6m
Oil-water separator	1	90 m^3	Same	Same

1.4.1 Major Components

1.4.1.1 Cement Finish Mill Plant

The Cement Finish Mill Plant is consist of clinker bin, gypsum bin, limestone bin, and pozzolana bin, enclosed belt conveyor system, bucket elevator, air slide conveyor, finish mill combination provided with bag type dust collection system and air separator provided with dust collection system.

Plate 1.4.1: Existing Cement Finish Mill Plant

1.4.1.2 Packhouse

The Packhouse is consist of bucket elevator; closed-type vibrating screen; cement silos provided with bag type collection system; rotopacking machine provided with bag-type dust collection system; enclosed belt conveyor system; and drag chain conveyors.

Plate 1.4.2: Existing Packhouse

As stated above, the project involves finish mill only which includes the following activities:

- Gypsum, pozzolan, flyash, limestone and other cementitious materials are added to the clinker and then fed to the finish grinding mills. Gypsum serves as a retarder in the too rapid setting or hardening of cement.
- Blended cement is pulverized in a closed circuit system in the finish mills to the desired fineness.
- Cement is transported to cement silos.
- Cement is packed into bags by inline packers or loaded as bulk and bags are distributed either by land using forwarder trucks and bulk trucks or by sea using barges or bulk ships

The source of clinker is other RCBM Cement Plants and other third party sources.

1.4.1.3 Quarry Area

The quarry area located approximately 200m from Cement Finish Mill Plant is the declared commercial area of RCBM for the quarry operation. The mining operations involve extraction only of quarry materials only and will not involve processing.

Plate 1.4.3: Photographs of the Quarry Area

1.4.2 Support Facilities

1.4.2.1 Power Supply System

The main power supply of the project is from the independent power producers and distributed by CEBECO II. Moreover, RCBM has an existing Diesel-Fired "Cummins" Generator Set with a capacity of 650 kW, which is used to supply emergency power to the plant during power outage.

1.4.2.2 Water Supply System

The water requirements of the project will be sourced from the four (4) existing deepwells of RCBM, as described in **Table 1.4.2**. The water supply is stored at the existing water storage tank of RCBM.

Table 1.4.2: Existing Deepwells of RCBM

Name	Capacity (Liters/Second)	Use	Coordinates	
			Latitude	Longitude
Deepwell 3 – Submersible Pump	10.00	Domestic	10°33'43.37"	124°01'00"
Deepwell 4 – Submersible Pump	10.00	Industrial	10°33'25.57"	124°00'56.23"
Deepwell 5 – Submersible Pump	10.00	Industrial	10°35'39.79"	124°01'2.18"
Deepwell 6 – Submersible Pump	9.89	Industrial	10°33'47.67"	124°00'56.43"

1.4.2.3 Fire Protection System

A fire protection system according to the National Fire Protection Association (NFPA) requirement will be provided for the entire plant. The system will provide in depth capability for early detection, alarm, containment and suppression of fires. The extent of the system will vary with the magnitude of combustibles present in an area and the magnitude of possible loss from fire. The system will consist of the following:

a. Fire Water Supply System for:

- Outside hydrant system of the plant
- Stand pipe system for all buildings
- Deluge sprinkler system for oil filled transformers
- Wet pipe sprinkler system for turbine oil area and lubricant storage area in warehouse.
- Foam type protection system for fuel oil tanks

b. Halon Protection System for switchgear, MCC, battery and battery charger and control rooms
c. Portable fire extinguishers in various buildings; and
d. Fire Detection and Alarm System

1.4.2.4 Safety Devices

The Instrumentation and Control (I&C) and the Distributed Control System (DCS) will incorporate automatic safety measures which will include but not limited to:

- Automatic and immediate shutdown in an event of complete failure of the Bag Filters;
- Pressure relief and control valves (PRCs/PRVs) and temperature control for high-pressure systems
- Insulation of high temperature lines and equipment for personnel protection
- Safety stairs, rails and ladders
- Mandatory use of Personnel Protective Equipment (PPE) such as hard hats, eye goggles, ear mufflers, safety shoes, etc.
- Warning signs and posters at appropriate locations
- Setting of off-limits to non-authorized personnel at certain locations of the plant.

1.4.3 Pollution Control Devices

1.4.3.1 Cement Finish Mill

1.4.3.1.1 Material Recovery Facility

The existing MRF with a dimension of 3m x 5m will be modified to have a dimension of 4.5m x 9.6m.

1.4.3.1.2 Temporary Hazardous Waste Storage Facility

The existing Hazardous Waste Storage Facility with a dimension of 4m x 6m will be modified to have a dimension of 14.5m x 9.6m.

1.4.3.1.3 Oil-Water Separator

The existing Oil-Water Separator has a capacity of 90 m^3.

1.4.3.1.4 Dust Collector

A dust collector is a system used to enhaced the quality of air released from the equipment/facilities by collecting dust and other impuriries from air or gas. Thus the proper operation of dust collectors is important to every stage of the process in a cement industry. **Table 1.4.3** presents the existing dust collector system in the Cement Finish Mill Plant, which uses Jet Pulse Dust Collector technology for the treatment and collection of the dust before going to the atmosphere.

Table 1.4.3: Existing Dust Collector System

Facility Being Served / Source	Quantity	Capacity	APCF/Control
Cement Mill Separator	1 unit	165,000 m3/h	Jet Pulse Dust Collector
Cement Mill Main	1 unit	60,000 m3/h	Jet Pulse Dust Collector
Weigh Feeder	1 unit	18,000 m3/h	Jet Pulse Dust Collector
Packhouse	2 units	20,000 m3/h	Jet Pulse Dust Collector
Cement Silo	2 units	9,600 m3/h	Jet Pulse Dust Collector
Flyash Silo	2 units	20 m2 filter area	Jet Pulse Dust Collector
Bulk Loading	1 unit	2,300 m3/h	Jet Pulse Dust Collector
Rotopacker	1 unit	18,000 m3/h	Jet Pulse Dust Collector

The dust collectors from the pyroline (kiln) which is part of this downgrade were already dismantled and demolished. Only the facilities mentioned above are existing and operational.

Each collector has 90-100% collection efficiency. The plant is using the standard Cement Sustainability Initiative (CSI) for the Computation of CO_2 emission as provided in **Table 1.4.4**. The CO2 emission reduction greatly achieve through utilizing more cementitious materials with less clinker addition but maintaining its world class cement quality. Other CO2 emission reduction initiatives is the tree planting program of RCBM which contributes to carbon sequestration.

Table 1.4.4: CO_2 Emission Inventory Generated Using Cement Sustainability Initiative

WBCSD Cement Sustainability Initiative
Cement CO_2 and Energy Protocol, Version 3.1.CRH, CO_2 Emissions and Energy Inventory

Date of latest update	11/09/2018

INFORMATION

			2015	2016	2017	2018	2019
General Plant Information							
PERFORMANCE INDICATORS							
Absolute Direct CO_2 Emissions			2015	2016	2017	2018	2019
59	Absolute gross CO_2 including CO_2 from on-site power generation	[t CO_2/yr]	3,951	2,664	2,378	2,866	2,908
Gross CO_2 Emissions (=direct fossil CO_2 excluding CO_2 from on-site power generation)			2015	2016	2017	2018	2019
59c	Absolute gross CO_2	[t CO_2/yr]	3,951	2,664	2,378	2,866	2,908
59a	calcination component	[t CO_2/yr]	0	0	0	0	0
59b	fuel component	[t CO_2/yr]	3,951	2,664	2,378	2,866	2,908
Net CO_2 Emissions (= gross CO_2 minus alternative fossil fuels CO_2, excluding CO_2 from on-site power generation)			2015	2016	2017	2018	2019
71	Absolute net CO_2	[t CO_2/yr]	3,951	2,664	2,378	2,866	2,908
Specific Gross and Net CO_2 Emissions per Cementitious Produced			2015	2016	2017	2018	2019
62	Specific gross CO_2 per tonne of cementitious product	[kg CO_2/t cem prod]	22	23	21	18	18
62a	calcination component	[kg CO_2/t cem prod]	0	0	0	0	0
62b	fuel component	[kg CO_2/t cem prod]	22	23	21	18	18
74	Specific net CO_2 per tonne of cementitious product	[kg CO_2/t cem prod]	22	23	21	18	18
77	Improvement rate - net CO_2 per tonne of cementitious product	[% relative to base yr]	n. appl.	n. appl.	n. appl.	n. appl.	n. appl.

Source: RCBM

Plate 1.4.4: Rotopacker Dust Collector

1.4.3.1.5 Drainage System

Water usage in the finish milling process is limited only as a top-up to the recirculated cooling water for the equipment motor. Any water overflow or discharge from the milling process is directed into the settling tank to remove any suspended particles before being discharged. No chemicals is added nor used in the milling process, hence water discharge is not contaminated with nor contain any chemicals. No washing of equipment and no floor water cleaning in the operation is performed as this can damaged the cement product. All discharged water generated from lavatories goes to septic tanks with overflow outlet which enters into the Anaerobic Wastewater Treatment Facility. The storm/rainwater has a separate canal and is separated from the process and domestic effluent. The storm/rainwater is discharged to the canal passing the box culvert along the national highway then to Dunggoan coastal water.

1.4.3.2 Quarry

1.4.3.2.1 Siltation ponds

Quarry is provided with drainage canal along the quarry road and berm. Storm/rainwater is directed into a siltation pond.

Quarry operation is limited only to extraction of materials, loading into dump trucks and hauling of materials. Only fugitive dust is generated during the quarry operation which is mitigated through speed limit, road watering and covering of load with tarpaulin.

Provided below are maps of the siltation ponds as quarry drainage.

Figure 1.4.3.2.1.1: Settling Pond for Shale

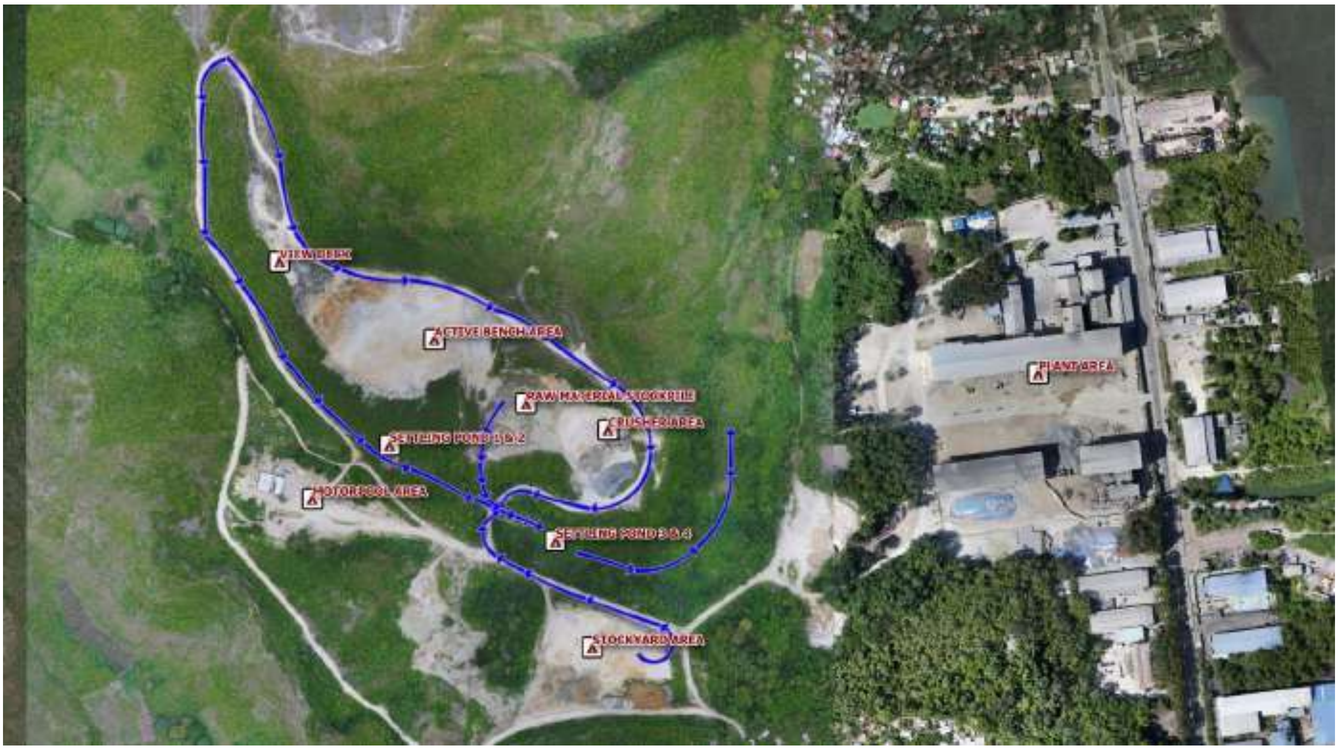


Figure 1.4.3.2.1.2: Settling Pond for Limestone

1.4.3.2.2 Plant Nursery

The existing Plant Nursery has an area of more or less 500 m^2 besides the new admin building.

Figure 1.4.1 to **Figure 1.4.4** present the general layout of facilities (old and existing), the Site Development Plan, and the Drainage Plan for the project. **Figure 1.4.5** provides the Project Layout Route for Transport of Materials while **Figures 1.4.6** and **1.4.7** provide the Siltation/Sedimentation ponds at the quarry site.

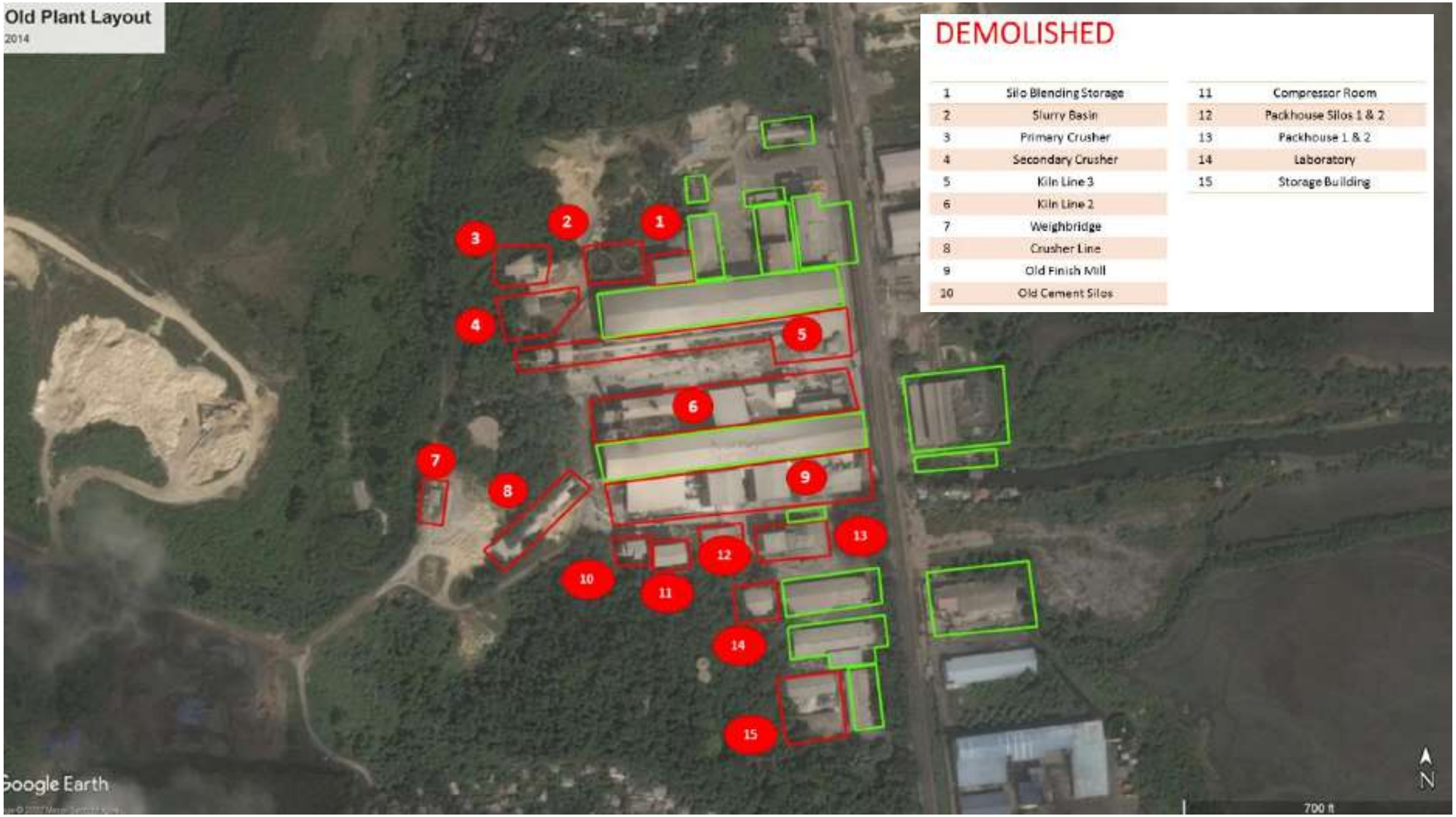


Figure 1.4.1: Old Plant Layout

Figure 1.4.2: Existing Plant Layout

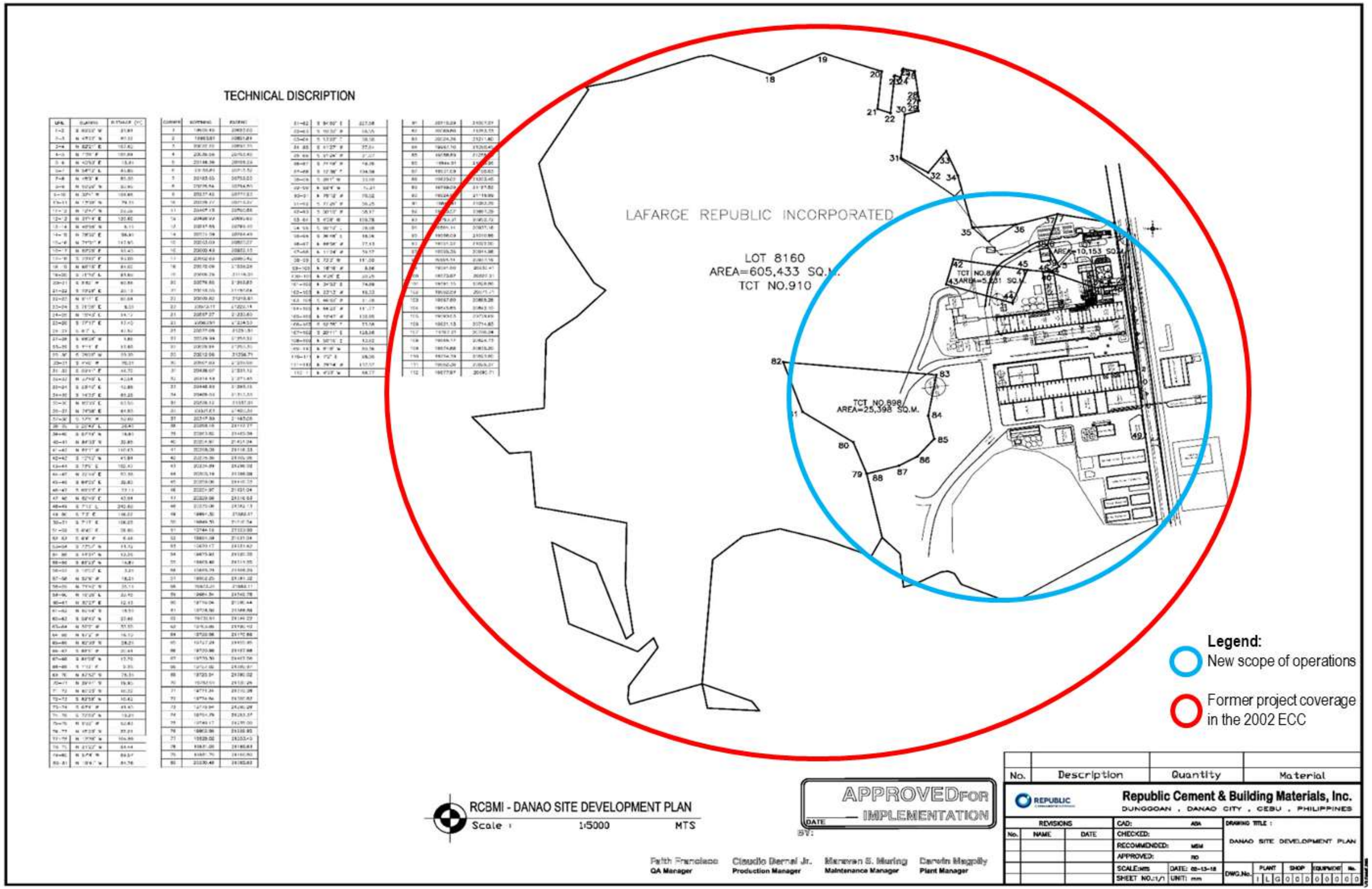


Figure 1.4.3: Site Development Plan

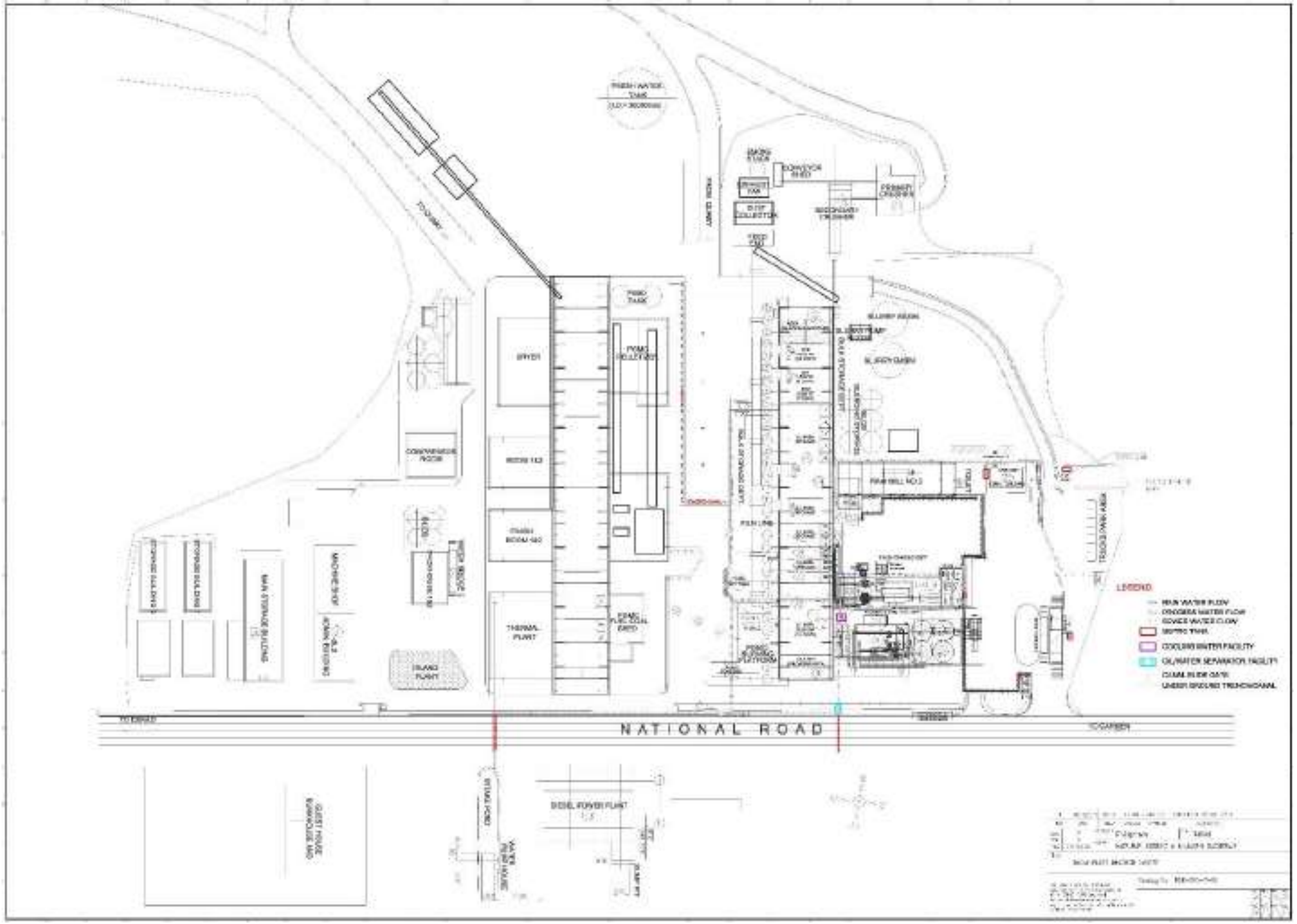


Figure 1.4.4: Drainage Plan

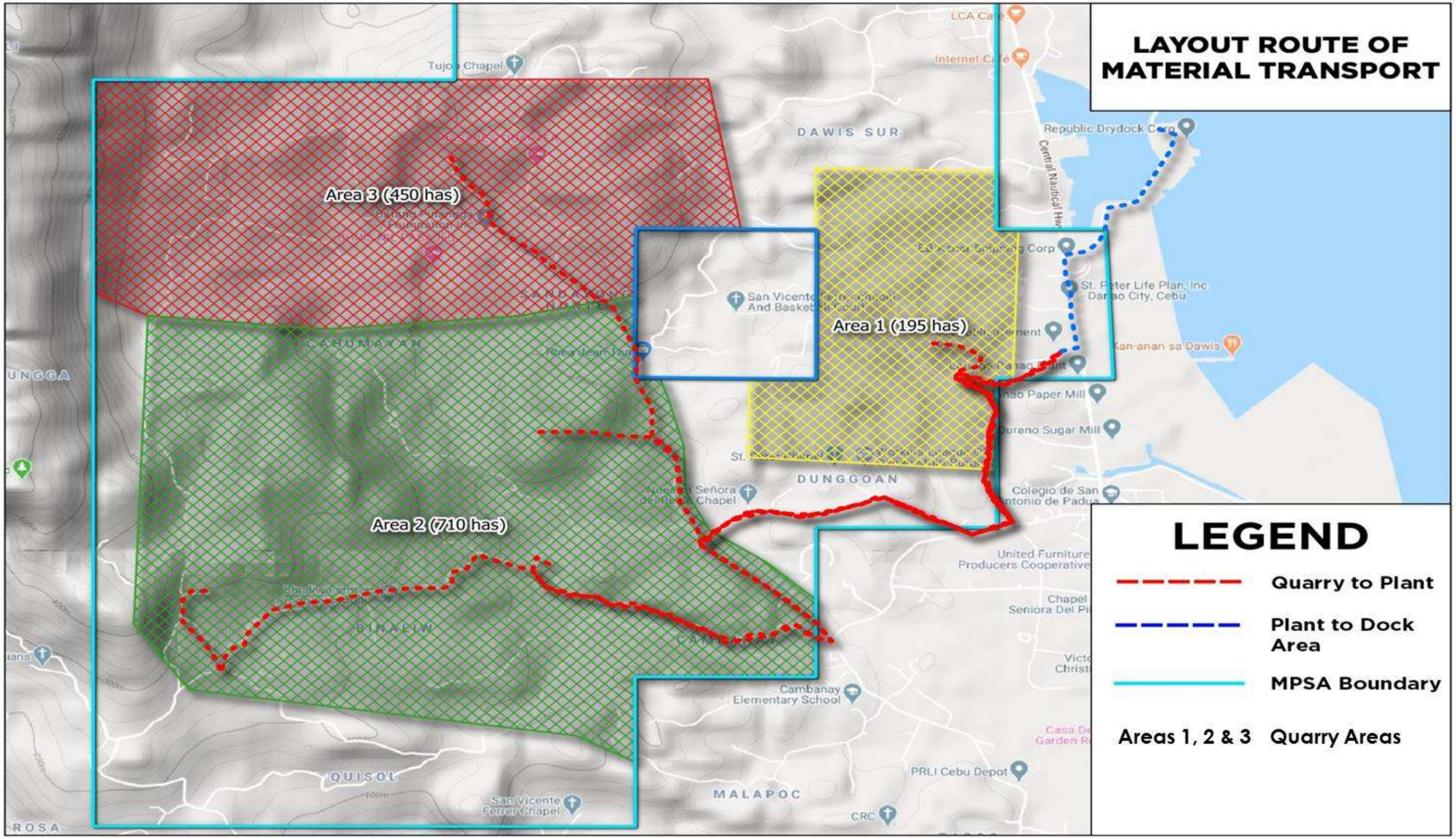


Figure 1.4.5: Quarry Project Layout with the Route for Transport of Materials

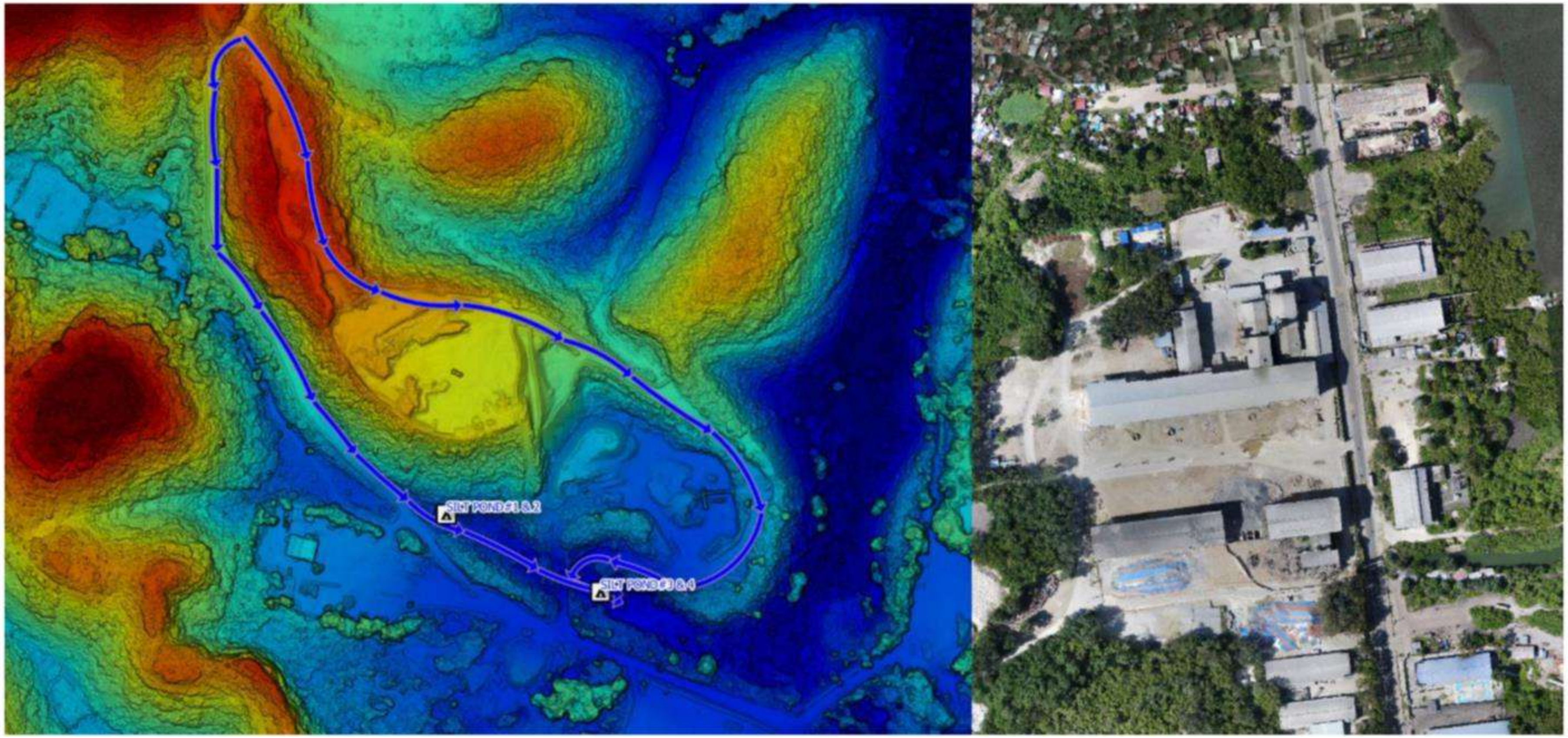


Figure 1.4.6: Settling Ponds at the Limestone Quarry Site in Dunggoan

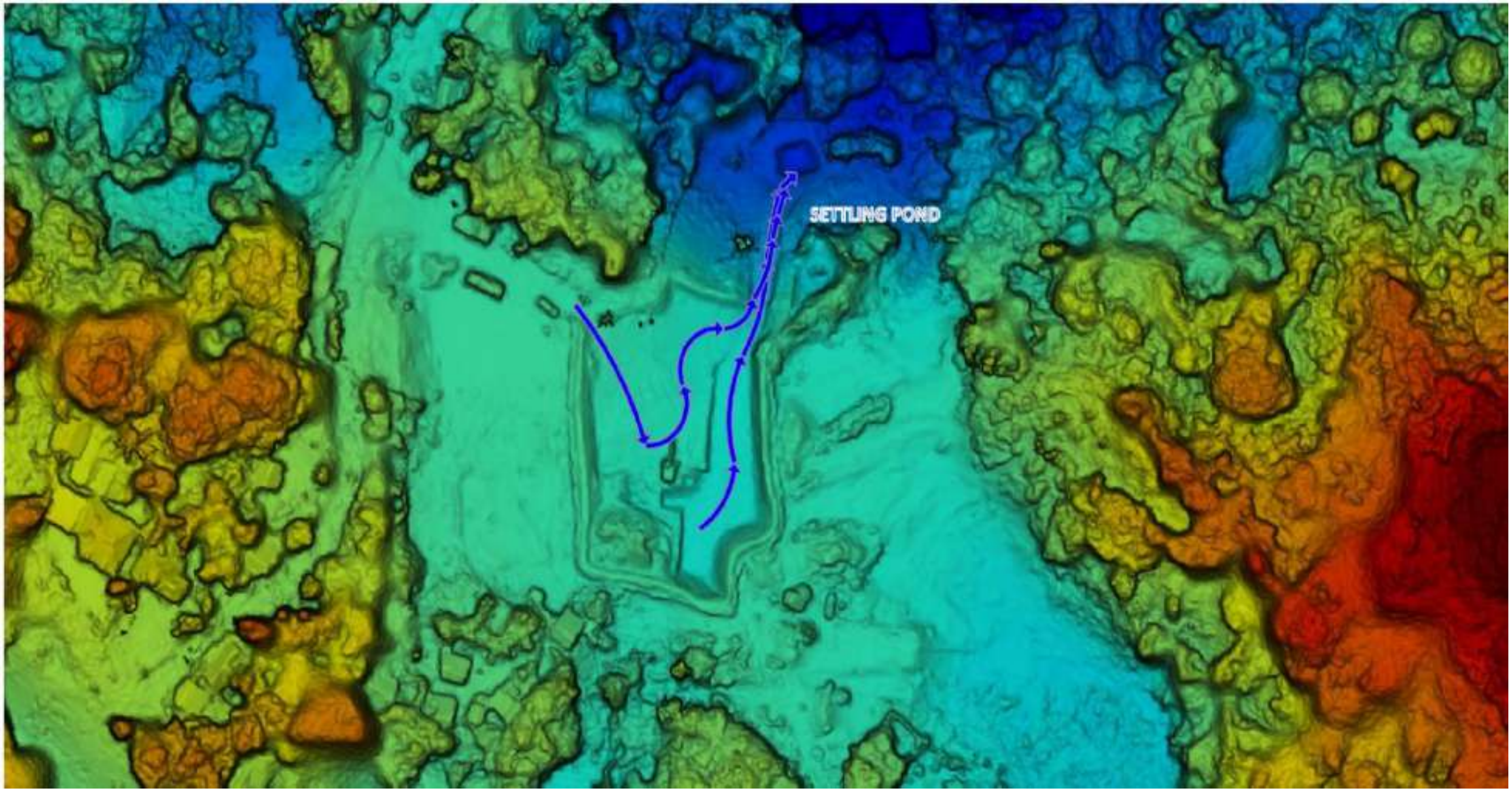


Figure 1.4.7: Settling Ponds at the Shale Quarry in Cambanay/Sandayong

1.5 PROCESS/TECHNOLOGY

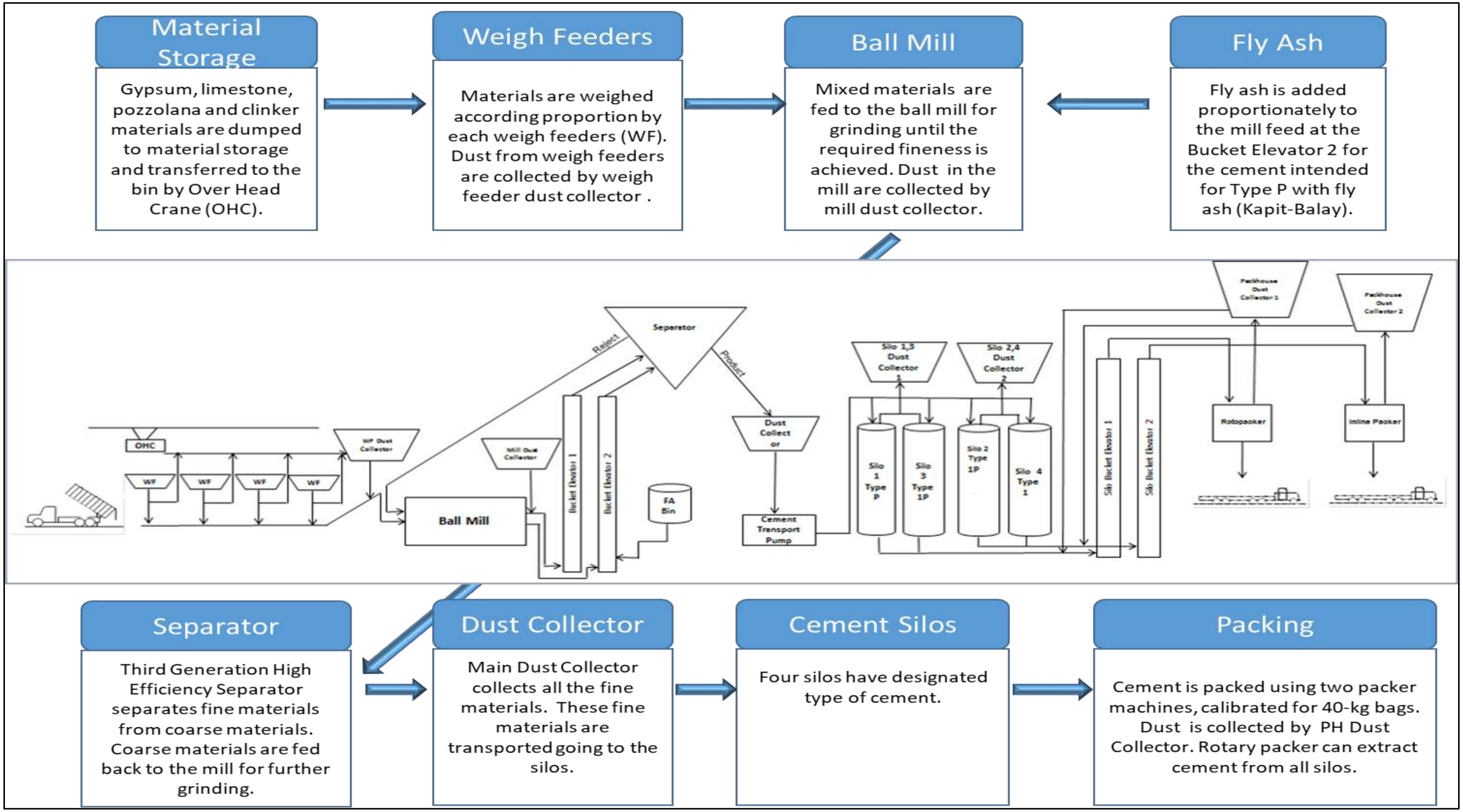
1.5.1 Cement Processing

The existing cement finish mill operations of RCBM Danao employs the most efficient technology with blending systems. The process only involves the grinding of Clinker materials for cement production and blending. With the Clinker being produced from other manufacturing sites, the process generally starts at grinding of the raw materials.

From the clinker storage, clinker is transferred to the clinker bin. It passes through the weigh feeder, which regulates its flow in proportion with the additive materials. At this stage, gypsum, pozzolan and limestone are added to the clinker and then fed to the finish grinding mills. Gypsum serves as a retarder in the too rapid setting or hardening of cement. Blended cement is pulverized in a closed circuit system in the finish mills to the desired fineness. Cement is then transported to cement silos then packed into bags by inline packers or loaded as bulk and bags are distributed either by land using forwarder trucks and bulk trucks or by sea using barges or bulk ships.

The facilities are environment-friendly and compliant with environmental standards. The cement line, crushing and cement production are highly automated for more efficient monitoring and maintenance. Storage facilities for crushed raw materials and finished products within the plant area are all enclosed or in silos. Dust management system is also being implemented to minimize dust particulates.

Figure 1.5.1 presents the Cement Finish Mill processing flow diagram of RCBM while **Figure 1.5.2** presents the Process Control System.



Source: RCBM

Figure 1.5.1: Cement Finish Mill Process

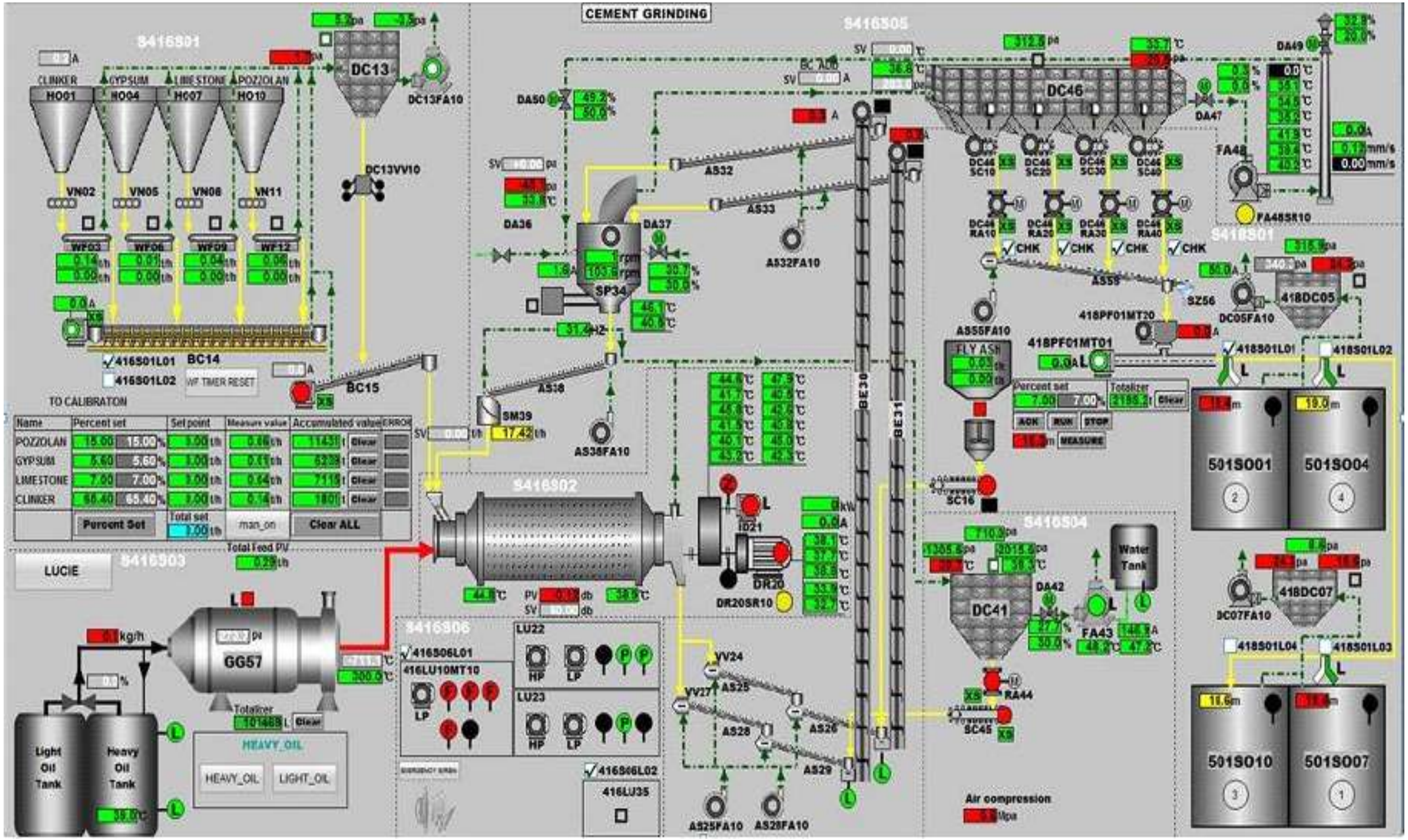


Figure 1.5.2: Process Control System

1.5.2 Quarry Operation

RCBM will employ the Surface Mining Method for the quarry operation. Quarrying starts at elevation 45. The final floor level is 30 meters above sea level and the final pit slope is 36 degrees. Surface Mining Method can be described as contour mining and there will be no portion of the quarry area that will go much deeper than the general elevation of the environs.

Generally, quarrying will involve dozing-loading-hauling cycle using bulldozer, grader; loaders, back hoe and hauling trucks.

1.5.2.1 Material Sourcing/Quarrying

Soil Profile

Flat to undulating terrain characterize the exploration area, with flatlands along the coast becoming rugged inland. Altitudes range from a minimum of 10 meters above sea level in the east side to about 680 masl (Danao Peak) in the west. Soil cover is expected to be thin in the area, which is characteristic of most limestone areas in the Philippines. Soils are commonly undifferentiated hill soils. General soil types in the project area are the Cebu hydrosol, Mandaue clay loam, Baguio clayloam, Faraon clay and Faraon clay steep phase.

There are four (4) different types of soil series in RCBMI Danao (Table 16 and Map 6). Among these, the most dominant soil series in the area is Faraon clay (steep phase) comprising around 66% with a total area of 1,675 hectares. Additionally, this is typically found at the northwest portion of RCBMI Danao. Moreover, this soil series is only distributed in the provinces of Cebu, Leyte, Negros Occidental, and Negros Oriental. Further, the Faraon clay is the second largest coverage constituting about 31%. Conversely, only a small portion of the area is underlain by Mandawe clay loam and Baguio clay loam comprising only 3% and 0.21%, respectively. The general characteristics of these soil series were described in the World Soils Book Series' the Soils of the Philippines (Carating et al. 2014) as follows:

Baguio series. It was initially described in the north central Cebu. The characteristics of the surface soil is brown to dark brown clay loam, and moderately compact. The series is also sticky when wet and slightly friable when most, and hard when dry. It is usually vegetated with primary and secondary forests, and cogon.

Faraon series. The soil is typically black and clayey occurring on rolling to hilly relief. The limestone rocks are usually soft, coarsely angular, and colored. The soil depth ranges from 15 to 30 centimeters from the surface. The subsoil varies from dark yellowish gray to light gray, grayish black to dark gray coarse to moderately fine clay. The primary land uses are for corn, sugarcane, coconut, plantation crops, vegetables, and root crops.

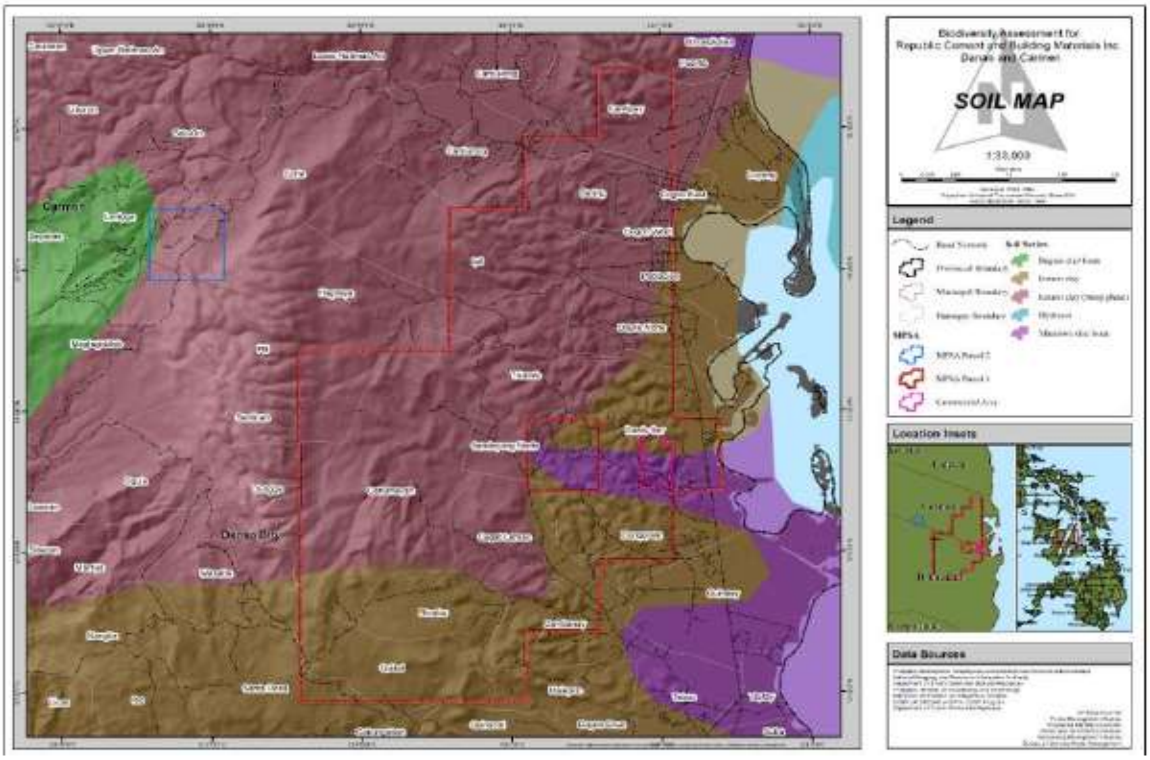
Table 1.5.2.1.1: Soil Series of RCBM Danao

Soil Series	Area (ha)	Percentage (%)
Baguio clay loam	5.45	0.21
Faraon clay	794.12	31.13
Faraon clay (steep phase)	1,675.17	65.67
Mandawe clay loam	76.29	2.99
Grand Total	**2,551.03**	**100.00**

The dominant soil series is greatly found in Barangay Cahumayan with 404 hectares and Ipil with 252 hectares (Table 1.5.2.1.2). Additionally, it is observed in all covered areas of Carmen. Moreover, the Baguio clay loam is solely situated at Barangay Lapniga with about 6 hectares. Furthermore, Mandawe clay loam is also located in few areas such as Barangay Dawis Sur and Barangay Dunggoan.

Table 1.5.2.1.2: Soil Series per barangay of RCBM Danao

Municipality /City/Barangay	Soil				Grand Total
	Baguio clay loam	Faraon clay	Faraon clay (Steep phase)	Mandawe clay loam	
Carmen	**5.45**	**155.18**	**933.31**	**60.42**	**1,154.35**
Baring			133.73		133.73
Cantipay			107.00		107.00
Cantumog			18.02		18.02
Cogon East			8.69		8.69
Cogon West		0.96	28.79		29.74
Corte			39.72		39.72
Dawis Norte		24.05	92.97		117.02
Dawis Sur		121.40	17.64	60.42	199.46
Hagnaya			1.11		1.11
Ipil			251.94		251.94
Lanipga	5.45		28.78		34.23
Poblacion		8.77	56.42		65.19
Puente			1.51		1.51
Triumfo			147.00		147.00
Danao City	**-**	**638.94**	**741.86**	**15.87**	**1,396.67**
Binaliw		143.81	1.58		145.39
Cagat-Lamac		34.78	140.22		175.00
Cahumayan		53.02	403.57		456.58
Cambanay		78.99	6.62		85.61
Dungga			35.41		35.41
Dunggoan		116.94		15.87	132.81
Guinacot		0.01			0.01
Magtagobtob			6.90		6.90
Malapoc		12.53			12.53
Masaba		6.17			6.17
Pili			44.47		44.47
Quisol		173.97			173.97
Sandayong Norte			57.36		57.36
Santa Rosa		18.72			18.72
Santican			45.73		45.73
Grand Total	**5.45**	**794.12**	**1,675.17**	**76.29**	**2,551.03**



Map 1: Soil Series Map of RCBM Danao

Two (2) types of materials are necessary for the production of cement: one rich in calcium or calcareous materials such as limestone, chalk, etc., and one that is rich in silica or argillaceous materials such as diorite/andesite, greywacke, clay, pozzolan and shale. All of these raw materials/rocks are either scraped or blasted from the quarry and then transported to the crusher.

1.5.2.2 Stripping of the Overburden

Stripping involves the removal of the top soil to expose the target rock/commodity. Dozers pushes the topsoil to designated loading areas and excavators load it to off road dump trucks. Stripping of the overburden is done until the target rock/commodity is exposed. Weathered rocks are transported to the cement plant while fresh varieties are drilled and blasted. The overburden stockpile is located within the disturbed mined out area of the quarry. The overburden thickness varies from 1-2m.

1.5.2.3 Excavation and Loading

The materials are extracted and loaded into trucks by backhoe excavators for transport to the crusher.

1.5.2.4 Hauling

Upon loading of the materials to the dump trucks, it will be transported to crusher traversing a 220m inner road.

The crushing plant is equipped with an apron feeder, a jaw crusher, belt conveyors, two cone crushers, a scalping screen, two sizing screens, a sand classifier, silt traps and water reservoirs with pumps.

Figures 1.5.3 to 1.5.8 present the mine development plan for the commercial quarry areas of RCBM.

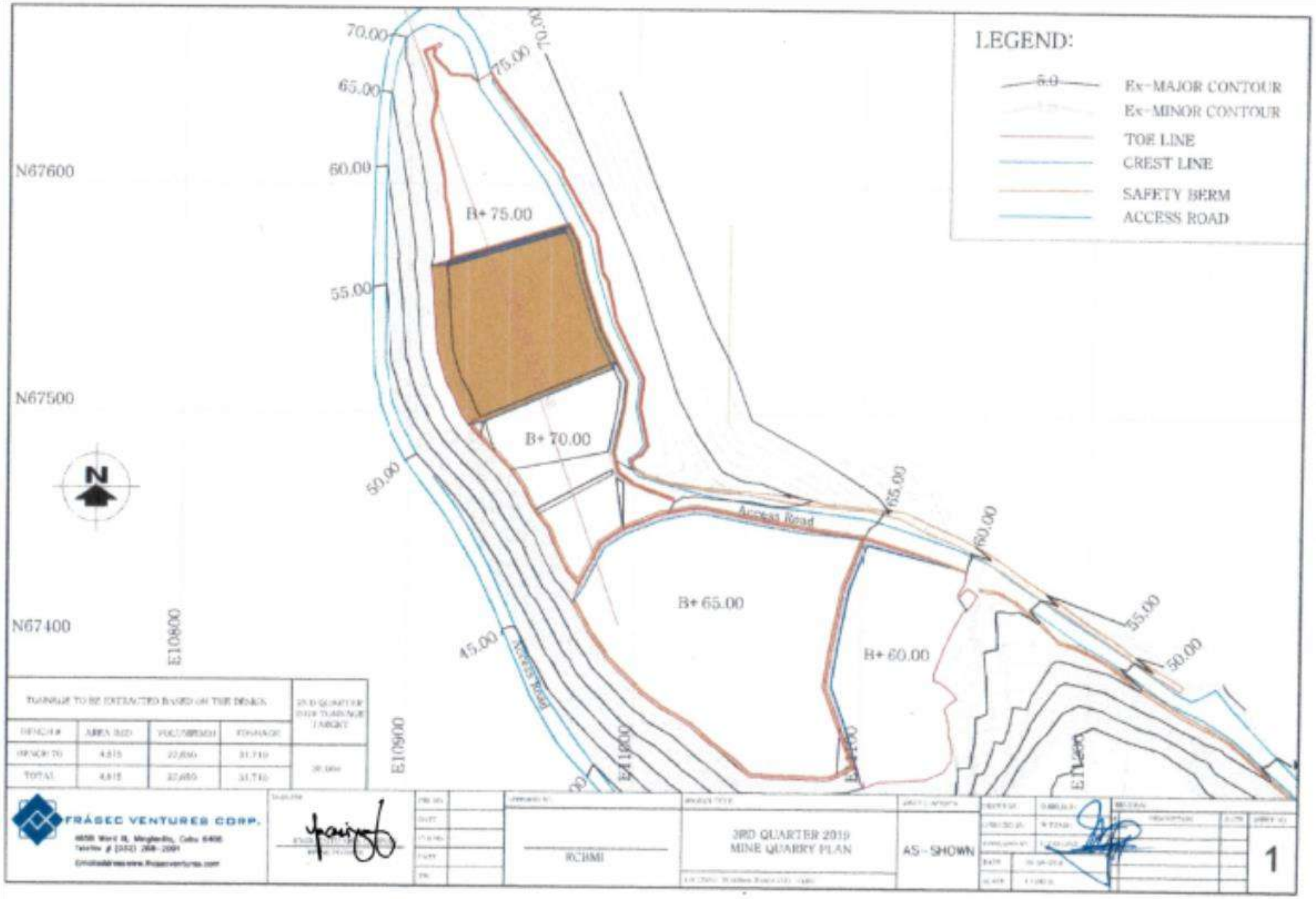


Figure 1.5.3: 3rd Quarter 2019 Mine Quarry Plan

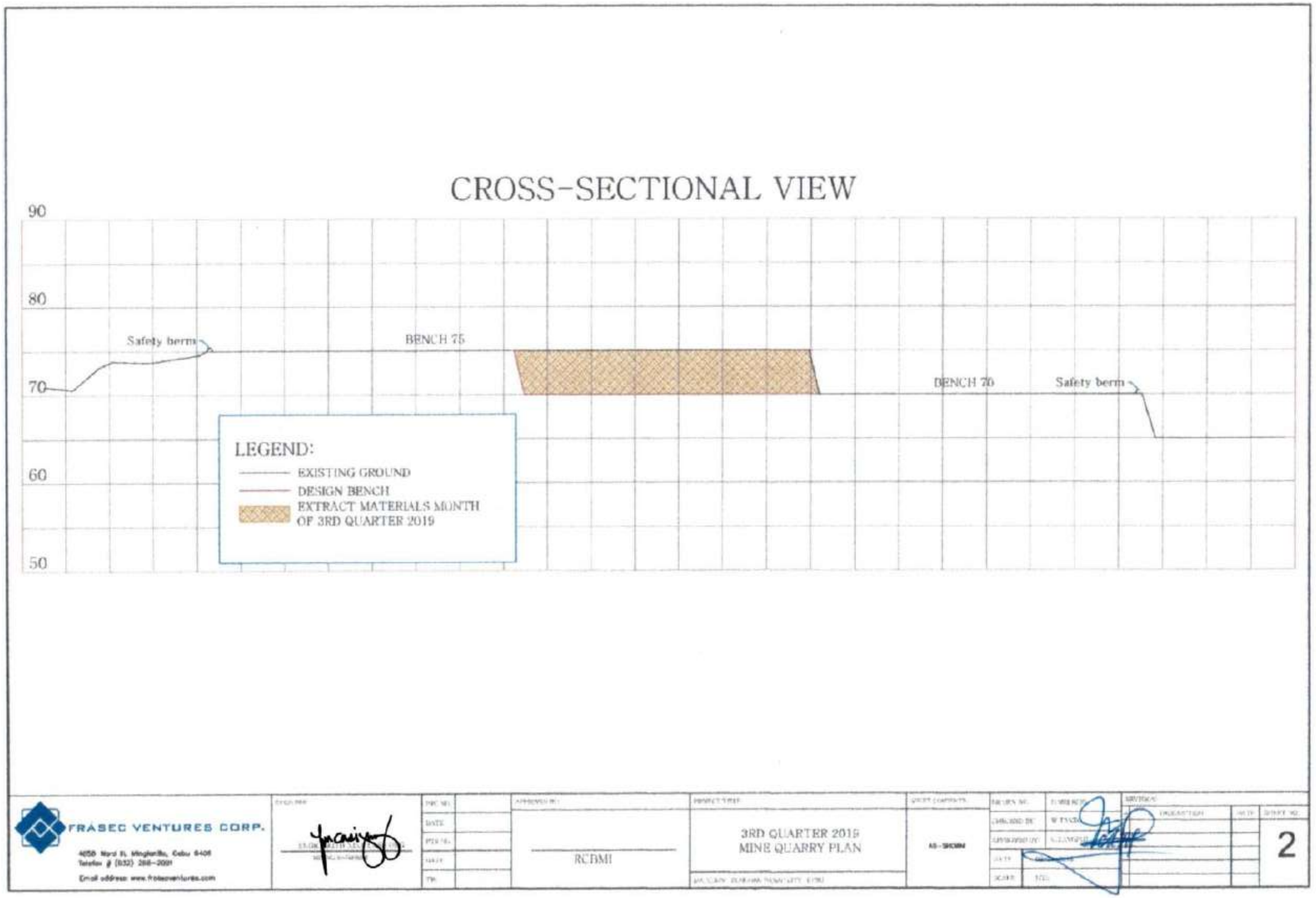


Figure 1.5.4: 3rd Quarter 2019 Mine Quarry Plan – Cross Sectional View

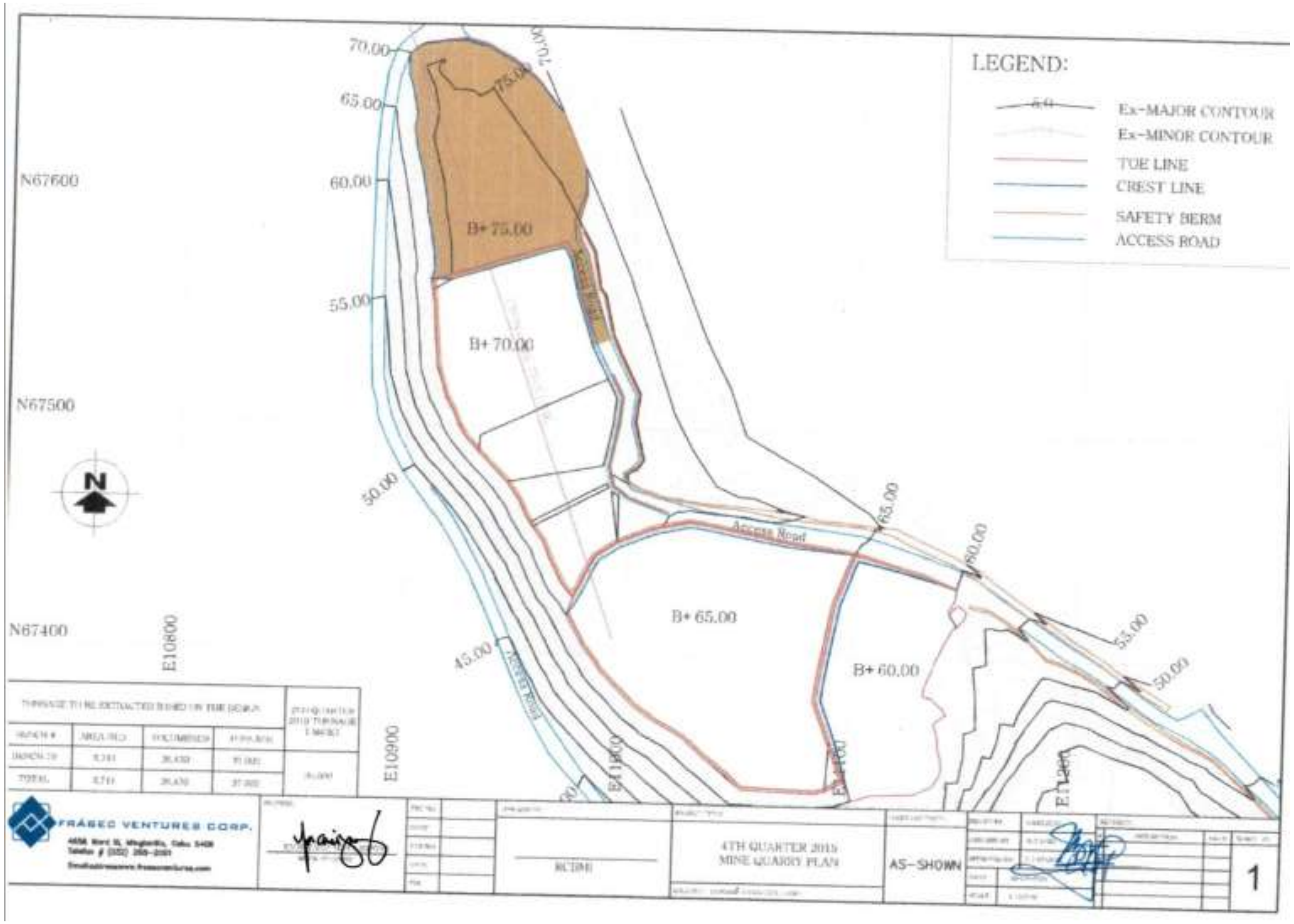


Figure 1.5.5: 4th Quarter 2019 Mine Quarry Plan

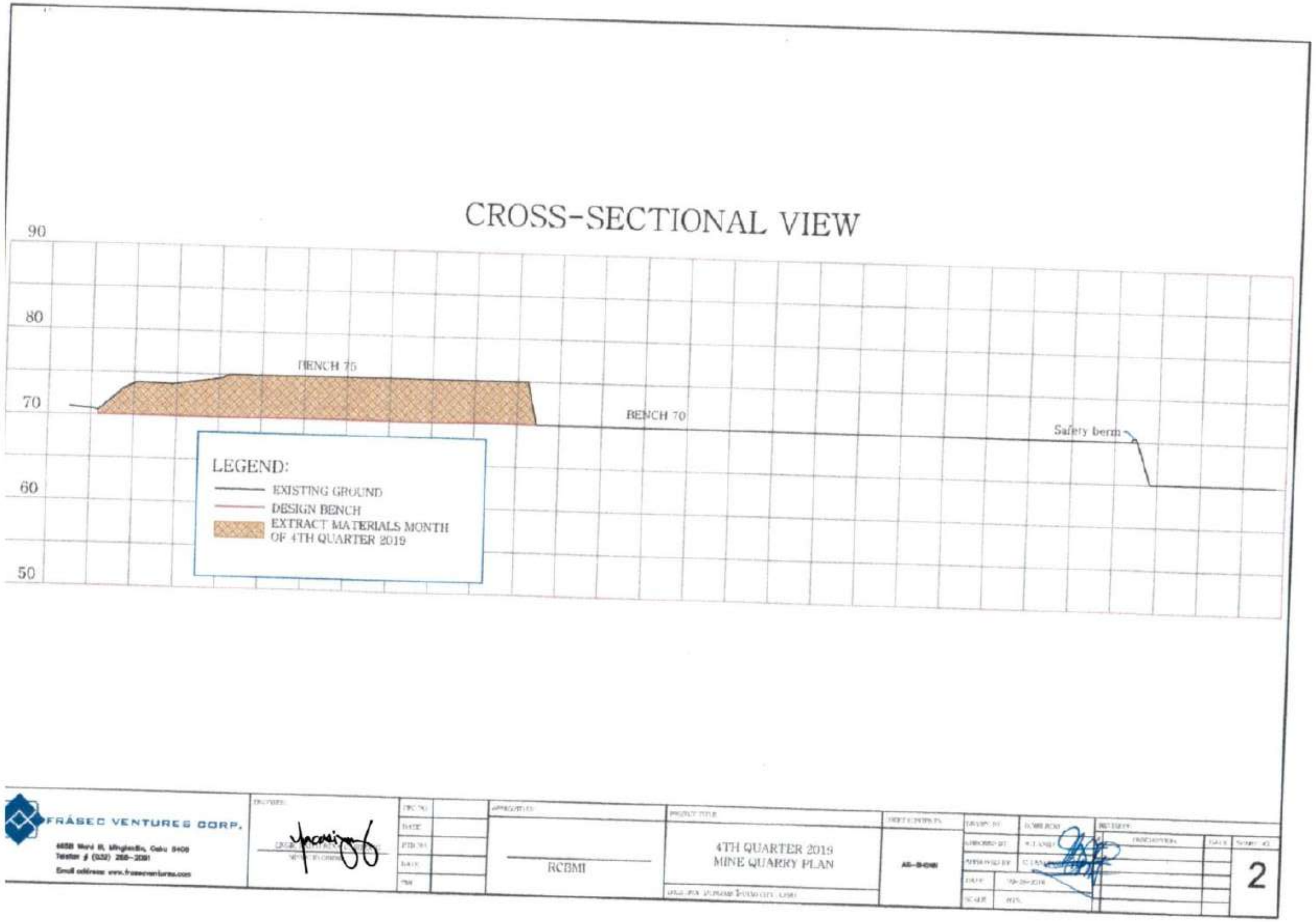


Figure 1.5.6: 4th Quarter 2019 Mine Quarry Plan – Cross Sectional View

Figure 1.5.7: RCBM-Danao 2nd Year 2020 Mine Quarry Plan

Figure 1.5.8: RCBM-Danao Third Year 2021 Mine Quarry Plan

1.5.3 Utility Requirements

1.5.3.1 Raw Materials

The raw materials needed for the production of cement are (1) Clinker, (2) Pozzolan / Shale, (3) Limestone, (4) Gypsum, and (5) Fly Ash.

Clinker is the basic material required for the production of all types of cement. RCBM will outsource clinker from other RCBM Cement Plants and/or other third party sources locally or internationally. Limestone and Pozzolan/Shale, as additive components, are being sourced from the 1,355 quarry area within the MPSA commercial area of RCBM. The mineral reserves/resources within the MPSA areas for limestone is 579 million metric tons. Gypsum will be sourced locally and/or from other countries and fly ash will be sourced from local coal-fired power plants. The volume of raw materials needed for the Production of 1,200,000 MT of cement per year is presented in **Table 1.5.1**.

Table 1.5.1: Raw Materials Needed for the Production of 1,200,000 MT of Cement per Year

Raw Materials	Volume (MTPY)	Source
Clinker	764,640.00	Outsourced
Pozzolan / Shale	158,400.00	MPSA – Quarry Area with an extraction rate of 150,000 MTPY
Limestone	171,840.00	MPSA – Quarry Area with an extraction rate of 500,000 MTPY
Gypsum	28,320.00	Outsourced
Fly Ash	76,800.00	Outsourced
TOTAL	**1,200,000.00**	

Provided in **Annex 1-6** is the copy of supply agreements for phosphogypsum and outsourcing of fly ash. Provided in **Figure 1.5.9** is the material balance of the Project.

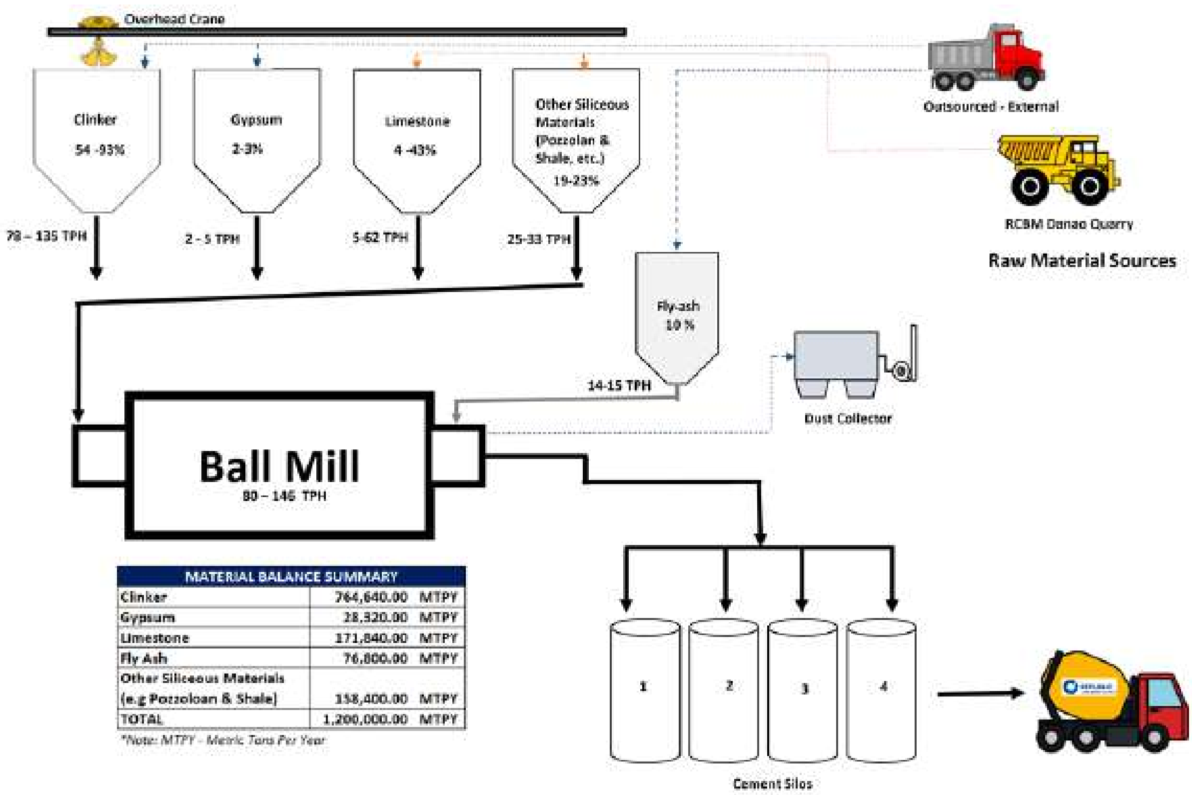
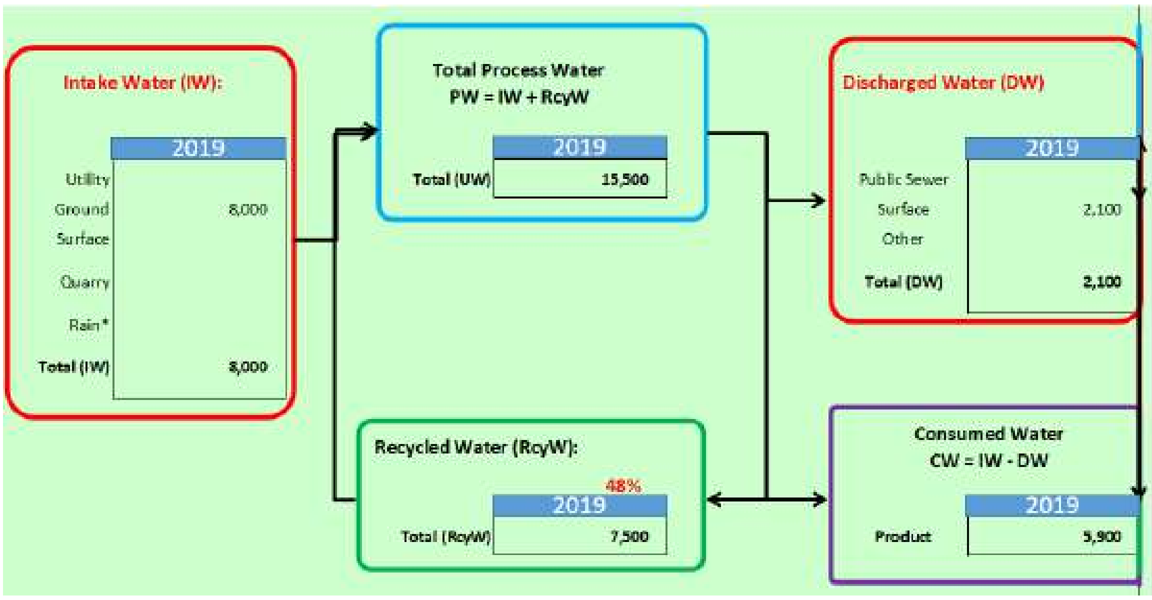


Figure 1.5.9: Material Balance of the Project

1.5.3.2 Water

The domestic and industrial water requirement of the project, which is approximately 8,000 m^3 annually, will be sourced from the four (4) existing deepwells of RCBM. Drinking water will be sourced from commercial provider of purified water. The overall water consumption of the project is around 5,900 m^3 while the discharge water is around 2,100 m^3. About 48% or around 7,500 m^3 of the total process water are recycled annually in the system. **Figure 1.5.10** presents the water requirement and the water balance diagram for the project.



Note: Plant Capacity: 80tph

Figure 1.5.10: Water Balance

1.5.3.3 Electricity

The main power supply of the cement plant is from the independent power producers and distributed by CEBECO II. The total power requirement of the plant on the average load is 3.5 MW per month and estimated load to 42 MW per year.

During power outage, the emergency power supply will be sourced the existing Diesel-Fired "Cummins" Generator Set of RCBM with a capacity of 650 kW.

1.5.4 Pollution Control Devices and Waste Generation and Built-in Management Measures

The Cement Mill Project has several Dust Collectors to address dust emission. They are installed in the following areas with specific dust collector type per area:

- Cement Mill Separator Main Dust Collector (Jet Pulse)
- Cement Mill Main Dust Collector (Jet Pulse)
- Weigh Feeder Dust Collector (Jet Pulse)
- Packhouse Dust Collector (Jet Pulse)
- Cement Silo Dust Collector (Jet Pulse)
- Flyash Silo Dust Collector (Jet Pulse)
- Bulk Loading Dust Collector (Jet Pulse)
- Rotopacker Dust Collector (Jet Pulse)

To address solid waste, the Project has Material Recovery Facility. The existing MRF with a dimension of 3m x 5m will be modified to have a dimension of 4.5m x 9.6m. It also has a Temporary Hazardous Waste Storage Facility with a dimension of 4m x 6m will be modified to have a dimension of 14.5m x 9.6m.

To abate and mitigate water pollution, the Project has an Oil-Water Separator with a capacity of 90 m^3.

With the current yearly requirement of 65,000 Metric Tons and with the nature and occurrence of limestone in Danao, there is no need for blasting activity is needed. However if the volume requirement will increase then there is a need to blast (rare case), caution blast or drill and break.

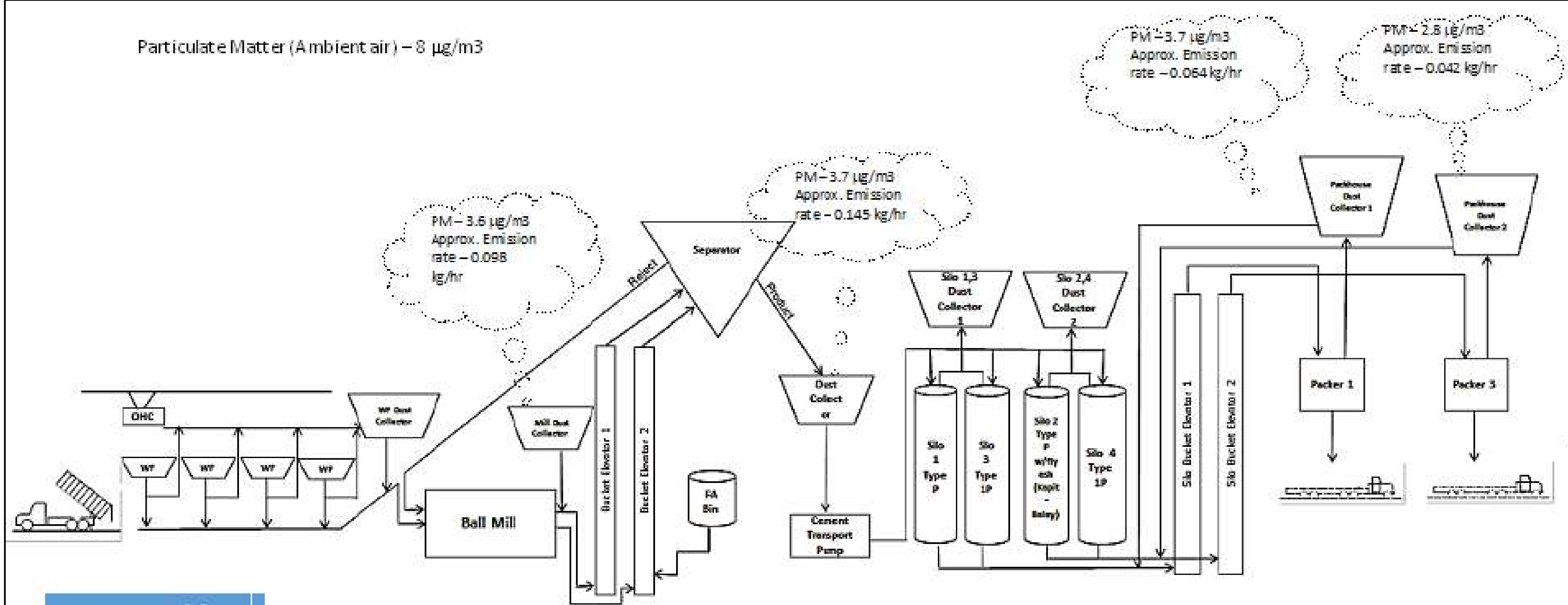
Current quarrying method employs and uses backhoe excavators, bulldozers, and occasional breaking using hydraulic breakers when encountering harder limestone. Currently, extraction in Danao is more on stripping , drilling, and breaking due to characteristic and type of material of material (coralline limestone) described as milky white to gray color limestone. Porous that ranges from soft , to semi hard to hard but in case , volume increase and if needed , specially when we reach or encounter the Uling Limestone which described as light gray to beige, semi-hard to hard , with moderate to tight fracture that have clay infills in portions, shake or soft blast will be implemented.

The methodology is surface mining in broader terms, and contour mining (rather than open pit) in specific terms. This is because the resulting elevation of the mine will not be lower than the general surrounding elevation.

The LOADING of limestones and other siliceous uses backhoe excavators, wheel payloader while HAULING of limestone and other siliceous materials uses dump trucks.

The project has an oil-water separator with a capacity of 90 m^3 and newly constructed drainage and septic treatment for domestic waste with a capacity 12 m^3.

Figure 1.5.11 presents the summary of pollution control devices and the wastes generated at different project phases of the project. It may be noted that dust generated during operation are returned into the system and used as raw material.



Raw Materials
Clinker
Gypsum
Pozzolan
Limestone
Fly Ash

- All dust collected from the dust collectors returns to the system
- All material spillage are recycled back to the system
- Cooling water for the equipment are being recirculated

Solid Wastes – 10 cu.m/month		
Damaged Cement Jumbo bags	97%	sold to 3rd party (scrap buyer)
Cement bags	2.5%	Biodegradable
Residual & Domestic wastes	0.5%	Collected by LGU

Figure 1.5.11: Summary of Wastes Generated on All Project Phases

1.6 PROJECT SIZE

1.6.1 Project Capacity

The project will produce cement at 1,200,000 metric tons per year.

For the Danao Limestone Project, the limestone resource estimates consist of limestone from the Carcar Formation and Uling Formation. Tabulation of limestone resource estimates for each rock formation is presented in Sections 7.7.1 and 7.7.2.

A total of ***255 Million Tonnes of Measured and Indicated Limestone Resources*** was estimated for the Danao Limestone Project with an average grade of ***50.89% CaO and 0.74% MgO***. Additional ***Inferred Limestone Resource is estimated at 1,354 Million Tonnes with 50.75% CaO and 0.75% MgO***. However, note that the Inferred resource was estimated based on limited number of drill holes and warrants additional in-fill drill holes to upgrade the resource category to Measured or Indicated.

The Danao Limestone Project mineral resource estimates are summarized in ***Table 7-4***. Grade-tonnage data is presented in ***Table 7-5***. Grade-tonnage curve is shown in ***Figure 7-6***.

Table 7-4. Danao Limestone Project Mineral Resource as of March 31, 2020.

MEASURED				
Resource Classification	**Volume**	**Tonnage**	**% CaO**	**% MgO**
High Grade Limestone	23,352,000	56,043,000	52.84	0.72
Low Grade Limestone	6,022,000	14,453,000	43.21	0.90
Dolomitic Limestone	-	-	-	-
Sub-total / Ave.	**29,374,000**	**70,496,000**	**50.87**	**0.75**
INDICATED				
Resource Classification	**Volume**	**Tonnage**	**% CaO**	**% MgO**
High Grade Limestone	60,426,000	145,022,000	53.01	0.70
Low Grade Limestone	16,590,000	39,815,000	43.22	0.87
Dolomitic Limestone	-	-	-	-
Sub-total / Ave.	**77,016,000**	**184,837,000**	**50.90**	**0.74**
MEASURED + INDICATED				
Resource Classification	**Volume**	**Tonnage**	**% CaO**	**% MgO**
High Grade Limestone	83,778,000	201,065,000	52.96	0.71
Low Grade Limestone	22,612,000	54,268,000	43.21	0.88
Dolomitic Limestone	-	-	-	-
Sub-total / Ave.	**106,390,000**	**255,333,000**	**50.89**	**0.74**

INFERRED				
Resource Classification	**Volume**	**Tonnage**	**% CaO**	**% MgO**
High Grade Limestone	437,837,000	1,050,808,000	52.55	0.70
Low Grade Limestone	126,256,000	303,014,000	44.50	0.93
Dolomitic Limestone	-	-	-	-
Sub-total / Ave.	**564,093,000**	**1,353,822,000**	**50.75**	**0.75**

Notes:
5. The Danao Limestone Project Mineral Resource statement has been generated by CP Jayrrel T. Guzman under the supervision of CP Tomas D. Malihan. CPs Malihan and Guzman have sufficient experience relevant to the style of mineralization and type of deposit under consideration and to the activity that has been undertaken to qualify as a Competent Person as defined in the PMRC Code.
6. Mineral Resources are reported in accordance with the PMRC 2007.
7. The Mineral Resources reported in the table above represent estimates as of March 31, 2019. Mineral Resource estimates are not precise calculations, being dependent on the interpretation of limited information on the location, shape, continuity of the mineralization and the availability of sampling results. Tonnages in the table have been rounded to the nearest thousands to reflect the relative uncertainty of the estimate.

The objective of the expansion is to increase the area covered by the existing ECC for future expansion of the area of operation (e.g sandayong shale and dunggoan limestone quarry) and as much as possible to cover the area within the MPSA for other siliceous material that can be used as Cement Raw Material. With this, 255 Million Metric Tons of Measured and Indicated Resources and with only 65K Mt limestone yearly requirement, the life of Mine is 3,923 Yrs**.**

Detailed Exploration Report is provided in **Annex 1-7**.

1.6.2 Project Area

The project covers a total area of 1,365 ha, as presented in **Table 1.6.1**.

Table 1.6.1: Project Area of the Proposed Project

Description	Area (ha)
Cement Finish Mill and Packhouse/Storage	**10**
Quarry Area	**1,355**
Area 1: Dunggoan in Danao and Dawis Sur in Carmen	195
Area 2: Sandayong Norte, Cagat, Cambanay, Binaliw in Danao	710
Area 3: Triumpo, Hagnaya in Carmen	450
Total	**1,365**

1.7 DEVELOPMENT PLAN, DESCRIPTION OF PROJECT PHASES AND CORRESPONDING TIMEFRAMES

1.7.1 Pre-Construction and Construction Phases

These phases are not applicable because the Cement Finish Mill Plant facilities are already existing. Only upgrade and improvement of the facilities will be undertaken.

1.7.2 Operation Phase

Currently, RCBM has completed the following permits for the operation of the project:

- Permit to Operate
- Discharge Permit
- Hazardous Waste Generator ID
- CCO Registration Certificate for Asbestos and PCB
- Philippine Standard Quality Mark License for Cement

These Permits are provided in **Annex 6-3**. The Plant is ready for the expanded production as well as the quarry sites. As soon as the amended ECC is issued, project implementation of these expansion efforts will proceed.

1.7.2.1 Cement Finish Mill

The project involves finish mill only which includes the following activities:

- Gypsum, pozzolan, flyash, limestone and other cementitious materials are added to the clinker and then fed to the finish grinding mills. Gypsum serves as a retarder in the too rapid setting or hardening of cement.
- Blended cement is pulverized in a closed circuit system in the finish mills to the desired fineness.
- Cement is transported to cement silos.
- Cement is packed into bags by inline packers or loaded as bulk and bags are distributed either by land using forwarder trucks and bulk trucks or by sea using barges or bulk ships

The cement finish mill will operate 365 days per year for 24 hours with maintenance shutdown allowance of 15 days per year and will produce 1,200,000 MT of cement.

Provided in **Table 1.7.1** is the list of Plant Structures/Facilities in the cement plant complex that are still existing with their utilization plan.

Table 1.7.1: List of Plant Structures/Facilities in the Cement Plant Complex for Demolition with Utilization Plan

	Plant Structures For Demolition	Utilization Plan
1	Thermal Plant	open area
2	Finish Mill 1 & 2	open area
3	Ball Mill (small) 1 & 2	open area
5	Dryer Building	open area
6	Fuel Coal Shed (nickel machine)	open/parking space
7	PGMC Pelletizer Building	open/parking space
8	Small Kiln Covered Building	open/parking space
9	Kiln #3 smoke stack	open area
11	L3 EP structure & foundation	open area
12	L3 RM feed bin building	open area
13	Line 3 kiln structure & piers	open area
14	Line 3 clinker cooler, fans & transport auxs.	open area
15	Secondary crusher building	stockpile area
16	Conveyor shed building	stockpile area
17	Primary crusher	stockpile area
18	Slurry Basin (2 units)	open area
19	Slurry pump house	open area
20	Silo Blending Storage (6 silos)	open area
21	L3 RM overland transport conveyor to storage (existing)	open area
22	L2 RM overland transport conveyor to storage (mcci)	open area
23	L1 & L2 Feed tank	open area
24	Old cement silos (8 units) for FM1 & FM2	stockpile area
25	Old pack house extension	stockpile area
26	Overhead pipelines and steel structures	open area
27	Pack house 1 & 2 cement silos (4 units)	open area
28	Pack house 1 & 2	open area
29	Storage building 1 & 2	open stock area
30	Power plant (mcci)	excess cement warehouse
31	Laboratory	open area
32	Engineering water pump house	open area
33	Removal of overhead crane from storage line 1 & 2	N/A
34	L3 RM Building	spare parts warehouse

1.7.2.2 Quarry Operation

The quarry operation will involve the following activities:

- Material Sourcing/Quarrying
- Stripping of the Overburden
- Excavation and Loading; and
- Hauling

The quarry operation will involve extraction of 500,000 MT of limestone per year and 150,000 of pozzolan/shale per year. About 200,000 MTPY of the limestone will be used for the cement raw materials in Cement Finish Mill Plant in Danao, Cebu while remaining 300,000 MTPY will be supplied to the Cement Finish Mill Plants of RCBM located in Luzon and Mindanao Plants.

On the other hand, 158,400 MTPY of pozzolan/shale will be used for the cement raw materials in Cement Finish Mill Plant in Danao, Cebu.

1.7.3 Abandonment Phase

Although there are still existing structures withn the cement plant complex such as the power plant wich will no longer be used/operated, dismantling and demolition will not yet be implemented because the existing structurs may be used for other purposes.

Progressive rehabilitation will be implemented during the Environmental Protection and Enhancement Program (EPEP) period of the project. This tree-planting program was designed not only to stabilize the slopes but also to enhance the visual effect of the quarry from the National Highway approximately 5 meters and the bench width is 5 meters with a final bench height at 10 meters.

The decommissioning of this Project will abide by good environmental practices and principles, especially the management of wastes resulting from the dismantling process. The separate and detailed Abandonment Plan will be integrated with the FMRDP for the manufacturing plant itself and submitted to all the government regulatory agencies concerned.

By the nature of the project, there are no anticipated residual soil, water and air contamination with hazardous substances in event of project abandonment.

The proposed final landform for each project component are the following:

Table 1.7.2: Proposed Final Land Form of the Project

Component	Proposed Final Land Form
Cement Finish Mill Plant	
Major Component	
Finish Grinding Clinker Bin, Ball Mill	Stable and revegetated area. The structures will be removed.
Packing and Distribution Packhouse	Stable and revegetated area. The structures will be removed.
Support Facilities	
Office Buildings	Retained for other productive use.
Warehouse	Retained for other productive use.
Laboratory	Structure retained for other productive use. Laboratory equipment transferred to other projects or sold.
Truck Scale	Stable and revegetated area. The truck scale will remove for transfer to another project or will be sold.
Hardstands/parking areas	Retained as hardstands/parking area.
Powerhouse	Structure retained for other productive use.
Motorpool Area	Structure retained for other productive use.
Guard Houses/Gate	Structure retained to provide security for other productive use of the area.
Canteen/Cooperative	Structure retained for other productive use.
Chapel	Retained as chapel.
Project Personnel Housing	Retained as housing/subdivision.
Silt traps/ponds, drainage system	Silt traps/ponds backfilled and revegetated. Main siltation pond retained as recreation area for the housing/ subdivision. Drainage system retrofitted to conform to proposed final land use.
Nursery	Retained to support the care and maintenance after the FMRDP implementation.
Quarry Area	
Active Quarry Slopes	Stable and revegetated area
Quarry Pit Bottom Area	Stable and revegetated area
Haul roads (within the quarry area)	Stable and revegetated area
Topsoil stockpile area (within quarry area)	Stable and revegetated area
Settling Pond (within the pit bottom)	Stable and revegetated area

1.8 MANPOWER

The Cement Finish Mill Project will operate at 24 hours x 7 days with 286 workers including the Family Contractors. Quarrying operation is expected to be contracted out to accredited quarry service contractors and expected to have a total workforce 27 people. Some of the workers came from Danao City and Carmen and the rest of Cebu with only 6% representing those sourced from outside Cebu.

The existing manpower will be sufficient for the implementation of the expansion programs. In case there will be additional employment requirements, job advertisements will be utilized to outsource the manpower requirement. These may be in the form of newspaper ads, job posters at LGU, school networking and placement agencies.

Provided in **Table 1.8.1** is the detailed tabulation of manpower.

Table 1.8.1: Detailed Tabulation of Manpower

	TOTAL HC	Gender		TOTAL	Age Range			TOTAL	Residence			TOTAL
		Male	*Female*		*18 to 30*	*31 to 45*	*46 to 60*		*Danao & Carmen*	*Rest of Cebu*	*Outside*	
Family Contractor	250	238	12	250	67	133	48	248	218	21	11	250
Regular Employees	36	31	7	38	9	22	5	36	22	9	5	36
	286	269	19	288	76	155	53	284	240	30	16	286
	100%	94%	7%		26%	54%	18%		84%	10%	6%	

1.9 INDICATIVE PROJECT INVESTMENT COST

The total estimated/indicative investment cost is Four Hundred Fourteen Million and Three Hundred Thousand Pesos (PhP414.3 Million).

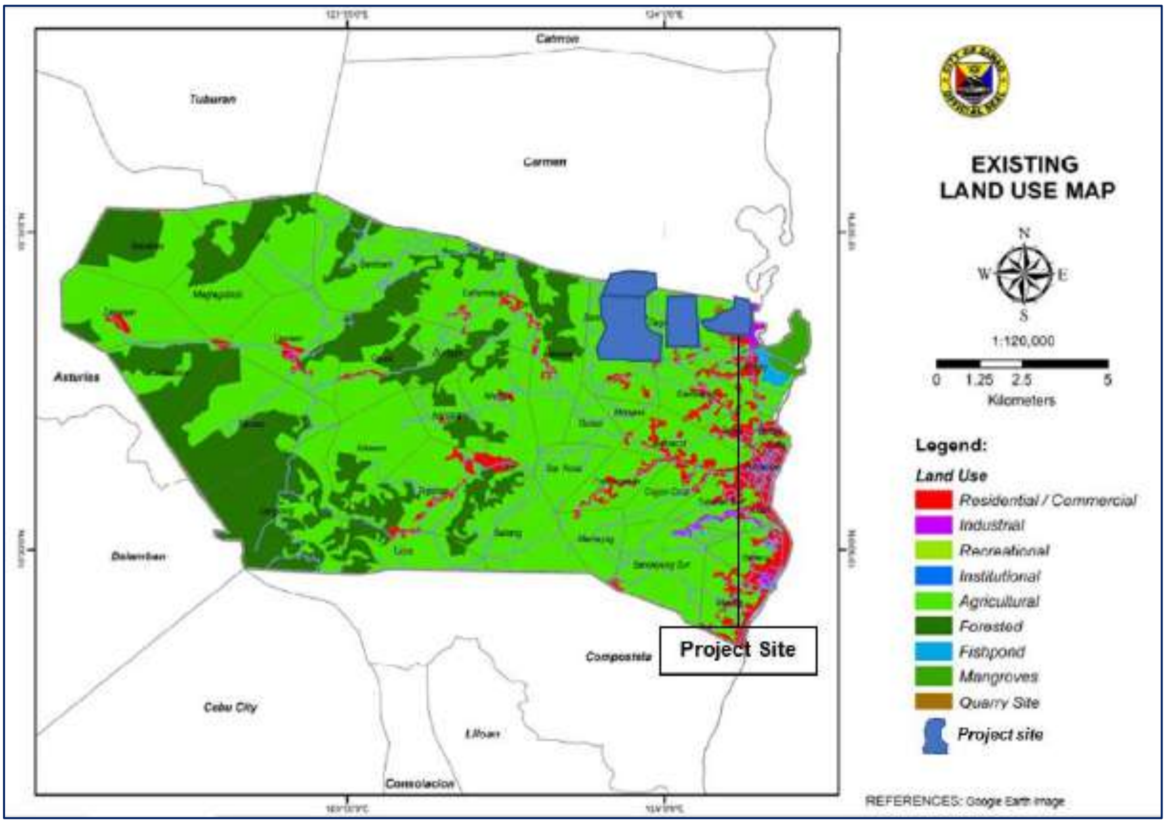
2. ANALYSIS OF KEY ENVIRONMENTAL IMPACTS

2.1 LAND

2.1.1 Land Use and Classification

2.1.1.1 Existing Land Use

Danao City is composed of agricultural/grassland, forest, mangrove, quarry, fishpond, and urban areas. Majority of the land in Danao City are presently used for agriculture (**Figure 2.1.1**). The land use of the area of the project site is designated as an industrial area as this is located inside the existing Cement Plant Complex of RCBM in Barangay Dunggo-an. Therefore, there is no issue in terms of compatibility with the existing land use.



Source: Danao City Comprehensive Land Use Plan (CLUP) 2017 - 2027

Figure 2.1.1: Existing Land Use Map of Danao City

2.1.1.2 Land Tenure

The project site is privately owned by RCBM with respect to the cement plant area and has existing and valid MPSA with respect to the quarry areas.

2.1.1.3 Impact in Terms of Compatibility with Existing Land Use

There is no issue in terms of compatibility with the existing land use, because the project site is located inside the existing Cement Plant Complex of RCBM in Barangay Dunggoan, which is designated as an industrial area.

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

Environmentally Critical Areas (ECA) are environmentally sensitive areas declared under Presidential Proclamation No. 2146 of 1981 where significant environmental impacts are expected if certain types/thresholds of proposed project are located, developed or implemented in it. **Table 2.1.1** presents the list of ECA and their relevance to the proposed project site.

Table 2.1.1: List of ECA and Relevance to the Project Site

No.	Environmentally Critical Areas	Relevance to the Project Site
1.	All areas declared by law as national parks, watershed reserves, wildlife preserves, sanctuaries	The Project site is not a declared national park, watershed reserve, wildlife preserve or sanctuary. Moreover, the project site is located inside the existing Cement Plant Complex which is an industrial area of RCBM and within the MPSA.
2.	Areas set asides as aesthetic potential tourist spots	Based on the Land Use Map of Danao, the project site is not a potential tourism area.
3.	Areas which constitute the habitat of any endangered or threatened species of Philippines wildlife (flora and fauna)	There are no endangered or threatened species present in the project site.
4.	Areas of unique historic, archaeological, or scientific interests	There are no unique historic and archaeological area within the project site.
5.	Areas which are traditionally occupied by cultural communities or tribes	There is no ancestral domain area within the project site.
6.	Areas frequently visited and/or hard-hit by natural calamities (geologic hazards floods, typhoons, volcanic activity, etc.)	The project area is visited by at least two (2) typhoons per year based on the Typhoon Frequency Map.
7.	Areas with critical slopes	The cement mill project site is flat while the quarry sites have sloping/rolling terrain.
8.	Areas classified as prime agriculture lands	The project site is designated as industrial area.
9.	Recharged areas of aquifers	Based on the 1997 Groundwater Availability Map of the Philippines, the project site falls under unproductive aquifers
10.	Water bodies characterized by one or any combination of the following conditions: tapped for domestic purposes; within the controlled and/or protected areas declared by appropriate authorities; which support wildlife and fishery activities	The project site is not located near a marine protected area.
11.	Mangrove areas characterized by one or any combination of the following conditions: with primary pristine and dense young growth, adjoining mouth of major river systems: near or adjacent to traditional productive fry or fishing grounds; areas which act as natural buffers against shore erosion, strong wind and storm floods; areas on which people are dependent for their livelihood.	The project site is located adjacent to the Mangrove Area which has been propagated by the Proponent.
12.	Coral reefs characterized by one or any combination of the following conditions: With 50% and above live coral cover; Spawning and nursery grounds for fish; act as natural breakwater of coastlines.	The Project will not disturb the marine ecology as the project focus on cement milling and quarry operations which is both away from the marine environment.

Source: Presidential Proclamation No. 2146 (1981)

2.1.1.5 Impact on Existing Land Tenure Issue/s

The project site is owned by RCBM with respect to the cement plant area and has existing and valid MPSA with respect to the quarry areas. Also, with respect to land tenure issues, discussions with informal settlers are prioritized in cases where their areas will be affected. Proper negotiation and remuneration will be undertaken in case relocation will be an option.

2.1.1.6 Impairment of Visual Aesthetics

There are no visually significant landforms/ landscape/structures near the project site. However, the operation of the old quarry will create new visual condition of the area. This is an unavoidable impact. The activities inside the processing plant will also invite the attention of the passers-by.

Control measures may be progressive rehabilitation, reforestation, etc. To minimize the impact, there will be tree plantation around the quarry. This will be an activity that will be jointly achieved by the company and the community. The processing plant's fence shall be constructed and maintained. Security guards shall be posted in strategic locations.

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

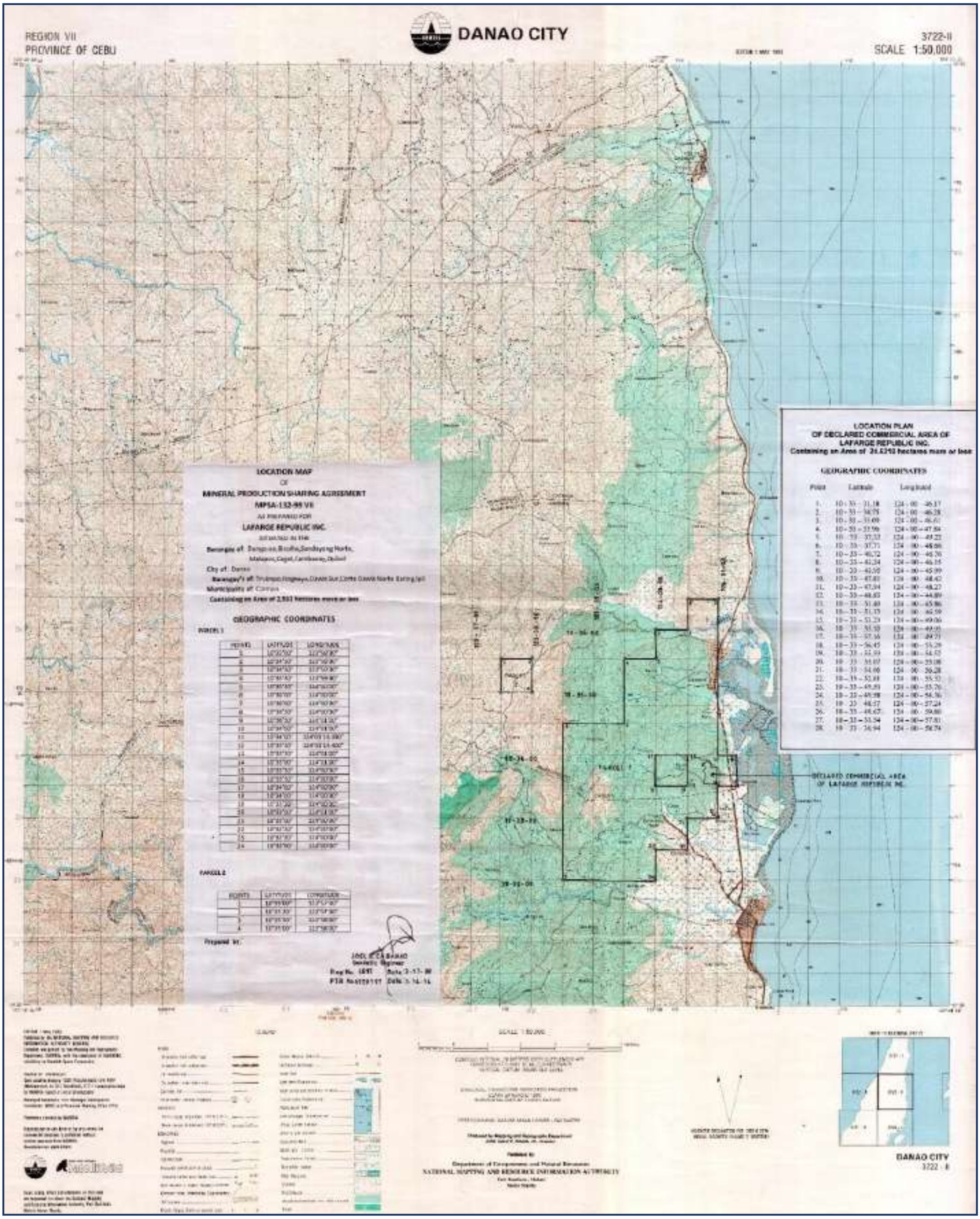
The Project will not contribute to the devaluation of land value resulting from improper solid waste management and other related impacts because the Project will faithfully comply with the provisions of RA 9003 and adhere to Cebu's ordinances on solid waste and environmental programs. Moreover, Cebu City is one of the cities which fully implement the Republic Act 9003 otherwise known as the Ecological Solid Waste Management Act.

Moreover, the entire cement plant is properly landscaped in order to increase its aesthetic impact. The property line along the highway is fenced and planted with ornamental plants visual appeal. Road cleaning is done regularly by local contractor during hauling activity. Contracted sweepers will include the roads from the plant gate towards the packhouse and admin area, as well as other access road that is paved.

2.1.2 Geology/Geomorphology

2.1.2.1 Surface Landform/Geomorphology/Topography/Terrain/Slope

Danao City lies in the northern half of Cebu Province and appears as an elongated roughly rectangular area on the eastern side of the island ridge. It starts from the mountainous ridge and slopes down eastward to Camotes Sea. In terms of general landform types, the city has plains along the eastern coast, hills toward the west, and mountains further west which are part of the island ridge system. There is a small part of the city west of the highlands that have an elevated plain area surrounded by hills. **Figure 2.1.2** shows the Topographic Map of the project site.



Source: NAMRIA

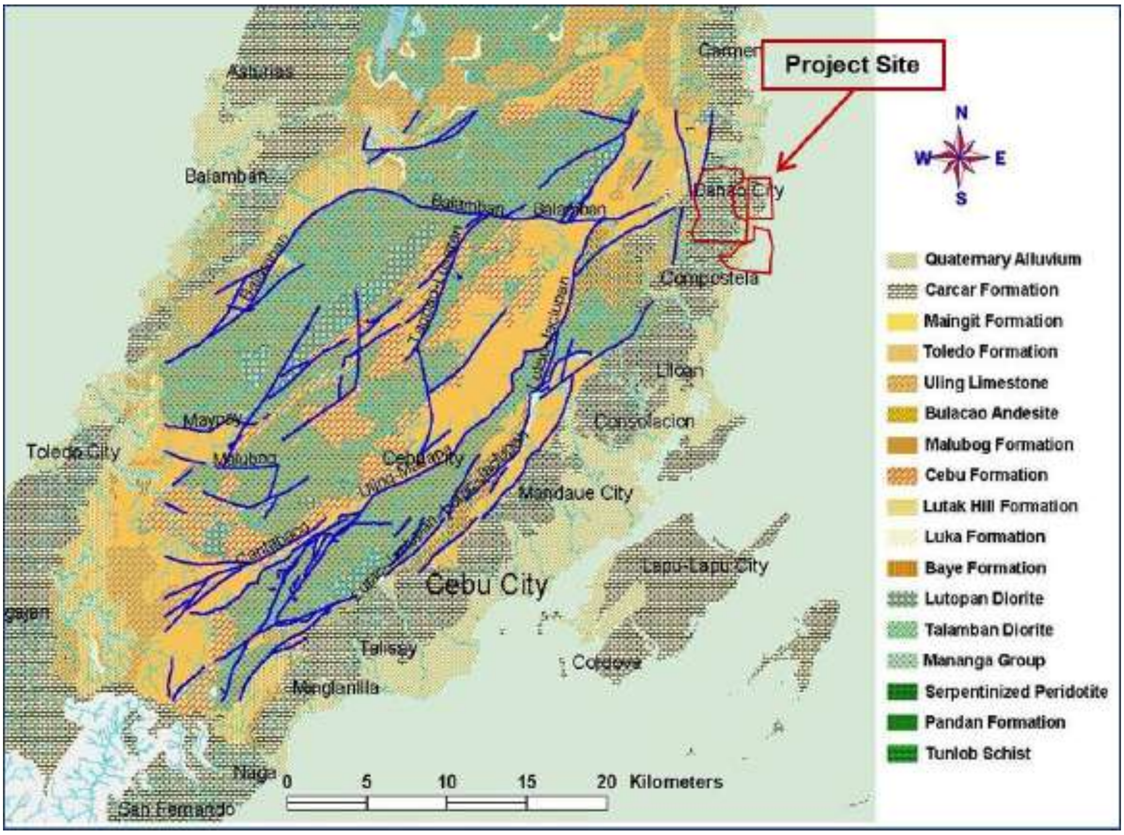
Figure 2.1.2: Topographic Map of the Project Site

2.1.2.2 Sub-Surface Geology/Underground Condition

Lithology and Subsurface Geomorphology

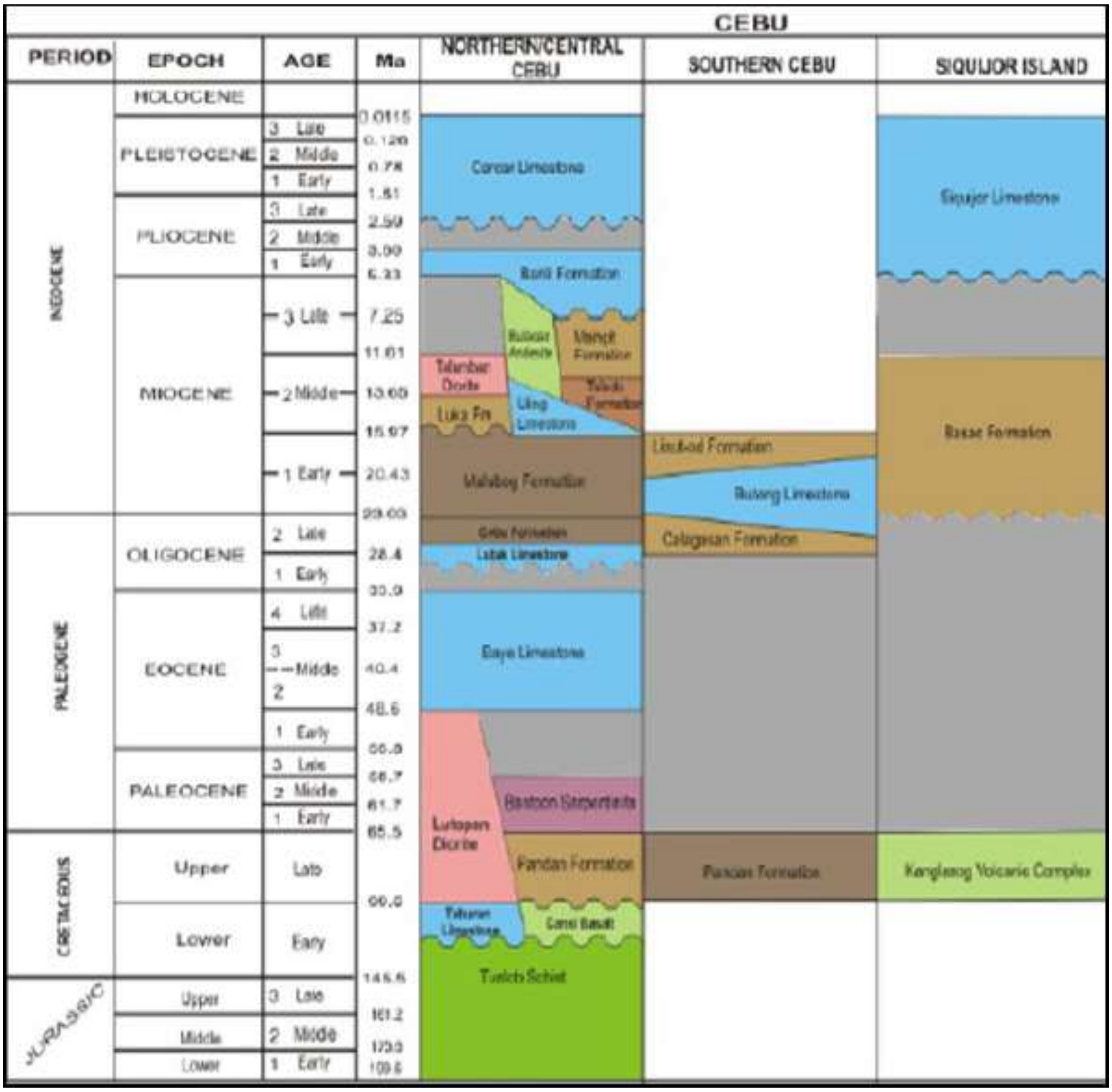
Central Cebu Area is an uplifted rhombus area in the bulge of the island. Prominent vertical or steeply dipping faults trending NNE-SSW are: Cabagdalan and Uling Masaba faults in the west, and Lutac-Jaclupan and Danao-Gukong faults in the east. The Central Highlands cover the area from Toledo to Asturias in the west and Naga to Carmen in the east. The uplifted area was formed by the recommencement of the subduction processes in short lived magmatic phase occurring the Lower/Middle Miocene period (Buchsel, 1992). In this area, deep trench and ridges confined the thick (1,000 m) silty clayey, shale and siltstone deposits of the Malubog, Uling, Toledo and Mapolo formations in the Oligocene to Lower Miocene. With the collision of the continental terrain with the western periphery of the Visayas heavy folding was formed. With this erosion, process took place on the sedimentary rocks, and it formed the Uling Limestone, which had widely covered the island into remnant caps in the highlands. Malubog formation thins out in the west at Toledo-Balamban and in the east from Naga – Danao. As central part continued to be uplifted in the Pleistocene period, both western and eastern coastal areas which dip at 5 –10° to the sea were covered with marine limestone deposits, which is now called the Carcar Limestone formation. Due to the continuing erosion process, the “Basement Complex” is now exposed in the inner areas of the island.

Figure 2.1.3 shows the inland older formations comprising largely of the basaltic Mananga Group, intrusive Diorites and pyroclastic Cansi Volcanics and flanked to the east by siltstone/mudstone Malubog formation. These group areas were capped by the older limestone Cebu formation. The inland formations are all flanked by the younger limestone Carcar formation in the lowlands. The recent sediments overlaid the Carcar formation towards the coast. **Figure 2.1.4** presents the Stratigraphic Column of Cebu.



Source: River Basin Coordinating Office

Figure 2.1.3: Geological Map of Central Cebu



Source: MGB

Figure 2.1.4: Stratigraphic Column of Cebu

The various formations can be classified into hydrogeologic classes depending on how water could pass through their porosity under the influence of gravity. In general, water would flow through the formation with high porosity and low water retention potential. The materials with high porosity and low water retention will allow a large flow of water (high permeability). The material with medium porosity and low water retention potential will allow a medium flow (medium permeability). Formations with low porosity and low water retention potential will allow little flow (low permeability). While those with low porosity and low water retention will allow very little flow (very low permeability). The last two could be lumped into the same class due to uncertainty in determining the porosity and water retention characteristics of formations.

The hydrogeologic characteristics of these units, showing the recharge rate and water storage potentials are summarized in **Table 2.1.2**.

Table 2.1.2: Hydrogeologic Units in the Project Area

Hydrogeologic Unit	Strategraphy	Lithology	Sp. Storage Capacity	Water Transport Potential	Recharge Potential	Remarks
Unit 1 - High Porosity Limestone	Baye Formation Carcar Formation Lutak Hill Formation Uling Limestone Quaternary Alluvium- sandy	Limestone Limestone Limestone Limestone Sediments	High for Carcar Limestone Low for older limestone	High	High	RC = 0.2 RC = 0.35 RC = 0.3 RC = 0.35 RC = 0.3 RC = 0.2
Unit 2 – Conglomerate, sandstone and fractured rocks and sandy sediments Older limestone	Bulacao Andesite Cebu Formation Luka Formation Sandstone and limestone of Malubog Formation Maingit Formation Mananga Group Malubog Formation Maingit Formation Quaternary Alluvium-silty/clay	Volcanics Conglomerate/ karstic limestone Limestone Sedimentary Conglomerates Volcanics Sandstone/Limestone Fine sediments/silty sand	Moderate for conglomerates Moderate for sandy alluvial deposits Low for older limestone	Low	Low to moderate	RC = 0.2 RC = 0.2 RC = 0.2 RC = 0.2 RC = 0.2 RC = 0.2 RC = 0.2 RC = 0.1 RC =0.05
Unit 3 – much older formations, basalt rocks, shale, mudstones and clayey sediments	Barili Formation Cebu Formation Malubog Formation Mudstone/shale Lutopan Diorite Talamban Diorite Mananga Group Maingit Formation Serpentinized Peridotite Toledo Formation Tunlob Schist	Limestone Sedimentary coal measures Siltstone Shale/Mudstone Volcanics Volcanic diorite Volcanic pyroclastics metamorphic tuffaceous sediments metamorphic	Very low to limited	No	Limited to no recharge	RC = 0.05 RC = 0.01 RC = 0.01

Source: River Basin Coordinating Office

Recharge rate is the fraction of rainfall that percolates to the water table and translate to annual recharge, in cubic meter per year, is basically computed from the recharge area (horizontal plane of exposed outcrop) multiplied by the recharge rate.

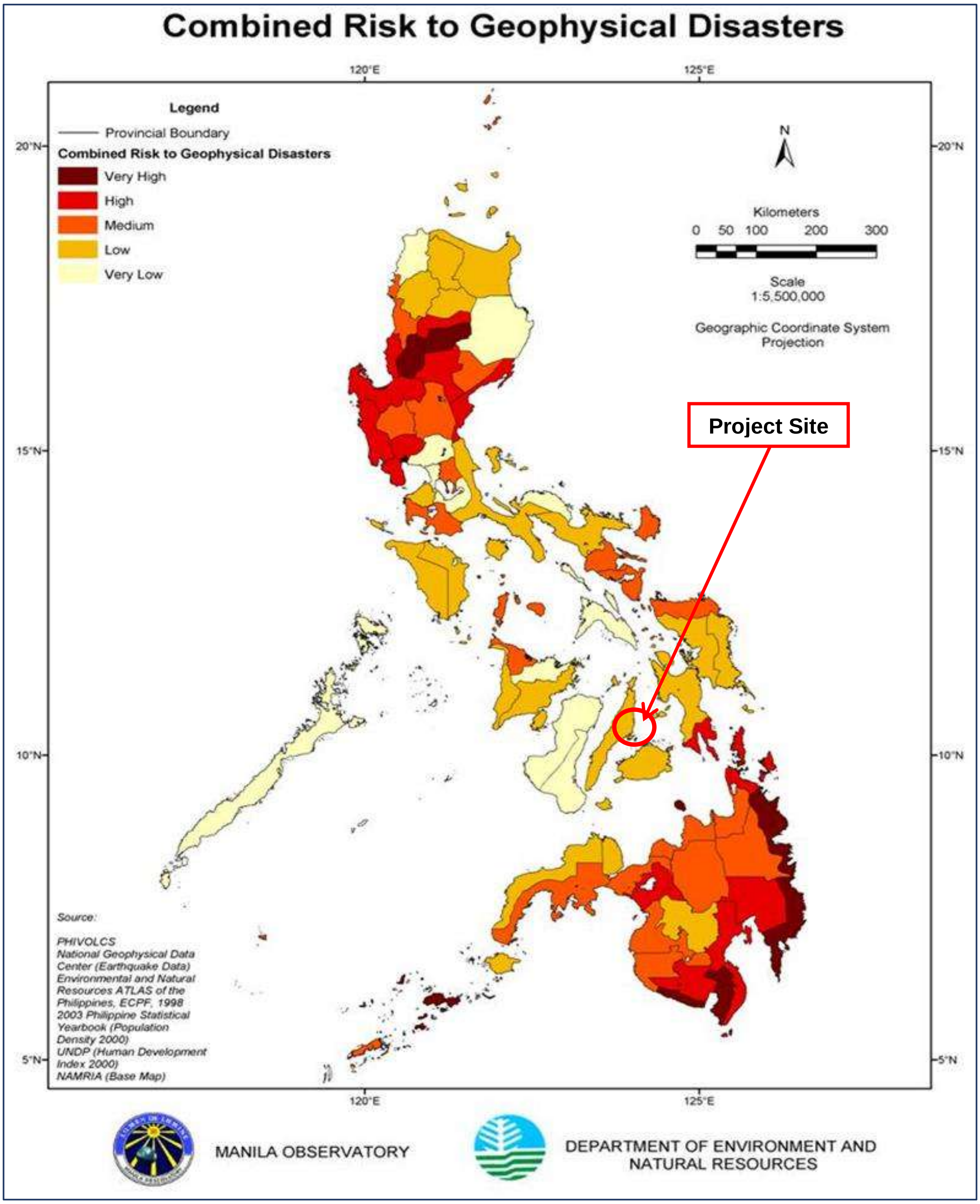
Rates of recharges of the three (3) hydrogeologic units are estimated from various reports on ground water developments in Metro Cebu by KKLI and Cebu Consultants and other sources of references, such as dissertation on hydrogeology of Cebu by F. Wolcke and sources from the internet.

For water balance and potential calculation, the recharge value for Carcar Limestone is recommended to be 250 mm/year (15%); while that of the coastal alluvial sediments is 10% of average annual coastal rainfall.

For recharge in volcanic and clastic formations, Wolcke recommended about 10% of upland average rainfall. In heavily fractured Bulacao Andesite, in uncemented conglomerates and tuffaceous sediment areas, the recommended recharge coefficient is 15%. Recharge in diorite, massive volcanic, is 5%, while those of shale and mudstone formations are 1%.

2.1.2.3 Geologic and other Natural Hazards

The Combined Risk to Geophysical Disasters Map presented in **Figure 2.1.5** shows that the project site has low susceptibility to the combined risk to geophysical disasters. Combined Risk to Geophysical Disasters means that there may be presence of several risks or disasters in a particular area such as a combination of earthquake and landslides, volcanic eruption, earthquake and tsunamis and so on. Detailed Geohazard Report is provided in **Annex 2-1**.



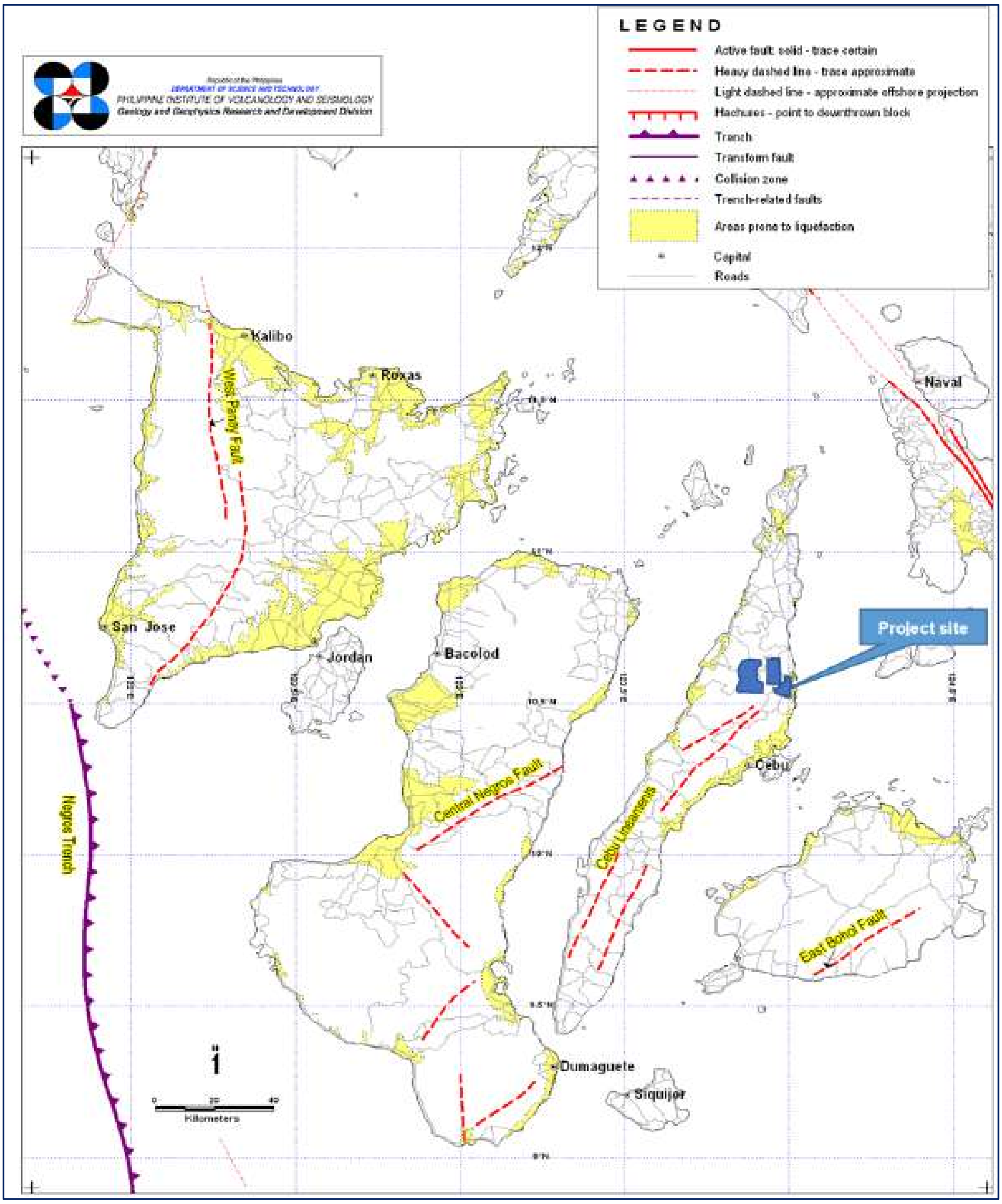
Source: DENR/MO

Figure 2.1.5: Map showing Combined Risk to Geophysical Disasters

Seismic Hazard

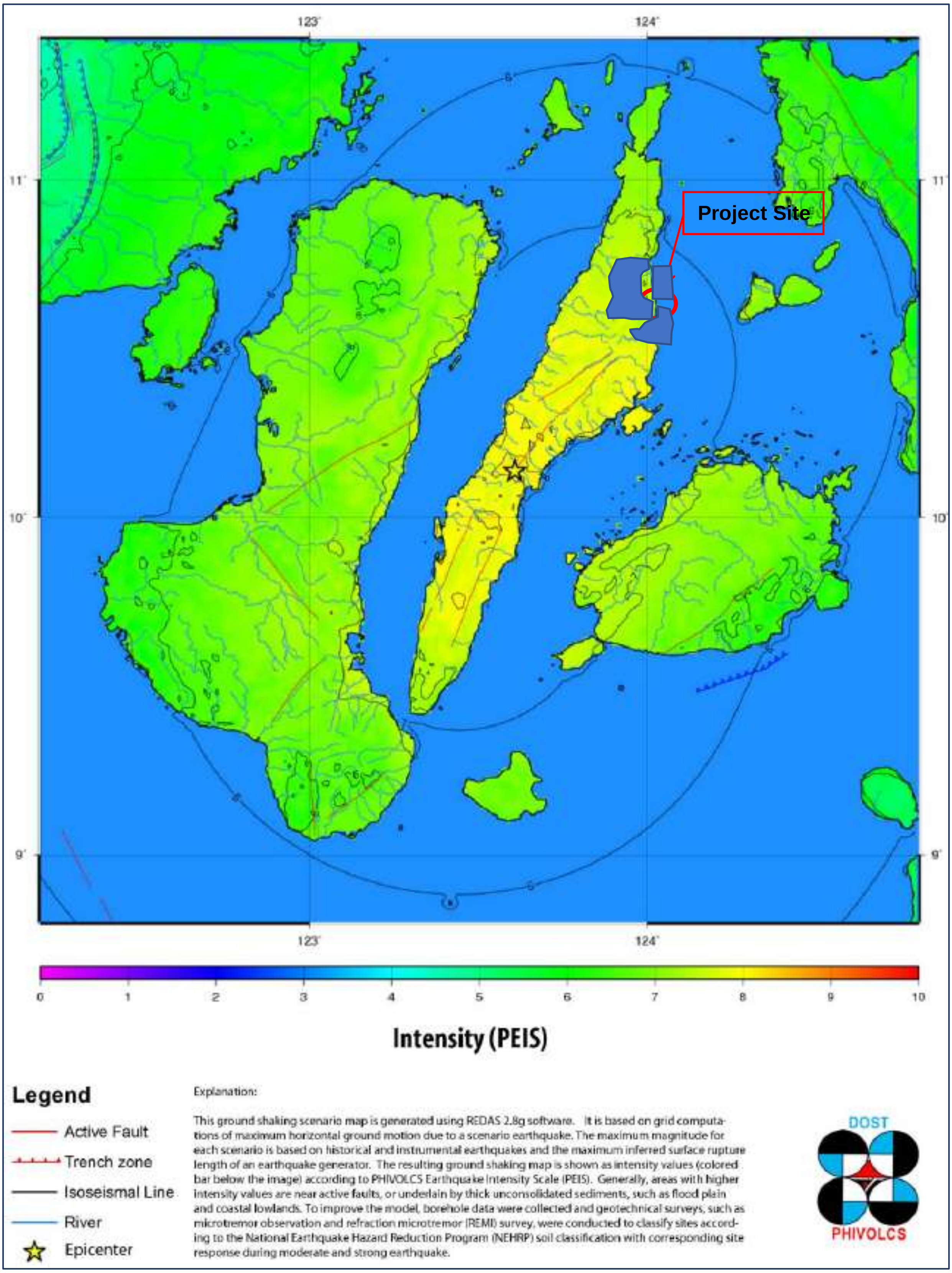
Seismic hazard is the perceptible trembling to violent shaking of ground caused by either tectonic movements or volcanic activity. Areas that are susceptible to this hazard are those underlain by unconsolidated soils and sediments deposited on the low-lying areas. The area investigated is prone to ground shaking hazards due to the presence of several earthquake generators in the region (Punongbayan, 1989). These possible seismogenic structures include the active Cebu Lineaments, East Negros Fault, Central Negros Fault, and the Bohol Fault. Philvocs ground shaking scenario maps generated using REDAS 2.8g software shows that Cebu including the project site falls under Philvocs Earthquake Intensity Scale ranging from 7.0 to 8. (**Figure 2.1.6**).

Figure 2.1.7 presents the map of Magnitude 7.5 Cebu Fault System Scenario Earthquake, while **Table 2.1.3** presents the historical earthquake occurred in Cebu from 1973 to 2014.



Source: PHILVOLCS

Figure 2.1.6: Active Faults and Liquefaction Susceptibility Map



Source: PHILVOLCS

Figure 2.1.7: Map showing the Magnitude 7.5 Cebu Fault System Scenario Earthquake

Table 2.1.3: Historical Earthquake Events

Year	Magnitude											Intensity/Location
1973	09	26	09	46	48.80	10.220	125.270	033		5.4		Surigao and Cebu City RF2
1974	11	04	19	43	35.40	9.970	123.200	059		4.1		Cebu City RF2
1984	11	11	23	07	21.30	10.550	125.600	032	5.0			RF2-Cebu
1996	05	27	05	45	24.90	9.980	124.100	003			5.6	Lapu-Lapu RF5; Tagbilaran F4; Cadiz City RF3; Iloilo RF2; Palo RF1; Hibok-Hibok RF1
1996	07	02	13	52	53.00	10.000	124.100	003			4.1	Talisay Cebu RF3; Tagbilaran RF2; Cebu City RF2
1996	10	02	09	48	1.70	11.930	125.640	019			6.2	Borongan RF5; Palo RF4; Bulusan RF4; Surigao RF3; Masbate RF2; Cebu RF2
1997	04	08	16	56	31.70	10.990	124.430	003			4.7	Intensity III - Palompon Leyte; Intensity II - Cebu City
1997	10	03	09	32	25.10	10.030	123.970	006			4.0	Intensity II - Lapu-Lapu City Cebu
2000	05	08	10	25	23.80	11.031	124.843	006	4.7	5.6	5.0	Intensity IV - Palo and Ormoc Leyte; Intensity II-Cebu City
2000	05	08	13	54	58.28	10.987	124.674	001	4.8	5.7	5.1	Intensity IV - Palo Leyte; Intensity II - Cebu City
2000	05	17	09	46	21.75	10.923	123.807	012	4.5	5.5	4.8	Intensity IV - Danao City and Iloilo City; Intensity III - Cebu City, Lapu-Lapu City and Cadiz City
2001	01	13	08	52	51.00	9.798	124.777	010	4.3	5.3	4.5	Intensity III – Anda, Duero, Mabini, Danao, and Guindulman all in Bohol, and Camiguin Island; Intensity II- Lapu-Lapu City
2001	01	13	15	44	22.77	9.726	124.763	006	4.3	5.3	4.5	Intensity II - Cebu City, Anda Bohol and Guindulman Bohol; Intensity I- Lapu-Lapu City and Camiguin Island
2003	02	15	05	47	59.17	12.121	123.827	002	5.3	6.2	5.9	Intensity VI - Dimasalang Masbate; Intensity V - Masbate Masbate; Intensity IV - Legaspi City; Intensity III - Bulusan Sorsogon, Mandaue City and Palo
2003	05	02	15	30	22.71	12.007	123.946	006	4.6	5.6	4.9	Intensity V - Dimasalang Masbate; Intensity IV - Legaspi City; Intensity II - Palo Leyte; Intensity I - Lapu-Lapu City
2003	05	23	02	24	43.95	11.862	124.037	004	5.2	6.1	5.7	Intensity IV - Masbate Masbate; Intensity III - Tacloban Legaspi; Intensity II - Bulusan Metro Cebu Roxas
2003	06	15	23	04	55.62	11.932	123.940	001	4.4	5.4	4.7	Intensity III - Dimasalang Masbate; Intensity I - Lapu-Lapu and Roxas
2003	10	27	12	47	57.84	10.477	124.985	001	4.3	5.3	4.5	Intensity II - Palo Leyte; Intensity I - Mandaue
2003	11	05	02	38	29.50	12.000	123.966	008	4.5	5.5	4.8	Intensity IV - Masbate Masbate; Intensity III - Bulusan; Intensity II - Lapu-Lapu City Mandaue Lignon Hill Legaspi City
2004	03	17	06	16	25.25	11.145	124.711	012	4.3	5.4	4.5	Intensity V - Tongonan Leyte; Intensity III - Palo Leyte; Intensity II - Lapu-Lapu

Year	Magnitude											Intensity/Location
2004	03	26	14	48	47.80	9.847	124.677	015	4.3	5.4	4.5	Intensity IV - Mabini Bohol Intensity III - Guindulman Candijay Anda Duero Bohol Intensity Intensity II Talisay Cebu Intensity I Mandaue Hibok Hibok
2004	03	27	23	21	2.92	11.341	124.370	002	4.7	5.7	5.1	Intensity VI - Tabango Leyte; Intensity V- I Villaba Leyte; Intensity IV - Ormoc City; Intensity III - Cebu City; Intensity Ii Palo Tacloban
2004	05	19	21	28	7.77	10.006	123.982	005	4.8	5.8	5.2	Intensity VI - Tubigon Bohol; Intensity V - Loboc Bohol; Intensity IV - Corella Bohol; Cebu City; Intensity III - Tagbilaran Lapu-Lapu Argao
2004	07	01	04	32	13.04	9.830	124.672	022	4.5	5.5	4.7	Intensity III - Anda Bohol; Intensity II - Duero Bohol Metro Cebu; Intensity I - Hibok-Hibok Camiguin Island
2004	07	01	08	04	23.07	9.825	124.653	020	4.3	5.3	4.6	Intensity III Anda Duero Ubay Guindulman Bohol; Intensity II Metro Cebu Maasin Leyte
2004	10	25	22	29	1.84	9.884	123.398	001	4.4	5.4	4.7	Intensity IV Argao Cebu; Intensity II Tagbilaran City; Mandaue City; Naga Cebu; Talisay Cebu
2005	01	11	07	21	35.89	9.100	125.613	009	4.4	5.4	4.6	Intensity IV - Butuan City; Intensity II - Hibok-Hibok; Intensity I - Mandaue; Cagayan De Oro
2005	03	31	12	25	31.79	9.671	124.265	012	4.4	5.4	4.7	Intensity V - Sierra Bollones; Intensity IV - Jagna Duero Ubay Bohol and Mambajao Camiguin Mandaue City; Intensity III - Tagbilaran Bilar Tubigon Corella Bohol and Cagayan De Oro City; Intensity II - Lapu-Lapu City
2005	07	14	22	53	47.31	10.644	122.478	026	4.7	5.6	5.0	Intensity V - Iloilo City; Intensity IV - Bacolod City; Intensity III – Dumaguete; Intensity II - Metro Cebu
2010	11	05	16	40	37.84	12.825	122.897	019			5.8	Intensity VI - San Pascual Burias Island; Intensity IV - Masbate City; Sorsogon City; Irosin Sorsogon; Sto Domingo Albay; Odiongan Romblon; Legaspi City; Intensity II - Cebu City; Roxas City
2012	02	06	11	33	36.18	9.917	123.111	006	5.0	6.0	5.5	Intensity IV - Iloilo City; Cebu City; Argao Cebu; Intensity III - Sibalom Sebaste and San Jose Antique; Dipolog City
2012	02	07	20	37	44.75	10.151	123.257	010	4.7	5.7	5.1	Intensity IV - Guihulngan Negros Oriental; Intensity II - Hinigaran Negros Oriental; Lapu-Lapu City and Cebu City
2012	02	07	20	48	7.70	10.172	123.209	022	3.9	5.0	4.0	Intensity III - Guihulngan Negros Oriental; Intensity II - Cebu City
2012	02	07	21	59	12.19	10.063	123.245	007	4.8	5.8	5.2	Intensity IV - Guihulngan Negros Oriental; Intensity I - Lapu-Lapu City
2012	02	11	05	39	8.28	10.118	123.212	005	4.3	5.3	4.5	Intensity IV - Vallehermoso Negros Oriental; Intensity III - Linao Hinigaran Negros Occidental; Cebu City

Year	Magnitude											Intensity/Location
2012	07	04	11	09	48.48	11.522	124.379	003	4.6	5.6	4.9	Intensity V - Naval Biliran and Calubian Leyte; Intensity IV - Kawayan Almeria and Culaba Biliran; Intensity II - Palompon Leyte and Tacloban City; Intensity I - Cebu City
2013	10	15	00	12	31.11	9.848	124.044	012	6.2	7.0	7.2	Intensity VIII - Sagbayan Catigbian Loon Maribojoc San Isidro Antequera Cortes Clarin and Buenavista Bohol; Intensity VII - Tagbilaran City, Cebu City, Lapu-Lapu City, Mandaue City, Toledo City, Carcar City, Naga City Cebu, Danao Carmen Bilar Loboc Loay Baclayon Albuquerque and Dauis Bohol; Intensity VI - Hinigaran Negros Occidental, Dumaguete City, Siquijor Island, Lila Dimiao Valencia Garcia Hernandez Jagna Duero Guindulman and Candijay Bohol; Intensity V – Iloilocity, La Carlota City, Guimaras Island, Abuy
2013	10	16	02	42	21.55	9.974	124.256	003	5.4	4.4	4.7	Intensity V - Lapu-Lapu City; Intensity III - Sibulan Negros Oriental; Intensity II - Iloilo City; Ormoc City
2013	10	16	05	28	37.58	9.947	124.143	005	5.0	4.0	4.0	Intensity III - Lapu-Lapu City. This is an Afteshock of 15 October 2013 M7.2 Bohol Earthquake.
2013	10	16	06	33	29.65	9.890	124.146	003	5.3	4.3	4.5	Intensity III - Lapu-Lapu City; Intensity II - Sibulan Negros Oriental
2013	10	16	07	31	26.45	9.599	123.579	000	5.1	4.0	4.1	Intensity III- Lapu-Lapu City and Sibulan Negros Oriental. This is an Aftershock of 15 October 2013 M7.2 Bohol Earthquake
2013	10	16	07	36	10.18	9.673	123.568	001	5.2	4.1	4.2	Intensity III -Lapu-Lapu City. This is an Aftershock of the 15 October 2013 M7.2 Bohol Earthquake
2013	10	16	09	56	52.52	9.908	124.070	007	5.7	4.7	5.0	Intensity III - Lapu-Lapu City; Intensity II - Sibulan Negros Occidental
2013	10	16	22	19	10.84	9.938	124.061	010	5.1	4.0	4.1	Intensity III – Lapu-Lapu City. This is an Aftershock Of The 15 October 2013 M7.2 Bohol Earthquake.
2013	10	16	23	37	30.05	9.769	123.778	017	5.4	4.4	4.6	Intensity VI - Tagbilaran City; Intensity IV - Dumaguete City, Lapu Lapu City, and Sibulan Negros Oriental; Intensity II - Maasin
2013	10	17	03	29	22.85	9.814	124.336	008	4.4	5.4	4.6	Intensity III - Lapu-Lapu City
2013	10	18	08	48	3.31	9.836	123.963	007	4.3	5.3	4.5	Intensity V - Catigbian Bohol; Intensity III - Boljoon Cebu; Lapu-Lapu City
2013	10	18	13	22	9.39	9.618	123.624	007	4.3	5.3	4.5	Intensity III - Argao Cebu
2013	10	19	20	40	40.95	10.031	124.238	005			5.1	Intensity IV - Lapu- Lapu City; Intensity II - Iloilo City
2013	10	19	21	43	27.19	10.018	124.173	008			4.3	Intensity III - Lapu-Lapu City; Intensity I - Cagayan De Oro City
2013	10	20	01	45	33.53	9.859	124.057	011			4.9	Intensity V- Tagbilaran City; Intensity III - Lapu-Lapu and Dumaguete City
2013	10	20	06	23	58.46	10.075	124.152	009			4.1	Intensity III - Lapu-Lapu City

Year	Magnitude											Intensity/Location
2013	10	20	08	05	40.85	9.768	123.680	014	4.5	5.5	4.8	Intensity V - Tagbilaran City; Loon Bohol; San Isidro Bohol; Lapu-Lapu City; Intensity III - Cebu City; Dumaguete City; Kabangkalan Negros Occidental; Intensity II - Hibok-Hibol Camiguin; Iloilo City
2013	10	20	08	39	49.90	9.760	123.641	007			4.1	Intensity III - Lapu-Lapu City; Loon Bohol
2013	10	20	23	03	18.34	9.891	124.028	007			5.4	Intensity V - San Isidro Bohol; Intensity IV - Metro Cebu; Intensity III - Tagbilaran Bohol; Intensity II - Iloilo City
2013	10	20	23	34	10.54	9.761	124.079	006			4.6	Intensity IV - Metro Cebu
2013	10	21	11	43	13.76	10.062	124.171	003	5.1	4.0	4.1	Intensity IV- Cebu City; Intensity III- Lapu-Lapu City; Intensity I- Sibulan Negros Oriental
2013	10	25	03	01	9.27	9.884	124.082	003			4.0	Intensity IV - Lapu-Lapu City; Intensity II - San Isidro Bohol; Intensity I - Sibulan Negros Oriental
2013	10	25	16	59	48.87	9.817	123.950	007			4.6	Intensity V - San Isidro Bohol; Intensity III - Lapu-Lapu City; Tagbilaran City
2013	10	29	15	41	19.80	10.037	124.203	004	4.0	5.0	4.0	Intensity III - Cebu City; Intensity II - Lapu-Lapu City
2013	10	31	10	11	43.74	9.897	124.107	007			4.5	Intensity V- Sagbayan Bohol; Intensity IV - Mandaue City; Intensity III - Cebu City; San Isidro Bohol; Intensity II - Lapu-Lapu City
2013	11	01	07	02	47.51	9.753	123.610	011	4.1	5.2	4.3	Intensity III - Argao Cebu
2013	11	01	13	58	39.68	9.849	124.123	005	4.8	5.8	5.2	Intensity V - Talibon Bohol; Mandaue City; Intensity IV - Tagbilaran City; San Isidro Bohol; Intensity III - Dumaguete City; Intensity I - Hibok-Hibok
2013	11	01	16	08	46.27	9.899	124.068	008	4.1	5.2	4.2	Intensity V - Mandaue City; Intensity II - Cebu City; Intensity I - Lapu-Lapu City
2013	11	12	05	21	22.61	9.883	124.070	006	4.3	5.3	4.5	Intensity V - San Isidro Bohol and Mandaue City; Intensity IV - Cebu City; Intensity III – Lapu-Lapu City, Tagbilaran City, Calape and Loboc Bohol; Intensity II - Talisayan Misamis Oriental and Dumaguete City
2013	11	14	18	13	55.31	9.908	124.032	027			4.5	Intensity V - Mandaue City; Intensity IV - San Isidro Bohol; Intensity III - Tagbilaran City
2013	12	29	08	21	3.48	10.048	124.199	001	4.1	5.2	4.3	Intensity IV - Mandaue City; Intensity II - Cebu City
2014	01	03	03	45	10.43	10.205	124.183	003	4.0	5.0	4.0	Intensity III - Cebu City; Intensity I - Lapu-Lapu City

Source: PHILVOLCS

Ground Acceleration

Ground acceleration caused by earthquakes may result to great damage and destruction to property and infrastructure accompanied by loss of life. Factors that influence the intensity of ground shaking include the magnitude of the earthquake, distance of the site in relation to the earthquake generator, characteristics of the underlying rocks, and the soundness of the building. The Philippines is located near or along the so called “earthquake belt” and is prone to seismic hazards. The reason why the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the United States Geological Survey (USGS) conduct ground motion hazard mapping in terms useful to engineering design using modern probabilistic methodology. In the study, the peak horizontal ground accelerations that have a 10 % probability of being exceeded in 50 years have been uniformly estimated for rock, medium soil, and soft soil site condition. Result of the study shows an estimate on rock ranging from a low of 0.11g in Visayas to a high of 0.30g in the vicinity of Casiguran fault zone in eastern Luzon. Estimates for soft soil conditions are considerably higher and range between 0.27g for Visayas and 0.80g along the Casiguran fault zone.

The project site which, is underlain mainly by reefal limestone rock and siltstone fall under the 0.11g as shown in the delineated Acceleration Map for Rock, 0.17g for Medium Soil, and 0.27g for soft soil (**Figure 2.1.8**).

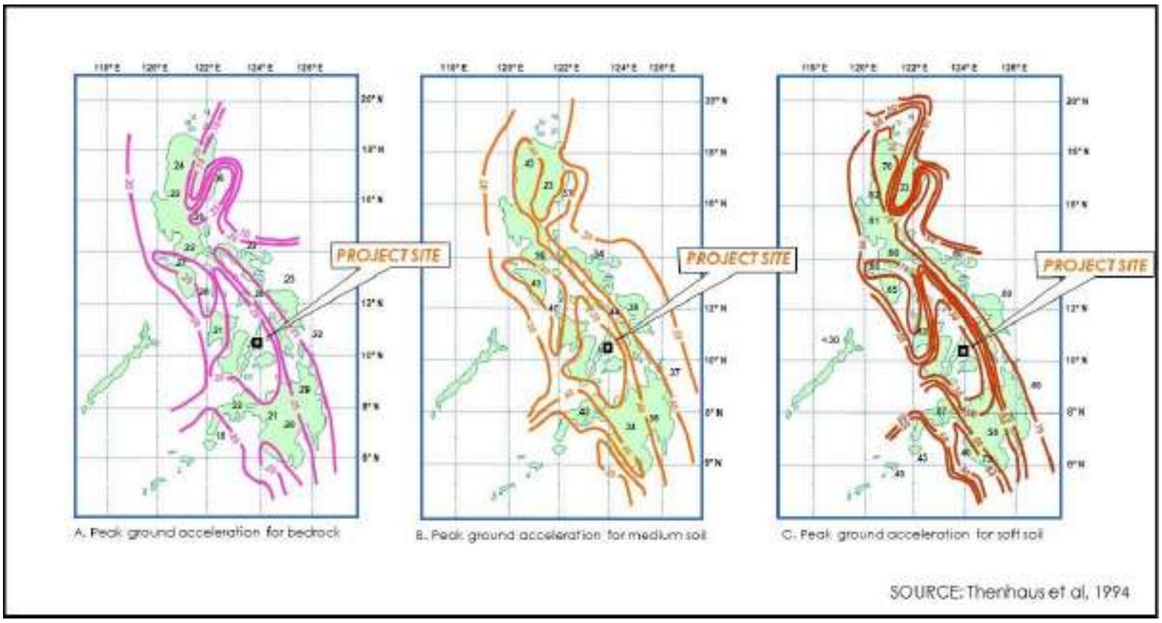


Figure 2.1.8. Maps Showing Peak Horizontal Acceleration Amplitude on Bedrock, Medium Soil and Soft Soil for the Philippine Region

Applying directly the deterministic method of Fukushima and Tanaka (1990) in determining the probable peak ground acceleration values for the project site using the following attenuation relation:

$$Log_{10}A = 0.41M - log_{10} (R + 0.032 \times 10^{0.41M}) – 0.0034R + 1.30$$

where: A= mean of the peak acceleration from two horizontal componentsat each site (cm/sec^2)
R= shortest distance between site and fault rupture (km)
M= surface-wave magnitude

Considering an earthquake magnitude of *7.5* and distance of the site of Area 1 - 6.70km, Area 2 - 3.50km and Area 3 - 5.10km from the Central Cebu Fault, the following peak ground acceleration (PGA) values were computed (**Table 2.1.4**).

Table 2.1.4: Computed Ground Acceleration

QUARRY SITE	FAULT	DISTANCE (km)	MAGNITUDE (Mw)	COMPUTED GROUND ACCELERATION (g)		
				Bedrock	Medium Soil	Soft Soil
AREA 1	CENTRAL CEBU FAULT	6.70	7.50	0.308	0.446	0.713
AREA 2	CENTRAL CEBU FAULT	3.50	7.50	0.340	0.493	0.787
AREA 3	CENTRAL CEBU FAULT	5.10	7.50	0.323	0.469	0.749

Landslide

Landslide involves the bulk transfer of masses under the influence of gravity. This is usually triggered by prolonged and heavy precipitation, ground shaking and possibly slope excavation. Mass movement such as landslides, rockfall and subsidence can cause great casualties and damages to properties. The project falls within the delineated low to moderate risk to landslide hazard map by MGB Region 7 (**Figure 2.1.9**).

There were several landslides, rockslide/rock fall prone areas identified during mapping and these include the road leading to the motor pool (east side of the active quarry) (**Plate 2.1.1**). During mine operation rocks from the quarry may fall or roll towards this location.

Note: The left portion is the east wall of the active limestone quarry. The wall has a slope face of about 70° and is prone to rock fall and or rock slide during mining.

Plate 2.1.1: Road Leading to the Motor Pool

The Old Quarry 1 has still a positive limestone reserve which could be mine in the future. If mining operation on this pit is activated the residential areas located 70m from the pit must be protected against rock fall/rock slide by putting barrier. Boulders noted at the foot of the quarry (along road) is an evidence of rock fall coming from the pit. In addition, the hanging boulder noted at right side of the quarry must be bar down to prevent accident (**Plate 2.1.2**).

The outcrop of highly weathered conglomeratic rock exposed along the road at Barangay Triumfo with slope face of about 70° to 80° is also prone to landslide and must be protected with retaining wall. (**Plate 2.1.3**). A structure tending N-NE was mapped cutting this outcrop exposure.

Plate 2.1.2: Rock Boulders Noted Along Mine Road East of Old Quarry 1, an Evidence of Rock Fall

Plate 2.1.3: Outcrop of Highly Weathered Conglomerate Rock Behaving Like Soil with Slope Face of About 75°to 80°

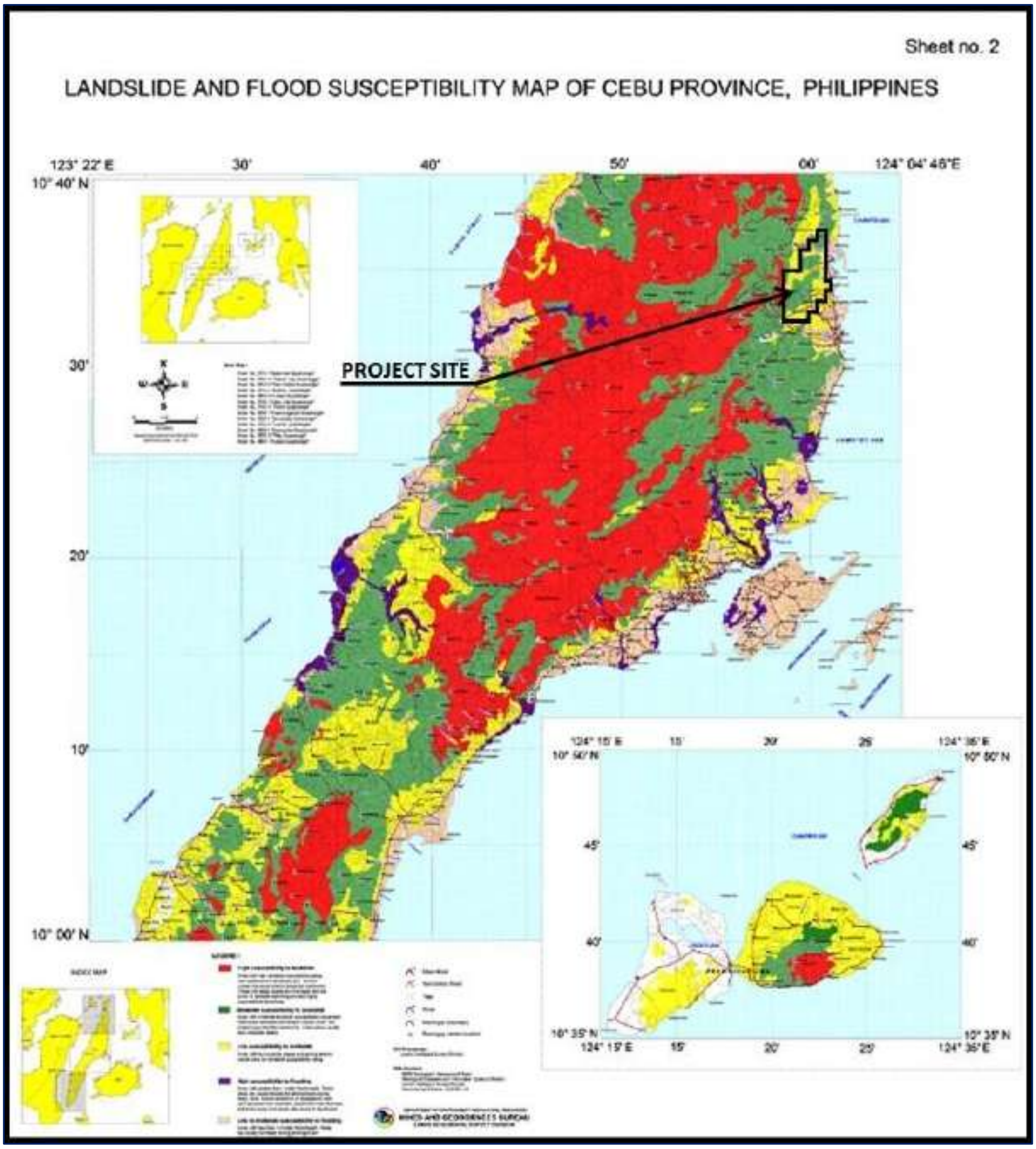
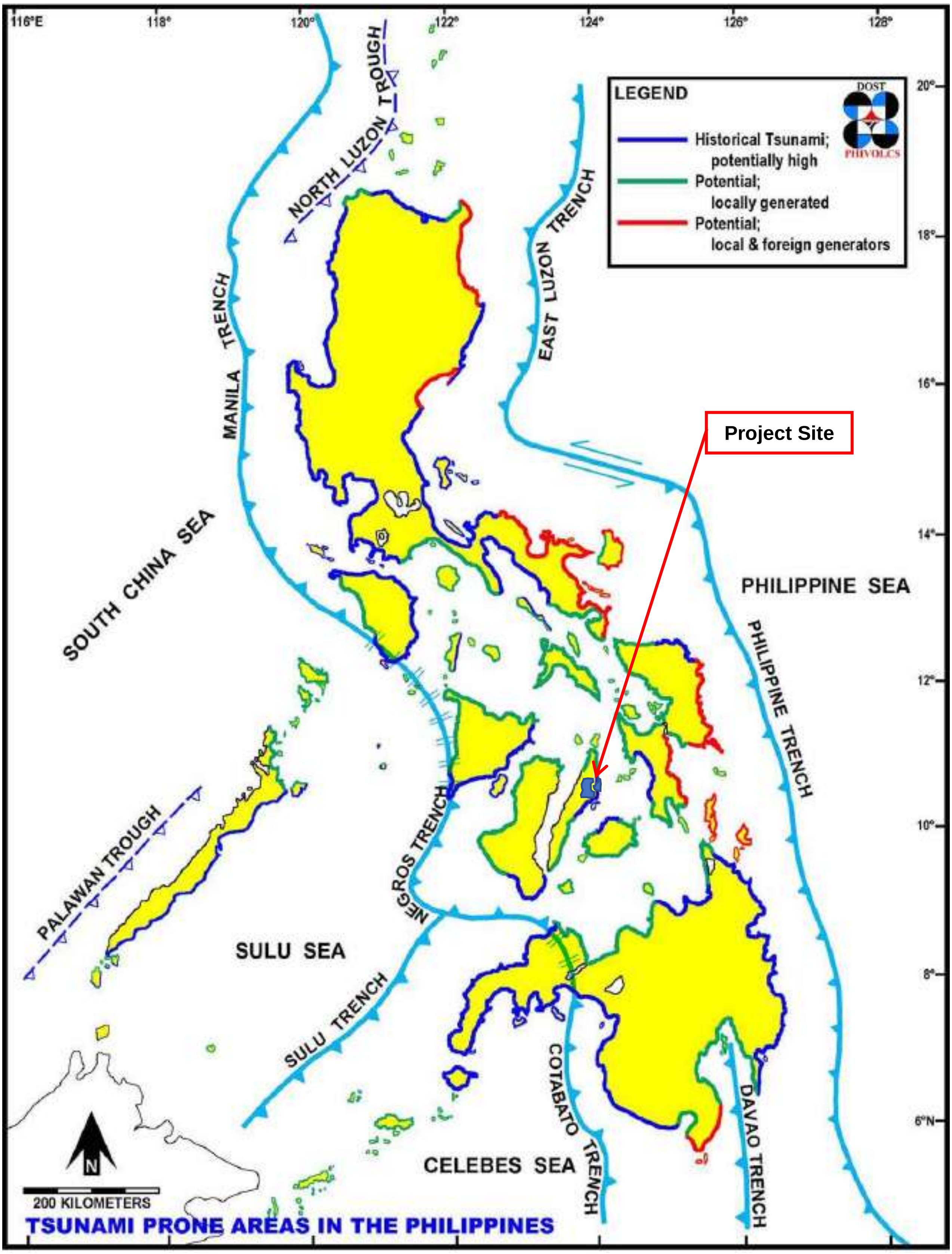


Figure 2.1.9: Landslide Prone Areas in Cebu

Tsunami

Tsunamis are high amplitude ocean waves generated by earthquakes, volcanic eruptions or other underwater explosions. Sudden displacements in the ocean floor caused by fault movements generate these large waves, which can travel over long distances. Historically, the project site has high potential to experience tsunami based on the map of Tsunami Prone Areas in the Philippines as published by PHIVOLCS (**Figure 2.1.10**).



Source: PHILVOLCS

Figure 2.1.10: Map of Tsunami Prone Areas in the Philippines

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

During quarry operation, the construction of hauling roads shall incur minor changes in the topography of the project site. Some backfilling works will be undertaken on some low areas highly susceptible to flooding.

2.1.2.5 Change in Sub-Surface Geology/Underground Condition

Since quarry operations will definitely impact the subsurface geology/underground conditions, proper quarry methodology shall be observed and practiced. Quarry operations which start with the stripping of overburden, digging/breaking/loosening the materials, clearing of vegetation particularly trees shall be covered with tree cutting permit issued by DENR.

Quarrying equipment digs, breaks and loosens the materials to produce muck before scooping and loading into the trucks. Digging hard materials will require full throttle of engine power which results to generation of exhaust smoke. Smoke emissions are lesser for brand new and slightly used equipment which has higher breakout force.

RCBM will hire a competent blasting contractor to ensure that the blasting operation will be handled by the expert. It will use appropriate blasting pattern, charging of explosives and firing sequence to limit the ground vibration that will be generated during blasting.

Deployment of brand new equipment or not too old backhoe digging equipment will eliminate/minimize the noise during travelling, digging and loading because the moving parts, such as the bushing of track shoe, bucket arm pin and hinges are still tight/no clearance for metal to metal contact. Contractors will be required to conduct regular PMS and daily applications of grease and lubricants to the moving parts of the equipment and replacement of bucket tooth.

Proper technique of digging hard materials especially in high banks will be employed to avoid boulder materials from dropping to the ground. Chipping thinly the material instead of one bucketful grab will eliminate the production of boulders. Operators will be advised to drop the first bucket load of material close enough to the dump box of the truck. Boulder materials will be mixed with fine materials to avoid the banging noise when materials drop to the dump box of the truck.

During Loading and Hauling, the materials are loaded in buckets at a height higher than the level of the dump box of the truck. The booms are slewn at appropriate swing speed to avoid fine materials to spill down from the bucket when swept by strong winds. Materials are then hauled by trucks which is the significant source of dust. Constant passage of truck tires pulverizes/mills the road surface creating fine particles that cling onto the thread of tires, and as tire rolls, fine particles will be ejected by the momentum of the speeding trucks; and when swept by strong winds, will be dispersed as dust. Smoke emissions are common to old and dilapidated hauling trucks.

Upon loading of the blasted materials to the dump trucks, it will be transported to crusher traversing a 4.5-kilometer inner road. Dust dispersal during loading can be minimize by observing proper loading procedure of dropping the first bucket load at same level with the dumb box, avoid overfilling of bucket and reduce speed when slewing the bucket to drop the load. Conduct regular dust suppression of the loading bay and hauling road by wetting/sprinkling with water using water truck. Regular maintenance and PMS schedule of hauling trucks will be enforced to lessen the smoke emission. Trucks more than fifteen (15) years will be grounded.

2.1.2.6 Inducement of Subsidence, Liquefaction, Landslide, Mud/Debris Flow, etc.

The natural hazards which can potentially affect the project are the earthquake related hazards and landslides. The design and construction of the structures and foundation of the facilities comply with the provisions of the National Building Code and the Structural Code of the Philippines, and international standards based on the geotechnical and seismicity studies to eliminate/minimize impacts of earthquake related hazards. Coordination with the PHIVOLCS during earthquake events will be made in order to make adjustments including assessment of possible damages to the structures. In case of the emergency, emergency escape route, early warning system, as well as emergency power supplies were installed to ensure continued operation of vital services during emergencies. Earthquake drills will also be conducted annually. Emergency Response Plan is also implemented

2.1.3 Pedology

2.1.3.1 Soil Type

According to the Provincial Planning and Development Office, Province of Cebu, Nov 2008, thirteen kinds of soils textures can be found in the province of Cebu. These are the Cebu Hydrosol (7,650 ha); Mandaue Clay (28,220 ha); Mandaue Silt Loam (13,708 ha); Medellin Clay (7,710 ha); Beach Sand (1,660 ha); Faraon Clay (62,425 ha); Faraon Clay Steep Phase (87,516 ha); Bolinao Clay (58,575 ha); Bolinao Clay Steep Phase (23,500 ha); Lugo Clay (98,321 ha); Baguio Clay Loam (96,336 ha); Mantalongon Clay (20,222 ha); Area of Unclassified Islets (2,996 ha). The overlying residual soils at the project site comprise mixed deposits of sand, gravel and clay.

Soil Profile

Flat to undulating terrain characterize the exploration area, with flatlands along the coast becoming rugged inland. Altitudes range from a minimum of 10 meters above sea level in the east side to about 680 masl (Danao Peak) in the west. Soil cover is expected to be thin in the area, which is characteristic of most limestone areas in the Philippines. Soils are commonly undiff erentiated hill soils. General soil types in the project area are the Cebu hydrosol, Mandaue clay loam, Baguio clayloam, Faraon clay and Faraon clay steep phase.

There are four (4) different types of soil series in RCBMI Danao (Table 16 and Map 6). Among these, the most dominant soil series in the area is Faraon clay (steep phase) comprising around 66% with a total area of 1,675 hectares. Additionally, this is typically found at the northwest portion of RCBMI Danao. Moreover, this soil series is only distributed in the provinces of Cebu, Leyte, Negros Occidental, and Negros Oriental. Further, the Faraon clay is the second largest coverage constituting about 31%. Conversely, only a small portion of the area is underlain by Mandawe clay loam and Baguio clay loam comprising only 3% and 0.21%, respectively. The general characteristics of these soil series were described in the World Soils Book Series' the Soils of the Philippines (Carating et al. 2014) as follows:

Baguio series. It was initially described in the north central Cebu. The characteristics of the surface soil is brown to dark brown clay loam, and moderately compact. The series is also sticky when wet and slightly friable when most, and hard when dry. It is usually vegetated with primary and secondary forests, and cogon.

Faraon series. The soil is typically black and clayey occurring on rolling to hilly relief. The limestone rocks are usually soft, coarsely angular, and colored. The soil depth ranges from 15 to 30 centimeters from the surface. The subsoil varies from dark yellowish gray to light gray, grayish black to dark gray coarse to moderately fine clay. The primary land uses are for corn, sugarcane, coconut, plantation crops, vegetables, and root crops.

Table 2.1.3.1.1: Soil Series of RCBM Danao

Soil Series	Area (ha)	Percentage (%)
Baguio clay loam	5.45	0.21
Faraon clay	794.12	31.13
Faraon clay (steep phase)	1,675.17	65.67
Mandawe clay loam	76.29	2.99
Grand Total	**2,551.03**	**100.00**

The dominant soil series is greatly found in Barangay Cahumayan with 404 hectares and Ipil with 252 hectares (Table 2.1.3.1.2). Additionally, it is observed in all covered areas of Carmen. Moreover, the Baguio clay loam is solely situated at Barangay Lapniga with about 6 hectares. Furthermore, Mandawe clay loam is also located in few areas such as Barangay Dawis Sur and Barangay Dunggoan.

Table 2.1.3.1.2: Soil Series per barangay of RCBM Danao

Municipality /City/Barangay	Soil				Grand Total
	Baguio clay loam	Faraon clay	Faraon clay (Steep phase)	Mandawe clay loam	
Carmen	**5.45**	**155.18**	**933.31**	**60.42**	**1,154.35**
Baring			133.73		133.73
Cantipay			107.00		107.00
Cantumog			18.02		18.02
Cogon East			8.69		8.69
Cogon West		0.96	28.79		29.74
Corte			39.72		39.72
Dawis Norte		24.05	92.97		117.02
Dawis Sur		121.40	17.64	60.42	199.46
Hagnaya			1.11		1.11
Ipil			251.94		251.94
Lanipga	5.45		28.78		34.23
Poblacion		8.77	56.42		65.19
Puente			1.51		1.51
Triumfo			147.00		147.00
Danao City	**-**	**638.94**	**741.86**	**15.87**	**1,396.67**
Binaliw		143.81	1.58		145.39
Cagat-Lamac		34.78	140.22		175.00
Cahumayan		53.02	403.57		456.58
Cambanay		78.99	6.62		85.61
Dungga			35.41		35.41
Dunggoan		116.94		15.87	132.81
Guinacot		0.01			0.01
Magtagobtob			6.90		6.90
Malapoc		12.53			12.53
Masaba		6.17			6.17
Pili			44.47		44.47
Quisol		173.97			173.97
Sandayong Norte			57.36		57.36
Santa Rosa		18.72			18.72
Santican			45.73		45.73
Grand Total	**5.45**	**794.12**	**1,675.17**	**76.29**	**2,551.03**

2.1.3.2 Soil Erodibility

Soil erosion may occur during development and operations stages because of the cut and fill activities that may be undertaken and the actual quarrying/mining of the project site. Improper mining methodology and indiscriminate disposal of fill materials and excavated soils may also affect erosion patterns. To mitigate such impacts, the following mitigation measures are recommended:

- Implement best engineering practices such as suitable backfilling material, proper slope, grading and contouring to minimize possibility of subsidence or
- Differential settling; and

- Progressive ground preparation and clearing to minimize total area of land that will be disturbed at any one time, where practical.

2.1.3.3 Soil Quality and Fertility

No annual monitoring of soil quality is being undertaken because the Cement Finish Mill Plant and quarry operations do not use chemicals that will affect the quality of the soil. However, soil sampling was conducted in November 2018 to investigate the elements, particularly heavy metals, which are present in the soil matrix within the project site. Heavy metals are a special concern since these substances are hazardous, even in small amounts and have a potential to contaminate the surrounding environment. Also, the aspects of soil erosion/soil quality/fertility were taken into consideration as there are some farming activities ongoing at the project site. Soil quality test was conducted at the project site using Swedish EPA Generic Guideline Value for Soil (2009), as there are no standards under the Philippine law.

Heavy metals such as mercury, arsenic, cadmium and lead as well as hexavalent chromium, potassium, phosphorus, total organic matter, total nitrogen and pH were tested. Results of soil sampling were compared with Swedish EPA Generic Guideline Value for Soil (2009) for hexavalent chromium, potassium, phosphorus, total organic matter, total nitrogen and pH. This sampling and analysis were undertaken to determine whether soil require urgent remediation due to unmitigated contamination. Although all of the parameters were detected in the Project area, they are all below the Dutch target values and Swedish EPA Generic Guideline Value for Soil (**Table 2.1.5**). This shows that pedology is still unaffected by heavy metal contamination. Although the present DENR-EMB guideline does not have a definitive acceptable standard or limits on the presence of heavy metals on soils. Details of Soil Test is provided in **Annex 2.2**.

The results on current soil baseline information will not be affected with the project implementation because the project will not use chemicals which may contaminate the soil of the Plant. The project site will maintain the same soil quality.

Table 2.1.5: Soil Quality Test Results

Parameters	Results	Swedish EPA Generic Guideline Value for Soil (2009)	
		Sensitive Land Use	Less Sensitive Land Use
Total Mercury	ND	0,25	2,5
Total Arsenic	4.6	10	25
Total Cadmium	1	0,8	12
Total Lead	12	50	400
Hexavalent Chromium	ND	2	10
Potassium	2,210	No standards	No standards
Total Phosphorus	591	No standards	No standards
Toal Organic Matter	2.45	No standards	No standards
pH** Lab (@ 25.0°C)	8.0	No standards	No standards
Total Nitrogen	1,170	No standards	No standards

Note: ND – Not Detected (Below Reporting Limit)

As to Soil Acidity/Alkalinity Level & Nutrient Composition, Soil Organic Matter Content (%), Available Potassium Content (Avail K) and Available Phosphorus Content (Avail P) according to the Regional Soils Laboratory, following figures illustrate these for Cebu province:

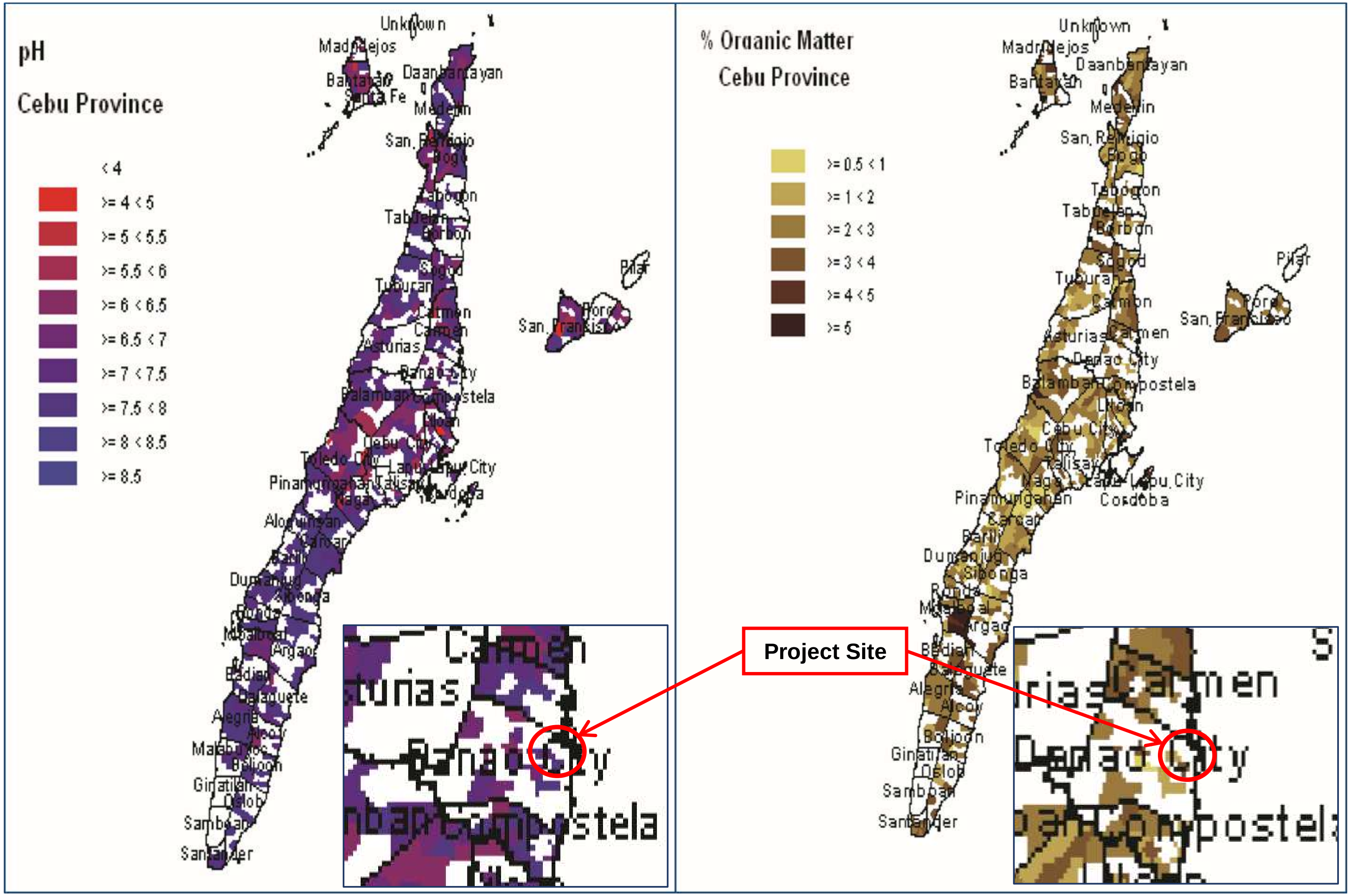


Figure 2.1.11: Soil Acidity/Alkalinity and Soil Organic Matter Content (%) of Soils in Cebu

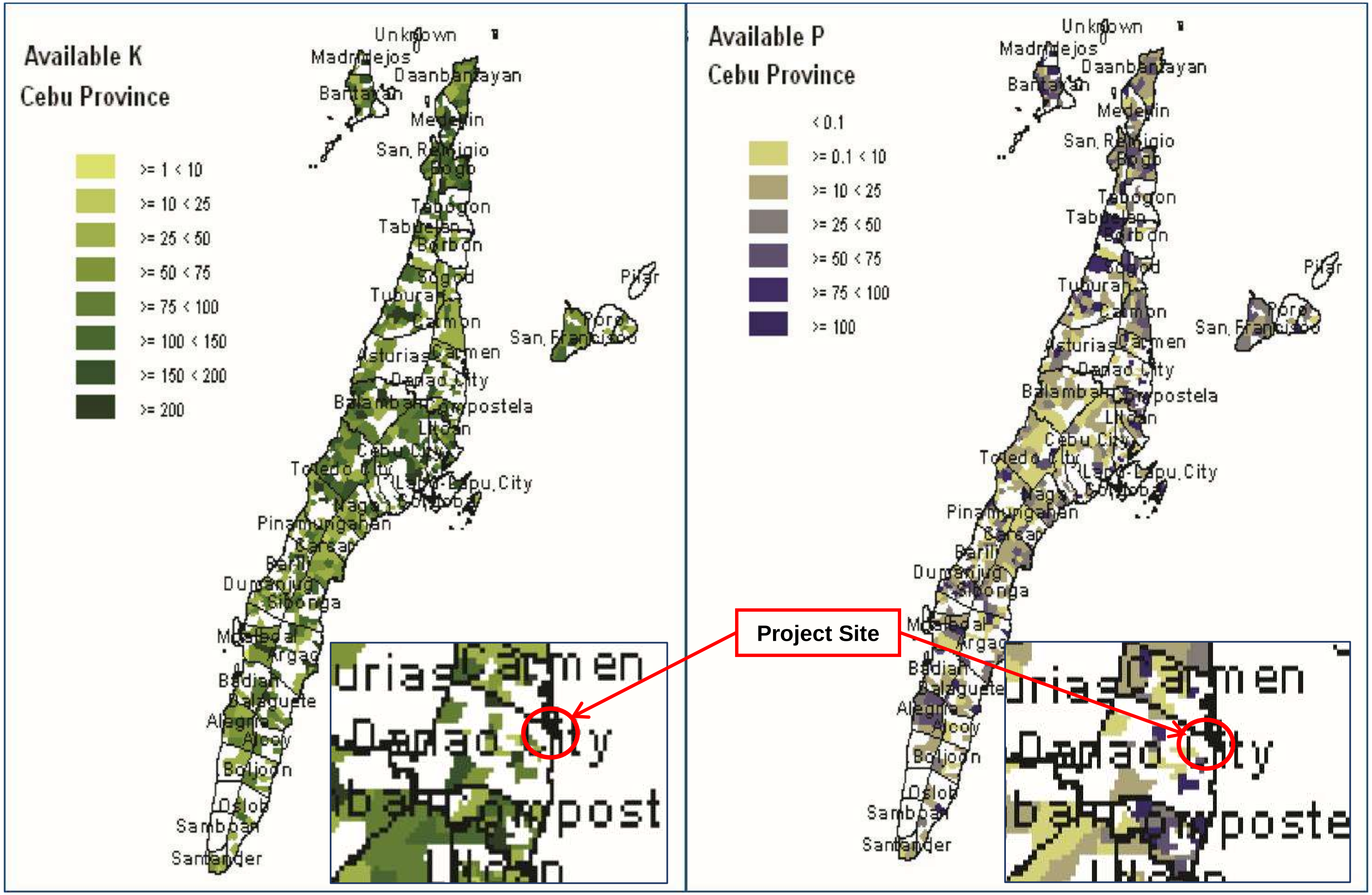


Figure 2.1.12: Available Potassium (Avail K) and Phosphorous (Avail P) Contents of Soils in Cebu

2.1.3.4 Soil Erosion/Loss of Topsoil/Overburden

There will be no soil erosion nor loss of topsoil/overburden involved in this project as far as cement mill operations is involved. However, soil erosion and loss of topsoil/overburden during quarry operations at the MPSA area are likely to occur. Backfilling will be undertaken as well as proper mining operations methods and procedures will be implemented to avoid soil erosion on site.

2.1.3.5 Change in Soil Quality/Fertility

The aspects of soil erosion/soil quality/fertility are not relevant for the project site which is dedicated to cement manufacturing operations and wherein no agricultural activities are undertaken and no land conversion is necessary.

With the implementation of the project, it is presumed that soil quality will not be significantly affected because the cement mill process nor the mining operations will not involve the use of chemicals which may contaminate the soil. In case of project abandonment, proper soil remediation measures will be implemented on case soil contamination of used oil will be determined.

2.1.4 Terrestrial Ecology

2.1.4.1 Terrestrial Flora

Terrestrial flora survey was conducted on May 26, 2017 at the established sampling stations in Barangay Dunggoan, Danao City where quarry area and cement finish mill plant are located. Sampling stations were established with reference the corner points of the project area, land use or existing vegetation, and access point. Areas that were surveyed include brushland and agricultural areas mostly planted to Moringa species intercropped with corn.

Reconnaissance survey was conducted within the direct impact area to gather initial impression in terms of floral composition/assemblage (i.e. homogenous or heterogeneous plant community) and ecosystem type as well as the overall condition of the area such as topography and aspect, soil characteristics, presence of water tributaries (creeks and/or gullies), and other physical attributes relevant to floral assessment. This was done to determine appropriate actions/ methods to be employed for primary data gathering.

Terrestrial flora survey was conducted using Quadrat Sampling Method with 20m x 20m (400m^2) dimensions established on the ground along the transect walk/line with either ridges, trails, and gullies as access point. Floral inventory involves characterizing and assessing floral assemblages (i.e. agricultural, grassland, brushland, and forest plantation ecosystems) to approximate the relativities of densities, frequencies, dominance, and importance values of each species and plant community or ecosystem within the study area. Plant species and plant form/habit were identified and recorded in-situ following the scientific standard of taxonomic nomenclatural and classification system. Other relevant information pertaining such as endemicity, conservation status, and economic importance/ use were recorded. **Table 2.1.6** and **Figure 2.1.13** present the sampling stations for terrestrial flora survey.

Table 2.1.6: Sampling Stations for Terrestrial Flora Survey

Sampling Stations	Coordinates	
	Latitude	Longitude
Station 1	N 10°33'32.60"	E 124°00'56.60"
Station 2	N 10°33'31.90"	E 124°01'00.79"
Station 3	N 10°33'35.82"	E 124°00'59.80"
Station 4	N 10°33'34.62"	E 124°01'01.97"
Station 5	N 10°33'36.46"	E 124°01'05.27"
Station 6	N 10°33'40.08"	E 124°01'05.72"

Sampling Stations	Coordinates	
	Latitude	Longitude
Station 7	N 10°33'38.34"	E 124°01'03.14"
Station 8	N 10°33'09.99"	E 124°01'01.39"
Station 9	N 10°33'46.20"	E 124°00'45.20"
Station 10	N10°33'45.10"	E 124°00'43.10"
Station 11	N 10°33'33.90"	E 124°00'47.80"
Station 12	N 10°33'33.00"	E 124°00'40.10"
Station 13	N 10°33'30.70"	E 124°00'41.9"

Note: Coordinates were taken using Garmin GPSmap 60CSx

Source: Mediatrix Business Consultancy, 2017

Figure 2.1.13: Map showing the Sampling Stations for Flora and Fauna Assessment

For computing the relative indices, measures of absolute and relative abundance were used to assess the distribution of each species to a community. These measures include the relativities of density, frequency, dominance, and importance values which illustrates how the indices changes relative to the number species in a given sampling station. Below are the formulas used to determine the indices of each species in a given sampling stations:

i. $Relative\ Density\ (RD), in\ \% = \frac{Number\ of\ Individuals\ in\ a\ Species}{Total\ Area\ Sampled}\ x\ 100\%;$

ii. $Relative\ Frequency\ (RF), in\ \% = \frac{Number\ of\ Samples\ in\ which\ Species\ Occur}{Total\ Number\ of\ Sampling\ Plots}\ x\ 100\%;$

iii. $Relative\ Dominance\ (RDom), in\ \% = \frac{Total\ Basal\ Area\ of\ Species}{Total\ Area\ Sampled}\ x\ 100\%;$

iv. $Importance\ Value\ Index\ (IVI)\ = \sum(RD + RF + RDom)$

For diversity measurements, the Shannon-Weiner Diversity Index was used to estimate habitat quality of each sampling stations. This method is one of the most widely used for computing species diversity index for examining the overall community characteristics comparing two or more distinct habitats. Measurement of diversity is significant and important in determining the quality of every ecological system. Shannon-Weiner Biodiversity Index was used to compute the biodiversity levels of each ecosystem. The Shannon Index is a measure of the average of “uncertainty” in predicting to what species an individual chosen at random from a collection of *S* species and *N* individuals will belong (Magurran, 1998). The indices could later be used as an indicator of biodiversity loss or gain when used as monitoring tools. Below is the formula for Shannon-Weiner Biodiversity Index:

$$\boldsymbol{H'} = -\sum_{i=0}^{S}[(\boldsymbol{pi})\,\boldsymbol{ln}(\boldsymbol{pi})],$$

where;
$\boldsymbol{H'}$, represents the symbol for the amount of diversity in ecosystem;
$\boldsymbol{pi}$, represents the proportion or relative abundance of each individual species to the total (measured from 0 to 1); and
$\boldsymbol{ln\ pi}$, represents the natural logarithm of $\boldsymbol{pi}$

The uncertainty of occurrence increases both as the number of species increases and as the individuals are distributed more and more evenly among the species already present. Using Fernando Biodiversity Scale (1998), Shannon Biodiversity Index may result in diversity value (H) ranging from zero indicating low community complexity to 3.5 and above which indicates very high community complexity. **Table 2.1.4** presents the Fernando Biodiversity Scale (1998) which indicates the level of community complexity.

The maximum possible species diversity (H_{max}) for a community of *S* species would be the condition where the individuals composing the community were evenly distributed among all *S* species. This is the condition of maximum evenness. Species evenness can be calculated by dividing the species diversity of the community (H’) by the maximum possible diversity for the community denoted by $J=H/H_{max}$ when $H=H_{max}$ the community has reached its maximum diversity. The value of J will approach zero (0) as the community becomes dominated by a single species. This means that diversity is decreasing. The formula for species evenness then, $J = H/H_{max} = -\sum(p_i)\ (\ln p_i) / \ln S$, where *S* is the number of species in the community. **Table 2.1.7** shows the Fernando Biodiversity Scale following the Shannon-Weiner Biodiversity Index and Pielou Evenness Index indicating the level of community complexity.

Table 2.1.7: The Fernando Biodiversity Scale, 1998

Relative Values	Shannon Biodiversity (H’) Index	Pielou (J’) Evenness Index
Very High	3.5 and above	0.75-1.00
High	3.0 – 3.49	0.50-0.74
Moderate	2.5 – 2.99	0.25-0.49
Low	2.0 – 2.49	0.15-0.24
Very Low	1.9 and below	0.05-0.14

On determining the endemicity/conservation status of the each species, the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species was used. The IUCN Red List is the world’s most comprehensive inventory of the global conservation status of biological species. The Red List is set upon precise criteria to evaluate the extinction of thousands of species and subspecies. The aim of the Red List is to convey the urgency of conservation issues to the public and policy-makers, as well as help the international community to try to reduce species extinction. It is aimed to provide scientifically based information on the status of species and subspecies at a global level; draw attention to the magnitude and importance of threatened biodiversity; influence national and international policy and decision-making; and provide information to guide actions to conserve biological diversity. Plants and animals assessed for the IUCN Red List are the bearers of genetic diversity and the building blocks of ecosystems, and information on their conservation status and distribution provides the foundation of making informed decisions about conserving biodiversity from local to global levels. This system is designed to determine the relative risk of extinction and the main purpose of the Red List is to catalogue and highlight those plants and animals that are facing a higher risk of extinction either those listed in **Table 2.1.8**. In addition, the DENR Administrative Order 2017-11 “Establishing the National List of Threatened Philippine Plant and Their Categories, and the List of Other Wildlife Species" was also used pursuant to Section 22 of Republic Act No. 9147, otherwise known as the Wildlife Conservation and Protection Act of 2001.

Table 2.1.8: IUCN Categories

Conservation Status/ Categories	International Union for the Conservation of Nature (IUCN)	DENR Administrative Order 2017-11
EXTINCT (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died.	Not defined.
EXTINCT IN THE WILD (EW)	A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.	Not defined.
CRITICALLY ENDANGERED (CR)	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.	Refers to species, subspecies, varieties, or other infraspecific categories facing extremely high risk of extinction in the wild in the immediate future.
ENDANGERED (EN)	A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.	Refers to species, subspecies, varieties or forma that is critically endangered but whose survival in the wild is unlikely if the causal factors continue operating.
VULNERABLE (VU)	A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.	Refers to a species or subspecies, varieties, formae or other infraspecific categories of plant that is not critically endangered nor endangered but is under threat from adverse factors throughout its range and is likely to move to the endangered category in the future. This shall include varieties, formae or other infaspecific categories.
LOWER RISK (LR)	A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:	Not defined.
	a. Conservation Dependent (CD). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.	Not defined.
	b. Near Threatened (NT). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.	Not defined.
	c. Least Concern (LC). Taxa which do not qualify for Conservation Dependent or Near Threatened.	Not defined.
DATA DEFICIENT (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology is well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.	Not defined.
NOT EVALUATED (NE)	A taxon is Not Evaluated when it has not yet been assessed against the criteria.	Not defined.

Source: (1) International Union for the Conservation of Nature Red List of Threatened Species (www.iucn.org)
(2) DENR Administrative Order 2017-11 "Updated National List of Threatened Philippine Plants and Their Categories". 02 May 2017.

2.1.4.1.1 Flora Composition/Plant Community

A total of 76 species of flora representing 69 genus and 40 families were recorded in the study area. In terms of number of representative species, the three (3) largest plant families are MORACEAE with nine (9) individuals or 11.84% of the total number of species recorded followed by POACEAE with seven (7) individuals or 9.21% and ANACARDIACEAE, ANNONACEAE, ASTERACEAE, and EUPHORBIACEAE, each with four (4) individuals or 5.26% of the total number of species (**Table 2.1.9**).

Table 2.1.9: List of Families and Number of Individuals Recorded in the Study Area

Families	No. of Individuals	Percent (%) of Total
1. ANACARDIACEAE	**4**	**5.26**
2. ANNONACEAE	**4**	**5.26**
3. APOCYNACEAE	1	1.32
4. ARACEAE	1	1.32
5. ARECACEAE	2	2.63
6. ASPLENIACEAE	1	1.32
7. ASTERACEAE	**4**	**5.26**
8. BURSERACEAE	1	1.32
9. CAESALPINIACEAE	1	1.32
10. CARICACEAE	1	1.32
11. CLUSIACEAE	2	2.63
12. COMMELINACEAE	1	1.32
13. CONVULVULACEAE	1	1.32
14. CYPERACEAE	1	1.32
15. EBENACEAE	1	1.32
16. EUPHORBIACEAE	**4**	**5.26**
17. FABACEAE	3	3.95
18. LAMIACEAE	2	2.63
19. LAURACEAE	2	2.63
20. LECYTHIDACEAE	1	1.32
21. LEEACEAE	1	1.32
22. MALVACEAE	1	1.32
23. MORINGACEAE	1	1.32
24. MELIACEAE	2	2.63
25. MIMOSACEAE	2	2.63
26. MORACEAE	**9**	**11.84**
27. MUSACEAE	1	1.32
28. MYRTACEAE	1	1.32
29. OLEACEAE	1	1.32
30. OXALIDACEAE	1	1.32
31. POACEAE	**7**	**9.21**
32. PTERIDACEAE	1	1.32
33. RUTACEAE	2	2.63
34. SAPINDACEAE	1	1.32
35. SAPOTACEAE	2	2.63
36. SCHIZACEAE	1	1.32
37. STERCULIACEAE	1	1.32
38. TILIACEAE	1	1.32
39. ULMACEAE	1	1.32
40. URTICACEAE	1	1.32
TOTAL	**76**	**100.00**

In terms of species population, the most number of individuals recorded in all the study area is cogon *(Imperata cylindrica)* with 92 individuals; seconded by hagonoi *(Chromolaena odorata)* with 89 individuals; third in rank is centrocema *(Centrocema virginianum)* with 88 individuals; fourth is kulot-kulotan *(Triumfetta bartamia)* with 79; and fifth is bokaui *(Crytochloa fenixii)* with 72 individuals. All of these species are commonly found in open areas or grassland areas with poor soil condition (**Table 2.1.10**).

Table 2.1.10: List of Species and Number of Individuals Recorded in the Study Area

Family Name	Common Name	Scientific Name	Total No. of Individual	Percentage (%)
ANACARDIACEAE	1. Mango	*Mangifera indica*	23	1.68
	2. Ligas	*Semeicarpus cuneiformis*	7	0.51
	3. Lamio	*Dracontomelon edula*	2	0.15
	4. Balinghasai	*Buchanania arborescens*	3	0.22
ANNONACEAE	5. Anolang	*Papualthia lanceolata*	18	1.31
	6. Bagang-aso	*Anaxagorea luzoniensis*	4	0.29
	7. Anonas	*Annona muricata*	1	0.07
	8. Amuyong	*Goniothalamus amuyon*	4	0.29
APOCYNACEAE	9. Pandakaki	*Tabernaemontana pandacaqui*	3	0.22
ARACEAE	10. Yautia	*Xanthostoma violaceum*	17	1.24
ARECACEAE	11. Palasan	*Calamus merrillii*	10	0.73
	12. Coconut	*Cocos nucifera*	7	0.51
ASPLENIACEAE	13. Pakpak lawin	*Asplenium musae*	3	0.22
ASTERACEAE	14. Hagonoy	*Chromolaena odorata*	89	6.5
	15. Sambong	*Blumea balsamifera*	14	1.02
	16. Coronitas	*Lantana camara*	21	1.53
	17. Aluka	*Acmella uliginosa*	2	0.15
BURSERACEAE	18. Pagsahingin	*Canarium asperum*	7	0.51
CAESALPINIACEAE	19. Sampalok	*Tamarindus indica*	5	0.36
CARICACEAE	20. Papaya	*Carica papaya*	23	1.68
CLUSIACEAE	21. Bitaog	*Callophyllum inophyllum*	1	0.07
	22. Salinggogon	*Cratoxylum sumatranum*	8	0.58
COMMELINACEAE	23. Alikbangon	*Commelia spp.*	1	0.07
CONVULVULACEAE	24. Kakalaknit	*Merremia vitifolia*	3	0.22
CYPERACEAE	25. Mutha	*Cyperus rotundus*	22	1.61
EBENACEAE	26. Kamagong	*Diospyrus philippensis*	2	0.15
EUPHORBIACEAE	27. Binunga	*Macaranga tanarius*	36	2.63
	28. Hamindang	*Macaranga bicolor*	18	1.31
	29. Kamoteng kahoy	*Manihot esculenta*	18	1.31
	30. Banato	*Mallotus philippensis*	12	0.88
FABACEAE	31. Centrocema	*Centrocema virginianum*	88	6.42
	32. Kakawate	*Gliricidia sepium*	18	1.31
	33. Payang-payang	*Desmodium pulchellum*	16	1.17
LAMIACEAE	34. Lingo-lingo	*Viticipremna philippinensis*	1	0.07
	35. Molave	*Vitex parviflora*	2	0.15
LAURACEAE	36. Sablot	*Litsea glutinosa*	7	0.51
	37. Malabonga	*Notaphoebe malabonga*	4	0.29
LECYTHIDACEAE	38. Lamog	*Planchonia spectabilis*	2	0.15
LEEACEAE	39. Amamali	*Leea guineensis*	1	0.07
MALVACEAE	40. Kulot-kulotan	*Triumfetta bartamia*	79	5.77
MELIACEAE	41. Mahogany	*Sweitenia macrophylla*	19	1.39
	42. Bayanti	*Aglaia rimosa*	2	0.15
MIMOSACEAE	43. Ipil-ipil	*Leucaena leucocephala*	34	2.48
	44. Makahiya	*Mimosa pudica*	6	0.44
MORACEAE	45. Hauili	*Ficus septica*	31	2.26

Family Name	Common Name	Scientific Name	Total No. of Individual	Percentage (%)
	46. Antipolo	*Artocarpus blancoi*	10	0.73
	47. Niog-niogan	*Ficus bengalensis*	46	3.36
	48. Is-is	*Ficus ulmifolia*	37	2.7
	49. Apanang	*Neotrewia cumingii*	7	0.51
	50. Malatibig	*Ficus satterhwaitei*	3	0.22
	51. Aplas	*Ficus irisana*	14	1.02
	52. Kalios	*Sterblus asper*	9	0.66
	53. Anubing	*Artocarpus ovatus*	21	1.53
MORINGACEAE	54. Malungai	*Moringa oleifera*	5	0.36
MUSACEAE	55. Banana	*Musa sapientum*	23	1.68
MYRTACEAE	56. Guava	*Psidium guajava*	5	0.36
OLEACEAE	57. Karaksan	*Linoceria ramiflora*	1	0.07
OXALIDACEAE	58. Kamias	*Averrhoa bilimbi*	3	0.22
POACEAE	59. Grass spp.	*Hyparrhenia diplandra*	42	3.07
	60. Cogon	*Imperata cylindrica*	92	6.72
	61. Para grass	*Brachiaria mutica*	63	4.6
	62. Bikal	*Dinochloa acutiflora*	52	3.8
	63. Bokaui	*Cyrtochloa fenixii*	72	5.26
	64. Goose grass	*Eleusine indica*	51	3.72
	65. Buho	*Schizostachyum lumampao*	32	2.34
PTERIDACEAE	66. Alambrillong gubat	Adiantum caudatum	11	0.8
RUTACEAE	67. Kalomata	*Clausena brevistyla*	1	0.07
	68. Kalomata	*Clausena brevistyla*	1	0.07
SAPINDACEAE	69. Uas	*Harpullia arborea*	1	0.07
SAPOTACEAE	70. Betis	*Madhuca betis*	1	0.07
	71. Caimito	*Chrysophyllum cainito*	1	0.07
SCHIZACEAE	72. Nito	*Lygodium flexuosum*	35	2.55
STERCULIACEAE	73. Bayok-bayokan	*Pterospermun niveum*	1	0.07
TILIACEAE	74. Datiles	*Muntingia calabura*	5	0.36
ULMACEAE	75. Anabiong	*Trema orinetalis*	25	1.82
URTICACEAE	76. Dalunot	*Pipterus arborescens*	6	0.44
		Total	**1,370**	**100.00**

The 76 species recorded in the study area belong to a different plant form or habit. Epiphyte and fern consists of one (1) individual each of families PTERIDACEAE and FABACEAE, respectively. Grass consists of seven (7) species belonging to seven (7) genera of the family POACEAE, while herbs composed of 13 species and 13 genera and 11 families. Palms consists of two (2) species belonging to family ARECACEAE, six (6) species of shrubs with six (6) genera and six (6) families, two (2) species of vines belonging to two (2) families, and 44 species of trees with 37 genus and 23 families with family MORACEAE with nine (9) species (**Table 2.1.11**).

Table 2.1.11: Distribution of Species Based on Plant Habit/Form

Plant Habit/Form	No. of Species	No. of Genus	No. of Family
Epiphyte	1	1	1
Fern	1	1	1
Grass	7	7	1
Herb	13	13	11
Palm	2	2	1
Shrub	6	6	6
Tree	44	37	23
Vine	2	2	2
Total	**76**	**69**	**26**

The floral composition/association, open/grassland area dominates the land use classification of the study area. Of the eight sampling stations, five (5) stations are considered open / grassland area while the rest are found in patches of secondary growth forest. Most of the grassland vegetation are generally covered with cogon and other associated species such as centrocema and hagonoy. The other type of vegetation consists of second growth forest are usually situated in gullies and creeks. The most common species observed in the second growth forest belongs to *Ficus* species. *Ficus* species are good indicator on the presence of water as they conserve water during wet season and eventually release them during dry season. In addition, a number of wildlife species benefits from *Ficus* for food and shelter. These species, along with other pioneer species are also indicators that the area is undergoing a seral succession stage wherein pioneer species tends to dominate the original vegetation.

2.1.4.1.2 Relative Density, Relative Frequency, Relative Dominance, and Importance Value

Measures of absolute and relative abundance are used to assess the contribution of each species to a community. These measures include density, the number of individuals within a chosen area; **relative density**, the density of one species as a percentage of total density; **frequency**, the percentage of total quadrats or points that contains at least one individual of a given species; **relative frequency**, the frequency of one species as a percentage of total frequency; **dominance**, the total basal area of a given species per unit area within the community; **relative dominance**, the dominance of one species as a percentage of total dominance; and **importance value**, expressed as the relative contribution of a species to the entire community expressed as a combination of relative density, relative frequency, and relative dominance.

Each measure offer a different insight into the abundance of the species composing a community. Density tells us the number of individuals per unit area but density is not necessarily proportional to dominance because dominance for a given species expresses the area occupied by the species per unit area. A species composed of primarily large individuals can have high dominance but it will likely have low density, and unless regularly distributed, it will also have low frequency. Frequency, which is often independent of density, expresses one measure of the distribution of individuals within the community. A clumped species can have high density but also low frequency because it occurs in a limited portion of the community. In contrast, a species that is individually and regularly distributed over the landscape will have a high frequency but can have low density. Relative importance, as a combination of relative values for density, frequency, and dominance, is used as a summary of the influence that an individual species may have within the community. Recognize that two species with the same relative importance can have markedly different values for relative density, frequency, or dominance as any differences can be overshadowed by the addition process.

2.1.4.1.3 Broadleaves Community

The top 10 species with the highest importance value are Mangifera indica (33.18%), Ficus ulmifolia (13.00%), Artocarpus blancoi (11.25), Macaranga tanarius (11.22%), Leucaena leucocephala (8.84%), Ficus septic (8.29%), Ficus nota (8.00%), Macaranga bicolor (6.24%), Papualthia lanceolata (5.55%), and Artocarpus ovatusb (5.54%). Mangifera indica, having the highest importance value is said to occupy the large portion of the area for broadleaves community or well represented among the 44 species found within the study area. Ficus ulmifolia and Macaranga bicolor appeared to have occurred in all sampling stations and this scenario could influence the existing vegetation to compete with the other species for space, nutrients, and sunlight to survive. **Table 2.1.12** presents the relative density, relative frequency, relative dominance, and importance value of the flora recorded in the study area.

Table 2.1.12: Relative Density, Relative Frequency, Relative Dominance, and Importance Value of Broadleaves Community

Scientific Name	Family Name	Total No. of Individuals	Relative Density	Relative Frequency	Relative Dominance	Importance Value
Mangifera indica	**ANACARDIACEAE**	**23**	**1.68**	**1.54**	**29.96**	**33.18**
Ficus ulmifolia	**MORACEAE**	**37**	**2.70**	**4.10**	**6.20**	**13.00**
Artocarpus blancoi	**MORACEAE**	**10**	**0.73**	**3.08**	**7.44**	**11.25**
Macaranga tanarius	**EUPHORBIACEAE**	**36**	**2.63**	**2.56**	**6.03**	**11.22**
Leucaena leucocephala	**MIMOSACEAE**	**34**	**2.48**	**2.56**	**3.80**	**8.84**
Ficus septica	**MORACEAE**	**31**	**2.26**	**2.56**	**3.46**	**8.29**
Ficus nota	**MORACEAE**	**19**	**1.39**	**3.08**	**3.54**	**8.00**
Macaranga bicolor	**EUPHORBIACEAE**	**18**	**1.31**	**3.59**	**1.34**	**6.24**
Papualthia lanceolata	**ANNONACEAE**	**18**	**1.31**	**2.56**	**1.68**	**5.55**
Artocarpus ovatus	**MORACEAE**	**21**	**1.53**	**2.05**	**1.95**	**5.54**
Averrhoa bilimbi	OXALIDACEAE	3	0.22	0.51	3.91	4.64
Tamarindus indica	CAESALPINIACEAE	5	0.36	0.51	2.79	3.67
Sandoricum koetjape	MELIACEAE	5	0.36	0.51	2.51	3.39
Gliricidia sepium	FABACEAE	18	1.31	0.51	2.68	4.51
Psidium guajava	MYRTACEAE	5	0.36	0.51	0.56	1.44
Trema orinetalis	ULMACEAE	25	1.82	1.03	0.93	3.78
Litsea glutinosa	LAURACEAE	7	0.51	1.03	1.04	2.58
Muntingia calabura	TILIACEAE	5	0.36	0.51	0.47	1.34
Neotrewia cumingii	MORACEAE	7	0.51	1.03	0.78	2.32
Notaphoebe malabonga	LAURACEAE	4	0.29	2.05	0.45	2.79
Ficus satterhwaitei	MORACEAE	3	0.22	0.51	0.45	1.18
Ficus irisana	MORACEAE	14	1.02	1.54	0.78	3.34
Madhuca betis	SAPOTACEAE	1	0.07	0.51	0.04	0.62
Harpullia arborea	SAPINDACEAE	1	0.07	0.51	0.07	0.66
Sterblus asper	MORACEAE	9	0.66	1.54	0.34	2.53
Canarium asperum	BURSERACEAE	7	0.51	2.05	0.91	3.47
Mallotus philippensis	EUPHORBIACEAE	12	0.88	1.03	0.67	2.57
Semeicarpus cuneiformis	ANACARDIACEAE	7	0.51	2.05	0.26	2.82
Dracontomelon edule	ANACARDIACEAE	2	0.15	1.03	0.07	1.25
Aglaia rimosa	MELIACEAE	2	0.15	0.51	0.19	0.84
Buchanania arborescens	ANACARDIACEAE	3	0.22	1.54	0.45	2.20
Clausena brevistyla	RUTACEAE	1	0.07	0.51	0.06	0.64
Annona muricata	ANNONACEAE	1	0.07	0.51	0.07	0.66
Pterospermun niveum	STERCULIACEAE	1	0.07	0.51	0.04	0.62
Callophyllum inophyllum	CLUSIACEAE	1	0.07	0.51	0.06	0.64
Cratoxylum sumatranum	CLUSIACEAE	8	0.58	1.03	1.34	2.95
Chrysophyllum cainito	SAPOTACEAE	1	0.07	0.51	1.12	1.70
Planchonia spectabilis	LECYTHIDACEAE	2	0.15	0.51	2.61	3.26
Linoceria ramiflora	OLEACEAE	1	0.07	0.51	0.74	1.33
Viticipremna philippinensis	LAMIACEAE	1	0.07	0.51	0.37	0.96
Goniothalamus amuyon	ANNONACEAE	4	0.29	0.51	2.23	3.04
Diospyrus philippensis	EBENACEAE	2	0.15	0.51	0.37	1.03
Vitex parviflora	LAMIACEAE	2	0.15	0.51	1.86	2.52
Clausena brevistyla	RUTACEAE	1	0.07	0.51	0.37	0.96
TOTAL		**1370**	**100**	**100**	**100**	**300**

2.1.4.1.4 Brushland/Grassland Area with Solitary Agricultural Crops

Table 2.1.13 presents the top 10 most abundant species in the brushland / grassland community. These are; *Imperata cylindrica* (17.80%) importance value, *Centrocema virginianum* (17.38%), *Pipterus arborescens* (16.61%), *Chromolaena odorata* (16.33%), *Triumfetta bartamia* (14.11%), *Ficus* *bengalensis* (11.81%), *Brachiara mutica* and *Dinochloa acutiflora* (10.11%) each, *Cytochloa fenixii* (9.89%), and *Musa sapientum* (8.23%). The influence of grass and shrubs association which are invasive in nature, is quite overwhelming since its albedo property increases the temperature of the area and at the same time the evaporation also increases. This makes the ecosystem very dry, and harsh condition would limit the entry and growth of other species into its habitat. This is the case where soil condition favors only those species that have the ability to survive in a very low biomass and insufficient soil nutrient contents.

Table 2.1.13: Relative density, relative frequency, relative dominance, and importance value of brushland / grassland community

Scientific Name	Family Name	Total No. of Individuals	Relative Density	Relative Frequency	Importance Value
Imperata cylindrica	**POACEAE**	**92**	**9.66**	**8.14**	**17.80**
Centrocema virginianum	**FABACEAE**	**88**	**9.24**	**8.14**	**17.38**
Pipterus arborescens	**URTICACEAE**	**6**	**0.63**	**1.16**	**16.61**
Chromolaena odorata	**ASTERACEAE**	**89**	**9.35**	**6.98**	**16.33**
Triumfetta bartamia	**MALVACEAE**	**79**	**8.30**	**5.81**	**14.11**
Ficus bengalensis	**MORACEAE**	**46**	**4.83**	**6.98**	**11.81**
Brachiaria mutica	**POACEAE**	**63**	**6.62**	**3.49**	**10.11**
Dinochloa acutiflora	**POACEAE**	**52**	**5.46**	**4.65**	**10.11**
Cyrtochloa fenixii	**POACEAE**	**72**	**7.56**	**2.33**	**9.89**
Musa sapientum	**MUSACEAE**	**23**	**2.42**	**5.81**	**8.23**
Hyparrhenia diplandra	POACEAE	42	4.41	3.49	7.90
Carica papaya	CARICACEAE	23	2.42	4.65	7.07
Manihot esculenta	EUPHORBIACEAE	18	1.89	1.16	3.05
Desmodium pulchellum	FABACEAE	16	1.68	1.16	2.84
Blumea balsamifera	ASTERACEAE	14	1.47	1.16	2.63
Calamus merrillii	ARECACEAE	10	1.05	2.33	3.38
Lantana camara	ASTERACEAE	21	2.21	3.49	5.69
Commelia spp.	COMMELINACEAE	1	0.11	1.16	1.27
Lygodium flexuosum	SCHIZACEAE	35	3.68	3.49	7.16
Xanthostoma violaceum	ARACEAE	17	1.79	4.65	6.44
Asplenium musae	ASPLENIACEAE	3	0.32	1.16	1.48
Anaxagorea luzoniensis	ANNONACEAE	4	0.42	3.49	3.91
Tabernaemontana pandacaqui	APOCYNACEAE	3	0.32	1.16	1.48
Leea guineensis	LEEACEAE	1	0.11	1.16	1.27
Merremia vitifolia	CONVULVULACEAE	3	0.32	1.16	1.48
Cocos nucifera	ARECACEAE	7	0.74	2.33	3.06
Adiantum caudatum	PTERIDACEAE	11	1.16	2.33	3.48
Acmella uliginosa	ASTERACEAE	2	0.21	1.16	1.37
Eleusine indica	POACEAE	51	5.36	1.16	6.52
Schizostachyum lumampao	POACEAE	32	3.36	2.33	5.69
Mimosa pudica	MIMOSACEAE	6	0.63	1.16	1.79
Cyperus rotundus	CYPERACEAE	22	2.31	1.16	3.47
TOTAL		**952**	**100.00**	**100.00**	**300.00**

2.1.4.1.5 Endemicity, Conservation Status, and Economic Importance

Of the total 76 species recorded in the study area, three (3) species are considered Philippine Endemic while the rest are exotic and widely distributed in some parts of the world. Endemic species that were identified are *Diospyrus philippensis* (EBENACEAE), *Vitticepremna philippinenesis* (LAMIACEAE), and *Dracontomelon edule* (ANACARDIACEAE). They are commonly found in the lower to middle level elevation.

Exotic species is an introduced species outside its natural habitat. Present in the study area are *Chromolaena odorata* and *Lantana camara*. These species are considered as “invasive” species which can be found in the ultramafic ecosystem where the conditions are more favorable.

There are three (3) species that were identified in the DENR AO 2017-11 or the National List of Threatened Philippine Plants and their categories while five (5) species in the IUCN Red List as either Endangered, Vulnerable, and Other Threatened Species as presented in **Table 2.1.14**. These species, as described in both list, are considered under threat from adverse factors throughout its range and will likely to move to a higher priority of conservation if not mitigated.

Table 2.1.14: List of Endangered, Vulnerable, and Threatened Species Observed at the Study Area

Species/ Family	DENR AO 2017-11	IUCN Red List
Diospyros philippinensis A. DC./ Ebenaceae	Vulnerable	Endangered
Vitex parviflora Lam./ Lamiaceae	Not cited	Vulnerable
Ficus ulmifolia Lam./ Moraceae	Not cited	Vulnerable
Madhuca betis (Blanco) J .F .McBr./ Sapotaceae	Vulnerable	Vulnerable
Aglaia rimosa (Blanco) Merr./ Meliaceae	Other threatened species	Near-threatened

On economic status, trees represent one of the most important components of each and every terrestrial ecosystem. There are tangible and intangible benefits that can be derive from floral ecosystem. For tangible, trees plays an important role in addressing climate change and global warming while for intangible benefits are timber and implements to support heavy construction. On the other hand, other plant forms such vines, grasses, shrubs, and herbs also provides important role in the ecosystem. Grasses are commonly used as ground cover to lessen the impact of the raindrops to soil; bamboos are effective in soil stabilization of riverbanks while vines are primary source of raw materials for weaving and handicraft industry. Majority of the plant species that were identified have economic values to support the economic activity in the community. Although many of the brush species are considered weeds, they can be utilized for medicinal purposes, as food, construction materials, and ornamental plants. Others can be utilized for handicrafts, agricultural implements, fibers, ground cover, dyes, and forage.

Some ecological implications of the presence or absence of species would not apply in forests over ultramafic soils. As for the ecological significance of the species found in the area, the presence of MORACEAE indicates a riverine habitat. The predominance of leguminous species indicates a type of adaptation to poor acerbic soil – nitrogen fixation. This is a symbiotic association of roots of plants with nitrogen-fixing bacteria like Rhizobium sp. Moreover, one explanation for the proliferation of the climax species – the dipterocarps – is another type of functional biological adaptation, i.e., mycorrhiza, a symbiotic association of plant roots and fungi. These types of adaptation will play a very significant role in the consideration in the rehabilitation of lateritic soils in the area.

Other than economic importance, trees also have ecological functions. They directly fed and house the majority of the animal creatures such as birds, mammals, insects, reptiles, thus they play a major role as of the important components of natural ecosystem. Similarly, trees also provide protective and conservation measures such as barriers to strong typhoons and windbreaks. For conservation purposes, there are a number of species that can be used for soil and water conservation. Species belonging to family MORACEAE and POACEAE are good indicators of water sustainability and soil erosion control of riverbanks.

2.1.4.1.6 Biodiversity Level and Species Richness

Biological diversity or biodiversity means that many kinds of living things live together in the same area. Having a variety of living this in an area is important in the health of the environment or biological systems. In general, the higher or the more diversity of life in the environment, the better the environment is. On the other hand, species richness occurring within a specific area or community measures a unique level of ecological organization which reflects the biological structure of a community. A community with high species richness and diversity will likely have a complex network of trophic pathways, In contrast, a community with low species richness and diversity likely have a fewer species and trophic interactions. Interactions among species within the food web of communities with high species diversity are theoretically more complex and varied than in communities of low species diversity. Indices of species richness and species diversity are often used in a comparative manner, that is, to compare communities growing under different environmental conditions or to contrast seral stages of succession. **Table 2.1.15** provides the biological diversity and species richness of study area.

Table 2.1.15: Biodiversity Index and Species Evenness Index of the Study Area

Sampling Stations	Shannon Biodiversity Index	Species Richness
1	3.04	0.95
2	2.53	0.86
3	3.15	0.87
4	2.70	0.78
5	1.77	0.71
6	2.94	0.89
7	2.38	0.86
8	3.12	0.97

Based on the Fernando Biodiversity Scale, sampling station 8 is rated with “high” biodiversity and showed even distribution of species with 3.12 and 0.97, respectively. This was followed by sampling station 1 which generated a value of 3.04 (high biodiversity level) and species richness of 0.95. Sampling stations 2, 4, and 6 showed a “moderate” biodiversity level with values 2.53, 2.70, and 2.94 and their species evenness index is very high with 0.86, 0.74, and 0.89, respectively. Sampling station 7 exhibits a “low” biodiversity level at 2.38 while sampling station 5 falls under “very low” bracket of relative values with only 1.77 biodiversity level.

2.1.4.2 Terrestrial Fauna

In 1997, terrestrial faunal survey was conducted at Barangays Triumpo and Binaliw, for a period of six days from June 14-19, 1997 with the following objectives:

- to conduct a survey and come up with a list oof wildlife species in the proposed study site with notes on their status and abundance;
- to identify probable impacts on the wildlife presented by the project during its various stages of development and
- to formulate mitigative and monitoring measures that will permit sustainable utilization of resources in the proposed project area.

Methodology

Habitat Evaluation of the Study Area

Character vegetation and condition of each study area were noted although basic information about the forest/vegetational structure were mainly based on the results obtained by the forest research team. Types and extent of any habitat disturbance (both natural and human-caused) were also noted.

Trapping of Non-volant Mammals

Thirty (30) Victor snap traps were operated in the study site for six days and night. The traps were baited with cooked coconut meat laced with peanut butter and were rebaited every afternoon. The traps were set on the ground along natural runways, near holes within root system of trees and bamboos while other traps were set along logs or branches of trees. Captures animals were identified down to the species level. Body weight, age, sex, tail length, body length, reproductive condition and other such related parameters were measured and recorded to facilitate proper identification of specimens.

Capture of Volant Mammals and Birds

For the same reasons as aforementioned, mist-netting stations composed of seven nets (42 m in length) were set up in Site I only for a period of three days. Nets were set 2-3 m high with a clearance of approximately 0.30 m above the ground. Mist nets were strategically placed along the top of the ridge, shrubland and near bamboo thickets and dense undergrowth with possible flyways of birds as well as bats. Nets were checked three times each day, early in the morning (for nocturnal birds and netted bats), noontime and late afternoon. The nets were checked in the evening for an hour for the probable presence of insectivorous bats.

Captured animals were identified to the species level. Basic information such as age, sex, biometrics and reproductive condition, were recorded in field catalogue sheets which proved to be essential during the process of specimen identification.

Transect Survey for Birds

An estimated two-kilometer transect line was designated for each site and was traversed and was traversed twice a day, early in the morning and late in the afternoon, by the observer for the transect count of birds. The following information/parameters were recorded:
a. species name;
b. number of individuals;
c. perpendicular distance from the transect line;
d. type of habitat
e. vertical distance from the ground
f. if seen, heard or flying; and
g. if seen singly, in pairs or in flock.

The methodology, is based primarily on Burnham et.al., 1980; Danielsen, et.al., 1991; Mallari, 1992; Miranda, 1987; and Gonzales, 1993. Nomenclature and classification of bird species were based on du Pont, 1971 and Dickinson et. al., 1991. The following bird species diversity measurements were made:
- Bird Species Richness (BSR), base in the total number and species recorded at study/transect site
- Bird Species Density (P), P = pi x 100; were pi id the proportion of the total number of individuals belonging to its species (ni) and the total number of individuals recorded (N)
- Bird Specie Dominance Index (D), D = pi based on Simpson's formula (1949)
- Bird Species Diversity Index (H), based on Shannon-Weiner's formula (1963): H = 3 pi (ln pi), where ln = natural logarithm
- Evenness Index (e), based on Peilou's formula (1966):
  H/Hmax, where Hmax = proportional abundance calculated by natural logarithm of BSR
- Endemicity (E) computed by total number of endemics over total number of species

Transect Line for Herpetofaunal Survey

The transect route for birds was used to study the herpetofaunal population of the study area. Animals were captured either by hand, plastic bags or sticks for verification purposes. Ocular/Visual observations, although less reliable as compared to the actual collection method was also employed. Computations similar to bird species diversity measurements whenever possible (and appropriate) were done to determine the status of the said herpetofaunal species present in the study area.

Other Methods for Survey of Terrestrial Vertebrates

Other methods or techniques for survey such as direct observation, roosting and nesting sites, fecal materials were employed to identify other wildlife species present the study area.

Ethnobiological surveys of local inhabitants (local guides, farmers, kagawad) were also conducted especially on the presence of wildlife vertebrates, abundance and frequency etc. Likewise, extent of rate of decline of the species population as brought about by hunting, collection, and other factors affecting population conditions were assessed during random interviews.

Results and Discussion

Habitat Analysis

Two sampling points, one in Barangay Binaliw and the other in Barangay Triumpo, were studied. Each site represents a particular habitat type which vary from agricultural or cultivated areas to scrubland.

Site I is situated at Barangay Binaliw which is some five kilometers from the existing cement plant. It covers the 131 hectares of uling formation for the proposed quarrying operations. The area is basically cultivated with various crops such as maize and camote. Some portions of the mountain are covered with 'iba-iba' (similar to iba or kamias) with patches of bamboos and other thriving small to medium-sized trees. The bignai pugo (*Antidesma petandrum*) and the viny shrub known as 'kilat' seems to be the most abundant fruit-bearing plant species. On the upper portion of the ridge the dominating vegetation is grassland with some portions of shrubs. Small-scale agriculture is also being practiced in the area.

Starting from the barangay road, the transect line followed the foot trails that lead to the upper ridge of the area. Some wooden houses were found along the trail. The elevation range of the study area started from 100 to 300 meters above sea level.

Site II is situated on the northern side and is approximately three kilometers from the previous site. It is located in Barangay Triumpo where the area is mostly planted to mangoes. Other agricultural plants present in the area were coconut and bananas. Basically, the area covered by the sampling point is heavily characterized by grassland with cogon as the dominating species. The elevation of the study area ranges from 50-150 meters above sea level.

Mammalian fauna

Unfortunately, the mammalian fauna observed in the areas comprises only of two species, which are recognized for their relationships with human habitation. *Cynoterus brachyotis* (Short-nosed fruit bat) is a volant mammal that commonly occurs in disturbed areas, particularly cultivated lands. Disturbance brought about by farming are tolerable to some species, since fruit trees and agricultural crops can provide alternate food source. Presence of these nocturnal mammalian species suggest that the present habitat condition in the area can accommodate such as tolerant species which primarily feed on fruits and nectar from flowering plants found to be abundantly growing around the area. They play an important role in seed dispersal which is crucial in the regeneration process of secondary growth forest and other agricultural crops.

Only one species of non-volant mammal were recorded in both areas: *Rattus exualns* (Polynesian rat). This species is one of the most persistent and most destructive among the rodents that cause severe damage both to coconut and corn plantations. The absence of other rodent species is indicative that the vegetation community in the area is no longer suitable to accommodate bigger number of animals that require various types of niches.

Avian Fauna

A total of 25 species from 16 avian families were recorded in 196 individuals of birds observed in the study areas. Twenty-four species were recorded directly from transect count and an additional four species were gathered from ethnobiological account. Of these figures thirteen are Philippine endemic. Comparatively, Site 1 supports more avian species with bird species richness (BSR) value of 25 while Site 2 has a BSR value of 16. In terms of endemicity, Site 1 has higher endemic species due to the presence of various habitat types such as grassland, agroforest and shrubland. The site support fifteen (15) endemic species. The edge effect produced by the ecotones assures the presence of diverse niche for wildlife species. Site 2, on the other hand, is basically a grassland area with some portions of it devoted to mango plantation. The number of endemics supported by this site is nine (9). Inspite of the degraded condition of the forest in Site 1, a larger species of birds, particularly endemics, still persist in the area. Apparently, these species were able to tolerate severe disturbances. The condition described for Site 1 is typically and persistently habituated by species that are generalist in habitats.

In terms of bird species diversity computed from the transect counts, the most diverse area is Site 1 with a BSD value of 2.8339. The evenness for this site is 0.8917 and the dominance index is 0.0698, an indication that no single species tend to dominate the area. Similar pattern of values was obtained for Site 2. The evenness and dominance values obtained were 0.07918 and 01540, respectively.

Herpertofaunal Survey

The only anuran species recorded in the area is the common commensal species, *Polypedates leucomystax* (Common banana tree frog), which is usually found in second growth forest, agricultural areas and even communities with enough vegetative growth.

Five reptilian species from four families were recorded of which two are significant species. *Varanus salvator* (Malay Monitor Lizard) occupies a wide range of habitat and is usually the last to leave in case of serious environmental disturbance. The Philippine sailfin lizard (*Hydrosaurus pustulosus*) is considered threatened (IUCN, 1994) due to hunting and overcollection for pet trade.

Table AI2-c: List of Avifaunal Species recorded at Brgys. Triumpo and Binaliw, Danao City, Cebu

Species	Common Name	Status	Remarks
Family Rallidae			
Rallina eurizonoides eurizonoides	Staty-legged crake	Resident	Ethno
Rallus torquatus torquatus	Barred rail	Resident	Obs
Family Columbidae			
Phapitreron leucotis nigrorum	White-eared brown fruit dove	Endemic	Obs
Treron vernas			
Chalcopaps indica indica	Common emerald dove	Resident	Ethno
Geopelia striata striata	Zebra dove	Introduced	Obs
Family Cuculidae			
Centropus bengalensis philippinenis	Lesser coucal	Resident	Obs
Family Apodidae			
Colocalia esculenta marginate	Phil. Glossy swiftlet	Endemic/subspecies	Obs
Colocalia troglodytes	Pygmy swiftlet	Endemic	Obs
Family Oriolidae			
Oriolus chinensis chinensis	Black-naped oriole		Obs
Family Corvidae			
Corvus macrorhyncus philippinus	Large-bllled crow	Resident	Ethn
Family Pycnonotidae			
Pycnonotus goiavier samarensis	Visayan yellow-vented bulbul	Endemic/subspecies	Ons/net
Hypsipetes philippinus philippinus	Phil. bulbul	Endemic	Obs/net
Family Turdidae			
Copsychus saularis mindanensis	Phil. magpie robin	Endemic/subspecies	Obs
Saxicola caprata randi	Phil. pied chat	Endemic	Obs
Family Sylviidae			
Megalurus palustris forbesi	Striated cane grass warbler	Endemic	Obs/net
Cisticola exilis		Subspecies	Obs
Family Laniidae			
Lanius crsitatus lucionensis	Brown shrike	Migratory	Obs
Family Sturdidae			
Aplonis payanensis payanensis	Phil. glossy starling	Endemic/subspecies	Obs/net
Sarcops calvus melanolotus	Coleto	Endemic/subspecies	Ethn

Family Nectariniidae			
Nectarinia jugularis jugularis	Olive-backed sunbird	Endemic/subspecies	Obs/net
Family Caprimulgidae			
Caprimulgus sp.	Nightjar	Resident	Obs
Family Ploceidae			
Passer montanus malaccensis	Tree sparrow	Intro	Obs
Family Estrildidae			
Lonchura malacca jagori	Chestnut munia	Endemic/subspecies	Obs
Family Meropidae			
Meropsviridis	Chestnut-headed bee-eater	Endemic	Ethno

Table AI2-d: Herpetofaunal at Barangays Triumpo and Binaliw, Danao City, Cebu

Species	Status	Remarks
Family Rhacophoridae		
Polypedates leucomystax	Commensal	Observed
Common Banana tree frog		
Family Geckonidae		
Gecko gecko	Resident	Observed
Tockay gecko		
Family Scincidae		
Mabuya multifasciata	Resident	Observed
Common Mabiuya skink		
Family Varanidae		
Varanus salvator	Resident	Ethno
Malay salvator lizard		
Hydrosaurus pustulosus	Endemic	Ethno
Phil. Sailfin lizard		
Phyton reticulatus	Resident	Ethno
Reticulated python		

A new terrestrial fauna survey was conducted at the same sampling stations established for terrestrial flora survey. The survey of faunal resources was conducted thru ocular/aural observation, mist netting, field diary, and interview with key informants. Ocular and aural observations were employed along the trails of each sampling stations from 10AM until 4PM. Birds were systematically surveyed (diurnal only) for it is being considered as proxy for assessing the faunal composition of the study area. The reason is that birds can easily be observed unlike other wildlife group which requires trapping or mist-netting. Bird observation over an established transect line is a widely used standard in conducting rapid site assessment (Herzog et.al 2002). Data collected from the field includes listing of species and the number of individuals both from visual and aural observations. Bird species nomenclature follows Kennedy et.al 2000. Aside for standardized line transect counts (Bibby et.al 1992), other fauna which includes non-volant mammals, bats, reptiles, and amphibians were included on the assessment through opportunistic observations. Wildlife identification was conducted based on physical and unique features, markings, sounds and remains (i.e. feathers, fecal remains, tracks and other remnants). Wildlife survey techniques employed during the survey are described as follows:

1. Transect method – an imaginary line following accessible roads or trails or ridges within the covered area. It is commonly used in order to observe and record the presence of wildlife species occurring in the area;
2. Mist-netting – establishing mist nets on areas where possible occurrence of nocturnal birds and other avian wildlife species are crossing;
3. Ocular survey/ observation – actual observation of wildlife along the imaginary transect line based on the physical and unique features, markings, sounds/ aural, and remains i.e. feathers, fecal, tracks and other remnants;
4. Field Diary – recording all observations encountered during the survey; and
   Key Informant Interview/Ethnobiological Survey – gathering information from key informants or residents with regard to the historical accounts of wildlife species that were not encountered during the actual survey, human activities such as hunting and trapping in each of the study areas.

2.1.4.2.1 Species Richness, Composition, Diversity and Evenness

A total of 25 species were recorded comprised of 22 avi-fauna, two (2) herpeto-fauna and one (1) mammal. These species are common in the Philippines and relatively thrived in the vegetation type the project area holds. **Table 2.1.16** presents the list of fauna species observed in the study area. In the 1997 study, wildlife fauna species observed in the area is 27 composed of mammalian species with 2, avian fauna species (birds) with 25, and a lone species of herpeto-fauna.

Table 2.1.16: List of Fauna Species Observed in the Study Area

Family Name	Common Name	Scientific Name	Geographical Distribution
Bird Species			
Alcedinidae	White-collared Kingfisher	Halcyon chloris	Oriental region; Australasia; Native in American Samoa (American Samoa); Australia; Bangladesh; Brunei Darussalam; Cambodia; Eritrea; Fiji; India; Indonesia; Lao People's Democratic Republic; Malaysia; Micronesia, Federated States of Myanmar; Northern Mariana Islands; Oman; Palau; Papua New Guinea; Philippines; Saudi Arabia; Singapore; Solomon Islands; Thailand; Timor-Leste; Tonga; United Arab Emirates; Vanuatu; Viet Nam; Vagrant in China; Christmas Island; Hong Kong; Japan; Somalia
	White-throated Kingfisher	Halcyon smyrnensis	Native in Afghanistan; Azerbaijan; Bangladesh; Bhutan; Cambodia; China; Egypt; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Israel; Jordan; Kuwait; Lao People's Democratic Republic; Lebanon; Macao; Malaysia; Myanmar; Nepal; Pakistan; Palestinian Territory, Occupied; Philippines; Saudi Arabia; Singapore; Sri Lanka; Syrian Arab Republic; Thailand; Turkey; United Arab Emirates; Viet Nam; Vagrant in Bulgaria; Cyprus; Greece; Qatar; Taiwan, Province of China
Apodidae	Pygmy Swiflet	Collocalia troglodytes	Native in the Philippines
	Glossy Swiflet	Collocalia esculenta	Native in Brunei Darussalam; Christmas Island; India; Indonesia; Malaysia; Myanmar; New Caledonia; Papua New Guinea; Philippines; Singapore; Solomon Islands; Thailand; Timor-Leste; Vanuatu; Vagrant in Australia
Artamidae	White-breasted Wood-Swallow	Artamus leucorynchus	Native in Australia; Brunei Darussalam; India; Indonesia; Malaysia; Myanmar; New Caledonia; Palau; Papua New Guinea; Philippines; Timor-Leste; Vanuatu
Columbidae	Zebra Dove	Geopelia striata	Native in Brunei Darussalam; Cambodia; Indonesia; Malaysia; Myanmar; Philippines; Singapore; Thailand
	White-eared Brown Dove	Phapitreron leucotis	Native in the Philippines
	Common Emerald Dove	Chalcophaps indica	Native in Australia; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Christmas Island; Hong Kong; India; Indonesia; Japan; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; New Caledonia; Norfolk Island; Papua New Guinea; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Timor-Leste; Vanuatu; Viet Nam
Cuculidae	Lesser Coucal	Centropus bengalensis	A widespread and common resident in all countries of Southeast Asia; Native in Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Philippines; Singapore; Thailand; Timor-Leste; Viet Nam; Vagrant in Sri Lanka
Estrildidae	Chestnut Munia	Lonchura malacca	Native in Bangladesh; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia;

Family Name	Common Name	Scientific Name	Geographical Distribution
			Myanmar; Nepal; Philippines; Taiwan, Province of China; Thailand; Viet Nam
	Scaly-breasted Munia	Lonchura punctulata	Native in Afghanistan; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Timor-Leste; Viet Nam
Hirundinidae	Barn Swallow	Hirundo rustica	Throughout SE Asia
	Pacific Swallow	Hirundo tahitica	Common resident of Southeast Asia; Native in Brunei Darussalam; Cambodia; Fiji; French Polynesia; India; Indonesia; Japan; Malaysia; Myanmar; New Caledonia; Papua New Guinea; Philippines; Singapore; Solomon Islands; Taiwan, Province of China; Thailand; Timor-Leste; Tonga; Vanuatu; Viet Nam
Laniidae	Brown Shrike	Lanius cristatus	Oriental Region; SE Asia, Australasia; Native in Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Hong Kong; India; Indonesia; Japan; Kazakhstan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Mongolia; Myanmar; Nepal; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam; Vagrant in Christmas Island; Denmark; Maldives; Palau; United Arab Emirates; United Kingdom
	Long-tailed Shrike	Lanius schach	Oriental Region; Philippines, Singapore, Hongkong; Native in Afghanistan; Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Kazakhstan; Kyrgyzstan; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Oman; Pakistan; Papua New Guinea; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Tajikistan; Thailand; Timor-Leste; Turkmenistan; Viet Nam; Vagrant in Israel; Japan; Maldives; United Arab Emirates; United Kingdom
Locustellidae	Striated Grassbird	Megalurus palustris	Native in Bangladesh; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Thailand; Viet Nam
	Tawny Grassbird	Megalurus timoriensis	Native in Australia; Indonesia; Papua New Guinea; Philippines; Timor-Leste
Meropidae	Blue-tailed Bee-eater	Merops philippinus	Native in Bangladesh; Cambodia; China; Hong Kong; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Papua New Guinea; Philippines; Singapore; Sri Lanka; Thailand; Timor-Leste; Viet Nam
Oriolidae	Black-naped Oriole	Oriolus chinensis	Oriental Region; SE Asia; Native in Bangladesh; Cambodia; China; India; Indonesia; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Taiwan, Province of China; Thailand; Viet Nam; Vagrant in Nepal and Sri Lanka
Passeridae	Eurasian Tree Sparrow	Passer montanus	Introduced in Australia; Guam; Marshall Islands; Micronesia, Federated States of ; Northern Mariana Islands; Palau; Philippines; Timor-Leste; United States (Georgia - Native)
Pycnonotidae	Yellow-vented Bulbul	Pycnonotus goiavier	Southeast Asia; common in the Philippines, Singapore and Brunei; Native in Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam
Sylviidae	Zitting Cisticola	Cisticola juncidis	A common resident and winter visitor throughout SE Asia except Borneo
Herpeto-Fauna Species			
Pythonidae	Reticulated Python	Python reticulatus	Philippine Islands (Basilan, Bohol, Cebu, Leyte, Luzon, Mindanao, Mindoro, Negros, Palawan: Calamian Islands, Panay,

Family Name	Common Name	Scientific Name	Geographical Distribution
			Polillo, Samar, Tawi-tawi, Sulu Archipelago, Itbayat); Singapore, Thailand, Vietnam
Varanidae	Monitor Lizard	Varanus marmoratus	This species is endemic to the Philippines, and is found on the islands of Luzon, Mindoro, Sabtang, Batan, Palawan, Calamianes, Polilo, Balabac, the Semirara Islands (observations by M. Gaulke pers. comm. 2008 for Balabac and the Semirara Islands) and the islands of the Sulu Archipelago.
Mammal Species			
Muridae	Brown Rat	Rattus norvegicus	Introduced in the Philippines

The survey area is comparatively not thickly vegetated by premium tree species but rather dominated by shrubs and grasses. Some areas are planted with agricultural crops such as Malunggay and Corn while a certain portion occupied Mahogany Reforestation Project. With these available resources, wildlife species observed included those that inhabit shrubland and grassland areas, which are relatively common and resident of the country. Further to that, the area is highly disturbed by noise pollution made by heavy equipment being used in the company operations, thus, habitats are also distressed and the thriving wildlife as well.

Plate 2.1.4: Group of Chestnut Munia Observed at the Study Area

Plate 2.1.5: Perching BlueTailed Bee-Eater (left) and Perching Brown Shrike (right) Observed at the Study Area

2.1.4.2.2 Conservation Status

There were 25 different species of wildlife observed in the survey area in Barangay Dunggoan, Danao City, Cebu. Most of these species are common and inhabitant of the country. Among the 25 species, only Reticulated Python and Monitor Lizard are under Convention on International Trade in Endangered Wild Fauna and Flora Species (CITES) Appendix II. As such, these species are not necessarily now threatened with extinction but may become so unless trade is closely controlled. It also includes so-called "look-alike species," i.e. species of which the specimens in trade look like those of species listed for conservation reasons. However, IUCN categorized them as least concern while they are listed as other threatened species and vulnerable under DAO 2004-15. On the other hand, majority of the species observed are least concern under the IUCN. Nevertheless, some species recorded particularly in the group of aves are native of the Philippines.

Table 2.1.17 presents the list of fauna species observed in the survey area referring to the CITES, *IUCN and DAO 2004-15, Establishing the List of Terrestrial Threatened Species and their Categories, and the List of other Wildlife Species Pursuant to RA 9147.*

Table 2.1.17: Conservation Status of Fauna Species Identified in the Project Area

Common Name	Cites	DAO 2014-15	IUCN
Bird Species			
White-collared Kingfisher	NC	-	LC
White-throated Kingfisher	NC	-	LC
Pygmy Swiflet	NC	-	LC
Glossy Swiflet	NC	-	LC
White-breasted Wood-Swallow	NC	-	LC
Zebra Dove	NC	-	LC
White-eared Brown Dove	NC	-	LC
Common Emerald Dove	NC	-	LC
Lesser Coucal	NC	-	LC
Chestnut Munia	NC	-	LC
Scaly-breasted Munia	NC	-	LC
Barn Swallow	NC	-	LC
Pacific Swallow	NC	-	LC
Brown Shrike	NC	-	LC
Long-tailed Shrike	NC	-	LC
Striated Grassbird	NC	-	LC
Tawny Grassbird	NC	-	LC
Blue-tailed Bee-eater	NC	-	LC
Black-naped Oriole	NC	-	LC
Eurasian Tree Sparrow	NC	-	LC
Yellow-vented Bulbul	NC	-	LC
Zitting Cisticola	NC	-	LC
Reptile Species			
Reticulated Python	Appendix II	Other Threatened Wildlife	LC
Monitor Lizard	Appendix II	Vulnerable	LC
Mammal Species			
Brown Rat	NC	-	LC

2.1.4.2.3 Ecological and Economic Importance

All life forms play an essential role in the ecological and biological processes that are significant to life as well. Naturally speaking, wildlife maintains balance of nature in various aspects such as: regulation of population of different species, food chain and/or food web, and other natural environmental cycles, and seed dispersal and pollination. On the other hand, wildlife are also being utilized as food and trade pets while there are some who believes that they can also be used as medicine.

Anyhow, the enumerated ecological significance of wildlife does not made them exempted to numerous threats as human have been exploiting their potentials in economic industry. Nowadays, illegal activities caused by human interference are still prominent resulting to - loss of habitat that is equivalent to loss of biodiversity.

2.1.4.3 Vegetation Removal and Loss of Habitat

The vegetation at the quarry area will be stripped out during quarry operation. This entails to further disturbance of wildlife, loss of habitats and reduction to biodiversity composition in the area. Mammals, reptiles and amphibians however will be more severely impacted by the phases of the project. Faunal community will change as a result of the modification to the landscape during the phases of the project. As the project progress, habitats will be altered and emptied.

Different variety of trees will be planted at the identified reforestation area. The seedlings will be taken at the Nursery that is constructed near the new admin building and adjacent to drivers lounge in open space to absorb better fresh air and for the purpose of propagating more seedlings for the reforestation activity. RCBM shall also limit site preparation within an area required by MGB to be open at one given time and keep to a minimum vegetation removal ensuring that only necessary/planned clearings are undertaken. Monitoring of the growth of planted trees shall be done quarterly.

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

On determining conservation status and endemicity of each species, the International Union for the Conservation and Nature (IUCN) Red List of Threatened Species and DENR-AO 2017-11 “Establishing the National List of Threatened Philippine Plant and Their Categories, and the List of Other Wildlife Species were employed. The IUCN Red List is the world’s largest and most comprehensive inventory of the global conservation of biological species. The Red List is set upon precise criteria to evaluate the extinction of thousands of species and subspecies. The aim of the Red List is to convey the urgency of conservation issues to the public and policy-makers, as well as help the international community to try to reduce species extinction. It is aimed to provide scientifically based information on the status of the species and subspecies at a global level; draw attention to the magnitude and importance of threatened biodiversity; influence national and international policy and decision-making; and provide information to guide actions to conserve biological diversity (Source: Convention on International Trade of Wild Flora and Fauna, Joint Meeting of the Animals and Plants Committee, Shepherdstown, USA., December 2000, retrieved November 2012). Plants and animal assessed for the IUCN Red List are the bearers of genetically and the building blocks of ecosystems, and information on their conservation status and distribution provides the foundation of making informed decisions about conserving extinction and the main purpose of the Red List is to catalogue and highlight those plants and animals that are facing higher risk of extinction. In addition, the DENR AO 2017-11 was also used pursuant to Section 22 of Republic Act 9147, otherwise known as the Wildlife Conservation and Protection Act of 2001.

2.1.4.5 Threat to Abundance, Frequency and Distribution of Important Species

Known commercial hardwood tree species producing timber for medium to heavy construction are Gmelina and Santol which are present at the site. Other than tree species suitable for construction materials, there are fruit-bearing trees/ herbs/ shrubs that produces fruits edible to mankind and have been cultivated for many years for economic and livelihood activities such as Papaya, Mango, Coconut, Jackfruit, star apple and santol. Likewise, other by-products derived from the trees such as tannins/dyes, bast fiber, essential oil, fuelwood, and timber are of good source of income. Tannins/dyes and essential oil are usually used as primary raw materials for the production of various cosmetic products and for the production of varnish and paints.

2.1.4.6 Hindrance to Wildlife Access

During quarry operation, vegetation will be stripped out including overburden causing migration of animals to nearby areas.

Project Key Impacts to Remaining Wildlife Species

Removal of vegetation/ loss of habitat
The project will require land clearing resulting to the removal of remaining vegetation to give way to plant construction. This entails further disturbance of wildlife, loss of habitats and reduction to biodiversity composition in the area. Mammals, reptiles and amphibians, however will be more severely impacted by the phases of the project. Faunal community will change as a result of the modification to the landscape during the phases of the project. As the project progress, habitats will be altered and emptied. Area to be affected by land clearing for quarry expansion and installation of ancillary facilities is only 24 hectares. Land clearing will be confined on designated areas/ sites based on the approved utilization and development workplan, i.e. 5-year utilization and development workplan approved by MGB. Hence, limiting land clearing and quarrying operations a given time.

Decrease/ migration of faunal species
Further loss of vegetative cover as a result of land clearing may encourage movement/migration of wildlife species in the area aggravated by the loss of habitat and remaining sources of food for survival. Likewise, wildlife disturbance due to noise generated during operation brought about by the operation of heavy equipment's will force faunal species to migrate in other or nearby areas/habitat where disturbance is less.

Though, most of the faunal species are mobile in nature this situation will force them to migrate in other areas to search for new habitats. Migration of other wildlife to new territory/ies or ecosystem will pose threat to their existence. Since, they can be further exposed to hunting, persecution and trading. Continuous destruction of faunal habitats and disturbance will threaten the remaining species population and survival in the near future if not prevented. Thence, decrease of population to some species will be expected to happen while others may not incur significant change.

Hindrance to Wildlife Access
Changing the landscape will directly impact movement ecology of wildlife. This impact will be more severe for species whose movements are assisted by certain habitats. For example, some mammals may not be able to cross the barrier created by roads. However, since the landscape is predominantly of grassland, shrub land, there will be very few forest-dependent species directly impacted. Having said that, the project might prevent dispersal of some endemic birds that probably use this area as stepping stone to their ideal habitats.

Proposed Mitigating and Enhancement Measures

Replacement of trees cut due to land clearing
Prior to project implementation the proponent will coordinate to DENR to seek clearance for the identification of required documents for the issuance of needed tree cutting permit (PD 705). Moreover, to compensate the loss vegetation, the proponent will replace the number of trees removed/cut and plant them to nearby areas (buffer zone) to serve as noise and dust barriers or in accordance with the advice of the DENR. Replacement of affected trees shall follow DENR Memorandum Order no. 05 of 2012 mandated that "*Uniform replacement ratio for cut or relocated trees"* item 2.2 *"For planted trees in private land and forest lands... tree replacement shall be 1:50 while naturally growing trees on the same area, including those affected by the project shall be 1:100 ratio in support of the National Greening Program (NGP) and Climate Change Initiatives of the Government*". Species that will be used for the reforestation must be indigenous trees such as gmelina and mahogany and/or fruit bearing trees like jackfruit which are endemic in the place that can attract the return of wildlife. In addition, the Company, in coordination with local DENR offices (PENRO/ CENRO) and duly accredited People's Organization, may opt to offset disturbed areas through establishment of bamboo plantation following the instruction of the DENR Secretary to establish Bamboo Plantation for the Mining Sector (contractors/ permittees/ permit holders) equivalent to 10% of the declared mined-out areas and 10% of the final mine area. Furthermore, the Company is currently involved in the National Greening Program (NGP) for the Mines Sector pursuant

to MGB Memorandum Order 2012-01 which started in 2013 involving 44 hectares. The basis of which is the 1:1.5 ratio of the disturbed area and area to be reforested. RCBM-Danao NGP area is located at Barangay Tagbubunga, Asturias, Cebu in partnership with Paghiusa sa mga Magsasaka sa Tagbububga (PAGMATA) and rehabilitation of mangrove areas in Barangay Dungguan, Danao City in partnership with Danao Women's Federation. A copy of the latest quarterly report is attached as ANNEX A. On the other hand, the Company is implementing progressive rehabilitation within the MPSA area under Adopt-a-Mountain Program in 1995 as shown in the Table below. The program was later renamed to Mining Forest Program (MFP). A copy of the latest MFP Semi-Annual Accomplishment Report submitted to MGB Regional Office VII is attached as Annex B.

Table AI2-e: LRIC Trees Planted/ Survival Results

Trees Planted	YEAR 1995			1996			1997			1998			1999			Total		
	No.	S	%S	No.	S	%S	No.	S	% S	No.	S	% S	No.	S	%S	No.	S	%S
G-melina	1,300	1,274	98	2,000	1,250	62.5	-	-	-	-	-	-	-	-	-	3,300	2,524	76.4
Mahogany	200	200	100	200	105	52.5	3,500	1,400	40	-	-	-	780	780	100	4,680	2,485	53.1
Acacia	85	85	100	85	68	80	-	-	-	-	-	-	-	-	-	170	153	90
Mango	-	-	-	-	-	-	-	-	-	193	189	98	77	77	100	270	266	98
Jackfruit	-	-	-	-	-	-	-	-	-	195	189	97	30	30	100	225	219	97
Santol	-	-	-	-	-	-	-	-	-	43	40	93	-	-	-	43	40	93
TOTAL																		

LRIC, 2000 Note: No.- number of trees planted S- trees survived %S- percentage of tree survival

Measures to minimize decrease/migration of faunal species
Land clearing will be confined on designated sites only. The contractor will ensure to prohibit his employee's to engage in any mode of wildlife collection and/or hunting, rather, the contractor shall promote conservation and protection of remaining wildlife species. Promote wildlife protection using innovative means such as putting up of warning signage's on strategic areas for public information and warning.

Gradual Land Clearing
Gradual land clearing and removal of vegetation is encouraged to provide sufficient time for wildlife species to transfer in the nearby habitat. Further, it is recommended that intact vegetation within the project area shall be protected (in patches) to serve as refuge and forage/ feeding area for wildlife species that can thrive in disturbed area. Planting of naturally growing tree species in the designated areas might encourage other wildlife species / migratory birds which may use the sites as a stopover point during migration.

2.2 WATER

2.2.1 Hydrology/Hydrogeology

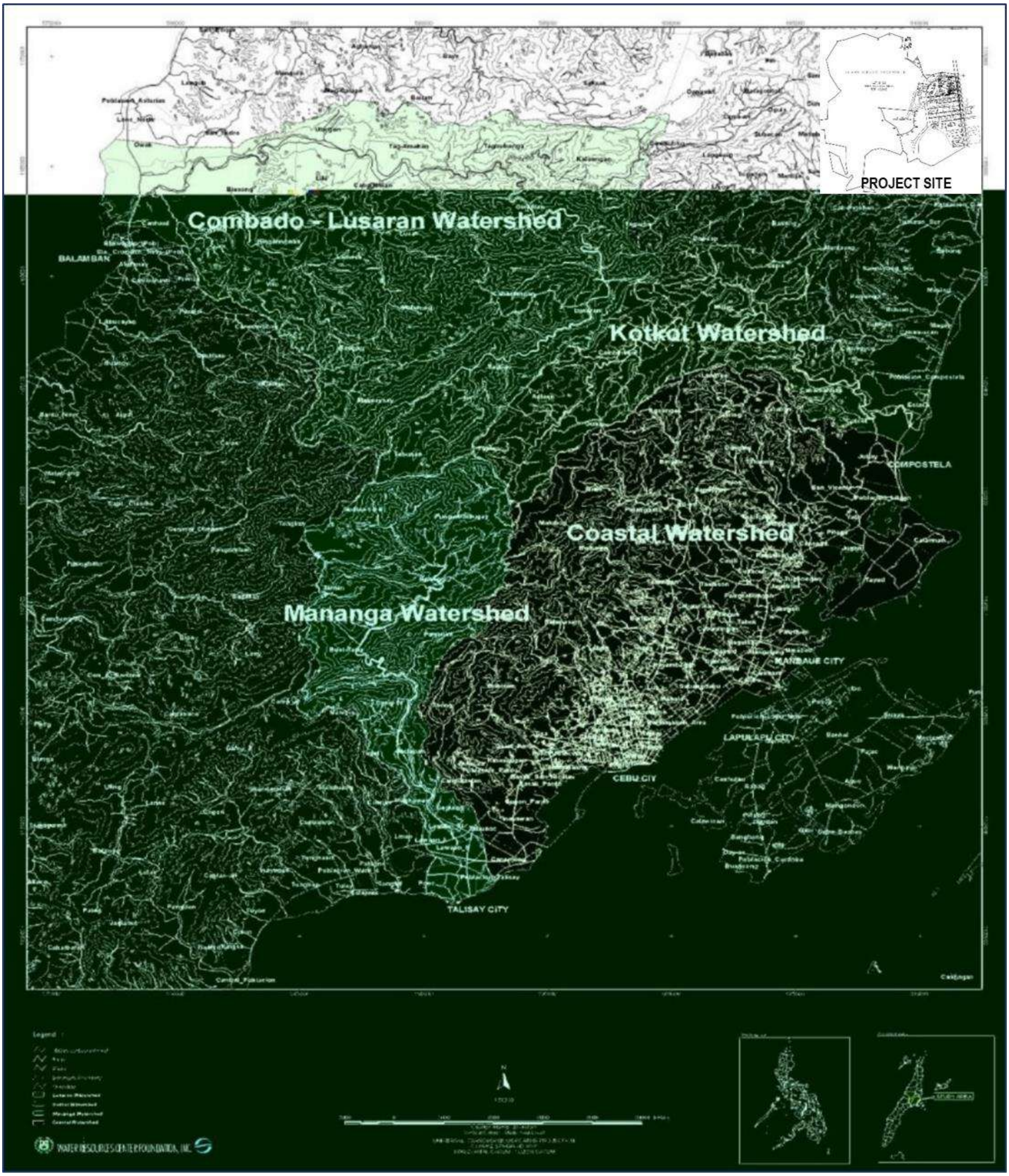
2.2.1.1 Drainage Morphology/Flooding/Stream Volumetric Flow

Drainage Morphology

The topography of Cebu is mountainous, with a major mountain range running parallel to the islands north-northeast to south-southeast axis. Despite the island's narrow width, its steeply sloping mountain range rises to heights of more than a thousand meters. Rivers run from the main water divide in the island's center in either northwestern or southeastern direction to the coastal plains, which are up to 5km wide.

Ipil River and Luyang River in Carmen, Cebu are the main river traversing the northern sector of the MPSA of the Project. Cagat River in Danao City, on the other hand, traverses the middle to southern portion of the MPSA. The nearest segment of Cagat River to the project's plant site is about 2 km northwest. The Ipil River is more than 2.5 km north of the plant site.

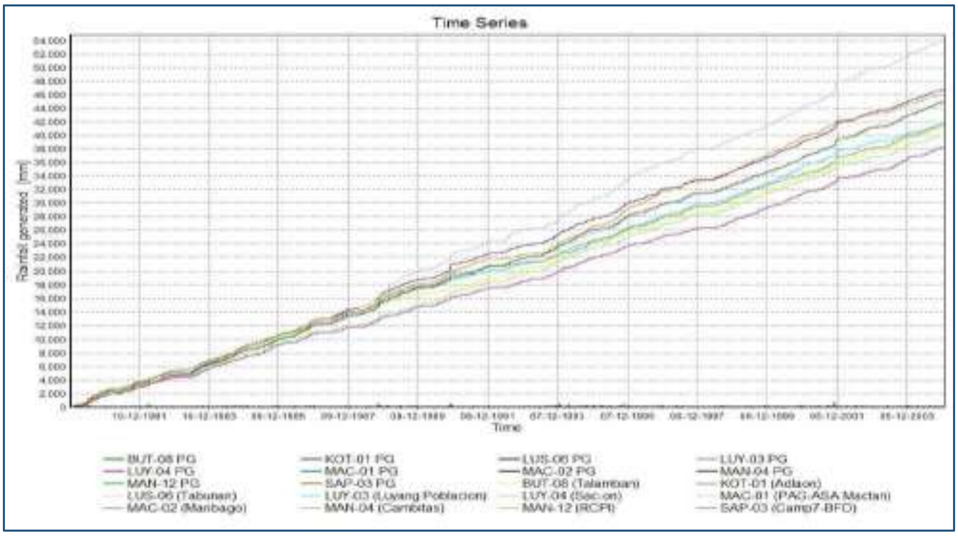
Figure 2.2.1 provides the Central Cebu River Basins and Coastal Watershed superimposing the project site at the upper right corner of the map.



Source: River Basin Coordinating Office

Figure 2.2.1: Central Cebu River Basins and Coastal Watershed

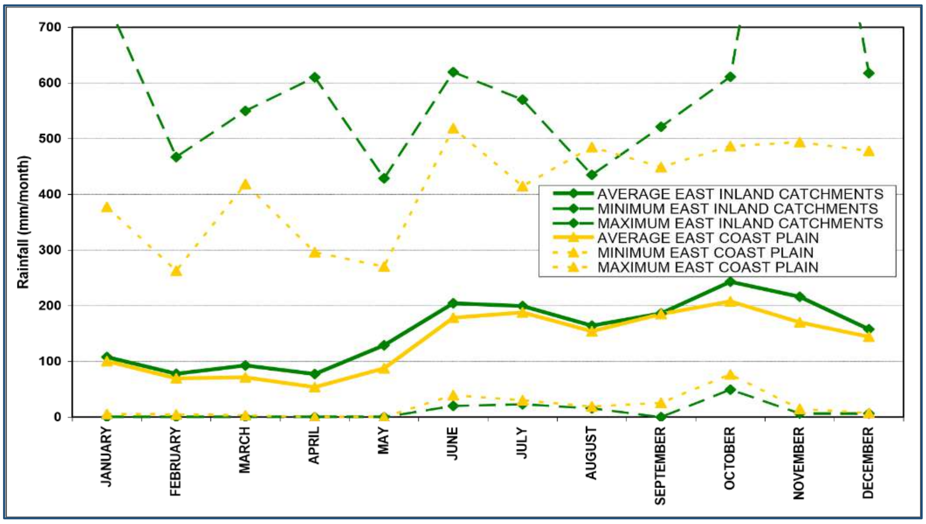
Average rainfall in the eastern coastal plain was calculated at 1,610 mm/year and 1,860 mm/year at higher elevations (about 1000 m). The 250 mm/year difference is attributed to elevation effect otherwise known as aerographic effect. While in the western coast, there are indications of higher rainfall indicated by the new established stations but records are too short to make a valid comparison. **Figure 2.2.2** shows the cumulative 25-year rainfall records for selected stations in Central Cebu.



Source: River Basin Coordinating Office

Figure 2.2.2: Cumulative 25-Year Rainfall Records for Selected Stations in Central Cebu

The intense rainfall falling on steep slopes results in very 'flashy' discharge regimes laden mostly with high sediment load. This is the case for Central Cebu River Basins and coastal watersheds as shown in **Figure 2.2.3**. The condition complicates discharge monitoring.



Source: River Basin Coordinating Office

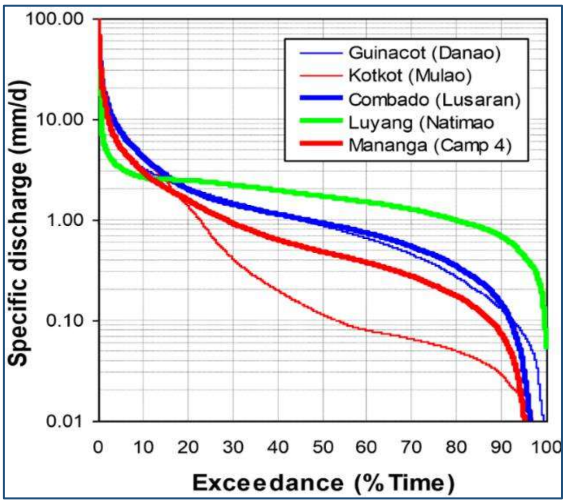
Figure 2.2.3: Rainfall Monitoring per Month

The geology of the basins likewise influences the regime to some extent, in particular, the base flows or dry season flows.

Catchment Model Type	**Limestone Cover**	**Discharge Characteristic**

Mananga at Camp4	<25%	Limited base flow
Combado at Lusaran	25%-50%	Moderate base flow
Luyang at Natimao-an	>50%	High base flow

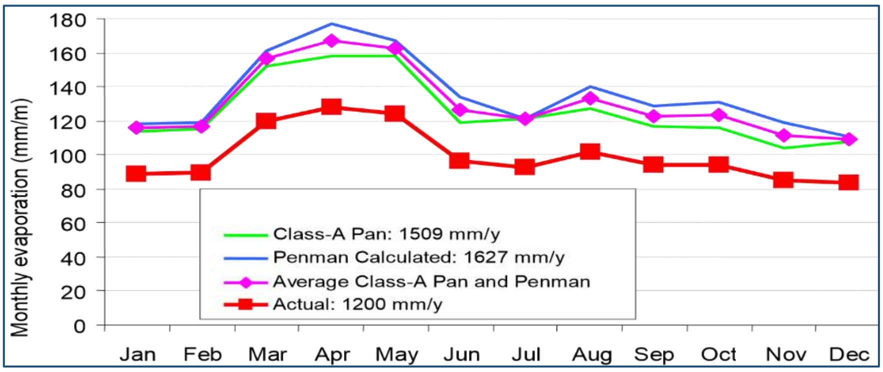
Given the complexities of the natural situation flow duration curves for five of the Central Cebu Basins have been derived and the result is shown in **Figure 2.2.4**.



Source: Aljosja, 2005

Figure 2.2.4: Flow Duration Curve for the Five Representative Rivers Studied in Water REMIND for 25 Years

The average evapotranspiration in the area is determined to be between 1,100 and 1,200 mm/day (Wolcke, 1991). A conservative value of 1,200 mm/year is assumed to apply to all areas which correspond with 65% to 75% of the annual rainfall. Evaporation from open surfaces using Class A pan, penman equation and the average of penman and Class A pan is graphically shown **Figure 2.2.5.**



Source: River Basin Coordinating Office

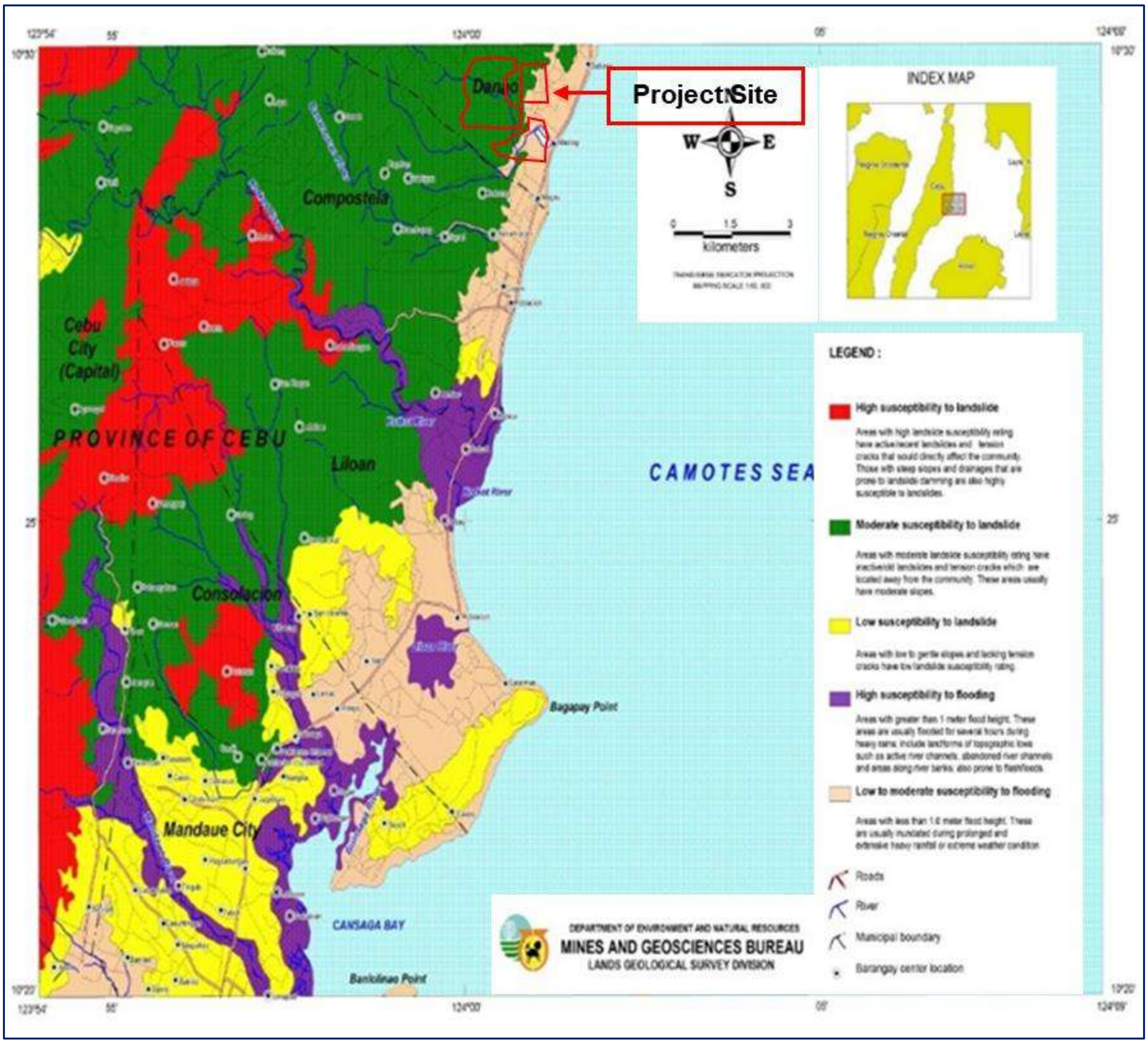
Figure 2.2.5: Evaporation Monitoring per Month

Flooding

Floods usually occur during or after heavy rainfall wherein the river channels are saturated with water resulting to river swelling and overflowing of floodplains. The project area falls under moderate and low to moderate susceptibility to flooding as delineated by MGB (**Figure 2.2.6**). The project site could experience "localized flooding" if the drainage systems are inadequate and not fully maintained.

The potential impact that may be experienced may include heavy siltation caused by typhoon-induced rainfalls may cause. Therefore, RCBM has installed Disaster Preparedness Plan for to mitigate the risks. Engineered and strategically located sediment mitigation facilities and drainage systems which include siltation ponds, stabilization of gullies and construction of run-off weirs at desirable distances along and within the existing gullies were instituted.

Floods usually occur during or after heavy rainfall wherein the river channels are saturated with water resulting to river swelling and overflowing of floodplains. The low-lying areas with poor drainage system are susceptible to flood hazard.

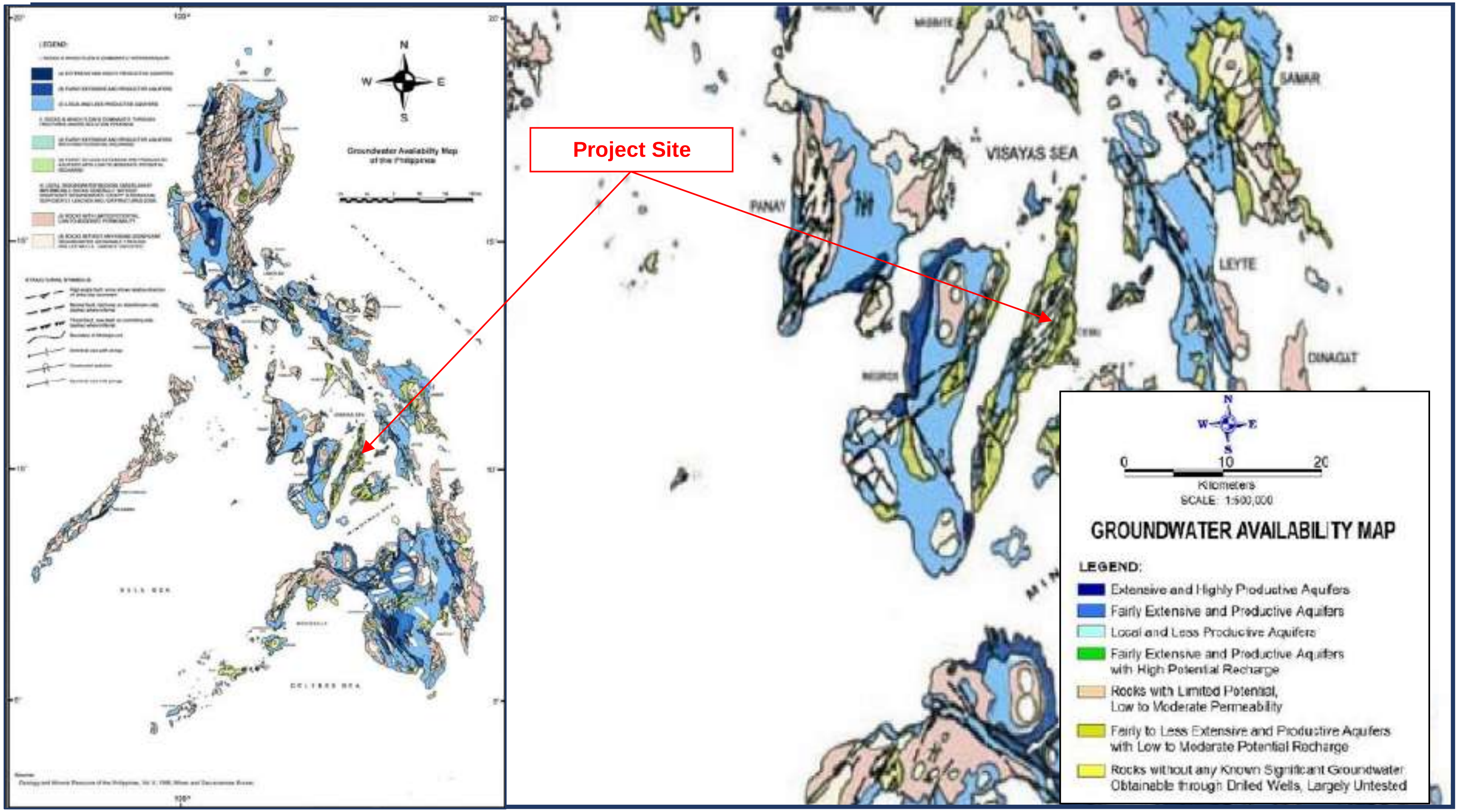


Source: MGB

Figure 2.2.6: Map showing the Landslide and Flood Susceptibility

2.2.1.2 Hydrogeology

Based on the 1997 Groundwater Availability Map of the Philippines, the Project Site falls under fairly to less extensive and productive aquifers with low to moderate potential recharge as shown in **Figure 2.2.7**. The classification is attributed to the scarcity of productive wells in the area.



Source: MGB

Figure 2.2.7: Groundwater Availability Map

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

The drainage within the active quarry area is designed in a manner that the run-off will flow towards the siltation ponds or open area and flow towards the natural drains. The run-off water from the active quarry area is directed to siltation pond and/or the area where there is enough space of siltation sumps and rain water can be directly absorb by land considering rain water volume before it discharges to small creek. No incident of flooding in the nearby community is yet recorded.

2.2.1.4 Change in Stream and Lake Water Depth

There will be no surface water extraction from the river; therefore, no reduction in stream flow rate is expected due to the project. The water requirement for the operation of the plant will be fully sourced from the existing deep wells.

2.2.1.5 Depletion of Water Resources/Competition in Water Use

RCBM has existing deepwells to supply its water requirements. For domestic use, water will be sourced from the local water utilities/local water district.

2.2.2 Oceanography

The Project Site is approximately 1 km away from the sea. This body of water which is part of the Camotes Sea will not be affected by the project because the project will not drain nor use water from this source.

2.2.2.1 Change/Disruption in Water Circulation Pattern, Littoral Current, Coastal Erosion and Deposition

There will be no change/disruption in water circulation pattern, littoral current, coastal erosion and deposition because the project will not drain nor use water from this source.

2.2.2.2 Change in Bathymetry

There will be no change in bathymetry because the project will not drain nor use water from this source.

2.2.3 Water Quality

Provided below is the trend of RCBM's performance on water quality from 2016 up to February of 2020. It can be seem from Table 2.2.3.1 that all results passed the DENR standards.

Table 2.2.3.1: Trend of RCBM's performance on water quality from 2016 up to February of 2020

Report Analysis	Year																			
	2016						2017										2018	2019		
	Jul-27	Aug-24			Nov-23		Jul-06			Sep-29		Dec-14		Dec-18			Dec-17	Feb-13	Apr-02	May-07	
Sampling ID	Effluent	Source Water	Receiving Body	Effluent	Source Water	Receiving Body	Source Water	Influent (Inlet of Oil & Water Separator)	Effluent (Out of Oil & Water Separator)	Before WWTP	After WWTP	Before WWTP	After WWTP	Before WWTP	After WWTP	Effluent	Oil and Water Separator	Settling Tank (Discharge)	Wastewater Settling Tank Effluent	Wast Eff
pH	7.6	7.2	7.3	9.2	8.2	7	7	9.1	7.6	-	-	-	-	-	-	8.3	8	7.1	7.9	
Temperature (°C)	30.5	33.5	37.2	34.9	34.9	31.4	33.1	31.5	31	-	-	-	-	-	-	29	28	27	29	
Total Suspended Solids (mg/L)	42	<1	19	<1	<1	24	2	8	1	-	-	-	-	-	-	11	24	10	6	
Oil & Grease (mg/L)	2.4	<1	<1	<1	<1	<1	<1	1	1	3	2	<1	<1	-	-	<1	<1	<1	<1	<1
Biological Oxygen Demand (mg/L)	45	-	-	-	-	-	-	-	-	5	2	5	3	-	-	9	3	1	5	
Surfactants (mg/L)	-	-	-	-	-	-	-	-	-	0.1	<0.1	1.71	1.4	-	-	0.3	0.19	0.14	0.13	
Fecal Coliform MPN/100mL	-	-	-	-	-	-	-	-	-	92x10^2	35x10^2	35x10^2	35x10^2	-	-	<1.8	54x10^2	<1.8	24x10^2	
Phosphate (mg/L)	-	-	-	-	-	-	-	-	-	0.31	0.13	-	-	0.28	0.64	0.02	0.04	<0.01	<0.01	
Ammonia as NH3-N (mg/L)	-	-	-	-	-	-	-	-	-	0.06	0.13	-	-	0.16	0.12	<0.03	<0.03	0.1	0.43	
Nitrate as NO3-N (mg/L)	-	-	-	-	-	-	-	-	-	0.28	0.82	-	-	0.24	0.22	0.31	0.57	1.24	2.39	
Color (TCU)	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chemical Oxygen Demand (mg/L)	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The collected samples for water quality assessment were subjected to physical, chemical, microbiological, nutrient and heavy metal analyses.Water samples were preserved in iced boxes prior to transport to the laboratory facility for the analysis of parameters presented in **Table 2.2.3.2**.

Table 2.2.3.2: Water Quality Parameters and Corresponding Methods of Analysis

Parameters	Method of Analysis
pH	Electrometric
Total Suspended Solids (TSS)	Gravimetric
Oil & Grease	Petroleum Ether Extraction
Biochemical Oxygen Demand (BOD_5)	Azide Modification (Dilution Technique)
Chemical Oxygen Demand (COD)	5220 B. Modified Open reflux Dichromate
Dissolved Oxygen (DO)	Dissolved Oxygen Meter
Temperature	Alcohol-filled Thermometer
Lead	Flame AAS-EPA Method 7420
Mercury	Flame AAS-EPA Method 7420
Cadmium	Flame AAS-EPA Method 7130
Chromium Hexavalent	Diphenylcarbazide-SM Method 3500CrB
Copper	Flame AAS-EPA Method 7210
Arsenic	Colorimetry- SDDC SM Method 3500
Fecal Coliform	Multiple tube Fermentation – Method 9221B&E
Total Coliform	Multiple tube Fermentation – Method 9221B&E

Source: DAO 34 Series of 1990, Approved Methods of Analysis

2.2.3.1 Groundwater Quality

In addition to the regular monitoring of water quality being conducted by RCBM, additional groundwater quality sampling was conducted on April 16, 2019 and is provided in **Table 2.2.3.1.1** below.

Table 2.2.3.1.1: Results of Groundwater Sampling Analysis

Parameters/ Station	Units	Deepwell 10° 33' 26.9" N; 124° 00' 50.3" E
Date and Time of Sampling		April 16, 2019/ 1125H
pH		7.7
Temperature	(°C)	31
Biochemical Oxygen Demand	(mg/L)	<1
Total Suspended Solids (TSS)	(mg/L)	3
Oil and Grease	(mg/L)	<1
Surfactants	(mg/L)	<0.03
Phosphates	(mg/L)	<0.01
Fecal/Thermotolerant Coliform	(MPN/100mL)	<1.1
Ammonia as NH3-N	(mg/L)	0.09
Nitrate as NO3- -N	(mg/L)	*1.44

2.2.3.2 Freshwater Quality

The old AI document of Llotds Richfield provided that the characterization of Cagat River was based on the analysis of the water quality along the river. A total of four water samples have been taken from the Northern Tributary of Cagat River. The result of laboratory analysis are shown below in **Table 2.2.3.2.1**.

Table 22.3.2.1: Results of Laboratory Analysis of Water Samples Can-Asujan Small Reservoir Irrigation Project, Carcar, Cebu

Sample Code		Northern Tributary				Southern Tributary
		WLD 1	WLD 3	WLD7-R	WLD8-R	WLD5-R
pH		8.0	8.1	8.4	8.4	8.3
Turbidity	NTU			2.7	6.0	13.8
Oil & Grease	mg/L			0.1	0.2	0.1
TH	mg/L			221.0	170.0	292.0
TDS	mg/L	268	246.0	226	269.0	527.0
TSS	mg/L	14	23	30.0	17.0	19.0
Nitrate	mg/L	0.1	0.3			
Chloride	mg/L	11.1	11.8			
Alkalinity	mg/L		175.1	193.5	161.25	
Total PO_4	mg/L		0.49	ND	0.49	
Color, PCU			4.0	3.0	3.0	
BOD	mgO_2/L			3.0	2.0	2.0
DO	mg/L			7.3	8.6	9.5
Fecal coliform				TNTC		TNTC
TNTC – too numerous to count						

The physical quality of the Northern Tributary of the Cagat River is still good. The TDS values ranging from at 226 mg/L to 268 mg/L are below the specified maximum value of 1,000 mg/L for Class a water. The TSS values at 14 mg/L to 30 mg/L are low. The turbidity levels at 2.7 NTU to 6.0 NTU are also low.

The chemical quality of the river is also good where the values of the chemical parameters fall within acceptable levels. The pH values ranges from 8.0 to 8.4. Nitrate values at 0.1 to 0.3 mg/L are low. The oil and grease concentrations of 0.1 mg/L to 0.2 mg/L show that the river is not contaminated by oil and grease that could come from vehicles, heavy equipment and from household use.

Biological Characteristics

Based on the BOD values ranging from 2.0 mg/L to 3.0 mg/L and the DO values ranging from 7.3 mg/L to 8.6 mg/L (please see Table No.1), the river water quality along the Northern Tributary of Cagat River is good. According to DAO 34 guidelines on water quality criteria for fresh waters, the river water met the specifications for Class A classification.

Although there are residences upstream and poultry farms whose runoff flows toward the river, the values obtained indicate the following conditions:

a) the river flow could have adequately diluted the present volume of wastewater generated in the area.

b) even if the wastewater treatment systems of these residences and establishments are slightly inadequate or non-existent (as is common for rural areas, the natural filtering system of the alluvial ground formation (due to its good permeability) served as an adequate filtration system (for now) because of the low volume of wastewater generated and discharged; a condition supported by the low density of occupancy in the area. However wastewater and air pollution (odor) from poultry raising can be become an area of concern in the years ahead if the wastes and pollution generated cannot be properly addressed at an early stage.

These conditions indicate that the carrying capacity of the river catchment is still adequate to support the present environmental situation and/or development in the area.

Bacteriological Characteristics

The bacteriological quality of the river is poor. The results of the analysis on the river samples indicate degeneration where fecal coliform analysis registered TNTC (too numerous to count) levels.

Southern Tributary: Physico-Chemical Characteristics

The physical quality of the Southern Tributary if the Cagat River is still good. The TDS value at 527 mg/L is below the specified maximum value of 1,000 mg/L for Class A water.

The TSS value at 19 mg/L is also low. The only exception is the turbidity level. Which at 13.8 NTU is quite high.
The chemical quality of the river is also good where the values of the chemical parameters fall within acceptable levels. The pH value is 8.0. Nitrate values at 0.1 to 0.3 mg/L are low. The oil and grease concentration of 0.1 shows that the river is not contaminated by oil and grease that could come from vehicles, heavy equipment and from household use.

Biological Characteristics

Based on the BOD value of 2.0 mg/L and a DO value of 9.5 mg/L (please see Table No. 1), the river water quality along the Southern Tributary of Cagat River is good. According to DAO 34 guidelines on water quality criteria for fresh waters, the river water met the specifications for Class a classification.

Bacteriological Characteristics

The bacteriological quality of the river is poor. The results of the analysis on the river samples indicate degeneration where fecal coliform analysis registered TNTC (too numerous to count) levels.

Additional freshwater quality monitoring was also made and is presented in Table 2.2.3.2.2. It shows that all levels of parameters are below the standards set by DENR for Class C Waters except for Color, Oil & Grease, Chlorides, Copper and Fecal Coliform. The exceedance may be attributable to the effluent of other contributors in the freshwater body where the samples were taken because thre are no discharges from RCBM that will contribute to the said exceedance.

Table 2.2.1.2.2: Results of Freshwater Sampling Analysis

Parameters/ Station	FW-1	FW-2	FW-3	DENR Standard for Class C Waters
Date and Time of Sampling	April 3, 2018/ 1400H	April 3, 2018/ 1500H	April 3, 2018/ 1530H	
pH	6.82	7.11	7.87	6.5-8.5
Color (Apparent), PCU	125	125	125	75
TSS, mg/L	11	62	4	<30 mg/L increase
Oil & Grease, mg/L	3.64	3.85	3.01	2
COD, mg/L	24	1,680	8	-
Chlorides, mg/L	717	21,391	34	250
Nitrates, mgNO_3-N/L	1.417	1.084	6.055	7
Phosphate, mg/L	0.056	<0.003	0.709	0.5
Temperature, °C	20.2	22.3	22.4	25-31
Copper, mg/L	0.031	0.0245	0.0229	0.02
Iron, mg/L	0.1815	0.0893	0.1381	1
Fecal Coliform, MPN/100ml	130	79	220	200
Total Coliform, MPN/100 ml	2,400	350	2,400	3,000
Benzene	ND	ND	ND	0.01

Parameters/ Station	FW-1	FW-2	FW-3	DENR Standard for Class C Waters
Date and Time of Sampling	April 3, 2018/ 1400H	April 3, 2018/ 1500H	April 3, 2018/ 1530H	
Toluene	ND	ND	ND	0.7
Ethylbenzene	ND	ND	ND	0.3
Xylene	ND	ND	ND	0.5

Note: ND-below the method detection limit: Red color are the results that exceed the limit.

2.2.3.3 Marine Water Quality

For marine water quality, the following results of marine quality monitoring presented in Table 2.2.3.3.1 were conducted for the first time. Results show that all levels of parameters are below the standards set by DENR for Class C Waters except for Chlorides in both stations. The exceedance in Chlorides may be attributable to the effluent of other contributors in the freshwater body where the samples were taken because there are no Chloride discharges from RCBM that will contribute to the said exceedance. **Figure 2.2.3.3.1** presents the marine water quality sampling stations.

Table 2.2.3.3.1: Results of Marine Water Sampling Analysis

Parameters/ Station	SW-1	SW-2	DENR Standard for Class C Waters
Date and Time of Sampling	April 3, 2018/ 0830H	April 3, 2018/ 1500H	
pH	7.73	7.45	6.5-8.5
Color (Apparent), PCU	10	10	75
TSS, mg/L	1	2	<30 mg/L increase
Oil & Grease, mg/L	1.05	1.15	2
Chlorides, mg/L	39,307	22,482	250
Nitrates, mgNO$_3$-N/L	0.1	0.645	7
Phosphate, mg/L	<0.003	<0.003	0.5
Temperature, °C	20.2	20.5	25-31
Copper, mg/L	0.0132	0.0164	0.02
Iron, mg/L	0.0498	0.0893	1
Fecal Coliform, MPN/100ml	130	79	200
Total Coliform, MPN/100 ml	350	130	3,000
Benzene	ND	ND	0.01
Toluene	ND	ND	0.7
Ethylbenzene	ND	ND	0.3
Xylene	ND	ND	0.5

Note: ND-below the method detection limit: Red color are the results that exceed the limit.

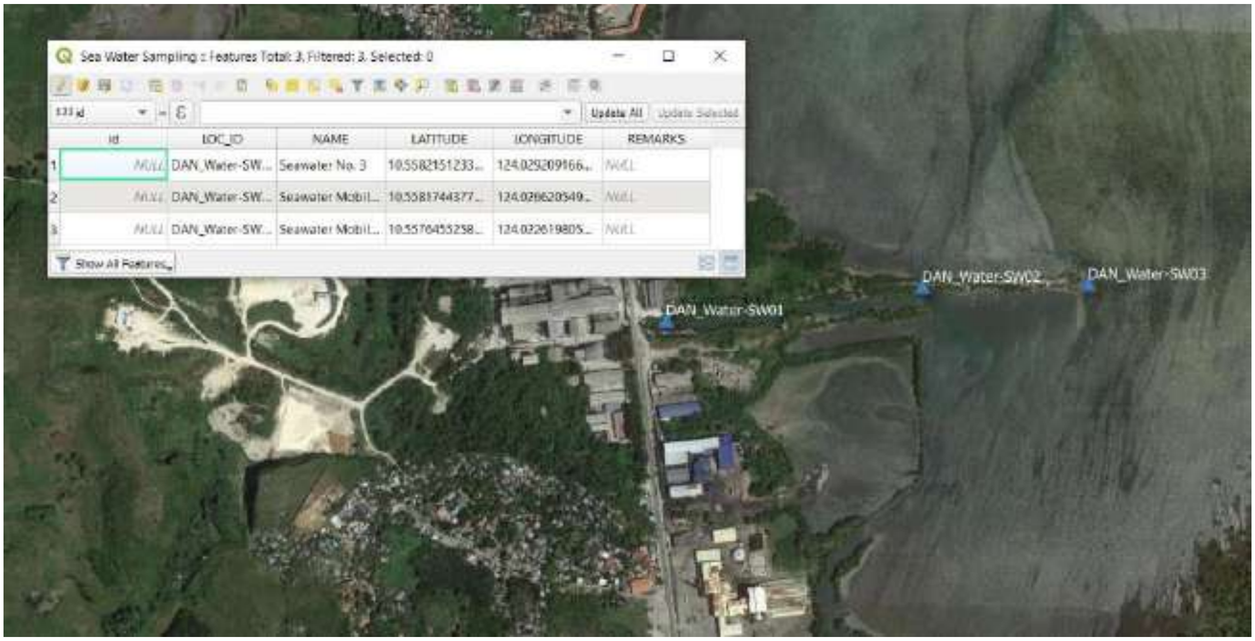


Figure 2.2.3.3.1: Marine Water Quality Sampling Stations

2.2.3.4 Effluent Quality

The following additional effluent quality monitoring was part of the data presented in Table 2.2.3.1 to assess the water quality of RCBM's wastewater. The results of effluent quality monitoring are presented in Table 2.2.3.4.1 below.

Table 2.2.3.4.1: Effluent Quality Monitoring Results for 2019

Name	Sample Description	Date of Issue	Parameters (Unit) *Method*									
			pH (--)	Temperature (°C)	Biochemical Oxygen Demand (mg/L)	Total Suspended Solids (TSS) (mg/L)	Oil and Grease (mg/L)	Surfactants (mg/L)	Phosphates (mg/L)	Fecal/Thermotolerant Coliform (MPN/100mL)	Ammonia as NH3-N (mg/L)	Nitrate as NO3--N (mg/L)
WW ANALYSIS Feb 13, 2019	Oil and Water Separator (10:47 AM)	2/27/2019	8.0	28	3	24	<1	0.19	0.04	54x102	*<0.03	*0.57
EFFLUENT APRIL 2019	Settling Tank (discharge) (11:46 AM) N= 10° 33' 31.8" E= 124° 01' 20.9"	4/16/2019	7.1	27	1	10	<1	0.14	<0.01	<1.8	0.10	*1.24
EFFLUENT MAY 2019	Wastewater Settling Tank Effluent (11:16 AM)	5/21/2019	7.9	29	5	6	<1	0.13	<0.01	24x102	0.43	*2.39
EFFLUENT JULY 2019	Wastewater Effluent (03:00 PM)	7/26/2019	8.8	30	14	49	<1	0.12	0.08	4.5	*0.11	*1.31
EFFLUENTAUG August 2019	Wastewater Effluent (12:10 PM)	9/3/2019	7.8	31	6	<2	<1	0.22	<0.01	<1.8	*0.18	*2.96
EFFLUENTOCTOBER 2019	Wastewater Effluent (04:10 PM)	11/5/2019	8.0	30	17	10	<1	0.32	<0.01	<1.8	*0.41	*1.17

Provided below in Figure 2.2.3.3.2 is the existing Water Quality Sampling Stations while Figure 2.2.3.3.3 shows the old water quality sampling map used in the old EIS.

Figure 2.2.3.3.2: Existing Water Quality Sampling Stations

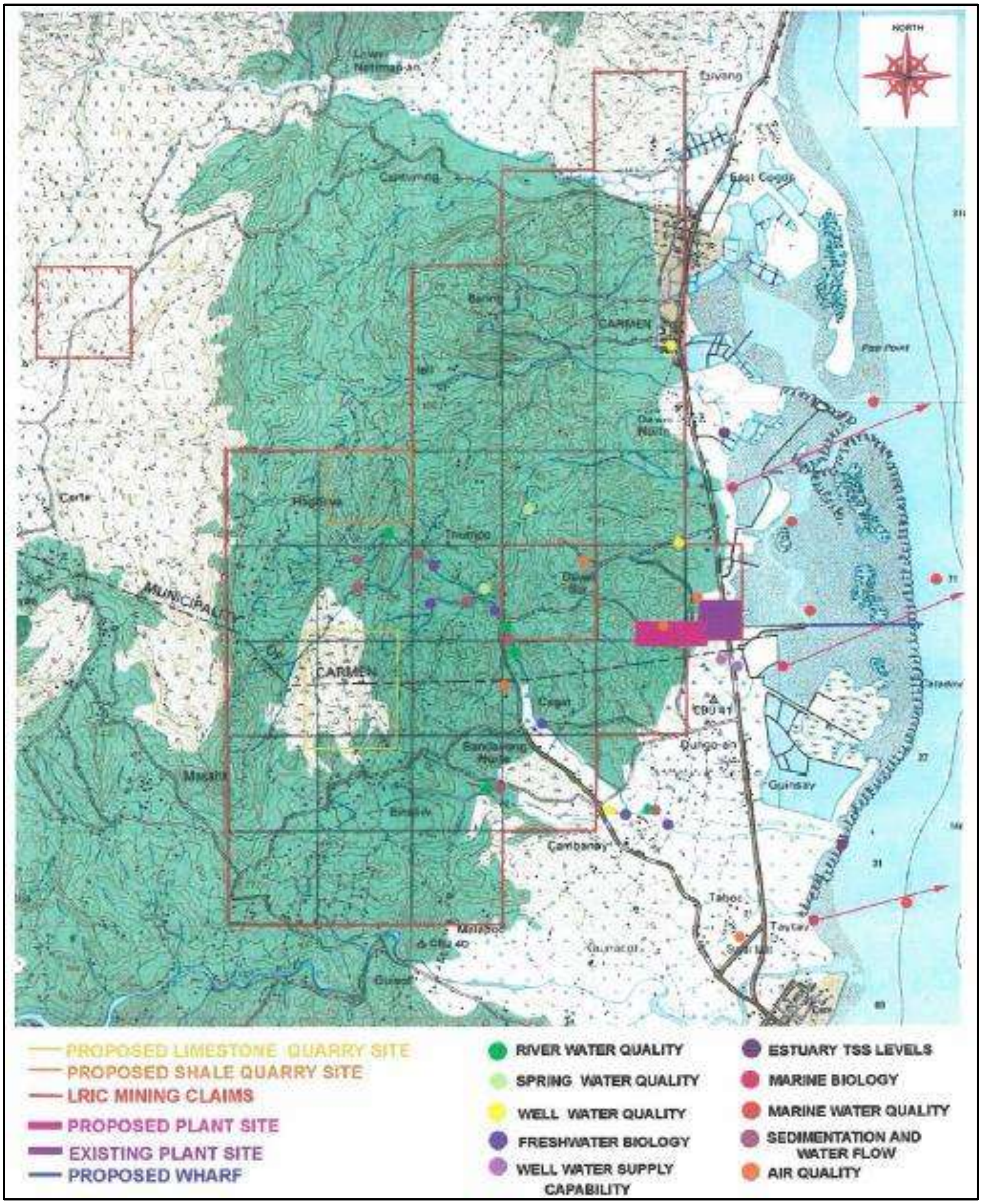


Figure 2.2.3.3.3: Old water quality sampling map used in the old EIS

2.2.3.5 Degradation of Groundwater, Freshwater and Marine Water Quality

The project will not generate process wastewater and this is dry in nature. Wastewater generated during operations phase which include domestic wastewater may enter groundwater through seepage or through freshwater and sea water bodies as surface runoff. The wastewater may degrade the water quality in these areas.

Wastewater is managed using the existing sanitation facilities of the plant. However, wastewater generated by the workers especially at the quarry sie may cause deterioration of the existing water quality if inadequate portable toilets are not provided at the quarry site. Fuel, lubricant and hydraulic oil discharges from poorly maintained equipment, machineries and heavy vehicles will also impact on water quality.

RCBM is implementing a management plan which is strictly being implemented. During repair of equipment and machinery, containers/drip trays are used to collect leakage. Any spilled or spent oil is collected and disposed by an accredited waste hauler and transporter. Scheduling of excavation activities during dry season if possible will be applied to reduce impact of soil erosion and sedimentation of waterways. Storm runoff will be directed through the siltation pond system prior to discharge to the channel. Contaminated rainwater in the maintenance area will be directed to the oil and water separator before discharge to the drainage system. A regular inspection and maintenance of the siltation pond will be conducted to avoid leakage, which can pollute the drainage system. Quarterly monitoring shall continuously be conducted.

2.2.4 Freshwater Ecology

Freshwater ecology assessment was conducted to establish baseline ecological parameters in the three (3) river systems and to determine the presence of important aquatic fauna that can be susceptible to potential anthropogenic issues that can arise during the establishment and operation of the project, particularly sediment streams. The assessment was focused on determining plankton community structure, presence of fish biota, macro-invertebrates, macro-benthos, and other river fisheries resources that can be susceptible to the operation of the project.

The assessment aimed to record fisheries uses and other aquaculture practices in the river system if present at the time of the survey. More importantly, documentation of actual fishing operations, catch composition and catch rates in the river estuary – which a communal fishing ground - was included. The result of actual river fishing documentation was supplemented by key informant interviews in communities living beside the banks of the Luyang River. The survey thus aimed to identify species of fish in the river system particularly focusing on species of significant value for food or fisheries trade. For plankton communities, all of four stations were subjected to biotic sampling for phytoplankton, zooplankton, and epibenthic benthos communities. The survey also aimed to identify and catalogue other macro-invertebrates of significant economic value for food and livelihood through core sampling and opportunistic surveys in all stations but the presence of bivalves and gastropods were significant only in the estuary station where gleaning for bivalves and gastropods was witnessed and documented

In the estuary, the presence of mangroves and seagrass meadows right in the river mouth required surveys for these resources, employing standard line-quadrant methods.

Freshwater ecology assessment was conducted in four (4) sampling stations in the upstream, midstream and downstream (estuary) sections of the Luyang River in Barangay Luyang, Carmen which is the main freshwater body traversing the northern sector of the MPSA of the Project on December 14-15, 2019 (**Figure 2.2.9**). Additional assessment was conducted at six (6) sampling stations in the upstream, midstream and downstream (estuary) sections of the Ipil River and the Cagat River on January 23-26, 2020 (**Figure 2.2.10**). Both river systems are located in the primary impact area of the project, with the Ipil River passing through the northern MPSA of the RCBM and the Cagat River in the middle to southern portion of the MPSA. The nearest segment of Cagat River to the project plant site is about 2 km northwest. The Ipil River is more than 2.5 km north of the plant site.

The Luyang River is a perennial system that emanates from the central Cebu highlands in Danao, fed by watersheds around Mt. Mago and Mt. Uragay in the vicinity of Baranggay Upper Natimao-an (**Figure 2.2.11**). It flows in a meandering easterly direction running more than 8km passing through four Barangays in Danao before emptying into the southern Camotes Sea. Although the river itself does not support extensive fisheries, the Luyang River estuary is a popular fishing ground for small-scale fishers, with seasonal occurrences of anchovies and sardines providing a significant portion of the catch. A portion of the Luyang River also traverses the northern part of Republic Cements MPSA in Carmen. Although it is not classified as a major river system by the National Water Resource Board, the Luyang River serves several significant uses. Cebu Water draws water from the river in the vicinity of Barangay Corte where a dam has been built by the company. Water drawn from river eventually supplies Carmen and Danao City with potable water. In addition, at least three (3) spring resorts in upper Carmen utilize water from the river to supply its swimming pools. The popular Mangitngit Falls is also fed by the Luyang River. Along its lower course, poultry farms, croplands and the Shemberg Carrageenan Company, among others, are the other major river users. Although the river itself does not support extensive fisheries, the Luyang River estuary is a popular fishing ground for small-scale fishers, with seasonal occurrences of anchovies and sardines providing a significant portion of the catch. The river itself is also a popular bathing area (**Plate 2.2.1**).

Both the Ipil and Cagat Rivers are intermittent freshwater systems. The Ipil River emanates from the highlands of Carmen in the vicinity of Mt. Uragay and empties into the Camotes Sea passing through Poblacion Carmen. Key informants claim that the Ipil River has just been recently flooded and dries up during the peak of the dry season. At the time of the survey, some portions of the river had meager water and were almost stagnant. However, a small water impoundment system is found in its upper reaches and which is a popular bathing area in the summer months. Unlike in Luyang, there are no industrial establishments along its course and river fisheries in no longer being practiced. Its estuary is small but opens up to a wide mangrove patch of *Avicennia marina* and *Sonneratia alba*. In the estuary itself, the riverbank is populated with sporadic mangroves, aroma trees and *Nipa fructicans.* Fishers in the vicinity of the estuary claim insignificant fisheries production in the estuarine area due to its small size and heaps of trash that block parts of the river.

Cagat River emanates from the Central Cebu Protected Landscape, meanders through four upland Barangays of Danao, before emptying in the southern region of Camotes Sea through a wide lagoon between Barangays Suba and Taytay south of Poblacion. The Cagat River estuary empties in the vicinity of Brgy. Taytay in a sandy-muddy flat with sporadic trees of *Avicennia marina, Sonneratia alba* and aroma trees bordering the estuary riverbanks. The Cagat River trickles down to a small stream with pockets of pools during the peak of the dry season. Fishers living near the estuary claim that the Cagat River does not support an extensive fishery as few species of fish inhabit the system.

Between the Ipil River and Cagat River, extensive sandy flats, patches of mangroves, seagrass meadows occur in lagoons that fringe the shoreline. Recreational facilities, industrial establishments that include ship building and drydocking facilities, as well as human settlements occur in the shoreline.

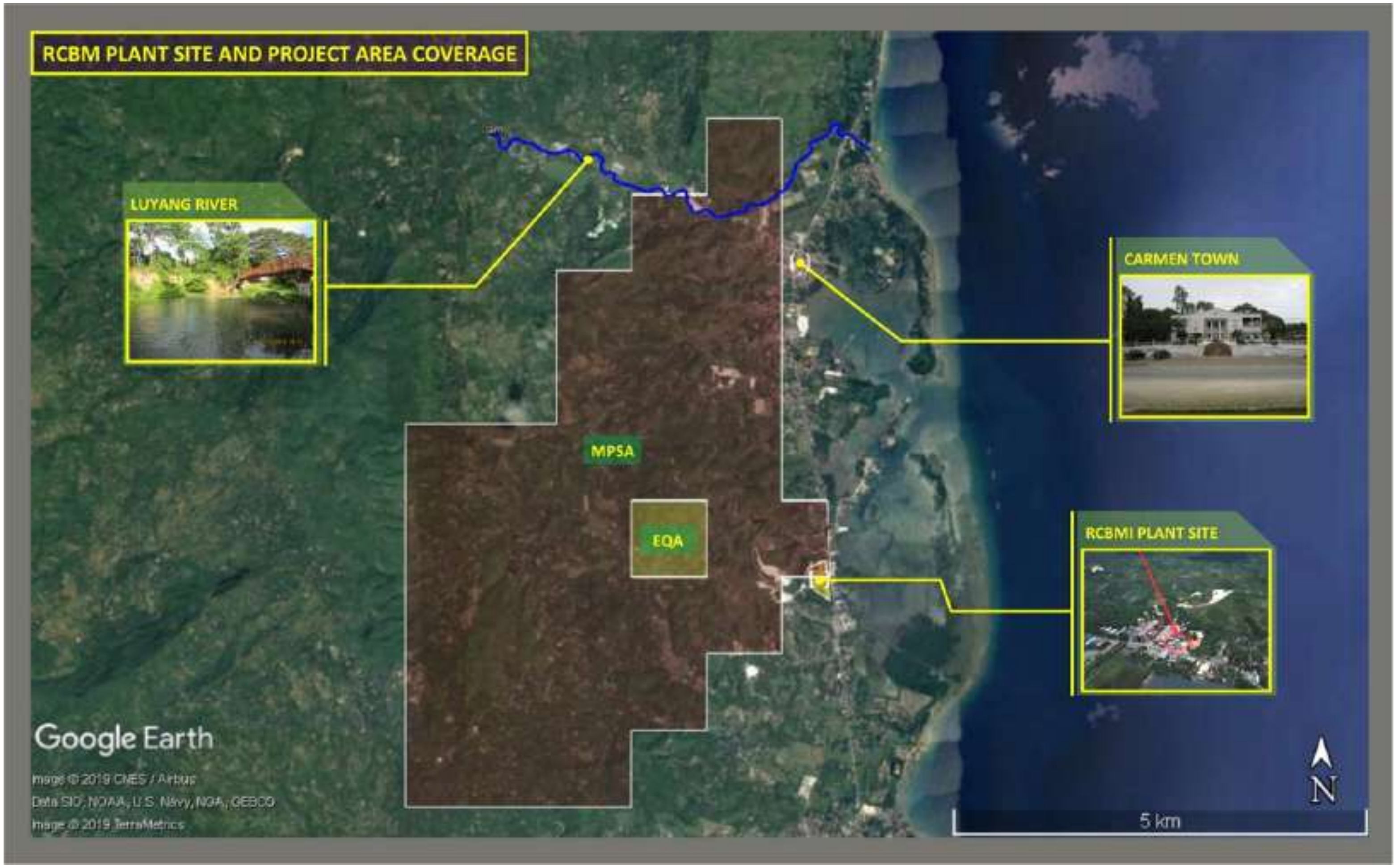


Figure 2.2.8: Map showing the Luyang River flowing across the northern region of the Project Site

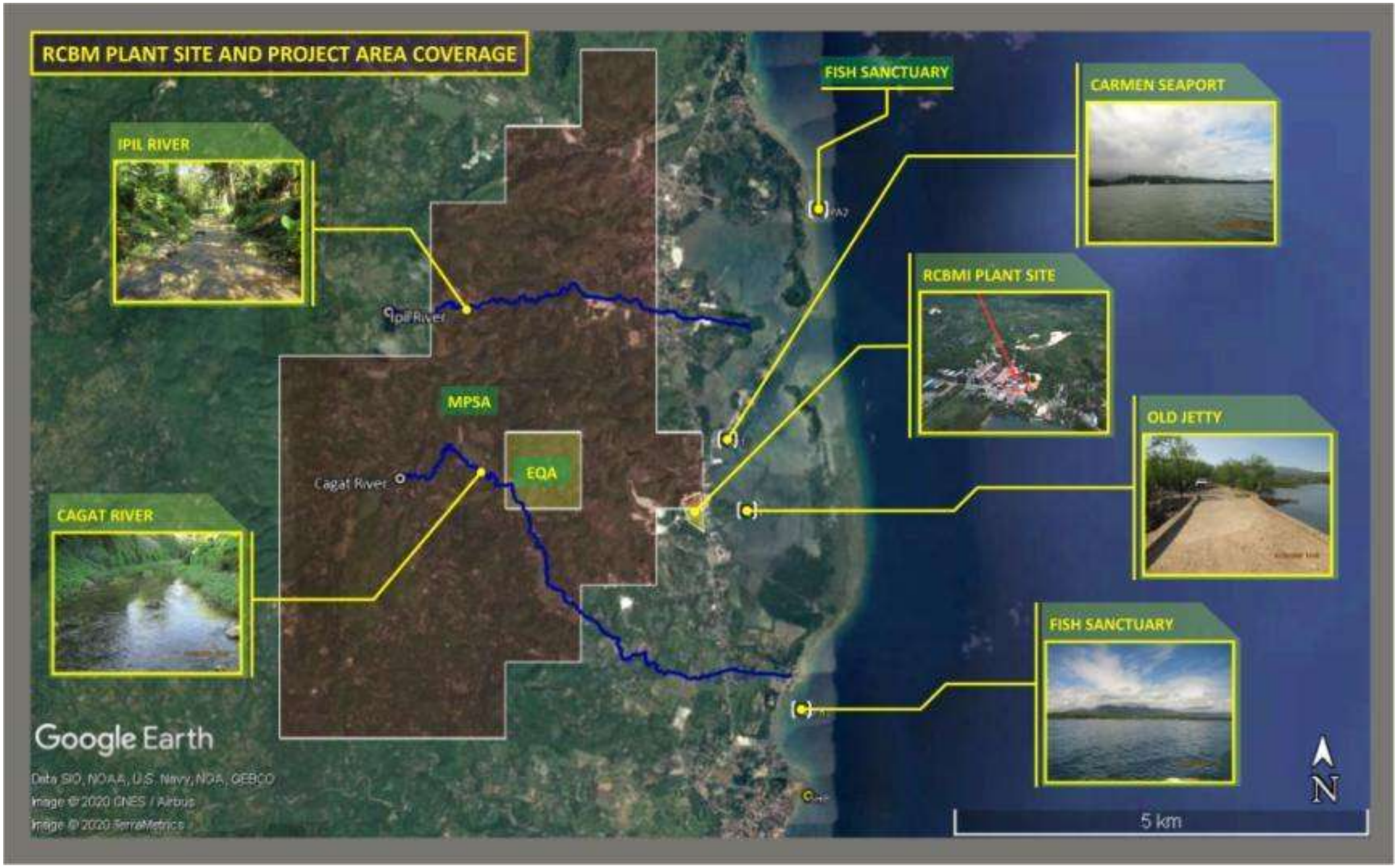


Figure 2.2.9: Map showing the Ipil and Cagat Rivers flowing across the central and southern region of the Project Site

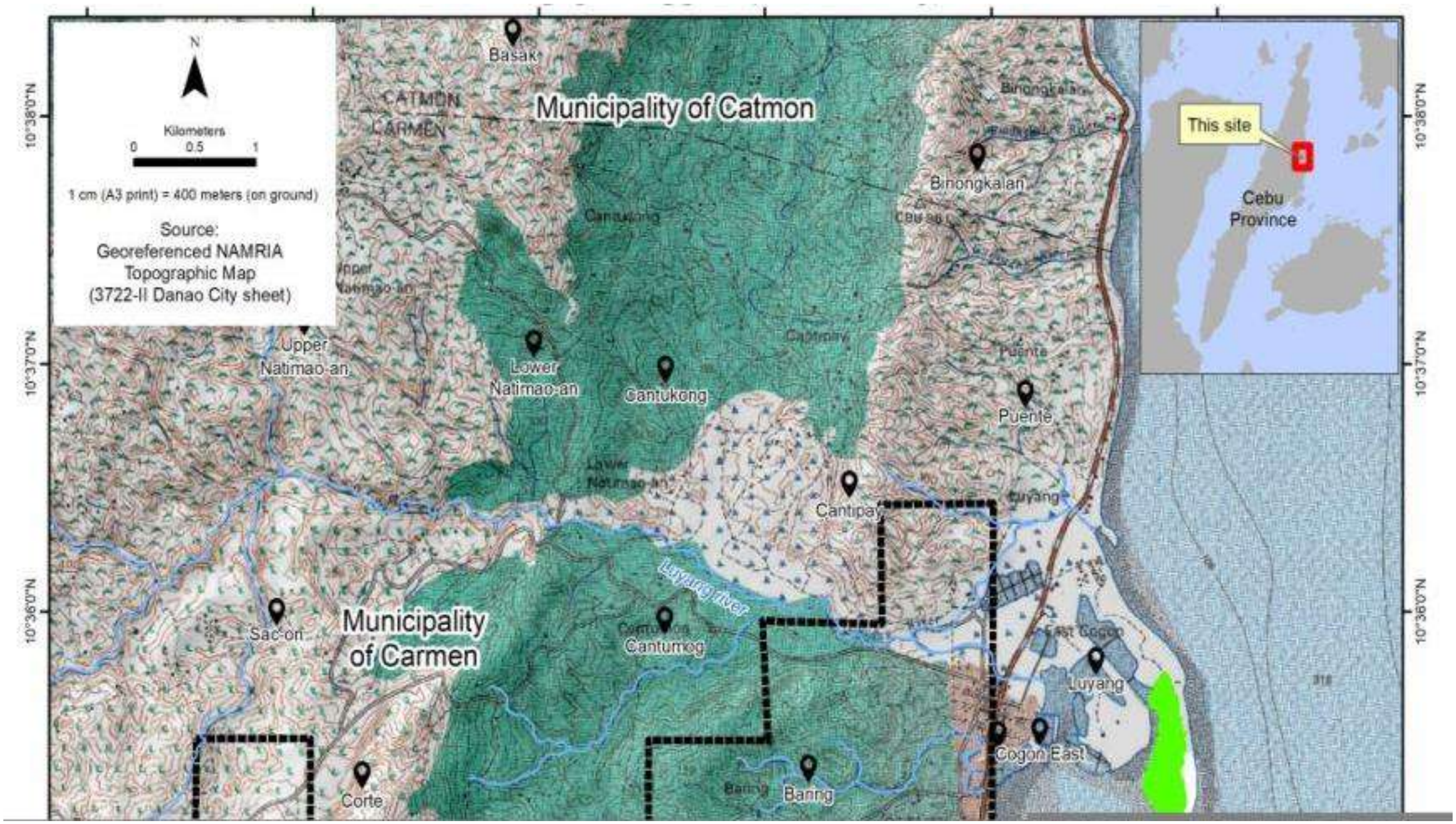


Figure 2.2.10: Map showing the Luyang River, flowing in an easterly direction in the northern vicinity of the Project Site

Note: The Luyang River in Carmen, Cebu is a source of water for the Cebu Water, several resorts and a popular communal bathing area. The Ipil River and the Cagat River estuary are intermittent systems that supply water for croplands beside the rivers.

Plate 2.2.1: Luyang River (top photos), Ipil River (lower left photo), and Cagat River Estuary (lower right photo)

Sampling Parameters and Methodology

(i) River Physical properties

Parameters describing the basic morphology of the rivers were documented *in situ*. Among others, this included riparian width, substrate composition, dominant riverbank vegetation, depth, temperature, river surface flow velocity measurement and total dissolved solids (TDS). Where depth permits, turbidity measurements were undertaken using a standard secchi disc. Total Dissolved Solids (TDS) was measured employing a portable E-1 TDS and EC meter.

(ii) Aquatic Biota - Plankton

Composition, abundance and density of phytoplankton communities was determined using standard methodologies, including plankton net surveys, Shannon-Weaver Diversity/Evenness Indices and bio-assessment metrics. Plankton community quantitative and qualitative analysis through water sampling was conducted in six (6) stations. As river water was not deep enough in all sampling stations to permit collection of samples through vertical towing employing a 20 µm Plankton net (**Plate 2.2.2**), plankton water samples were collected by scooping ten water replicates in pools and streams. Morphological characteristics were used as the basis for the identification of the different plankton species. After fixing the samples with Lugol's solution (10mL:1L), the samples were transported to the UP MSI laboratory for counting and identification, where 1 ml aliquot samples were taken for plankton identification and enumeration under a Zeiss Axioskop II Microscope. Identification of the phytoplankton organisms using the taxonomic guide of Tomas (1997) were done up to species level whenever possible. Nannoplankton and piccoplankton were not included in the phytoplankton identification. Cell counts up to 200 cells were made using a Sedgewick Rafter counter chamber. Diversity (H') and evenness (J') index was computed according to Shannon-Weaver (1963) and Pielou (1966) considering only the identified organisms at genus and species level. Counting and identification of organisms was conducted using a Sedgwick-Rafter plate. For zooplankton, a dissecting microscope was used. Phytoplankton were counted and identified to the lowest taxonomic level (genera) possible while zooplankton were identified to major groups using available references. Phytoplankton and zooplankton densities are presented as number of cells or organisms per liter.

Plate 2.2.2: Plankton Sampling in Luyang River (left) and Macrobenthos Sampling in the Cagat River (right)

(iii) Macrobenthos

Benthic macrobenthos were collected through core sampling of benthic and epibenthic benthos using a Surber kick net and trowel in the same stations as plankton community sampling. Identification of other macro-invertebrates, particularly those with significant economic value for food and trade was supplemented through opportunistic surveys along the riverbanks with special attention of macro-invertebrates of significant value in the estuary station where gleaning activities by local residents is commonplace. Identification of animals collected were undertaken in-situ or in case of minute organisms, in the UP MSI laboratory.

(iv) Fish Biota

Determination of common species of fish in the river, if present, was undertaken through key informant interviews and actual fishing using a bottom set gill net in the estuary. Actual observation of fish species in the upstream stations were undertaken through opportunistic observations in river pools with submerged vegetation and natural fish shelters along shallow and calmer portions of the river. This was reinforced with 100-meter transect walks along the river for chance identification of fish species and macro-invertebrate species, if any are encountered. Observation of fish and crustacean species present in the river was also undertaken in the same stations where plankton sampling was undertaken. Fisheries information was supplemented by documentation of actual fishing operations of a fisher using hook and line fishing gear encountered in the estuary survey station in Luyang River. There were no fishers in the Ipil and Cagat River estuaries at the time of the survey.

(v) Macro-invertebrates of significant value for food and/or trade

Many species of benthic organisms occurring in the tidal flats and rock pools east of the mangrove patch in the estuary serve as supplemental food for the community but stocks of macro-invertebrates were observed to be thinly distributed presumably due to over-gathering. Macro-invertebrates, like mollusks and bivalves, are usually used for assessment of site – specific effects since they are sessile organisms and their sedentary nature allows effective analyses of pollutants and effects of benthic disturbance, including the presence of biotoxins normally triggered during plankton blooms. The presence of macro-benthos in the sediment is therefore one of the best biological indicators on fertility of the bottom sediment and, on the other hand, the unsuitability of benthic substrates for the viable existence macro-invertebrate populations, at times brought about by habitat alteration. The assessment was supplemented with opportunistic observations of the presence of mollusks near the river estuaries, particularly in the Luyang River in as much as the inter-tidal flat near the Luyang estuary is a gleaning area for macro-invertebrates. Opportunistic observations of macro-invertebrate life forms in seagrass areas was also undertaken. Identification of univalves and bivalves were referenced through *FAO's Species Identification Guide for Fisheries Purposes; Volume 1: Seaweeds, Corals, Bivalves, and Gastropods (Carpenter, K. E and V. H. Niem, eds., 1998).*

2.2.4.1 Luyang River

Four sampling stations – one (1) upstream, two (2) midstream and one (1) station in the estuary were investigated for standard river physical parameters, plankton community structure, total dissolved solids, fish biota, and river uses, if any. The sampling stations are located in four (4) Barangays of Carmen, with the farthest upstream station located about 2 km from the Project's MPSA and more than 5 km from the plant site. The portion of the river nearest to the proposed project is Station 3, which is located in the primary impact area about 800m from the MPSA of the project.

The coordinates of the four (4) stations surveyed in Luyang River for river parameters, aquatic biota, and plankton are listed in **Table 2.2.6** and shown in **Figure 2.2.12**. For fish diversity in the estuary, one station was investigated with actual fishing documentation, as shown in **Figure 2.2.13**. The coordinates of the actual fishing documentation are N 10.604652°, E 124.026490°.

Macro-invertebrate surveys were undertaken in two (2) stations in the Luyang River, both of which were located in shelf in front of the mangroves in the estuary, as shown in **Figure 2.2.14**. Station coordinates are N 10.604556° and E 124.027086°; and N 10.606656° and E 124.022934°.

Table 2.2.2: Location of Sampling Stations for Basic River Parameters, Plankton, Macrobenthos and Aquatic Biota in Luyang River, December 14-15, 2019

Station Code	LATITUDE	LONGITUDE	Survey date and time	Remarks
RVR1	N 10.604939°	E 123.986121°	12/14/2019 1405H	Located in upstream section of Luyang River in Brgy. Corte some 500 m upstream of the Cebu Water dam and water treatment facility.
RVR2	N 10.603940°	E 123.996672°	12/14/2019 1113H	Located about 100 m downstream of Barangay Cantipay spillway bridge; about 1 km NW of project MPSA.
RVR3	N 10.606656°	E 124.022934°	12/15/2019 1228H	Located in portion of Luyang River with concrete revetments along the riverbanks, 300 m west of Luyang Bridge in Brgy. Luyang, Carmen, Cebu. Station is about 1.2km from main project site.
RVR4	N 10.603967°	E 124.027125°	12/15/2019 1334H	Located in the Luyang River estuary in Brgy. Fuente, Carmen. The river mouth is about 5km from the main project plant site.

Figure 2.2.11: Map Showing Location of River Ecology Sampling Stations (December 14-15, 2019)

Figure 2.2.12: Location of Actual Fishing Documentation (December 14-15, 2019)

Figure 2.2.13: Location of survey station for macro-invertebrates of significant value for food and trade (14-15 December 2019)

2.2.4.1.1 Station Profiles, Fish and Macro-invertebrate Biota

2.2.4.1.1.1 Station 1: Luyang River Upstream

Characteristics/Morphology

Freshwater ecology Station 1 is located in a scenic portion of the Luyang River upstream of the Cebu Water dam. The station is about 2km west of the project's MPSA boundary in Carmen, Cebu (**Figure 2.2.15**). The width of the river between both riverbanks varies from 3m to 4m, with the upper section of the river station cascading through rocks (**Plate 2.2.3**), with rifle pools downstream. Dense tree vegetation in some portions has resulted to considerable canopy and leaf litter production. However, no significant periphyton-feeding benthic communities were observed. Depth of the sampling area is almost 1m, with sand, rocks and pebbles dominating the riverbed. Canopy along the banks is thick, with a mixture of old growth trees and dense foliage. No households or crops were seen along the riverbanks. River water is only slightly turbid with total dissolved solids measured at 234 ppm. In view of the cascades, average stream water velocity was relatively rapid, measured at 0.28 m/s (**Table 2.2.7**).

Plate 2.2.3: Sampling Station 1 in Luyang River (December 14-15, 2019)

River Uses and Fish/Macro-Invertebrate Biota

Key informants living near the river claim that there are no fishing activities or river recreational activities being undertaken in station 1 in Luyang River. The informants further asserted that they have not observed anadromous fish or crustacean species migrating into the upper reaches of the river. There were no fishing activities observed at the time of the survey and no set traps were seen in a 100m transect walk. River biota was insignificant with only sporadic occurrence of the apple snail *Pomacea sp* documented during opportunistic surveys for macro-invertebrates. Test fishing using a scoop net in calm areas suspected to refuge aquatic organisms in riparian portions yielded no fish species.

Figure 2.2.14: Location and Basic Chracteristics of Freshwater Ecology Station 1 (upstream) in Luyang River (14-15 December 2019)

2.2.4.1.1.2 Station 2: Luyang River Upper Midstream

Characteristics/Morphology

Station 2 is located about 300m upstream of the Cebu Water dam and less than 1km from the boundary of Republic Cement's MPSA in Barangay Cantipay, Carmen (**Figure 2.2.16**). This portion of the river is located near a bridge for crossing of tricycles going to Barangay Cantumog. A spillway has been built below the bridge. There is no inter-locking tree canopy although large acacia trees permit significant shaded areas. Periphyton were observed in rocks and cobble stone that carper the riverbed. The width of the Luyang River in this site varies from 6m to 7m, with light green water, average depth at 54 centimeters (cm) and surface stream flow velocity of 0.68m/sec (**Plate 2.2.4**). With only slight turbidity, total dissolved solids (TDS) was measured at 223 ppm. Households situated along the riverbanks tended crops and trees dominated by mahogany, bamboo, coconut, and banana.

River uses, fish biota and macro-invertebrate biota

Even as households dot the riverbanks near the sampling station, no significant fishing activities, aquaculture or stationary fishing gears (e.g., 'baklad') were encountered in the sampling area and contiguous river lagoons. However, fishers in the area who were interviewed on the presence of fish species in the river claimed that several species of fish inhabit the river, including 'bugaong' (convex-lined theraponid *Therapon jarbua*), 'kasili' (freshwater eel *Anguilla sp*), "pantat" (river catfish *Clarias sp*), tilapia (*Oreochromis sp*) and the local "Bia" (Goby; Family *Gobidae*). In addition, key informants claim that the "pasayan" (*Nematopaleomon tenuepsis*) were occasionally seen in the river albeit in very small numbers in previous years. However, a 100m river transect walk to spot fish or crustacean species in riparian areas and stream pools yielded negative results even with the use of a scoop net. In addition, key informants declared that "fish kills" have occurred in the river, presumably brought about the discharge of wastewater or used water from resorts or farms upstream of the station. After the 'fish kills', fishing activities, even as they were sporadic, were no longer undertaken in the river.

Plate 2.2.4: Sampling station 2 in the Luyang River (14-15 December 2019)

There were no macro-invertebrates of commercial significance for food or trade observed in river ecology Station 2. Two (2) species of macro invertebrates – the freshwater trumpet snail *Tarebia granifera* from the family Thiaridae, and the apple snail *Pomacea sp,* both with no economic value, were documented during opportunistic observations (**Plate 2.2.5**). *Thiara* snails are considered invasive herbivores and bioturbators. In terms of conservation status, it is categorized as "least concern" according to the IUCN red list of threatened species indicating that that no conservation action is needed. Ecologically, both species are very adaptable and resilient in various environmental conditions with species commonly found in rivers including tidal areas, and lakes, and a wide variety of anthropogenic habitats including pools, and canals.

Note: invasive thiarid Tarebia granifera (left) and Pomacea sp (right)

Plate 2.2.5: Two Species of Freshwater Gastropods –were Documented in Freshwater Ecology Station 2 in the Luyang River (December 14, 2019)

Figure 2.2.15: Location and basic freshwater ecology parameters recorded in station 2 (midstream) in the Luyang River (14-15 December 2019)

2.2.4.1.1.3 Station 3: Luyang River Lower Midstream

Characteristics/morphology

Freshwater ecology sampling station 3 is located about 180 meters west of the Luyang bridge and 800m from the coastline. The sampling site is less than a kilometer from the northern sector of the MPSA. Both riverbanks in this station are fortified with concrete rip-rap and few vegetation, except for acacia trees, coconut trees and shrubs, occur beyond the revetments (**Plate 2.2.6**). Width of the river was measured at 9 meters, depth at 54 cm and surface velocity at 0.68m/sec. Riverbed substrate consisted of sand, pebbles and rocks. Water was light green, with total dissolved solids measured at 1986 ppm. This station is largely open canopy and pools of calmer river water suggest dense plankton growth. A summary of river parameters catalogued in station 3 is shown in **Figure 2.2.17**.

Plate 2.2.6: Sampling station 3 in the Luyang River (14-15 December 2019)

River uses, fish and macro-invertebrate biota

Similar to Station 2, key informants declared that previous "fish kills" that occurred in the river allegedly caused by periodic release of wastewater from an industrial firm along the river has eliminated most of the fish species that inhabit the river. The loss of fisheries productivity subsequently deterred all types of fishing activities. No fishing operation was seen during the survey. However, fishers in the area who were interviewed claimed that several species of fish still inhabit the river, including 'bugaong' (convex-lined theraponid *Therapon jarbua*), 'kasili' (freshwater eel *Anguilla sp*), "pantat" (river catfish *Clarias sp*), tilapia (*Oreochromis sp*) and the local "Bia" (Goby; Family Gobidae). Indeed, groups of gobies and convex-lined theraponids were observed in the calmer portions of the river, particularly in pools (**Plate 2.2.7**).

Similarly, no significant populations of macro-invertebrates were observed around the sampling area, except for apple snails *Pomacea sp* and empty carapace of the common oyster. No live oysters were seen even as extensive opportunistic surveys around the area were conducted. The demise of the oyster population cannot be ascertained at the time of the survey.

Plate 2.2.7: Gobies (left photo) and Theraponid Fish Species, along with Empty Oyster Shells (right), the Only Riverine Biota Catalogued in Station 3 in the Luyang River

Table 2.2.3: Summary of River Parameters for Luyang River; 14-15 December 2019

River Station	Location	Depth (average)	Width (range)	Substrate	Color	Mean Stream Flow Velocity (surface)	Turbidity (Secchi Disc; cm)	TDS (ppm)	Riverbank vegetation
RVR1 River Upstream	Bgy. Corte, Carmen, Cebu	94 cm	3-4m	Sand and pebbles, rocks	Light green	0.284 m/sec	65 cm	234 ppm	Thick foliage; hardwood trees
RVR2 upper midstream	Bgy. Cantipay, Carmen	54 cm	6-7m	Rocks, sand, some silt	Light green	0.68 m/sec	Too shallow	223 ppm	Dense vegetation - Hardwood trees, bamboo, banana, ferns
RVR3 Lower midstream	Bgy. Luyang, Carmen	54 cm	9 m	Pebbles, sand, rocks	Light green	0.68m/sec	NA	1986 ppm	Concrete revetments on some portions; grass on riverbanks; acacia trees
RVR4 Downstream (estuary)	Bgy. Fuente, Carmen	42 cm	15m	Sand, mud, pebbles	Green	0.22m/sec	Too shallow	4200 ppm	Thin strip of mangroves in northern flank; concrete revetments

Figure 2.2.16: Location and basic parameters recorded in freshwater ecology station 3 (lower midstream) in the Luyang River; 14-15 December 2019

2.2.4.1.1.4 Station 4: Luyang River Estuary

Characteristics/morphology

The Luyang River estuary in Bgy. Fuente, Carmen is more than 5km from the Cement plant in Danao City, Cebu and about 300m from the Brgy. Luyang Bridge. The river opens to a mouth of about 15m from bank to bank, with heavily turbid waters in a substrate of mud, sand and rocks (**Table 2.2.7**). Significant portions of the river have been fortified with concrete revetments. Total dissolved solid was measured at 4200 ppm; depth in the center was measured at 42 cm. The shelf in front of the estuary is relatively wide, extending to about 200m from the river mouth, characterized by undulating sand bars and alluvial deposits. The southern portion of the coastal shelf hosts patches of seagrass that are popular gleaning areas for edible macro-invertebrates. A mangrove patch of less than 2 ha fringe the northern coastline while dense households are found in the south. A summary of river parameters recorded in station 4 is shown in **Figure 2.2.18**.

River uses, fish and macro-invertebrate biota, result of actual fishing

The shallow coastal sea in front of the estuary is a favored fishing ground from Barangay Fuente due to the fact that many marine species prefer to graze in brackishwater environments. In fact, some lucrative species spend part of their life cycles in estuaries, including mullets, penaeid shrimp, blue crab, wrasses, rabbitfishes, and trevallies. In view of this, gears used for fishing activities by the resident fishers in Barangays Fuente and Luyang are consist of hook and lines, bottom-set gillnet, surface gill net and cast net. The catch is erratic and has been declining in the past ten years. Fisher key informants claim that catches of shrimps in the river mouth is no longer profitable, averaging less than 1kg per fisher per day for a four hour fishing time. Catch of blue crab is likewise seasonal, normally during the rainy season where bottom-set gillnet can capture at least 3-6 pieces of mud crabs and blue crabs as by-catch after a nightlong setting. By any standard, the catch rate and catch composition is poor and is indicative of deficient fisheries productivity.

Two actual fishing operations were documented *in-situ t*o determine (i) fishing gears used, (ii) common catch composition, and (iii) catch rates. The first operation involved a surface gill net which was set across the river about 100m from the estuary. Two settings of the gear yielded no fish (**Plate 2.2.8**).

Plate 2.2.8: Two Actual Fishing Operations Documented in the Estuary of Luyang River

The second gear involved hook and line that revealed a low catch per unit effort (CPUE) of 1.5 kg in 3 hours of operation (or 0.5 kg/fishing hour), consisting of garfish (*Hemiramphus robustus*), theraponid (*Therapon sp*), cardinalfish (*Apogon sp*), blue crabs (*Portunus pelagicus*), snapper (*Lutjanus fulvus*), and the common whiting (*Sillago sihama*) (**Plate 2.2.9**). Altogether, fisheries in the Luyang River and its estuary have a narrow species diversity (**Table 2.2.8**). None of the species of fish catalogued in the estuary are classified by the IUCN as either endangered, threatened or endemic. Fisheries productivity is, however, boosted by the seasonal influx of sardines and a species of herring (*Engraulis japoonicus*, aka Japanese goby) from December to January (**Plate 2.2.10**). These species migrate very close to the Luyang River estuary.

Plate 2.2.9: Catch from a 3-hour hook and line operation documented in-situ yielded seven (7) species of fish weighing approximatrely 1.5 kg in 3 hours fishing time

Table 2.2.4: Common catch composition of species of fish caught in the Luyang River estuary and inner river fishing grounds

Family	Species Name	Local Name	Common Name
Sardinella	*Sardinella lemuru/pacifica*	Tamban	Bali sardine
Sillaginidae	*Sillago sihama*	Aso-os	Common whiting
Gobiidae	*Glossogobius sp*	Biya	Goby
Theraponidae	*Terapon jarbua*	Tunghod/Bugaong	Covex-lined teraponid
Mugilidae	*Mugil cephalos*	Banak	Flathead mullet
Lutjanidae	*Lutjanus quinquelineatus*	Saging-saging	Five-lined snapper
Lutjanidae	*Lutjanus fulvus*	Maya-maya	Blacktail snapper
Plotosidae	*Plotosus lineatus*	Hito; Ito	Striped Catfish
Penaeidae	*Metapenaeus ensis*	Suahe	Greasyback shrimp
Penaeidae	*Nematopaleomon tenuepsis*	Pasayan	Freshwater shrimp
Apogonidae	*Ostorhinchus hartzfeldii*	Moong	cardinalfish
Cichlidae	*Oreochromis sp*	Tilapia	Tilapia
Hemiramphidae	*Hemiramphus robustus*	Bugiw	Garfish
Apogonidae	*Apogon cookie*	Buslit	Cardinalfish

Plate 2.2.10: Specimen of sardine (Sardinella lemuru) and herring (Engraulis japoonicus) caught seasonally in the Luyang River estuary

Figure 2.2.17: Location and basic parameters recorded in freshwater ecology station 4 (estuary) in the Luyang River surveyed during freshwater ecology baseline assessment; 14-15 December 2019

2.2.4.1.2 Macro-invertebrates of economic significance in the estuary

Two stations - one near the mangrove patch and the other in the seagrass meadows were investigated for the presence and diversity of macro-invertebrates of significant importance for food and trade by local residents. The stations yielded poor diversity – with two (2) species of ark shells (*Scapharca cornea* and *Scapharca globosa*) dominating the macro-invertebrate population with more than 60 specimens collected in both stations within 1 hour. Other macrto-invertebrates consisted of a lone venus clam *Anadontia sp*, several conch shells (*Strombus sp*), and two species of juvenile sea cucumbers (*Stichopus chloronotus* and *Thelonota ananas); (***Plate 2.2.11***).*

Note: top row: ark shell and venus clam (lower left); bottom row: sea cucumber

Plate 2.2.11: Few Species of Important Macro-Invertebrates Collected in the Estuary of Luyang River

2.2.4.1.3 Plankton Community

2.2.4.1.3.1 Phytoplankton

Phytoplankton encompassed all microscopic algae which drift with currents or float on water surface of an ocean, rivers, lakes and other water bodies. They play a major role as the basis of the aquatic food web, providing essential ecological function of all aquatic life. The many kind of phytoplankton are classified into many different classes, families, genera and species of both marine and freshwater. They have rapid response to environmental changes, and hence their occurrence, species composition and diversity are widely used as biological indicator of the quality of the water conditions.

As a part of the survey to assess the important aquatic communities in Luyang river to be possibly affected by the operation of the project, a water sampling was conducted to determine the plankton composition, abundance, distribution and diversity in four stations representing different river elevations (upstream, midstream and downstream) and up to the river mouth in December 14-15, 2019. Determining species composition is critically important in knowing the identity of all the different organisms that make up a community. Overall, a total of thirty-one (31) phytoplankton species were identified belonging to five (5) major groups, i.e diatoms, dinoflagellates, green algae, euglenophyte and cyanophytes (**Table 2.2.9**). Among these, diatoms were the most dominant phytoplankton group accounting for almost 92% relative abundance (RA) and followed by green algae with 5% RA, cyanobacteria with 2% RA while green algae and euglenoids were almost negligible with a combined total of less than 1% RA (**Figure 2.2.19**). A total density of 2.1 x 10^6 cells/m^3 phytoplankton was quantified in all the stations combined. During the sampling, the station located at the upstream area (station Ph1) of the Luyang River harboured the highest density of diatoms particularly the pennate diatom *Fragilaria* with cell density of 326,667 cells/m^3. Other pennate diatoms like *Gomphonema, Navicula* and *Nitzschia* contributed significance phytoplankton abundance (>250,000 cells/m^3) in this station. Commonly found in tropical freshwater environment, the occurrence of these diatom species indicate clean, eutrophic, shallow and fast-flowing streams and provide a significant influence in the overall primary productivity in in this body of water. The only potentially harmful microalgal taxa recorded was *Oscillatoria* sp. which was reported to bloom at high density and clog water canals and drainage system. The cell density of this species, however, was relatively low to cause major problem, but continuous monitoring is highly recommended.

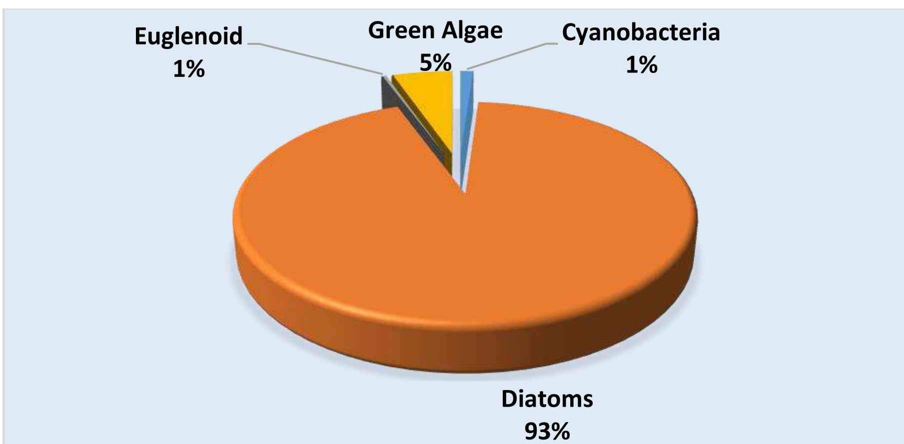


Figure 2.2.18: Percentage composition of phytoplankton genera in four stations in Luyang River; December 2019

Table 2.2.5: Phytoplankton composition, distribution, diversity and abundance (cells/m3) in four stations in Luyang River; December 2019

TAXA	TAXA				Grand	Rel.
	PH1	PH2	PH3	PH4	Total	Abund.
Cyanobacteria	**13,333**		**9,000**	**1,167**	**23,500**	**1.12**
Merismopedia			9,000		9,000	0.43
Nostoc	13,333			500	13,833	0.66
Oscillatoria				667	667	0.03
Diatoms	**1,373,333**	**526,667**	**20,400**	**24,833**	**1,945,233**	**92.91**
Achnanthes				167	167	0.01
Bacillaria					0	0.00

TAXA	**TAXA**				**Grand**	**Rel.**
	PH1	**PH2**	**PH3**	**PH4**	**Total**	**Abund.**
Campylodiscus					0	0.00
Chaetoceros		20,000	600	333	20,933	1.00
Climacosphenia				500	500	0.02
Coconeis	13,333	73,333	400		87,067	4.16
Coscinodiscus sp2				167	167	0.01
Cylindrotheca				167	167	0.01
Diploneis			200	333	533	0.03
Fragilaria	326,667	26,667	10,000	15,333	378,667	18.09
Gomphonema	273,333	53,333			326,667	15.60
Melosira	26,667	13,333			40,000	1.91
Navicula	253,333	180,000	1,000	500	434,833	20.77
Nitzschia	313,333	33,333	800		347,467	16.60
Pinnularia	13,333		200	333	13,867	0.66
Pleurosigma			200	1,500	1,700	0.08
Rhabdonema	26,667	73,333	800	1,333	102,133	4.88
Surirella		40,000	4,600	333	44,933	2.15
Synedra	126,667	6,667	800	3,833	137,967	6.59
Terpsinoe		6,667	800		7,467	0.36
Euglenoid		**6,667**	**200**		**6,867**	**0.33**
Phacus		6,667	200		6,867	0.33
Green Algae	**93,333**	**6,690**	**4,800**	**4,500**	**109,323**	**5.22**
Closterium			400		400	0.02
Cosmarium		333	200		533	0.03
Oedegonium					0	0.00
Scenedesmus	13,333	2,556			15,889	0.76
Spirogyra	33,333	3,456	4,000		40,789	1.95
Staurastrum		345			345	0.02
Stauroneis	46,667		200		46,867	2.24
Grand Total	**1,480,000**	**533,333**	**34,400**	**45,833**	**2,093,567**	**100**
Richness	**13**	**16**	**18**	**15**		
Evenness (J')	**0.78**	**0.82**	**0.70**	**0.62**		
Diversity (H')	**2.00**	**2.04**	**2.04**	**1.79**		

The mean phytoplankton abundance during this sampling was 523,398 cells/m^3. In terms of spatial distribution, the station located at the upstream area (station Ph1) of the Luyang river recorded the highest phytoplankton abundance with 1.5 x 10^6 cells/m^3 while the station located at the downstream area (station Ph3) and the station located river mouth (station Ph4) harbored the most number of phytoplankton genera with 18 each (**Figure 2.2.20**). Conversely, the lowest phytoplankton abundance was quantified in downstream station (Ph3) with 34,400 cells/m^3. The diversity index based on Shannon-Weiner was generally low with computed values ranging from 1.79-2.04. Computed values above 3.0 indicate that the habitat structure is stable and balanced, while values midway from 1.0 to 2.0 describe a threatened condition. Furthermore, values lower than 1.0 indicates pollution and degradation of habitat structure (Goncalves and Menezes, 2011); however, it should be noted that the diversity index very rarely exceeds a 4.5 value. In addition, the computed index of evenness was not so variable with computed value ranging from 0.63-0.82.

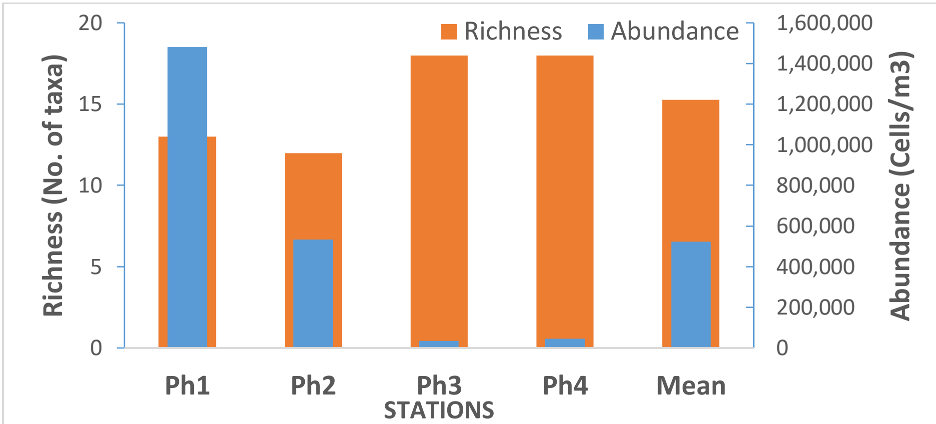


Figure 2.2.19: Total phytoplankton density and richness in four stations in Luyang River; December 2019

2.2.4.1.3.2 Zooplankton

Analysis of water samples collected from four stations in Luyang River revealed a total of thirteen (13) zooplankton groups belonging to Cladocera, Copepoda, Insecta, Mollusca, Polychaeta and Rotifera. Zooplankton observed during this sampling is typical of groups/types found in freshwater environment. Generally, copepods were the most dominant group accounting for 48% of the total abundance, followed by rotifer with 41%. Other zooplankton taxa accounted for 11% of the total zooplankton count (**Figure 2.2.21**).

The total zooplankton abundance was 20,566 individuals/m^3 from the four stations combined. The most taxa rich site was observed in water sample collected from the station located at the upstream station of Luyang river (ZP1) with 8. The highest total density was also quantified from the same station (ZP1) with 7800 individuals/ m^3 (**Figure 2.2.22**). The most depauperate station was observed in the station located at the downstream (ZP3) with just 3 zooplankton group identified. No fish larvae and decapod larvae were observed during the sampling. Diversity based on Shannon Wiener index was low (<2) with the highest value computed at the ZP2 with 1.60 (**Table 2.2.10**). The computed index of evenness among the four stations was quite variable with values ranging from 0.41-0.85 indicative of variable zooplankton community. In this survey, most of the zooplankton are common types with no endemic or rare groups encountered.

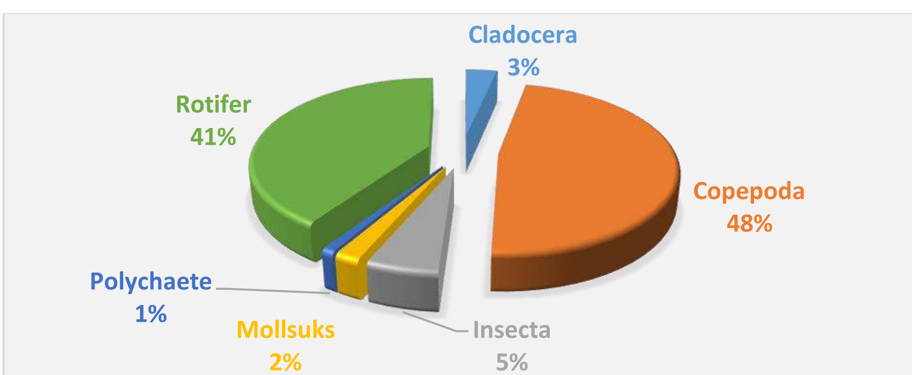


Figure 2.2.20: Percentage Composition of Zooplankton Taxa in Four Stations in Luyang river; December 2019

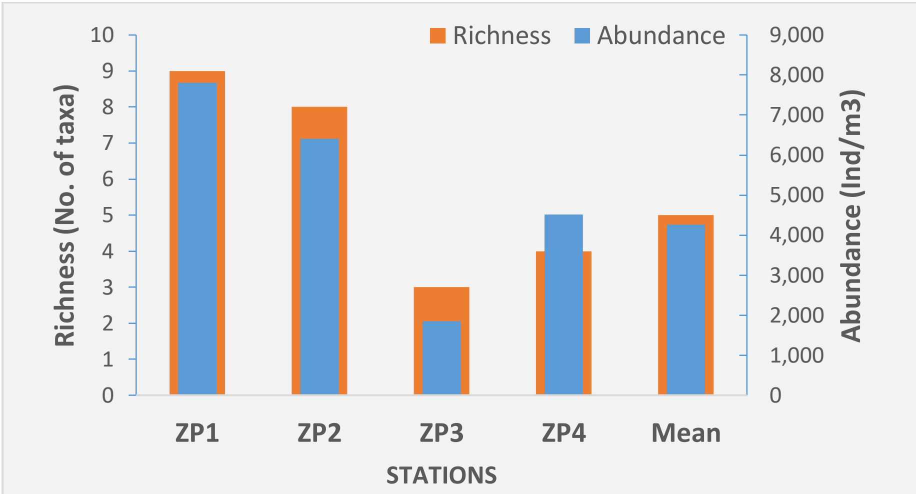
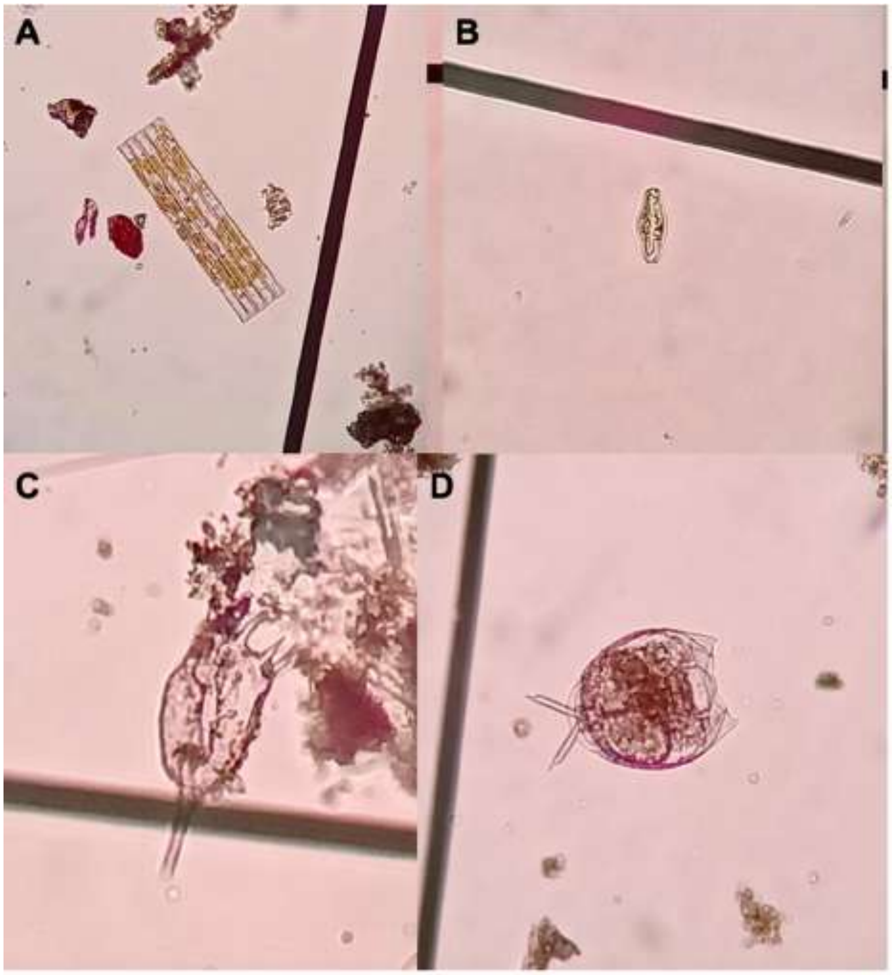


Figure 2.2.21: Total zooplankton density and taxa richness in four sampling stations in Luyang river; December 2019

Table 2.2.6: Zooplankton composition, distribution, diversity and abundance (individuals/ m3) in four sampling stations in Luyang River; December 2019

TAXA	STATIONS				Grand	Rel.
	ZP1	ZP2	ZP3	ZP4	Total	Abund.
Cladocera		**700**			**700**	**3.40**
Cladoceran		700			700	3.40
Copepoda	**2,600**	**2,567**	**150**	**3,760**	**9,077**	**44.14**
Copepod calanoid	200		150	200	550	2.67
Copepod cyclopoid				2,700	2,700	13.13
Copepod nauplius	2,400	2,567		860	5,827	28.33
Insecta	**200**	**933**			**1,133**	**5.51**
Chaoboridae		233			233	1.13
Mayfly Larvae	200	467			667	3.24
Midges Larvae		233			233	1.13
Mollsuks	**400**				**400**	**1.94**
Bivalve veliger	400	356			756	3.68
Polychaete	**200**				**200**	**0.97**
Polychaete trophocore	200				200	0.97
Rotifer	**4,400**	**2,211**	**1,695**	**750**	9,056	**44.03**
Bdelloid rotifera	400				400	1.94
Brachionus rotifer	567	344	45		956	4.65
Lecane sp.	3,200	1,400	1,650	750	7,000	34.04
Ploesoma	233	467			700	3.40
Grand Total	**7,800**	**6,411**	**1,845**	**4,510**	**20,566**	**100**
Richness	**9**	**8**	**3**	**4**		
Evenness (J')	**0.70**	**0.82**	**0.41**	**0.56**		
Diversity (H')	**1.36**	**1.60**	**0.29**	**1.46**		

Photomicrographs of the dominant plankton identified during the survey are presented in **Plate 2.2.12**. A map showing the distribution of dominant plankton groups per station is also presented in **Figure 2.2.23**.



Note: (A) Fragilaria (B) Gomphoneis (C) Ploimida (D) Lecane sp.

Plate 2.2.12: Common plankton taxa identified in four stations in Luyang; December 2019

Figure 2.2.22: Diversity of dominant plankton groups in the Luyang River, 14-15 December 2019

2.2.4.1.4 Freshwater Macrobenthos Fauna

Benthic macro-invertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimeter in size. Benthos – organisms that live on or within sediments, rocks, logs, debris and aquatic plants during some period in their life span includes immature forms of aquatic insects, mollusks, aquatic worms and crustaceans. The benthic macro-invertebrates community contributes immensely to the functioning of the aquatic ecosystem.

Benthic macrofauna are small, bottom-dwelling aquatic organisms that are found in and around water bodies during some period of their lives. They are often found attached to rocks, vegetation, logs and sticks or burrowed into the bottom sand and sediments They are reliable indicators of stress in the aquatic environment because they spend most of their life cycles in or under the substrate and are susceptible to disturbances of anthropogenic origin.

As a part of the survey to assess the biotic community in Luyang river near the Project site, a sampling was conducted in four stations representing different water elevations (upstream, midstream and downstream) last December 14-15, 2019. Overall, a total of 88 individuals belonging to seventeen (17) class/ families were identified during the survey with different abundances at various sites. Detailed information on the composition abundance, distribution and diversity of the macrobenthos in the four sampling station is presented in **Table 2.2.11**.

Table 2.2.7: Density and Abundance of freshwater macrobenthos fauna genera in four sampling stations in the Luyang River; December 2019

TAXA	STATIONS				Grand Total	Rel. Abund.
	BN1	BN 2	BN3	BN4		
Phylum Annelida						
Class Oligochaeta			1		1	1.14
Phylum Mollusca						
Class Bivalvia						
Family Corbiculidae						
Corbicula sp.			1		1	1.14
Family Veneridae				1	1	1.14
Class Gastropoda						
Family Thiaridae						
Thiara sp.	4	2			6	6.82
Melanoides sp.	9	21	1	3	34	38.64
Melanoides maculata						
Tarebia granifera	4		3	4	11	12.50
Family Neritidae						
Neritina sp.			1		1	1.14
Neritina pulligera						
Family Ampullariidae						
Pomacea sp.	1	2	4		7	7.95
Family Lymnaeidae						
Lymnaea sp.			1		1	1.14
Family Planorbidae						
Planorbis sp.		2	3		5	5.68
Family Physidae						
Physa sp.			1		1	1.14

TAXA	STATIONS				Grand	Rel.
	BN1	BN 2	BN3	BN4	Total	Abund.
Phylum Arthropoda						
Subphylum Hexapoda						
Class Insecta						
Order Ephemeroptera						
Family Baetidae						
Baetis sp.	2	4			6	6.82
Family Caenidae						
Caenis sp.		3	3		6	6.82
Order Odonata						
Family Coenagrionidae						
Agrion sp.		1			1	1.14
Family Libellulidae						
Order Coleoptera						
Family Psephenidae						
Psephenus sp.		2			2	2.27
Order Trichoptera						
Family Hydropsychidae						
Hydropsyche sp.		1			1	1.14
Order Diptera						
Family Chironomidae						
Chironomous sp.	1	1			2	2.27
Family Ceratopogonidae				1	1	1.14
Grand Total	**21**	**39**	**19**	**9**	**88**	**100**
Richness	**6**	**10**	**10**	**4**		

Figure 2.2.24 shows the Relative Abundance (RA) of all the macro-invertebrate families/class observed in the four sampling stations in the assessement in December 2019. RA is the ratio of individuals in a certain taxon to the total number of individuals of all taxa which is affected by various factors. A community dominated by relatively few species could indicate environment stress (Plafkin et al., 1989 in ESS Group, Inc. (2001). High percentage contribution by a taxon generally indicates community imbalance (Bode, 1988).

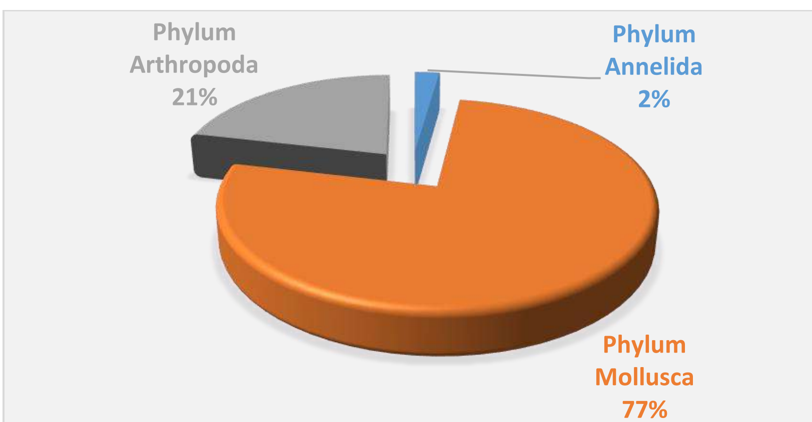


Figure 2.2.23: Percent composition of macrobenthos phyla observed in four stations in Luyang river; December 2019

For this survey, only three (3) macrobenthos phyla were recorded i.e., Phylum Mollusca and Phylum Arthropoda and Annelida. Among them, mollusks were the most dominant which accounted for 77% of the total macrobenthic faunal count. Meanwhile, arthropods were the most family rich with Ten (10), mollusks were represented by eight (8) families and annelids were only represented by one (1) class. The top three (3) taxa in terms of relative abundance were *Melanoides* (38%) and *Tarebia sp.* (12%) and *Pomacea* asp. (8%). The remaining macrobenthos taxa accounted for 42% of the community. The top three most dominant taxa belonged to family Thiaridae. Gastropods belonging to the Thiaridae family are well known to tolerate the presence of low dissolved oxygen and high suspended particulate matter in river water. They are very abundant in waters affected by agricultural waste even at low level of dissolved oxygen (Isom 1986). The highest number of macrobenthic fauna was quantified in station BN2 which was located in the midstream area of the river with 39 while the lowest was in BN4 located at the river mouth with nine (9). In term of richness, stations BN2 and BN3 harbored the highest number of taxa with ten (10) while the lowest was observed in station BN4 with four (4); (**Figure 2.2.26**).

The overall impression of the benthos assessment during this survey is poor due low number and types of macrobenthos fauna recorded in this survey. There was no endemic species or threatened species recorded during the survey. Photomicrographs of the dominant macrobenthos fauna are shown in **Plate 2.2.13.**

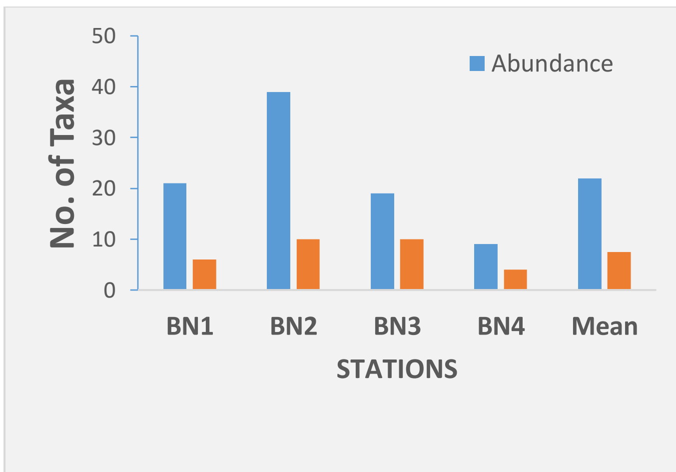


Figure 2.2.24: Total benthos abundance and richness in four stations samples in Luyang river, December 2019

Note: (A) Thiaridae (Melanoides sp.); (B) Oligchaete; (C) Chiromonidae

Plate 2.2.13: Common macroinvertebrates found in Luyang River, December 2019

2.2.4.2 Ipil River

Three sampling stations – upstream, midstream and downstream – were investigated for basic parameters, river uses, plankton, macro-benthos and fish biota on 23-25 January 2020. The first station is located in Purok Kabulihan, Barangay Ipil, Carmen, about 4km northwest of the Cement plant and less than half a kilometer from the southern boundary of the MPSA (**Figure 2.2.15**). The midstream station is situated in Sitio Dual-ug in Poblacion, Carmen, in mostly agricultural lands more than 3km from the plant site. The third station was established the river estuary in Barangay Dawis Norte in Carmen and is about 2km northeast of the plant site and way out of proximity to the MPSA. The coordinates of the stations investigated are listed in **Table 2.2.12**.

Table 2.2.8: Location of sampling stations in Ipil River for basic river parameters, plankton, macrobenthos and aquatic biota, January 23-25, 2020

WP Code	Latitude	Longitude	Location
I-RVR1	N 10.580195°	E 123.992723°	Upstream portion of Ipil River at Bgy Ipil, Carmen, Cebu; measurements taken 1454H 23 January 2020; This station is nearest to the MPSA but is farthest from the Republic Cement plant site.
I-RVR2	N 10.582570°	E 124.007060°	Midstream portion of Ipil River located in Poblacion, Carmen, Cebu; measurements taken 1523H 23 January 2020
I-RVR3	N 10.578353°	E 124.026742°	Downstream portion of Ipil River located in Bgy Dawis Norte, Carmen-Cebu; measurements taken 1005H 25 January 2020

Figure 2.2.25: Location of Sampling Stations for Basic River Parameters, Plankton, Macrobenthos and Aquatic Biota in Ipil River (January 23-25, 2020)

2.2.4.2.1 Station Profiles, Fish and Macro-invertebrate Biota

2.2.4.2.1.1 Station 1: Ipil River Upstream

Station Characteristics/Morphology

Freshwater ecology station 1 is located upstream of the Ipil river. The width of the river between both riverbanks in the sampling station varies from 5-6m (**Plate 2.2.14**). Residents living near the river claim that the Ipil River has just been recently flooded and dries up during the peak of the summer months. A cemented footbridge for pedestrian and small vehicle crossing has been built in the upper portion of the station across cascading waters. Depth of the sampling area is at 9.65 cm with rocks, sand and pebbles dominating the riverbed. Dense foliage of grasses, vines, ferns and shrubs line up the riverbanks. Hardwood such as gmelina, *bangkal,* coconut trees and bananas comprises the canopy of the river station. There are number of households at the upper and western side 50-100m away from the river banks. An area clearing along the eastern side of the bank indicates an intention of vegetable gardening. River water is slightly turbid and light green in color with total dissolved solids measured at 303 ppm. The average water current is measured at 0.38 m/s.

Plate 2.2.14: Station 1 in the upstream portion of the Ipil River, 23-25 January 2020

River Uses, Fish and Macro-Invertebrate Biota

Key informants and a guide familiar in the area claim that there are no fishing or river recreational activities being undertaken in station 1. Farther upstream, however, key informants declared that a water impounding pool has been built and serves as a popular picnic area especially during the Holy Week. Households along the river banks utilize the stream in watering their potted flowering plants and perennial garden plants such as eggplant and cassava. No fishing activities were encountered and residents claim that river fishing is not being practiced due to the absence of significant foodfish, except for the 'dalag' *Chianna striata*, which can hibernate and survive periodic episodes of river drying. Except for small gobies (**Plate 2.2.15**), no fish fauna was observed in 100m transect walk in the shallower portion of the river. Key informants claim that river biota comprise mostly of "paitan" fry (Cypriniidae; *Pontius sp*.), Gobiidae (*Glossogobius sp)* and troupes of the apple snail *Pomacea sp* and few pond snail *Physella sp* documented during the surveys for macro-invertebrates. *Pomacea* (Family Ampullaridae) are hardy and prolific gastropods and bursts of their population can be invasive. Test fishing using a scoop net in areas suspected to refuge aquatic organisms yielded no fish. A map showing the basic features of Ipil River sampling station 1 is presented as **Figure 2.2.27**.

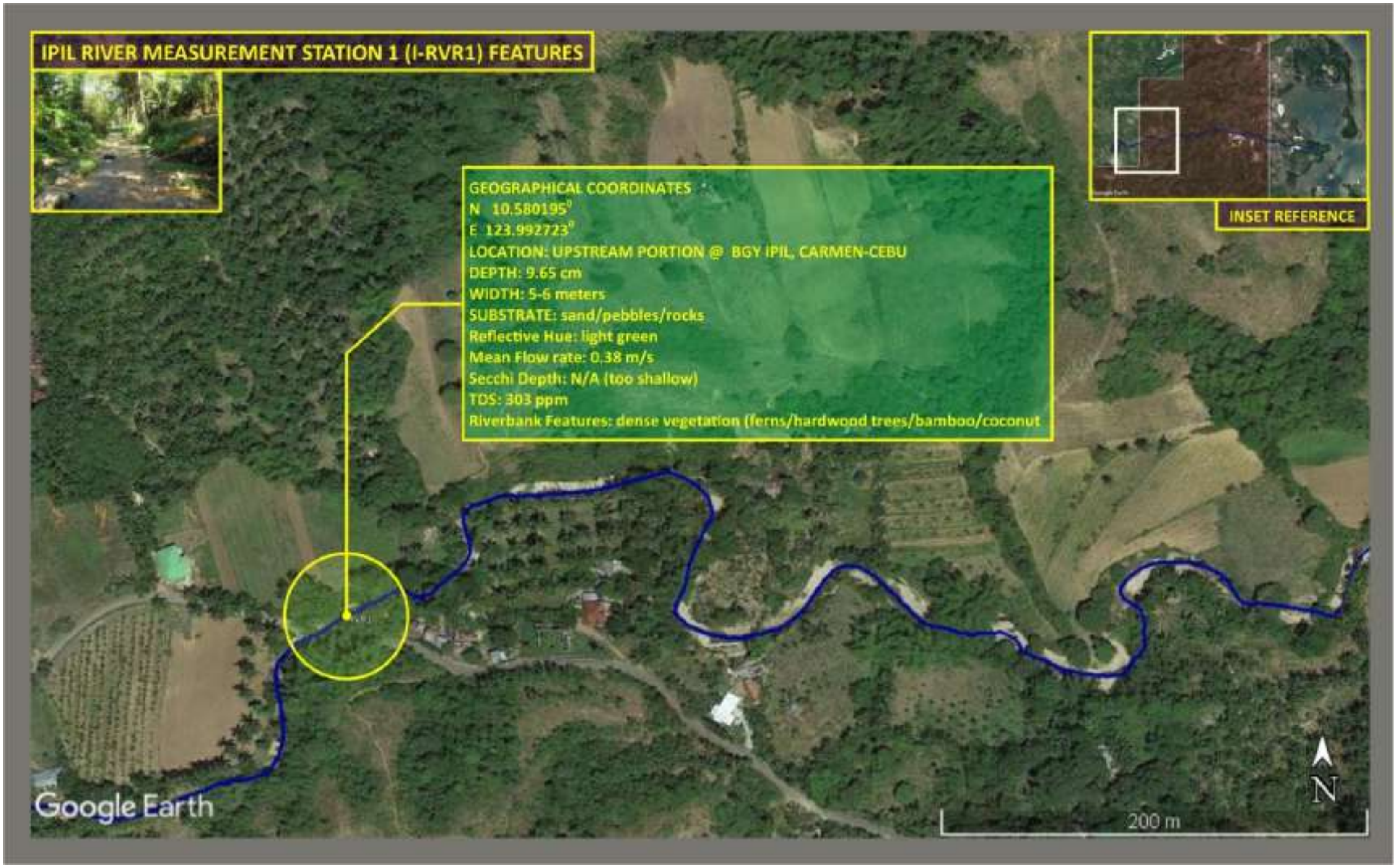


Figure 2.2.26: Location and basic parameters recorded in freshwater ecology station 1in the Ipil River, Carmen, Cebu surveyed during freshwater ecology baseline assessment, 23-25 January 2020

Plate 2.2.15: Apple snail (Pomacea sp), some pond snails Physella sp, fry of the cyprinid Pontius sp (with arrows) and gobies are the only aquatic fauna observed in Ipil River Sampling Station 1

2.2.4.2.1.2 Station 2: Ipil River Midstream

Station characteristics/morphology

Freshwater ecology sampling station 2 is in the midstream of the Ipil river located at Sitio Dualog, Poblacion, Carmen. The width of the river in this site varies from 4-5m with light green water; average depth of 15 cm and surface stream flow velocity of 0.41 m/s (**Figure 2.2.29**). Low gradient riffles were observed, even as the river is shallow, with pools generating particulate deposition. It has slight turbidity and total dissolved solids (TDS) was measured at 349 ppm. Households situated nearby utilize the river for washing of clothes, occasional bathing and other domestic chores, as well as to supply water for various crops (**Plate 2.2.16**). Households near the riverbanks tend crops such as banana and coconut, as well as trees dominated by Gmelina, mahogany, *dualog* and bamboo.

River uses, fish and macro-invertebrate biota

There were no significant river use activities, aquaculture or set fish traps (e.g., fish post or bubo) encountered in the sampling area and contiguous river lagoons. However, The two women who were washing clothes and cleaning kitchen utensils in the river claimed that their husbands catch several fishes that inhabit the river such as catfish “pantat”, *Clarias sp,* freshwater shrimp (“ulang”; *Macrobacchium sp),* Goby (“bia”; Gobiidae) using improvised spear at day time as recreational activities The absence of significant and profitable ctahc of these species has rendered fishing as livelihood unfeasible. In addition, key nformants claim that macro invertebrates such as freshwater crab (“takla/ kagang” *Sundalthepusa sp.)* and swamp frogs (“baki”; *Limnonectes sp.)* can be caught at night time. However, catching of these species are undertaken rarely, as periodic food supplements.

Plate 2.2.16: The Ipil River in the vicinity of sampling station 2

Figure 2.2.27: Location and basic parameters recorded in freshwater ecology station 2 in the Ipil River, 23-25 January 2020

2.2.4.2.1.3 Station 3: Ipil River Downstream,

Station characteristics/morphology

Station number 3 is located near the mouth of the Ipil River estuary in Brgy. Dawis Norte, Carmen about 2.3km northeast of the Cement plant and south of the Carmen port. The estuary is bordered by clumps of mangroves. The river spills out in two branches into an intertidal flat with alluvial mounds, sand and gravel bars that restrict the flow of the river, creating semi-stagnant pools of water further upstream. It is presumed that flooding in the river will change and magnify the river delta, and the presence of dense mangrove trees further downstream suggests more dynamic invertebrate interactions during such periods. Both canals were less than 2m wide and during the sampling, one of the canals is totally dry while the other had just enough water for sampling (**Plate 2.2.18**). The depth in this area was measured at 2.54 cm (**Figure 2.2.29**). The water is green and flowing at surface velocity of 0.18 m/s, slowing down particulate deposition and increasing pools with muddy substrate. Total dissolved solids (TDS) was measured at of 3515 x 10 ppm. The substrate is knee-deep mud which explains the growth of a mangrove canopy comprised of *Aviccennia sp*., *Sonneratia sp*. and *Nypas fruticans.* The upper part of the river bank is planted with banana and coconut trees. Past the river mouth and sandy flat, dense mangroves consisting of *Rhizopora sp* and *Avicennia sp* occur.

Note: Left photo shown stagnant water resulting from the meager stream flow in the estuary.

Plate 2.2.17: Sampling Station 3 Near the Ipil River Estuary (right) with Clumps of Avicennia sp Mangroves

River uses, fish and macro-invertebrate biota

In spite of significant peryphyton observed in the riverbed substrate, few invertebrates were seen during the survey. A key informant (Mr. Sid Tarife) living near the river claim that there are no fishing activities aside from occasional gathering of crabs in station 3 downstream of the Ipil river. There were no fishing activities observed at the time of survey and no set traps or nets were seen in a 100-meter transect walk. The informant declared that the mangrove mud lobster ("manla"; *Thalassina sp*.), small mud crabs ("alimango"; *Scylla sp*.) and tunneling mud crab ("Talangka"; *Helice sp.)* are gathered occasionally but the quantity gathered are oftentimes too few for selling but only for household consumption. Fishes often observed entering during high tides were fingerlings of mangrove snapper ("mangagat"; *Lutjanus argentimaculatus*) and spotted scat ("kikiro" *Scatophagus argus)*. During the transect walk organisms such as fiddler crab and mud skipper were observed. Opportunistic surveys for commercially important macro-invertebrates yielded negative results; only the swamp cerith (*Telescopium telescopium*), nerith shells (*Nerita costata*) and a few ark shells (*Scapharca glubosa*) were seen (**Plate 2.2.18**). Mangrove crabs are caught in the dense mangrove patch past the river estuary.

Figure 2.2.28: Location and basic parameters recorded in freshwater ecology station 3 in the Ipil River, 23-25 January 2020

Plate 2.2.18: Swamp cerith (left) and species of spotted scat (Scatopaghus sp) sometimes caught in the estuary of the Ipil River

A tabulated summary of river characteristics recorded during the freshwater ecology survey for all stations in the Ipil River is also presented in **Table 2.2.14.**

2.2.4.3 Cagat River

Three sampling stations – upstream, midstream and downstream – were investigated for basic parameters, river uses, plankton, macro-benthos and fish biota in the Cagat River which runs across the existing quarry area and the southern portion of the MPSA on 23-25 January 2020. The first station is located in upper Barangay Cagat-Lamac, Danao City about 2km west of the Cement plant. The station is inside the MPSA and the existing quarry area (**Figure 2.2.30**). The midstream station, which is also inside the MPSA, is situated in lower Barangay Cagat-Lamac, Danao City, about 2km southwest of the plant site. The third station was established the Cagat River estuary in Barangay Taytay, Danao City, and is about 2km southeast of the plant site. The coordinates of the stations investigated are listed in **Table 2.2.13**.

Table 2.2.9: Location of sampling stations in Cagat River for basic river parameters, plankton, macrobenthos and aquatic biota; 23-25 January 2020

WP Code	Latitude	Longitude	Location
C-RVR1	N 10.559137°	E 124.001279°	Upstream portion of Cagat River in Bgy Cagat-Lamac, Danao City, Cebu; inside MPSA and EQA. Measurements taken 1603H 23 January 2020
C-RVR2	N 10.549298°	E 124.006375°	Midstream portion of Cagat River in Bgy Cagat-Lamac, Danao City, Cebu; inside MPSA. Measurements taken 1632H 23 January 2020
C-RVR3	N 10.540229°	E 124.031717°	Estuary portion of Cagat River in Bgy Taytay, Measurements taken 1132H 24 January 2020

Figure 2.2.29: Location of river sampling stations for basic river parameters, plankton, macrobenthos and aquatic biota during freshwater ecology baseline assessment in the Cagat River (23-25 January 2020)

2.2.4.3.1 Station Profiles, Fish and Macro-invertebrate Biota

2.2.4.3.1.1 Station 1: Cagat River Upstream

Station characteristics/morphology

Station 1 is located upstream of Cagat river, Brgy. Cagat/lamak Danao city, Cebu.It is about 2km west of the Cement plant complex. This portion of river Cagat has a width that varies from 4-5m with rocks, pebbles and sand as substrate. River water is only slightly turbid, with light green color and total dissolved solids (TDS) was measured at 301 ppm. The average depth is 20cm; surface stream flow velocity was measured from three replicates at an average of 0.44 m/s. Riverbanks were fortified concrete revetments presently covered with shrub, ferns and vines (**Plate 2.2.20**). Coconut, bamboo trees, ipil-ipil, among others, function as the main canopy, although tree vegetation is not dense. Periphyton is significant in the heterogenous riverbed, but aquatic organisms were not observed, apart from small fish fry, presumably Gobiidae. Riffle macro-invertebrate communities were not seen during the sampling period, apart from snails. This portion of the river appears to be undisturbed, with few woody debris.

River uses, fish and macro-invertebrate biota

There were no significant activities, aquaculture or river fisheries encountered in the sampling area and contiguous river lagoons downstream. A key informant claimed that there are hardly any fish and crustaceans in the river at this point as the Cagat River only had sufficient water 3 to 4 months ago. However they claimed that fish species such as snakehead ("dalag" *Chana sp*.), spotted barb ("paitan"; *Puntius sp.)*, river catfish ("pantat"; *Clarias sp*.) are caught by hook and line set overnight but fishing is not a activity and not practiced as a source of livelihood. No macro-invertebrates of significant importance were observed during the survey. However, key informants allege that macro-invertebrates like freshwater crab ("kagang"; *Sundathelpusa sp*.) and apple snail ("Ige*" Physella sp.)* are abundant on months nearing the peak of summer. Farmers and planters of corn and sugarcane tend small plantations along the riverbank and use the river water in irrigating their crops.

Plate 2.2.19: Photographs of freshwater sampling station 1, upstream of Cagat River, surveyed during freshwater ecology baseline assessment, 23-25 January 2020.

The highlights of river characteristics recorded in Station 1 in the Cagat River are presented in a map in **Figure 2.2.31**.

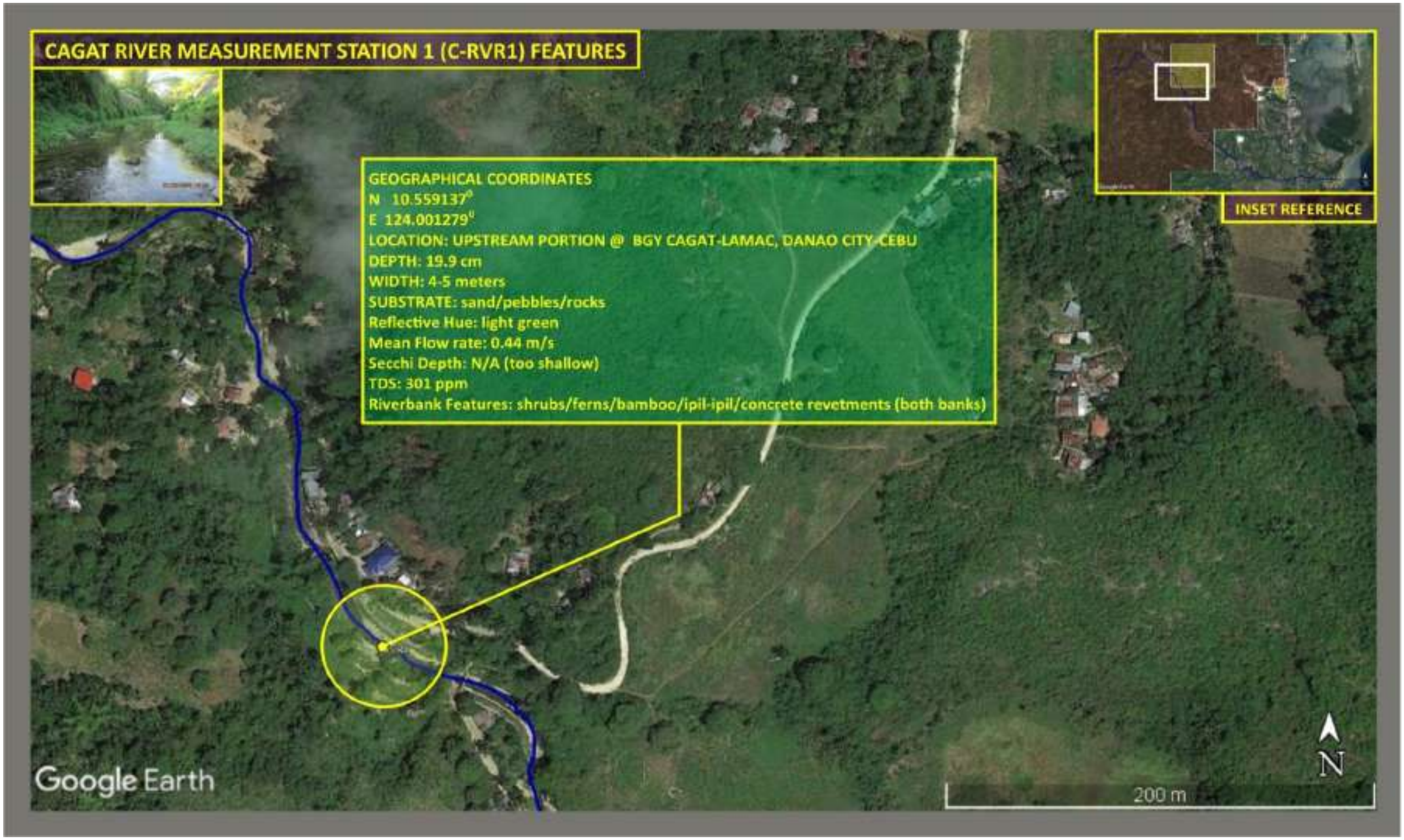


Figure 2.2.30: Location and basic parameters recorded in freshwater ecology station 1 in the Cagat River, 23-25 January 2020

2.2.4.3.1.2 Station 2: Cagat River Midstream

Station characteristics/morphology

Freshwater ecology sampling station 2 in the Cagat River is located in Bgy, Cagat, Danao City about 1.9km southwest of the Cement plant complex. Water in this portion of the river is shallow at the time of the survey, with an average depth of 28.4 cm in the center; the width of the river varies from 5-6m with rocks, pebbles and sand as substrate. River water is green with total dissolved solids (TDS) measured at 299 ppm and a stream surface velocity of 0.19 m/s (**Figure 2.2.32**). River riffles at this portion is not pronounced, and even as the water is shallow and fertilized with litterfall, few aquatic and riparian grazers were seen. In shallow riparian sections, in-stream primary productivity appears to be robust but no significant communities of grazing fish and crustaceans, as well as similar functional feeding groups were seen. Households along the river banks tend crops such as mango, coconut and hardwood of gmelina species. In the river itself, there is no significant riparian vegetation shade and many portions are exposed to open canopy and sunlight. Anthropogenic disturbance in the river, caused by disposal of wastes, particulate matter deposition and extraction of water for crops was observed.

Plate 2.2.20: Photographs of freshwater sampling station 2, midstream of Cagat River, surveyed during freshwater ecology baseline assessment, 23-25 January 2020.

River uses, fish and macro-invertebrate biota

Even as households dot the riverbanks near the sampling station, no significant fishing activities, aquaculture or stationary fishing gears (e.g., set-traps) were encountered in the sampling area and contiguous river lagoons. However key informants in the area who were interviewed declared on the presence of fish species claimed that the freshwater shrimp ("Ulang"; *Macrobachium sp.)* and spotted barb "paitan/pait" *Puntius sp* are caught using improvised spear gun. Pond snail ("ige"; *Physella sp*.) are also gathered from the cemented foot of the bridge. There were no macro-invertebrates of commercial significance for trade observed during the sampling. The water in this area is being used for washing cars and motorcycles, as a picnic area and for bathing.

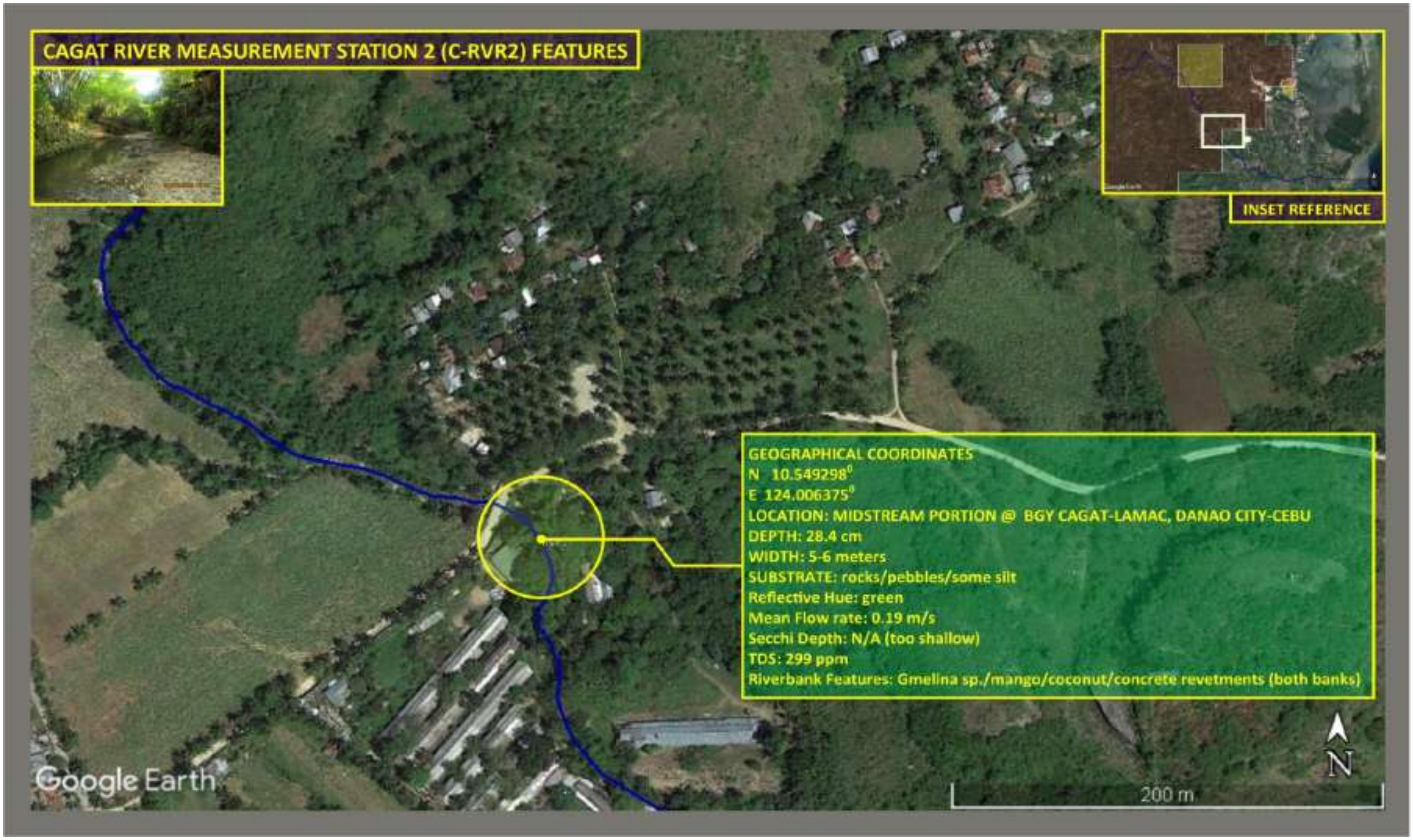


Figure 2.2.31: Location and basic parameters recorded in freshwater ecology station 2 in the Cagat River, Danao City, Cebu surveyed during freshwater ecology baseline assessment, 23-25 January 2020

2.2.4.3.1.3 Station 3, Cagat River Estuary

Station characteristics/morphology

Station 3 is in the river estuary located at Brgy. Taytay, Danao City, about 2.3km southeast of the Cement plant site. This portion of the river is intertidal with sand, gravel and silt as substrate. The river flow during the sampling was not taken due to the ebbing of tide but river discharge is vividly slow. The Cagat River estuary is characterized by a low gradient stream with loose rocky substrates, cobbles and boulders amidst sandy deposits and dunes that opens up to a wide sandy-rocky flat. The constrained flow of the river and presence of large woody debris and extensive trash from communities nearby suggests that migration of anadromous species of fish into the upstream portion is constrained. On the other hand, long-standing debris helps to form pools around the wood debris that retain organic matter, nurturing availability of food resources for both grazers and predators during periods of high flooding. At the time of the survey, increased particulate deposition due to slow water velocity coupled by the absence of mangroves in the alluvial deposits also indicates a low diversity of riverine animals. The width of the river varies from 8 to 9 meters, slightly turbid and green in color and with total dissolved solids of 3015 x10 ppm. Along and nearby the river bank are community settlements. Patches of mangrove trees such as *Aviccennia marina* and *Sonneratia alba*, mixed with thorny Aroma shrubs occur in the riverbanks. Riffle and stream pool macro-invertebrate communities were conspicuously absent at the time of the sampling. The sampling station is of open canopy and shallow water with an average depth of 35.6 cm in the center.

The summary of river characteristics is depicted in a map in **Figure 2.2.33**. A tabulated summary of river characteristics recorded during the freshwater ecology survey for all stations in the Cagat River is also presented in **Table 2.2.14**.

Plate 2.2.21: The Cagat River Estuary, 23-25 January 2020

River uses, fish and macro-invertebrate biota

The river mouth serves as entrance to shelter boats during bad weather by the community residents. Key informant claimed that flathead mullet ("aguas/banak" *Mugil sp.)*, scats ('kikiro" *Scatophagus argus)*, convex-lined theraponid ("Bagaong" *Therapon jarbua)*, whip-fin silver biddy ("latab" *Gerres sp.)* were the popular fish species caught by a set gillnet placed at the river mouth during the lowering of tide (**Plate 2.2. 23**).

Plate 2.2.22: Some species caught in the estuary of the Cagat River system in Danao City, Cebu: convex-lined teraponid Terapon jarbua; large scale mullet Chelon macrolepis, dalag or snakefhead Chianna striata, whipfin mojarras Gerres oyena

Figure 2.2.32: Location and basic parameters recorded in freshwater ecology station 3 in the Cagat River estuary, Danao City, Cebu surveyed during freshwater ecology baseline assessment, 23-25 January 2020.

Table 2.2.10: Tabulated summary of river characteristics recorded in the Ipil River and Cagat River, 23-25 January 2020

River Station	Location	Depth (average)	Width (range)	Substrate	Color	Mean Stream Flow Velocity (surface)	Turbidity (Secchi Disc; cm)	TDS (ppm)	Riverbank vegetation
I-RVR1 (Ipil River) Upstream	Purok Kabulihan, Bgy. Ipil, Carmen	9.65 cm	5-6 m	Sand and pebbles, rocks	Light green	0.38 m/sec	Too shallow	303 ppm	Dense vegetation, fern hardwood trees, bamboo and coconut
I-RVR2 (Ipil River) Midstream	Sitio Dual-ug Poblacion, Carmen	15 cm	4-5 m	Rocks, sand, silt	Light green	0.41 m/sec	Too shallow	349 ppm	Dense vegetation, Ferns – Dual-ug trees, Mahogany Acacia, bamboo, and banana,
I-RVR3 (Ipil River) Downstream	Bgy Dawis Norte, Carmen	2.54 cm	2 m	mud	Green	0.18 m/sec	NA	3515 x 10 ppm	Sparse growth of *Mangroves S. alba, Avicennia sp* and *Nypas futicans*
C-RVR1 (Cagat River) Upstream	Bgy. Cagat-Lamac, Danao City	19.9 cm	4-5 m	Sand, pebbles and rocks	Light green	0.44 m/sec	Too shallow	301 ppm	With concrete revetments, Shrubs and fern, Bamboo, aratiles and ipil-ipil
C-RVR2 (Cagat River) midstream	Bgy Cagat-Lamac, Danao City	28.4 cm	5-6 m	Rocks, pebbles and some silt	Green	0.19 m/sec	Too shallow	299 ppm	Bordered by concrete revetments, Gemilina trees, mango and coconut
C-RVR3 (Cagat River) Estuary	Bgy Taytay, Danao City	35.6 cm	8-9 m	Sand, silt and gravel	Dark green	NA River flow vs. Ebbing tide	Too shallow	3015 x 10 ppm	Human settlements, Growth of *A.Marina, S alba* and Aroma shrub

2.2.4.4 Plankton Community, Ipil and Cagat Rivers

Phytoplankton encompassed all microscopic algae which drift with currents or float on water surface of an ocean, rivers, lakes and other water bodies. They play a major role as the basis of the aquatic food web, providing essential ecological function of all aquatic life. They have a rapid respond to environmental changes, and hence their occurrence, species composition and diversity are widely used as biological indicator of the quality of the water conditions. On the other hand, zooplankton are drifting organism living in the oceans, particularly the pelagic and littoral zones, as well as in rivers, lakes and ponds. Majority of them are microscopic, unicellular or multicellular forms with size ranging from a few microns to a millimeter or more. Zooplankton are the heterotrophic group of plankton as they feed on phytoplankton. It is generally recognized that zooplankton occupy an important role in the economy in the sea, both as consumer of phytoplankton and as contributors to the next higher trophic levels. The summary of composition, abundance, diversity and distribution of plankton recorded at the three water elevations (upstream, midstream and downstream) of the two rivers is tabulated in **Table 2.2.15**.

Table 2.2.11: Plankton composition and abundance (cells or ind/m^3) in six sampling stations in Ipil River and Cagat River, 23-25 January 2020

TAXA	Cagat			Ipil			Grand	Rel.
	C-PLK1	C-PLK2	C-PLK3	I-PLK1	I-PLK2	I-PLK3	Total	Abund.
Cyanobacteria	**6,533**	**1,300**		**2,333**	**2,633**		**12,800**	**3.66**
Arthospira	4,200	1,300		467	2,167		8,133	2.32
Merismopedia	933			1,867			2,800	0.80
Nostoc	1,400				467		1,867	0.53
Diatoms	**75,900**	**23,400**	**16,467**	**79,767**	**23,400**	**6,067**	**225,000**	**64.30**
Achnanthes	2,333	1,300		6,533	433		10,600	3.03
Cymbella	933			1,400			2,333	0.67
Fragillaria	23,800	4,767	5,633	22,867	6,933	433	64,433	18.41
Gomphonema	15,400	3,467		19,600	3,033		41,500	11.86
Gyrosigma	3,267	2,600		1,867	1,300		9,033	2.58
Navicula	1,867	433	1,733	5,133	867	433	10,467	2.99
Nitzschia	1,400	867	433	4,200	8,233	867	16,000	4.57
Pinnularia	1,867	5,633	867	4,667	867	1,300	15,200	4.34
Rhabdonema	933		3,033	467		0	4,433	1.27
Stauroneis	2,167	1,733		433			4,333	1.24
Surirella	933	0	1,300	2,800	0	867	5,900	1.69
Synedra	15,867	2,600	3,467	9,333	1,733	2,167	35,167	10.05
Terpsinoe	5,133			467			5,600	1.60
Dinoflagellates	**9,800**	**3,033**	**433**	**933**	**433**	**867**	**15,500**	**4.43**
Peridinium	9,800	3,033	433	933	433	867	15,500	4.43
Green algae	**4,667**	**1,300**		**3,267**	**2,167**		**11,400**	**3.26**
Closterium	2,800	1,300		933	867		5,900	1.69
Cosmarium	1,867	0		2,333	1,300		5,500	1.57
Rotifer	**1,200**	**1,300**	**1,733**	**3,300**	**6,067**		**13,600**	**3.89**
Bdelloid rotifera		433			3,033		3,467	0.99
Lecane sp.			1,733	1,300	2,600		5,633	1.61
Brachionidae	1,200			2,000			3,200	0.91
Pleosoma sp.		867			433		1,300	0.37
Cladeocera			**3,033**				**3,033**	**0.87**
Copepod		**433**	**6,067**		**2,600**	**5,200**	**14,300**	**4.09**
Copepod cyclopoid			1,300		1,733	2,167	5,200	1.49
Copepod nauplius		433	4,767		867	3,033	9,100	2.60
Insect	**2,000**			**1,200**			**3,200**	**0.91**

TAXA	Cagat			Ipil			Grand	Rel.
	C-PLK1	C-PLK2	C-PLK3	I-PLK1	I-PLK2	I-PLK3	Total	Abund.
Chaoboridae (Midges larave)	2,000			1,200			3,200	0.91
Molluscs	**6,400**	**6,500**	**6,500**	**14,800**	**7,800**	**9,100**	**51,100**	**14.60**
Bivalve veliger	5,600	5,633	2,600	11,200	6,500	6,933	38,467	10.99
Gastropod veliger	800	867	3,900	3,600	1,300	2,167	12,633	3.61
Grand Total	**106,500**	**37,267**	**34,233**	**105,600**	**45,100**	**21,233**	**349,933**	**100**
Richness	**23**	**17**	**14**	**23**	**20**	**11**		
Evenness (J')	**0.82**	**0.90**	**0.92**	**0.81**	**0.87**	**0.86**		
Diveristy (H')	**2.57**	**2.54**	**2.43**	**2.54**	**2.59**	**2.06**		

Results of the analysis showed that plankton density was generally low in all the sampling locations of both rivers. This indicates that there is no cultural eutrophication in this river ecosystem. The most conspicuous effect of cultural eutrophication is the formation of dense blooms of noxious, foul-smelling phytoplankton that reduce water clarity and degrade water quality. In this sampling, cell density was not that high to be categorized at this level. Although the general abundance was low, taxa richness was relatively high with a total of twenty-nine (29) taxa identified in all stations combined. Of which thirteen (13) were diatoms, three (3) for cyanobacteria, two (2) were green algae, two (2) were cyanobacteria, four (4) were rofiers, two (2) for copepod, two (2) for mollusks veligers, and one (1) for dinoflagellates, Cladocera, insect larvae. No single species was observed to be the totally dominant plankton in any of the sampling sites as indicated by high index of evenness (0.81–90) which is indicative of a balance plankton community. Also, diversity Index (H) at the sampling locations were moderately high (>2.0) in all stations. Computed values above 3.0 indicate that the habitat structure is stable and balanced, while values midway from 1.0 to 2.0 describe a threatened condition. Furthermore, values lower than 1.0 indicates pollution and degradation of habitat structure (Goncalves and Menezes, 2011).

Except in the downstream area of Ipil river which was dominated by mollusks, diatoms were the most dominant plankton group in all sampling stations, accounting for >50% of the plankton community (**Figue 2.2.34**). There were no cyanobacteria identified from samples collected at the downstream stations which were brackish waters The overall plankton density from the three water elevations (upstream, midstream, downstream) quantified in Cagat River was 178,000 cells/m^3. This is slightly higher than that of Ipil River with 171,933 cells/m^3 (**Figure 2.2.35**). In Cagat river, the upstream areas (C-PLK1) recorded the highest density (106,500 cells/m^3) while the lowest was recorded in its downstream area (C-PLK3) (34,233 cells/m^3). The same trend was observed in Ipil river where the upstream station (I-PLK1) recorded the highest density (105,600 cells/m^3) while the lowest was quantified at the downstream area (I-PLK3) (21,233 cells/m^3). The pennate diatom *Fragilaria* sp. was typically the most abundant species particularly at the upstream stations of Cagat and Ipil rivers stations PLK1 with 23,800 cells/m^3 and 6,933 cells/m^3. In midstream stations (PLK2), the pennate diatoms *Pinnularia* sp. and *Niztschia* was the most abundant with 5,633 cells/m^3 and 8,233 cells/m^3. These diatoms species are commonly found in freshwater bodies characterized by flowing water and low inputs of organic pollution.

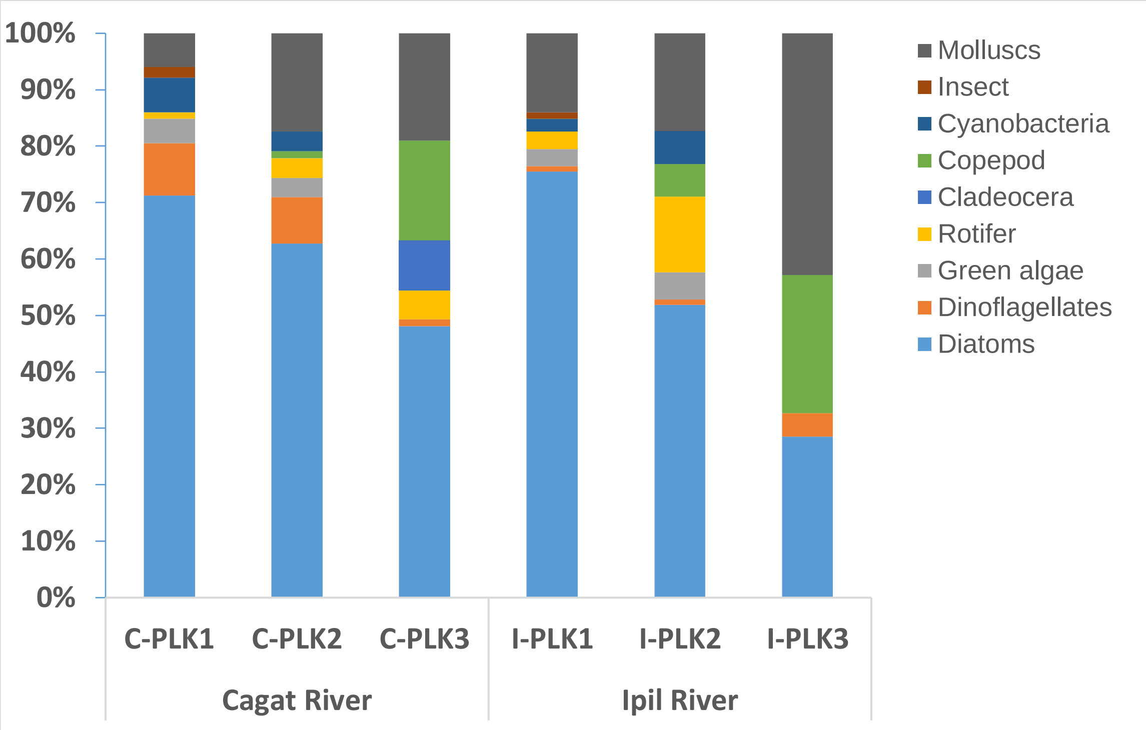


Figure 2.2.33: Percent composition of major phytoplankton groups surveyed in the Ipil and Cagat River, 23-25 January 2020

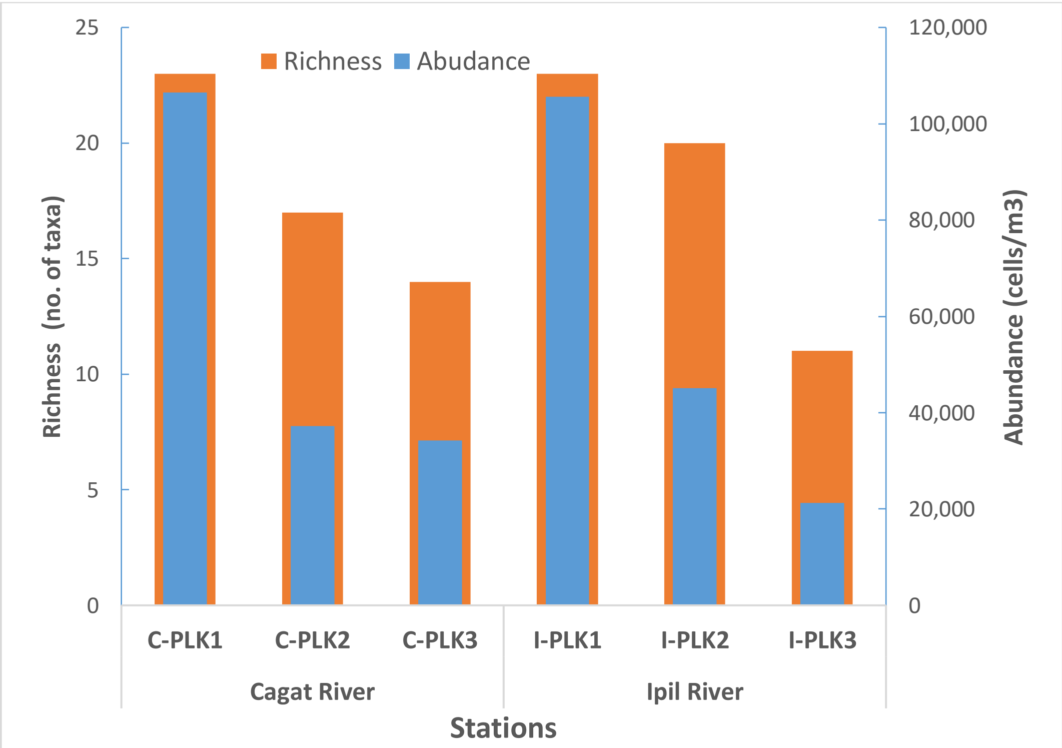


Figure 2.2.34: Total plankton abundance and richness in six sampling station in Cagat River, Carmen Cebu and Ipil River, 23-25 January 2020

The physical and chemical characteristics of the sampling sites affect the density, diversity, distribution and stability of the plankton. Therefore the density and distribution of plankton studied can be used as comparison in future reference and potential monitoring program to be set-up by the company. It is however important to note that this plankton monitoring report should be interpreted in conjunction with the data obtained with physio-chemical parameters, as changes in the physical environment would eventually affect the ecology of the surrounding environment including plankton.

2.2.4.5 Macrobenthos Fauna in Ipil and Cagat Rivers

For the assessment of the freshwater macrobenthic community, samples were collected in three water elevations (upstream, midstream, and downstream) of Ipil River and Cagat rivers on January 25, 2020. Data on the composition, abundance distribution diversity of macrobenthos community in six sampling stations collected near in vicinities of the project are summarized in **Table 2.2.16**. A total of one hundred twenty (120) taxa were quantified across all stations belonging to three major phyla i.e, Mollusca, Annelida and Arthropoda. Among these, the Phylum Arthropda was the most dominant group both the upstream (I-BN1, C-BN1) and midstream stations (I-BN2, C-BN2) of Ipil and Cagat River, while Phylum Mollusca dominated the downstream stations (I-BN3, C-BN3); (**Figure 2.2.36**). The top three macrobenthos family/order identified in this survey were Thiaridae (21%), Chiromonidae (20%), and Baetidae (8%). Other macrobenthos families accounted for 51% of the total macrobenthos community. Gastropods belonging to family Thiaridae are known for their tolerance in the presence of low dissolved oxygen and high suspended particulate matter in river's water. Gastropod especially *Melanoides* is usually abundant in waters affected by agricultural waste even at low level of dissolved oxygen. Chironomids, also known as "non-biting midges" was generally the most abundant as pointed out earlier. They are one of the important groups of insects worldwide in freshwater, aquatic ecosystems with very wide distribution. They are important as indicator organisms, i.e., the presence, absence, or quantities of various species in a body of water can indicate whether pollutants are present (Armitage 1995). Overall, there is no commercially important species nor species listed as a conservation concern in the IUCN red list of species.

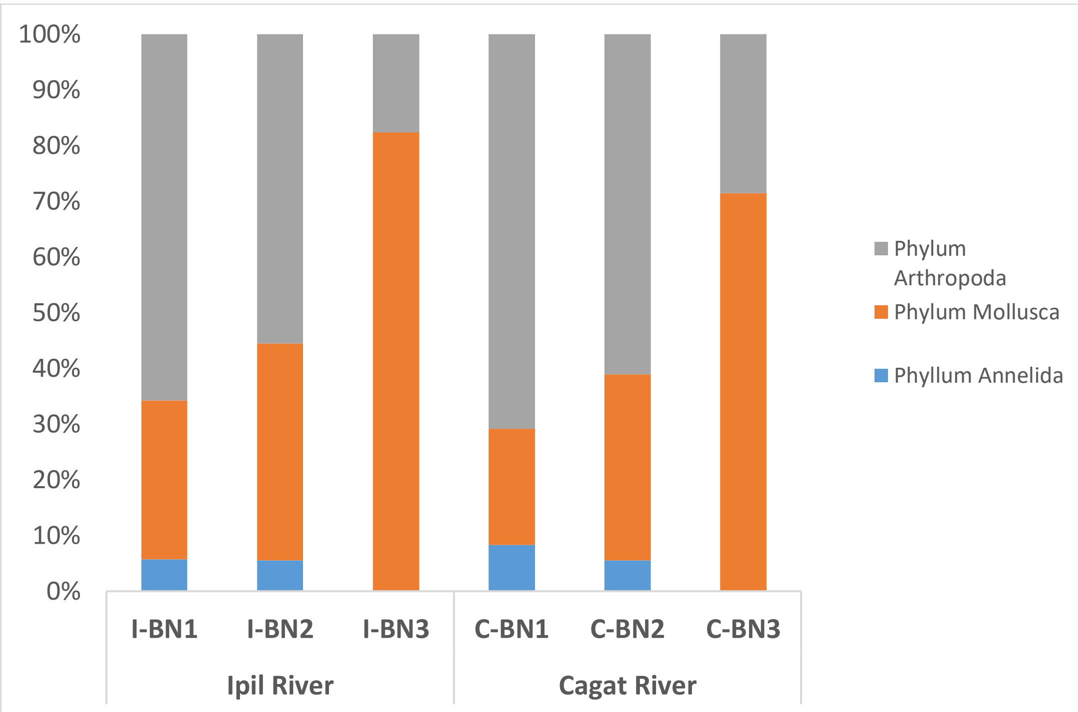


Figure 2.2.35: Percentage composition of major macrobenthos phyla in six stations surveyed during freshwater ecology baseline assessment, 23-25 January 2020.

Table 2.2.12: Macrobenthos Composition, Abundance, Distribution and Diversity in Ipil River and Cagat River, 23-25 January 2020.

Freshwater Benthos Taxa	Ipil River			Cagat River			Grand	Rel.
	I-BN1	I-BN2	I-BN3	C-BN1	C-BN2	C-BN3	Total	Abund.
Phyllum Annelida	**2**	**1**		**2**	**1**		**6**	**5.00**
Class Oligochaeta	2	1		2	1		6	5.00
Phylum Mollusca	**10**	**7**	**14**	**5**	**6**	**6**	**48**	**40.00**
Class Gastropoda								
Family Thiaridae								
Melanoides sp.	6	4	2	2	4	1	19	15.83
Thiara sp.		2		3	1		6	5.00
Family Neritidae	2						2	1.67
Neritina sp.		1	3		1		5	4.17
Family Planorbidae								
Planorbis sp.	2		4			2	8	6.67
Family Muricidae			2			1	3	2.50
Class Bivalvia								
Veneridae			3			2	5	4.17
Phylum Arthropoda	**23**	**10**	**3**	**17**	**11**	**2**	**66**	**55.00**
Subclass Crustacea								
Class Malacostraca								
Order Tanaidacea		1			1		2	1.67
Order Gammaridae		2	3		1	2	8	6.67
Order Decapoda								
Family Atyidae								
Caridina sp.		1					1	0.83
Class Ostracoda								
Order Podocopa	1			1	2		4	3.33
Class Insecta								
Order Ephemeroptera								
Family Baetidae	2	1		3	3		9	7.50
Order Hemiptera								
Family Gerridae	4	2		2	1		9	7.50
Order Diptera								
Family Chironomidae	14	2		6	2		24	20.00
Family Ceratopogonidae	2	1		5	1		9	7.50
Total	**35**	**18**	**17**	**24**	**18**	**8**	**120**	**100.00**
Richness	**9**	**11**	**6**	**8**	**12**	**7**		

The abundance and richness of macrobenthos recorded in three stations is shown in **Figure 2.2.37**. Spatially, the highest density of macrobenthic fauna was recorded in the upstream station (I-BN1) of Ipil river with 35 individual. The lowest macrobenthos count was observed in the downstream station of Ipil river (I-BN3) with 18 individuals. In terms of species richness, the station at the midstream area of Cagat river (C-BN2), also harbored the highest number of macrobenthos taxa with twelve(12) while the lowest number of taxa (6) was recorded in downstream station (i-BN3) of Ipil river. 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).

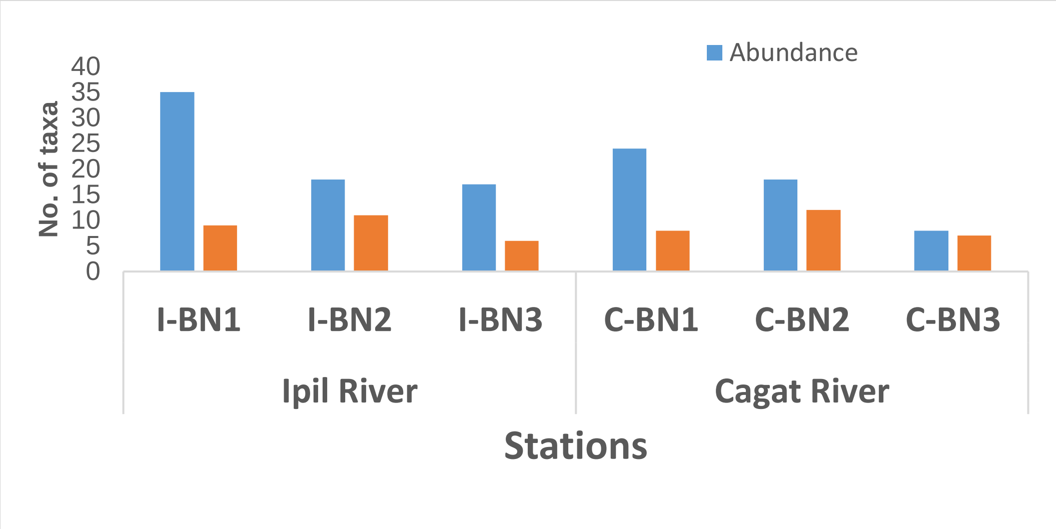


Figure 2.2.36: Species Richness and Total Abundance in Six Sampling Stations; 23-25 January 2020

2.2.4.6 Freshwater Fish Biota Endemicity and Conservation Status

No species of fish in the three river systems and in the estuary stations are endemic. None have been classified by the IUCN as rare, near-threatened, threatened or extinct. The conservation status (IUCN) is presented in **Table 2.2.17**.

Table 2.2.13: Conservation Status of Fish Species Observed in Luyang River; December 2019

Family	Species Name	Local Name	Common Name	IUCN Red List Status
Sardinella	*Sardinella fimbriata*	Tamban	Fimbriated sardine	Not assessed
Sillaginidae	*Sillago sihama*	Aso-os	Common whiting	Least concern
Gobiidae	*Glossogobius sp*	Biya	Goby	Least concern
Theraponidae	*Therapon jarbua*	Tunghod/Bugaong	Theraponid	Unknown/Not assessed
Mugilidae	*Mugil cephalos*	Banak	Flathead mullet	Least concern
Lutjanidae	*Lutjanus quinquelineatus*	Saging-saging	Five-lined snapper	Least concern
Lutjanidae	*Lutjanus fulvus*	Maya-maya	Backtail snapper	Least concern
Plotosidae	*Plotosus lineatus*	Hito; Ito	Striped Catfish	Not assessed
Penaeidae	*Metapenaeus ensis*	Suahe	Greasyback shrimp	Least concern
Penaeidae	*Nematopaleomon tenuepsis*	Pasayan	Freshwater shrimp	Not assessed
Apogonidae	*Ostorhinchus hartzfeldii*	Moong	cardinalfish	Least concern
Cichlidae	*Oreochromis sp*	Tilapia	*Tilapia*	Least concern
Apogonidae	*Ostorhinchus hartzfeldii*	Moong	Cardinalfish	Not assessed
Hemiramphi-dae	*Hemiramphus robustus*	Bugiw	Garfish	Not assessed
Cichlidae	*Oreochromis sp*	Tilapia	Tilapia	Least concern

2.2.4.7 Presence of Pollution Indicator Species

Freshwater fish species found in the study area are not utilized as pollution indicator species and the low species diversity and abundance as observed in the river sampling stations indicates unproductive river ecology, even as river water is clear in two streams. In all freshwater ecology stations surveyed, there were no ecologically and economically important species apart from teraphonid fish and species of gobies in Luyang River station 3. On the other hand, the invasive *Thiara* gastropods are also not in significant proportions except in Luyang station 3. The presence of Thiaridae species in significant numbers is indicative of a polluted environment although this can be localized and not in the entire river system.

2.2.4.8 Threats to existence and/or loss of important local species and habitats

No water will be extracted in any of the river systems around the MPSA. The project will not discharge wastewater from operations to any of the rivers. All process water will be reused.

During the project's operations phase, poorly-managed domestic waste disposal system can lead to solid and liquid wastewater contamination in the river, with uncontained waste streams generated from personnel quarters and offices potentially carried by run-off water into river gullies. This may include coliform and surfactants from disposed laundry soap due to the increase in personnel in the processing plant site. This may further adversely affect water quality in the Luyang, Ipil and Cagat Rivers. Domestic wastewater pollution can lead to hyper-nutrient loading and trigger algal blooms in time of high river water. It is to be noted however, that sediments and domestic waste waters normally come from a broad range of sources, in many instances, other industrial establishments, domestic wastewater from households, open latrines, fertilized croplands, and denuded watersheds. Households and croplands border many portions of the river banks of the river systems.

The risk of oil and grease contamination of the river can only occur if disposal of fuel-based wastes is not undertaken properly and accidental spills near waterways that drain into the rivers happens. From portions of the river, oily sludge, processing slurry and hazardous wastes can be inadvertently carried to coastal waters if containment, recovery and treatment systems are not efficiently established and maintained. Such fugitive wastes will have far-reaching and irreversible impacts on benthic communities in the estuaries, resulting to contamination of grazing areas that may depress fish growth and recruitment, loss of fish habitats and reduction of primary productivity.

There will be no abstraction of river water in any of the river systems and no materials will emanate from the project that can cause river blocking. In view of this, no freshwater fishes, habitats and migration pathways of fish and crustaceans will be affected.

Fugitive sediment streams generated from project operations can be washed into gullies and carried down to the river during heavy rainfall.

2.2.4.9 Abundance of ecologically and economically important species (fishes, benthos, planktons)

Results of plankton sampling reveal poor plankton community diversity, with diatoms constituting 93% of the phytoplankton abundance during the sampling period. Results of the plankton analysis in the Ipil and Cagat Rivers showed that plankton density was generally low in all the sampling locations of both rivers. This indicates that there is no cultural eutrophication in this river ecosystem. Likewise, macrobenthos community, with only three (3) macrobenthos phyla recorded in the Luyang River, is indicative of a stressed environment resulting to narrow taxa diversity. The macrobenthos community in the Ipil and Cagat Rivers, however, reveal modest diversity belonging to three phyla. Macrobenthic organisms, because of their contact with sediments reflect that their relative abundance, ubiquity, and sedentary nature, are considered to be suitable bio-indicators of the long-term environmental status of sediments contaminated by hydrophobic organic micropollutants (Louati, et. al., 2014). The variability of macrobenthic organisms are generally affected by abiotic factors such as substrate types, salinity, water temperature, and dissolved oxygen. Moreover, the presence of pollution-tolerant and gastropod shells (F. Thiaridae) in the river should be looked upon to as it indicates that there is already a factor causing the situation. Physical and habitat disturbances to the rivers can lead to higher natural mortality which affects the diversity of the macrobenthic community. isturbance to the habitat through anthropogenic issues can lead to displacement of benthic organisms and alteration of their habitat due to turbidity of the water column. Other disturbances on the habitat in either anthropogenic or natural in origin, like water pollution and introduction of thick sediments may cause severe depletion of their population due to disruption of reproductive functions. However, few fish species were seen during the surveys in the river, with key informants claiming fish kills in previous years that resulted to elimination of some important species. Moreover, fish migration upstream, if any, will be impeded by the dam constructed in the lower upstream portion of the river. This situation also led to the cessation of river fisheries. Nevertheless, the project's operations are unlikely to cause severe anthropogenic sedimentation as no process water is discharged and domestic wastewaters are efficiently filtered and treated.

The fact that efficient wastewater and sediment containment systems will be installed reduces the likelihood of further fish habitat alteration in the estuary area.

Project operations will not have any direct impact on the river systems as there will be no river water extraction and in the same manner, no liquid discharges from the plant operations.

The primary mitigation strategy to prevent escape of sediments and terrigenous material disturbed during operation into the gullies and streams around the project site is the establishment of a series of silt ponds in strategic areas. Control measures will also include a series of sediment mitigation structures, including catchment and diversion canals to ensure that silt and sediments will not wantonly flow into river gullies. All water diverted into settling ponds will be sieved through filters and geotextile materials in all project diversion waterways. In MPSA area under development, loose soils will be piled up and re-used in revegetation efforts. The stabilization of areas where earth moving has occurred will be undertaken in all areas affected by project and site clearing through extensive vegetation cover enrichment in order to increase sediment amalgamation capacity and soil compacting.

Heavy equipment areas will be located away from waterways where erosion control measures can be easily applied. Operation materials stockpiles shall be covered. As a precautionary approach, slurry walls will be built around areas where such slurries can emanate extensively.

Modern wastewater treatment facilities and a solid waste management plan will be implemented and strictly enforced as mitigation to potential waste disturbances. This will include the setting up of a wastewater treatment facility in premises where project offices, personnel quarters and mess halls are to be located. State-of-the art modern sanitation facilities with 3-chambered septic tanks will be installed in all project latrines.

An oil and grease containment and oily waste containment and recovery plan will be formulated and enforced in all aspects of project operations. Remediation will include recovery and treatment of sludge. Carpools will be located farthest from river systems and all vehicle oil discards will be recovered.

Regular *in-situ* monitoring of river water quality and the state of habitats and diversity of aquatic fauna will be conducted.

2.2.5 Marine Ecology

Marine ecology assessment was conducted on January 23-25, 2020 in the nearshore areas covering four (4) coastal Barangays in the coastline of Danao City, downstream of the Cement Finish Mill Plant and Quarry Area, and two (2) Barangays in Carmen, where the shipyard and drydocks are located (**Figure 2.2.38**). The assessment was conducted to account and describe the condition of primary benthic habitats that are within distance of possible stressor pathways from the project, its associated fisheries resources, resource use practices and ecological functions that can be potentially susceptible to disturbances emanating from the establishment of the project, or be subjected to stresses associated with potential anthropogenic environmental impacts attributable to the Project's operation. The baseline data set generated from the survey of the study area and contiguous environs will subsequently be used as input to the overall Environmental Impact Assessment (EIA) for the project. Ultimately, the baseline profile will serve as the principal tool in crafting appropriate response measures to ensure that such negative project impacts, if any, are mitigated over the long run and in the most effective manner. The underpinning goal of the baseline assessment and coastal habitat profiling is therefore to illustrate the current condition of habitats and resources in the project's impact areas so that these can be comparatively viewed in the future when the project is already operating. By obtaining data and variables of the same types and employing consistent survey protocols, susceptible end points and critical benthic habitats can be characterized in their current state and identification of potential causes and pathways of stressors can be defined for future monitoring purposes.

The sea in front of the project site is part of the southern Camotes Sea and is a busy ferryboat route. The coastal shelf is irregularly indented, with the shipyard located in a lagoon tucked between mangrove outcrops. Most of the sandy seabed within the lagoon is populated with extensive seabgrass meadows which make the area a popular macro-invertebrate gleaning site of local fishers, women and residents in the coastline. A fringing reef nestled in an irregular shelf of shallow water hugs the coastline starting in Brgy. Taytay in Danao and ending south of the Luyang River estuary in Brgy. Dawis Norte in Carmen (**Figure 2.2.39** and **Plate 2.2.23**). Coral distribution is limited to narrow stretches of mostly fringing reef flats, interrupted by sandy substrates located north of the shipyard lagoon. Steep slopes or drop-offs were observed at the offshore edge of the shelf about 400m from the shoreline but no significant coral formations were found in the slopes in two (2) Barangays, south of the Dunggoan, which were primarily dominated by sandy deposits. In the northern and southern ends of the survey area, sandy-muddy substrate dominates the seabed and coral reefs were absent. Small-scale municipal capture fisheries is practiced extensively in the Dunggoan-Dawis Sur coastal waters but no mariculture activities (e.g., seaweed farming) were observed in nearshore waters, except for five units of permanently set *baklads* (fish corals). The reef disappears south of Barangay Dawis Norte in Carmen, due to the presence of estuaries and the nearshore area broadens into a sandy flat. Patches of mangroves communities fringe the coastline from Brgy. Guinsay in Danao to Dawis Sur in Carmen, with isolated clumps of mangroves occurring separately (**Figure 2.2.39**).

The survey focused on principal, and oftentimes, fragile ecological components in the primary and secondary impact areas in the nearshore area and coastline near the project site. These comprised of a total of twenty-six (26) survey stations covering coral reefs, mangroves, seagrass, fish species diversity, benthos, plankton community structure and macro-invertebrates of economic importance. In addition, a total of thirty-four (34) manta tow survey pathways were observed for coral distribution, presence of seagrass and seabed characterization. The data sets generated were reinforced by fisheries profiling to determine resource use practices and indicative productivity through the observation of actual fishing operations. A total of eight (8) actual fishing operations were documented to record catch per unit effort (CPUE). The actual fishing operations were focused in the cove fronting the shipyard which is a popular fishing ground for small-scale fishers.

Plate 2.2.23: Coastal Waters in a Cove in Baranggay Dunggoan, Danao City, Cebu where the Shipyard and Port Complex is Located

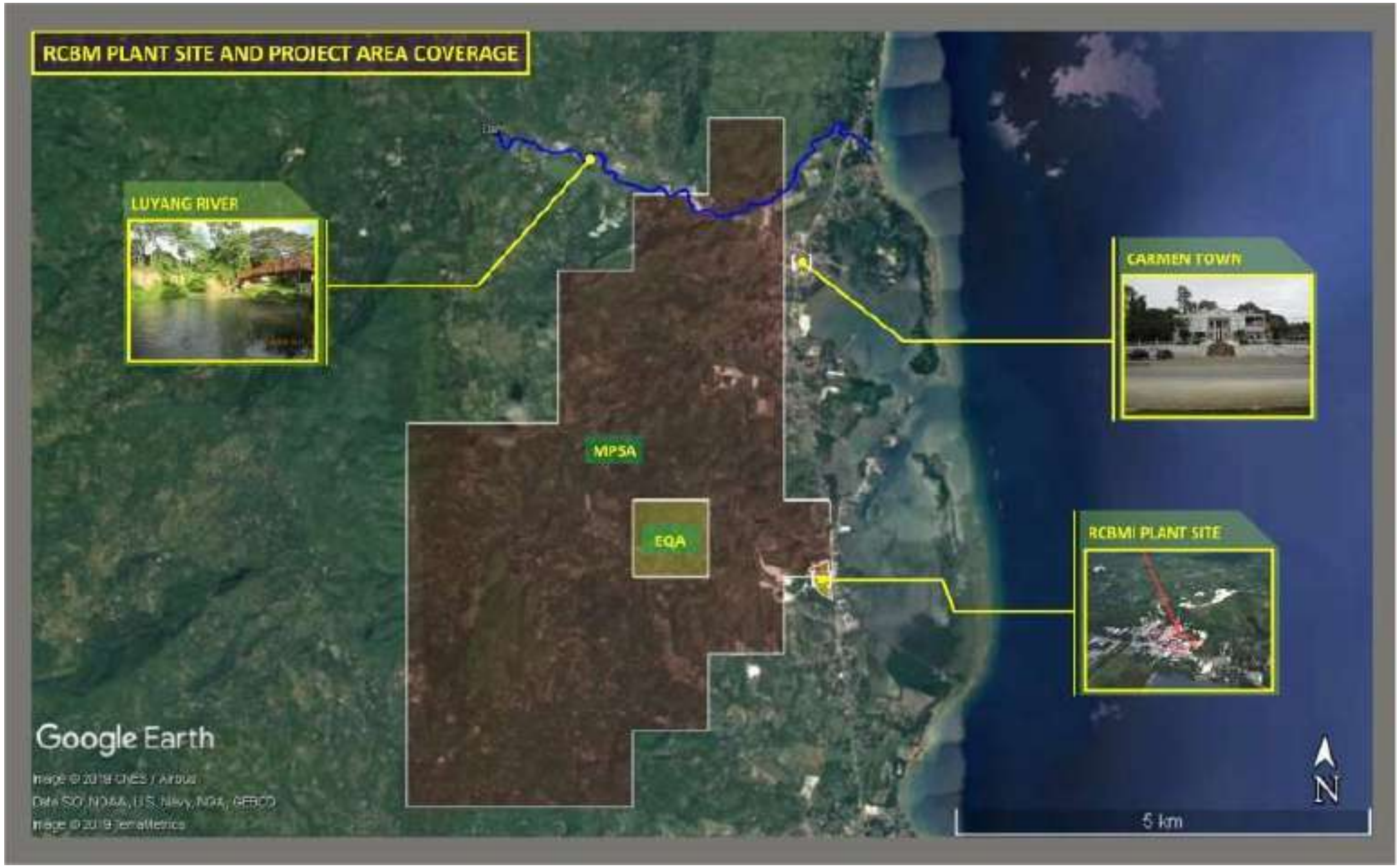


Figure 2.2.37: Map showing project site and impact area of the proposed Republic Cement Finish Mill Plant and Quarry Operations and MPSA in Danao City and Carmen, Cebu

Figure 2.2.38: Coastal Barangays in Danao City and Carmen, Cebu showing Habitats Surveyed during Marine Ecology Baseline Assessment, 23-25 January 2020

Scope of assessment

The scope of work of the marine ecology baseline assessment was focused on the conduct of the following surveys:

- Broad area benthic profiling across the impact area through continuous manta tows in order to define coral distribution and pinpoint areas of diversity for more detailed assessment;
- Determination of distribution and composition and coral cover and associated benthic life forms and abiotic components in stations with relatively better coral cover;
- Definition of species richness, abundance, and diversity of reef-associated fish communities in fish visual census survey stations;
- Rapid assessment of species composition, estimation of catch rates of primary target species of fish, and fishing gears employed;
- Determination of species, composition, density, and diversity of seagrasses and associated macro-benthic algae;
- Species composition and present condition of mangrove stands within the study area;
- Determination of major macro-invertebrate species of commercial importance for food and trade of local fishers;
- Survey of plankton and benthos community composition in selected stations.

Extensive characterization of significant coastal habitats present in the primary impact area of the cement mill project is designed to portray the current condition of the coastal environment and the marine resources present in the area at the time of sampling and cannot represent an irreversible situation, especially in the context of current environmental stressors already existing in the study area at the time of the survey. Given the open access nature in the Philippine coastal zone, it is evident that the issues currently affecting coastal resources are already diverse and extensive and this is already apparent in coastal waters around the project site, as indicated by siltation and presence of extensive dead coral with algae in the coral reefs surveyed. The influx of other issues that can cause further coastal degradation can happen anytime and may exacerbate the current condition of the coastal environment. Nevertheless, the large number of survey stations investigated around the project site offers a definitive pattern of ecological characteristics and attributes which can be utilized as baseline reference for predicting environmental impacts and defining the most suitable mitigation measures. Moreover, the baseline data sets can be used as a reliable benchmark for comparison with data sets obtained in future monitoring activities by the multi-sectoral monitoring team, if the same sampling stations are monitored. The survey methods employed follow standard coastal resource survey techniques prescribed by English *et. al.* (1997) and modified in accordance with *in-situ* conditions employing prescriptions developed though rapid coastal assessment processes evolved in several coastal management projects (e.g. DENR - Coastal Resource Management Project (CRMP) and the BFAR - Fisheries Improved for Sustainable Harvest (FISH) Project.

2.2.5.1 Coral Reef

Two survey methods were employed to describe the benthic environment and the current state of coral reefs in the impact area of the project: (i) Manta Tows and (ii) Line Intercept Transects (LIT).

Manta tows were employed to document benthic conditions and type of resources in a broad stretch of coastal wares, normally tracing reef contours or reef flats where they occur. Manta tow was employed as it is an effective method in generating a broad picture of a large segment of the study area and the use of general categorization of reef cover allows the snorkeler-observer to cover much more distances that also includes location of seagrass beds, following the coral distribution isobath. In the assessment, a total of thirty-four (34) manta tow observation stations were observed (**Figure 2.2.40**; **Plate 2.2.24**). The tow pathways started in the shelf in front of Taytay in Danao City, followed the reef flats around Brgy. Guinsay and Dunggoan, and finally in the reef slopes in Brgy Dawis Norte in Carmen, Cebu. The tow pathway covered an approximate linear distance of 8.7 km (**Figure 2.2.40**). In areas where significant coral reefs occur, results from the manta tow survey were used to pinpoint location of specific stations where more detailed underwater coral characterization employing the line intercept line transect method. Manta tow surveys are also used to identify areas where seagrass and macro-invertebrate survey stations will be established. Coral reefs observed using manta tows were segregated into five (5) categories – LHC or live hard coral cover, SC or soft corals, DCA or dead corals with algae, DC or dead corals and abiotic components of sand, silt or rocks (S/R).

The LIT method (English, et. al., 1994) of coral reef assessment was used to more precisely estimate the relative abundance of living and nonliving components in a survey station where more prominent coral reef resources occur. A major advantage of LIT is that it can more accurately pinpoint susceptible life forms that can be invariably affected by anthropogenic issues. The LIT stations were pre-determined from results of the manta tow surveys, distinguishing coral reef of relatively significant diversity. The survey protocol involved the laying out of 50m transects parallel to the shoreline and spatially following the reef crest isobaths (**Plate 2.2.24**). The survey team recorded all observed benthic life forms along the transect line and the survey therefore provides more precise information of percent coral cover as well as species distribution of corals in a given area. The stations and results of the baseline LIT can be the basis for future monitoring as they are repeatable and comparable if the same stations are surveyed. The overall characterization of coral life forms are described following standard categorization as shown in **Table 2.2.18**.

Table 2.2.14: Criteria for Determining Condition of Coral Reef

Category	Condition in terms of live coral cover distribution within the transect
Excellent	76-100% coverage live coral cover
Good	51-75% coverage live coral cover
Fair	26-50% coverage live coral cover
Poor	0-25% coverage live coral cover

Source: Gomez, et. al., 1994

Two (2) line intercept stations were surveyed in reef the fringing reef fronting Brgy. Dunggoan and Dawis Sur where better coral profiles were observed during manta tows. The descriptiong and the location map of the survey stations are presented in **Table 2.2.19** and **Figure 2.2.41**, respectively. Station 1 is located in Barangay Dawis Sur in Carmen, north of the “drydock” cove where the highest live coral cover was seen; while station 2 was positioned in a reef slope in the boundadry of Barangays Guinsay and Dunggoan along the mouth of the ‘drydock” cove.

Table 2.2.15: Coordinates of Stations Surveyed for Coral Distribution Employing the Line Intercept Method during marine ecology baseline assessment; 23-25 January 2020

WP Code	Latitude	Longitude	Remarks
LIT1	N 10.571130°	E 124.038325°	Located in Brgy Guinsay about 1 km northeast of the fish sanctuary and 2 km southeast of the Cement Plant site in Brgy. Dunggoan.
LIT2	N 10.548091°	E 124.039269°	Located north of the mouth of “drydock” cove in Brgy Dawis Sur, Carmen and more than 2 km northest of the Cement plant in Brgy. Dunggoan. The station is inside the buffer zone of a fish sanctuary (MPA is without buoy markers).

Plate 2.2.24: Manta Tow Survey (left) and Line Intercept Transect Coral Survey (right) during Marine Ecology Baseline Assessment, 23-25 January 2020

Coral profiling through the LIT method was then supplemented with two (2) spot dives in order to describe other prominent reef areas observed during manta tows, albeit these areas host relatively lower live coral cover as compared to the LIT stations. The spot dives were focused in the mouth of the cove where the Republic plant site and shipyard is located. The stations are part of the fringing reef that hugs the coastline from Bgy. Guinsay in Danao City up to Brgy. Dawis Sur in Carmen. Apart from the LIT stations where live coral cover was highest, the spot dive stations are located in portions of the reef where live corals were relatively higher than in most manta tow stations where only 5-10% were observed. The coordinates of the spot dive stations are listed in **Table 2.2.21** and locations are mapped in **Figure 2.2.42**.

Table 2.2.16: Coordinates of Two Spot Dive Stations Surveyed for Additional Coral Reef Profiling during Marine Ecology Baseline Assessment; 23-25 January 2020.

WP Code	Latitude	Longitude	Remarks
SPD1	N 10.547560°	E 124.039024°	Located in a portion of the fringing reef near the boundary Brgy. Dunggoan and Brgy. Guinsay fronting mangrove swamp in the coastline
SPD2	N 10.553710°	E 124.039885°	Located in a portion of the fringing reef in the coastline of Brgy. Dunggoan fronting mangrove strips near the "drydock" cove

Figure 2.2.39: Location of manta tow stations surveyed during marine ecology baseline assessment in the coastal impact area of the proposed Republic Cement Finish Mill Plant and Quarry Operations and MPSA in Danao City and Carmen, Cebu; 23-25 January 2020

Figure 2.2.40: Location of coral line intercept survey stations during marine ecology baseline assessment in the coastal impact area of the proposed Republic Cement Finish Mill Plant and Quarry Operations and MPSA in Danao City and Carmen, Cebu; 23-25 January 2020

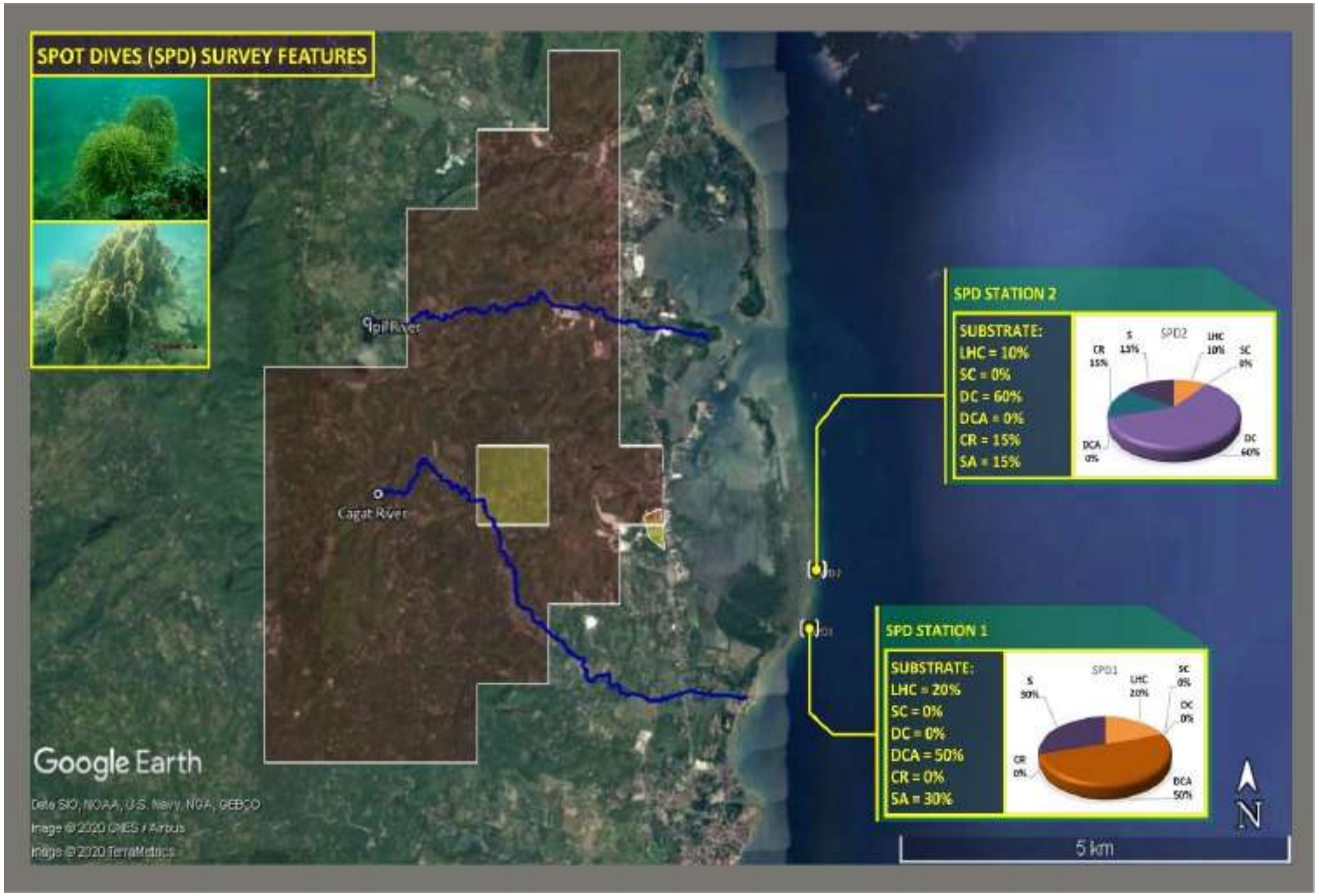


Figure 2.2.41: Location of spot dive stations during marine ecology baseline assessment in the coastal impact area of the Project; 23-25 January 2020

2.2.5.1.1 Coral Reefs Observed during Manta Tows

Out of thirty-four (34) manta tow benthic observation pathways, twenty-one (21) tow pathways hosted live coral cover ranging from 5% to 30%, with sixteen (16) stations – or roughly more than 75% of the fringing reef - having live coral cover of 5 to 10% (Poor) and only five (5) tow pathways with live hard coral cover (LHC) of between 20 to 30% (lower *Fair* category); (**Table 2.2.21**). A total of eight (8) stations were without coral colonies, with the benthic environment dominated by sandy substrate. The live coral cover with relatively better coral colonies is about 24% of the total reef area covered in the tow pathways. The stations with relatively higher coral cover are found in the boundary of Brgy. Dunggoan in Danao City and Brgy. Dawis Sur in Carmen, where a fish sanctuary is located. Going southwards of the fringing reef, live hard coral cover was consistently registered at 5% with few stations hosting 10% LHC (**Figure 2.2.43**). These degraded coral reefs are located in the fringing reef that starts in Bgy. Taytay, Guinsay and the southern portion of Brgy. Dunggoan. In this region, dead corals with algae dominated the reef, with values ranging from mostly 50 to 80% of the reef across the tow pathways. The dense algae community consisted of green algae *Sargassum spp*, *Turbinaria sp,* and brown algae *Padina manor*. Past the reef of 30% live coral cover, the stations were again dominated by dead corals and extensive coral rubble, indicating widespread damage caused by blast fishing. The coral rubble and sandy-muddy substrate were catalogued in the last four stations in Brgy. Dawis Sur, approaching the Ipil River and Luyang River estuaries.

The coral colonies with relatively higher live coral cover were encountered specifically in Tow Stations 25 to 28, in the vicinity of a fish sanctuary in Brgy. Dawis Sur. However, in spite of better coral cover as compared to the rest of the stations, dead corals with algae in these four stations is also high – ranging from 50 to 70% of the reef. Live corals were dominated by few hardy species - *Acropora granulose, Acropora indonesia; Acropora Formosa, Seriatopora hystix, Montipora digita,* massive varieties of *Porites spp,* mushroom corals *Fungia spp,* and the fire coral *Millepora sp* (**Plate 2.2.25**).

There are no indications of recent and serious coral reef disturbance caused by external factors. No fresh dynamite marks were encountered; no cyanide bleaching were observed and even damage from boat anchors were insignificant. However, coral bleaching was observed in some parts of the reef.

Across all 34 stations, the mean coral cover was recorded at only 7%, dead corals with algae at 42% and sandy substrate at 42% (**Figure 2.2.43**). However, discounting the stations where no corals were seen, the mean live coral cover across thirty-four (34) stations where corals were catalogued is 11% (Poor). Dead corals with algae (DCA) –catalogued in all stations - resulted to an average of 65% across the 21 stations with coral colonies. Coral rubble was registered in four (4) stations, while sandy substrate was documented in eight (8) stations).

It should be mentioned that a few crown-of-thorns starfish (*Acanthaster sp*) were seen in colonies where the highest live coral cover occur (**Plate 2.2.25**). The highlights of the manta tow survey are shown in a map in **Figure 2.2.44**.

Table 2.2.17: Tabulated summary of results of manta tow assessments for benthic life form distribution across thirty-four (34) stations; 23-25 January 2020

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	R	S	Remarks
T01-T02	N 10.527504° E 124.034467°	0	0	0	0	0	100	Bgy. Taytay, Danao; Sand and rocks
T02-T03	N 10.529436° E 124.033961°	0	0	0	0	0	100	Sand and rocks
T03-T04	N 10.530526° E 124.033130°	0	0	0	0	0	100	Sand, rocks and silt; with *Padina* sp. and *Sargassum* sp. algae
T04-T05	N 10.531408° E 124.031808°	0	0	0	0	0	100	Bgy. Guinsay; Sand and silt; approx 20% of pathway with seagrass

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	R	S	Remarks
T05-T06	N 10.532668° E 124.030935°	0	0	0	0	0	100	Bgy. Guinsay; Sand and silt; approx 30% of pathway with seagrass
T06-T07	N 10.534050° E 124.030277°	0	0	0	0	0	100	Bgy. Guinsay; Sand and silt
T07-T08	N 10.548485° E 124.039340°	0	0	0	80	0	20	Dead corals with *Sargassum* algae; few seagrass
T08-T09	N 10.550387° E 124.039639°	5	0	0	60	0	35	Reef crest; encrusting live corals, few branching Acropora
T09-T10	N 10.552300° E 124.039850°	0	0	0	75	25	0	Reef crest; dead corals with dense *Sargassum* algae, some *Padina* algae
T10-T11	N 10.554076° E 124.040334°	0	0	0	60	10	30	Coral rubble; dead corals with *Sargassum* algae
T11-T12	N 10.555918° E 124.039900°	5	0	60	35	0	0	Reef crest to slope in Bgy. Dunggoan; coral rubble and *Sargassum* algae; fire coral *Millepora* and encrusting *Montipora*
T12-T13	N 10.557770° E 124.039864°	5	0	30	50	0	15	Coral rubble; live corals consisting of fire coral *Millepora* and some *Seriatopora hystix*
T13-T14	N 10.559639° E 124.039773°	5	0	0	75	0	20	Reef crest; live corals mostly consisting of fire coral *Millepora* sp.
T14-T15	N 10.561570° E 124.039476°	5	0	0	75	0	20	Reef crest; live corals mostly consisting of fire coral *Millepora* sp.
T15-T16	N 10.563515° E 124.039207°	5	0	0	70	0	25	Reef crest; few branching corals and massive *Porites* sp.
T16-T17	N 10.565340° E 124.039018°	5	0	0	70	0	25	Few branching corals and massive *Porites* sp.
T17-T18	N 10.566285° E 124.038713°	10	0	0	70	0	20	Reef slope; few tabulate coral *Acropora indonesia*; *Montipora digita* and fire coral *Millepora*
T18-T19	N 10.567219° E 124.038345°	5	0	0	70	0	25	DCA with few *Millepora* sp.
T19-T20	N 10.569294° E 124.038492°	10	0	0	50	0	40	Reef slope; Few *Montipora digita* and fire coral *Millepora*; wide sandy channels
T20-T21	N 10.571217° E 124.037965°	25	0	0	75	0	0	Reef slope; few tabulate coral *Acropora indonesia*; *Seriatopora hystix* *Montipora digita* and fire coral *Millepora*
T21-T22	N 10.572816° E 124.037288°	5	0	0	50	0	45	Reef crest; mostly DCA
T22-T23	N 10.574595°	5	0	0	50	0	45	Reef crest; mostly DCA

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	R	S	Remarks
	E 124.036670°							
T23-T24	N 10.575909° E 124.035437°							Deep water – channel for navigation of ships going to shipyard
T24-T25	N 10.577804° E 124.034659°	0	0	0	70	0	30	DCA with dense *Sargassum* sp. and patches of seagrass
T25-T26	N 10.579785° E 124.036596°	30	0	0	60	0	10	Bgy. Dawis Sur, Carmen; reef crest with tabulate, branching and massive corals in between sandy channels
T26-T27	N 10.581576° E 124.036926°	20	0	0	70	0	10	Reef crest with tabulate, branching and massive corals
T27-T28	N 10.583719° E 124.035940°	30	0	0	60	0	10	Reef slope of fish sanctuary; few tabulate coral *Acropora indonesia*; *Seriatopora hystix*, *Montipora digita* and fire coral *Millepora*
T28-T29	N 10.585538° E 124.035426°	30	0	0	50	0	20	Reef slope of fish sanctuary; few massive corals *Porites* sp.; tabulate coral *Acropora indonesia*, *Seriatopora hystix*, *Montipora digita* and fire coral *Millepora sp*
T29-T30	N 10.587419° E 124.034973°	10	0	40	20	0	30	Mostly coral rubble
T30-T31	N 10.589469° E 124.034695°	10	0	70	0	0	20	Mostly coral rubble
T31-T32	N 10.591279° E 124.034694°	5	0	0	0	80	15	Mostly coral rubble
T32-T33	N 10.593031° E 124.034547°	5	0	0	25	0	70	Mostly sand, mud and silt
T33-T34	N 10.594853° E 124.034063°	0	0	0	0	0	100	Mostly sand, mud and silt
T34-EOT	N 10.596716° E 124.033080°	0	0	0	0	0	100	Mostly sand, mud and silt
EOT	N 10.598615° E 124.031369°	-	-	-	-	-	-	End of Tow
Average Reef and Substrate Composition		**7**	**0**	**6**	**42**	**3**	**42**	

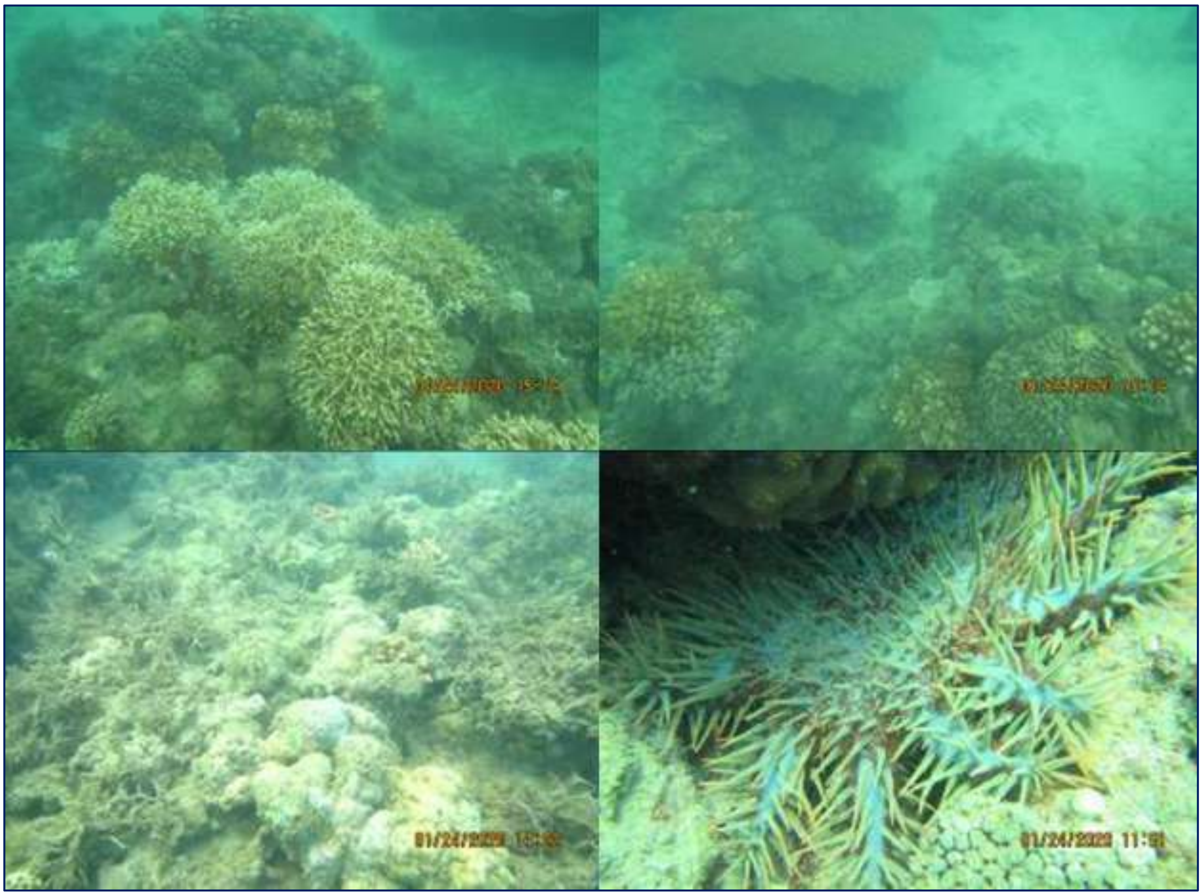
Site name:	Coastal waters across the Republic Cement Plant and MPSA area covering the coastal waters of Danao City and Carmen, Cebu	**Observers:**
Time / Date:	1040H-1504H / 24 January 2020	Benjamin Francisco
Tow Speed:	4.0 kmh (ave)	Ernie Fontamillas
Visibility:	Varying from ± 10m	Rene Villegas
Weather:	Fair to Sunny	
Wave:	Rolling crests of approx. ±10cm	
Current:	None (preliminary tows) to Strong (approaching final tows)	
Tide:	Rising at start of tow from 0.62m approaching peak at 0.76 then lowering to 0.50m at the end of the tows	

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	R	S	Remarks
	Ref: Carmen Tidal Station (WXTIDE 32 App)							
Water Temp:	Approx. ±30°C							
Wind:	Beaufort Scale #1							
Cloud Type:	Cumulus and some Cirrus clouds							

Note:

- Tow area coverage are expressed in Decimal Degrees notation in reference to WGS84 Map Datum
- Reef and Substrate composition are expressed in (%) and described as follows:
    - Live hard coral (LHC) – coverage of stony or hard corals on the bottom or part of the bottom
    - Live soft coral (SC) – coverage of soft corals attached to the bottom
    - Dead coral (DC) – recently dead coral still attached and recognizable at the bottom in the original upright position, color usually white with no living tissue
    - Dead coral with algae (DCA) – corallite still visible, skeletal structure can still be seen but algae dominate the structure (often appears greenish to brownish)
    - Cpral rubble/rock (CR) – loose broken frahments of stony corals, consolidated hard bottom or large blocksof hard reef materials not attached or easily moved around
    - Sand/silt (S)

Pie graphs showing coral cover distribution per station are shown in **Annex 2-4**.



Note: Lower photos show dead corals with algae with some bleached massive corals (left) and a crown-of-thorns starfish Acanthaster sp seen feeding on a massive coral colony (right photo). Note presence of some coral recruits.

Plate 2.2.25: Live hard corals observed in manta tow stations T25 to T287, mostly branching Acropora sp, foliose Montipora sp and massive Porites sp.

Note: Tow stations number 25 to 29 hosted the highest live coral cover

Figure 2.2.42: Results of manta tows survey in thirty-four (34) stations; 23-25 January 2020

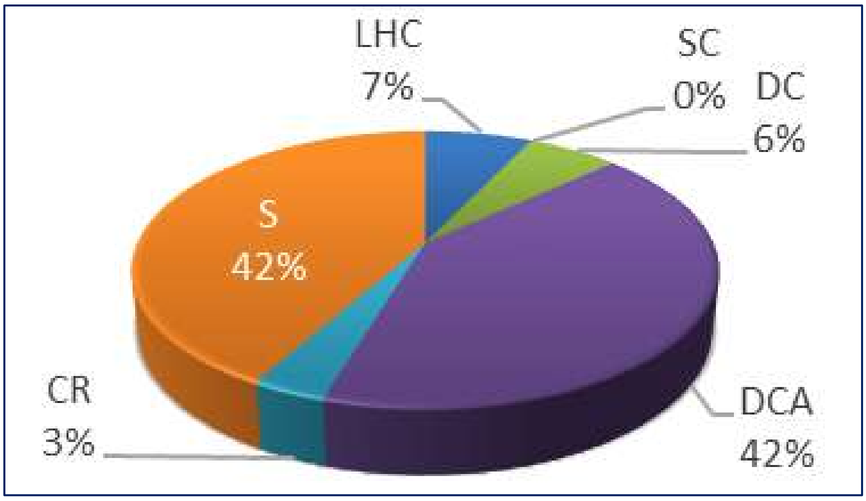


Figure 2.2.43: Mean coral cover and substrate composition across thirty-four (34) manta tow stations, 23-25 January 2020

2.2.5.1.2 Coral Reefs Observed during LIT

The results of the detailed coral assessment by laying out LIT in the fringing reef where better coral profile was discerned in manta tows in Barangay Dawis Sur, Carmen revealed a mean live hard coral cover (LHC) of 25% (Fair) across the two stations (**Table 2.2.22**). The LIT result is similar to the manta tow observation. Dead corals with algae was recorded at an average of 37% and coral rubble at 23% (**Figure 2.2.45**). The presence of a high ratio of coral rubble signifies coral damage through blast fishing in recent years. To a lesser degree, coral mortality also appears to have been caused by bleaching. Massive *Porites* varieties comprised almost 5% of the live coral cover; while the fire coral *Millepora sp* comprised 6%. Even as the entire reef in the survey area is relatively in the poor condition and only few portions hosted corals in 'Fair' condition, the coral colonies were diverse with Acropora tabulate, branching and digitate corals averaging 1.6 to 3% of relative distribution. Other coral varieties consisted of non-Acroproa branching, foliose, encrusting and non-scleractinian mushroom corals, comprising 0.4%, 1%, 2.6% and 2.9% of relative distribution, respectively (**Plate 2.2.26**). Together with massive and fire corals, these types of hard live hard corals dominated the reefs surveyed across three stations, occupying about 18% of the survey corridor. In view of this diversity, at least 66 species of hard corals, mushroom corals and soft corals were catalogued across the tow LIT stations and contiguous reefs subjected to spot dives (**Table 2.2.23**) were recorded. A modest scattering of coral recruits were observed in the reef, mostly consisting of massive, branching *Acropora* and tabulate *Acropora,* indicating coral recovery in portions of the reef with more stable settlement substrate for coral planulae.

Table 2.2.18: Average Percentage Cover of the Different Lifeform Categories Across Two LITs, 23-25 January 2020

Lifeform Categories		Code	Average Percentage Cover *(in %)*
Acropora	*Branching*	*ACB*	***2.80***
	Digitate	*ACD*	***1.60***
	Tabulate	*ACT*	***2.90***
Non-Acropora	*Branching*	*CB*	***0.40***
	Encrusting	*CE*	***1.00***
	Foliose	*CF*	***2.60***
	Massive	*CM*	***4.90***
	Mushroom Coral	*CMR*	***2.90***
	Coral Millepora	*CME*	***5.90***
AVERAGE PERCENT LIVE HARD CORAL (LHC) COVER			***25.00 Fair Condition***

Lifeform Categories		Code	Average Percentage Cover *(in %)*
Dead Coral		*DC*	**1.90**
Dead Coral with Algae		*DCA*	**37.10**
Other Fauna	*Soft Coral*	*SC*	**6.10**
	Sponge	*SP*	**1.30**
	Giant Clam	*OT*	**0.20**
Abiotic	*Sand*	*S*	**3.20**
	Rubble	*R*	**23.30**
	Rock	*RCK*	**1.90**

Note: Status Category: Poor = 0 - 24.9; Fair = 25 - 49.9%; Good = 50 - 74.9%; Excellent = 75 - 100% (Gomez et al. 1981)

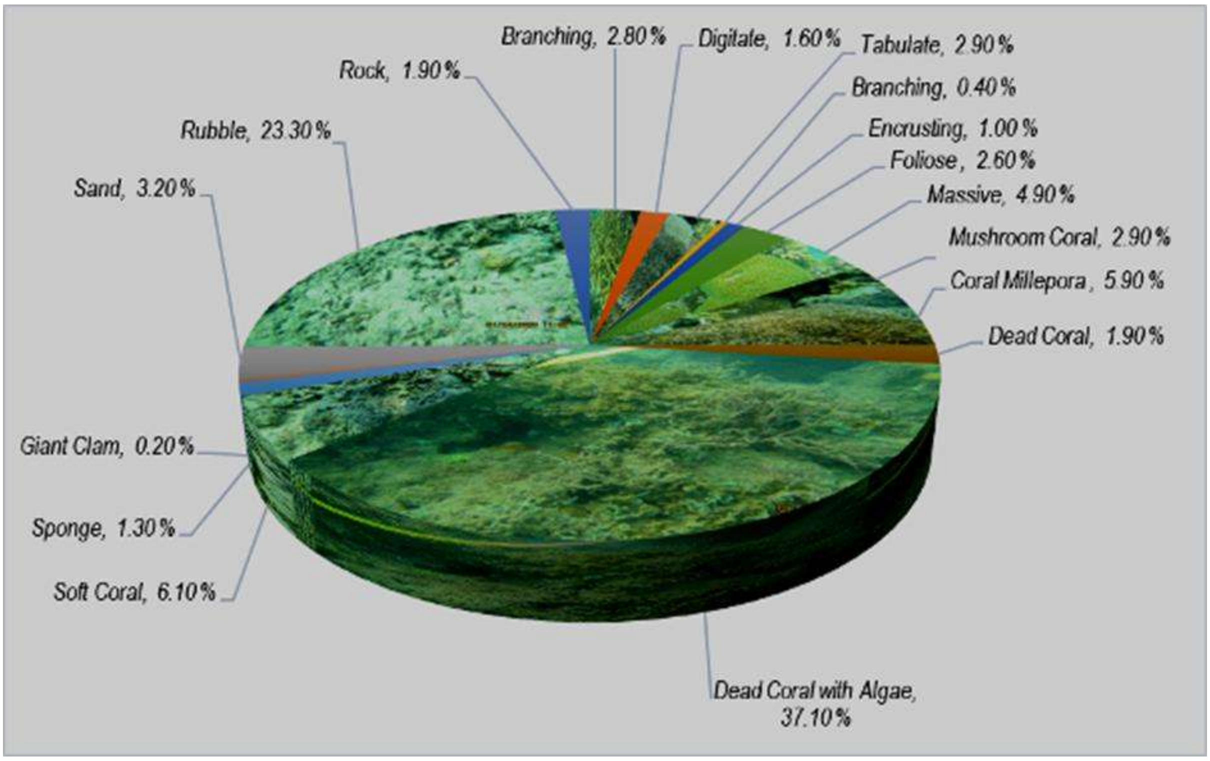
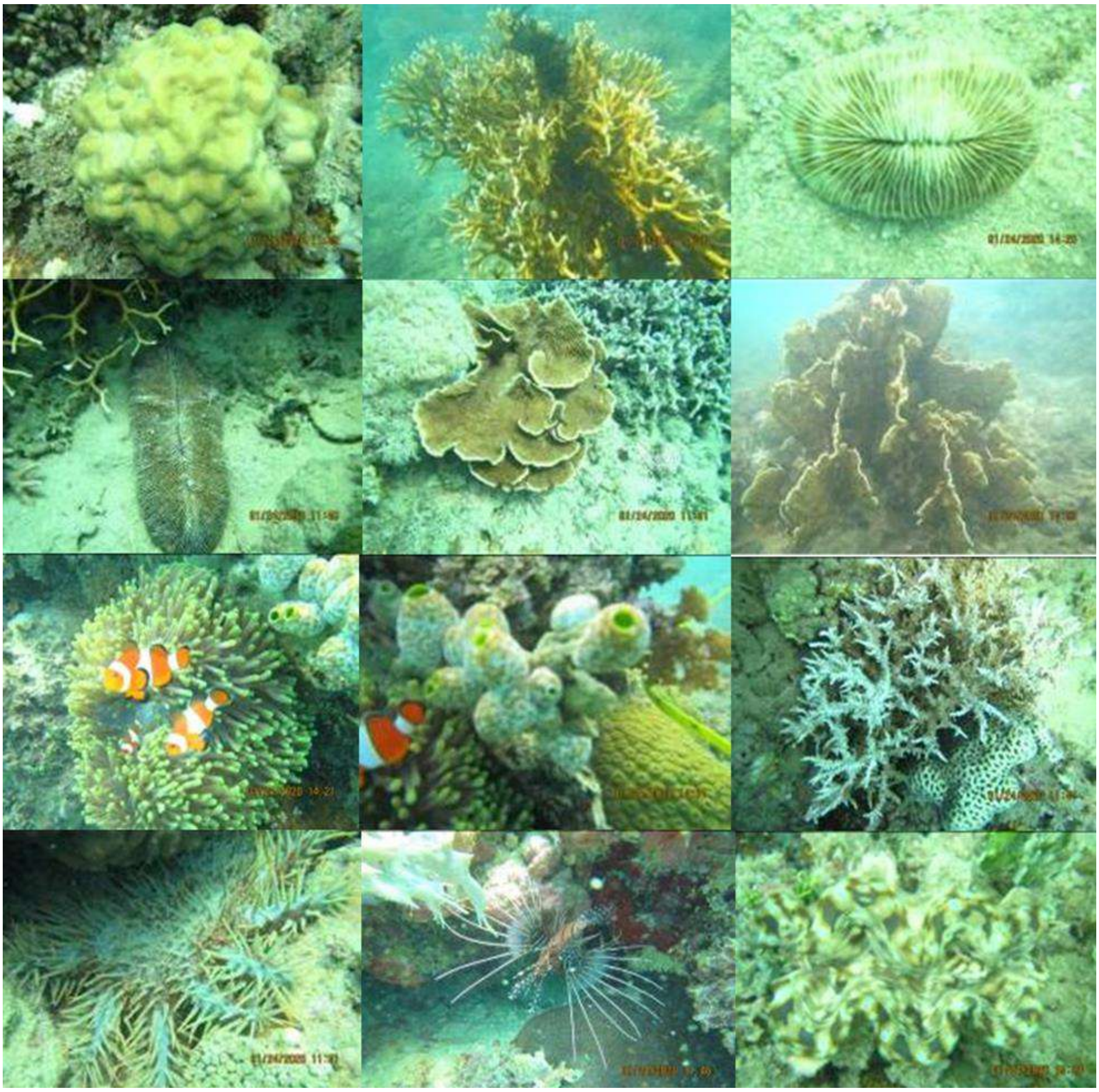


Figure 2.2.44: Distribution of Coral Life Form Categories in Two LIT Stations, January 23-25, 2020



Note:). Left to right: staghorn coral (Acropora formosa); velvet finger coral (Montipora digitata); table-like coral (Acropora indonesia); boulder/Lobe coral (Porites lobata); Cabbage/lettuce coral (Montipora confusa); Mushroom coral (Fungia paumotensis); rough feather coral (Ctenactis crassa); sea ginger colonial fire coral (Millepora alcicornis) and blade/plate fire coral (Millepora platyphylla); common soft coral (Clavularia viridis) has symbiotic mutualism with Chagos anemonefish (Amphiprion chagosensis); lumpy growing sponge (Holopsamma helwigi); bleached staghorn coral (Acropora exquisita); crown of thorns starfish (Acanthaster planci) feeding on a massive coral; a venomous coral reef fish Red lionfish (Pterois volitans) taking refuge in a dead coral with algae and a fluted giant clam (Tridacna squamosa).

Plate 2.2.26: Photographs of the Dominant Live Hard Corals, Soft Corals Associated Fish, Sponge and Giant Clam in the Survey Site, January 24-25, 2020

Table 2.2.19: Some Coral Species Encountered in Two LIT Stations; 23-25 January 2020

Massive	Branching	Digitate, Encrusting, Mushroom, Foliose, Soft Corals, Sponges & Other Fauna
Acanthastrea echinata	*Acropora exquisita*	*Acropora crateriformis*
Acanthastrea hemprichii	*Acropora formosa*	*Acropora digitifera*
Acanthastrea hillae	*Acropora grandis*	*Acropora humilis*
Leptoria phrygia	*Acropora donei*	*Acropora gemmifera*
Leptoria species	*Acropora florida*	*Acropora humulus*
Lobophyllia dentatus	*Acropora granulosa*	*Acropora digitifera*
Lobophyllia hemprichii	*Acropora indonesia*	*Montipora digitata*
Montipora efflorescens	*Acropora loripes*	*Montipora capitata*
Montipora incrassata	*Acropora mirabilis*	*Montipora cebuensis*
Porites australiensis	*Acropora robusta*	*Montipora confusa*
Porites lobata	*Acropora hemprichii*	*Montipora friabilis*
Porites lutea	*Anacropora pillai*	*Montipora monasteriata*
Porites solida	*Montipora digitata*	*Montipora turtlensis*
Porites vaughani	*Pocillopora elegans*	*Montipora mactanensis*
Porites species	*Porites nigrescens*	*Ctenactis crassa*
Symphyllia recta	*Montipora hirsuta*	*Fungia danai*
	Montipora samarensis	*Fungia granulosa*
	Montipora stellata	*Fungia horrida*
		Fungia paumotensis
		Fungia seychellensi
		Herpolitha weberi
		Lithophyllon lobata
		Montipora foliosa
		Millepora platyphylla
		Millepora alcicornis
		Clavularia viridis
		Oxycomanthus bennetti
		Sarchophyton elegans
		Cliona tenuis
		Holopsamma helwigi
		Verongula rigida
		Tridacna squamosa

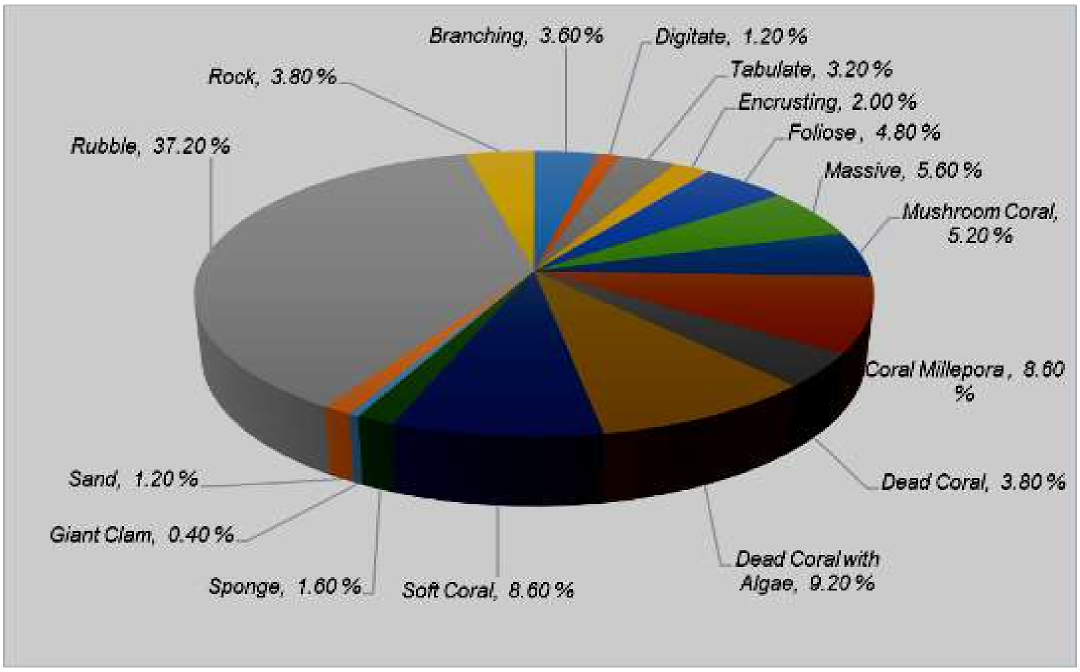
The highest and most diverse live cover was recorded in Station 1 which is inside the MPSA in Brgy. Dawis Sur, Carmen, north of the mouth of the cove where the shipyard is located (**Table 2.2.24; Figure 2.2.46**). This station is almost 2.5 km northeast of the primary impact area in plant site and MPSA (**Figure 2.2.48**). Live coral cover in this area was estimated at 34.2%, which is categorized as 'Fair' condition (based on Gomez, 1981). The live coral cover in this station is dominated by non-Acropora fire corals, massive corals, foliose and mushroom corals, altogether comprising 24.2% of total relative distribution of live corals in the station. Soft corals comprised 8.6% of the community, sponges at 1.6% and *Tridacna* giant clams at 0.4%. Coral rubble was significant at 37% of the survey line.

Table 2.2.20: Distribution (in % of Total Coral Cover) of Coral Life Forms per LIT Stations; 23-25 January 2020.

Lifeform Categotes		Code	Distribution per Transect *(in %)*	
			1	2
Acropora	*Branching*	*ACB*	3.60	2.00
	Digitate	*ACD*	1.20	2.00
	Tabulate	*ACT*	3.20	2.60
Non-Acropora	*Branching*	*CB*		0.80
	Encrusting	*CE*	2.00	
	Foliose	*CF*	4.80	0.40

Lifeform Categotes		Code	Distribution per Transect *(in %)*	
			1	2
	Massive	*CM*	5.60	4.20
	Coral Mushroom	*CMR*	5.20	0.60
	Coral Millepora	*CME*	8.60	3.20
AVERAGE PERCENT LIVE HARD CORAL COVER			***34.20 (Fair)***	***15.80 (Poor)***
Dead Coral		*DC*	3.80	
Dead Coral with Algae		*DCA*	9.20	65.00
Other Fauna	*Soft Coral*	*SC*	8.60	3.60
	Sponge	*SP*	1.60	1.00
	Giant Clam		0.40	
Abiotic	*Sand*	*S*	1.20	5.20
	Rubble	*R*	37.20	9.40
	Rock	*RCK*	3.80	
Name of Site: Barangays Dawis Sur & Libon		**Municipality/City & Province:** Carmen & Danao City, Cebu Province		
Date: January 24 - 25, 2020		**Observers:** Victor L. Pantaleon & Ronald T. Pocon		
Location:				**Depth** *(in meter)*
Study Station No.: 1 Start: 124. 038325^0 E, 10.571130^0 N; End: 124. 038251^0 E, 10. 571559^0 N				7 - 10
Study Station No.: 2 Start: 124. 039269^0 E, 10. 548091^0 N; End: 124. 039292 ^{0} E, 10. 548536^0 N				9 - 12

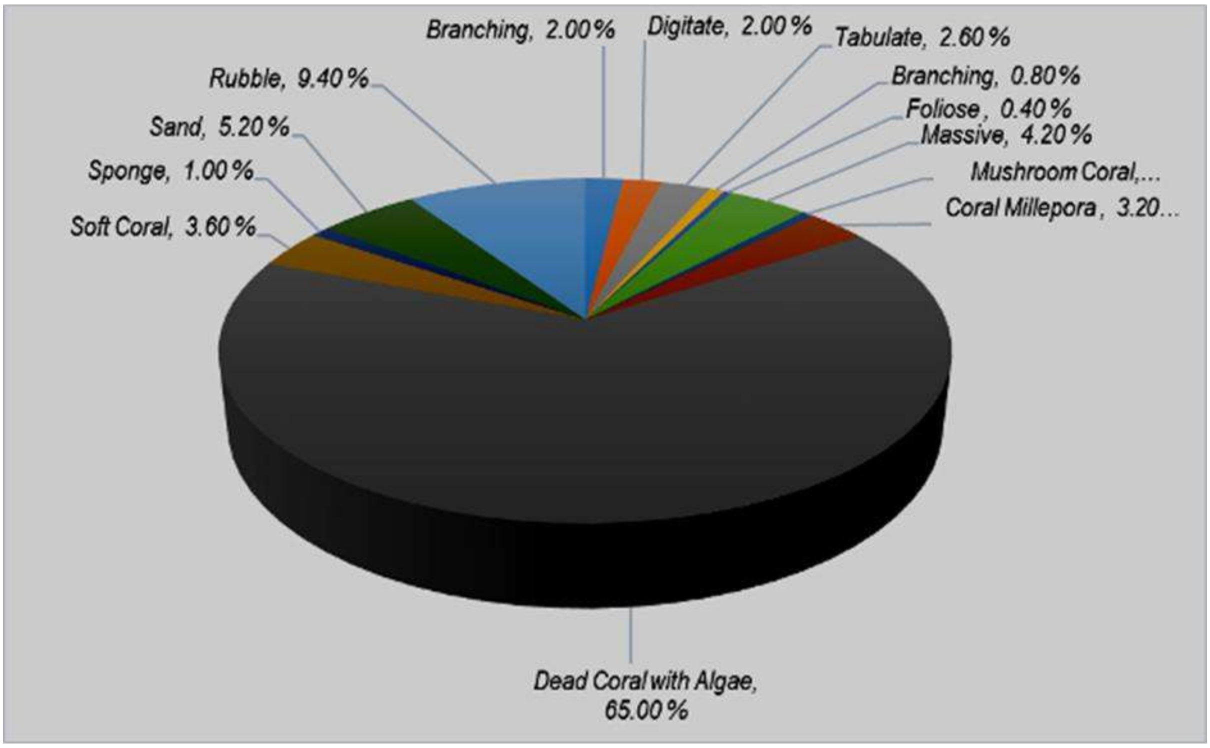
Note: Status Category: Poor = 0 - 24.9; Fair = 25 - 49.9%; Good = 50 - 74.9%; Excellent = 75 - 100% (Gomez et al. 1981)



Note: Coordinates of Transect (Start: 124. 0383250 E, 10.5711300 N; End: 124. 0382510 E, 10. 5715590 N

Figure 2.2.45: Distribution (in % of Total Coral Cover) of Coral Life Forms in LIT Station 1 in Brgy. Dawis Sur, Carmen; 23-25 January 2020

‘Poor’ coral cover dominated LIT Station 2 – catalogued at 15.8% of the transect line (**Table 2.2.25** and **Figure 2.247**). This station is located about 3 km south of station 1 in the shelf slope in the boundary of Brgy Dunggoan and Guinsay (**Figure 2.2.48**). Dead corals with algae in this station was catalogued at a high 65%, and coral rubble at almost 10%. Algal colonies were dense and consisted primarily of Sargassum seaweeds. The dominant live corals in the transect include massive corals (4.2% relative distribution), Millepora corals (3.2%), and Acropora branching corals consisting of digitate, tabulate and branching varieties, accounting for 6.6 of relative live coral distribution combined.



Note: Coordinates of Transect (Start: 124. 0392690 E, 10. 5480910 N; End: 124. 039292 0 E, 10. 5485360 N)

Figure 2.2.46: Distribution (in % of Total Coral Cover) of Coral Life Forms in LIT Station 2 in Brgy. Dunggoan, Danao City; 23-25 January 2020

Figure 2.2.47: Average Percentage Cover of Corals and Associated Life Forms per Transect Station Observed in Two LIT Stations; 23-25 January 2020

2.2.5.1.3 Coral Reefs Observed during Spot Dives

Spot dives conducted at two (2) stations revealed low coral cover which was typical in the rest of the fringing reef except in the tow areas where the LIT stations were investigated. Live coral cover in station 1 was recorded at 20% with dead corals with algae 50 and sandy substrate at 30% (**Table 2.2.25**). Station 1 is about 1.5 km south of the LIT station 1 where live hard corals was recorded at 34% previously. This implies that the reef with fair coral cover is short. Results of spot dive station 2, which is near the LIT station 2 where 15% LHC was previously observed yielded almost the same results as in the LIT survey, with live hard corals catalogued at only 10% and dead corals and coral rubble at 75% (**Figure 2.2.49**). The live corals are dominated by the fire coral *Millepora sp* and massive varieties *Porites spp*. The results of the spot dives further validate that the presence of relatively better live coral cover is limited to a small area in the vicinity of the MPA in Brgy. Dawis Sur in Carmen.

Table 2.2.21: Results of Spot Dives for Additional Coral Reef Profiling in Two Stations; 23-25 January 2020

WP Code	Latitude	Longitude	LHC	SC	DC	DCA	R	S	Remarks
SPD1	N 10.547560°	E 124.039024°	20	0	0	50	0	30	Live Hard Coral=20%, Soft Coral=0%, Dead Coral=0%, Dead Coral w Algae=50%, Coral Rubble=0%, Sand/Silt=30%; coral forms are encrusting and branching with some *Millepora* sp. and *Porites* sp.; Surveyed within a 50 meter radius
SPD2	N 10.553710°	E 124.039885°	10	0	60	0	15	15	Live Hard Coral=10%, Soft Coral=0%, Dead Coral=60%, Coral Rubble=15%, Sand/Silt=15%, some *Millepora* sp.; Surveyed within a 50 meter radius

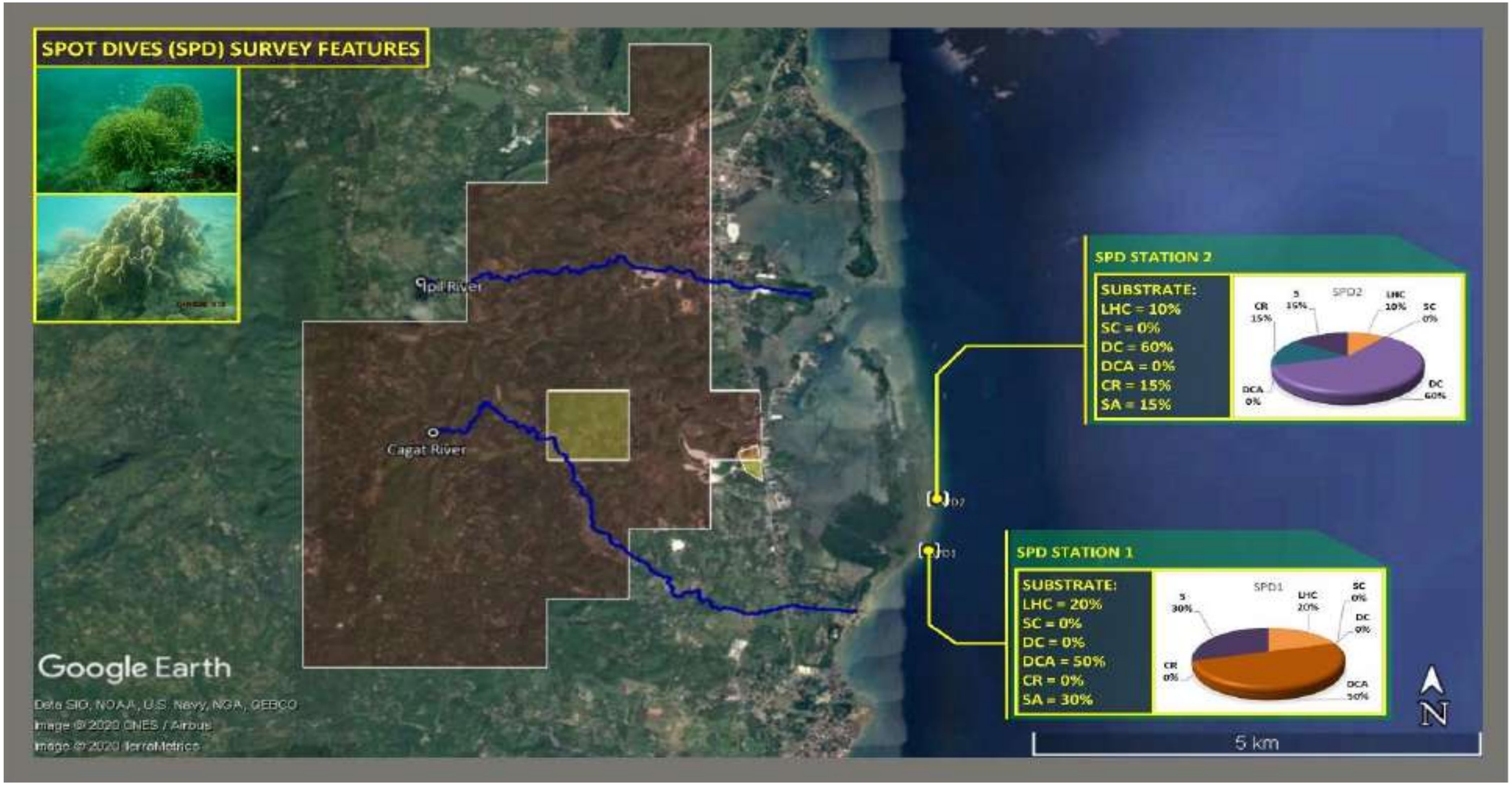


Figure 2.2.48: Results of Spot Dives for Additional Coral Reef Profiling in Two Stations; 23-25 January 2020

2.2.5.2 Reef Associated Fish Communities

The two (2) LIT stations were subsequently used to account for fish communities associated with coral reefs through standard fish visual census (FVC) prescribed by English et. al., (1997). The conduct of FVC is designed to document a fairly accurate picture of demersal fish species richness and abundance in benthic habitats. In this case high values for these principal variables can indicate the overall ecological condition of a reef area and can give a glimpse of a healthy or poor ecosystem functioning. Collectively, the results of coral reef assessments and fish visual census are used as reference points for comparative monitoring of changes in spatial distribution and diversity of benthic life forms in periodic environmental impact monitoring. The coordinates of the stations are presented in **Table 2.2.26** and depicted in **Figure 2.2.50**.

Fish species were categorized as target, major or indicator species based categories recommended in FishBase 2004. Target species are economically important fish species that are normally sought by fishers for their relatively higher economic value. These include species such as groupers, snappers, jacks and some species of surgeons. Fish that belong to the major fish category are considered to be ecologically important because they occupy unique niches and sometimes symbiotic relationships in the coral reef ecosystem. Many of these species are represented by members of the damselfishes (*Pomacentridae*) and wrasses (Labridae). Indicator species are coral-feeders whose presence, variety and abundance in a given reef may give an indication of the general condition of the reef area. These are mostly butterfly fishes (*Chaetodontidae*) and a few species of damsels and wrasses.

The total lengths of fish were estimated to the nearest centimeter and their numbers determined through actual counts. With length and abundance data, fish biomass was then calculated using the standard formula W = aLb, where W represents weight of the fish in grams, L is the total length in centimeters, and *a* and *b* are the assigned weight-length constants for fish species as prescribed in various scientific literature (Gonzales, et. al., 2000).

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Table 2.2.22: Coordinates of stations surveyed for reef-associated fish species richness and abundance in two FVC stations; 23-25 January 2020

WP Code	LATITUDE	LONGITUDE	Remarks
FVC1	N 10.571130°	E 124.038325°	Same station as LIT 1 located in Brgy Guinsay about 1 km northeast of the fish sanctuary and 2 km southeast of the Cement plant site in Bgy. Dunggoan.
FVC2	N 10.548091°	E 124.039269°	Same station as LIT 2 located north of the mouth of “drydock” cove in Brgy Dawis Sur, Carmen and more than 2 km northest of the Cement plant in Brgy. Dunggoan. The station is inside the buffer zone of a fish sanctuary (MPA is without buoy markers).

Figure 2.2.49: Location of Fish Visual Census Survey Stations; 23-25 January 2020

2.2.5.3 Mangroves

Mangrove forests are natural sediment traps and contribute significantly to the reduction of sediment plumes that can otherwise suffocate coral reef colonies. Dense patches of mangroves are found in at least four major locations in the cove where the shipyard is located. The mangroves are dominated by old growth trees with a mixture of re-planted trees through rehabilitation projects. Undisturbed growth is consistent in all sites and there were no signs of mangrove tree cuttings; neither are there indications of extensive pollution. The mangrove forests therefore clearly support importance ecological functions that can directly promote fish population replenishment and export of nutrients that sustain fish and crustacean food webs, particularly for larval nursery and development in the lower base of the marine food chain.

Five (5) stations were subjected to the standard transect-quadrat survey method (**Plate 2.2.29**). The first two stations are located in the mouth of the ‘shipyard cove’, while two other stations were surveyed south of the first stations, along the coastline of Brgy Guinsay. Coordinates of the sampling stations are listed in **Table 2.2.30** and shown in a map in **Figure 2.2.56**.

In the estuary of the Luyang River, mangrove assessment employing the standard transect-quadrant method was conducted in four (4) quadrates in the inner patch of mangroves located in northern side of the Luyang river mouth on 15 December 2019 (station 5). The mangrove area is a small strip of mixed old growth and younger trees of less than 2ha with two (2) species – *Sonneratia alba* and *Rhizopora mucronata*. This is the only mangrove patch in the coastal zone along the Luyang River estuary and contiguous coastline to the north.

Table 2.2.23: Coordinates of stations surveyed for mangrove diversity and relative distribution of species during marine ecology baseline assessment; 23-25 January 2020

WP Code	Latitude	Longitude	Remarks
MGV1	N 10.566370°	E 124.034520°	Located in patch of offshore mangroves fronting the “drydock cove” in Bgy Dawis Sur, Carmen with mostly *Avicennia marina, Rhizophora mucronata* and *Rhiphora apiculata*
MGV2	N 10.561500°	E 124.034130°	Located in patch of offshore mangroves south of station 1 fronting the “drydock cove” in Bgy Dunggoan, Danao City with mostly *Avicennia marina and Rhizophora mucronata*
MGV3	N 10.545400°	E 124.034800°	Located in patch of offshore mangroves 2 km south of station 2 in a fringing mangrove patch in Bgy Guinsay southeast of the “drydock cove” area; mostly *Avicennia marina* and *Sonneratia alba.*
MGV4	N 10.553480°	E 124.036150°	Located in patch of offshore mangroves 1 km south of station 3 in an offshore manfgove patch in Bgy Dunggoan fronting the Republic Cement plant site; mostly *Avicennia marina* and *Sonneratia alba.*
MGV5	N 10.605890°	E 124.026438°;	Located in the Luyang River estuary in Bgy Fuente, Carmen, Cebu; mixed old growth and young *Avicennia marina, Rhizophora mucronata*

Plate 2.2.27: Survey of Mangroves in the 'Shipyard Cove' (upper photos), and in the Luyang River Estuary (lower photos), January 23-25, 2020

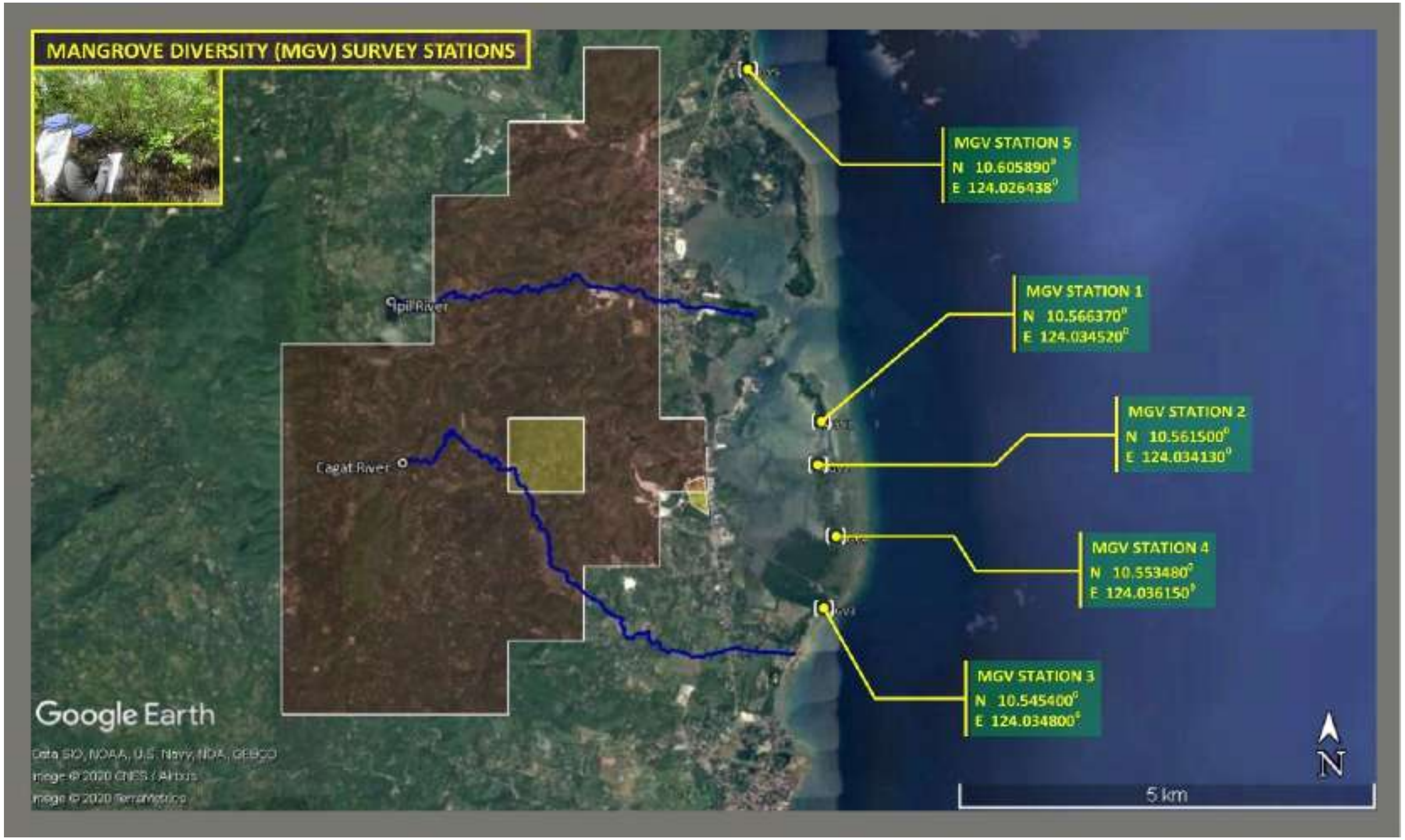


Figure 2.2.50: Location of mangrove survey stations during marine ecology baseline assessment in the coastal impact area of the proposed Republic Cement Finish Mill Plant and Quarry Operations and MPSA in Danao City and Carmen, Cebu; 23-25 January 2020

The five (5) separate patches of mangroves existed separately the coastline starting in Brgy Guinsay in Danao City up to Brgy. Luyang in Carmen. The mangroves in Brgy. Guinsay fringe the coastline; those in Brgy. Dunggoan and Dawis Sur are offshore patches. Four species of true mangroves are found across the area surveyed – *Rhizopora mucronata* (bakawan babae), *Rhizopora apiculata* (bakawan lalake), *Sonneratia alba* (api-api) and *Avicennia marina* (bungalon); (**Table 2.2.31**).

A total of 163 trees were counted in a total of 10 quadrats in five (5) transect stations with the highest density found in Transect 1 which had forty-four (44) trees, or 27% of abundance, in a sandy substrate. This station is located about 1km from the shoreline of the cove where the shipyard is located. The least number of trees was catalogued in the mangrove patch in station 5 near the Luyang River estuary which only had 22 trees in two quadrats. However, majority of the mangroves in station 5 were old growth trees, with average height registered at 17m and crown cover at 77%, both parameters are rated as excellent. In the four stations in the Dunggoan-Dawis Sur area, average height ranged from 2.8m to 3.9m; which is "Fair" to "Good' height; and crown cover ranging from 22.5% to 31.3%, considered as 'Poor" to 'Fair'

Table 2.2.24: Results of Mangrove Assessment; 23-25 January 2020

	Station 1	Station 2	Station 3	Station 4	Station 5	Mean
No. of quadrats	2	2	2	2	2	
No. of trees catalogued	44	25	35	37	22	Total of 163 trees (33 trees per station)
No. of species	4	4	4	4	2	
Species name	*Avicennia marina; Sonneratia alba; Rhizophora apiculata; Rhizophora mucronata*	*Avicennia marina; Sonneratia alba; Rhizophora apiculata; Rhizophora mucronata*	*Avicennia marina; Sonneratia alba; Rhizophora apiculata; Rhizophora mucronata*	*Avicennia marina; Sonneratia alba; Rhizophora apiculata; Rhizophora mucronata*	*Rhizophora mucronata Sonneratia alba;*	
Donimant species	*Avicennia marina (bungalon) 41% RD*	*Avicennia marina (bungalon) 40% RD*	*Avicennia marina (bungalon); 52% RD*	*Avicennia marina (bungalon); 57% RD*	*Rhizophora mucronata* (bakawan babae) 59%RD	
% Crown cover	28.6% (Fair)	22.5% (Poor)	31.31% (Fair)	26.31% (Fair)	77.17% (Excllent)	37.17 (Fair)
Average Height (m)	3.2 m (Good)	3.88 (Good)	2.83 (Fair)	3.92 (Fair)	17.09 m (Excellent)	6.18 (Good)
Regeneration Capacity seedlings/ m^2	5.57.m^2 (Excellent)	4.5% (Excellent)	2.33% (Excellent)	6.67.% (Excellent)	1.17% (Excellent)	Excellent

Note: *RD – relative distribution

Across the four stations in the Dunggoan-Dawis Sur mangroves, the dominant species is *Avicennia marina* (bungalon) accounting for a mean of 47.5 % of all trees. *Avicennia* was densest in station 4 where it comprised 57% of the community (**Figure 2.2.57**). *Rhizophora mucronata* was the second dominant species in stations 1, 2 and 3; but *Sonneratia alba* and *Rhizophora apiculata* were denser in station 4. However, in the Luyang station in Carmen which is more than 5 km from the Republic plant site in Bgy Dunggoan, Danao City, *Rhizophora mucronata* and Sonnertia alba were almost equally distributed (**Figure 2.2.58; Figure 2.2.59**). In all stations, regeneration capacity was rated as excellent, with a total of 75 seedlings and 52 saplings counted in five (5) stations.

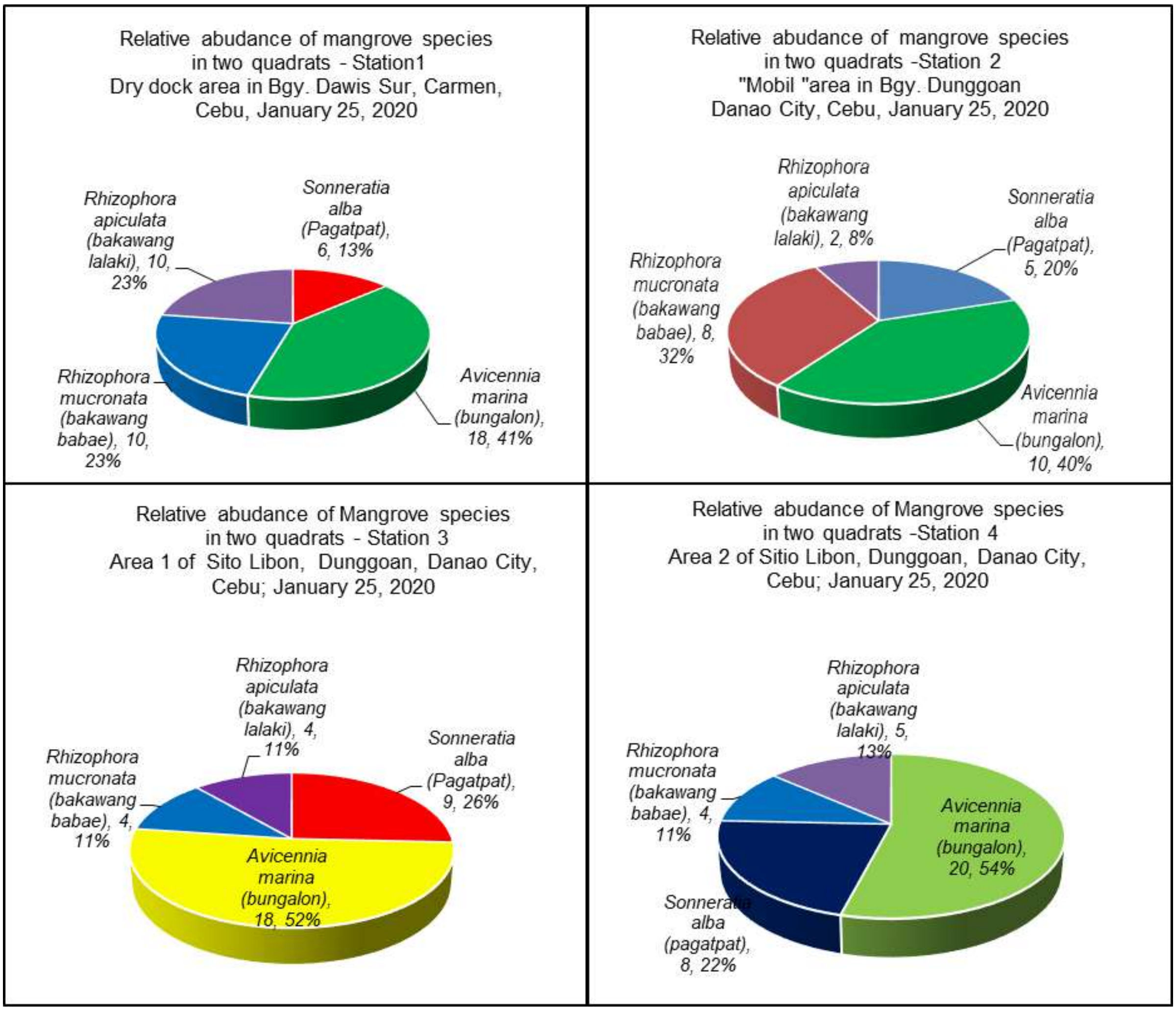


Figure 2.2.51: Relative distribution of mangrove species in four stations in the Dunggoan-Dawis Sur area in the vicinity of the shipyard; 23-25 January 2020.

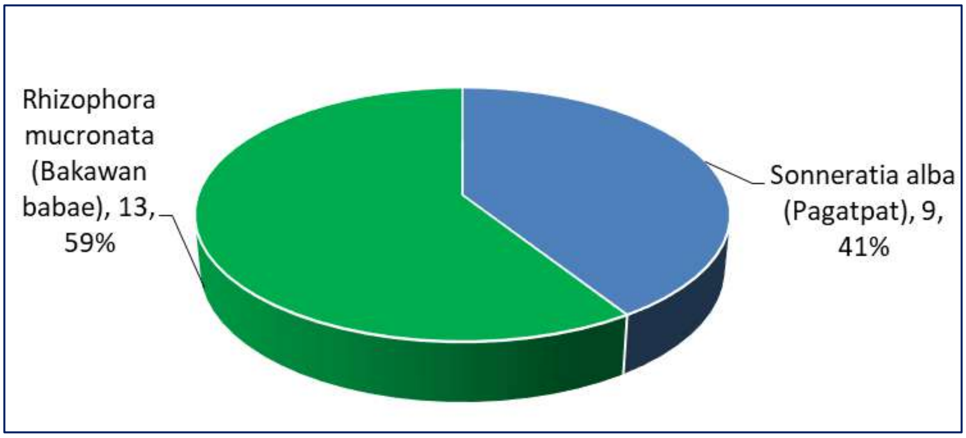


Figure 2.2.52: Relative Distribution of Mangrove Species in the Luyang River Estuary; December 15, 2019

Figure 2.2.53: Results of Mangrove Diversity and Relative Distribution in Four Stations; 15 December 2019

2.2.5.4 Seagrass

Seagrasses are the true plants of the sea and are present broad, dense meadows around the cove and shelf in from Barangay Dunggoan in Danao City to Barangay Dawis Sur in Carmen. The seagrass meadows are popular gleaning areas for many local residents and fishers employing fish pots to capture crustaceans and the exotic dwarf eel – *Bakasi*. There is evidently a huge community of macro-invertebrates in the seagrass meadows and the beds create a barrier that subsequently decreases water currents as the seagrass roots and rhizomes stabilizes the seabed by sequestering and fastening sediments and silt into the bottom substrate. Seagrass meadows provide shelter to many species of fish and invertebrates and the diversity of the seagrass beds in the area can be a contributing factor to the recruitment and settlement of mollusks, small cephalopods, crustaceans and associated epiphytes.

Assessment of seagrass beds and associated macro-benthic algae was undertaken using the Saito-Atobe quadrate-transect method (English *et. al*., 1997), employing a series of 1 x 1 m^2 quadrats in five (5) stations. The seagrass stations studied are shown in **Figure 2.2.60** and coordinates are presented in **Table 2.2.32**. Transects and quadrates were laid out where the seagrass habitat begins, and where the observed habitat ends. Intervals between quadrates are determined by the size and expanse of the habitat.

Table 2.2.25: Coordinates of stations surveyed for seagrass diversity and relative distribution of species during marine ecology baseline assessment; 23-25 January 2020

WP Code	Latitude	Longitude	Remarks
SGR1	N 10.564190°	E 124.037200°	Located in expanse of seagrass meadows in the 'drydock' cove in Brgy Dawis Sur,Carmen, Cebu; 1.5 km from shoreline/drydock
SGR2	N 10.561490°	E 124.034600°	Located in extensive seagrass meadows in the 'drydock' cove in Brgy Dawis Sur,Carmen, Cebu; 1.3 km from shoreline/ east of the drydock
SGR3	N 10.562110°	E 124.035450°	Located in expanse of seagrass meadows in the 'drydock' cove in Brgy Dawis Sur,Carmen, Cebu; 1.2 km from shoreline/ east of the drydock
SGR4	N 10.553190°	E 124.037520°	Located in expanse of seagrass meadows fronting an offshore mangrove patch 1.6 km southeast of the drydock.
SGR5	N 10.605860°	E 124.026589°	Located in the seagrass beds in the estuary of the Luyang River in Brgy. Fuente, Carmen, Cebu.

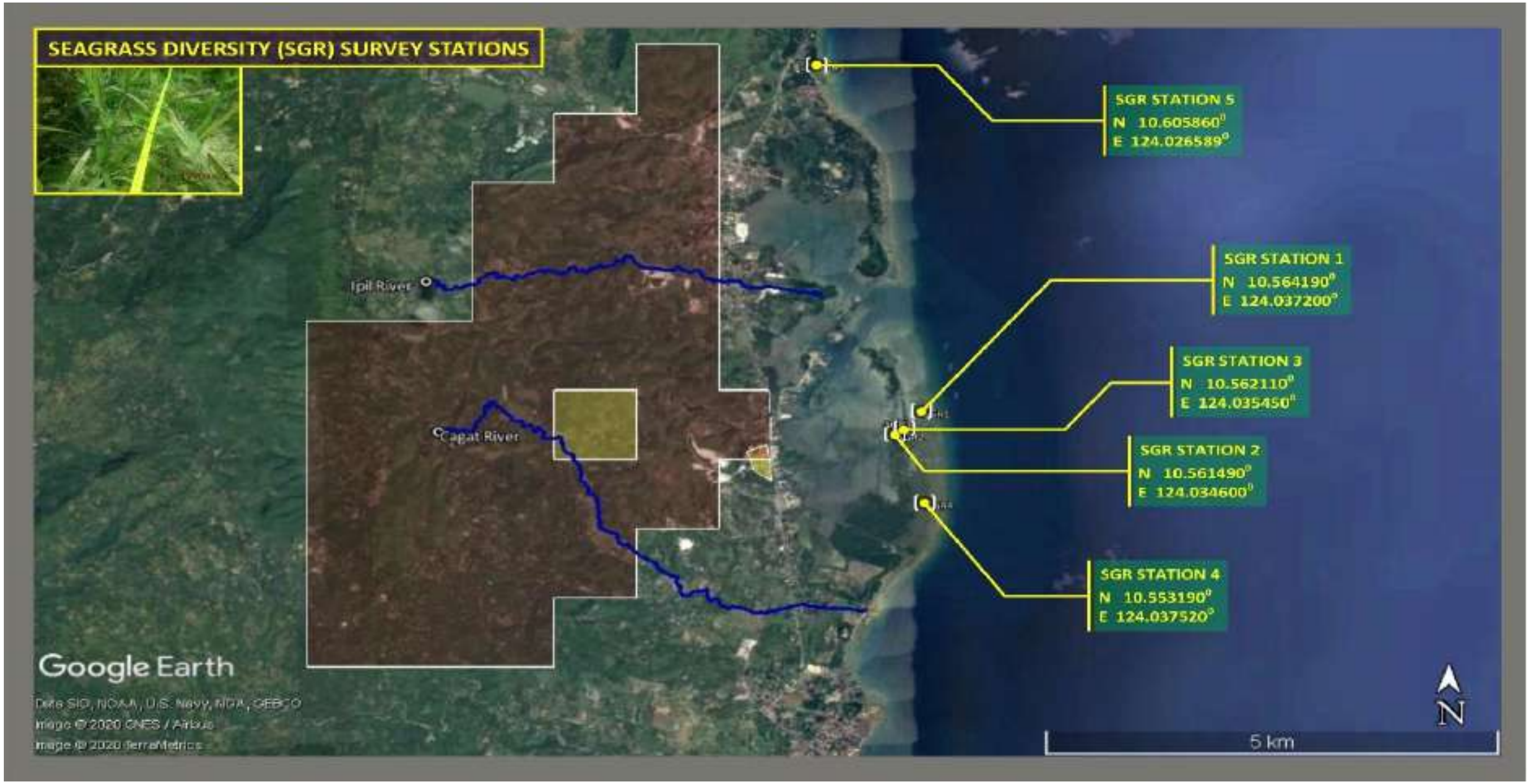


Figure 2.2.54: Location of seagrass survey stations during marine ecology baseline assessment in the coastal impact area of the proposed Republic Cement Finish Mill Plant and Quarry Operations and MPSA in Danao City and Carmen, Cebu; 23-25 January 2020

The cove in the vicinity of the shipyard in the boundary of Brgy. Dunggoan in Danao City and Brgy. Dawis Sur in Carmen, (also locally known as “drydock”), hosts extensive seagrass meadows that cover almost the entire cove and extending southwards to Brgy. Guinsay and northwards to the boundary of Brgys. Dawis Sur and Dawis Norte in Carmen. Survey results in five (5) stations showed excellent condition of seagrass beds consisting of six (6) species (**Figure 2.2.61** and **Table 2.2.33**). The species include: *Cymodocea rotundata* (ribbon seagrass), *Thalassia hemprichii* (sickle seagrass), *Halodule uninervis* (needle seagrass), *Halophila ovalis* (spoon seagrass), *Enhaulus acoroides* (eel seagrass), and *Syringodium isoetifolium* (syringe seagrass); (**Plate 2.2.30**). The first four stations located in the extensive seagrass meadows in the “drydock” cove in Bgy. Dunggo and and Dawis Norte, hosted dense seagrass beds ranging from 61% to 76.5% of the survey belts, with five (5) species. The seagrass meadows across these four stations are considered as “Excellent” condition. The seagrass station in Luyang, Carmen, near the river estuary had the least dense seagrass community with only 27% distribution relative to the survey substrate. Across the five seagrass stations surveyed, the ribbon seagrass *Cymodecea rotundata* dominated the communities, comprising 40.50% of relative distribution (**Plate 2.2.31**). *Thalassia hemprichii* and *Enhaulus acoroides* comprised 5.3% and 5.70% of the communities, respectively. The seldom seen spoon seagrass was the least dense at only 1.60% of relative distribution and was catalogued in two of the five stations.

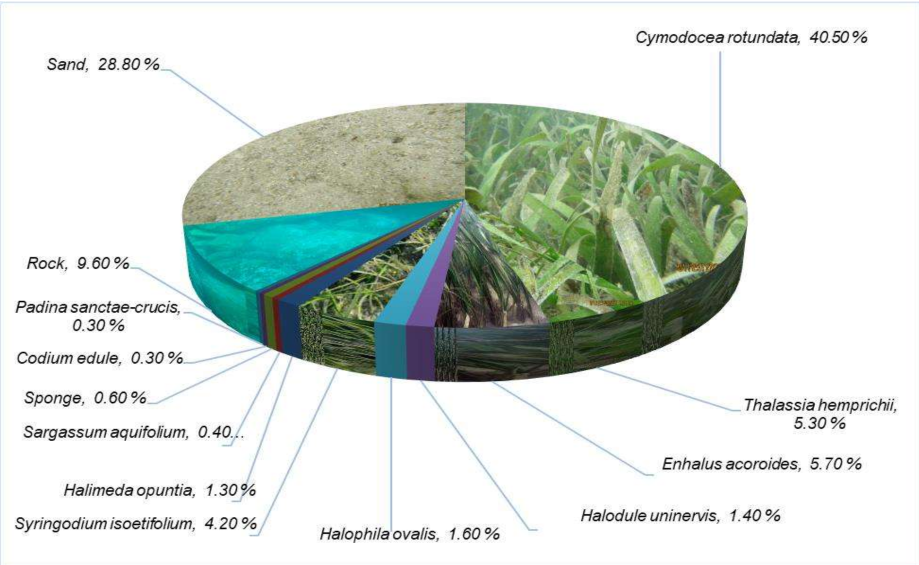


Figure 2.2.55: Relative Distribution of Seagrass Species Catalogued in Five Stations; December 15, 2019 and January 23-25, 2020

Table 2.2.26: Diversity and Distribution of Seagrass Species in Five Stations; 15 December 2019 and 23-25 January 2020

Transect No.:	Seagrass Distribution		Remarks/Observations
	Species	**Percent Cover** *(in % of total)*	
1	*Cymodocea rotundata*	41.00	33.00% sand, Rock 5%, 1.00% *Padina sanctae-crucis* and sedimentation was also observed in the study site which can physically smother the seagrass or it can cause such turbidity in the water that photosynthesis was impaired.
	Thalassia hemprichii	11.00	
	Enhalus acoroides	5.00	
	Halophila ovalis	4.00	
	Sub-total Percentile	**61.00**	
2	*Cymodocea rotundata*	57.00	11.50% sand, 6.50% *Halimeda opuntia,* 2.00% *Sargassum aquifolium,* 2.00% Sponge, 1.50% *Codium edule* and dissolved nutrients contributed by rivers,
	Enhalus acoroides	12.00	
	Thalassia hemprichii	7.50	
	Sub-total Percentile	**76.50**	

Transect No.:	Seagrass Distribution		Remarks/Observations
	Species	**Percent Cover** *(in % of total)*	
			storm runoff, sewage or industrial discharges reduces water clarity in the study station.
3	*Cymodocea rotundata* *Enhalus acoroides* *Halophila ovalis*	58.50 7.00 4.00	30.00% sand, 0.50% *Padina sanctae-crucis* and sedimentation was also observed in the study site which can physically smother the seagrass or it can cause such turbidity in the water that photosynthesis was impaired.
	Sub-total Percentile	**69.50**	
4	*Cymodocea rotundata* *Thalassia hemprichii* *Halodule uninervis* *Enhalus acoroides*	46.00 8.00 7.00 4.500	23.50% sand, 10.00% *Rock,* 1.00% Sponge, 1.50% and dissolved nutrients contributed by rivers, storm runoff, sewage or industrial discharges reduces water clarity in the study station.
	Sub-total Percentile	**65.50**	
5	*Syringodium isoetifolium* *Thalassia hemprichii*	21 6	Open substrate – sand and rocks 73%; mud and silt from mangrove swamp
	Sub-total Percentile	27	
AVERAGE PERCENTILE		**60.00**	**Excellent cover/condition.**

Site Name: **Barangays Dunggoan & Guinsay, Danao City; Bgy Luyang, Carmen**
Date: December 15, 2019 (Carmen); January 25-26, 2020 (Danao)

Municipality & Province: **Danao City and Carmen, Cebu Province**
Observers: **Victor L. Pantaleon and Ronald T. Pocon**

Locations:
Transect/Station1 – Start: 124.03720^0 E; 10.56419^0 N; End:124.037200°E; 10.564190°N
Transect/Station 2 – Start: 124.03460°E; 10.561490°N; End:124.03506^0 E; 10.56149^0 N
Transect/Station 3 – Start: 124.03545^0 E; 10.56211^0 N; End: 124.03583^0 E; 10.56228^0 N
Transect/Station 4 – Start: 124.03752^0 E; 10.55319^0 N; End: 124.03790^0 E; 10.55342^0 N
Transect/Station 5 – Start: 124.026589° E; 10.605860°

Legend: Ho – Halophila ovalis, Cr – Cymodecea rotundata, Ea – Enhaulus acoroides, Hu- Halodule uninervis, Th – Thalassia hemprichii, Si- Syringodium isoetifolium.

Plate 2.2.28: Seagrass Species in Five (5) Stations; January 23-25, 2020

The transect in station 1, positioned in the mouth of the cove near a mangrove patch in the "drydock" cove, was populated with four species occupying a total of 61% % of the survey belt (**Figure 2.2.62**. Station 2, established south the first transect, consisted of four (4) species with excellent cover of 76.5%. Station 3 had seagrass cover of 69.5% of the surveyed area with three (3) species. Staion 4, positioned offshore of a patch of mangroves in the boundary of Brgy. Dunggoan and Bgy. Guinsay in Danao City hosted four (4) seagras species with 65.5% cover. The ribbon seagrass, *Cymodocea rotundata* dominated the seagrass meadows across all these stations, altogether comprising a mean of 46.5% across the stations.

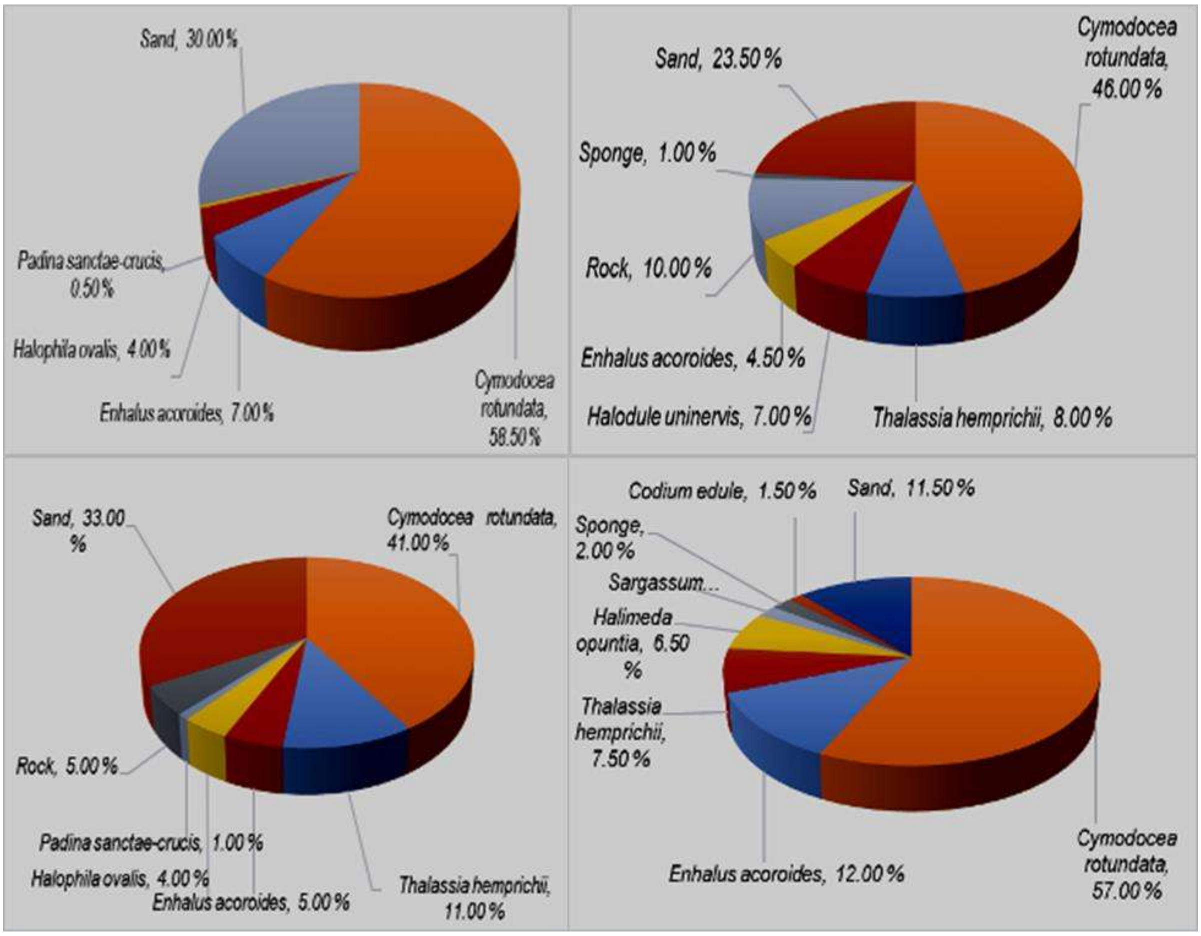


Figure 2.2.56: Distribution of seagrass species in four stations; 23-25 January, 2020

The 5th station, established in small, intermittent patches of seagrass beds near the Luyang River estuary in Carmen, Cebu hosted 2 species - *Syringodium isetifolium* and *Thalassia hemprichii*, with the former dominating the seagrass beds at 21% of the substrate in surveyed station (**Figure 2.2.63**). Highlights of the seagrass survey in the first four stations are displayed in a map in **Figure 2.2.64**.

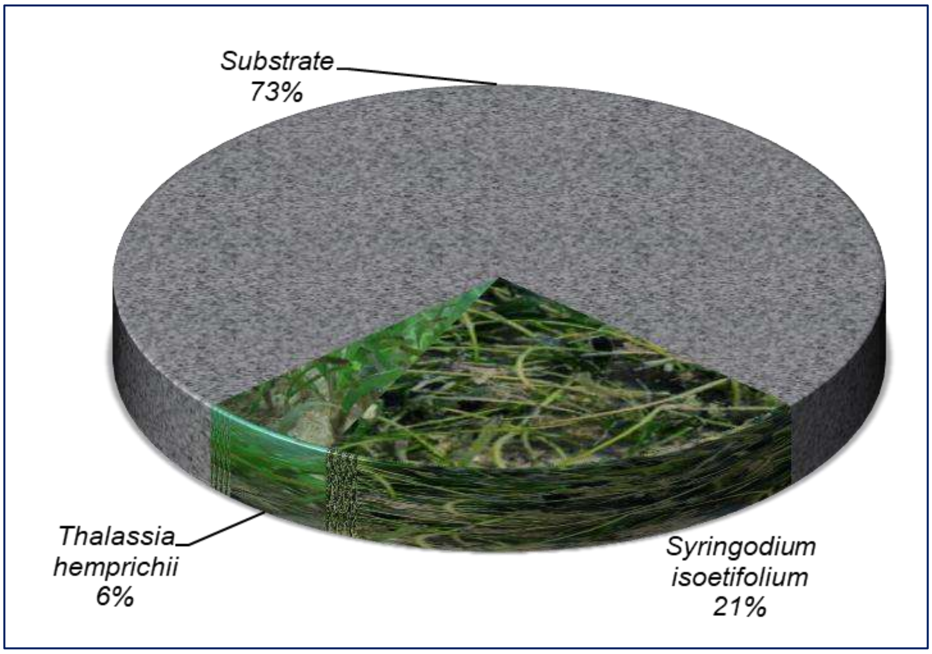


Figure 2.2.57: Distribution of seagrass species in the 5th station surveyed in the vicinity of the Luyang River estuary in December 2019

In spite of intensive gleaning and fishing activities over the seagrass meadows, there were no observed disturbances caused by fishing operations for seagrass-associated marine organisms such as rabbitfishes, bivalves and sea cucumbers. Moreover, an investigation of the diversity and quantity of macro-invertebrates collected by local gleaners in the Dunggoan-Dawis Sur seagrass meadows reveal a rich diversity of mollusks, bivalves and gastropods that include sea ccumbers, ark shells and the thorny oyster, among others. The seagrass meadows also nurture the exotic dwarf reticulated moray eel known locally as *bakasi* (*Gymnothorax polygonius;* **Plate 2.2.31**) which is widely alluded to as an aphrodisiac. The fish grows to about 12 to 15 inches long and is captured through fish pots made of wicker strands. Larger species of siganids can be harvested in the reef areas bordering the seagrass communities with hook and line gear. It was also noted that large, mature macro-invertebrates such as the thorny oyster (*Spondylus squamosa*), spider shell (*Lambis spp*) and conch shells (*Strombus spp*) were present in the seagrass beds.

Plate 2.2.29: Seagrass meadows was dominated by the ribbon seagrass Cymodecea rotundata (right); the exotic dwarf reticulated moray eel (bakasi) inhabits the seagrass meadows (left)

Figure 2.2.58: Relative Distribution of Seagrass Species in Five Survey Sites; 23-25 January 2020

2.2.5.5 Macro-Invertebrates of Commercial Significance

Macro-invertebrate surveys were undertaken in three (3) stations, two (2) of which are located in shipyard cove – the widest and most popular gleaning area in the study site, while a third station was investigated in a smaller gleaning area in Brgy. Guisay; shown in **Figure 2.2.65**. Station coordinates are listed in **Table 2.2.34**. The assessment was undertaken through actual documentation of bivalves, gastropods and mollusks actually harvested by gleaners (**Plate 2.2.30**) and supplemented with opportunistic collection of specimens in the seagrass meadows. Identification of univalves and bivalves were referenced through FAO's Species Identification Guide for Fisheries Purposes; Volume 1: Seaweeds, Corals, Bivalves, and Gastropods (Carpenter, K. E and V. H. Niem, eds., 1998).

Table 2.2.27: Coordinates of stations surveyed for macro-invertebrates of significant value for food and trade; 23-25 January 2020

WP Code	LATITUDE	LONGITUDE	Remarks
MAC1	N 10.558290°	E 124.026470°	Sample specimens photographed, documented and returned to source
MAC2	N 10.564250°	E 124.037200°	Sample specimens photographed, documented and returned to source

Plate 2.2.30: In-situ Documentation of Macro-Invertebrates of Significant Value for Food and Trade Gathered by Gleaners; January 23-25, 2020

Figure 2.2.59: Location of stations for documentation of macro-invertebrates of significant value as food and incomes of local fishers; 23-25 January 2020

Gleaning for bivalves, gastropods and echinoderms is a popular source of income for local residents. Two inter-tidal areas with dense seagrass meadows exposed during neap tides that yield a diverse array of macro-invertebrates, with some species – such as the thorny oyster *Spondylus squamosa* (*talabang matinik*) gathered in significant quantities, were investigated for diversity.

The first macro-invertebrate station, located in an area known as "mobil" in Barangay Dunggoan was dominated by the ark shell *Scapharca spp* and the "sikad-sikad" (conch, *Strombus sp*). The 'mobil' area is a popular shellfish market of makeshift stalls visited by many buyers. Apart from ark shells, the macro-invertebrates being gathered and sold in the area include conch (sikad-sikad), furrowed horse mussel (*Modiolus aratus*), venus clam (*Katelsya hiantina*), bittersweet clam (*Glycemeris sp*) and exotic seahare eggs. During the survey in the second station in the 'drydock' inter-tidal shelf on 25 January 2020, some 20 people were seen gleaning for macro-invertebrates. Actual documentation of the species gathered by three women and a male fisher indicate that the dominant species include the thorny oyster, conch or *sikad-sikad*, hammer oyster (*Malleus sp*), top shell (*Trochus conus*) and at least four species of sea cucumbers – the common *balatan Stichopus chloronotus and Holothuria scabra,* curryfish *Stichopus herrmanni,* and *Bohadschia argus* - a distinctive Holothurian with whitish skin patterned with brown bands. The volume gathered by the three women consisted of two (2) 15-liter pails of sea cucumbers, one small pail of conch and at least 3 kg of ark shells. In the first station in 'mobil' ark shells and *sikad-sikad* being sold in four stalls was estimated at more than 10 kg combined. One seller was offering sea hare eggs (**Plate 2.2.31**). **Table 2.2.32** shows the list of macro-invertebrates found in the two survey stations. Images of the dominant species/station are also shown in **Figure 2.2.61**.

Table 2.2.28: Species of Macro-Invertebrates Used for Food and Trade Collected in two Gleaning Areas Investigated In-Situ; 23-25 January 2020

Species Name	Common English Name	Habitat	Group
Strombus sp	Conch; *sikad-sikad*	Seagrass	Gastropod
Spondylus squamosa	Thorny oyster	seagrass	Bivalve
Trochus niloticus	Top shell	Coral reef	Gastropod
Trachycardium sp	Cockle	Sandy-muddy substrate	Bivalve
Anadara antiquata	Antique ark shell	Muddy substrate	Bivalve
Tripnuestes gratilla	Edible sea urchin	Sand/seagrass	Echinoderm
Modiolus sp	Philippine Horse mussel	Seagrass/sand	Bivalve
Pinna muricata	Prickly pen shell	Sandy flats near corals	Bivalve
Malleus sp	Hammer oyster	Sand flats w/ seagrass	Bivalve
Conus aulicus	Textile conus	Coral reef	Gastropod
Tridacna squamosa	Giant clam	Coral reef	Bivalve
Turbo setosus	Rough turban	Coral reef	Gastropod
Conus marmoreus	Conus shell	Coral reef	Gastropod
Telescopium telescopium	Swamp cerith	mangrove	Gastropod
Abra primatica	Venus clam	Sandy flats	Bivalve
Holothuria scabra	Sea cucumber	Seagrass- Sandy flats	Echinoderm
Stichopus herrmanni	Curryfish	Seagrass- Sandy flats	Echinoderm
Stichopus chloronotus	Sea cucumber/sandfish	Seagrass- Sandy flats	Echinoderm
Bohadschia argus	Banded sea cucumber	Seagrass- Sandy flats	Echinoderm
Katelsya hiantina	Venus clam	Sandy-muddy substrate	Bivalve
Anodontia edentula	Bittersweel clam	Sand/seagrass	Bivalve
Lambis lambis	Spider shell	Sand-seagrass	Gastropod
Atrina vexullum	Pen shell	Sand/seagrass	Bivalve
Atrina pectinata	Comb pen shell	Sand/seagrass	Bivalve
Nerita costata	Costate nerith	Mangroves/seagrass	Gastropod
Terebralia sp	Swamp cerith	Mangroves	Gastropod
Strombus luhuanus	Strawberry conch	seagrass	Gastropod
Aplysia sp	Sea hare	Seagrass/seaweeds	Gastropod

Note: Top row left to right: conch or sikad-sikad, furrowed horse mussel, thorny oyster; middle row: comb pen shell and thorny oyster, spider shell, curryfish sea cucumber; bottom row: sea cucumber, octopus and sea hare eggs.

Plate 2.2.31: Dominant species of commercially-important macro-invertebrates documented; 23-25 January 2020

All in all a total of twenty (28) genera of macro-invertebrates collected for food and trade were found in the sampling stations. These consisted of twelve (12) species of bivalves, eleven (11) species of gastropods, and five (5) species of echinoderm. Except for three species, all f the species collected in the sampling areas are considered edible and constitute a supplemental source of food for artisanal fishers. Among the more lucrative species are holothurian sea cucumbers, pen shells, thorny oysters, ark shells and hammer oysters. Also, most of the species found were of significant interest to fisheries, forming a major part of the marine food chain and serving as diet to many species of fish and crustaceans in the reef and seagrass ecosystems. In conclusion, the survey findings indicate a productive macro-invertebrate community that supplies additional income to coastal dwellers living near the inter-tidal flats. The major macro-invertebrate species found in the survey are highlighted in **Figure 2.2.61**.

Figure 2.2.60: Highlights of Species of Macro-Invertebrates Used for Food and Trade Collected in Two Sampling Stations; 23-25 January 2020

2.2.5.6 Plankton and Benthos

Water and substrate samples for plankton and benthos community assessment were collected in four (4) stations, one (1) of which was located in the 'dockyard cove', two near river estuaries and a fourth station in the upper region of the impact area near the northern portion of the MPSA (**Figure 2.2.62**). The coordinates of the sampling sites are listed in **Table 2.2.33**. Composition, abundance and density of phytoplankton communities was determined using standard methodologies, including plankton net surveys, Shannon-Weaver Diversity/Evenness Indices and bio-assessment metrics. Benthos sample were taken through grab sampling in the same four (4) stations (**Figure 2.2.63**).

Table 2.2.29: Coordinates of Plankton and Benthos Sampling Stations; 23-25 January 2020.

Station Code	Coordinates		Location
PLK1/BLK1	N 10.5402296°	E 124.031717°	Located near the Cagat River estuary in Barangay Guinsay, Danao City
PLK2/BLK2	N 10.557027°	E 124.040342°	Located in coastal waters in front of the "dockyard" cove in the boundary of Brgy. Dunggoan, Danao City and Brgy. Dawis Sur, Carmen, Cebu.
PLK3/BLK3	N 10.578353°	E 124.026742°	Located in front of the Ipil River estuary in Carmen, Cebu
PLK4/BLK4	N 10.600857°	E 124.031858°	Located near the Luyang River estuary, Barangay Fuente, Carmen, Cebu

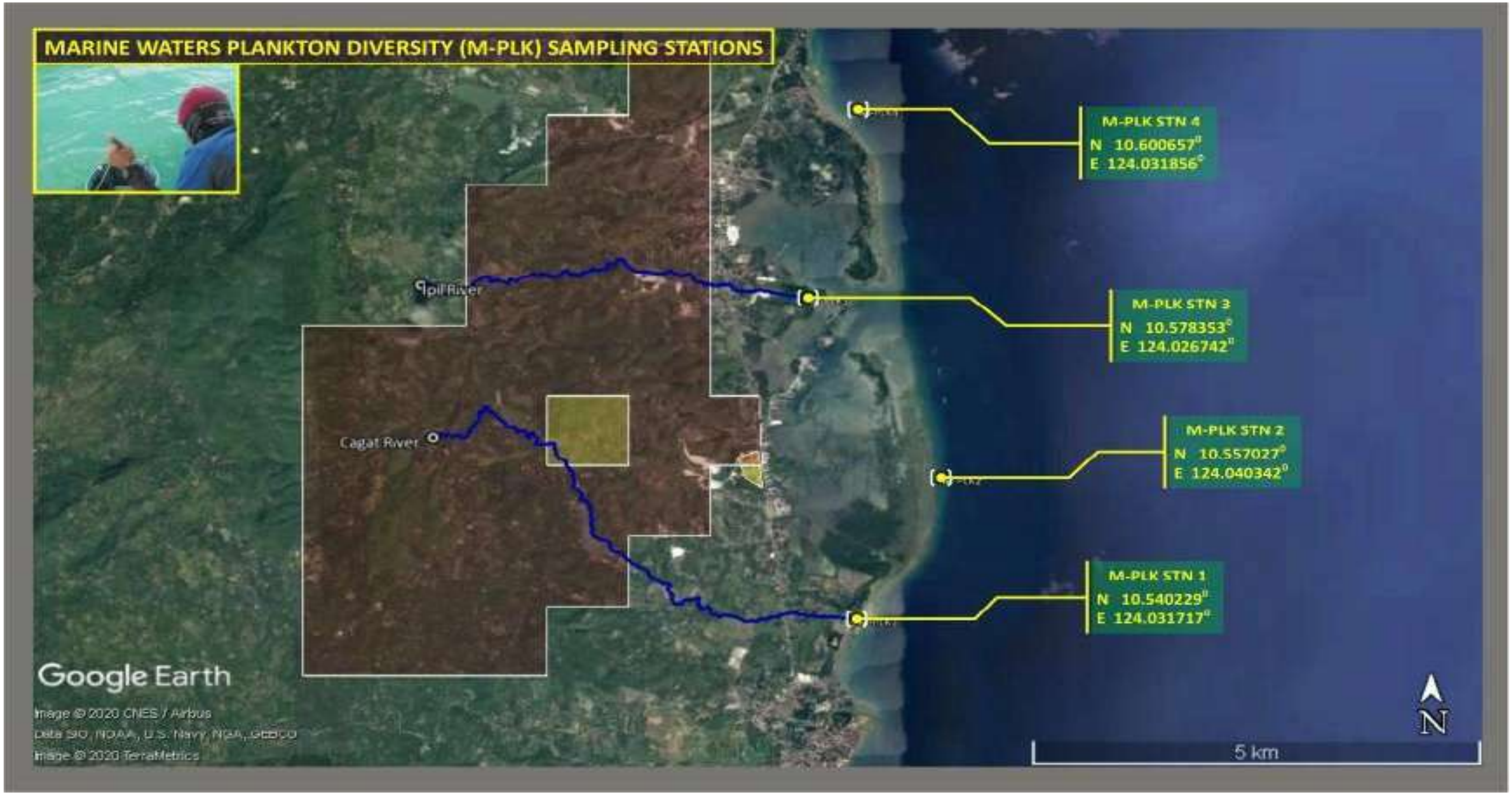


Figure 2.2.61: Location of Stations for Plankton Community Sampling; 23-25 January 2020

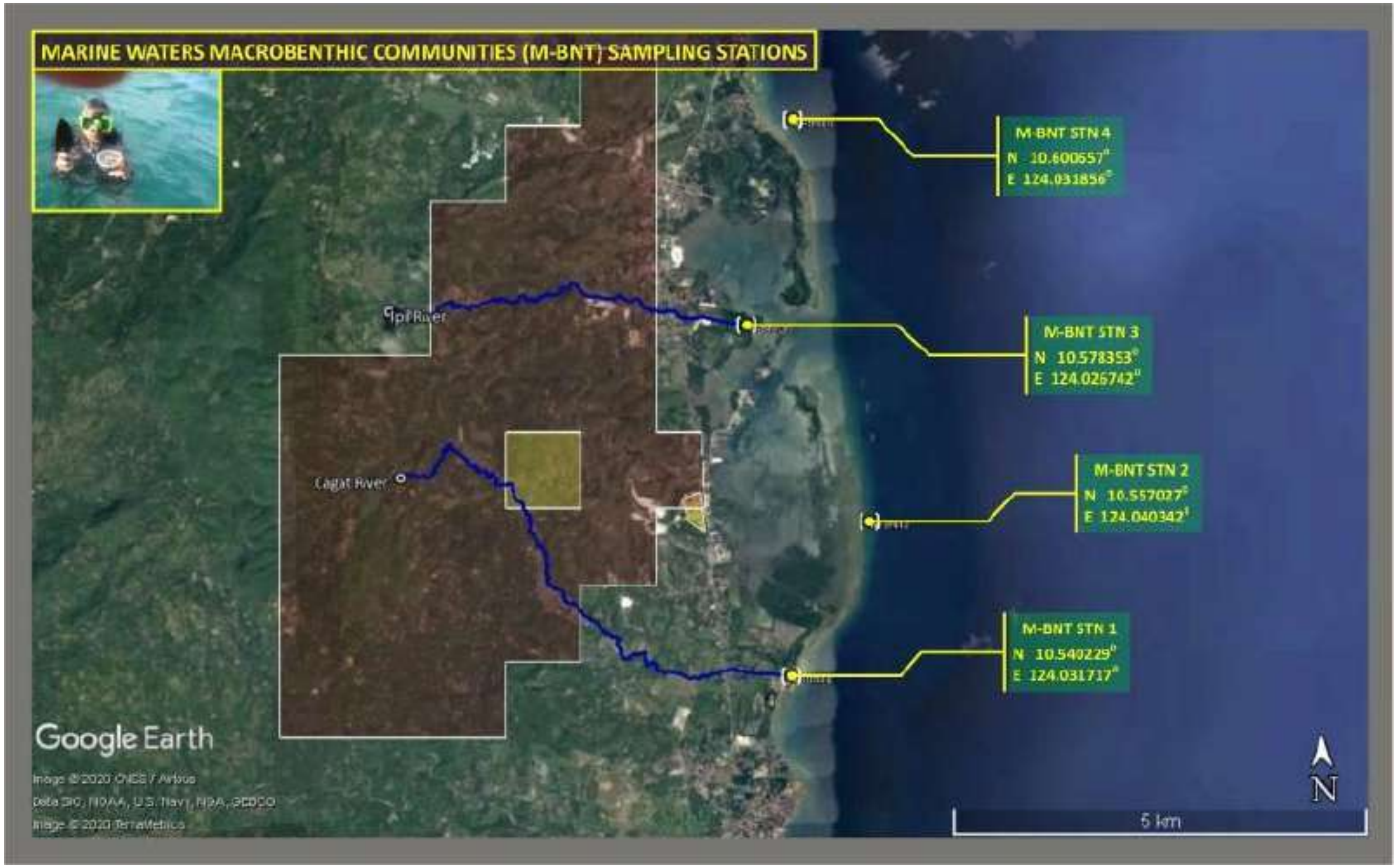


Figure 2.2.62: . Location of Stations for Benthos Sampling; 23-25 January 2020

2.2.5.6.1 Phytoplankton

Table 2.2.34 shows the detailed species composition, abundance (cells/m^3), distribution, diversity and relative abundance of phytoplankton identified over the four sampling stations. A total of twenty-seven (27) phytoplankton taxa were identified belonging to Bacillariophyte (diatoms) and Dinophyte (dinoflagellates). Overall, diatoms totally dominated the phytoplankton community accounting for >86% of the total abundance quantified in every stations (**Figure 2.2.64**). Dinoflagellates on the other hand, only constituted 5%. Among the diatoms, the centric diatom *Thalassiosira* sp, *Bacteriastrum* spp. and *Chaetoceros* spp*.* mostly represented the bulk of the diatoms with a total relative abundance of 53% (**Plate 2.2.32**)*.* Commonly found in warm tropical waters, these diatoms provide significant influences in the overall primary productivity in the marine environments. Furthermore, these are some of the major food sources of filter- feeding shellfish, which were found along the coastal waters of the survey area. The potentially harmful phytoplankton organism recorded in this survey was *Pseudonitzschia* spp. with maximum cell density of 9,936 cells/m^3 (1.19% of total composition. Some species of this genus are known to produce domoic acid (DA) – a toxin associated with Amnesic Shellfish Poisoning (ASP) (FAO, 2004). With the 51 described species, almost half of which have been shown to produce DA. Toxigenic and non-toxogenic species commonly co-occur; therefore, discrimination between various *Pseudonitzschi*a spp. is important to determine the potential toxicity of an algal bloom. However, the light microscopy identification techniques employed in the analysis of the samples are inadequate to distinguish among *Pseudonitzschia* species. Therefore, *Pseudonitzschia* spp. is usually treated as a harmful species as precautionary measure. Unlike certain dinoflagellate blooms, domoic acid-producing. *Pseudonitzschi*a spp. must be present in high concentrations (greater than 100,000 cells/L or 1.0 x 10^8 cells/m^3) to contaminate shellfish at a level that should cease harvesting. The density recorded during this sampling was still very low (10,279 cells/m^3) to be of a major concern but continuous monitoring is highly recommended even after the project. For the dinoflagellates, the armored taxa *Peridinium* sp. was the most abundant constituting for 4%. Generally, bacillariophytes are consistently the most dominant phytoplankton groups in the four stations.

Table 2.2.30: Phytoplankton Composition, Diversity, Distribution and Abundance (cells/m^3) in Four Stations; 23-25 January 2020

TAXA	STATIONS				Grand	Rel.
	M-PLK1	M-PLK2	M-PLK3	M-PLK4	Total	Abund.
Bacillariophyta	**16,467**	**216,817**	**6,067**	**168,634**	**407,984**	**91.38**
Bacteriastrum		21,071		54,991	76,063	17.04
Chaetoceros		39,916		23,299	63,214	14.16
Coscinodiscus		5,825		2,227	8,052	1.80
Eucampia		14,390		5,653	20,044	4.49
Fragilaria	5,633	17,303	433	3,769	27,138	6.08
Hemiaulus		5,825		7,709	13,534	3.03
Lauderia		2,741			2,741	0.61
Lioloma		9,509		11,649	21,159	4.74
Navicula	1,733	2,398	433	1,732	6,297	1.41
Nitzschia	433	7,709	867	2,056	11,065	2.48
Odontella		7,366			7,366	1.65
Pinnularia	867	3,693	1,300	3,598	9,457	2.12
Pseudonitzschia				9,936	9,936	2.23
Rhabdonema	3,033	3,084		1,371	7,487	1.68
Rhizosolenia		4,378		1,243	5,621	1.26
Surirella	1,300		867		2,167	0.49
Synedra	3,467	13,191	2,167	1,371	20,195	4.52
Thalassiosira		58,418		38,031	96,449	21.60
Dinophyta	**433**	**30,836**	**867**	**6,339**	**38,475**	**8.62**
Ceratium fusus		3,940		1,884	5,825	1.30
Lingulodinium		5,653		2,398	8,052	1.80
Peridinium	433	15,247	867	1,199	17,746	3.97

TAXA	STATIONS				Grand Total	Rel. Abund.
	M-PLK1	M-PLK2	M-PLK3	M-PLK4		
Prorocentrum		2,056			2,056	0.46
Protoperidinium		3,940		857	4,797	1.07
Grand Total	**16,900**	**247,653**	**6,933**	**174,973**	**446,459**	**100**
Richness	**8**	**21**	**7**	**19**		
Evenness (J')	**0.85**	**0.85**	**0.93**	**0.73**		
Diversity (H')	**1.77**	**2.58**	**1.80**	**2.15**		

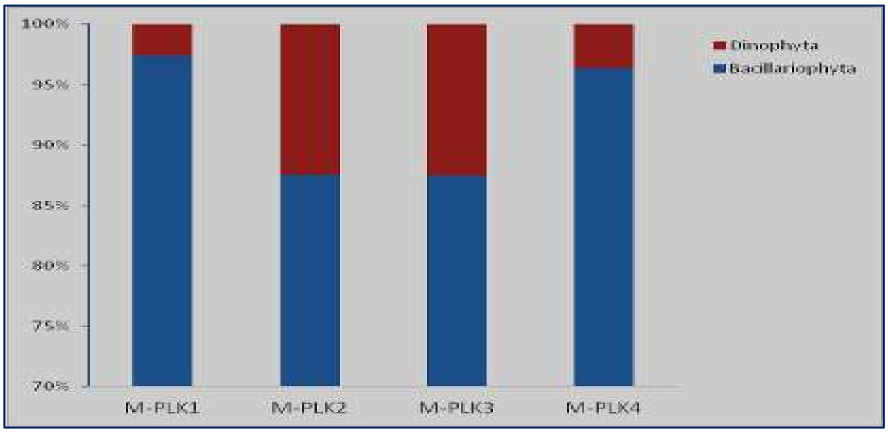


Figure 2.2.63: Percent Composition of Major Phytoplankton Group Identified in Four Stations; 23-25 January 2020

Spatially, station located offshore (M-PLK2) recorded the highest phytoplankton abundance and taxa richness with 247,653 cells/L and 21 taxa while the lowest was in station located at the river mouth (M-PLK3) with 6,933 and 7 taxa (**Figure 2.2.65**). The index of evenness was not so variable among most stations (0.73-0.93) indicative of a relatively balanced phytoplankton community. Species diversity was highest in station M-PLK2 with 2.58 while was lowest was computed in station M-PLK1 with 1.77. Computed values above 3.0 indicate that the habitat structure is stable and balanced, while values midway from 1.0 to 2.0 describe a threatened condition. Furthermore, values lower than 1.0 indicates pollution and degradation of habitat structure (Goncalves and Menezes, 2011); however, it should be noted that the diversity index very rarely exceeds a 4.5 value.

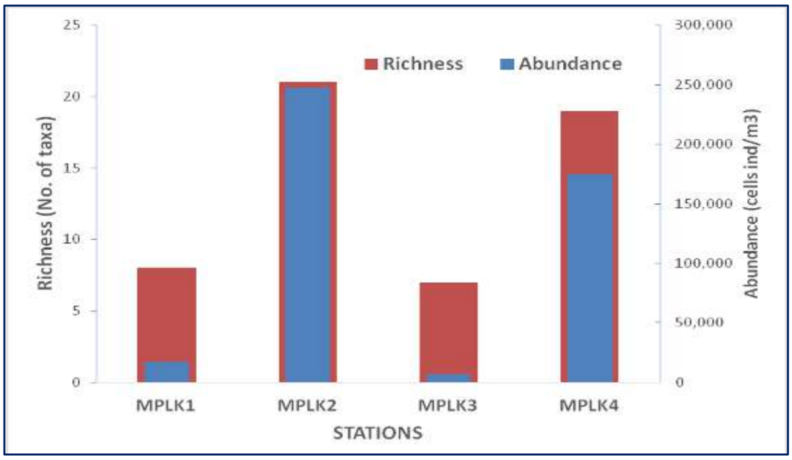


Figure 2.2.64: Total Phytoplankton Density and Abundance in Four Stations; 23-25 January 2020

2.2.5.6.2 Zooplankton

Table 2.2.35 shows the species composition, distribution, diversity and abundance (ind/m^3) of zooplankton taxa that were identified over the four sampling stations. A total of thirteen (13) zooplankton taxa belonging to arthropods, chaetognatha, chordata, mollusca, echinodermata and rotifera was identified. Arthropods the most dominant zooplankton group ain station offshore (M-PLK2, MPLK4) while mollusks dominated stations at the river mouth (M-PLK1, M-PLK3) (**Figure 2.2.66**). Rotifers were only found in stations sM-PLK1, M-PLK3 while chaetognath and echinoderm larvae were only found in M-PLK2 and MPLK4. Ecologically the planktonic copepods provide functionally important links in the aquatic food chain feeding on the microscopic algal cells of the phytoplankton and, in turn, being eaten by juvenile fish and other planktivores, including some whales. Because of their smaller size and relatively faster growth rates, copepod contributes to secondary productivity of the world's ocean and to global ocean carbon sink. They also have a significant role in grazing pressure on the phytoplankton community due to their high density (Merrel and Stoeker, 1998). Arthropods are consistently observed in all station making it the most common zooplankton group. Among the arthropods, harpacticoid copepod was the most abundant accounting for 20% of the total zooplankton community (**Plate 2.2.32**). Copepod nuaplius larvae also contributed for significant abundance with 16%.

Table 2.2.31: Zooplankton Composition, Diversity, Distribution and Abundance (ind/ m^3) in Four Stations; 23-25 January 2020

TAXA	STATIONS				Grand	Rel.
	M-PLK1	M-PLK2	M-PLK3	M-PLK4	Total	Abund.
Arthropoda		**23,984**	**5,200**	**61,673**	**90,856**	**70.57**
Calanoid copepodite		1,713		5,139	6,853	5.32
Calanoida		3,426		11,992	15,418	11.98
copepoda nauplius larva		5,139	3,033	13,705	21,878	16.99
Cyclopoid copepodite		1,713		3,426	5,139	3.99
Cyclopoida			2,167	13,705	15,872	12.33
Harpacticoida		11,992		13,705	25,697	19.96
Chaetognatha		**3,426**		**3,426**	**6,853**	**5.32**
Sagitta sp.		3,426		3,426	6,853	5.32
Chordata				**3,426**	**3,426**	**2.66**
Oikopleuridae				3,426	3,426	2.66
Echinodermata				**1,713**	**1,713**	**1.33**
Echinopluteus larva				1,713	1,713	1.33
Insect	**2,000**				**2,000**	**1.55**
Midges (Chaoboridae)	2,000				2,000	1.55
Molluscs	**13,600**		**9,100**		**22,700**	**17.63**
Bivalve veliger	5,600		6,933		12,533	9.73
Gastropod veliger	8,000		2,167		10,167	7.90
Rotifer	**1,200**				**1,200**	**0.93**
Brachionidae	1,200				1,200	0.93
Grand Total	**16,800**	**27,410**	**14,300**	**70,238**	**128,748**	**100**
Richness	**4**	**6**	**4**	**9**		
Evenness (I')	**0.84**	**0.86**	**0.90**	**0.90**		
Diversity (H')	**1.16**	**1.54**	**1.25**	**1.98**		

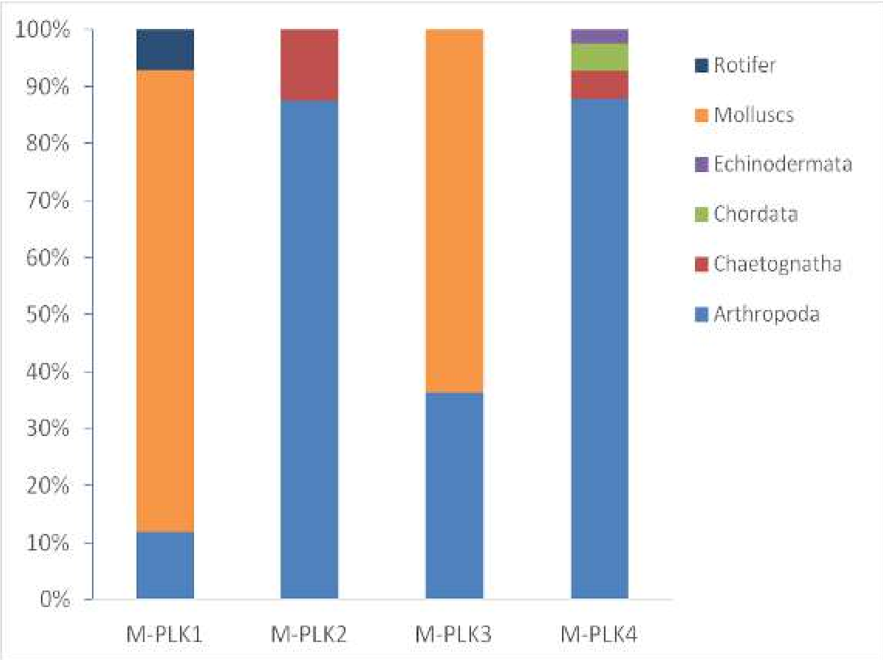


Figure 2.2.65: Percent Composition of Major Zooplankton Groups Identified in Four Stations; 23-25 January 2020

The highest zooplankton density and most taxa rich station was obtained from water sample collected in M-PLK4 with 70,234 ind/m^3 while the lowest was in MPLK3 with 14,300 cells/m^3 and 4 taxa (**Figure 2.2.67**) . The low zooplankton abundance and richness was very notable in river mouth stations which are brackish waters. Diversity index was also low (<2) ranging from 1.16–1.98. Computed values above 3.0 indicate that the habitat structure is stable and balanced, while values midway from 1.0 to 2.0 describe a threatened condition. Furthermore, values lower than 1.0 indicates pollution and degradation of habitat structure (Goncalves and Menezes, 2011); however, it should be noted that the diversity index very rarely exceeds a 4.5 value. The index of evenness was not so variable among stations with values ranging from 0.78–90.

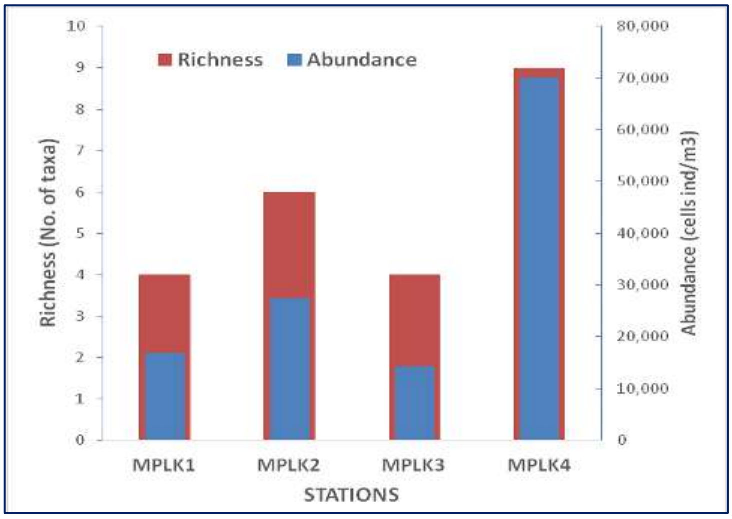
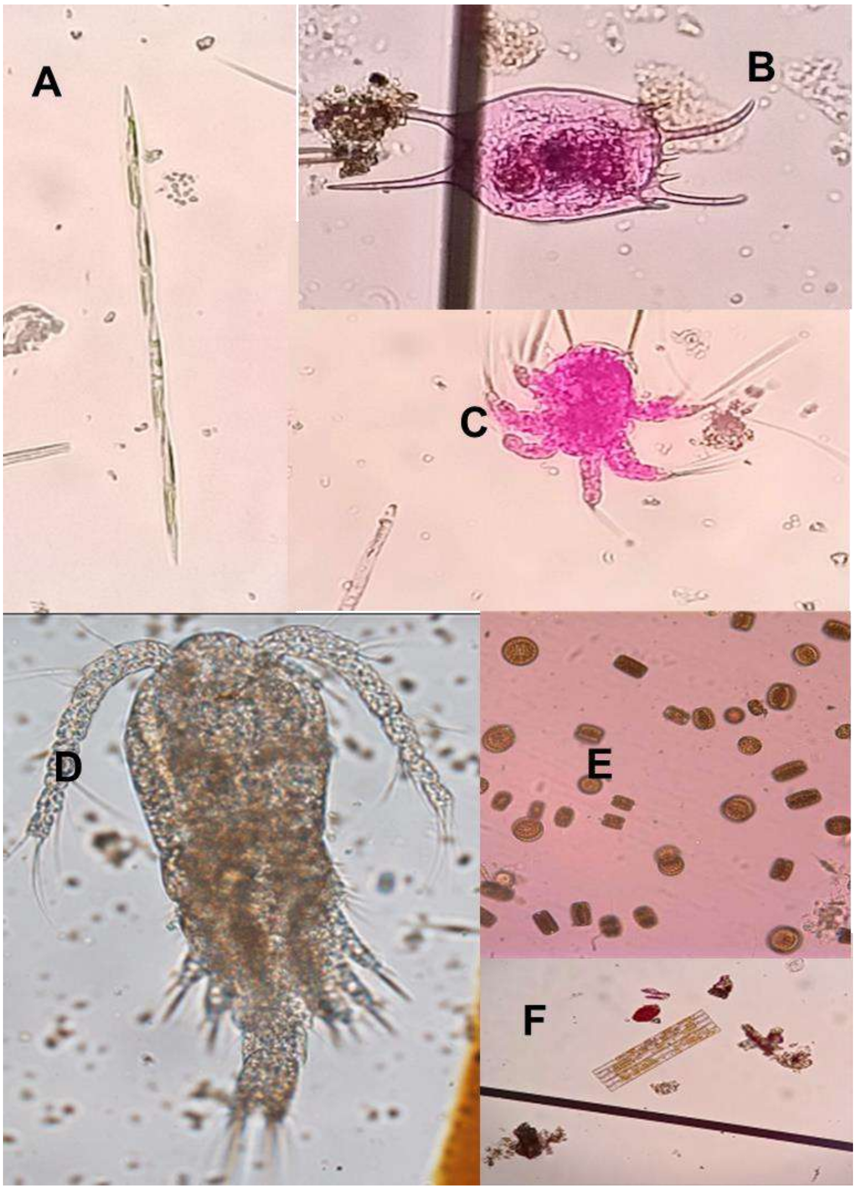


Figure 2.2.66: Total Zooplankton Density and Taxa Richness in Four Stations; 23-25 January 2020



Note: (A) Pseudonitzschia (B) Brachionidae (C) Nauplius copepod
(D) Harpacticoid copepod (E) Thalassiosira (F) Fragilaria

Plate 2.2.32: Photomicrograph of Some Phytoplankton Species in Four Sampling Stations; January 23-25, 2020

2.2.5.6.3 Macrobenthos

Data on the composition, abundance distribution diversity of macrobenthos community in four sampling stations near the vicinity of the proposed project are summarized in **Table 2.2.36**. A total of 179 taxa were quantified belonging to six (6) major phyla i.e, Foraminifera, Sipunculida, Nematoda, Mollusca, Annelida and Arthropoda. Taxa belonging to the Phylum Mollusca was the most dominant macrobenthic faunal group particularly in brackish water stations (M-BN1, M-BN2) accounting for >70% of the total relative abundance while Phylum Foraminifera dominated the marine stations collected offshore (M-BN2-MBN4) constituting for >70%. Other phyla (Nematoda, Mollusca, Sipunculida) accounted for <30% (**Figure 2.2.68**). The top five (5) macrobenthos family/order identified in this survey were Calcarinidae (49%), Peneroplidae (12%), Tanaidacea (7%), Gammaridae (5%), Veneridae (4%). Other macrobenthos families accounted for 24% of the total macrobenthos community. Some recent studies indicate that foraminifera are not only a group of great ecological importance as food organisms for fish and invertebrates, but also play an important role in the turnover of nutrients and energy in the sea. However, they are generally very common and abundant and not much of a concern for conservation endeavor. Another notable macrobenthos was the arthropod belonging to order Tanaidacea or Tanaids which constituted for 7%. Tanaids are small, shrimp-like organisms ranging from 0.5 to 120 millimeters in adult size, with most species being from 2 to 5 millimeters. It appears that the tanaids attracts schools of *sardines (Sardinella lemuru)* and *herring (Engraulis japoonicus)* migrating to nearshore areas seasonally. Majority of species are bottom-dwellers in shallow water environments but a few live in very deep water, exceeding for some species 9,000m. Again they are very common macrobenthic group in the marine environment and not a threatened group of organisms. For the polychaetes, species belonging to family Sabellidae were the most abundant with total count of 3 ind/m^2. Polychaetes play a major role in the functioning of benthic communities, in terms of recycling and reworking of benthic sediments, bioturbating sediments and in the burial of organic matter. There were no edible or economically important taxa nor species listed as a conservation concern in the IUCN red list of species in this survey.

Table 2.2.32: Macrobenthos Composition, Abundance, Distribution and Diversity in Four Stations; 23-25 January 2020

Marine Benthos Taxa	Stations				Grand total	Rel. Abund.
	MW 1	MW 2	MW 3	MW4		
Phylum Foraminifera						
Family Peneroplidae		4		17	21	11.73
Family Calacrinidae		33		54	87	48.60
Family Amphisteginidae		2			2	1.12
Phylum Sipunculida		1		1	2	1.12
Phylum Nematoda				2	2	1.12
Phylum Annelida						
Class Polychaeta						
Family Lumbrineridae		1			1	0.56
Family Sabellidae				3	3	1.68
Phylum Mollusca						
Class Gastropoda						
Family Thiaridae	2		1		3	1.68
Family Argonautidae				1	1	0.56
Family Nassariidae		1		2	3	1.68
Family Muricidae	2		1		3	1.68
Family Neritidae	3	3			6	3.35
Family Planorbiidae	4		2		6	3.35
Class Veneridae	3	2	1	1	7	3.91
Phylum Arthropoda						
Subclass Crustacea						
Class Malacostraca						
Order Tanaidacea				12	12	6.70
Order Isopoda		1		2	3	1.68
Order Cumacea				2	2	1.12
Order Amphipoda						
Family Gammaridea	3	3	2	1	9	5.03
Order Decapoda						
Family Paguridae		2			2	1.12
Class Ostracoda						
Subclass Myodocopa		1		3	4	2.23
Grand Total	**17**	**54**	**7**	**101**	**179**	
Richness	**6**	**12**	**5**	**13**		

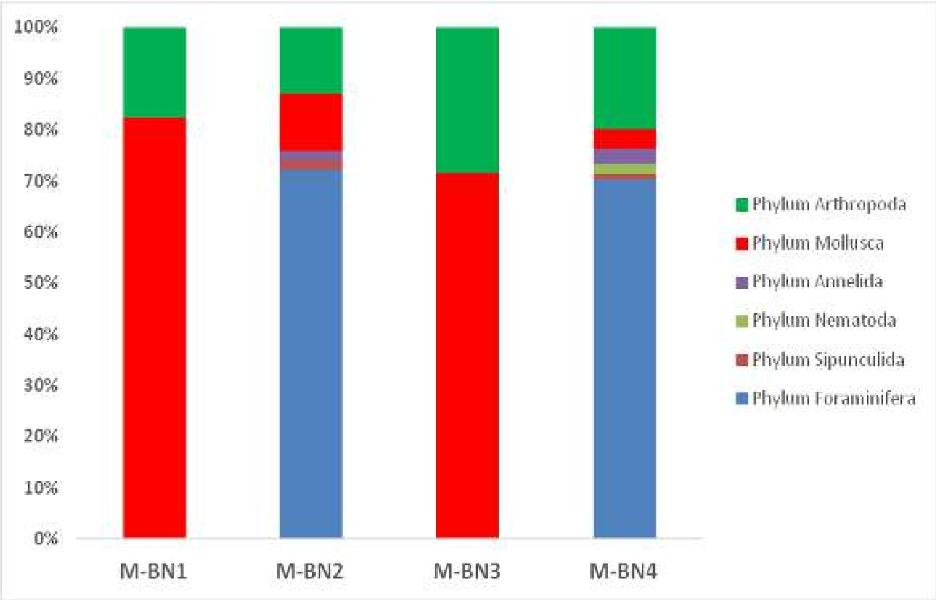


Figure 2.2.67: Percentage Composition of Major Macrobenthos Phyla in Four Stations; 23-25 January 2020

Overall, the total abundance in four stations was of 179 individuals. The abundance and richness of macrobenthos recorded in four stations is shown in **Figure 2.2.69**. The variability of macrobenthic organisms are generally affected by abiotic factor likes substrate types, salinity, water temperature, dissolved oxygen. Biotic factors like recruitment, predation, natural mortality could also affect the changes in microbenthic community. Other disturbance on the habitat either anthropogenic or natural in origin, like water pollution and displacement of bottom sediments may cause severe damage on their population. Spatially, the highest density of macrobenthic fauna was recorded in station B-BN4 with 101 individual. The lowest macrobenthos count was observed in Station B-BN3 located at the river mouth with seven (7) individuals. In terms of species richness, station M-BN1, yielded the highest number of macrobenthos taxa with thirteen (13) while the lowest number of taxa was recorded in station M-BN3 with 3. 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).

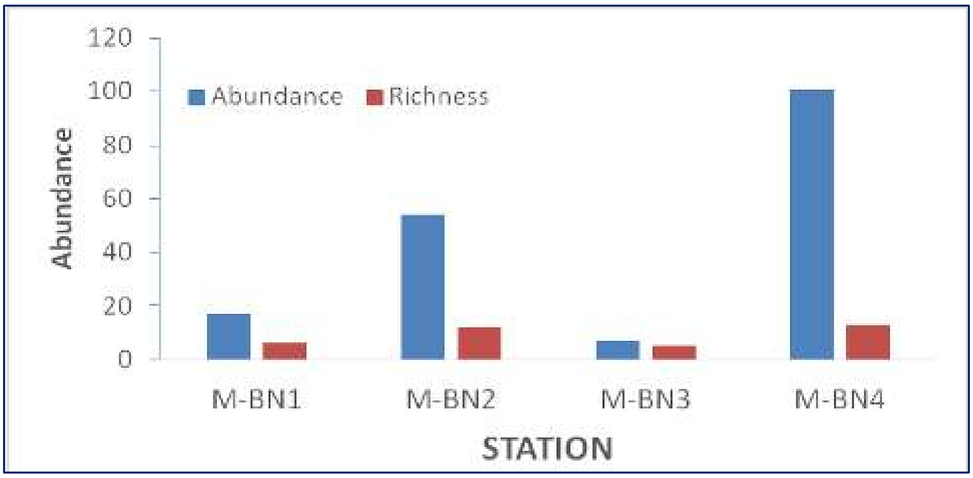


Figure 2.2.68: Species Richness and Total Abundance and Species Richness in Four Stations; 23-25 January 2020

Provided in **Annex 2-4** are the graphs and tables of the marine survey results.

2.2.5.7 Threats to existence and/or loss of important species and habitats and abundance/densities/distribution of ecologically and economically important species

Potential impacts arising from climate change scenarios

The possible impacts of climate change in the marine environment have been documented to include, among others, (i) rise in surface seawater temperature that may cause coral bleaching, (ii) rising sea level that may inundate shallow-water aquatic animals and cause changes in population structure, and (iii) saltwater intrusion into the land-sea interface. Present knowledge and experiences on mitigating measures are largely inadequate, and strategies to protect corals and associated habitats from CC-induced abnormalities are largely deficient. Climate change projections of the PAGASA indicate that mean temperatures in all areas in the Philippines are expected to rise by 0.9°C to 1.1°C in 2020 and by 1.8°C to 2.2°C in 2050, with the largest seasonal temperature increase anticipated to occur during the summer season (PAGASA, 2011). Corals have tolerance limits on warm seawater temperatures and may bleach in seawater temperatures that breach an increase of 3°C. In times of El Niño episodes, such a possibility can happen if the situation is exacerbated by climate-induced seawater temperature rise.

The fundamental safety net and adaptation strategy is to *protect as much habitats as possible*. Currently the most acceptable adaptation strategy is to enhance the establishment of marine protected areas that will integrate coral reef areas, mangrove forests and seagrass beds into a network of MPAs. The strategy seeks to ensure the gene banks are replicated over broad areas. In support of this overall strategy, the Project will seek to:

(i) Conduct periodic monitoring to check habitat impairment or modification as a result of climate-induced seawater temperature increases;
(ii) Support the establishment, expansion and effective management of the marine protected area (MPA);
(iii) Enhancement of mangrove rehabilitation projects to increase carbon sinks;
(iv) Enhance seagrass habitats by considering feasible transplantation strategies;
(v) Support the protection of areas where fish spawning aggregations are found;
(vi) Since the Company operates a marine hatchery, it can consider intensifying stock re-seeding in mangrove, coral reefs and estuarine areas (e.g., mud crabs, abalone and sea cucumber).

Presence of pollution indicator species

Corals – There are no standard prescriptions on the monitoring of the condition of coral reefs as an indicator of marine pollution. However, the suffocation of coral polyps due to heavy sediment blanketing is a good yardstick of the extent of seawater pollution arising from total suspended solids that emanate from anthropogenic origins. Widespread fluctuations in seawater dissolved oxygen will also negatively affect the corals; and isolated bleaching can occur in extreme conditions. Findings from periodic monitoring of the condition of coral reefs in consistent survey stations can therefore be used to correlate issues of sediment intrusion and coral suffocation and track pathways where such issues occur. Based on observations of DCA values across all three coral reef assessment stations undertaken in the current survey, silt pollution in the project site and contiguous coastal environs is occurring but these have not reached extreme proportions, particularly in the marine sanctuary.

Bivalves and fish species – Many bivalve species are either filter-feeders or detritus feeders that can be used to determine biotoxin levels that can be harmful to humans if such biotoxins reach a certain threshold of multiplication. The presence of ark shells and oysters in the seagrass meadows can be used to determine biotoxin, if monitoring is undertaken periodically. An appropriate strategy is to involve the BFAR Red Tide monitoring team in such periodic assessments. In most cases, algal blooms are manifested in Red Tide episodes triggered by hyper-nutrient loading in coastal waters and the measurement of the density of algal species known to multiply excessively into "bloom" proportions can be monitored through periodic plankton sampling in the coastal impact area.

Fish – Certain small pelagic species of fish have been used to determine potential ingestion of heavy metals carried through zooplankton diets through investigations of their abdominal organs. However, in most cases, marine fish species have not been normally used as indicators of pollution, except where biotixins are involved (e.g. plankton-filtering fish species in PSP-affected areas such as Anchovies). On the contrary, some species of fish have been used as "indicators" of a relatively good coral reef habitat and its ecosystem functions. In the survey stations, such "indicator" species are represented by species of the butterfly fish *Chaetodontidae.* In this survey, five (5) species of Chaetodontids, including the seldom see yellow-dotted butterflyfish *Chaetodon selene* were observed three line intercept stations surveyed for coral life forms. These fishes are characteristically indicative of a healthy coral reef and inversely, the loss of these species over time is indicative of continuing loss of coral reef resources. This shall be one of the parameters to be investigated during periodic fish visual census in the reefs around the project's impact area. The correlation is that an increase in the number and species diversity of indicator species normally denote an improving coral reef ecosystem.

Potential Impacts of Sediments

Coral Reefs. Earthmoving in the MPSA will likely lead to the addition of sediment spills if control measures are not effectively adopted. Although the marine sanctuary is located about 4km south of the project site, uncontrolled silt and sediment streams from the Project can be inevitably carried to coastal areas near the sanctuary and may eventually blanket sensitive benthic environments, particularly corals especially during strong, wind-driven currents during the northeast monsoon season. Such sediment streams will likely amplify coastal water turbidity, in the form of total suspended solids (TSS) and further reduce sunlight penetration into the water column. In extreme cases, turbidity will lead to reduced photosynthetic function which can affect microscopic primary producers of phytoplankton and dependent zooplankton communities, depressed seagrass and macrobenthic algae settlement, and deterioration of dissolved seawater oxygen content. Fishes will most likely avoid such altered water column, in effect impairing nearshore fisheries. Macro-invertebrates can be smothered and can lead to smothering of large populations of bivalves and gastropods, including the valuable sea cucumbers. The most serious impact would be smothering of coral reef patches in the reef flat and slope of the fringing reefs within the marine sanctuary.

Large volumes of terrigenous materials and mining residues can intensify sediment streams spilling onto coastal waters and exacerbate silt and sediment pollution if sediment sequestration and filtering measures are inadequate. The impacts on coral reefs can be widespread suffocation of coral polyps inside and outside of the MPA. Intense suffocation of corals, particularly branching corals which are the most susceptible, can lead to coral mortality over a broad area. Coral recruitment and settlement will be seriously affected. Where such sediment loads are extremely heavy, even resistant varieties of massive corals may be impaired. The cumulative effects of sedimentation will vary in the inner shelf and outer coastal waters but the resulting invasion can be far reaching especially during the southwest monsoon where floodwater run-offs are expected to be more widespread. Over the long run, such persistent, unregulated silt loads can impair inter-connected ecological structures and functions – including fish and macro-invertebrate reproduction, over a long stretch of fragile benthic habitats in the marine sanctuary and reefs in the mouth of the "drydock" cove and further south of the MPA.

Sediment streams that may reach the MPA and contiguous reefs to the north and south of the fish sanctuary needs to be prevented as suspended sediments can cause demise of coral polyps and affect productivity of the marine food web in the area, depress reproductive physiology of reef-dwelling species of fish, and may cause low larval survival; all of which may affect animal symbiotic relationships within the coral reef, seagrass and mangrove ecosystems. In contrast, reduction of sedimentation will result to progressive improvement in the growth of the corals, expansion of the reef through recruitment and increased diversity of benthic fauna associated with coral reefs. In the inner reef flats, it is anticipated that algal assemblages will continue to progressively inhabit degraded reef areas but the survey also observed new settlement of coral planulae and seagrass recruits that can slowly regain coral colonies where settlement is favorable.

Seagrass Meadows. The extensive seagrass meadows in the "drydock" cove in front of the shipyard are the most susceptible to sediment invasions. Even as seagrass have the natural ability to hold silt along its leaves and compress sediments through its roots, excessive sedimentation can impair this important function and lead to smothering of seagrass beds over a broad area in the cove. Loss of seagrass meadows will ultimately lead to the loss of fish and macro-invetebrate nursery and grazing grounds, among them species of siganids, snappers, the "bakasi" and bivalves and echinoderms of significant economic valu. Moreover, loss of seagrass beds will exacerbate turbidity, as seagrass actually helps in the sequestration of sediments by enabling it to settle at the bottom and holding them through their roots. This primary function actually prevents the silt from reaching the reefs which are more delicate as they need clearer water and are highly sensitive to sedimentation.

Benthic Macro-Invertebrates. While benthic macro-invertebrates, especially sea cucumber, bivalves and gastropods that are currently a significant source of supplemental income to locals, have the capacity to resist sediment blanketing up to a threshold where anaerobic conditions start to set in. In most cases, such mobile animals, although slow-moving, can actually relocate to more suitable areas. Communities of bivalves and gastropods in the inter-tidal shelf, however, will be most susceptible to physical alteration of the seabed and massive disturbance and reconfiguration of macro-invertebrate habitats can lead to mortality of shellfish stocks. Reproductive and recruitment capacity can be greatly reduced and with persistent exposure to such stressors, entire stocks can be lost irretrievably.

Mangrove. Due to their natural capacity for accretion of sediments it is unlikely that incursion of sediment and silt – laden seawater into mangrove swamps will have profound impacts on growth, recruitment and overall survival of mangrove trees.

Improving the company's sediment sequestration measures, reinforced with a stronger integrated coastal management program can be the most effective handle to arrest further degradation of the reef ecosystem and expand conservation areas where growth, maturation and recruitment of corals and its associated marine fauna can be enhanced. Canals that divert sediment-laden process waters and runoff from mine sites into containment and settling ponds will be constructed. Topsoils and substrates from the expansion mining areas will also be immediately contained, hauled and re-used in revegetation. Sediment streams potentially emanating from project arthworks, road construction and maintenance that have the potential to intrude into the sea particularly during rainy periods can be prevented first and foremost by controlling erosion at source, thence diverting all loose or fugitive soil and sediments into project waterways fitted with filter systems before being diverted into containment ponds where they are further sieved after settlement. Adequate and diverse structures and engineering mechanisms will be strategically established in order to prevent sediment spills onto other waterways and drainage systems. If sediments are observed to be intruding into sensitive coastal areas, silt curtains consisting of geo-textile screens will be installed to minimize escape of silt.

RCBM will support fisheries management and stock enhancement measures through collaboration with the Barangay government and fisher associations. Development of an ecosystem-based fisheries management plan will supported. Support to protection of the MPA will be accorded as the MPA, over the long run, can contribute to increase in fish stocks. Offshore fishing can be supported through the fish aggregating device (FADs) installed with management of fishing effort. Mariculture of lucrative foodfish will also be supported through environment-friendly culturing systems.

On macro-invertebrates that support local livelihoods, areas of high density will be identified and subjected to monitoring to ensure no sediment blanketing occurs in the area(s). Re-seeding and trans-location of shellfish removed from highly-disturbed areas will be undertaken.

Mangrove forests are natural filters and enhancers of sediment accretion and the RCBM will therefore support mangrove protection and rehabilitation in suitable areas. Community participation in mangrove rehabilitation and management will be the principal tool for engaging stewardship and conservation arrangements. Tangible benefits for the community will be enabled, and income generating projects associated with mangrove-aquasilviculture will be supported. Protecting mangrove forests can be supplemented with mariculture–based income generating activities such as re-stocking of mud crab juveniles in special management areas and culture of sea cucumbers in pens.

Wastewater

Wastewater from heightened personnel in the plant and in quarry areas, combined with organic wastes and nutrients stirred up during earth moving activities, can end up in waterways if wastewater containment is inadequate. Such wastewater can ultimately spill into coastal waters and cause increased levels of marine pollution that can lead to further degradation of sea water quality. Also, pollution of waters through hyper-nutrient loading is suspected to trigger algal blooms that may lead to anaerobic conditions causing fish kills, and the outbreak of the dreaded Red Tide organism that cause paralytic shellfish poisoning or PSP. Results of the plankton community assessment revealed the presence of the potentially harmful phytoplankton organism *Pseudonitzschia* spp. Some species of this genus are known to produce domoic acid (DA) – a toxin associated with Amnesic Shellfish Poisoning the cyanophite. However, the plankton analysis showed very low concentration of the organism.

The use of 3-chambered septic tanks shall be installed in all project facilities where wastewaters and other effluents are generated. Waste minimization will be practiced in all aspects of project operation. The objective is to ensure that pollution-causing effluents that can be potentially carried downstream are treated at the source.

Oil and Grease Contamination

Corals in the marine sanctuary can also be susceptible to oil and grease contamination if fugitive spills from improperly disposed fuel-based wastes is carried into coastal waters and dispersed through current movement, particularly in the shipyard and ship docking pier. While this issue is not anticipated to be severe, oil slicks can be very detrimental not only to corals and organisms in the benthic environment but can also defile inter-tidal sandy areas and rock pools where communities of macro-invertebrates exists. The detrimental effects can be irreversible.

An oil and grease containment and waste containment plan will be formulated and enforced in all aspects of project operations.

Monitoring

Periodic environmental assessment of the condition of corals and seagrass in the marine sanctuary will be conducted in order to discern changes and possible increased impacts of siltation in the reef habitats as a pivotal strategy in enabling a science-based indicator monitoring system, employing standard methods. Results of the monitoring will be used as an early warning gauge so that sediment mitigation measures can be periodically reviewed and ehnaced.

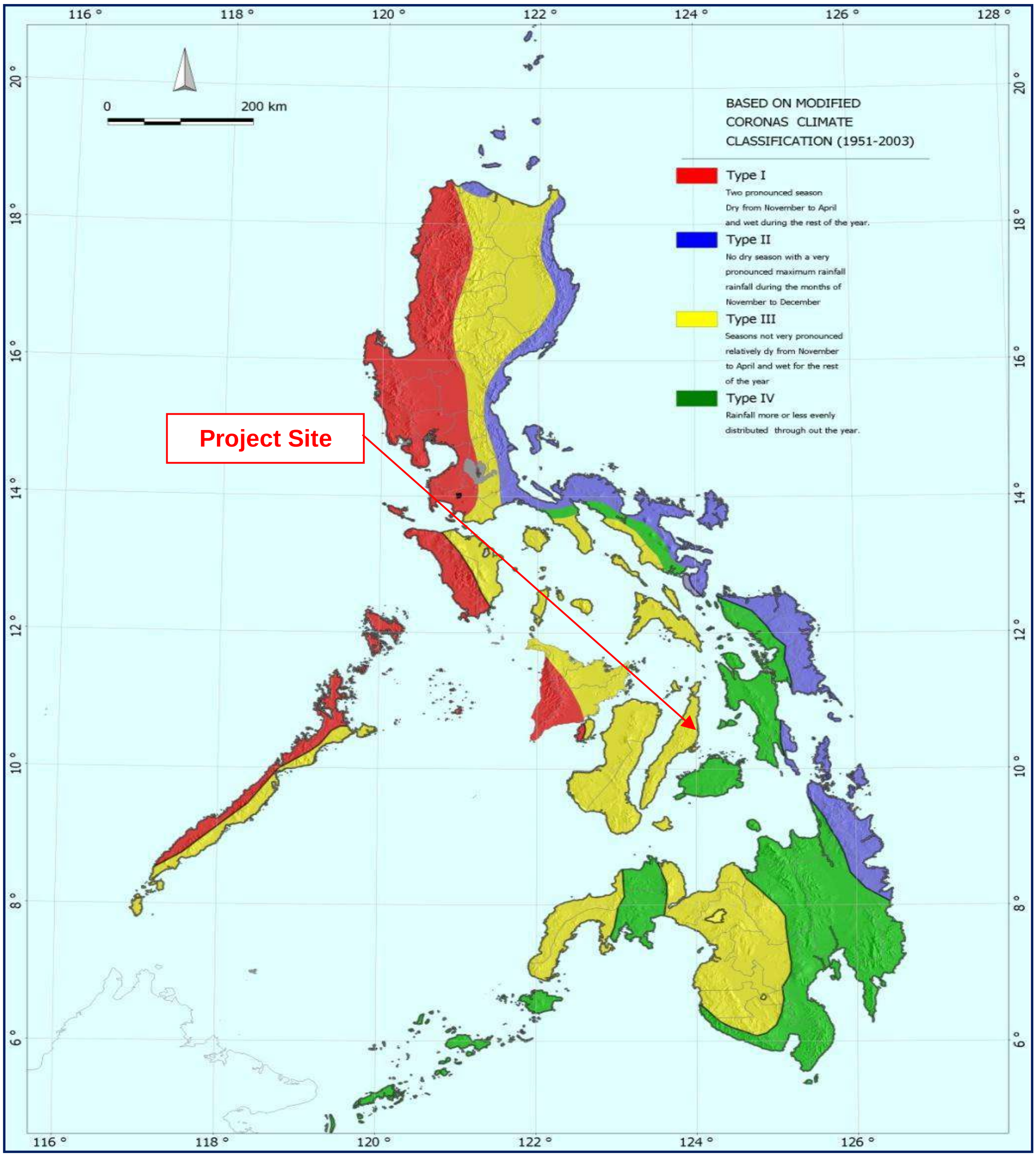
RCBM will support the implementation of strategies to strengthen marine protected area management and the inclusion of more mangrove, seagrass and coral reef habitats into integrated special area management regimes in support of adaptive management led by the local government .

2.3 AIR

2.3.1 Climatology and Meteorology

2.3.1.1 Climate Type

The climate at the project site falls under Type III category based on the Modified Coronas Climate Classification of the Philippine Climate (**Figure 2.3.1**). Type III climate is characterized as not very pronounced maximum rain period with a short dry season from November to April and wet during the rest of the year.



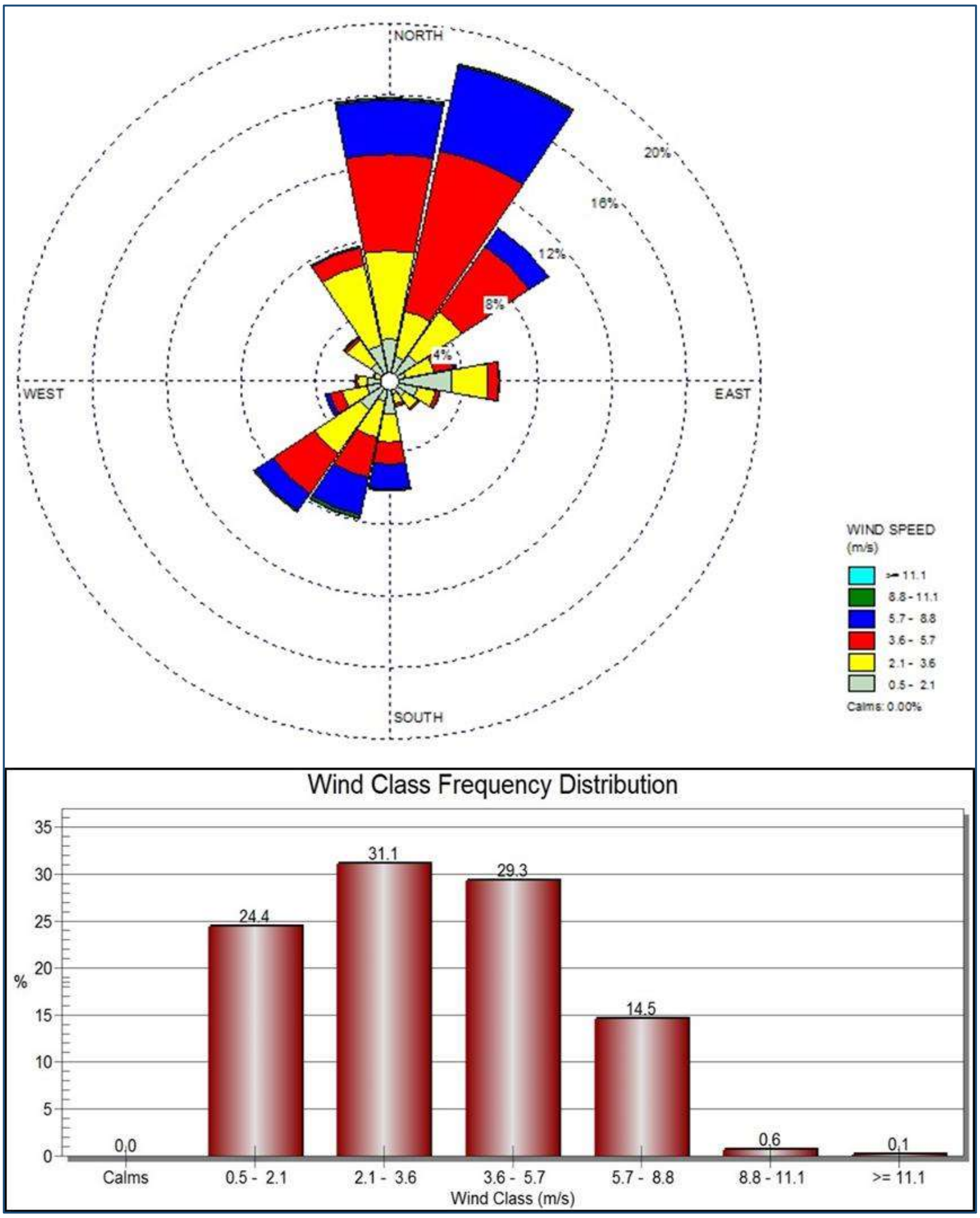
Source: PAGASA

Figure 2.3.1: Philippine Climate Map

2.3.1.2 Wind Regime

The Cebu PAGASA Synoptic Station located in Mactan International Airport, Cebu is the nearest meteorological station in the project site. The geographical position of the upper-air and surface synoptic station is 123°58'48.47"E and 10°19'20.80"N with an elevation of 25.703 meters above mean sea level (mamsl).

The hourly meteorological data recorded at Cebu PAGASA Synoptic Station for the year 2015 shows that the prevailing wind at the project site is from north-northeast, north, and northeast, which comprises 18%, 16%, and 11%, respectively (**Figure 2.3.2**). The average hourly wind speed is 3.48 m/s and majority of winds occupy 31.1% of the time with speed of 2.1 m/s to 3.6m/s. Calm conditions were observed 0.0% of the time. Strongest winds with speed of ≥11.1m/s came from south-southwest occupy 0.1% of the time.



Source: WRPLOT View Version 7.0.0

Figure 2.3.2: Windrose Diagram Based from the 2015 Data Recorded at Cebu PAGASA Synoptic Station

2.3.1.3 Relative Humidity

Relative humidity refers to the amount of water vapour in the air, expressed as a percentage of the maximum amount that the air could hot at a given time. The mean annual relative humidity recorded at the Cebu PAGASA Synoptic Station is 84% with seasonal variation (i.e. mean monthly relative humidity range of 81% to 87% based from 2004-2014 meteorological data). The months of December to February are the most humid months of the year (**Table 2.3.1**). Factors affecting humidity are changes in temperature and atmospheric circulation. The air is said to be saturated when it contains the maximum amount of water vapour possible at a given temperature. When the temperature of the air falls below the dew point, some of the water vapour contained in the air condenses, clouds form, and precipitation can result in the form of rain.

Table 2.3.1: Relative Humidity Recorded at Cebu PAGASA Station, 2004-2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2004	87	84	88	87	85	87	82	82	82	86	92	91	86
2005	90	87	87	86	86	88	90	91	92	93	88	93	89
2006	93	93	90	87	88	87	81	82	83	84	80	82	86
2007	85	80	76	75	78	79	83	83	86	85	87	86	82
2008	87	85	81	80	84	81	83	79	80	82	81	83	82
2009	82	83	79	79	78	81	85	84	83	84	83	84	82
2010	86	83	79	80	76	82	84	85	84	87	86	88	83
2011	90	87	88	84	86	86	86	86	84	85	86	89	86
2012	88	86	84	80	82	82	84	79	85	82	82	83	83
2013	83	83	78	75	78	84	82	81	78	79	83	82	81
2014	83	80	79	79	77	80	83	80	83	82	79	82	81
Mean	87	85	83	81	82	83	84	83	84	84	84	86	84

Source: Cebu PAGASA Synoptic Station

2.3.1.4 Temperature

The annual mean average temperature is 28.1°C, with January being the coldest month having an average temperature of 26.8°C; while the month of May is the warmest with an average temperature of 29.3°C. The highest and lowest temperatures occur in the months of April to July and December to February, respectively. The mean maximum and minimum temperatures range from 29.8–32.8°C and 23.9–25.8° C, respectively, as presented in **Table 2.3.2**.

Table 2.3.2: Climatological Normal Recorded at Cebu PAGASA Station, 1981-2010

Month	Rainfall, mm		Temperature, °C			Wind		No. of days with	
	Amt.	Rdg.	Max	Min	Mean	Dir	Spd	Thunder	Lightning
Jan	105.2	12	29.8	23.9	26.8	NE	3	1	0
Feb	69.6	9	30.2	24.0	27.1	NE	3	1	1
Mar	58.6	8	31.1	24.5	27.8	NE	3	1	1
Apr	48.1	6	32.3	25.4	28.8	NE	3	3	2
May	95	8	32.8	25.8	29.3	E	2	9	8
Jun	175.6	14	32.1	25.4	28.8	SW	2	11	9
Jul	192.9	16	31.5	24.9	28.2	SW	2	13	9
Aug	143.5	14	31.7	25	28.4	SW	3	11	7
Sep	179.6	15	31.8	24.9	28.3	SW	2	14	10
Oct	194.8	16	31.4	24.8	28.1	NE	2	14	10
Nov	161.9	14	31.0	24.7	27.8	NE	3	6	6
Dec	139.7	14	30.2	24.3	27.3	NE	3	3	2
Annual	1564.5	146	31.3	24.8	28.1	NE	3	87	65

Source: Cebu PAGASA Synoptic Station

Climatological extreme values from the 30-year monthly and annual summaries of temperature, rainfall, and wind speed are presented in **Table 2.3.3**. The recorded annual extreme high and low temperature is 37.6°C and 19.8°C, respectively. The amount of extreme greatest rainfall is 276.1 mm, while the annual average extreme highest wind is 55 m/s.

Table 2.3.3: Climatological Extreme Recorded at Cebu PAGASA Complex Station, 1972-2010

Month	Temperature, (°C)				Greatest Daily FR, (mm)		Highest Wind, (m/s)		
	Date	High	Date	Low	Date	Amount	Date	Speed	Direction
Jan	01-03-88	33.5	01-21-97	19.8	01-88-99	126.6	01-24-75	30	NE
Feb	02-16-83	34.8	02-16-04	20	02-07-03	77	02-18-88	22	E
Mar	03-31-04	33.9	03-01-02	19.4	03-26-82	141.3	03-26-82	25	SW
Apr	04-15-92	35.6	04-01-03	22.1	04-04-94	174	04-04-94	30	SW
May	05-30-79	36.4	05-27-07	22	05-27-00	106	05-17-87	20	W
Jun	06-12-93	37.6	06-13-75	22.5	06-09-84	87.8	06-25-92	18	SW
Jul	07-20-73	35.3	07-05-90	20.8	07-09-73	99.6	07-17-98	20	SE
Aug	08-27-98	35.6	08-19-81	20.8	08-17-82	96.6	08-15-86	25	SW
Sep	09-23-87	35.2	09-18-72	21.5	09-26-89	127	09-02-84	48	NE
Oct	10-22-87	34.4	10-24-86	21.6	10-28-95	166.1	10-28-95	25	SW
Nov	11-01-93	33.8	11-22-98	20.4	11-12-90	276.1	11-12-90	55	S
Dec	12-01-06	34	12-28-96	20	12-05-01	158.4	12-26-93	42	S
Annual		37.6		19.4		276.1		55	S

Source: Cebu PAGASA Synoptic Station

2.3.1.5 Rainfall

The rainfall pattern at the project site is described using the rainfall data recorded at Cebu PAGASA Synoptic Station. The rainfall over Cebu is averaging 1.5m per year with heavy rains occurring between May to December causing flood in low lying areas. The coastal areas receive considerably less rainfall than the mountains.

An average of 60% of rainwater runs off fast to the sea due to the steep, deforested mountains of Cebu and the remaining 40% partly evaporates and partly seeps through to the island's aquifer. The heaviest precipitation occurred in the month of July with an average of 242.7 mm from 2004 to 2014. The total annual average amount of rainfall from 2004-2014 is 1,972.9 mm (**Table 2.3.4**).

Table 2.3.4: Monthly Total Annual Rainfall Climatic Data 2004-2014 at Mactan Airport, Cebu

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2004	238.8	17.0	170.2	217.2	212.8	594.0	317.3	200.2	354.6	367.5	855.5	572.0	4117.1
2005	66.5	36.2	28.2	26.7	14.4	169.5	222.1	94.2	238.5	214.4	76.2	211.9	1398.8
2006	129	152.7	34.7	14.3	93.5	339.7	56.3	210.7	126.3	145.5	49.3	208.9	1560.9
2007	202.4	16.8	11.8	9.8	177.5	185.9	242.1	107.3	248.8	184.3	234.3	136.5	1757.5
2008	176.6	69.2	154	173.6	380.8	120.6	235.3	159.9	139.8	142.0	110.3	137.8	1999.9
2009	33.2	132.0	46.6	107.2	131.2	149.1	120.6	106.7	113.3	46.2	168.2	63.8	1218.1
2010	80.6	16.0	11.7	30.5	2.4	200.6	344.3	203.4	189.0	289.2	222.6	116.6	1706.9
2011	405.9	107.3	127.3	15.2	107.5	216.8	245.6	275.5	137.9	227.9	87.8	411.0	2365.7
2012	202.6	224.9	143.2	51.2	95.2	72.2	358.6	31.8	400.2	141.5	71.1	145.0	1937.5
2013	124.7	145.6	3.8	15.8	157.1	322.7	280.7	218.0	63.2	111.7	156.7	56.0	1656.0
2014	270.7	10.2	98.8	67.8	63.3	164.9	246.5	262.1	193.3	317.1	115.8	173.1	1983.6
Mean	175.5	84.4	75.5	66.3	130.5	230.5	242.7	170.0	200.4	198.8	195.3	203.0	1972.9

Source: PAGASA

2.3.1.6 Cyclone Frequency

The most number of cyclones occur during the months of June to December. These tropical cyclones are associated with the occurrence of low pressures areas (LPA) normally originating from the North Western Pacific Ocean of the Philippine Area of Responsibility (PAR) and generally moving northwestward. Tropical cyclones also originate in the South China Sea or at the western part of the country, having unusual motions, and quite rare with 52 occurrences in fifty (50) years (Perez, 2001). PAGASA categorized these cyclones as tropical depressions (TD), with wind speeds up to 63 kph; tropical storm (TS), with wind speeds from 64-117 kph; and tropical typhoon (TY), with wind speeds over 117 kph.

Based from the Typhoon Risk Map of the Philippines presented in **Figure 2.3.3**, Cebu falls under Low Risk to Typhoon with a frequency of one (1) cyclone per year. From 1948-2011 (period of 64 years), PAGASA determined an annual average of 20 tropical cyclones in the PAR with nine (9) of these passing through the Philippine landmasses. Overall, PAGASA had tracked 64 tropical cyclones that crossed in the Province of Cebu, as shown in **Figure 2.3.4**.

The relevance of typhoons to the project/project site is reckoned from rain-induced localized flooding and risk to personnel. The potential impact that may be experienced may include heavy siltation caused by typhoon-induced rainfalls. Therefore, RCBM has installed Disaster Preparedness Plan for to mitigate the risks. Engineered and strategically located sediment mitigation facilities and drainage systems which include siltation ponds, stabilization of gullies and construction of run-off weirs at desirable distances along and within the existing gullies were instituted.

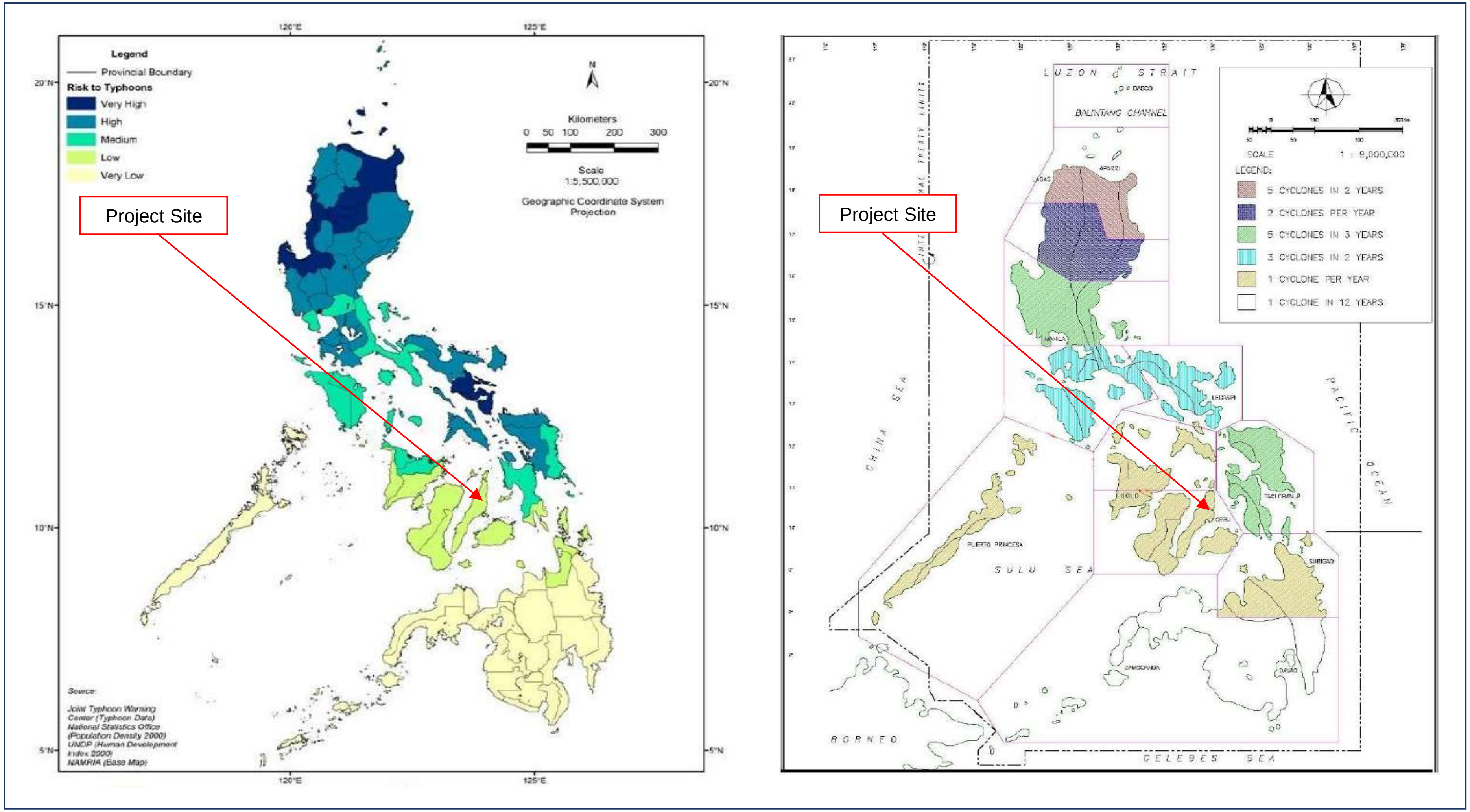
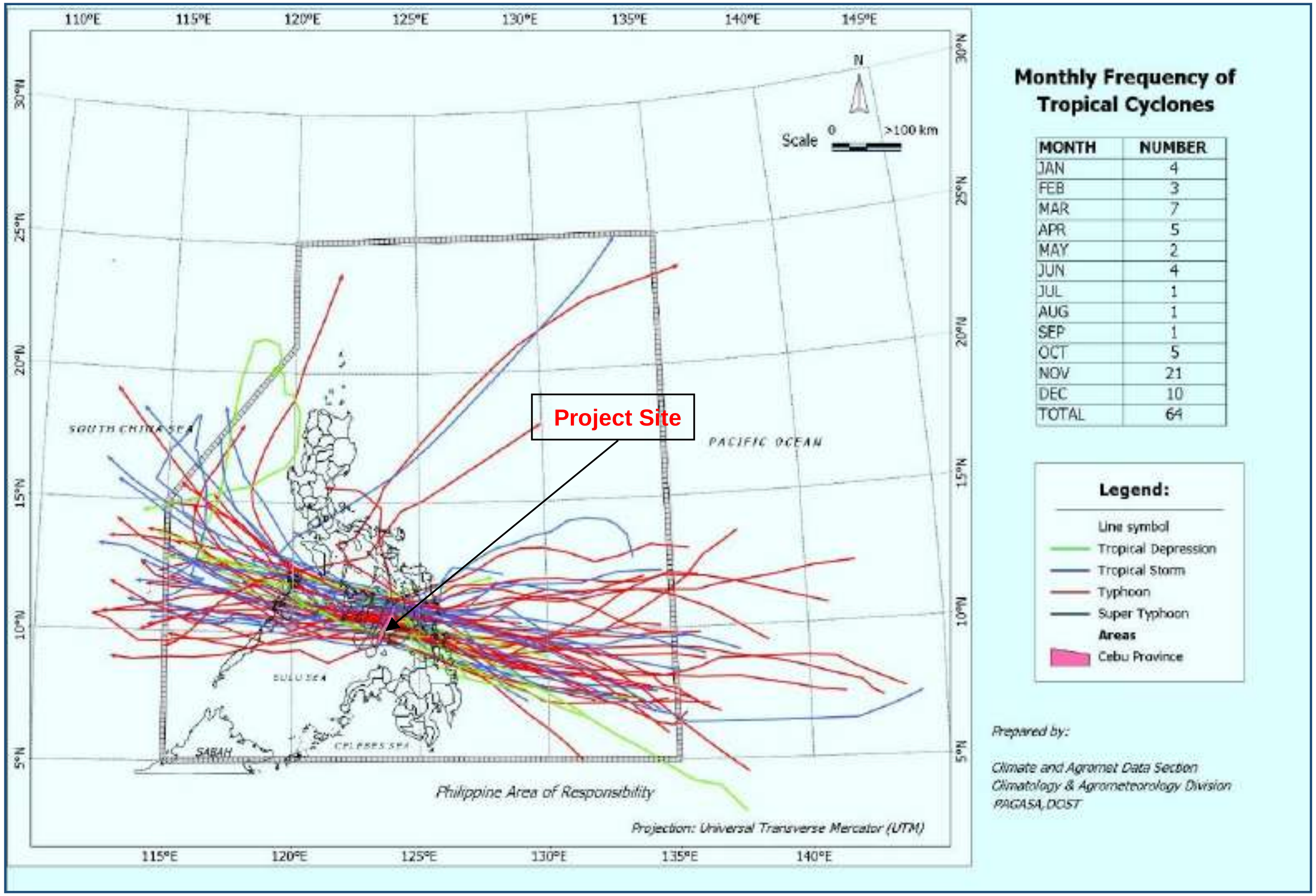


Figure 2.3.3: Philippine Typhoon Risk Map



MONTH	NUMBER
JAN	4
FEB	3
MAR	7
APR	5
MAY	2
JUN	4
JUL	1
AUG	1
SEP	1
OCT	5
NOV	21
DEC	10
TOTAL	64

Source: Cebu PAGASA Synoptic Station

Figure 2.3.4: Tracks of Tropical Cyclones which Crossed the Province of Cebu, 1948-2011

2.3.1.7 Change in the Local Micro-Climate

Temperature Change

The historic average annual ambient air temperature is 28.1°C. The data indicate that there is little monthly or seasonal variation in average temperatures. Daily time-step, temperatures can vary by 5 to 8°C on average during a day, peaking above 30s and dropping to the low 20s overnight.

The Climate Change Scenario in the Philippines as published by PAGASA in February 2011 indicates that the Province of Cebu will have an increase in temperature (**Table 2.3.5**).

Table 2.3.5: Seasonal Temperature increase (in °C) in 2020 and 2050 under medium range emission scenario in Cebu Province

Observed Baseline (1971-2000)				Change in 2020 (2006-2035)				Change in 2050 (2036-2065)			
DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
26.8	28.4	28.2	27.9	0.9	1.2	1.1	1.0	1.9	2.4	2.1	1.9

Source: Climate Change in the Philippines, 2011 PAGASA

It is projected that average monthly ambient temperature over the period 2006–2035 will increase by 0.9 to 1.2°C, while temperatures for the period of 2036-2065 will increase by 1.9 to 2.4°C. The annual average temperature covering the period 2006-2035 will rise to 29.1°C. However, it will rise to 30.1°C for the period of 2036-2065. **Table 2.3.6**, **Figures 2.3.5**, and **2.3.6** present the projected monthly average temperature with climate change (T_{ave} CC) and without climate change (T_{ave} base).

Table 2.3. 6: Projected Monthly Average Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline/Without Climate Change Scenario (1981-2010)												
Max	29.8	30.2	31.1	32.3	32.8	32.1	31.5	31.7	31.8	31.4	31.0	30.2
Min	23.9	24.0	24.5	25.4	25.8	25.4	24.9	25.0	24.9	24.8	24.7	24.3
Ave	26.8	27.1	27.8	28.8	29.3	28.8	28.2	28.4	28.3	28.1	27.8	27.3
With Climate Change Scenario (2006-2035)												
Max	30.7	31.1	32.3	33.5	34.0	33.2	32.6	32.8	32.8	32.4	32.0	31.1
Min	24.8	24.9	25.7	26.6	27.0	26.5	26.0	26.1	25.9	25.8	25.7	25.2
Ave	27.7	28.0	29.0	30.0	30.5	29.9	29.3	29.5	29.3	29.1	28.8	28.2
With Climate Change Scenario (2006-2065)												
Max	31.7	32.1	33.5	34.7	35.2	34.2	33.6	33.8	33.7	33.3	32.9	32.1
Min	25.8	25.9	26.9	27.8	28.2	27.5	27.0	27.1	26.8	26.7	26.6	26.2
Ave	28.7	29.0	30.2	31.2	31.7	30.9	30.3	30.5	30.2	30.0	29.7	29.2

Source: Cebu PAGASA Synoptic Station, 1981-2010
Note: Calculated based in the PAGASA Climate Change in the Philippines, 2011

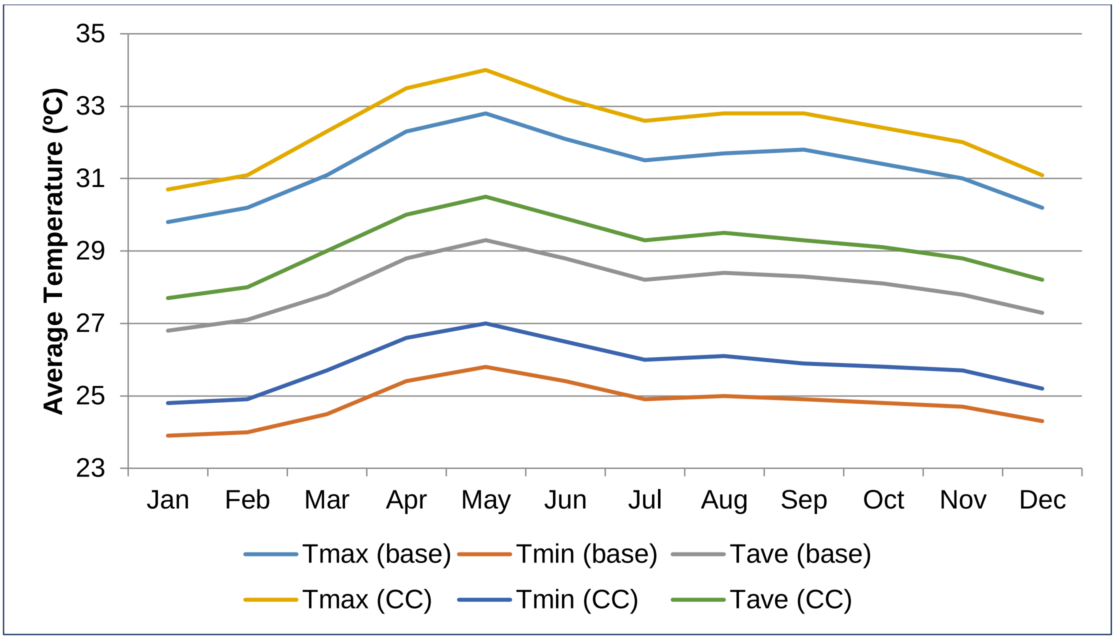


Figure 2.3.5: Graph of Computed Change in Temperature (2006-2035)

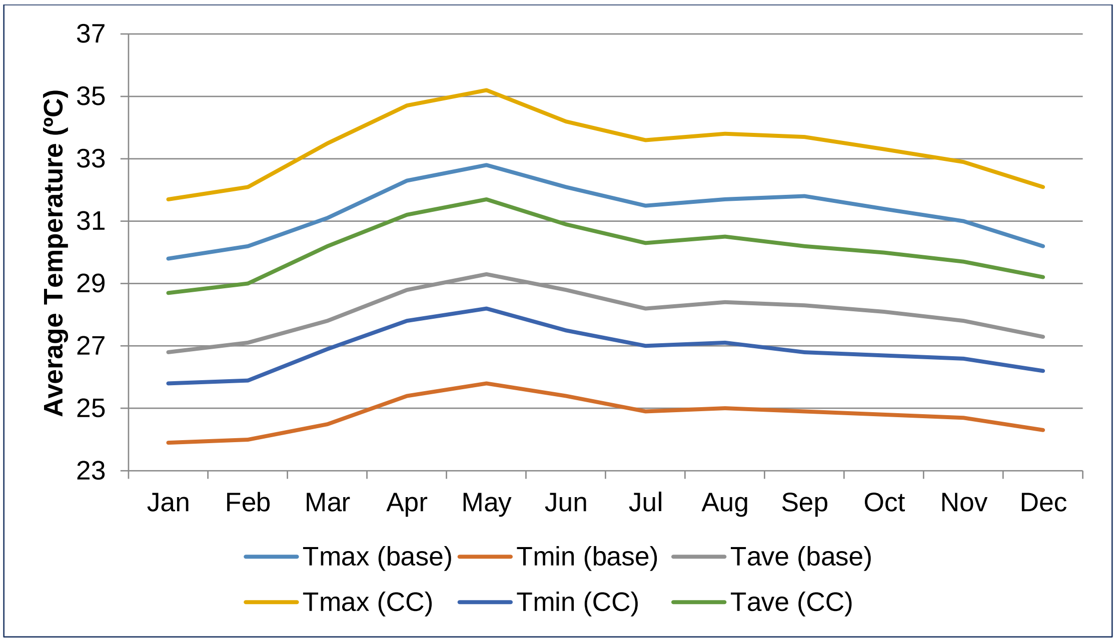


Figure 2.3.6: Graph of Computed Change in Temperature (2036-2065)

Rainfall Change

The historic average annual rainfall of Cebu is 130.4mm. Based from the climate change scenario for the Philippines as published by PAGASA in February 2011, the Province of Cebu will have an increased rainfall in 2020 and 2050 (**Table 2.3.7**).

Table 2.3.7: Seasonal Rainfall Change (in %) in 2020 and 2050 Under Medium Range Emission Scenario in Cebu Province

Observed Baseline (1971-2000)				Change in 2020 (2006-2035)				Change in 2050 (2036-2065)			
DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
324.0	228.3	595.1	607.4	17.7	0.8	7.7	7.7	19.6	0.5	18.9	17.8

Source: Climate Change in the Philippines, 2011 PAGASA

It is projected that the average monthly rainfall over the period 2006–2035 will increase by 0.8% to 17.7%; while the rainfall for the period of 2036-2065 will increase by 0.5% to 19.6%. The annual average rainfall covering the period of 2006-2035 will increase to 141.9mm, while the rainfall for the period of 2036-2065 will increase to 152.5mm. **Table 2.3.8** and **Figure 2.3.7** present the projected monthly average rainfall with climate change scenario for the periods of 2006-2035 and 2036-2065.

Table 2.3.8: Projected Monthly Average Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline/Without Climate Change Scenario (1981-2010)												
Ave	105.2	69.6	58.6	48.1	95.0	175.6	192.9	143.5	179.6	194.8	161.9	139.7
With Climate Change Scenario (2006-2035)												
Ave	123.8	81.9	59.1	48.5	95.8	183.1	207.8	154.5	193.4	209.8	174.4	164.4
With Climate Change Scenario (2036-2065)												
Ave	125.8	83.2	58.9	48.3	95.5	208.8	229.4	170.6	221.6	229.5	190.7	167.1

Source: Cebu PAGASA Synoptic Station, 1981-2010
Note: Calculated based on the PAGASA Climate Change in the Philippines, 2011

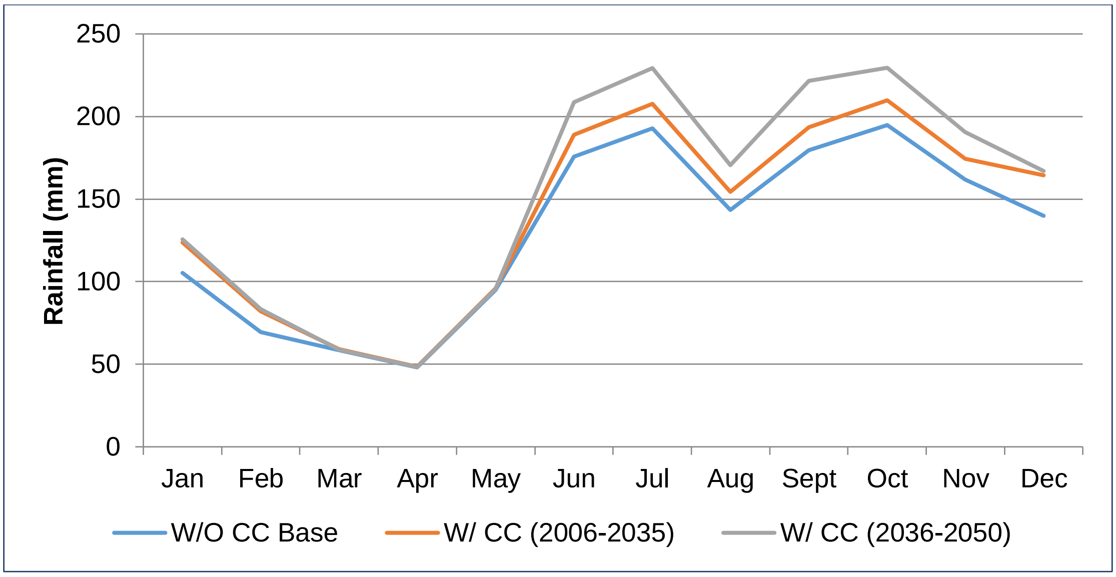


Figure 2.3.7: Graph of Computed Average Rainfall With and Without Climate Change Scenarios

Frequency of Extreme Events

Based from the Climate Change Scenario in the Philippines as published by PAGASA in February 2011, the Province of Cebu will have 1,488 days with maximum temperature of >35°C during the 2006-2035 period and 2,463 days during the 2036-2050 period; 5,720 dry days during the 2006-

2035 period and 5,693 dry days during the 2036-2050 period; and four (4) days with rainfall >100mm during the 2006-2035 period and 17 days during the 2036-2050 period, as presented in **Table 2.3.9**.

Table 2.3.9: Frequency of Extreme Events in 2020 and 2050 under Medium Range Emission Scenario

No. of Days w/ T_{max} >35ºC			No. of Days			No. of Days w/ Rainfall >100mm		
OBS (1971-2000)	2020	2050	OBS	2020	2050	OBS	2020	2050
25	1488	2463	7112	5720	5693	12	4	17

Source: Climate Change in the Philippines, 2011 PAGASA

2.3.1.8 Contribution in Terms of Greenhouse Gas Emissions (GHG)

One of the most important environmental changes now in progress is a build-up of atmospheric carbon dioxide (CO_2). Undoubtedly, the added CO_2 in the atmosphere is coming from the burning of fossil fuels, the cutting of forests, and the wastage of soil humus (the colloidal organic complex in the soil). The main outcome of the build-up is likely to be a climate change, notably toward greater warmth. The atmospheric CO_2 content is usually measured in terms of its concentration relative to all other gases in parts per million by volume (ppmv).

The GHG emissions from the project include carbon dioxide, methane and nitrous oxides. Calculation of these GHG emissions employ the Tier 1 Approach of the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines. This method calculates the GHG emissions from all sources of combustion and indirect off-site sources on the basis of the quantities of fuel consumed and average emission factors. The following equation was used:

$$CO_2 \text{ emissions} = FC \times NCV \times CEF \times FC \times K$$

Where: FC = Fuel Consumption, MT
NCV = Net Calorific Value, Tj/MT
CEF = Carbon Emission Factor, MT C/Tj
FC = Fraction Carbon Oxidized
K = *Molecular Weight Ratio of CO_2 to C, (44/12)*
A = Fuel Type

The CO_2 emissions of the project were released from the exhaust tailpipe of trucks, heavy equipment, and other vehicles plying in the quarry area. **Table 2.3.10** presents the amount of CO2 emitted from the exhaust tailpipe for each liter of fuel.

Table 2.3.10: Tailpipe Emissions/Liter of Fuel Consumed

Fuel Type	CO_2 Emissions, (kg/L)
Petrol	2.3
LPG	2.6
Diesel	2.7

Source: Department of Sustainability, Environment, Water and Population Communities, Australia

Assuming the project activities will deploy 50-units 30-tonner trucks, 10-units heavy equipment, 20-units service pick-up, and 10-units service vans. By using the data in **Table 2.3.10**, the estimated total CO_2 emission is 528,831.60MT/yr, as described in **Table 2.3.11**.

Table 2.3.11: Calculated CO2 Emissions

Emission Sources	No. of Units	Fuel Type	Fuel Consumption (L/km)	Assumed distance travelled (km/yr)	Emission Factor (kg/L)	Calculated CO_2 Emissions (MT/yr)
Heavy Equipment	10	Diesel	30	5,000	2.7	40.50
30-Ton Truck	50	Diesel	30	15,000	2.7	607.50
Pick-up	20	Diesel	20	12,000	2.7	129.60
Van	10	Diesel	20	10,000	2.7	54.00
Finish Mill						528,000
Total CO_2 Emission (MT/yr)						528,831.60

The estimated CO_2 emission based on IPCC 2006 and United States Environmental Protection Agency (USEPA) is 136,175.33 metric tons per year. The Philippines Initial National Communication on Climate Change has projected 122,344 Gg of CO_2 for 2008 for energy sector (**Table 2.3.12**). Using these projections of INC, the Project is expected to contribute approximately 0.43% of the total CO_2 emission. In the global level projection of CO_2 emission for 2020 under the USEPA Sectoral Trend in Global Energy Use and Greenhouse Gas Emissions, Climate Protection Division, Office of Air and Radiation, the estimated contribution of the Project is only 0.00585%. Therefore, the Project can still be considered as a low-end greenhouse gas emitter in the world.

Table 2.3.12: INC/SNC Data

Year	Gg CO2/yr	GHG %
Global Level[a]		
2000	6,118,000	0.00864
2010	7,936,000	0.00664
2020	9,042,000	0.00585
Energy Sector		
SNC		
2000	69,667	0.75908
2020	100,402	0.52671
INC		
INC Projected 2008	122,344	0.43225

Note: [a] – Sectoral Trend in Global Energy Use and Greenhouse Gas Emissions, Climate Protection Division, Office of Air and Radiation, US EPA, 2006
INC – Initial National Communication on Climate Change
SNC – Second National Communication on Climate Change

2.3.2 Air Quality and Noise Level

2.3.2.1 Ambient Air Quality

Because the only source document that was retrieved was an incomplete AI document, air quality portion of the said document is lacking. The only information provided on Air are mitigating measures as follows:

"2.3.2 Operation Phase

- *Bare areas must be planted with trees and vegetation not only to replace those that have been removed, but also to increase the surface cover with vegetation. Apart for enhancing the beauty of the surroundings, vegetation can also absorb dust and* *minimize noise. These trees can also lessen the impact of the urbanization effect on local air temperature.*

- *All roads leading to the cement plant (pier and power plant) must be paved. This will ensure the smooth flow of traffic and minimize dust emissions. Trucks that will transport raw materials from the quarry to the cement plant must be covered to prevent spills.*

- *To ensure minimum release of atmospheric pollutant from an area source such as the quarry roads, an effective traffic scheme must be properly enforced and implemented. Vehicles shall be allowed a maximum speed limit. Likewise, engines of hauling trucks and personnel vehicles shall be properly maintained and checked to avoid belching.*

- *Devices shall be installed in the cement and power plants that will minimize fugitive emission. Dust collectors shall be subjected to rigorous program of maintenance and inspection. Spare parts of the anti-pollution equipment such as the electrostatic precipitators, and bag filters shall be on hand at all times.*

- *Regular monitoring of sack emissions shall ensure that the emissions are within the acceptable limits. It is also recommended that the stack height of the power plant shall be 30 meters. If the power plant structure or adjacent building is taller than 30 meters, the height of the smoke stack should be increased so that the tip of the smoke stack will be at least 1.5 meters higher than adjacent buildings. This will ensure that the plume will not be trapped in building cavities. Engines of the power and cement plants should be maintained regularly to keep emission concentrations within the designed level. Sampling port should be provided for stack sampling. Old engines, which can no longer be kept in good condition should be replaced.*

- *All storage tanks and processing vessels shall be equipped with vapor seal valves that will be inspected regularly to avoid potential leaks. In particular, storage vessels shall be provided with floating heads to handle the intermittent expansion of the vapor formed in the tank*

- *Cement Plant*

  Baranggay Dunggo-an is located about 800 m SSW of the cement plant. Therefore, the critical wind direction of thebaranggay is NNE since the plume will be directed towards SSW. The predicted maximum concentration is 36.32 ug/Ncm at about 1 km SSW of the plant. if interpolated logarithmically, the predicted concentration at the Dunggo-an Elementary School (which is located at about 800m from the plant) is at 30 ug/Ncm. Adding the background concentration of 51.69 ug/Ncm, the total predicted TSp concentration in the school is about 81.69 ug/Ncm which is well within the DENR standard of 300 ug/Ncm. This is true on the assumption of continuous operation and maintenance of the air quality pollution control devices (electrostatic precipitators and bag filters) by the cement plant.

  For Dancar Village (located around 700 m NNW from the plant), the critical wind direction in SSE. TSP concentrations show a maximum concentration of 87.09 ug/Ncm located at 800 m from the plant. This contributes to about 60 ug/Ncm in the village. Since the background concentration in Dancar Village is 540.37 ug/Ncm, the total predicted concentration of TSP is at 600.47 ug/Ncm. This value exceeds the DENR standard of 300ug/Ncm. Even the background value alone is already exceeded the DENR standards. The present main source of TSP is the on-going road repairs (national road) very close to the village. These road repairs generate dusts, which re suspend during passages of vehicles. However, this source is very temporary in nature. When road repairs are finished, the expected background concentrations would not be very different from that of Dunggo-an station, which is only about 50 ug/Ncm. Furthermore, the existing cement plant at the project site was in operation and the plume was generally directed towards the village. It is expected that the new power *plant will have lesser emissions than the existing one. Therefore, further reduction in the total predicted TSP concentration is predicted.*

For the other barangays around the cement plant (Cagat and Daws Sur), the analyses of the results is done in a similar manner. The critical wind direction was determined and the contribution of the cement plant to the ambient TSP concentrations was estimated. The background concentration observed was then added to get the total predicted TSP concentrations. In these two barangays, the total predicted TSP concentration do not exceed the DENR standards.

*If the pollutant sources are considered are only of those from the cement plant, the predicted pollutant concentrations (for TSP, NO2, and SO2) are shown in figures 4.1~4.48 in the EIS. In concentration isoline varies from 20 to 100 ug/Ncm. when the wind direction is N (Fig 4.1) When the wind direction in N (**Fig 4.1**), the plume is directed towards the south (to Danao City) parallel to the shoreline. The maximum of 42.96µg/Ncm is located about 1 km south of the cement plant. The cement plant emissions contribute to ambient TSP concentrations in Danao City by an amount of about 2 µg/Ncm. If this is added to the background TSP concentrations, the sume will represent the total predicted TSP concentrations in the city. the other figures are interpreted are in the same manner*

For the other air quality parameters (SO_2 and NO_2), the background values are very small (about 10 µg/Ncm or less). The predicted maximum concentrations are also small (about 70 µg/Ncm of 80 µg/Ncm for SO_2 and about 70 µg/Ncm for NO_2) will not exceed the DENR standards for 340 µg/Ncm for SO_2 and 260 µg/Ncm for NO_2.

- *Cement Plant and Power Plant*

  *Considering that the combined cement and power plant sources of air pollutants as described in the EIS, the predicted pollutant concentrations are presented in **Figure 4.49 to 4.98** of the EIS. **Figure 4.49** shows the case when the wind direction is northerly. The figure shows that the plume is directed south towards Danao City where combined sources contribute ambient TSP concentrations by about 5 µg/Ncm.*

  *Following the same procedure as the case of the cement plant alone, the predicted TSP concentration in barangay Dunggo-an is abour 190 µg/Ncm for the critical wind direction of NNE (**Figure 4.50**). adding the background concentration of 51.96 µg/Ncm, the total predicted concentration in Dunggo-an is about 141.69 µg/Ncm. This is still within the DENR standard of 300 µg/Ncm.*

  The same procedure may be followed for the analyses of total predicted concentrations in other barangays and for other pollutants.

- *Emissions expected from coal combustion and coal additive*

  *The combustion of coal and coal additives will not result in the increase in the emission of SO_2 during cement production process. The kiln acts as natural desulfurizer as shown in this equation: **Sulfur dioxide + Calcium carbonate = Calcium sulfate**. $CaSO_4$ will be come part of the cement raw material.*

There is already an existing ambient air quality monitoring stations located in five (5) sampling stations within the project site and its vicinity. The selection of the sampling stations was based on the locations of receptors, source, and prevalent wind direction. Station identification and geographical location are presented in **Table 2.3.13**, while **Figure 2.3.8** shows the location of the stations.

The ambient TSP, PM_{10}, SO_2, and NO_2 concentrations were measured at the identified sampling points. Methods for sampling and analysis conformed to methods prescribed in Sec. 1(b) Rule VII

Part II of the Clean Air Act IRR. The resulting ambient air concentrations were compared with the National Ambient Air Quality Guidelines Values (NAAQGV), Rule VII, Part II and the National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations Section 1 Rule XXVI Part VII of the Clean Air Act IRR.

Table 2.3.13: Ambient Air Quality Monitoring Stations

Station	Station Description	Coordinates	
		Latitude	Longitude
STN-1	About 200 meters southeast from the gate of the plant	10°33'26.3"	124°1'22.6"
STN-2	About100 meters northeast from the gate of the plant	10°33'32.1"	124°1'20.8"
STN-3	About 150 meters from the north fence of the plant, beside Dancar Village	10°33'39.4"	124°1'12.0"
STN-4	About 150 meters northwest fence of the plant, Residential Area, Brgy. Dawis Sur	10°33'36.8"	124°1'8.10"
STN-5	About 300 meters southwest fence of the plant, Residential Area, Brgy. Dungo-an	10°33'19.9"	124°1'4.90"

Source: Mediatrix

Figure 2.3.8: Ambient Air Quality Sampling Stations

The monitoring results show that the concentrations of TSP, PM_{10}, NO_2, and SO_2 for 1-hour averaging period are all below the DENR standards of 300 µg/Ncm for TSP, 200 µg/Ncm for PM_{10}, 260 µg/Ncm for NO_2, and 340 µg/Ncm for SO_2, respectively, in all stations. The summary of the ambient air quality monitoring results is presented in **Table 2.3.14**.

Table 2.3.14: Ambient Air Quality Monitoring

AMBIENT AIR (TOTAL SUSPENDED PARTICLES), µg/NCM

STATION	2015		2016		2017		2018			2019
	July	Aug.	Oct	Dec.	July	Dec	June	Sept.	Dec.	Feb
Across MCCI	4.0	-	-	-	-	-	-	-	-	-
Sitio Dancar	-	45.0	43.0	N.D.	8	8	37	-	186	90
Near Dunggoan Brgy Hall	-	-	-	-	-	-	-	24	-	102

Remarks: N.D. – Not detected; Filter paper damaged upon receipt
Source: Ambient Air Quality Monitoring, RCBM

Construction Phase

There will be no construction activities that will be undertaken since the project is already existing.

Operation Phase

A dust particle is a potential environmental impact during quarry operation activities such as removal of the surface layers of the soil. Another possible source of dust will be coming from the moving vehicles, service vehicles and hauling equipment. The extraction of limestone would start from the existing topmost or upper section of the quarry that used to be the production benches and will progressed toward the lower parts until a well-defined quarry benching is achieved. If a section has to be developed, this is carried out through dozing and ripping method. The generated dust particles will increase the concentration of TSP and PM10 that will lead to health hazard for workers and surrounding resident at close proximity to the project site.

Minimum amount of sulfur dioxide, nitrogen dioxide, carbon dioxide and other gases pollutants are expected to generate from vehicular emissions. The operation of the cement finish mill will also result to dust but can be managed by utilizing the Air Pollution Control Device called the Pulse Jet Dust Collector System.

Emission Assessment through Air Dispersion Modeling

The EMB, MC 2008-03 "Guidelines for Air Dispersion Modeling" uses a tiered approach in assessing air contaminants concentrations against the Clean Air Act (CAA of 1999) air quality guidelines and standard. The tiered approach follows the United States Environmental Protection Agency (USEPA) that includes:

- Screening-level dispersion modeling techniques conducted using worst-case input data rather than site-specific data; and
- Refined level dispersion modeling techniques conducted using site specific meteorological data or derived regional meteorological data.

A fundamental assumption of the tiered approach to model selection is that the simpler modeling techniques always yielded more conservative results. It is assumed that screening level models would always predict higher ground-level concentrations than refined modelling techniques, and that the refined models would predict higher impacts than the 'best-estimate' models.

Tier 2 of MC 2008-03 using AUSPLUME Version 6.0 software was used to assess and determine the air quality impact due to the emissions of particulate matter, sulfur dioxide, nitrogen oxides, and carbon monoxide during the operation of the project. The default screening meteorological data (metsamp.met) were used. Also, the Benkly-Schulman method in mixing height were used with mean annual normal temperature.

The AUSPLUME model can also predict near field effects out to 4 km from the site. However, most of the significant effects of the emissions will occur within 1-2 km of the site. Simple terrain was utilized in this dispersion model within the receptor domain.

Plot Plan

The sources subject for this modeling are the area sources from the cement manufacturing operation. There are five (5) air sensitive receptors (ASR) identified within the domain. The coordinates of these receptors are listed in **Table 2.3.15**. **Figure 2.3.9** shows the relative location of ASRs.

Table 2.3.15: Description, Distance, Direction, and Coordinates of the ASRs

Modeling ID	Description	Distance from the source	Direction	Coordinates	
				Latitude	Longitude
ASR1	St. Anthony of Padua Parish, Brgy. Dungoan	313	SE	10°33'22.18"	124°1'22.12"
ASR2	Gainsay National High School, Brgy. Dungoan	794	S	10°33'4.47"	124°1'21.36"
ASR3	Residential Area, Brgy. Dungoan	412	SSW	10°33'15.84"	124°1'13.67"
ASR4	Residential Area, Brgy. Dawis Sur	1,334	WNW	10°33'38.57"	124°0'31.15"
ASR5	Dancar Chapel, Dancar Village, Bgry. Dancar Sur	330	NNW	10°33'39.82"	124°1'12.08"

Figure 2.3.9: Location of the Air Sensitive Receptors

Air Quality Monitoring Data

There are two (2) modeling scenarios considered in this study:

- Scenario 1 – Cement stack + cement area sources under normal operating condition; all control devices are working.
- Scenario 2 – Cement stack + cement area sources under upset operating condition; all control devices are not working.

These background concentrations including emissions from industrial emission sources (e.g., area and mobile sources, distant point sources, etc.) and non-industrial emission sources (e.g., vehicles, recreational watercraft, etc.) were not included in the model. Provided in **Annex 2-5** is the Selected Air Dispersion Modeling Input and Output Files.

Point Source Emission Load

Potential sources were assessed to generate dust during the operation of the finish mill manufacturing. These activities are raw mill, raw mill feed belt, raw mill separator, finish grinding mill, finish grinding air separator, etc. The finish mill will have a manufacturing capacity of 1,200,000 MT/yr with 150 MT per every hour of operation. The estimated production per day is 3,287.67 of finish mill. Table below presents the calculated dust concentration from finish mill operation.

The emission rates used in the modeling were calculated based on the CAA limit adjusted to stack condition. Equation used in calculating emission rate are from the USEPA Methods of Sampling 40 CFR Part 60 Appendix A. Below are the equation used:

Equation 1:

Qa = 60 x Vs x As

Where:

Qa = volumetric flow rate of wet flue gas, (m3/min)
Vs = flue gas velocity, (m/s)
As = area of stack, (m)

Equation 2:

Qs = 60 x Mfd x Vs x As (Tstd/Ts) x (Ps/Pstd)

Where:

Qs = volumetric flow rate of dry flue gas at standard condition, (scm/min)
Mfd = moisture content of flue gas, (%)
Vs = flue gas velocity, (m/sec)
As = area of stack, (m)
Tstd = standard temperature, (°C)
Ts = stack temperature, (°C)
Ps = stack gas pressure, (mm-Hg)
Pstd = standard pressure, (mm-Hg)

Equation 3:

Pmr = 0.00006 x Qs x Pconc

Where:

Pmr = pollutant mass rate, (kg/hr)
Qs = volumetric flow rate of flue gas, (m3/min)
Pconc = pollutant concentration, (mg/Ncm)

Assumptions used in the above equations were moisture content of flue gas at 8%; standard temperature of 298 K; and standard pressure of 760 mmHg. **Table 2.3.16** shows the summary of calculated emissions.

Table 2.3.16: Summary of Point Source Parameter

Parameter	Unit	Cement Dust Collector Stack	
		Normal	Upset
Operating hours	h/yr	6,700	
Flue gas volumetric flow rate	Nm^3/m	7200	
Flue gas velocity	m/s	16.98	
Flue gas exit temperature	°C	100	
Stack height above the ground	m	40	
Stack inside diameter	m	3	
Pollutant Emission Rate			
PM	g/s	18	35.82
SO_2	g/s	25.20	25.20
NO_2	g/s	60	60
CO	g/s	60	60

Area Sources Emission Load

Heavy equipment activities (e.g. trucks coming in and out of the area) are sources of dust emissions that may have substantial temporary impact on local air quality. The modeling input data are calculated based on the worst case condition. The assumption considered in truck volume is estimated based on the maximum truck flow expected in the area. Emission loads of each parameters are calculated based on the United States Environmental Protection Agency (USEPA) AP-42, 5th Edition. AP-42 is a compilation of air pollutant emission factors developed by the USEPA. Below is the general equation used in calculating emission rate of the modelled parameters which come from the USEPA AP 42 5th Edition:

$$E = A \times EF \times (1-(ER/100))$$

Where:
E = emissions
A = activity rate
EF = emission factor
ER = overall emission reduction efficiency

Table 2.3.17 presents the calculated dust concentration of dust from finish mill operation.

Table 2.3.17: Calculated Dust Emission Rate

Cement Raw Material Processing and Handling	Assumed tons of materials processed/hr	Assumed operating hours/day	Control device	Emission factor (lb/ton) AP-42	Percent efficiency of control	Controlled emission ($g/s/m^2$)	Uncontrolled emission ($g/s/m^2$)
Raw mill	150	21.92	Air separator with cyclone	0.012	99.9	0.000606	0.60601
Raw mill feed belt	150	21.92	None	0.0031	0	0.020873	0.2087
Raw mill air separator	150	21.92	Cyclones	0.032	99.9	0.000740	0.74045
Finish grinding mill	150	21.92	Dust collector	0.0094	99	0.006089	0.60894
Finish grinding mill feed bucket elevator	150	21.92	Dust collector	0.0024	99	0.084974	8.49744

Cement Raw Material Processing and Handling	Assumed tons of materials processed/hr	Assumed operating hours/day	Control device	Emission factor (lb/ton) AP-42	Percent efficiency of control	Controlled emission (g/s/m^2)	Uncontrolled emission (g/s/m^2)
Finish grinding mill weigh hopper	150	21.92	Dust collector	0.0094	99	0.002933	0.29334
Finish grinding air separator	150	21.92	Cyclones	0.028	99.9	0.001329	1.32912
Limestone crushing (primary/secondary)	150	21.92	Dust collector	0.001	99	0.003095	0.30958
Limestone transfer (primary/secondary)	150	21.92	Dust collector	0.000029	99	7.009E-06	0.00070

Modeling Result

Table 2.3.18 gives an overall summary of the predicted concentrations, i.e. maximum modeled concentrations. The predicted peak 1-hour and 24-hour emissions of TSP, SO_2, NO_2, and CO in are within the CAA limit. The highest GLC of all modeled parameters falls at 700 meters from the point source of emission. The highest GLCs predicted were for TSP followed by nitrogen dioxide from the proposed sources. Furthermore, the 1-hour and 24-hour GLCs predicted for SO_2, NO_2, and CO in Scenario 2 (upset condition) is within the CAA limit. However, TSP for 1-hour and 24-hour in Scenario 2 failed to meet the CAA limit. The upset conditions defined in Scenario 2 is considered as highly conservative because it assumed all the control equipment and measures failed at the same time; such probability of such occurrence is considered as remote.

Table 2.3.18: Summary of Predicted Maximum Concentration

Parameters	Scenario	Averaging Period	Predicted Maximum Concentration (µg/Ncm)	CAA limit (µg/Ncm)
TSP	1	1-hour	240	300
		24-hour	106	230
	2	1-hour	2450	300
		24-hour	1130	230
SO_2	1	1-hour	17.6	340
		24-hour	14.1	180
	2	1-hour	18.1	340
		24-hour	14.6	180
NO_2	1	1-hour	36.9	260
		24-hour	26.4	150
	2	1-hour	36.9	260
		24-hour	26.4	150
CO*	1	1-hour	0.039	35
		8-hour	0.0335	10
	2	1-hour	0.039	35
		8-hour	0.0335	10

*Note: *-mg/Ncm*

Generally, dispersion model results for controlled emissions of 1 hour and 24 hours averaging time for TSP, SO_2, NO_2, and CO are within the ambient air quality standards and guideline values under the Implementing Rules and Regulations (DAO 200-81)of the Philippine Clean Air Act (RA8749). Actual ambient air quality monitoring validation may result to higher concentrations due to contribution of several existing sources such as mobile, area, volume and line sources in the Cement Finish Mill Plant. **Figure 2.3.10** shows the plot of modeled parameters where the radius of highest concentration will occur.

Figure 2.3.10: Plot of Maximum Concentrations

Management and Mitigation Measures

The ambient air sampling shall be maintained at 300 µg/NCM near the residential area. To minimize the dust, RCBM commits to invest on water truck and do the watering of the quarry road and the haul road (up to the stockpile area of limestone) at least four (4) times a day during very dry days.

In the loading process, the distance of the bucket and the dump box shall be very minimal to avoid airborne or fugitive dust. In hauling limestone to the plant, it would be the policy of the company to minimize the speed to 20 kph in the plant and 15kph in the quarry.

The plant is equipped with pulse-jet fabric filters with high-efficiency separators. The cement dust collected by the fabric filter is restored to the system. In cold weather, a plume may develop at the baghouse vent.

2.3.2.2 Noise Quality

2.3.2.2.1 Ambient Noise Quality

Noise level measurement was conducted in five (5) sampling locations within the project site and its vicinity. The measured noise level from the established stations is used to represent the baseline data of the project. The noise monitoring station is the same as the ambient air station.

The noise level presented in Table 2.3.19 are the median of the noise measured at each station. Noise levels for all stations monitored were within the maximum allowable noise level during daytime period. The recorded noise sources include domestic noise, waves, videoke machine, vehicles sounds, wind, birds and crickets. The sound from birds, insects, animals and wind are common noise sources in the stations.

Table 2.3.19: Noise Measurement Monitoring

STATION	2018			2019	DENR Standards
	June	Sept.	Dec.	Feb	
Sitio Dancar	-	-	-	56	55
Near Dunggoan Brgy Hall	-	55	-	56	55
Inside Plant Compound (Near Drivers' Lounge)	70	-	63	-	55

Source: Noise Measurement, RCBM

2.3.2.2.2 Increase in Noise Level

The project is existing, therefore there will be no construction activities will be undertaken.

During operation phase, the sound power level during operation was assumed to be at steady state base load and bypass operations and will not consider following activities:

Commissioning phase;

- Failure conditions;
- Emergency conditions; and
- Other abnormal operating conditions.

The power mechanical equipment and its equivalent sound power levels are presented in **Table 2.3.20**. The equipment listed in the table is the typical equipment used during cement finish mill operation. As a worst case scenario for this modeling, it is assumed that all equipment listed is running at the same time during operation. The predicted noise measurement for operational activities were determined by summing logarithmically the sound power levels. Since there is no EMB published noise modeling guidelines and procedures, the computation used are based on international technical guidelines and procedures.

This assessment was carried out based upon the preliminary estimates of likely operational activities, plant selection and utilization. In the absence of reference, the noise data for individual items of equipment (in terms of source Sound Power Level (PWL) was taken from Hong Kong Environmental Protection Department's "Technical Memorandum on Noise from Construction Work other than Percussive Piling and Technical Memorandum of Noise from Percussive Piling."

The sound power levels derived/anticipated for each equipment item identified during the operation of the crushing plant were based on the given equipment noise data/sizes/dimensions extracted from an existing Project. However, it is advised that the detailed design should be updated to reflect equipment data whenever the design changes.

Table 2.3.20: Equivalent PWL of Power Mechanical Equipment for Operation Phase

Power Mechanical Equipment	PWL, dB(A)
Cement mill	105
Finish grinding mill	105
Rotary compressor	97
Bucket elevator	88

The total estimated sound power level for the operational equipment is 108.5 dB(A) from the data listed in **Table 2.3.22**.

The modeling guidelines used is the Technical Memorandum on Noise of Hongkong Environmental Protection Department, Noise Control Authority. Noise levels should be summed in a pairwise fashion and the final total rounded to the nearest whole dB(A), with values of 0.5 or more being rounded up.[1] **Table 2.3.21** shows the summation of noise levels. The summed noise assumed to be at the center of the project site.

Table 2.3.21: Summation of Noise Levels

Difference in dB(A) Between Two Noise Levels Being Summed	Amount in dB(A) to Add to the Higher Noise Level
0 to 0.5	3.0
1.0 to 1.5	2.5
2.0 to 3.0	2.0
3.5 to 4.5	1.5
5.0 to 7.0	1.0
7.5 to 12.0	0.5
More than 12.0	0

Source: Technical Memorandum on Noise, Hongkong Environmental Protection Department

[1] Technical Memorandum on Noise, Hongkong Environmental Protection Department, Noise Control Authority, January 1996

The total power level takes into account assumed maximum numbers of equipment and an assumed 'on-time' for the equipment, that is, period in percentage terms during which the equipment will be operating. The operational activities are predicted to be its worst case scenario where 24-hour operation is expected. Noise generated from blasting (if there's any) is not included in this modeling because blasting operation is on case to case basis only. CUSTIC software predict a continuous operation, if blasting is included, it simulated continuously for 24-hours.

Noise Prediction

Noise prediction for operational activities in the Project was derived using CUSTIC 2.0 modeling software. CUSTIC 2.0 is capable of executing predicted noise contours showing sound pressure as it moves away from the source.

Noise Sensitive Receivers (NSRs)

Noise sensitive receiver can be define as those locations or areas where dwelling units or other fixed, developed sites frequent human use occur (FHWA). The description and coordinates of the selected noise sensitive receptors is the same as the ambient air receptors listed in Table 2.3-17.

Modeling Input Data

The following input data were used to execute the noise simulation for the cement finish mill project:

- Internal source such as raw mill, grinding mill, roller mill, compressors or any other noise source placed inside of a building.
- Noise power (dB): This is the noise power at source position in decibels.
- Ambient Data: Ambient conditions are defined by the land and atmospheric conditions in the vicinity of the pollutant emission.
- Terrain – the data will use to draw topographical lines.
- Scale command – Use to set the scale in the X-axis width (in meters)

The Scale use for the model is 500 m x 500 m grid which is a scale view of CUSTIC 2.0. The following assumptions were made to execute the model: the model is that:

- Ambient Temperature - 25°C
- Relative Humidity – 90%
- Frequency – 500 Hz

Noise Modeling Results

The predicted noise levels in all sensitive receivers for the operation of the cement finish mill and quarry project as exhibited in **Table 2.3.22** which are all below the noise condition during daytime, morning/evening and night time. Therefore, the noise contribution from the operation of the Project is not expected to cause any significant noise impacts to the surrounding environment. The predicted noise contours for the operation is presented in **Figure 2.3.11**.

Table 2.3.22: Predicted Noise Level at Nearest Sensitive Receiver for Operation

Station No	Description/ Identification	Distance from the center of the Project, (m)	Predicted Noise Level (SPL), dB(A)	Allowable Noise Level, dB(A)		
				Daytime	Morning/ Evening	Nighttime
NSR-1	St. Anthony of Padua Parish, Brgy. Dungoan	313	43.53	55	50	45
NSR-2	Gainsay National High School, Brgy. Dungoan	794	31.99	55	50	45

Station No	Description/ Identification	Distance from the center of the Project, (m)	Predicted Noise Level (SPL), dB(A)	Allowable Noise Level, dB(A)		
				Daytime	Morning/ Evening	Nighttime
NSR-3	Residential Area Brgy. Dungoan	412	40.84	55	50	45
NSR-4	Residential Area, Brgy. Dawis Sur	1,334	22.71	55	50	45
NSR-5	Dancar Chapel, Dancar Village, Brgy. Dancar Sur	330	44.72	55	50	45

Note: The allowable noise standard used is from the Rules and Regulations of the National Pollution Control Commission (1978), Section 78, Table 1, Environmental Quality Standards for Noise in general areas

Figure 2.3.11: Operation Noise Contour

Management and Mitigation Measures

It is clearly important to limit the noise emission of all major noise sources on the mining area and at the cement finish mill operation for both environmental and occupational reasons. The specific noise limit to be placed on an individual item of equipment may be dictated by either the on-plant requirements or by the boundary noise limit, depending on the source size, location and elevation.

Providing the majority of the equipment complies with the relevant equipment noise specifications, noise levels on-plant should meet the 85 dBA limit and noise levels at all boundaries would then be expected to meet the DENR and DOLE requirements.

It is important therefore to ensure that appropriate noise limits are specified within the equipment tender documents and that guarantees are obtained for all major equipment. A detailed noise control study should be carried out as part of the detailed design of the mining area and cement finish mill to ensure that appropriate limits and noise control measures are incorporated.

Moreover, predicted noise levels are high within the radius of the mining area and cement finish mill which may bring negative impact to workers because of excessive noise. Therefore; it is recommended that personnel protection of workers should be provided and it is necessary to carry out the planned protective measures systematically. The stated measures include (i) controlling the noise level inside the mining area and cement finish mill and the surrounding inhabited areas; (ii) reducing the noise in individual plants and machines; (iii) applying acoustic protection by setting physical barriers or enclosures and applying personal protection instruments of the employees in the mine.

Protective panels, as physical barriers should be used as an additional measure for protecting the settlement from noise along with the envisaged green belt.

The effect of the panel is momentary reduction of noise emitted towards the settlement until the designed green belt has reached functional age. In terms of protection from emitted noise, the panels as movable structures follow the progression of mining activities.

Protective measures for reducing the negative impacts of noise on the working and living environment include the following:

- The mobile equipment and vehicles used in the quarry area and in the plant are provided with mufflers. These mufflers are regularly checked to ensure that they are in tip-top condition.
- If the noise level in the surrounding settlements exceeds legally allowed values, barriers should be set – sound protection panels for the reduction of noise between the open cast mine and the settlement;
- If it is practically possible and feasible, noise sources should be enclosed, which directly depends on the source nature;
- It is necessary to provide the equipment for protecting the hearing of the machines operators from the harmful consequences of excessive noise; and
- Planting a green belt around the open cast mine, especially in the part where the level of noise in the vicinity of an inhabited place is the highest.
- Defective equipment/parts with abnormal noise and/or vibration will be either repaired or replaced.

2.4 PEOPLE

2.4.1 Demography

2.4.1.1 Land Area and Population

Danao City is located in the northern part of Cebu facing the Camotes Islands. It lies in the eastern coast between the municipalities of Compostela and Carmen and bounded on the west by the municipalities of Balamban, Asturias, and Tuburan.

Danao City has a total of 42 barangays covering an area of 180.19 km^2 (18,019 ha). Barangay Dunggoan, the host barangay of the project, covers 2.55 km^2 or 1.42% of the city's total land area. The August 2015 Population Census conducted by the Philippine Statistics Authority (PSA) had recorded 136,471 persons in Danao City. The population of Danao City has increased by 2.89% from 119,252 in 2010 to 136,471 in 2015. On the other hand, the population of the host Barangay Dunggoan has increased by 3.75% from 5,313 in 2010 to 6,310 in 2015. **Table 2.4.1.1** presents the land area and population per barangay of Danao City.

On the otherhand, the Municipality of Carmen lies at the Northeastern coast of Cebu Province and is approximately 38.6 kms from Cebu City. It is bounded on the North by the Municipality of Catmon; on the South by the City of Danao; on the West by the Municipality of Tuburan; and on the East by Camotes Sea. **Table 2.4.1.2** presents the population per barangay of the municipality of Carmen.

Table 2.4.1.1: Land Area and Population per Barangay of Danao City, Cebu

No.	Barangay	Land Area (km^2)	Classification	Population				Annual Growth Rate (%)
				2010		2015		
				Number	Density	Number	Density	
1	Baliang	6.62	Urban	1,728	261	1,843	278	1.33
2	Bayabas	6.36	Rural	609	96	714	112	3.45
3	Binaliw	4.75	Rural	2,341	493	2,635	555	2.51
4	Cabungahan	3.04	Rural	2,201	724	2,317	762	1.05
5	Cagat-Lamac	2.02	Rural	1,023	506	1,253	620	4.50
6	Cahumayan	7.71	Rural	3,506	455	4,162	540	3.74
7	Cambanay	3.26	Rural	2,818	864	3,526	1,082	5.02
8	Cambubho	5.42	Rural	594	110	940	173	11.65
9	Cogon-Cruz	2.78	Rural	3,034	1,091	4,188	1,506	7.61
10	Danasan	6.27	Rural	1,266	202	1,350	215	1.33
11	Dungga	2.63	Urban	1,017	387	1,273	484	5.03
12	Dunggoan	2.55	Urban	5,313	2,084	6,310	2,475	3.75
13	Guinacot	3.40	Rural	4,089	1,203	4,853	1,427	3.74
14	Guinsay	4.72	Rural	7,887	1,671	9,152	1,939	3.21
15	Ibo	1.73	Urban	964	557	1,171	677	4.29
16	Langosig	11.19	Urban	750	67	1,020	91	7.20
17	Lawaan	6.84	Rural	1,352	198	1,679	245	4.84
18	Licos	4.43	Rural	1,581	357	1,852	418	3.43
19	Looc	0.89	Urban	9,200	10,337	9,543	10,722	0.75
10	Magtagobtob	4.82	Rural	382	79	453	94	3.72
21	Malapoc	0.98	Rural	974	994	1,256	1,282	5.79
22	Manlayag	2.83	Urban	1,578	558	1,638	579	0.76
23	Mantija	5.34	Rural	1,233	231	1,447	271	3.47
24	Masaba	6.68	Rural	2,743	411	3,090	463	2.53
25	Maslog	3.37	Rural	9,892	2,935	9,929	2,946	0.07
26	Nangka	2.62	Rural	446	170	413	158	-1.48
27	Oguis	5.67	Urban	600	106	634	112	1.13
28	Pili	7.02	Rural	677	96	777	111	2.95

No.	Barangay	Land Area (km^2)	Classification	Population				Annual Growth Rate (%)
				2010		2015		
				Number	Density	Number	Density	
29	Poblacion	0.81	Urban	8,710	10,753	9,090	11,222	0.87
30	Quisol	1.72	Rural	1,255	730	1,461	849	3.28
31	Sabang	2.77	Rural	9,945	3,590	12,431	4,488	5.00
32	Sacsac	10.70	Rural	514	48	618	58	4.05
33	Sandayong Norte	1.95	Rural	1,454	746	1,490	764	0.50
34	Sandayong Sur	6.26	Urban	2,808	449	3,069	490	1.86
35	Santa Rosa	2.58	Urban	1,151	446	1,559	604	7.09
36	Santican	9.25	Urban	1,014	110	1,218	132	4.02
37	Sibacan	6.12	Rural	519	85	635	104	4.47
38	Suba	0.49	Urban	6,785	13,847	7,523	15,353	2.18
39	Taboc	1.29	Rural	4,880	3,783	5,482	4,250	2.47
40	Taytay	0.41	Urban	3,618	8,824	3,914	9,546	1.64
41	Togonon	7.06	Urban	1,394	197	1,619	229	3.23
42	Tuburan Sur	2.84	Urban	5,407	1904	6,944	2,445	5.69
	Total	**180.19**		**119,252**	**72,753**	**136,471**	**80,872**	**2.89**

Source: Danao City Comprehensive Land Use Plan (CLUP) 2017 – 2027; 2010 and 2015 Census and Housing Population, Philippine Statistics Authority

Table 2.4.1: Population per Barangay of the Municipality of Carmen, Cebu

Barangay	Population
Baring	4,854
Cantipay	1,805
Cantumog	1,895
Cantukong	1,445
Caurasan	1,109
Corte	2,567
Dawis Norte	4,155
Dawis Sur	2,001
Cogon East	3,292
Hagnaya	2,019
Ipil	2,061
Lanipga	1,021
Liboron	603
Lower Natimao-an	1,241
Luyang	5,869
Poblacion	4,845
Puente	2,374
Sac-on	817
Triumfo	1,867
Upper Natimao-an	2,604
Cogon West	2,881
Total	**51,325**

2.4.1.2 Gender and Age Profile

In terms of gender, there are slightly more females than males, with 50.05% females and 49.95% males (**Table 2.4.2**). In terms of age, at least 64 out of 100 individuals are 15-64 years old and 36 are dependents, with 32 young dependents and 4 old/elderly dependents. For Carmen, Cebu (**Table 2.4.3**),

Table 2.4.2: Total Population by Age Group and Sex of Danao City

Five-Year Age Group	Population				
	Total	Male		Female	
		Number	%	Number	%
Under 1	2,903	1,551	53.43	1,352	46.57
1 - 4	12,129	6,317	52.08	5,812	47.92
5 - 9	14,930	7,723	51.73	7,207	48.27
10 - 14	13,890	7,051	50.76	6,839	49.24
15 - 19	13,672	6,630	48.49	7,042	51.51
20 - 24	14,293	6,775	47.40	7,518	52.60
25 - 29	11,323	5,629	49.71	5,694	50.29
30 - 34	9,819	5,040	51.33	4,779	48.67
35 - 39	8,933	4,480	50.15	4,453	49.85
40 - 44	7,723	3,934	50.94	3,789	49.06
45 - 49	6,739	3,481	51.65	3,258	48.35
50 - 54	5,624	2,852	50.71	2,772	49.29
55 - 59	4,728	2,373	50.19	2,355	49.81
60 - 64	3,745	1,820	48.60	1,925	51.40
65 - 69	2,429	1,101	45.33	1,328	54.67
70 - 74	1,555	660	42.44	895	57.56
75 - 79	1,125	433	38.49	692	61.51
80 years and over	911	323	35.46	588	64.54
Total	136,471	68,173	49.95	68,298	50.05

Source: 2015 Census of Population and Housing, Philippine Statistics Authority

Table 2.4.3: Total Population by Age Group and Sex of Carmen, Cebu

	POPULATION		
	Both Sexes	Male	Female
All Ages	44,524	22,435	22,089
Under 1	1,011	529	482
1 - 4	4,150	2,157	1,993
5 - 9	4,939	2,547	2,392
10 - 14	4,861	2,500	2,361
15 - 19	4,609	2,322	2,287
20 - 24	4,029	1,992	2,037
25 - 29	3,732	1,917	1,815
30 - 34	3,151	1,584	1,567
35 - 39	2,791	1,366	1,425
40 - 44	2,558	1,320	1,238
45 - 49	2,234	1,175	1,059
50 - 54	1,870	923	947
55 - 59	1,566	762	804
60 - 64	1,067	506	561
65 - 69	666	322	344
70 - 74	557	232	325
75 - 79	393	149	244
80 years old and over	340	132	208
0 - 17	17,797	9,160	8,637
18 years old and over	26,727	13,275	13,452

2.4.1.3 Literacy Rate and Education Attainment

Basic or simple literacy is the ability of a person to read and write with understanding a simple message in any language or dialect. In 2015, 98.67% of the total household population 10-year old and over of Danao City are basically literate (**Table 2.4.3**). Basically, the proportion of literate females is slightly higher (50.88%) than their male counterparts (49.12%).

Table 2.4.3: Literacy of the Household Population 10 Years Old and Over of Danao City, 2015

Particular	Male		Female		Both Sexes	
	No.	%	No.	%	No.	%
Population 10 years old over	52,161	49.20	53,864	50.80	106,025	100.00
Literate	51,384	49.12	53,231	50.88	104,615	98.67
Illiterate	777	55.11	633	44.89	1,410	1.33

Source: 2015 Census of Population and Housing, Philippine Statistics Authority

In terms of educational attainment, the population five (5) years old and over of Danao City (121,4339) consist largely of high school educated population at 46,401 persons or 38.21% of the total population, followed by elementary educated population at 45,098 or 37.14% of the total population (**Table 2.4.4**). Those who have reached, but did not complete college comprised 11,842 persons or 9.75% of the total population, while 9,739 or 8.02% of the total population have finished college and hold academic degree. Post Baccalaureates are about 0.05% or 65 persons.

Table 2.4.4: Education Attainment of Population 5 Years Old and Over of Danao City, 2015

Highest Grade/Year Completed	Total Population 5 Years Old and Over	
	No.	%
No Grade Completed	3,557	2.93
Pre-School	3,365	2.77
Special Education	32	0.03
Elementary	45,098	37.14
Highschool	46,401	38.21
Post-Secondary	1,327	1.09
College Undergraduate	11,842	9.75
Academic Degree Holder	9,739	8.02
Post Baccalaureate	65	0.05
Not Stated	13	0.01
Total	121,439	100.00

Source: 2015 Census of Population and Housing, Philippine Statistics Authority

2.4.2 Migration Profile

Based from the CLUP, residency in Danao City is quite stable from 2005-2010. About 98.51% of the total household population have been residing in the city at least since 2005. Only 1.49% of the total household population are non-resident of the city. About 1,054 individuals came from other cities and municipalities of Cebu, 463 from other provinces and 47 from foreign lands.

Table 2.4.5: Household Population Residency of Danao City in the Last Five Years, 2010

Place of Residence Five Years Ago	Household Population	
	No.	%
Same City	103,275	98.51
Other City/Municipality but Same Province	1,054	1.01
Other Province	463	0.44
Foreign Country	47	0.04
Unknown	1	0.00
Total	104,840	100.00

Source: Danao City Comprehensive Land Use Plan (CLUP) 2017 – 2027

2.4.3 Indigenous People

Based from the CLUP, Danao City has no ancestral domains considering that no indigenous people are seen to reside in the City's hinterlands.

2.4.4 Historical and Cultural Heritage

Danao City is known for its rich heritage features in the form of cultural, historical, natural, festival event and intangible asset attractions. Being an old settlement settled by the Spaniards in 1565, Danao City has its cultural and historical attractions such as the STVP Church and Convent in the Poblacion. The old Tapon Bridge and the Old Spanish Bridge in Bgy. Looc and the Old Milling Stone Footing in Quarry Looc, and the Church of St. Joseph in Bgy. Lawa-an. The large STVP Church and Convent which was built in 1755 is one of the oldest in the country and was constructed using cut coral stones. Its architecture reflects the Romanesque style with a central rose window. Faux columns and arched openings. It is a symbol of the Augustinian Order whose priests were the first to develop the city together with the Spanish administrator. The Church of Saint Joseph in Bgy. Lawa-an is the second oldest church in the city and is unique in being located in Bgy. Lawa-an at the western end of the city at a cool elevation of 2042 ft. that has a commanding view of the mountains of the city. The old bridges are quaint products of early Spanish engineering which used stone blocks from local quarries and the strong Roman arch building principle to support heavy users.

There are also notable natural heritage features in the city such as Mt. Manghilao/Cave/ Sleeping Giant), the highest peak in the city with a cross ADOP the peak (Bgy. Masaba); Garden of Gethsemane along the church yard of St. Anthony de Padua Church (Guinsay); Waterfalls (Bayabas); Fish Sanctuary (Guinsay); Hidden Waterfalls (Dunga); Cave (Baliang); Mountain Cliff (Sacsac); Water Spring (Sibakan); Marine Sanctuary (Sabang); Socorro Beach (Sabang); Quarry Beach (Looc); Mangrove Forest (Guinsay); Colo Spring (Dunggo-an); DPO Landmark (Looc); Old Milling Stone Footing (Quarry Looc); and Old Well (Catabay) (Maslog).

2.4.5 Existing Social Infrastructure and Services

2.4.5.1 Power Supply

The power requirement of Danao City is being supplied by Cebu Electric Cooperative (CEBECO) II. All of the 42 barangays of Danao City have access to electric power lines. However, not all of the households in the barangays have electrical connections. Out of the 22,957 households in 2014, 20,784 or 91% were served with electricity. In the host Barangay Dunggoan, all households have electrical connections.

2.4.5.2 Water Supply

Almost all of the urban barangays enjoyed the connection of piped water system which serves about 80.35% of the households. The piped water system is operated and maintained by the Danao City Waterworks Division under the City Administrator Department. For barangays not served by the water district, the City Government of Danao provided jetmatic pumps and deep well pumps for their use.

In 2013, the number of households served by piped water system is 9,069 households. However, 9,148 households have shared faucets in a communal sharing scheme, thus the total number of households with access to clean and potable water is 18,217. The total unserved households is 4,456 households. Of the unserved households, 3,091 households get their water supply from improvised spring, artesian wells, deepwells, streams, and from rainwater collection.

2.4.5.3 Education

Danao City has a total of fifty-eight (58) elementary schools, fourteen (14) schools are privately-owned and forty-four (44) are government-owned. The City has thirty-one (31) schools for secondary education. Twenty-two (22) of these schools are government-owned and nine (9) schools are privately-owned. For tertiary education, Danao City has one government-owned and five (5) private tertiary schools.

2.4.5.4 Communication

Danao City has different cell sites; the Globe cell sites, Smart cell sites, and Sun Cellular cell sites. For landline telephone connections, the city has Globelines of Innove Communications Inc. and PLDT. Danao City has telegraphic facilities based in Poblacion. These are Western Union branches, and the telegram/telegraphic facility of the Philpost, which runs the Bureau of Telecommunications. It is also serving as relay stations for telegrams, telex and telegraphic messages intended for distant places.

Radio broadcast or programs are heard in the City of Danao through a number of radio stations like DYAB, DYSS, DYHP, Bombo Radio and MOR. Newspapers reaching the City are national papers such as the Philippine Daily Inquirer, Manila Bulletin, The Philippine Star and others that are flown in from Manila to Cebu City at dawn and transported to Danao City by their distributors.

2.4.5.5 Peace and Order

Danao City has 64 police personnel at the headquarters and 6 detailed at Sabang Police Outpost. The police force in Danao City is headed by its Police Chief Inspector, who acts as the Chief of Police, and assisted by the Deputy Chief of Police or the Police Inspector. Given this number of police personnel, Danao falls short in complying with the standard police-to-population ratio of 1:1,000. To complement the police force, the Barangay Police Force, or “Barangay Tanod”, is established in every barangay. For fire protection, Danao City has 29 firemen, which falls short with the standard ratio of 1 fireman to 2,000 population.

The police force including the fire protection and jail management has a total of 9 vehicles, 6 fire trucks and an ambulance. The city also has 23 serviceable fire hydrants strategically located and installed to respond to fire incidence.

2.4.5.6 Waste Management

Danao City generates about 45 tons of solid waste daily or a volume of 112 to 150 cubic meters per day. Sources of solid waste are households/residential buildings, commercial establishments and industrial establishments. Roughly half (1/2) of the solid waste generation comes from residential or domestic sources. Disposal of waste is located at Brgy. Taboc, which is around 3 kilometers from the City Center.

At present time, there is no septage treatment facility in Danao City. Sewage finds its way to the rivers/creeks from all sources with little or no treatment at all. While it is true that most of the households have their septic tanks, the owner calls only for the septic services to dislodge night soil whenever the septic tank are overflowing with sludge, or when the sludge at the septic system hinders the flow resulting in backflow.

2.4.5.7 Drainage and Sewerage System

The city’s existing drainage system has several outlets, mostly into the riverbanks and into the sea. There is a street drainage system on one side or in both sides of Poblacion, Looc, Tuburan Sur, Taboc and Suba areas. Some barangays have a drainage system that conforms to their road network and are connected to the creeks or rivers. However, some interior barangays do not have existing drainage system.

Danao City has no existing public sewerage system, though it has a storm water drainage system which is planned informally or on a “need-arise” basis. The drainage system conveys both stormwater and waste flow and/or effluents from houses and septic tanks. In most cases, the storm drains are not properly designed and sometimes cannot accommodate the volume of stormwater.

2.4.6 Public Health and Safety Profile

2.4.6.1 Public Health Services

The basic health services in Danao City are provided through its City Health Office (CHO) which provides preventive and curative health care. The health office has 2 doctors, 23 nurses, 20 midwives, 3 sanitary inspectors, 2 dentists, 1 nutritionist, 1 medical technologist and 1 laboratory technician. To extend its services, Danao City established 33 barangay health stations. In addition, 93 Barangay Health Workers (BHW) were trained to assist the city health team in promoting health care at the barangay level. These health services include: maternal and child care, immunization, treatment of simple medical condition, nutrition, family planning, sanitary health care, health education and others. However, out of the 33 barangay health centers, only 20 are operational, 4 are non-operational, and 9 currently need repair.

Danao city has two (2) hospitals, a privately-owned and a government-run facility. The privately-owned, Mother and Child Hospital, is a 22-bed capacity hospital; with 3 doctors, 10 nurses and 1 midwife. Meanwhile, Cebu Provincial Hospital-Danao currently has 9 doctors, 10 nurses and 5 midwives. Moreover, there are about 17 licensed birthing homes or lying-in clinics in Danao City that can provide the basic health services for expectant mothers or pregnant women. Four (4) of these clinics are privately-owned and 13 are government-run facilities.

2.4.6.2 Morbidity and Mortality

From 2010 to 2014, the leading causes of morbidity within the past five years are respiratory related diseases; specifically, respiratory tract infections, pneumonia and bronchitis. In addition, the leading causes of mortality within the past five years are related to heart diseases and heart failure.

2.4.6.3 Environmental, Health and Sanitation Profile

Based on the 2010 NSO data, only about half or 52% of the households in Danao City have water-sealed toilets with septic tanks that are exclusive for their household use while 10% have the same toilet facility but in shared arrangement with other households. About 8% have water-sealed toilets but without septic tanks. The other 8% have open or close pit toilets while about 2% uses other means. Meanwhile, the remaining 20% do not have toilets at all. These households, particularly those in the far flung barangays and the informal settlements along the coastline, possibly practice open defecation.

Domestic wastes from households in Danao City are being disposed in various ways. Less than half or 43% of the households are being served by the LGU for their garbage disposal. Majority of the unserved barangays are located in the highlands which poses logistical problems in the garbage collection.

2.4.7 Socio Economic Profile

2.4.7.1 Local Economy

Danao City is classified as third class in terms of income. The major sources of income of Danao come from the manufacturing, agriculture and cottage industries. Per available financial records, the local government of Danao City has relatively increased its annual budget from CY 2011 as shown in **Table 2.4.6**.

Table 2.4.6: General Annual Funds Budgets of Danao City

Year	Budget (PhP)	+/- per year (%)
2011	255,403,075.66	
2012	427,278,969.16	+40.22%
2013	340,953,896.69	-25.32%

Source: Danao City Website

The commercial establishments registered at the Office of the Mayor showed that retail trade dominates the local players in the economy. These comprise the sari-sari stores, general merchandising, fresh fish and aquamarine products trading, dried fish retailing, vegetable and meat products vending, water refilling stations, soft drinks distribution, restaurant/carenderia, fast food chains and food stand handling. The biggest manufacturing establishment in Danao is the Cebu Mitsumi, a Japanese electronics firm located in Barangay Sabang. Other industries include coal mining, fishing, and pottery. In addition, there is a sugar mill and a cement factory located here. **Table 2.4.7** presents the list of existing industrial establishment in Danao City.

Table 2.4.7: Existing Industrial Establishment in Danao City, 2015

Name	Location
Heavy Industry	
RCBM (Cement Manufacturer)	Barangay Dunggoan
Petronas Energy Philis. Inc. (LPG Bottling and Import)	Barangay Dunggoan
Market Global Cebu Industries Inc. (Manufacturing)	Barangay Sabang
Cebu Mitsumi Inc. (Manufacturing)	Barangay Sabang
Cebu Yushin Inc. (Manufacturing)	Barangay Sabang
Medium Industry	
MCCI Corporation (Non-Metallic Processing Plant)	Barangay Dunggoan
Cebu Danao Paper, Inc. (Manufacturing of Paper)	Barangay Dunggoan
Light Industry	
Cebu Northern Port Realty Corp. (Paper Mill)	Barangay Dunggoan
RD Durano III & Company Inc. (Sugar Mill)	Barangay Dunggoan
Cebu Ace Group Co. Inc. (Processing/Warehousing)	Barangay Dunggoan
Asian Global Bio-Metal Inc. (Recycling)	Barangay Sabang
Gemina's Furniture (Furniture Manufacturing)	Barangay Sabang

Source: Danao City Comprehensive Land Use Plan (CLUP) 2017 – 2027

Tourism in Danao City is presently in the developing stage. Danao City boasts it landmarks and tourist attractions which are the following:

- Sto. Tomas de Villanueva Parish Church and Convent. A Spanish vintage church and convent established in 1671 by Augustinian Friars and reconstructed in 1981.
- Children's Paradise. It is situated in Barangay Poblacion and is being maintained by the city government.
- City Plaza Rizal. An elevated plaza located at Poblacion.
- Replica of Mt. Calvary**.** It is situated at the hill of Barangay Tuburan Sur. At the base of the hill is the Grotto of the Blessed Virgin of Lourdes.
- Garden of Gethsemane**.** It is situated at Barangay Guinsay along its churchyard of St. Anthony de Padua Parish Church and
- Mt. Manghilao**.** The highest mountain peak of Danao City where the wooden cross stands at the peak.

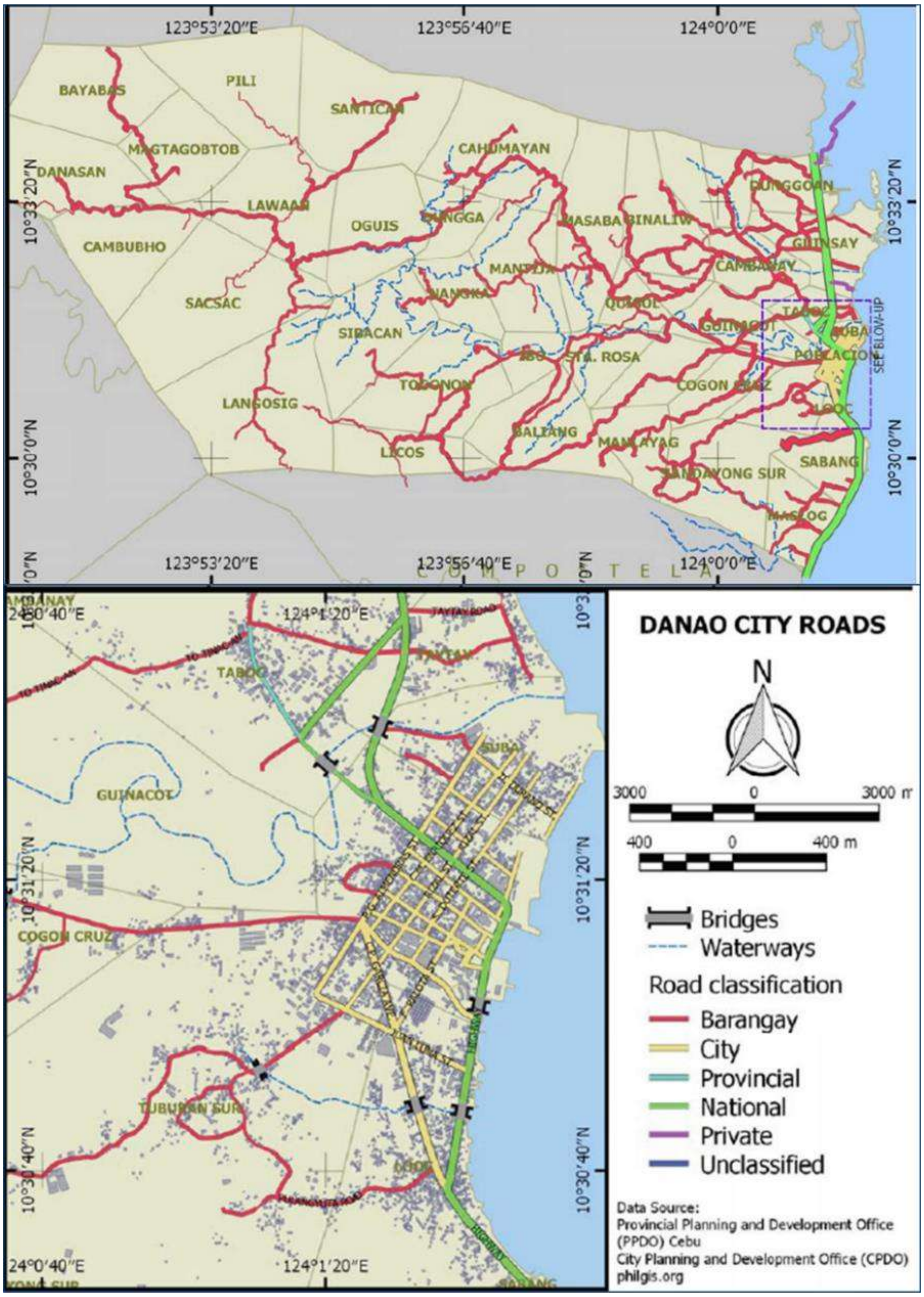
2.4.7.2 Labor Force Population

Out of the 86,599 labor force of Danao City in 2015, 57,313 or 66.18% are gainfully employed/working in various types of occupation. Majority (59.71%) of the gainful workers are males. Majority of the workers are engaged in plant/machine operation and assembly, while others are engaged in farming, forestry, fishing and trades.

2.4.8 Public Access

2.4.8.1 Road Network

There are four (4) types of roads in Danao namely: National, Provincial, City and Barangay roads (**Figure 2.4.1**). The National roads are made of either cement or asphalt concrete, its carriageway have an average width of 20 meters. It has a total length of 12.145 kilometers starting from barangay Maslog to barangay Dunggoan. These national road is generally of asphalt surfacing. City roads are concentrated on the Poblacion area. These are either cement concrete or asphalt concrete. Its total length is about 14.818 kilometers 12.53 are concrete roads, while 2.28 km are asphalt surfacing.



Source: Danao City Comprehensive Land Use Plan (CLUP) 2017 – 2027

Figure 2.4.1: Road Network Map of Danao City

Danao City is traversed by one (1) big river with several brooks and creeks. Nationally-funded bridges constructed by DPWH are found in Barangays Maslog, two (2) in Looc, Taytay, Taboc and two (2) in Guinsay. These bridges are made of concrete and are permanent in nature. On the other hand, the city has constructed hanging bridges, spillways and box culverts in different barangays of Guinacot, Cogon Cruz, Togonon, and other barangays. These structures are intended for crossing minor waterways. It should be noted further that these structures often become points where waterways overflow during rainfall events.

2.4.8.2 Transportation

The means of transportation in going to the barangays and suburbs is through motorcycles for hire (habal-habal), tricycles and jeepneys on irregular daily trips. Goods are transported to Danao Public Market and to other accessible commercial districts by means of public utility tricycles, minibuses, jeepneys, trisikads and habal-habal. Tricycle and jeepney terminals and parking facilities are located in Rizal, Pio del Pilar, E. Olivar and Duterte Streets.

2.4.8.3 Traffic Situation

The Cebu-Hagnaya North Road or National Highway is the mainland entry/exit route towards Danao City from Cebu, while there are two (2) sea entries from Camotes and Leyte located in Poblacion and Dungguan respectively. Traffic loads are moderate to heavy due to the presence of a large number of tricycles, trisikads and habal-habals, which are the main modes of transportation within the city and over short distances and in going to the inner or mountain barangays. It should be noted that the limited interconnectedness of the interior roads in Danao is the reason for the presence of tricycles, which are relatively slow-moving, along the highway.

Although there has been no official traffic count conducted, it could be surmised that even during peak hours the national highway and adjoining roads are still able to handle the traffic volume. However, there were events that his highway and some adjacent roads cannot handle the traffic volume. One of these notable events is the annual fiesta celebration of the city and of some coastal barangays.

For RCBM's existing operations, traffic was never an issue in RCBM Danao Plant. Improvement of the implementation of traffic management is a continuing effort at the Plant.

- For traffic within Plant premises:
  - RCBM ensures that the speed limit is set to a maximum of 20 kph while 15kph is the maximum for the quarry area
  - At the quarry area, passage of heavy equipment vehicles is the priority.
  - For the cement haulers and big trucks, the Plant guard assists them to their designated parking or waiting area to avoid road congestion within the Plant premises
  - Informative traffic signages are all visible. If additional traffic signages are needed, RCBM will provide and install.

- For traffic outside Plant premises:
  - Truck haulers are following speed limit in transporting raw materials
  - Truck haulers are strictly required to cover with tarpaulin the material being transported to avoid material spill over and dust generation
  - Safety orientation of truck hauler is mandatory. Otherwise, the hauler will not be authorized to enter RCBM Danao Plant premises
  - Parking outside the plant vicinity is not allowed

2.4.9 Perception Survey

The perception survey was conducted in May 2014 in Barangays Dunggoan, Binaliw and Sandayong Norte of Danao City. Additional perception survey was conducted on February 5-12, 2020 for the other affected barangays. Presented in **Table 2.4.8** is the actual surveyed population.

The Sample/Population Size were determined using the calculator Raosoft in http://www.raosoft.com/samplesize.html.

Table 2.4.8: Actual Surveyed Population

Barangay	Population	Sample Size	Level of Confidence	Margin of Error
DANAO				
Dunggoan	6,310	363	95%	5%
Binaliw	2,635	336		
Sandayong Norte	1,490	306 (+ 167)		
Cagat	1,253	295		
Cambanay	3.526	347		
CARMEN				
Dawis Sur	2,001	323	95%	5%
Triumfo	1,867	319		
Hagnaya	2,019	323		

The Sample/Population Size is the population of the area where random sample will be taken from. The 5% margin of error is the amount of error that can be tolerated. If 90% of respondents answered yes, while 10% answer no, a larger amount of error can be tolerated than if the respondent's answers were split 50-50 or 45-55. Lower margin of error requires a larger sample size. On the other hand, the 95% confidence level is the amount of uncertainty that can be tolerated. Suppose there is a 20 yes-no questions in the survey, with a confidence level of 95%, it can be expected that in one of the questions (1 in 20), the percentage of people who will answer yes would be more than the margin of error away from the true answer. Higher confidence level requires a larger sample size.

The survey covers the demographic characteristics, source of income, health profile, and the knowledge and attitude towards the project. The copy of the perception survey questionnaire and detailed results are presented in **Annex ES-3, item 2**.

Questions in the survey covered the following:

- Gender
- Age
- Civil status
- Religious affiliation
- Educational attainment
- Occupation
- Place of work
- Number of years earning income
- Monthly income
- Length of stay in the area
- Intention to out-migrate
- Material component of the dwelling unit
- House ownership
- Home utilities
- Causes of morbidity and mortality
- Health services
- Health facilities
- Type of Toilet
- Source of Drinking Water
- Garbage Disposal
- Current Environmental Conditions
- Awareness on the Proposed Project
- Impacts of Proposed Project: Positive and Negative
- Perception and attitude towards the Project

2.4.9.1 Respondents' Profile

The sample size was 1,032 household respondents which were extrapolated from the 2015 NSO population data of the barangays.

It should be noted that the absence of the baseline data used in the earlier phase of the Project could not lead to a discussion on the comparison of the socioeconomic conditions of the residents in the impact barangays during the original and proposed redesigned phases of the "Finish Mill and

Quarry Project" of RCBM. The profiling will only discuss the present baseline condition of the residents in the host Barangays.

2.4.9.2 Perception Survey Results

Table 2.4.9 shows that only 16% of the respondents were aware of the proposed project of RCBM through various means. About 31% of the respondents were made aware of the proposed project by the Barangay Officials. Majority (36%) of the respondents were in favor of the proposed project.

Table 2.4.9: Awareness and Acceptance of the Respondents to the Project

Particulars	Dunggoan	Binaliw	Sandayong Norte	Total	%
Awareness on the Project					
Yes	125	36	9	170	16%
No	267	229	0	496	48%
I don't Know	0	0	1	1	0%
No Answer	142	66	157	375	35%
Total	**534**	**331**	**167**	**1032**	**100%**
Source of Information					
Neighbors	171	72	54	297	29%
Barangay Officials	133	145	45	323	31%
Others	17	14	14	45	0.04%
No Answer	213	100	54	367	35%
Total	**534**	**331**	**167**	**1032**	**100%**
Acceptance of the Proposed Project					
Yes	146	166	57	369	36%
No	167	27	46	245	24%
I don't Know	149	64	35	248	24%
No Answer	72	69	29	170	16%
Total	**534**	**331**	**167**	**632**	**100%**

Source: Socioeconomic and Perception Survey, May 2014 and February 2020

Table 2.4.10 shows that 48% of the respondents were anticipating that the proposed project will provided employment. Other (21%) respondents considered that the proposed project will bring economic development to the affected barangays/city.

Table 2.4.10: Perceived Positive Effects of the Project

	Dunggoan	Binaliw	Sandayong Norte	Total	%
Employment	238	192	64	494	48%
Payment of Taxes and Permits to LGU	20	1	61	82	8%
Road Improvement	9	12	20	41	4%
Better Development and Projects Service of the LGU	32	1	22	55	5%
Economic Development for the Barangay/City	164	49	0	213	21%
Others, specify	71	6	0	77	7.5%
No Answer	0	70	0	70	6.8%
Total	**534**	**331**	**167**	**1032**	**100%**

Source: Socioeconomic and Perception Survey, May 2014

Annex ES-3, item 2 shows the details of the perception survey conducted.

2.4.10 Displacement of Settlers

No displacement of households and business establishment is expected during operation of the project.

2.4.11 In-Migration

In-migration of people coming from nearby barangays, cities, municipalities and provinces is expected because of the job or employment opportunities that the proposed expansion may offer.

Hiring policy to prioritize the hiring of local residents. However, those who will not qualify be provided with the appropriate skills training so they may improve their chances of employment by either the Company or other companies and industries. On the other hand, the skills they earned can also help the residents look for other equally good job opportunities other than the cement plant.

2.4.12 Cultural/Lifestyle Change

The people of Danao known as ***Danaowanons*** celebrate the **Karansa Festival** through dancing. They commemorate the festival as a thanksgiving for their accomplished work and bountiful blessings they received from the town's patron saint, **Sr. Sto. Thomas de Villanueva**. "**Karansa**" is a local term which means to rejoice and have fun.

There are no tribal communities or ancestral domains within the project site and the project-impact areas. Therefore no mitigation is required.

2.4.13 Impacts on Physical/Cultural Resources

Since the project involves quarry, possible unearthing of artifacts and archeological remains is inevitable. In the event that an archaeological asset is discovered during quarry operation, the following procedure will be implemented:

1. RCBM must preserve not disturb the potential archaeological sites/finds and report it immediately to the National Museum.
2. Closely coordinate with the National Museum on the appropriate course of action in protecting the archaeological finds.
3. Cease immediately all activities in the vicinity of the find/feature/site;
4. Hire an archaeologist, recognized by the National Museum, to ensure the following are carried out:

    - Delineate the discovered find/feature/site;
    - Record the coordinates of the find location, and all remains are to be left in place;
    - Secure the area to prevent any damage or loss of removable objects;
    - Assess, record and photograph the find/feature/site;
    - Undertake the inspection process in accordance with all project health and safety protocols under direction of the Health and Safety Officer;
    - Conduct all investigation of archaeological soils by hand;
    - Keep all finds, osteological remains and samples and submit to the National Museum as required;
    - In the event that any artefacts need to be conserved, secure approval from the National Museum;
    - Provide an on-site office and finds storage area to allow storage of any artefacts or other archaeological material recovered during the monitoring process;
    - In the case of human remains, in addition to the above, contact the National Museum and adhere to the guidelines for the treatment of human remains; and

- If skeletal remains are identified, tap an osteo-archaeological to examine the remains.

5. Implement the following process for conservation:

    - Hire a conservator, if required;
    - The consulting archaeologist completes a report on the findings and submits to the National Museum; and
    - National Museum reviews the report and informs when works can resume.

2.4.14 Threats to Delivery of Basic Services/Increase in Demand for Resources

Process water is used for cooling specific equipment such as mill bearings and air compressors.

Although cement plants generate generally the same final products using similar processes, plant layouts vary according to fuels and raw materials used, location, climate, site topography, and the manufacturer of the equipment.

Following are the Public Facilities available:
- Durano-Macapagal Fish Port: Situated along the National Highway in Poblacion where the commercial fishing operators operate a fish landing in this fish port daily. The smell of freshly-grilled fish will invite to stop and savor the delicious taste of "SUTUKIL" – sugba, tula, kinilaw, broiled fish, fish tinola, and fish salad by the sea.
- Danao City Terminal Cum Public Market: It has a unique architectural design with an area of 10,056 square meters situated in Poblacion.
- Danao Pier: Roro ships travel from Danao City to Camotes Island with 3 trips daily.

2.4.15 Threats to Public Health and Safety

There will essentially be no air pollutant discharges during this phase; power supply will be sourced from local independent power generators and distributed by CEBECO, hence no air emissions as would be the case if diesel engine generating units will be instead used.

Constant watering may also be observed by the RCBM to avoid the possible spread of dust particles that may cause respiratory diseases and irritation.

The cement manufacturing process in this project involves finish milling only. Particulate matter is emitted from mill vents, air separator vents, and material-handling system vents. The plant is equipped with pulse-jet fabric filters with high-efficiency separators. The cement dust collected by the fabric filter is restored to the system. In cold weather, a plume may develop at the baghouse vent; this may be mistaken for particulate matter, but actually is condensed water vapor from the cooling system.

In the shipping department particulate matter is emitted from the silos and the handling and loading operations. Active and passive fabric filters are used to collect this dust. In the same manner, all sections in this department are fitted with pulse-jet dust collectors to ensure dust-free operation.

2.4.16 Generation of Local Benefits

The primary positive impacts of the project as pointed out in the survey are the generation of employment and livelihood opportunities. Residents are expecting that their families and other relatives will be able to work in the Project. Other residents expressed their hopes that some kind of business may be derived from the finish mill operations. Failure of the proponent to adequately address the high expectations of the residents regarding employment and livelihood may have repercussions in its relations with the communities.

Priority shall be given to qualified residents especially from the impact barangays for employment during the operation of the project.

Hiring policy of the LGU will still be observed giving priority to the local residents. RCBM will continue to coordinate with the barangay LGUs to effectively implement the hiring policy.

RCBM will continue to implement the SDMP that will benefit the impact barangays to address the concerns on employment and livelihood, health and sanitation, education, electrification and environmental protection. The existing SDMP of RCBM includes the following:

- Tree planting and mangrove planting activities through Mangrove Rehabilitation and Reforestation Project
- Community support, such as Day Care programs, provision of concrete materials, medical mission, livelihood programs, and educational support.
- Continuing Information, Education and Communications Program via broadcast airing of radio program “Kalambuan sa Mina” to promote the revitalization of the minerals industry with Certificate of Appreciation from MGB VII
- Implementation of Solid Waste Management
- Maintenance of EGF Allotment

Payment for the national and local taxes, permits and licenses that will be due at the operational phase of the project. The barangays, city, municipality, province and region will directly benefit from the project through these additional financial resources mentioned.

The presence of the Finish Mill and Quarry Operations Project of the RCBM will contribute to the revenues of the local governments in the form of payments of property taxes, permits and licenses particularly during the operation of the said cement plant.

RCBM shall promptly pay the local taxes, permits and licenses to assist the city/barangays in meeting its financial obligations as well as improve its delivery of basic social and other development services.

2.4.17 Traffic Congestion

Speed limit inside the plant is 15 kph and 20 kph in the quarry. Safety orientation and Contractors Safety Training are required to contractor employees particularly the drivers to brief them of the traffic rules and regulation of the plant. Speed limit is strictly observed during hauling of raw materials and other commodities and implement safety polices and guidelines of the plant.

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 shall serve as the environmental monitoring and implementing guidelines for the project. This is a more generic plan because prior to project implementation, an Environmental Protection and Enhancement Program (EPEP) and Final Mine Decommissioning and/or Rehabilitation Plan (FMDRP) will be formulated and submitted to the MGB.

With the identification of the key project activities at each phase and key impact thereof (Chapter 2) and the delineation of the important baseline conditions (Chapter 3), this Section summarizes the significant impacts and corresponding management plan/mitigating measures.

Table 3.1.1 presents the EMP for the Cement Finish Mill Plant and Quarry Operation Project of RCBM which is similar for the current operation and proposed expansion while Table 3.1.2 is the summary of environmental management plan.

Table 3.1.2: Summary of Environmental Management Plan

Activity	Impact	Mitigating Measure	Efficiency of measures
Vegetation clearing	Reduction of vegetation, fauna disturbance and/or displacement	Limit site preparation within an area required by MGB to be open at one given time and keep to a minimum vegetation removal ensuring that only necessary/planned clearings are undertaken	100% replacement of removed vegetation with same species
		Replace with the same species of seedlings, tree and other plant species that are removed during site preparation and development	
	Potential siltation of nearby bodies of water due to surface water run-off	Provision of temporary bunds around the stockpiles of overburden wastes and drainage systems to convey the storm run-off to siltation ponds. Zero discharge of silt ponds.	100% conveyance of run-off water to siltation ponds
	Generation of dust from site/access road preparation	Sprinkling of water at least once a day along the access road and project area	100% no generation of dust/compliance of TSP level
Quarry Operation			
Extraction and hauling of materials (Silica)	Siltation to streams due to erosion of exposed soil and Overburden materials	Progressive rehabilitation and revegetation of mined out quarries and planting barren lots, with at least 200 endemic trees per year to prevent soil erosion.	100% No generation of silt
Crushing (sizing and sorting)		Utilize the recovered topsoil for re-soiling or as soil cover on waste dumps and other disturbed areas for rehabilitation and revegetation. All stockpiles shall be maintained and managed below the angle of repose of 45%	No. sediments to streams and 100% compliance with RA9275
Materials (Silica) Transport		Continue to implement sediment and erosion control plan	
		Proper drainage design at the bench toes and access roads, to control the flow of run –off water, and divert it to series of 3 stage siltation ponds	
		Rainwater and runoff collecting systems from crusher flatform shall be provided with primary and secondary silt traps	

	Generation domestic wastewater that may contaminate the soil and receiving body of water	● Provision of portalets (Note: at least one (1) portalet for 10 workers) with appropriate septic tanks for the workers. Wastes shall be collected by 3rd party hauler with valid permits/clearances	100% collection of wastewater
	Generation of solid wastes	● Proper management of domestic solid i.e. provision of Material Recovery Facility for proper waste management (segregation, collection, minimization, reuse, recycle, treatment and disposal	100% compliance to RA9003
	Generation of hazardous wastes from waste oil/ grease and spills from the heavy equipment and vehicles	● Provision of 2,000 liter storage capacity provided with bund wall ● Regular (2x a year) hauling of hazardous waste by DENR accredited transporter and treater	100% no oil spills and compliance to RA6969
	Generation of fugitive dust during the quarrying activities	● Regular water spraying of exposed dusty areas during high winds, and dry months. ● Establishment 20-meter wide buffer zone of different species combination of plants including shrubs, small and medium sized trees should be established around the quarry sites, to contain dust	100% no dust be seen in the area
	Generation of noise from the quarrying activities	Implement regular preventive maintenance to all vehicles/equipment and install mufflers	100% compliance to noise standards
	Fugitive particulate pollution	• Water spraying of transportation of tires of trucks before leaving the site • Utilize at least 1 water truck in water spraying unpaved haul roads for the whole 8 hours operation per day depending on weather condition • Strictly implement 30 kilometers per hour vehicle speed limits • Trucks loaded with ores will be covered to prevent fugitive dust	100% No dust be seen during transport of materials

Cement Mill operations	Contamination and improper management of hazardous waste materials, e.g. transformer oil spill	• Provision of Hazardous Waste area with proper labeling, segregation and storage of wastes
		• Management of transformer oil to prevent spills thru the following:
		  • Storage rooms have concrete containment.
		  • The transformer room/ area are designed to prevent accidental spills that may contaminate soil in the area.
		  • The storage room has containment, i.e. the Hazmat Storage Facility.
		• Transport, treatment and disposal of DENR accredited third party contractors
		• Provision of secondary containment for oil drums & diesel fuel tanks
		• Provision of oil skimmer for mechanical clean up in case of accidental spillage
			100% Compliance to disposal of toxic and hazardous waste

		• Proper labelling of oil drums & diesel tanks	
	Possible increase in ambient concentration of PM10, CO2, CO, Sox and NOx	• Regular maintenance of equipment • Use of enclosures for equipment • Quarterly monitoring of the ambient air to ensure the project's operation is compliant with the Clean Air Act	100% Compliance to the standards of the Clean Air Act
	Degradation of air quality due to fugitive dusts from equipment and vehicles	• Strict implementation of speed limits in vehicles • Proper maintenance of equipment • Designation of no idling zone • Strict implementation of routine plant maintenance and good house keeping • Regular wet suppression or water spraying during dry weather condition of the access road • Regular maintenance of trucks to reduce or maintain tailpipe emissions	100% Compliance to the standards of the Clean Air Act
	Indoor Dust Pollution	Provision of Control Ducting Facility to minimize fugitive dusts outside the building of cement mill operation	100% Compliance to the standards of the Clean Air Act
	Generation of Air Pollution from all sources	Regular annual stack test monitoring	100% Compliance to the standards of the Clean Air Act
	Noise from equipment and vehicles	• Maintain appropriate measures and buffer zones along the entire periphery of the industrial complex with appropriate species/dense vegetation cover to enhance the condition of the ecosystem and to serve as noise, vibration and dust buffers; • Enclosure of facility • Defective equipment/parts with abnormal noise and/or vibration will be either repaired replaced; • All employees working on site will be provided with proper PPE especially ear protectors • The Contractor shall at all times comply with all current statutory environmental legislation especially on noise.	100% Compliance to DENR Noise Standards
	Health and safety hazards	• Strict implementation of Health and Safety Policies at the Plant • Regular conduct of employee safety inspections and toolbox meetings • Regular APE and strict implementation on the use of PPEs • Regular conduct of First Aid Training • Provision of Fire Fighting System	100% Compliance to health and safety rules
	Traffic due to increase in number of trucks	Allocation of open yards and spaces for stationing of the trucks and provide ample parking spaces • Adequate signages and proper scheduled hours for the truck and vehicles coming in and out • Assign traffic personnel to manage the traffic	100% Compliance to traffic rules and non-contribution to worst traffic situation

Table 3.1.2: Environmental 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 Entry	Cost	Guarantee / Financial Arrangements
III- OPERATION PHASE						
Quarrying operation	A. The Land	Loss of vegetation Disturbance of wildlife resulting in displacement	Open and unused areas within the project site will be replanted as soon as practicable Development of a carbon sink program and provision of a nursery for the program Revegetation using native or indigenous species Retaining existing vegetation not affected by quarry operation Briefing of field personnel for proper and efficient environmental awareness and education Proper segregation and disposal of wastes Observance of specific regulations towards prohibition of hunting and poaching (or support of these activities) of any present wildlife Proper maintenance of vehicles and heavy equipment including fitting with appropriate mufflers or silencers to decrease noise levels	Proponent	Part of AEPEP	EPEP
		Generation of sewage and solid wastes	Placement of regulations on proper waste disposal Provide proper waste disposal facilities and toilet facilities Proper segregation of waste and implementation of 3Rs (reduce, reuse, recycling)	Proponent		
		Fugitive dust resulting from ground clearing operations and structure erection.	Regular spraying of water where earthwork activities are concentrated Replacement of vegetation in non-structure areas. Compacting of exposed soil and immediate hauling of spoils Provision of cover on trucks loaded with quarry materials Impose speed restrictions for trucks	Proponent		
Cement milling and Packing operation	Blasting, loading, hauling, crushing, screening of ores	Vibration, airblasts, flyrocks	Hiring of competent and well trained personnel Implement controlled blasting and personnel evacuation within safety zones during blasting Designation of buffer zones Regular safety training of workers Proper use of PPEs	Proponent		

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 Entry	Cost	Guarantee / Financial Arrangements
	B. The Water	Domestic waste discharges	• Use of Portable toilets • Establishment of drainage system • Establishment of siltation ponds	Proponent	Part of contract	Agreement with contractor
Cement milling and Packing operation	C. Air	Fugitive Dusts	• Use of dust collectors • Replacement of filter bags • Enhancement of dust collectors • Road water sprinkling • Tree nursery and tree planting	Proponent	Part of Operation Cost	
		SOx and NOx emissions from heavy equipment	Regular maintenance of heavy equipment and motor vehicles	Proponent		
		Increase in sound levels during operations	Regular maintenance of motor vehicle Use of mufflers Provision of barriers and shielding stationary vibrating equipment Provision of ear mufflers to workers Proper scheduling of noisy activities during day time Inform community when activities will generate excessive noise Use of PPEs	Proponent		
Cement milling and Packing operation	D. People	Enhancement	Socio economic benefits	Proponent		
IV- ABANDONMENT PHASE	More detailed plan will be provided in the FMRDP.					
	A. Land	Scraps Debris from demolished structures	Good housekeeping Use as filling materials for construction works	Proponent	N.A.	N.A.
		Removal of wastes and oil spills, Removal of all equipment, rehabilitation	Change in landform and use Loss of jobs and community programs			
	C. Air	Dusts from demolished structures	Sprinkling of water	Proponent		
		Noise from structures being demolished	No population center at construction sites	Proponent		
		Grading, drainage and slope stabilization works including levelling of sediment trap and settling ponds Soil Conditioning and planning of endemic species or reforestation				
	D. People	Social	• Payment of legal social benefits Retrenchment package Labor support programs	Proponent	Part of Social Plan	

4. ENVIRONMENT RISK ASSESSMENT AND EMERGENCY RESPONSE POLICY AND GUIDELINES

RCBM has highest regard to the environment and safety, which is its number one policy. RCBM commits to serve its consumers' and stakeholders' social and economic needs by providing livelihood projects, technical trainings, and career opportunities to deserving local residents of Cebu. DAO 2003-30's RPM defined Environmental Risk Assessment (ERA) as a process of analyzing and describing the risks associated with a project activity to ecosystems, human health and welfare. On top of this, RCBM is implementing its own Hazard Identification and Risk Assessment.

Annex 2-7e of the RPM provides for the guidelines on the degree of ERA requirements and preparation as provided below:

- Level 1: Preparation of an Emergency/Contingency Plan
- Level 2: Preparation of an Emergency/Contingency Plan and ERA Report

4.1 SCOPE AND COVERAGE

As required in the technical scoping agreement, the ERA details for this section will only be limited to the information provided in the succeeding section. This information will also provide the basis for further quantitative risk assessment in case will be required in the post EIA stage/process.

a) Presentation of the different type of safety associated risk relative to the project's operation;
b) Presentation of the different type of physical risk associated to the project's operation; and
c) Risk or Hazards Management measures or the general emergency procedures during the worst case scenario.

4.2 TYPE OF RISKS

4.2.1 Safety Risks

4.2.1.1 Fire

Probable major fires may not occur at the Plant. As an emergency measure, firefighting facilities, principally fire water lines, fire extinguishers and water hose stations and hoses will be installed at the Plant premises. Alarms will also be installed.

4.2.1.2 Explosion

The elements for explosion which are the extraordinary/release of energy accompanied by rapid increase in volume of explosive materials are not present in this Project.

The possible accident scenarios and the affected population are related to the operation of the major plant equipment and auxiliaries which are not present in this Project.

The instrumentation system of the plant is provided with control, measurements, recording and response mechanism to prevent equipment failures that may result in accidents. Pressure relief valves are installed in sensitive points to cause release of gases away from personnel. Unit or equipment shutdowns are automatically built in the instrumentation system.

4.2.1.3 Movement of Personnel to High Structures

Plant operators and maintenance personnel may necessarily climb to high structures as routine part of their functions. Thus, the potential for falling off from these structures exist. Appropriate PPEs are required for work at heights to prevent falls from heights.

4.2.1.4 Movement of Vehicles

Delivery trucks for materials will necessarily enter the plant premises. Only accredited vehicles and drivers and those which have undergone the RCBM safety orientation process may be allowed to enter the plant, Road signages will be posted conspicuously at strategic places.

4.2.1.5 Release of Toxic Substances

There are no toxic substances associated with the Project. Even if such is the case, RCBM will implement health hazard control programs on different levels as follows:

- Engineering controls:
    1. Design of bag filter system to minimize dust generation;
    2. Regular road watering during dry days to prevent fugitive dust; and

- Administrative controls:
    1. workplace and community level monitoring for noise, dust and smoke emissions;
    2. information, education and training strategies for workers
    3. dialogue, information and education of community members on health hazards of concern;
    4. provision of adequate housing and sanitary facilities for workers;
    5. personal hygiene facilities for workers; and
    6. immunization and/or medical prophylaxis for areas where endemic diseases are present.

- Personal protective equipment (PPE):
    1. dust mask and other respiratory protection or workers;
    2. ear protectors (either muffs or plugs) for workers; and
    3. hard hats and other safety PPE for workers.

- Proper storage of hazardous waste

Storage is the holding of waste for a temporary period of time prior to the waste being treated, disposed, or stored elsewhere. Hazardous waste is commonly stored prior to treatment or disposal, and must be stored in containers, tanks, containment buildings, drip pads, waste piles, or surface impoundments that comply with DENR regulations.

Busted lamps and bulbs and used automotive batteries are among the hazardous wastes that may be generated. These may be stored in containers or any portable device in which a hazardous waste is stored, transported, treated, disposed, or otherwise handled.

- Disaster management prevention and minimization:
    1. there must be a provision for a medical clinic at the plant site;
    2. first aid and emergency plan for plant accidents which needs trained people and detailed steps to include transport facilities and communication with the referral hospitals;
    3. disaster plan in case of excessive emissions of pollution, and

4.2.1.6 Toxic Metals in Air

Under the Philippine Clean Air Act, the emission limits for stationary sources (new facilities) for mercury and lead are: 5 mg/NcM and 10 mg/NcM respectively.

Under the Toxic and Hazardous Wastes Law (R.A. 6969) following are the limits for metallic elements:

Elements	Maximum Concentration
Mercury & mercury compound. Also include organ mercury compounds	Includes all wastes with a total Hg concentration > 0.2 mg/l
Lead compounds	Includes all wastes with a total Pb concentration > 5 mg/l

For this Project, no heavy metals will be generated because the project is grinding/finish mill only.

4.2.1.7 Complete inventory of hazardous wastes, including its Physical and Chemical Properties

Stock Inventory/Waste Chemical Generated:

Average Quantity of Waste Chemical Generated per month	0.5 liters	Total Quantity of Waste Chemical Generated per Quarter	2 liters
Quantity of Stock Inventory (Start of Quarter)	188 liters	Quantity of Stock Inventory (End of Quarter)	190 liters

Manner of handling hazardous wastes	✓ storage on-site ☐ storage off-site	☐ Treatment on-site ☐ Treatment off-site
Changes in Safety Management System	☐ Yes (please attach copy of revised plan) ✓ No	
Chemical Substitute Plan	☐ Yes (please attach copy if not submitted/included in previous report/s or had been revised) ✓ No	

Inventory of Hazardous Wastes

HW No.	HW Class	HW Nature	HW Cataloguing	Remaining HW from Previous Report		HW Generated	
				Quantity	Unit	Quantity	Unit
I101	Used oil	Lq	T,F	30.05	tons	0	tons
I104	Oil-contaminated materials	So	T, F	387	Pcs	10	Pcs
	Oil sludge	sludge	T, F	800	liters	0	liter
M506	Waste Electrical and Electronic Equipment (WEEE)	So	T	73	Pcs	5	Pcs
D407	Mercury & Mercury Compound	So	T	187	Pcs	10	Pcs
J201	Containers previously containing toxic chemical substances	So	T, F	212	Pcs	0	Pcs
G704	Non-halogenated organic solvents	Lq	T, F	206	Li	2	Li
M501	Pathological waste	So	T	6	kg	0	kg
M502	Asbestos	So	T	10	Ton	0	ton
L404	PCB	Lq	T	52	Tons	0	tons

Waste Storage, Treatment and Disposal

HW Details	HW No.: I101 HW Class: Used Oil Qty of HW Treated: 0 Unit: tons TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in plastic and metal drums

HW Details	HW No.: I104 HW Class: Oil-contaminated materials Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in steel drums

HW Details	HW No.: I104 HW Class: Oil sludge Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in steel drums

HW Details	HW No.: M506 HW Class: Waste Electrical & Electronic Equipment (WEEE) Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in steel drums

HW Details	HW No.: D407 HW Class: Mercury & Mercury Compound. Qty of HW Treated: 0 Unit: TSD Location:
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in steel drums

HW Details	HW No.: J201 HW Class: Containers previously containing toxic chemical substances Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in inside a bunded wall storage

HW Details	HW No.: G704 HW Class: Non-halogenated organic solvents Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in plastic drums

HW Details	HW No.: M501 HW Class: Pathological waste Qty of HW Treated: 0 Unit: TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Temporarily stored in plastic container

HW Details	HW No,: L404 HW Class: PCB Qty of HW Treated: 25.1628 Unit: tons TSD Location: Globecare TSD Facility, Plaridel, Bulacan

Storage	Name: Globecare Services, Inc. Method: Storage.
Transporter	ID: TP NCR-39 00009 Name: One Stop Logistics Solutions, Inc Date: December 6, 2018 and August 22, 2019
Treater	ID: TR-R3-14-00085 Name: Globecare Services, Inc. (c/o TREDI Plant) Method: Final disposal was decontamination and incineration with gas treatment Date: 09/12/2019

Disposal	ID: TR-R3-14-00085 Name: Globecare Services, Inc. (c/o TREDI Plant) Method: Final disposal was decontamination and incineration with gas treatment Date: 09/12/2019

HW Details	HW No,: M502 HW Class: Asbestos . Qty of HW Treated: N/A Unit: N/A TSD Location: N/A
Storage	Name: Republic Cement & Building Materials, Inc. Method: Packed and sealed.

On-Site Self Inspection of Storage Area

Date Conducted	Premises/Area Inspected	Findings & Observations	Corrective Action Taken (if any)
2019/12/2	Asbestos Storage area	Packed and sealed according to standard	N/A

4.2.2 Physical Risks

4.2.2.1 Breakdown of Pollution Control Facilities

In an event of Bag Filter failure, the cement operation will be shutdown and address the issue immediately thus preventing uncontrolled emission of particulate matters (PM) to the atmosphere.

4.2.2.2 Bag Filter System Diagram

To address the concerns of Bag Filter failures, the Project will adapt the following standards in the design, installation and operations/maintenance to prevent total failure. This design and operation and maintenance philosophy will make total Bag Filter failure improbable.

The bag filter system is installed to address the problem of cement dust emission that comes from operating equipment and silos wherein the cement is stored and extracted. The system comprises of bag filter fan, the discharging equipment which normally a screw conveyor or a rotary airlock, the bag filter casing which the filter media are enclosed, and the ducting (inlet and outlet).

Operation and Maintenance

The design will enable troubleshooting of common cause of field failure while the equipment and other fields are online. The Operation and Maintenance Philosophy will be based on USEPA “Manual for Operation and Maintenance” and “Inspection Procedures for Evaluation of the Control System Performance.”

4.2.2.3 Breakdown or Failure of Equipment and Facilities

Temperature Extremes as Precursor to Accidents

At worst case scenario extreme temperature rise is predicted at 2.4°C for a short term period of June/July/August in 2050. At the peak ambient temperature at this time of 29.3°C the effect on operations and maintenance personnel is unlikely.

Indirect adverse effects even if unlikely have to be factored in the design of equipment and safety system, noting that process design take into consideration ambient conditions, e.g., temperature. Failure of systems (e.g. instrumentation) may in theory trigger accidents.

Rainfall Extremes as Precursor to Accidents

Aberrations in predicted rainfalls are seen from the above table, certain months exhibit decrease in rainfalls while in other periods increase is predicted. These predicted increases are however, not expected to trigger accidents in the operation of the plant. Potential effects of heavy rainfalls is flooding. The plant however will be designed for appropriate drainage system.

4.3 HAZARD ANALYSIS

Natural Hazards

"Hazard is a potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. It can include latent conditions that may represent future threats and can have origins, natural (geological, hydrometeorological and "Natural Hazards" are the natural processes or phenomena occurring in the biosphere that may constitute a damaging event. It can be classified by origin: geological, hydrometeorological or biological.

Earthquake

Earthquake is the perceptible trembling to violent shaking of ground caused by either tectonic movements or volcanic activity. The Philippines is located near or along the so called "earthquake belt" and is prone to seismic hazards. Areas that are susceptible to this seismic hazard are those underlain by unconsolidated soils and sediments deposited on the low-lying areas.

The area investigated is prone to ground shaking hazards due to the presence of several earthquake generators in and near the region. These possible seismogenic structures include the active West Valley Fault, Lubang Island/Verde Passage Fault, Philippine Fault and the Manila Trench (Punongbayan, 1989).

4.4 SOCIAL

In terms of social aspect, following are the concerns during abandonment phase:

- Loss of jobs thru loss of income
- Loss of taxes paid to the government
- Loss of independent economy dependent on the project
- Loss of projects by contractors

On top of all of these measures, RCBM has formulated its Emergency Response and Disaster Preparedness Plan (DPP) and some life-saving rules as provided **Annex 4-1**.

5. SOCIAL DEVELOPMENT PLAN/FRAMEWORK AND IEC FRAMEWORK

5.1 SOCIAL DEVELOPMENT PLAN

RCBM will supply cement to the increased infrastructure projects in Visayas.

RCBM will be undertaking SDPs in consonance with its Corporate Social Responsibility (CSR) mission, which includes but not limited to:

- Skills training to prepare the community for employment opportunities during the operation phase of the project
- Sustainable livelihood training programs
- Environmental/Climate Mitigation Actions: Reforestation and Carbon Sink Programme

The SDP Framework of the EIS System was even improved by RCBM based on the Social Development and Management Program required under the Mining Law.

RCBM will continue to implement the SDMP that will benefit the impact barangays to address the concerns on employment and livelihood, health and sanitation, education, electrification and environmental protection. The existing SDMP of RCBM includes the following:

- Tree planting and mangrove planting activities through Mangrove Rehabilitation and Reforestation Project
- Community support, such as Day Care programs, provision of concrete materials, medical mission, livelihood programs, and educational support.
- Continuing Information, Education and Communications Program via broadcast airing of radio program “Kalambuan sa Mina” to promote the revitalization of the minerals industry with Certificate of Appreciation from MGB VII
- Implementation of Solid Waste Management
- Maintenance of EGF Allotment

Payment for the national and local taxes, permits and licenses that will be due at the operational phase of the project. The barangays, city, municipality, province and region will directly benefit from the project through these additional financial resources mentioned.

The presence of the Finish Mill and Quarry Operations Project of the RCBM will contribute to the revenues of the local governments in the form of payments of property taxes, permits and licenses particularly during the operation of the said cement plant.

RCBM shall promptly pay the local taxes, permits and licenses to assist the city/barangays in meeting its financial obligations as well as improve its delivery of basic social and other development services.

Provided in **Tabl 5.1.1** is the summarized Social Development And Management Program of RCBM

Table 5.1.1: Summary of Social Development and Management Program of RCBM

CONCERN	Responsible Community Member / Beneficiary	Government Agency/ Non-government Agency and Services	PROPONENT	Indicative Timeline	Source of fund
Livelihood / Employment (Men, Women, Youth & elderly)	Qualified Project Affected Men, Women, Youth & Elderly	Barangay Council City Council TESDA	Community Relations Officer	Operation	SDMP

CONCERN	Responsible Community Member / Beneficiary	Government Agency/ Non-government Agency and Services	PROPONENT	Indicative Timeline	Source of fund
• On the Job Training and Immersion Program especially for the Youth • Educational Assistance e.g. skills training and continuing education for out-of-school youth (tour-guiding, service crew, etc.) • Livelihood Projects for out of school youth, women and senior citizens		DTI DOT			
Health and Safety • Medical mission	Barangay Kagawad for Health • Project-affected Community(ies)	CHO Barangay Disaster Management	Community Relations Officer	Operation	SDMP
Education and Recreation • Community support, such as Day Care programs, provision of concrete materials, medical mission, livelihood programs, and educational support.	Barangay Kagawad for Education • Project-affected Families	DepEd	Community Relations Officer	Operation	SDMP
Environment and Sanitation ○ Tree planting and mangrove planting activities through Mangrove Rehabilitation and Reforestation Project ○ Climate Change and Disaster preparedness	Barangay Kagawad for Environment • Project Affected Community	CPDO/ CHO	Community Relations Officer	Operation	SDMP
Peace and order	Barangay Kagawad for Peace and order • Project Affected Community	LGU PNP	Chief Security Officer	Operation	SDMP
Others • Implementation of Solid Waste Management • Maintenance of EGF Allotment				Operation	SDMP

Provided below is the SDMP Accomplishment as of June 2020.

I. DEVELOPMENT OF HOST AND NEIGBORING COMMUNITIES (DHNC)

A. Access to Education and Educational Support Program

1. Provision of Academic Medals (Re-aligned: Support to stakeholders during COVID-19 pandemic due to suspension of Graduation Ceremony)
2. Provision of materials for the repainting of Dunggoan Elementary School classroom
3. Provision of materials for the repair of roofing of Dunggoan Elementary School classroom

B. Access to Health and Services, Health Facilities and Professionals

1. Provision of medical supplies for Barangay Health Center

C. **Enterprise Development and Networking**
   1. Honorarium of Barangay garbage collector
   2. Handicrafts using residual wastes

D. **Assistance to Infrastructure Development and Support Services**
   1. Provision of materials for the construction of Tanod outpost
   2. Maintenance / Gasoline and/or Registration of Barangay vehicle
   3. Provision of materials for construction of waiting shed

E. **Others**
   1. Provision of sports equipment / tools
   2. Provision of Projector
   3. Chairs and tables for Barangay Session hall

II. INFORMATION, EDUCATION AND COMMUNICATION (IEC) CAMPAIGN
1. Conduct Cement 101 & Open House Event
2. Support for the Implementation of National Unified Information, Education and Communication Plan (NUIECP)

III. DEVELOPMENT OF MINING TECHNOLOGY AND GEOSCIENCES
1. Attendance to the PMSEA
2. Support for the Implementation of National Unified Information, Education and Communication Plan (NUIECP)

5.2 INFORMATION, EDUCATION AND COMMUNICATIONS FRAMEWORK

The IEC for the project is a component of the SDMP. For both the SDP and IEC of the project, the programs are always and shall be derived from and aligned with the LGU's existing development plans. The project's SDP normally aims to prevent/mitigate and/or enhance a project's adverse and positive impacts, respectively, on people's livelihood, health and environment. The process of formulating the project's SDP shall be actively participated in by Barangay Council, the City Planning and Development Office (CPDO) and/or other Government Agencies whose mandates cover the management of impacts posed by project operations, e.g. DOH who may coordinate with the Proponent on the conduct of health impact studies or conduct of medical mission(s).

Among the focus of RCBM's IEC is IEC on RA 9275, RA 9003 and PD 1586 guidelines already given to the workers/seminars/ training as part of QEHS program.

The IEC will be a continuing process which has been initially undertaken and will continue through the life of the project. IEC necessarily involves public consultations or Focus Group Discussions (FGDs). The proposed IEC Plan/Framework is shown in **Table 5.2.1.**

Table 5.2.1: IEC Program

Target Sector Identified as Needing Project IEC	Major Topic/s of concern in Relation to Project	IEC Scheme / Strategy / Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost Pesos
LGUs (Bgys to City LGU)	• Project Description • Socio-economic • Benefits • Environment and community	Group Method	Focus Group Discussion Power Point Presentation	To be determined	SDMP
NGOs., Church, School	Impacts on environment and health	Group Method	Focus Group Discussion Printed Materials	Same	Same
MMT Members	The Project EIA Air Quality Management	Group method Individual	Printed materials Focus Group Discussions	Same	Same

Industries in the Industrial Zone	General Environmental Topics	Fora	Fora	To be arranged	Same
Professional society and individuals	Continuing consultation	Group Method	Focus Group Discussion Power Point Presentation	To be determined	Same
General Public	Climate Change Mitigation Climate Change Adaptation	Fora Local Printed Media	Fora Local Printed Media	 To be determined	Same
	Continuing Information, Education and Communications Program via broadcast airing to promote the revitalization of the minerals industry with Certificate of Appreciation from MGB VII	radio program "Kalambuan sa Mina"			Same

Provided below are photographs of the Corporate Responsibility Projects that were implemented by RCBM Danao Plant.

MEDICAL MISSION

GIVE KIDS A SMILE PROGRAM (Oral Health Month)

BRIGADA ESKWELA

BRIGADA ESKWELA

Quisol Integrated School

Binaliw Integrated School

Guinsay Elementary School

BRIGADA ESKWELA

Ramon M. Durano Sr. Foundation- Science and Technology Education Center

Turn-Over of Commercial Oven

OPLAN SUWAT

PROJECT ARAL

AGRO FAIR

BREAD AND PASTRY TRAINING

KIDDIE CHRISTMAS PARTY

Damaged Jumbo Bags into Recycled Products by BJMP

Conversion of waste jumbo bags into shopping bag, hammock and lounge chair

Adopt-A-Waterbody Clean-up Drive

ADOPT-A-WATERBODY CLEAN-UP DRIVE

LUYANG RIVER REHABILITATION

Luyang River Rehabilitation

Luyang River Rehabilitation

Luyang River Rehabilitation

Mangrove Planting

Arbor Day Tree Planting

Tree Planting (Brgy. Pamutan, Cebu City)


RCBMI –Danao Plant participated in International Coastal Cleanup – Sept. 21, 2019
Location: Luyang River, Carmen, Cebu
No. of RCBMI & Contractor participants: 51
Trash Collected by RCBMI: 63 kgs.
RCBMI Danao Plant volunteers with CENRO personnel
Weighing of garbage collected

6. ENVIRONMENTAL COMPLIANCE MONITORING

6.1 PERFORMANCE MONITORING

RCBM is committed to implement the measures stipulated in the IEE and ECC (ECC Reference Code 9906-014-1-5) which are intended to protect and mitigate the project's adverse impact to the environment and the health and welfare of the community. The ECC covers the existing operations of the Project, which are dutifully complied by the RCBM. Monitoring activities are also conducted to ensure compliance with the DENR standards. **Table 6.1.1** shows the status of ECC and EMP compliance of RCBM for the existing Project.

Table 6.1.1: Status of ECC Compliance

ECC/EMP Condition/Requirement Categorization	Complied		Summary of Actions Taken
	Yes	No	
Compliance with ECC			
Coverage Limit	✓		10 hectares manufacturing site and 272 hectares for the quarry. No expansion was made during the covered monitoring period. No expansion was made during the covered monitoring period
Extraction	✓		Mineral Limestone
Compliance on EPEP Budget Allocation	✓		Complied as scheduled
Implement proper benching pattern	✓		Complied as to standards
Buffer/Salvage zone of ten (10) meters to be maintained	✓		Provided
Provision of billboard at entry and exit points of the project site	✓		Complied with proper safety signage
Proper management of loose earth materials to prevent soil erosion and flooding	✓		Complied, no soil erosion
No dozing operations to be conducted	✓		Not applicable as proponent is large scale.
Installation of drainage canals with temporary catch basins/sediment traps of settling pond to serve for the eroded soils	✓		Complied and with constant monitoring on the volume of water in the collecting sump
Proponent to be responsible to shoulder damages caused by the implementation of the project	✓		RCBM will adhere to this in case of any incident/damages
Preparer to be held liable/accountable for the data/information contained in the IEE document	✓		Complied
Regular maintenance of equipment	✓		Daily Level 1 inspection and regular preventive maintenance
Hauling trucks to be covered with tarpaulin	✓		Complied
Local residents be given preference of employment	✓		Complied
No adverse effect caused by emission of vibration, smell, wastewater, waste products, oil etc.	✓		Complied
Permittee to ensure a copy of ECC be kept always by person in charge for day-to-day compliance	✓		Complied
All other permits from other concerned agencies be complied	✓		Complied
All conditions set forth in the special SSQP be strictly effected	✓		Complied
Transfer of ownership carries the same conditions	✓		

ECC/EMP Condition/Requirement Categorization	Complied		Summary of Actions Taken
	Yes	No	
Other ECC Condition/s			
Recycling of collected dust from bag filters	✓		Part of cement process
Implementation of effective mitigation measures and environmental monitoring for air, water and noise quality	✓		Daily monitoring on fugitive and dust emission; immediate action if any abnormality is observed
Strict implementation of Emergency Preparedness and Response Plan in cases of fire, flood or other hazards	✓		ERP Drill as per H&S program
A solid waste management program to include specific disposal	✓		Solid waste segregation – biodegradable, residual, recyclable are placed in a MRF and solid hazardous wastes are stored in Temporary Hazardous Waste Facility
Compliance with EMP			
For major provisions: • Catch Basin • Drainage • Drainage System • Garbage Disposal System • Tree species as vegetation	✓		Complied
Implementation of appropriate and effective environmental impact remedial actions in case of exceedances	✓		To be guided by the IMP and EMP
Complaints Management	✓		Plant management team has identified a responsible person to deal with any complaints
Realistic and sufficient budget for conducting the environmental monitoring and audit activities	✓		Budget allotted and complied
Accountability – qualified personnel are in-charge with the routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team	✓		IEC on RA 9275, RA 9003 and PD 1586 guidelines already given to the workers/seminars/ training as part of QEHS program
Others . . .	✓		a. Standby Generator Set emission – CO and NOx b. Mangrove Rehabilitation and Reforestation Project at Baragay Guinsay c. Maintenance of Drainage d. Community and Health Services, Trainings and seminar • Medical Mission • Brigada Eskwela • Palarong Pinoy • Cardiovascular • Awareness • Cancer Awareness • Oral Health Month • Safe Motherhood • Caravan e. NGP Visit and meeting with PO

Source: CMR for the period of January – June 2018, RCBM

Todate, no complaints have been received by RCBM and a harmonious relationship between the stakeholders/community and RCBM exists. **Annex 6-1** presents the latest SMR and CMR of RCBM. **Annex 6-2** presents the Project Environmental Monitoring and Audit Prioritization Scheme (PEMAPS). **Annex 6-3** presents the Permit to Operate (PTO), Discharge Permit (DP) and Hazwaste Generator ID of RCBM.

Water and air quality trends of performance were provided in Tables 2.2.3.1 for water quality and Table 2.3.14 for Ambient Air Quality on pages 2-57 and 2-196.

6.2 SELF-MONITORING PLAN

Provided in **Table 6.2.1** is the Self-Monitoring Plan as per Annex 2-20 of RPM for DAO 2003-30. Below is the definition of Environmental Quality Performance Level (EQPL):

Table 6.2.1: EQPL Definition

EQPL Level	Description
Alert or Red Flag	early warning
Action Level	point where management measures must be employed so as not to reach the regulated threshold or limit level, or to reduce deterioration of affected environmental component to pre-impact or optimum environmental quality
Limit Level	regulated threshold of pollutant (standard that must not be exceeded); point where emergency response measures must be employed to reduce pollutants to lower than standard limit.

Table 6.2.2 presents the Environmental Monitoring Plan (EMoP) for the project.

Table 6.2.2: Environmental Monitoring Plan (EMoP)

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l Sector	Parameter to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL MANAGEMENT SCHEME					
								EQPL RANGE			MGT MEASURE		
			Method	Frequency	Location			ALERT	ACTION	LIMIT	ALERT	ACTION	LIMIT
PRE-CONSTRUCTION PHASE: The Pre-construction phase in the EPRMP Report covers activities like planning, feasibility study, drawing of plans, surveys, and permit procurement. Earth moving activities, delivery of materials and similar activities include in the Construction Phase.													
CONSTRUCTION PHASE: The project has been constructed													
OPERATION PHASE													
Water Component (Water Quality)	Effluent water quality monitoring	BOD	Azide Modification (Dilution Technique)	Quarterly	Same monitoring stations	RCBM PCO	Included in the contract of RCBM and Consultant	35 mg/L	40 mg/L	50 mg/L	Determine Possible source	Check weather condition during the sampling.	Conduct resampling and retesting using 3rd party DENR accredited sampling firm
		TSS	Gravimetric (dried at 103-105°C)	Quarterly				56 mg/L	75 mg/L	100 mg/L			
		TDS	Gravimetric (dried at 103-105°C)	Quarterly				n/a	n/a	none			
		Oil and grease	Gravimetric (Petroleum Ether Extraction)	Quarterly				2.5 mg/L	3.75 mg/L	5 mg/L			
		Temperature	In situ using temperature meter	Quarterly				> 2.7 °C Change	> 2.8 °C Change	3°C Change			
		pH	In situ using pH meter / Glass electrode	Quarterly				6.6 - 8.1	7.0 - 8.5	6.0-9.5			
Air Component	Ambient air pollution (Generator Set)	Particulates, CO, SO_2, NO_2	Source emission tests	Semi-annual	Generator Set	RCBM PCO	Part of plant MOE	PM: 130 CO: 400 SO2: 1300 NO2: 900	PM: 140 CO: 450 SO2: 1400 NO2: 950	PM: 150 CO: 500 SO2: 1500 NOx: 1000	• ID source of pollutant • Evaluate plant process that emits the pollutant	• Corrective action on plant process that emits the pollutant.	Temporary stoppage of polluting source

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l Sector	Parameter to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL MANAGEMENT SCHEME					
								EQPL RANGE			MGT MEASURE		
			Method	Frequency	Location			ALERT	ACTION	LIMIT	ALERT	ACTION	LIMIT
	Ambient air pollution (AMBIENT)	PM10	High Volume with 10 micron particle-size inlet (A) Gravimetric USEPA 40 CFR, Part 50, Appendix J	Quarterly	Recommended AQ monitoring stations	RCBM PCO	Part of plant MOE	180	190	200 ug/ncm	• ID source of pollutant • Evaluate plant process that emits the pollutant •Monitor ambient levels at stations • Conduct air dispersion modeling	• Corrective action on plant process that emits the pollutant • Conduct monitoring after corrective action	Temporary stoppage of polluting source
	Ambient air pollution (AMBIENT)	TSP	(S) 1 hr High Volume- (A) Gravimetric USEPA 40 CFR, Part 50, Appendix B	Quarterly	Recommended AQ monitoring stations	RCBM PCO	Part of plant MOE	280	290	300 ug/ncm	-do-	-do-	-do-
	Ambient air pollution (AMBIENT)	SO_2	(S) 1hr Gas Bubbler (A) Pararosaniline Method (West and Gaeke Method	Quarterly	Recommended AQ monitoring stations	RCBM PCO	Part of plant MOE	300	320	340 ug/ncm	-do-	-do-	-do-
	Ambient air pollution (AMBIENT)	NO_2	(S) 1hr Gas Bubbler (A) Griess-Saltzman or Chemiluminescence Method	Quarterly	Recommended AQ monitoring stations	RCBM PCO	Part of plant MOE	230	250	260 ug/ncm	-do-	-do-	-do-
	Noise impacts in receptor areas (AMBIENT)	Sound levels	Hourly sound measurements	Quarterly	Recommended AQ monitoring stations	RCBM PCO	Part of plant MOE	70	73	75	• Identification of possible source of noise • Check buffer zones and noise attenuation	• Corrective action on noise equipment source • Conduct monitoring after corrective action	Temporary stoppage of noise source

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l Sector	Parameter to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL MANAGEMENT SCHEME					
								EQPL RANGE			MGT MEASURE		
			Method	Frequency	Location			ALERT	ACTION	LIMIT	ALERT	ACTION	LIMIT
											measures • Conduct noise modeling		
ABANDONMENT PHASE													
Closure of waste co-processing and plant operations	Solid wastes and Unused waste resources	Volume of waste received for co-processing	Volume estimation of delivered and processed wastes	Daily	RCBM-Norzagaray Plant Vicinity	RCBM Yard and Production supervisors	Included as part of operation budget	270 tons	280 tons	300 tons	Communicate high inventory stocks to supply chain	Locate temporary storage of delivered waste	Stop acceptance of wastes

6.3 MULTI-SECTORAL MONITORING FRAMEWORK

Provided below is the list of stakeholder-members of the MMT of the project:

1. DENR PENRO/CENRO
2. LGU Representatives:
   a. City of Danao
   b. Barangay Dunggoan
   c. Barangay Cagat, Danao City
   d. Barangay Sandayong Norte, Danao City
   e. Barangay Binaliw, Danao City
   f. Barangay Malapoc, Danao City
   g. Municipality of Carmen
   h. Barangay Triumfo, Carmen
   i. Barangay Hagnaya, Carmen
   j. Barangay Dawis Sur, Carmen
3. LGU-Accredited Local NGO
4. 2 reps from locally recognized community leaders
5. 3 reps from government agencies with related mandate on the type of proect and impacts during operations

With the implementation of DAO 2017-15 and 2018-18 and once the ECC has been amended, the following will be added as MMT Members:

1. Municipality of Carmen
2. Brgys., Cagat, Sandayong Norte, Binaliw and Malapoc in Danao City
3. Brgys. Triumfo, Hagnaya and Dawis Sur in Carmen Municipality

RCBM will be the Fund Manager.

6.4 ENVIRONMENTAL GUARANTEE AND MONITORING FUND COMMITMENTS

For resource extractive projects where this project of RCBM falls, a financial mechanism called Contingent Liability and Rehabilitation Fund (CLRF) is established in lieu of the EMF and EGF. The CLRF is an environmental guarantee fund mechanism that ensures the just and timely compensation for damages and progressive and suitable rehabilitation for any adverse effect a mining operation or activity may cause. This fund is further broken down as follows:

- Environmental Trust Fund (ETF) which is divided into Rehabilitation Cash Fund (RCF) and Monitoring Trust Fund (MTF);
- Mine Rehabilitation Fund (MRF);
- Mine Waste Tailings Reserve Fund (MWTRF); and
- Final Mine Rehabilitation and Decommissioning Fund (FMRDF).

As per the Bank Account of RCBM as of 12/2018, follow are the funds

- ETF = Php52,401.21
- MTF = Php52,401.21
- RCF = Php351,073.25

7. DECOMMISSIONING/ ABANDONMENT/ REHABILITATION POLICY

The decommissioning of this Project will be in accordance to the good environmental practices and principles, especially the management of wastes resulting from the dismantling process. The separate and detailed Abandonment Plan will be integrated with the FMRDP for the manufacturing plant itself and submitted to all the government regulatory agencies concerned. The Abandonment Plan for submission and approval to the EMB will be submitted at least six (6) months before the schedule or as may be prescribed in the future by the DENR/EMB.

By the nature of the project, there are no anticipated residual soil, water and air contamination with hazardous substances in event of project abandonment. However, the project closure will result to the following:

- Loss/decrease taxes by the National Government such as Corporate Income Tax, Excise Tax on Minerals, Customs Duties, Value Added Tax, Documentary Stamp Tax and Capital Gains Tax. On the local government level, the taxes that will be affected are Business Tax, Real Property Tax, Registration Fees, Occupation Fees, Community Tax and other Local Taxes. Other taxes such as Withholding Taxes on Payroll, Interest Income in Banks and Stockholders Dividends will likewise be affected.
- Loss of financial allocations for approved plans/programs such as the Social Development and Management Plan, EPEP, and FMRDP.
- Loss of employment. Currently (2018) there are 241 employees of the project including the contractors. The closure of the project will mean loss of income or business opportunities such as the transport sector, the Small-Medium Enterprises like stores, eateries, etc.
- Loss of funding for various company supported social work projects such as medical missions, outreach programs, support to education, etc.

Although the project is a downgrade in the operations of the project components of the cement complex, the structures existing in the project site, the power plant in particular will not be dismantled as it may be used for other purposes in the future. Only the power plant building is existing as the equipment were already sold.

RCBM proposes a final land use of a stable and revegetated area for the disturbed areas and the conversion of the support structures to other productive uses such as offices, warehouses, etc. Eventually, the area can become a residential and/or commercial area. The selection of the final land use for the Project was based on the following four (4) point criteria.

- **First Criteria.** The naturally occurring hazard in the area that may render it unusable or unfit for other productive land use. There are no naturally occurring hazards in the area. The area is not traversed by major active faults, it is not located within typhoon belt, it is not located in steep and landslide prone areas, etc. Hence, the area can be revegetated after the commercial life of the Project.
- **Second Criteria.** The level of environmental and social impacts cause by the operation. The environmental impacts of the project will not render the area unusable after the life of the project. There are no toxic wastes generated by the Project. It has lesser impact to the environmental considering that it is a non-metallic project. Moreover, the impact area of the project remains constant throughout the operating life. No additional areas are disturbed. On the social impacts of operations, the Project provided a positive effect to the host community in particular and to the national government in general. These are in terms of employments provided, taxes paid, etc. The Project started operation in 1967, since then, other industries and residential areas continue to develop near the Project.
- **Third Criteria.** The expected post-closure operational use of the land. The development of other industries and residential areas near the project and within the cities of Cebu and Danao as a whole caters well to the proposed final land use. The proximity of the project to Metro Cebu makes it also an ideal for the proposed final land use that could eventually become a residential and/or commercial area.
- **Fourth Criteria.** The productivity of the land surrounding the site. The proposed final land

use will adapt and fit in with the surrounding land use of Cebu City and Danao City. Currently, there are other quarrying/manufacturing industries and residential areas near the project as well as residential areas and agricultural lands.

Considering the above-cited criteria, RCBM is proposing a five (5) year FMRDP. However, if the proposed five (5) year FMRDP is not sufficient to guarantee the success of rehabilitation as determined during the periodic review of the FMRDP every two (2) years, RCBM commits to amend the FMRDP and provide the necessary financial requirement. Moreover, any residual care after the implementation of the FMRDP will be shouldered by RCBM. **Table 7.1.1** presents the proposed final land form for the project.

Table 7.1.1: Proposed Final Form of the Project

Component	Proposed Final Land Form
Cement Finish Mill Plant	
Major Component	
Finish Grinding Clinker Bin, Ball Mill	Stable and revegetated area. The structures will be removed.
Packing and Distribution Packhouse	Stable and revegetated area. The structures will be removed.
Support Facilities	
Office Buildings	Retained for other productive use.
Warehouse	Retained for other productive use.
Laboratory	Structure retained for other productive use. Laboratory equipment transferred to other projects or sold.
Truck Scale	Stable and revegetated area. The truck scale will remove for transfer to another project or will be sold.
Hardstands/parking areas	Retained as hardstands/parking area.
Powerhouse	Structure retained for other productive use.
Motorpool Area	Structure retained for other productive use.
Guard Houses/Gate	Structure retained to provide security for other productive use of the area.
Canteen/Cooperative	Structure retained for other productive use.
Chapel	Retained as chapel.
Project Personnel Housing	Retained as housing/subdivision.
Silt traps/ponds, drainage system	Silt traps/ponds backfilled and revegetated. Main siltation pond retained as recreation area for the housing/subdivision. Drainage system retrofitted to conform to proposed final land use.
Nursery	Retained to support the care and maintenance after the FMRDP implementation.
Quarry Area	
Quarry Slope	Stable and revegetated area
Quarry Pit Bottom Area	Stable and revegetated area
Haul roads (within the quarry area)	Stable and revegetated area
Topsoil stockpile area (within the quarry area)	Stable and revegetated area
Settling Pond (within the pit area)	Stable and revegetated area
Other Facilities	
Contractor’s Area (0.02 ha)	Removed. Stable and revegetated area
Storage Area (0.2 ha)	Removed. Stable and revegetated area
Crusher (0.02 ha)	Removed. Stable and revegetated area
Storage Tanks (0.001 ha)	Removed. Stable and revegetated area
Guard House (0.001 ha)	Retained.

For the facilities and structures within the cement complex, provided below is the Demolition and Utilization Plan which may be implemented anytime soon.

Table 7.1.1: List of Plant Structures/Facilities in the cement plant complex for demolition with utilization plan

	Plant Structures For Demolition	Utilization Plan
1	Thermal Plant	open area
2	Finish Mill 1 & 2	open area
3	Ball Mill (small) 1 & 2	open area
5	Dryer Building	open area
6	Fuel Coal Shed (nickel machine)	open/parking space
7	PGMC Pelletizer Building	open/parking space
8	Small Kiln Covered Building	open/parking space
9	Kiln #3 smoke stack	open area
11	L3 EP structure & foundation	open area
12	L3 RM feed bin building	open area
13	Line 3 kiln structure & piers	open area
14	Line 3 clinker cooler, fans & transport auxs.	open area
15	Secondary crusher building	stockpile area
16	Conveyor shed building	stockpile area
17	Primary crusher	stockpile area
18	Slurry Basin (2 units)	open area
19	Slurry pump house	open area
20	Silo Blending Storage (6 silos)	open area
21	L3 RM overland transport conveyor to storage (existing)	open area
22	L2 RM overland transport conveyor to storage (moci)	open area
23	L1 & L2 Feed tank	open area
24	Old cement silos (8 units) for FM1 & FM2	stockpile area
25	Old pack house extension	stockpile area
26	Overhead pipelines and steel structures	open area
27	Pack house 1 & 2 cement silos (4 units)	open area
28	Pack house 1 & 2	open area
29	Storage building 1 & 2	open stock area
30	Power plant (moci)	excess cement warehouse
31	Laboratory	open area
32	Engineering water pump house	open area
33	Removal of overhead crane from storage line 1 & 2	N/A
34	L3 RM Building	spare parts warehouse

8. INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

8.1 INSTITUTIONAL PLAN

This section provides the instrument required to establish a proactive institutional requirement to guarantee compliance with environmental regulations and policies and implementation of environmental safeguards and commitments. It is important to set up capable and competent unit/group with properly defined roles in the process of the monitoring and evaluation of post EIA requirements and commitments as well as with other environmental regulations. It is important to identify and provide the group that will implement said requirements for a sustainable project operation.

Function

The Environment Unit/Team is responsible for the environmental performance of the project. It ensures implementation of the environmental safeguards and controls for the project implementation (for all phases of the project) and is responsible for overseeing environmental compliance of RCBM activities, environmental requirements and regulatory obligations.

Core Function of the team/unit includes the following:

- Systems and Procedures
- Environmental Safeguards and Implementation
- Government Regulatory Compliance
- Environment Health Safety Program and Awareness
- EHS Program Compliance

Set Up

In many cases, the environmental unit leads the post EIA compliance and implementation process in collaboration with the other technical team/groups to provide technical support. There are no generally applicable, rigid rules, so many variations are possible depending on RCBM's personnel capacities and structures.

Roles and Responsibilities

In order to have a better understanding of the roles and responsibilities of the main actors in the institutional framework, below provides a brief explanation of the role of the key personnel, the technical team, and collaborating units/groups.

Key Personnel	Roles and Responsibilities
Pollution Control Officer/ Engineer	Compliance to environmental regulations & standards; maintenance of reports that are submitted to internal and external agencies
Safety Engineer	Responsible for implementation of emergency response procedures, handling of hazardous materials and environmental management systems and requirements of DOLE on occupational safety and health
CSR and SDP personnel	Community relations, design, training and implementation of CSR and SDP programmes

Following are the functions, roles and responsibilities of each departments:

- Operations – The operations department is responsible for acquiring the inputs and devising the best grinding plant operations methods so that value adding occurs in the most efficient and effective way. Thus, the role of operations management (and the operations manager) is to ensure a smooth production process that contributes to the output of goods and services of an organization. In additions, following are inherent responsibilities of the Operations Department:
    - Full Plant operations

  - Safety and Morale of the Department
  - Production / Schedule attainment
  - Continuous Improvement
  - Leadership and Direction, plant wide
  - Customer interface
  - Company policy enforcement
  - Production start-up / launch

- Maintenance – This department is in charge for the schedule and regular inspection, maintenance and repair of equipment.

- Engineering Support – This department is in charge of the automation control, optimization, safety and testing of necessary support needed by the grinding plant.

- Administration and Finance – This department is a unit to be assigned with various responsibilities concerning personnel, finance, publications, public relations, conferences, sale of documents and similar administrative functions; in particular:

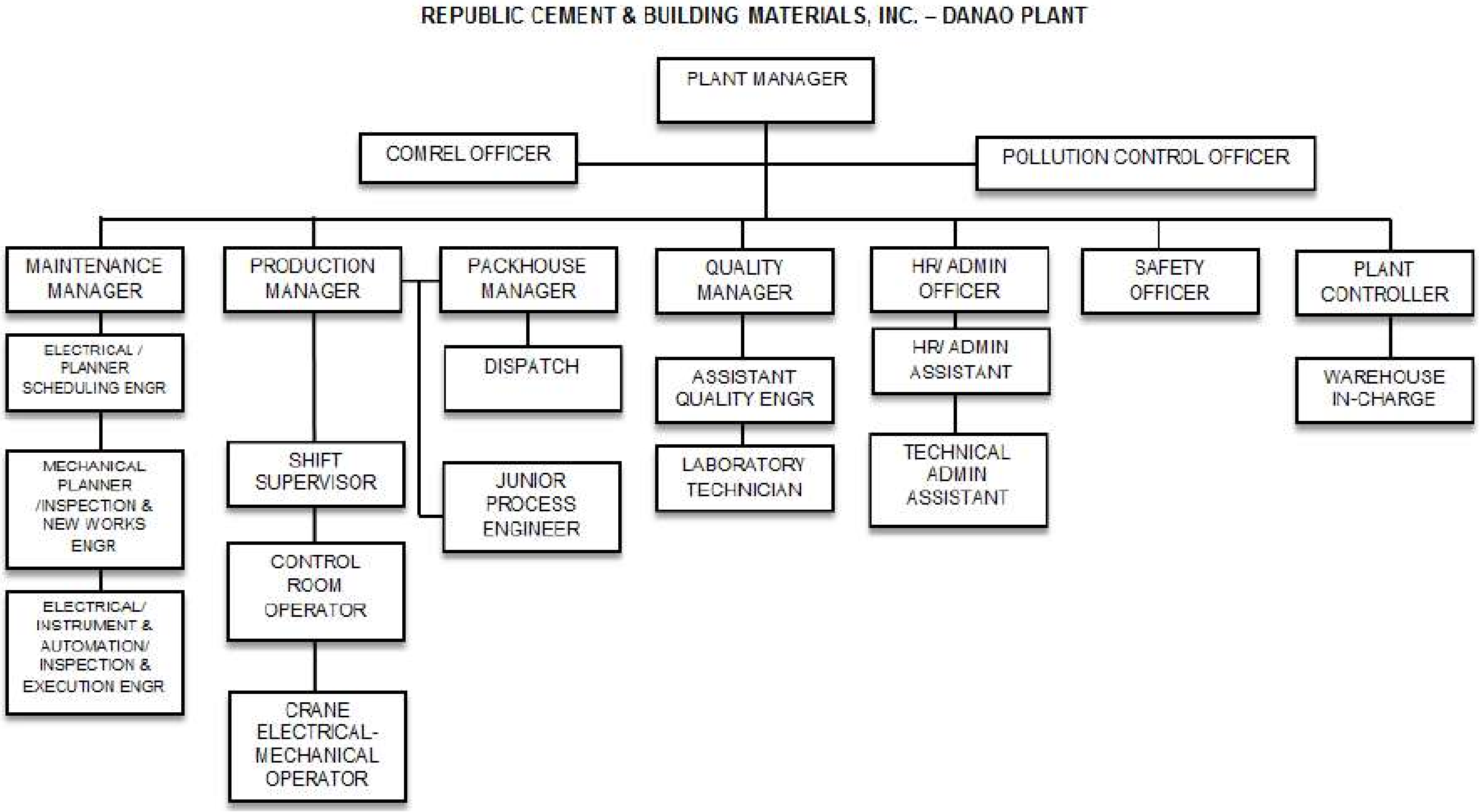
  - Personnel affairs;
  - Organization of training of officials and supervision of programs established to that effect;
  - General services including the general register of the staff and services;
  - Rendering consultations to other Departments on organizational matters;
  - Preparation of studies on the administrative organization;
  - Maintaining and auditing the accounts of the Company;
  - Supervision of storage and purchasing;
  - Preparation of the budget;
  - Organization of administrative services for conferences and meetings; and
  - Maintaining and organization of the library and the archives as well as their use.

Skills and Competency

Selection of competent and effective personnel comprising the environmental unit will be crucial in the institutional or organization building. Qualifications for the members may include the following:

- Understanding of environment management, legal regulatory framework, environmental impact assessment and reporting, and environmental compliance and audit management. Well-versed and familiar with the application of local laws and regulations on Environmental regulatory compliance.
- Experience in integrated environmental assessment
- Good relationship with the environmental regulatory authority
- capacity to dialogue with different stakeholders from both the public and private sector, and ability to build consensus on key environmental issues
- Oral and written communication skills; people skills; project coordination; monitoring and audit; scientific research and development; project planning; policy formulation; and training and facilitation.

Figure 8.1.1 illustrates the institutional framework for the project of RCBM.



Source: RCBM

Figure 8.1.1: Organizational Chart

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ANNEXES

ANNEX ES-1: Accountability Statement of the Proponent and Preparer

ANNEX ES-2: EIA Scoping and Screening Form

ANNEX ES-3: Public Participation Documentation

1. Copy of the perception survey questionnaire
2. Perception Survey detailed results
3. Public Scoping

ANNEX 1-1 : Copy of previous ECC

ANNEX 1-2 : SEC Registration of Republic Cement and Building Materials, Inc.

ANNEX 1-3 : Copy of the Change of Name of ECC Holder to RCBM

ANNEX 1-4 : MGB Letter of Approval

ANNEX 1-5 : Transfer Certificate of Title (TCT No. T-397 and 910)

ANNEX 1-6 : Copy of Phosphogypsum Supply Agreement and Fly Ash Agreement

ANNEX 1-7 : Exploration Report

ANNEX 2-1 : Geohazard Report

ANNEX 2-2 : MPSA 132-99-VII

ANNEX 2-3 : Water sampling results

ANNEX 2-4 : Graphs and tables of marine survey

ANNEX 2-5 : Selected Air Dispersion Modeling Input and Output Files

ANNEX 4-1 : ERP

ANNEX 4-2 : Safety Statistics

ANNEX 6-1 : Proof of receipt of CMR and SMR submission of RCBM

ANNEX 6-2 : PEMAPS Questionnaire

ANNEX 6-3 : Permits