Department of Public Works and Highways (DPWH)
Republic of the Philippines

In partnership with

Japan International Cooperation Agency (JICA)
CTI Engineering International Co. Ltd.

ENVIRONMENTAL IMPACT STATEMENT

Preparatory Survey for Cavite Industrial Area Flood Management Project

KRC ENVIRONMENTAL SERVICES
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CONTENT OUTLINE

EXECUTIVE SUMMARY

Project Fact Sheet

Basic Project Information

Project Type	**Flood Mitigation Project**
Project Name	**Preparatory Survey for Cavite Industrial Area Flood Management Project**
Project Location	**San Juan River Basin and Maalimango Creek in the Municipalities of Imus, Kawit, Rosario, Noveleta and Gen. Trias, Province of Cavite, Region IV-A**
Project Size	(see table below)

Measures	Components	Area
1.River Flood Mitigation	**1-1) San Juan Diversion Channel**	**28.7**
	1-2) Rio Grande River Improvement	21.9
	1-3) Ylang-Ylang River Improvement	14.2
1.Drainage Facilities	2-1) Maalimango Drainage Improvement	21.3
	2-2) Diversion Drainage-I	
	2-3) Diversion Drainage-II	
	Total	86.1

Project Component

.1. **River Improvement in San Juan River Basin**
   a. **River Improvement Works of San Juan River, Rio Grande River, and Ylang-Ylang River**
   b. **Construction of Diversion Channel from the confluence of Rio Grande and Ylang-Ylang rivers to Manila Bay**
2. **Drainage Improvement at Maalimango Creek**
   a. **Drainage Improvement Works (Dredging) of Maalimango Creek**
   b. **Drainage Improvement Works (Widening) of Maalimango Creek**
   c. **Construction of Diversion Drainage**
3. **Construction and improvement of Bridges as shown in figure 3.5**

Summary of Project Works

Item		Description	Length
River Improvement in San Juan River Basin	Rio Grande River Improvement	- River Excavation - Concrete Block Slope Protection - Foot Protection	Sta. 4+808 ~ 6+389 (L=1.6 km)
		- River Excavation - Concrete Block Slope Protection - Foot Protection	Sta. 10+600 ~ 13+200 (L=2.6 km)

		Ylang-Ylang River Improvement	- River Excavation - Concrete Block Slope Protection - Foot Protection - Excavation for Diversion Channel	Sta. 0+000 ~ 2+787 (L=2.8 km)
		San Juan Diversion Channel	- Dike Embankment - Concrete Block Slope Protection - Foot Protection	Sta. 0+000 ~ 2+000 (L=2.0 km)
	Drainage Improvement at Maalimango Creek	Maalimango Drainage Improvement	- Dredging/Drainage Channel Widening - Concrete Block Slope Protection	Sta. 1+300 ~ 3+000 (L=1.7 km)
		Diversion Drainage I	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~ 1+000 (L=1.0 km)
		Diversion Drainage II	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~ 3+200 (L=3.2 km)
Project Cost	**Php 9 B**			
Man Power	**2070 during construction**			

Proponent Profile

Proponent	**Government of the Republic of the Philippines** **Department of Public Works and Highway (DPWH)**
In partnership with	Japan International Cooperation Agency (JICA) CTI Engineering International Co., Ltd.
Represented by	Makihiko Otigawa
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In Charge of ECC Application:

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DESCRIPTION OF THE PROJECT'S EIA PROCESS

Initial screening using Annex 2-1b of the Revised Procedural Manual (RPM) of DAO 2003-30 showed that the proposed project is a Group_I-D projects. Reply letter regarding our request for technical scoping from EMB Central Office reveals that the project is to be process in the regional office.

The project is considered as new single project that requires ECC application and to submit an Environmental Impact Statement (EIS) report. The format in Annex 1-A of MC 2014 for New Single Projects was used in this report.

The EIA was prepared in accordance with the RPM DAO 2003-30 guidelines. Site visits were made to a) conduct the pre-scoping IEC, b) verify project location, c) establish sampling stations for air and water quality, d) collect air and water samples, and e) measure ambient sound and vibration levels. Secondary data were taken from government agencies, i.e., PAGASA. NSO, NWRB, LGUs, etc. and from related literature.

Terms of Reference of the EIA study

This document is prepared in accordance with the provision stipulated in the Revised Procedural Manual (RPM) for DENR Administrative Order No. 30 Series of 2003. Table below shows the issues raised by the stakeholders during the Technical and Public Scoping and how these were addressed in the EIS.

EIA Team

The EIA team is composed of several members, each have their own expertise. The team is headed by Engr. Marilou P. Avenido and Maria Carmela Capule.

Team Member	Function/Role
Maria Carmela Q. Capule	Project Manager/Environmental Scientist
Marilou P. Avenido	EIA Team Leader
Virgilio Montealto Garcia	Hydrogeology
Pablito C. Argamosa	Geologist
Carolyn DP Barrias	Flora and Fauna Specialist
Milagros Pasion-Asuncion	Sociologist

EIA Study Schedule

The EIA team undertook the following schedule from January to May 2016, as part of the preparation and conduct of the EIA process:

- Conduct of survey, field investigation and site inspection of the project including the outlying areas to determine its biophysical conditions (i.e., air and water quality, noise/sonic environment, land such as geological, etc.)
- Conduct of pre-scoping IEC and public and technical scoping to determine the issues to be addressed by the EIA team
- Conduct researches and gather data or information on the impact study area, i.e., geological, climatology, socio-economic aspects, past environmental conditions of the project.

- Review environmental regulations and standards implemented in the Philippines that cover the project.

EIA Study Area

The EIA study area is the a) San Juan River Basin) Maalimango Creek including the coastal area as the possible receiving end of discharges situated in 23 barangays within the municipalities of Kawit, Noveleta, Rosario, Imus at General Trias

The study areas in general are the primary and secondary impact areas. The primary impacts areas of the project are the adjacent community. These are the communities which will be affected by the impacts of the project particularly in its operation.

Coverage of Various Studies

Module	Coverage
Geology, Geomorphology, Hydrology and Hydrogeology, and Meteorology	San Juan River Basin, Maalimango Creek, areas to be widen and areas to be dredge, nearby barangays including coastal areas
Terrestrial and Marine water Biology	Site, nearby barangays, surface and coastal water
People Module	Communities within the site and nearby barangays.

EIA Methodology

Different methods were used in collecting primary data from the field but utilized similar technique for secondary data collection. Tables below show the methods used for each field of study and the general methods for the EIA study.

Component	Primary	Secondary	Data/Document	Source
Project Description	✓	✓	FS	Proponents
Land Component Geology Terrestrial	 ✓ ✓	 ✓ ✓	Geology/pedology Hydrology/hydrogeology Flora and fauna	 Actual survey
Water Ground & Spring Marine	 ✓ ✓		River, creeks, water table	Actual Sampling
Air	✓	✓	Meteorology	PAGASA
Socio Economics	✓	✓	Municipal Comprehensive Land Use Plans (CLUPs) and municipal and barangay profile which covers 5 municipalities/cities and 23 barangays	LGU/KII/actual survey

COMPONENT	METHODOLOGY
Project Description	Consultation with the Proponent regarding the details of the project
Land Geology	Used of Secondary data, actual site assessment and sampling Actual site assessment and use of NAMRIA map, Detailed and

Terrestrial	Reconnaissance site assessment Actual Survey and analysis by 20x20 m plot/10x10m plot/4x4 m plot), use of binocular, active searching, field observation, pail traps were installed, netting used for collecting specimens
Water	Actual Site assessment, baseline sampling/used of NAMRIA/Google maps
Air	Use of secondary data, actual baseline sampling ,Air modeling
Marine	Rapid resource assessment, Point Intercept method ,Quadrant transect assessment ,Bathymetry
Socio-economic component	Public Scoping, Key Informants interview, Project perception/social acceptability survey, Community Gender participation survey, Household survey on direct impact and secondary impact areas, secondary data gathering

Methods

General Methods for the EIA Study

Component	Methodology
Project Description and Concept Design	Meetings with the proponent and exchanges of emails.
Secondary Data and Relevant Environmental Laws	Research work with LGUs, NSO, PAGASA, EMB,OSHC for data gathering , Compilation of air and water standards
Delineation of the Impact Areas	Annex 2-2 of RPM DAO 2003-30
Identification of the stakeholders	Annex 2-3 of RPM DAO 2003-30
Description of the existing environment	EIS Scoping Checklist (Annex 2-7a of RPM DAO 2003-30) Secondary data collection Ocular inspection Ambient Air Quality Sampling Sound level measurements Terrestrial and Marine Survey Bathymetry Survey Water Quality Sampling Perception Survey, FGD, KII
Impact identification	Modified impact identification checklist by Canter (1996)
Impact assessment	Qualitative assessment Expert opinion
Environmental management and monitoring Plan	Impact Management Plan Template (Annex 2-17 of RPM DAO 2003-30) Template for Social Development Plan (Annex 2-18 of RPM DAO 2003-30) Template for IEC Plan (Annex 2-19 of RPM DAO 2003-30) Template for EMoP (Annex 2-20 of RPM DAO 2003-30)
Environmental Risk Assessment (ERA)	Procedural Scoping Guidelines for ERA (Annex 2-7e of RPM DAO 2003-30)

Public Participation

A total of 38 registered participants attended the public scoping held at Casa Hacienda Tejeros Convention, Rosario, Cavite last February 11, 2016. A second public consultation was held on November 28, 2016 with a total of 66 registered participants where forty (40) were males and twenty six (26) were females. The participants were representatives from the Local Government

Units of Rosario, General Trias, and Noveleta, representatives from the barangays covered by the project, provincial government, Non-Government Organizations (NGOs), and project consultants

Highlights of the Public Scoping

The one-day event on February 11, 2016 highlighted the (1) presentation of the proposed Project, its benefit and implications; (2) explanation/discussion of the EIA and the processes to be undertaken; (3) clarification/synthesis of issues and concerns raised; and (4) insights of all the stakeholders about the Project. The second public scoping focused on the presentation of the results of the baseline study conducted, the impact assessment on the environment and mitigating measures and future schedule of the project. Majority of the issues raised during the public consultation are related to resettlement.

The presence of different stakeholders during the public scoping is an indication of their concern/support on the implementation of the Project. Also, acquiring insights and recommendations from the stakeholders is very significant for the improvement and success of the project.

The public scoping attained the set objectives through the cooperation of the stakeholders. It is concluded that all issues and concerns can be resolved through proper consultation and coordination of the proponent to the stakeholders. Intensive Information-Education-Communication campaign about the project is very essential condition to generate full support to the project. Lastly, strict compliance with the existing laws and policies are very significant to avoid unnecessary impacts to the community and the environment.

Summary of Baseline Characterization, Key Environmental Impacts and Management and Monitoring Plan and EMF and EGF Commitments

Key Baseline Findings

COMPONENTS/ SUBCOMPONENTS	KEY BASELINE FINDINGS
LAND	
Geology	The greater part of the Project will sit on Quaternary Alluvium. The southern portion of the Project is underlain by Diliman Tuff that represents the upper member of the Guadalupe Formation. The Diliman Tuff is described by MGB as thin to medium-bedded, fine grained vitric tuffs and welded volcanic breccias with subordinate amount of fine to medium grained tuffaceous sandstone.
Topography	The Project Area can be divided into two (2) physiographical areas, namely: the lowest lowland area along the coastal plains; and the lowland area within the coastal and alluvial plains. The lowest lowland area is situated along the coastal plains of Kawit, Noveleta, and Rosario. The area is susceptible to tidal inundation due to its almost flat and extremely low ground level of El. 0 to 2 meters . The lowland area consists of coastal and alluvial plains with ground elevation ranging from EL. 2 to 30 meters. The alluvial plain covers Imus, some parts of Kawit, Noveleta, Rosario, and the southern parts

	of General Trias The topography is largely flat created by the deposition of sediments coming from rivers in the highland areas.
Soil	The greater part of the Project will encounter Quaternary Alluvium composed of unconsolidated clay, silt, sand and gravel. The southern portion of the Project is underlain by the Diliman Tuff composed of thin to medium-bedded, fine grained vitric tuffs and welded volcanic breccias with subordinate amount of fine to medium grained tuffaceous sandstone.
Terrestrial	
Flora	A total of 14 families containing 85 tree species were encountered from the 10 established 20x20m plots in the project area. It also shows that the family Meliaceae has the highest number of species and rank 3rd together with Anacardiaceae with 11.76%. It is followed by Moraceae which rank 2nd with 12.96%. While the family Lamiaceae, rank 1st with the highest vegetation composition even though it is one of the eight (8) out of the fourteen (14) families that has only one (1) species.
Fauna	Result of the assessment revealed that a total of twenty three (23) bird species were identified in the project area. Twenty two (22) species were observed and one (1) species is claimed to be present by the locals. Two (2) species of reptiles, three (3) mammals and one (1) amphibian were also recorded during the assessment. With the aid of pitfall traps and butterfly nets, insects were collected around the project site
WATER	
Hydrology/Hydrogeology	The main river system that affects the project area is the San Juan River. Its waters are sourced from the Rio Grande River on the west which started in Maitim, Amadeo. It traverses northward passing Maitim, Lalaan I, Biclatan, Manggahan, Jaime Baker; Buenavista, Pasong Kawayan, Bacao, Gen. Trias; Sta. Rosa, Noveleta and Putol, Kawit. The other source of San Juan River is the Ylang-Ylang River on the east which also traverses in the same direction from Pasong Camachile River which started from Santiago and passing San Gabriel then connect with San Juan River; San Jose, Dasmariñas converging with San Juan River at Bacao, Gen. Trias. The San Juan River Basin has an area of about 134.28 square kilometers from the mouth at Noveleta to the farthest point at Maitim, Amadeo with a river length of 39 kilometers and discharges to Bacoor Bay in Kawit.
Surface Water Quality	Based on the results of the sample taken, the non-conforming parameters in some sampling stations are biological oxygen demand, dissolved oxygen and salinity. The S1, S2, S9 and S10 stations have failed results for BOD and salinity, while S3 and S6 have non-conforming results for salinity only. Stations S2 and S10 have dissolved oxygen levels below the required minimum. The stations S3, S4, S5 and S8 have satisfactory results based on the tested parameters.
Fishery n Aquatic Life	The fish catch in the river consist of “tilapia”, “banak” “biya”, “buan-buan”, “bidbid”, “bagaong”, “asohos”, and “bangos”. It was observed during the present survey that the fish in all the stations sampled was mostly “tilapia”.

	Generally, the quality of fish obtained in the river /estuaries is quite poor due to the small size of the fish caught. Almost all of the fishes are inhabitants of shallow coastal habitats that enter the river or brackishwater / estuaries. Most of them are euryhaline, inhabiting coastal marine waters, brackish water lagoons, estuaries and may enter freshwaters (Carpenter and Niem, 1999). They can tolerate a wide range of temperature and salinity from highly saline to freshwater.
Ground Water	In 1982, there are 409 wells in the whole province of Cavite with depths ranging from 13 meters to 243 meters. In 2015, a total number of 2,673 wells are located in the province as per record from the Local Water Utilities Administration (LWUA). The average depth of wells in 1982 was 72.4 meters compared to the present average which is 155.6 meters. There are 63 wells located within the project area with an average depth of 155.6 meters. Depth of the wells ranges from 18.3 meters to 304.8 meters.
Ground Water Quality	It can be observed from the obtained data that only total coliform of GW4 has nonconforming result based on PNSDW limits. There are no limits for the other parameters analyzed. However, if the salinity results will be compared to those of surface water samples, GW1 has result beyond 350 mg/L chloride limit.
Mangrove	Based on the delineated mangrove map , there is an estimated area of 3.7 hectares are within the coverage of the proposed San Juan Diversion channel (77.29%) and Maalimango Creek (22.71%). Delineated mangrove area is undertaken using the Google earth 2016 photo and validated on ground during the conduct of site assessment to estimate the extent of mangrove coverage. Water channels, fishpond as well as settlements are not included in the measurement. Mangrove species are sporadically located in these sites in aggregates with fishponds, built up areas and settlements. It is dissected by natural drain channels including the maalimango creek. Further, it was observed that portions of the mangrove areas are already inhabited and even claimed as private/titled by some individuals. Portions are already converted into other land use such as settlement and industrial area.
AIR	
Climate	Type 1. Two pronounce Season. Dry from November to April and wet throughout the rest of the year.
Rainfall	The average annual rainfall recorded based on 30 years data is 2078.4 mm
Temperature	Annual temperature varies from 26^0Crecorded in the coastal area to 31^0C in the lowland and hilly areas.
PAGASA 2020-2050 projection	-The Philippines ranks high among the countries that are at risk to climate change. -Climate projections indicate increases in annual mean temperatures by 0.9-1.1 °C in the 2020s and 1.8-2.2 °C in the 2050s. -Hot days and dry days are likely to be more frequent over the Philippines with more heavy rainfall days especially over Luzon and Visayas by 2020 and 2050. -Reduction in rainfall in most parts of the Philippines is predicted during the summer (MAM) season. However rainfall increase is a trend during the southwest monsoon (JJA) until the transition (SON) season in most areas of Luzon and Visayas in 2020 and 2050.

	-Heavy daily rainfall will continue to become more frequent, and extreme rainfall is projected to increase in Luzon and Visayas only. But number of dry days is expected to increase in all parts of the country in 2020 and 2050.
Ambient Air Quality Ambient Noise	TSP and PM_{10} at Station A1 exceeded the NAAQGV guidelines at 230 µg/Ncm and 150 µg/Ncm respectively, while Station A2 in General Trias met the required limit. High results of TSP and PM_{10} at Sta. Rosa I, Noveleta, Cavite, Molina's compound may have been influenced by the 305 light vehicles and 1,130 motorcycles and tricyles plying in the area. It was also observed that a smoke was seen coming from the dump site which is 400 meters away from Station A1. Meteorological factors such as the wind velocity and direction may also have contributed to the movement of dust from the road. For NO_2, SO_2, and CO, all stations met the required standard limits. For SO_2 results, the detection limit in each station is different since they have different sampling volumes. For CO, there is no standard limit set in Ambient Air Quality under Philippine Clean Air Act.
Noise	Major sources of max noise levels came from vehicles plying in the streets.
Vibration	Peak movements recorded during surveys were caused by activities such as passing of vehicles on the road or by an ongoing construction as these activities were observed while capturing ground vibrations. Peak ground vibration at each of the three sites did not exceed the assessment criteria of 5mm/sec (0.5 cm/sec).
PEOPLE	
Population	As of 2010 NSO records shows a population of: Rosario – 92,253 Kawit – 78,209 Gen Trias – 243,322 Noveleta 37,865 Imus -301,624
Source of Income	Industries, fishing, agricultural
Power	Power is being supplied by MERALCO
Water Supply	Mostly source is ground water supplied by Maynilad Water Service Inc.

SUMMARY OF KEY IMPACTS and MITIGATING MEASURES

It has been determined that most of the negative impacts will be during construction phase like erosion, surface runoff, generation of both solid and liquid domestic waste, odor and handling and management of dredge material.. In terms of environmental impacts, the main components that need to be managed are: water quality at the receiving surface water, dredge materials disposal and possible odor generation. Positive impacts is expected during Operation Phase.

Project Phase	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
I. Pre-Construction Phase	This will be addressed during implementation of RAP as resettlement is expected to be done prior to project implementation or prior to construction.		

II. Construction Phase			
Environmental Aspect # 1	The Land	Change in land use Destabilization of slope Removal of vegetation and habitat disturbance Soil erosion Increase run off	• Set-up temporary fence around the construction area • Conduct slope stability analysis and construct silt trap and spoils disposal area • Ensure solid waste management plan prior to mobilization of project; proper segregation and disposal shall be included in the program; Strictly require contractors and their workers to observe proper waste disposal and sanitation • Cutting Permit will be secured if there are trees that will be affected during construction • Limit land clearing in designated sites only. Avoid the removal/ clearing of mangrove species that will serve as buffer zone against strong winds, tsunami, soil from soil erosion, and others. The mangrove area will be protected to serve as habitat to remaining faunal species and species genepool • Establishment of a small nursery as source of planting materials using the endemic species and fruit-bearing trees found onsite for the replacement of trees to be cut or removed • Gradual clearing and removal of vegetation to provide sufficient time for wildlife species to transfer to the nearby habitat. Further, the existing mangrove forest within the project area shall be protected to serve as refuge and forage/feeding area for wildlife species. Planting of naturally-grown species in the designated areas might encourage the wildlife species to return in the future.
Environmental Aspect # 2	The Water	• Increase in run-off -Generation of domestic wastewater -Generation of wastewater from cleaning of construction	• Site clearing will be limited to areas needed and restricted to acceptable weather conditions • No clearance or establishment works will be undertaken during high rainfall conditions to reduce the risk of sediment loss to the

		equipment, vehicles and regular watering activities • Contamination of surface water with oil and grease • Marine & terrestrial habitat disturbance	environment • Set up adequate toilet facilities; ensure sufficient washrooms for workers • Construction of settling ponds to contain inflow of muddy waters • Installation of oil traps and proper storage of used oil
Environmental Aspect # 3	The Air	• Dust generation during clearing of the site and stockpiling of soil • Dust generation during opening up of pits, associated with movement of vehicles and machinery and excavation, transportation and emplacement of rock and soil • Dust generation during construction of the processing plant, power plant and storage facility, associated with movement of vehicles and machinery and excavation, transportation and emplacement of rock and soil • Exhaust fumes and noise from vehicles	• Roads will be watered especially during hot and dry weather. Regular water spraying by water sprinklers (road tank watering) during construction. • Regulate speed of delivery/ hauling trucks • Provide equipment with ear plugs, mufflers and proper scheduling of noise-generating activities
Environmental Aspect # 4	The People	• Increase in livelihood and business opportunities • Increase in revenues	• Alleviate economy and generation of income to hosts and nearby barangays • Increased LGU revenues resulting from the purchase of locally available materials and equipment for construction, translating to additional taxes. Business establishments should be properly registered and payment of the required taxes shall be monitored.

		• Provide job opportunities for construction workers • Health Risk	• The construction of the project will generate employment opportunities for local residents as well as migrant workers. It will bring increased income to those who will be employed. Local manpower may have to compete with migrant labor for employment. Employment of local residents during the construction stage shall be given priority, particularly those from families in the Direct Impact Area. • Use of appropriate PPE and proper training of workers

Environmental Aspect #5	Solid and Hazardous Wastes	Used oil, paint wastes, scrap metals, busted lamps, and spent fuels	• Ensure a Solid Waste Management Plan to cover proper segregation, waste handling, waste storage and a waste disposal system. • Employ waste management strategies on reduce, re-use and recycle programs - Reduce – Reduction of waste through less packaging by promoting bulk purchasing without packaging; less single-use devices - Reuse – Choose water supply, office supplies that are re-usable, e.g. use printer inks that are refillable - Recycle – Composting the water supply and kitchen waste is a very useful form of recycling -Waste receptacles/bins shall be provided in strategic locations within the work areas. There shall be an identified designated area for the temporary disposal of domestic and construction wastes -Proper handling, transport and storage of chemicals such as used oil, used batteries, busted lamps etc. must comply with local regulations -Selling of scrap metals and used oil will adhere to local regulations • Material Safety Data Sheet will be in place • Climate Change Adaptation: - Reduction of greenhouse emissions from energy used in offices by using green energy power or use of lighting that is environment friendly such as LED lights. - Implementation of rain water harvesting - Recycle office paper, newspapers, beverage containers, electronic equipment and batteries. Reducing, reusing and recycling in the office helps conserve energy, and reduce

			pollution and greenhouse gases from resource extraction, manufacturing, and disposal. Reduce, reuse, and recycle in the office can be done by using two-sided printing and copying, buying supplies made with recycled content, and recycling used printer cartridges. For old electronics, donate used equipment to other organizations or sold to accredited scrap buyers.

III. Abandonment Phase (Immediate after Construction Phase)			
	The Land	• Land degradation • Damage to access and hauling roads • Loss of livelihood	• Preparation and implementation of comprehensive abandonment management plan • Proper clean-up and decontamination of affected site • Proper dismantling of equipment • Disposal of hazardous waste • Maintenance and rehabilitation of roads with drainage system in place • Retrenchment packages for displaced employees • Provision of alternative livelihood

Summary of Compliance Monitoring

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person
			METHOD	FREQUENCY	LOCATION	
CONSTRUCTION PHASE						
Environmental Aspect	Fresh Surface Water Quality Stations: Rio Grande River Ylang-Ylang River Maalimango creek San Juan River Manila Bay Riverbed Sediments	Surface Water Total Suspended Solids (TSS), pH, BOD, DO, Oil & Grease, Color, turbidity -Heavy metals (As, Ba, Cd, Cr, Cu, Pb, Hg,Se,F), OCPs, OPPs	Grab Sampling RA 9275 RA 6969	Monthly Quarterly	Upstream; midstream and downstream -For Manila Bay, sampling point to be monitored should be within the project site Same stations with fresh surface water quality	PCO
	Air Quality Proposed site	Total Suspended Particulates (TSP) & PM_{10}, CO, SO_2, NO_2,	1-hr Sampling per RA 8749	Quarterly	Upwind; downwind; NSEW direction	PCO

	locations -General Trias -Rosario -Noveleta	CO				
	Noise Quality Proposed site locations -General Trias -Rosario -Noveleta	Ambient Noise and Vibration (especially during drilling activities)	Grab sampling	Monthly/ Weekly during drilling	Upwind; downwind; NSEW direction	PCO
	Solid Wastes	Construction debris, papers, plastics, biodegradable waste		Daily	Construction site / SW storage area	PCO
	Wastewater (domestic)	TSS, BOD, pH, Oil & Grease (canteen)	Grab Sampling RA 9275	As necessary	Common septic tanks for toilets & canteens	PCO
	Chemicals & Hazardous Wastes	Used oil, busted lamps Used paints, spent solvents	Individual segregation & collection		Storage Area/ Motorpool	PCO
	Socio-economic	Displacement of informal settlers; relocation Recruitment/hiring for manual labor & other skills available within the Host Barangay & nearby communities			Project location	CRO
	Terrestrial Flora & fauna Impacts	Flora- species dominance within quadrants in terms of total cover, relative ground cover, absolute density, absolute frequency, relative density and relative frequency of individual species Fauna – species diversity index, dominance index, and evenness index Soil Nutrients, Plant Tissue Nutrients	Line transect/ quadrat / trap	Annual	Within project vicinity and its affected barangays	PCO
	Social Impacts	1. Income comparison for relocated households before & after relocation 2. Number of immigrants attracted by the project 3. Proportion of direct employment to residents of impact barangays to total direct employment provided by the	Interviews	Annual	Brgys. affected	PCO

		Project and distribution of employed residents per impact barangay 4. Number of alternative means of livelihood created and number of people actually benefited 5. Income comparison for brgys. and municipality before and during the project 6. Ratio of income gained and income lost				
	Health Impacts	1. Health impacts 2. Morbidity, mortality 3. Health profile of receptor communities 4. Vital health indices 5. Malnutrition Environmental Quality and Health 6. Environmental Sanitation ▪ OHS records of employees ▪ Interviews and medical examination of high-risk groups ▪ Inspection of facilities, control devices, PPEs, and working conditions ▪ Health data-basing for most vulnerable public groups	Interviews	Annual		HSE

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person
			METHOD	FREQUENCY	LOCATION	
ABANDONMENT PHASE (IMMEDIATE AFTER CONSTRUCTION PHASE)						
Environmental Aspect	Land (Disposal Site)	-Heavy metals (As, Ba, Cd, Cr, Cu, Pb, Hg,Se,F) OCPs, OPPs	Systematic sampling: Several Grab and composite Sampling	As prescribed	Designated disposal sites	PCO

	Clearing of construction debris; removal of construction equipment					

Republic of the Philippines
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MEMORANDUM

FOR : **REGIONAL DIRECTOR**
EMB REGION IVA

FROM : **CHIEF**
EIAM DIVISION

SUBJECT : **TECHNICAL SCOPING OF THE PROPOSED FLOOD MITIGATION PROJECT FOR CAVITE LOWLAND AREA**

DATE : JAN 25 2016

Forwarded is a letter from KRC Environmental Services dated 18 January 2016 requesting for a technical scoping of the proposed Flood Mitigation Project for Cavite Lowland Area. In accordance to the EMB Memorandum Circular 2014-005, the ECC application for this type of undertaking is within the jurisdiction of the Regional Office. Kindly coordinate with them for the processing of the project's ECC.

For your appropriate action.

ATTY. MICHAEL DRAKE P. MATIAS

Protect the environment... Protect life...

Republic of the Philippines
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JAN 25 2016

Engr. Marilou Avenido
Consultant
KRC ENVIRONMENTAL SERVICES
381 Sto. Rosario St., Angeles City

Dear Engineer Avenido:

This is in reference to your letter dated 18 January 2016 requesting for a technical scoping of the proposed Flood Mitigation Project for Cavite Lowland Area. Kindly be informed that in accordance to the EMB Memorandum Circular 2014-005, the ECC application for this type of undertaking is within the jurisdiction of our Regional Office. Thus, you are advised to submit your application to the Clearance and Permitting Division (CPD) of EMB Region IVA with office address at 1515 L&S Building, Roxas Boulevard, Ermita Manila. You may reach them at telephone numbers (02)536-9784 and (02)525-0348.

Very truly yours,

ATTY. MICHAEL DRAKE P. MATIAS
Chief, EIAM Division

Protect the environment... Protect life...

Chapter 1

Basic Project Information

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Chapter 1 – PROJECT INFORMATION

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1 BASIC PROJECT INFORMATION

1.1 Project Summary

The Philippines, particularly Luzon is predicted to have frequent extreme heavy rainfall as one of the effect of climate change. Every year our country is visited by strong typhoons putting lowland areas badly hit by floods. Floods that have cause loss of lives, properties and economic disasters. Cavite, which is one of the most industrialized and one of the fastest growing provinces in the country, is not spare from this catastrophe. It is for this reason that the Philippine Government requested the Japan International Cooperation Agency (JICA) to conduct a study in addressing the flood problems in the low land areas of Cavite with the following objectives.

1.1.1 Improvements in living environment and quality of life of the residents by mitigating the damages by flood/inundation in the lower reach of rivers at Cavite Province, particularly along San Juan River and Maalimango Creek.

1.1.2 Creation of more dynamic economy by providing a flood-free economic zone

As a result of the studies and surveys conducted in 2009 to 2015, JICA came up with a comprehensive master plan to address if not mitigate floods in Cavite lowland areas. The Master plan is composed of various components. However prior to the implementation there is a need to conduct an environmental impact assessment for its component and eventually secure an Environmental Compliance Certificate (ECC)

It is for this reason that this study is being conducted. The study will focus initially on the following project: River improvement Works of San Juan River, Rio Grande River and Ylang-Ylang River; Construction of Diversion Channel from the confluence of Rio Grande and Ylang-Ylang rivers to Manila Bay; Drainage improvement widening and dredging of Maalimango Creek and Construction of Diversion drainage Table 1.1 summarizes the project works.

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Table 1.1 Summary of Project Works

Item		Description	Length
River Improvement in San Juan River Basin	Rio Grande River Improvement	- River Excavation - Concrete Block Slope Protection - Foot Protection	Sta. 4+808 ~ 6+389 (L=1.6 km)
		- River Excavation - Concrete Block Slope Protection - Foot Protection	Sta. 10+600 ~ 13+200 (L=2.6 km)
	Ylang-Ylang River Improvement	- River Excavation - Concrete Block Slope Protection - Foot Protection	Sta. 0+000 ~ 2+787 (L=2.8 km)
	San Juan Diversion Channel	- Excavation for Diversion Channel - Dike Embankment - Concrete Block Slope Protection - Foot Protection	Sta. 0+000 ~ 2+000 (L=2.0 km)
Drainage Improvement at Maalimango Creek	Maalimango Drainage Improvement	- Dredging/Drainage Channel Widening - Concrete Block Slope Protection	Sta. 1+300 ~ 3+000 (L=1.7 km)
	Diversion Drainage I	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~ 1+000 (L=1.0 km)
	Diversion Drainage II	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~3+200 (L=3.2 km)

Basic information is summarized below:

1.2 Project Information

1.2.1 **Name of the Project: FLOOD MITIGATION FOR CAVITE LOWLAND AREA**

1.2.2 **Location: San Juan River Basin and Maalimango Creek, Cavite Province Region 4-A**

1.2.3 **Nature of Project: Flood Mitigation Project**

1.2.4 Size/Scale: Size and Scale is summaries in Table 1.2

Table 1.2 – Location, Size and Scale of the Project Works

Measures	Components	Area (ha)
1. River Flood Mitigation	1-1) San Juan Diversion Channel	24.9
	1-2) Rio Grande River Improvement	14.7
	1-3) Ylang-Ylang River Improvement	9.2
2. Drainage Facilities	2-1) Maalimango Drainage Improvement	11.3 - subtotal 5.0
	2-2) Diversion Drainage-I	2.4
	2-3) Diversion Drainage-II	3.9
Total		60.1

1.2.5 **Proponent**

Proponent Profile:

Proponent	**Government of the Republic of the Philippines** **Department of Public Works and Highway (DPWH)**
In partnership with **Represented**	Japan International Cooperation Agency (JICA) CTI Engineering International Co., Ltd. Makihiko Otigawa

by	
Address	Tachibana Annex Building 2-25-14 KamaeidoKoto-ku Tokyo, Japan 136-0071
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In Charge of ECC Application:

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Consultant	Engr. Marilou P. Avenido Maria Carmela Q. Capule
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Chapter 2

Description of the Project's EIA Process

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2. DESCRIPTION OF THE PROJECT'S EIA PROCESS

2.1 Terms of Reference of the EIA Study

This document is prepared in accordance with the provision stipulated in the Revised Procedural Manual (RPM) for DENR Administrative Order No. 30 Series of 2003. Minutes of the Technical Scoping and Technical Scoping Checklists are provided in Annex 2.1.

2.1.1 Policy, Legal and Administrative Framework

Table 2.1 shows the policies, laws, administrative orders and memorandum circulars that are applicable and discussed in the Environmental Impact Study.

Table 2.1 – Laws, Regulations and Administrative Orders Applicable in EIS

Category	Title
Environmental Impact Assessment	Revised Procedural Manual for DENR Administrative Order No. 30 Series of 2003 (Implementing Rules and Regulations of Presidential Decree No. 1586, Establishing the Philippine Environmental Impact Statement System), August 2007.
	Memorandum Circular No. 005, Series of 2014, Revised Guidelines for Coverage Screening and Standardized Requirements Under the Philippine EIS System
	Memorandum Circular No. 005, Series of 2011, Incorporating Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) concerns in the Philippine EIS System
Land (Terrestrial Flora)	Memorandum Circular No. 01, Series of 2014. Guidelines for the Implementation of the DPWH-DENR-DSWD Partnership on the Tree Replacement Project
Ambient Water Quality	Philippine Clean Water Act of 2004 or known as Republic Act 9275
	Administrative Order No. 10, Series of 2005, Implementing Rules and Regulations of the Philippine Clean Water Act of 2004
	DENR Administrative Order No. 34, Revised Water Usage and Classification/Water Quality Criteria Amending Section Nos. 68 and 69, Chapter III of the 197 NPCC Rules and Regulations
Ground Water Quality	Philippine National Standards for Drinking Water 2007
	Administrative Order No. 0012 Series of 2007
Ambient Air Quality	Republic Act 8749 or known as Philippine Clean Air Act,
	DENR Administrative Order No. 2000-81
Noise Quality	National Pollution Control Commission (NPCC) Rules and Regulations, Chapter IV, Article 1, Section 78
Solid Wastes	Republic Act 2003, Ecological and Solid Waste Management Act, Series of 2000
	Administrative Order No. 34, Series of 2001. Implementing Rules and Regulations of RA 9003
Hazardous Wastes	Republic Act 6969, Toxic Substances and Hazardous Wastes

	Act, 1990.
	Administrative Order No. 22, Series of 2013. Revised Procedures and Standards for the Management of Hazardous Wastes (Revising DAO 2004-36)

2.2 EIA Team

Table 2.2 shows the EIA composition and the field of expertise.

Table 2.2 – EIA Composition

EIA Team	Function/Role
Maria Carmela Q. Capule	Project Manager/Environmental Scientist
Marilou P. Avenido	EIA Team Leader
Carolyn D. Barrias	Flora and Fauna Specialist
Virgilio Montealto Garcia	Hydrologist
Pablito C. Argamosa	Geologist
Milagros Pasion-Asuncion	Sociologist

2.3 EIA Study Schedule

The EIA team undertook the following schedule on **Table 2.3** from December 2015 to December 2016 as part of the preparation and conduct of the EIA process:

Table 2.3 – EIA Schedule of Activities

Date	Activities
2015 December	Discussion of the project with CTI-JICA and DPWH
2016 January	Review environmental regulations and standards implemented in the Philippines that cover the project
2016 Jan-Feb	Conduct pre-scoping, technical scoping and 1st public consultation to determine the issues to be addressed by the EIA team
2016 March	Conduct survey, field investigation and site inspection of the project including the outlying areas to determine its biophysical conditions (i.e., air and water quality, noise/sonic environment, land such as geological, etc.)
Feb-March	Conduct researches and gather data or information on the impact study area, i.e., geological, climatology, socio-economic aspects, past environmental conditions of the project.
March –May	Report preparation
June - July	Submission of Draft Report to DPWH and revised report
November	2nd Public Consultation
December	Finalization of EIS and submission of final report to DPWH
January 2017	Submission of EIS to DENR

- Review environmental regulations and standards implemented in the Philippines that cover the project.
- Conduct of pre-scoping and public (site) and technical scoping to determine the issues to be addressed by the EIA team
- Conduct of survey, field investigation and site inspection of the project including the outlying areas to determine its biophysical conditions (i.e., air and water quality, noise/sonic environment, land such as geological, etc.)
- Conduct researches and gather data or information on the impact study area, i.e., geological, climatology, socio-economic aspects, past environmental conditions of the project.

2.4 EIA Study Area

The EIA study area is the San Juan River Basin, Maalimango Creek and their adjacent areas. Refer to **Table 2.4** for details.

- The San Juan /Rio Grande River which passes through the center of the administrative area of General Trias and merges with Ylang-Ylang River at the administrative boundary between municipalities of Imus and Noveleta about 4.8 km from the river mouth. The main River course after merging with Ylang-Ylang River, passes through the extremely low land area and finally flows into Bacoor Bay through an artificial Channel at the boundary of Noveleta and Kawit.
- The lowland area and the mangrove area of Kawit Municipality.
- Ylang-ylang River which meets Rio Grande after passing through the jurisdiction boundary of General Trias and Imus.

The study areas in general are the primary and secondary impact areas. The primary impacts areas of the project are the areas where dredging and widening will be done, areas where structures will be constructed. These are the communities which will be directly affected by the impacts of the project particularly during construction. The secondary impacts areas are the areas adjacent to the primary impacts areas. These are the areas that will be affected as a consequence of the projects.

Table 2.4 Coverage of Various Studies

Module	Coverage
Geology, Geomorphology, Hydrology and Hydrogeology, and Meteorology	3 river basins in the eastern part of Cavite, 5 municipalities: Imus, Kawit, Noveleta, Rosario and General Trias,
Terrestrial and Marine Water Biology	3 river basins in the eastern part of Cavite, including the Manila Bay near the outfall, Imus, Kawit, Rosario, Noveleta and Gen Trias
People Module	Communities within the site and nearby barangays.

2.5 EIA Methodology

Different methods were used in collecting primary data from the field but utilized similar technique for secondary data collection. **Table 2.5** and **Table 2.6** show the methods used for each field of study and the general methods for the EIA study.

Table 2.5 Methods Used during Field Surveys

Module	Coverage
Geology	Field Survey and Reconnaissance of secondary data, Geological Mapping using GPS, Geologic Compass, and Topographic Map
Hydrology	Delineation of water streams using Geologic Maps, Geographic location using GPS, water sampling and analysis
Meteorology	Secondary Data, maps, air sampling and analysis
Terrestrial Biology	Ocular and technical inspection, Random sampling, sampling plot distributed per area of improvement
People	Public Consultation. Focus group discussion, Interviews and random surveys

Table 2.6 - General Methods for the EIA Study

Component	Methodology
Project Description	Meeting with JICA and review of previous studies
Secondary Data and Relevant Environmental Laws	Research work: LGU,NSO,PAGASA,EMB,CTI Compilation of Water and Air/Noise standards
Delineation of the Impact Areas	Annex 2-2 of RPM DAO 2003-30
Identification of the stakeholders	Annex 2-3 0f RPM DAO 2003-30
Description of the Existing Environment	EIS Scoping Checklist (Annex 2-7a of RPM DAO 2003-30) Secondary data collection Ocular inspection Ambient Air Quality Sampling Sound and Vibration level measurements Terrestrial Survey Water Quality Sampling Soil Quality Sampling Perception Survey
Impact Identification	Modified impact identification checklist by Canter (1996)
Impact Assessment	Qualitative assessment Expert opinion
Environmental Management and Monitoring Plan	Impact Management Plan Template (Annex 2-17 of RPM DAO 2003-30)

	Template for Social Development Plan (Annex 2-18 of RPM DAO 2003-30) Template for IEC Plan (Annex 2-19 of RPM DAO 2003-30) Template for EMoP (Annex 2-20 of RPM DAO 2003-30)
Environmental Risk Assessment	Procedural Scoping Guidelines for ERA (Annex 2-7e of RPM DAO 2003-30)

2.6 Public Participation

A total of 38 registered participants attended the pre-public scoping held at Casa Hacienda Tejeros Convention, Rosario, Cavite last February 11, 2016. The participants were representatives from the Local Government Units of Rosario, Trias, and Noveleta, representatives from the barangays covered by the project, provincial government, Non-Government Organizations (NGOs), and project consultants.

A second public consultation was held on November 28, 2016 at Casa Hacienda Tejeros Convention, Rosario, Cavite. A total of 66 registered participants attended the meeting where forty (40) were males and twenty six (26) were females. The participants were representatives from the Local Government Units of Rosario, Trias, and Noveleta, representatives from the barangays covered by the project, provincial government, Non-Government Organizations (NGOs), and project consultants.

Highlights of the Public Scoping

The one-day event highlighted the (1) presentation of the proposed Project, its benefit and implications; (2) explanation/discussion of the EIA and the processes to be undertaken; (3) clarification/synthesis of issues and concerns raised; and (4) insights of all the stakeholders about the Project.

The second public scoping focused on the presentation of the results of the baseline study conducted, the impact assessment on the environment and mitigating measures and future schedule of the project. Majority of the issues raised during the public consultation are related to resettlement. Although there is a separate study for this concern, some participants still raised the issue to the team. The result of the consultation shows only that on the environment part, there are insignificant impacts identified and can be mitigated to minimized adverse impacts. On the other hand, the issue of resettlement should be taken into consideration to avoid misunderstanding between the proponent and stakeholders.

The presence of different stakeholders during the public scoping is an indication of their concern/support on the implementation of the Project. Also, acquiring insights and recommendations from the stakeholders is very significant for the improvement and success of the project.

The public scoping attained the set objectives through the cooperation of the stakeholders. It is concluded that all issues and concerns can be resolved through proper consultation and coordination of the proponent to the stakeholders. Intensive Information-Education-Communication campaign about the project is very essential condition to generate full support to the project. Lastly, strict compliance with the existing laws and policies are very significant to avoid unnecessary impacts to the community and the environment.

Details of public consultation and results are discussed in Chapter 4.5 and Appendix 4.

Chapter 3

Project Description

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Chapter 3 – PROJECT DESCRIPTION

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3. PROJECT DESCRIPTION

The study is one of the priority projects of the JICA which is a component of the Comprehensive Master plan for flood mitigation plan in lowland areas of Cavite. It constitutes combinations of structural and non-structural measures for the three (3) river basins vulnerable to flood in the eastern part of Cavite province **(Figure 3.1**). It will involve River improvement of San Juan River, Rio Grande River and Ylang-Ylang River. It will also involve the Construction of Diversion Channel from the confluence of Rio Grande and Ylang-Ylang Rivers to Manila Bay.

3.1 Project Location and Area

3.1.1 Project Location

The province of Cavite is located in the southern shores of Manila Bay in Region IV-A. The region is composed of five (5) provinces, namely Cavite, Laguna, Batangas, Rizal, and Quezon collectively known as CALABARZON (**Figure 3.2**).The province is bounded by Batangas in the south, Laguna in the east, Rizal in the northeast, Metro Manila and Manila Bay in the north, and the West Philippine Sea in the west. Cavite is one of the most industrialized provinces in the country. The closest point to Manila is Bacoor City located approximately 15 kms southwest of the metropolis.

3.1.2 Geographic Coordinates

The Project lies between geographic coordinates N 14^{0}22'0"-14^{0}26'0" Latitude and E 120^{0}51'40"-120^{0}54'0" Longitude (**Figure 3.3**). It covers the lowland municipalities of Kawit, Noveleta, Rosario,Imus and General Trias.

3.1.3 Accessibility

Travellers from Manila generally use the Aguinaldo Highway (Manila-Cavite Coastal Road) and the Las Piñas-Zapote Road as entry points to the province. The opening of the Cavite Expressway (CAVITEX) in 2011 lessened the heavy volume of vehicles along Aguinaldo Highway in Bacoor. The Muntinlupa–Cavite Expressway which was opened last 2015 reduced travel time from Daang Hari to Alabang Interchange as well as decongest traffic in Cavite, Las Piñas and Muntinlupa. There is a plan to extend the existing LRT Line 1 service southward to the cities of Parañaque, Las Piñas, and Bacoor. The 27-km route of the light railway system aims to serve approximately 1.9 million commuters from the aforementioned cities including the city of Pasay.

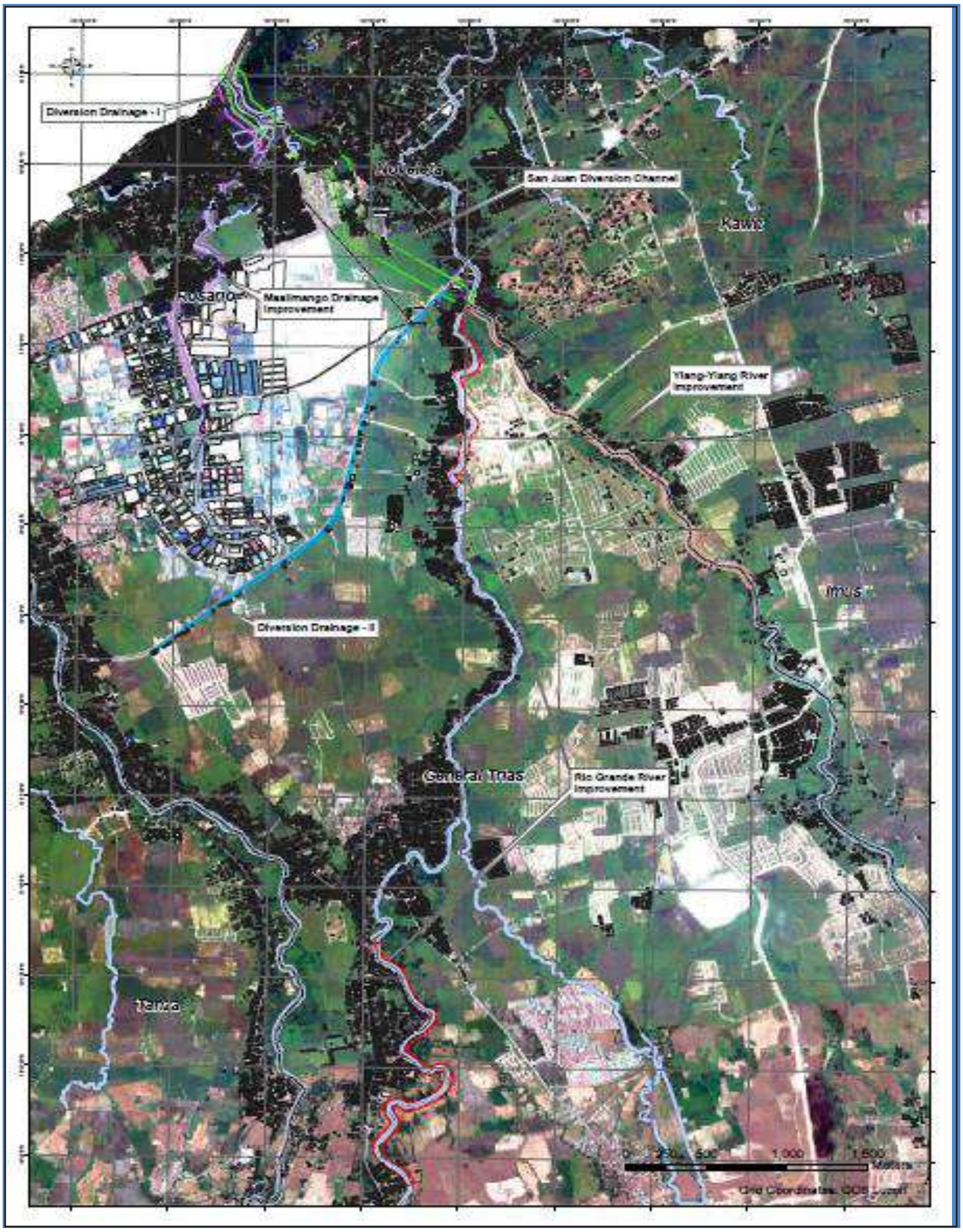


Figure 3.1: Project Area (Source: Project TOR, CTI Engineering International Co., Ltd).

Figure 3.2: Location of CALABARZON Region

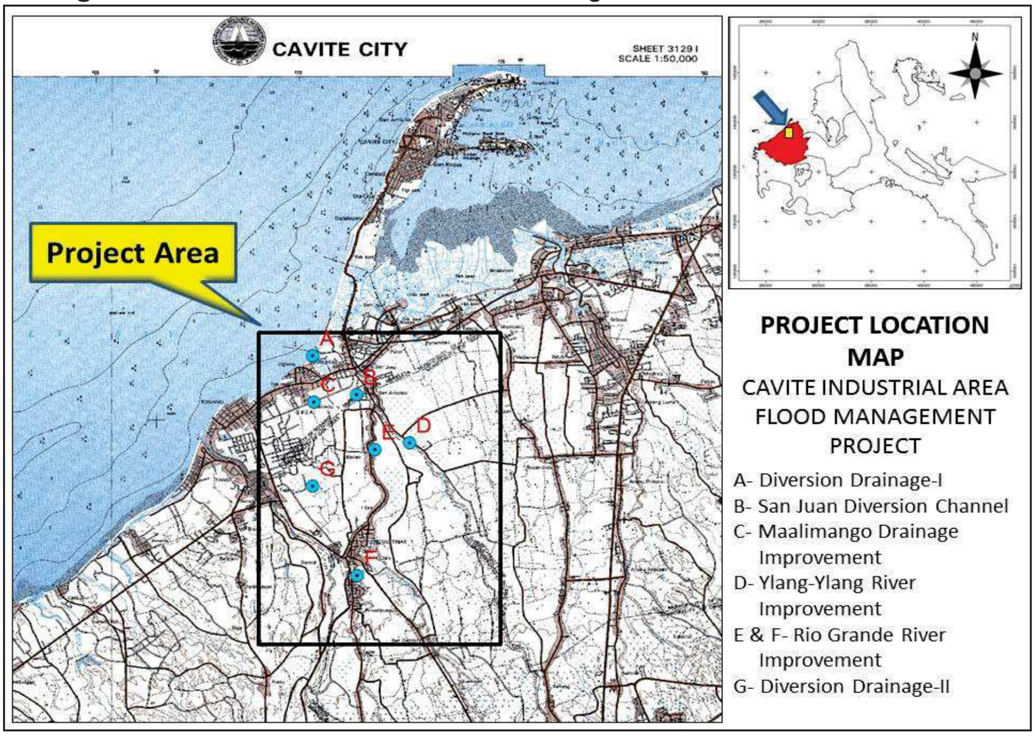


Figure 3.3: Project Location Map: (Base Map Source: NAMRIA Topographic Map Quad Sheet No. 3129-I Cavite City Scale 1:50,000).

3.1.4 Project Area

As summarized in **Table 3.1** the project measures and components will cover a total land area of 86.1 hectares with impact on 1,032 buildings, 1,912 households, and 8,341 people. The data will be updated once the RAP survey is done.

Table 3.1 Project Scope

Measures	Components	Preliminary Estimation			
		Area(ha)	Building	Household	Population
1.River Flood Mitigation	**1-1) San Juan Diversion Channel**	**28.7**	**579**	**1,210**	**4,598**
	1-2) Rio Grande River Improvement	21.9	164	246	1,294
	1-3) Ylang-Ylang River Improvement	14.2	89	178	920
4. Drainage Facilities	2-1) Maalimango Drainage Improvement	21.3	200	278	1,529
	2-2) Diversion Drainage-I				
	2-3) Diversion Drainage-II				
Total		86.1	1,032	1,912	8,341
Source: Project TOR, CTI Engineering International Co., Ltd.					

3.1.5 Impact Area

The direct impact areas that shall likely be affected by the project due to the improvement and widening of natural drain channels, construction of diversion and drain channels are those areas within and along the channels of Maalimango Creek, portions of Ylang-Ylang River, Rio Grande River, San Juan Diversion channel and within the proposed drainage alignments. Direct impact areas are located within the five municipalities of Cavite (Imus, Rosario, Noveleta, Gen. Trias, and Kawit) covering portions of the 23 barangays of the aforementioned municipality (see **Table 3.2**), the coastal area near the river mouth of the river improvement and the diversion channel as the coastal water quality will be affected; the areas where mangrove will be uprooted and the areas on the diversion channel where a number of houses and structures will be displaced, the houses and structures to be relocated.

Table 3.2 Project Component and Covered Areas

Project Component	Municipalities/Barangays
Diversion Drainage-I	Rosario -Ligtong I, Ligtong II Noveleta- San Rafael I
Maalimango Drainage Improvement	Rosario- Ligtong III, Bagbag I, Tejeros Convention
San Juan Diversion Channel	Noveleta- San Rafael II, Salcedo II, Salcedo I, Sta. Rosa I, Sta. Rosa II, San Antonio II
Ylang Ylang River Improvement	Noveleta- San Antonio II Kawit- San Sebastian Imus- Alapan II-A & II-B
Rio Grande River Improvement	Gen. Trias - Brgy. Bacao I, Prinza Pob., Sta. Clara, Pasong Camachile, Pinagtipunan
Diversion Drainage II	Rosario- Tejeros Convention Gen.Trias- Tejero, Bacao II

It also includes the selected access roads to facilitate delivery of construction materials and entry of machineries such as the dozers and dump trucks on site.

During the pre-construction phase, there are certain populations, house structures, improvements, crops and private lands directly affected by the project due to the acquisition of Right of Way (RoW) for the construction and improvements of those proposed drain channels. Among those areas directly impacted by the project includes portions of the mangrove area within the outlets of the proposed San Juan Diversion channel and Maalimango Creek in barangay San Rafael II and Ligtong I in the municipalities of Noveleta and Rosario, respectively.

3.1.5.1 Indirect Impact Area (IIA)

The indirect impacted area of the project are those areas not directly affected by the project development, however may have significant impacts to these developments. Among others includes those communities nearby, people working nearby the project site that shall experience anxiety due to traffic congestion, increase in noise, odor and dust pollution during construction including delivery of equipment and materials. Also, health and peace and order condition of nearby communities will somehow be affected during the construction phase due to the possible entry of several migrant workers. Likewise, primary roads along and near the proposed drain channels are also expected to experience more traffic during this phase. Indirectly impacted areas, also includes the relocation sites of Project Affected Families (PAFs).

On the other hand, most of the impacts are temporary but the positive impacts will forever benefits the whole lowland areas of Cavite as the project will address the flood problem in the area. Once the flood is resolve, economy will improve; there will be more jobs and employment.

Conversely, the impact of the project relative to the economy of the nearby communities and businesses shall be enhanced due to increase in demand of goods and services brought by the project. **Figure 3.4** shows the map of direct impact area- 50 meters from the center line in both sides (total of 100 meters) width. This covers the total width of the channel alignment intended for improvement, access road and immediate vicinity which will be impacted during construction activities.

Indirect impact- width is about 500 meters in both sides (total of 1km. width). This covers areas that will experience certain disturbance/enhancement of environment brought by the project activities. i.e. dust, noise, traffic adversity, peace and order issues due to possible temporary migration of workers in the project site etc. while, positive impact will be increased in goods/supply demand due to presence of workers which local economy will somehow be enhance during the construction phase.

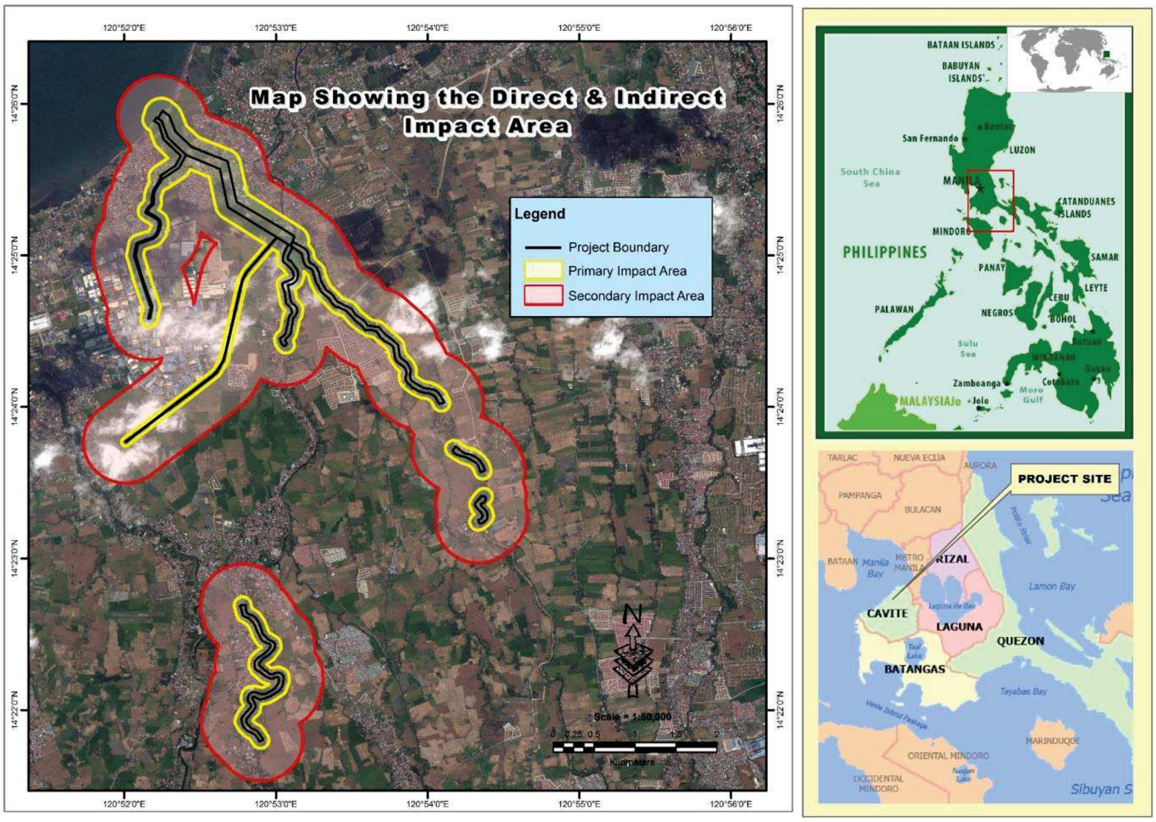


Figure 3.4 – Map of Direct and Indirect Impact Area

3.2 Project Rationale

The project is in response to the request of the Government of the Philippines to Japan International Cooperation Agency (JICA) to formulate a comprehensive plan for flood mitigation projects constituting structural and non-structural measures in the eastern portion of the Cavite Province where economic development is adversely affected with its vulnerability to flood. Thus, JICA Study Team came up with "THE STUDY ON COMPREHENSIVE FLOOD MITIGATION FOR CAVITE LOWLAND AREA" which was carried out from March 2007 to February 2009 (hereinafter referred to as “the JICA Study 2009”). The project aims to mitigate a natural disaster caused by flooding and contribute to a secure and more sustainable economic development at Cavite lowland area.

The project is the implementation of the JICA study 2009 and the JICA study 2015 which is needed on the premise to provide 25-50 years flood protection. The implementation of the project will address the growing flood problem in the area that has cause loss of lives, damage and loss of properties and disruption of economy of the area and the country as well.

The implementation of the project will save the government both local and national annual budget being used to address flood problem and saves Calamity fund being used for affected communities. It will unify the several efforts of the affected local government units in addressing the problem.

3.3 Project Alternative

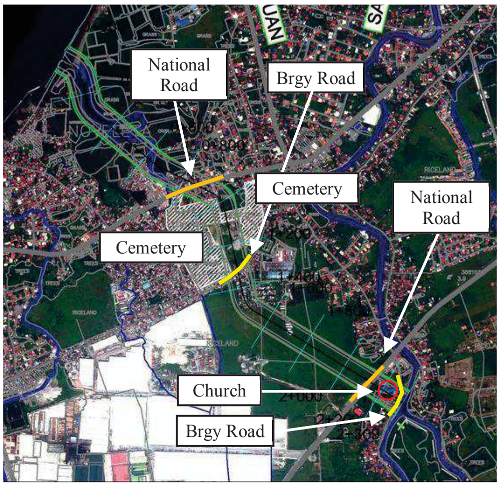
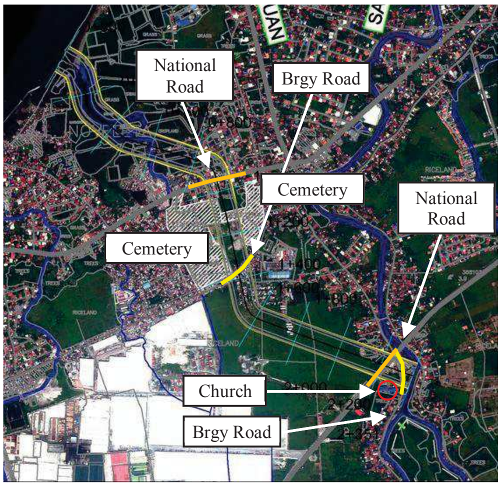
Alternatives in this context would mean the different alignment of the diversion channel and drainage improvement that were considered during the feasibility study such as the comparison of alignment of San Juan Diversion Channel and comparison of alignment of Maalimango Diversion drainage.

Each alternative was examined in terms of pollution Risk, the impacts on ecosystem, impacts on hydrogeological situation and geographical features, the number of household to be relocated and areas to be acquired and impacts on local communities.

The selections on the best alternative design were considered based on the lesser impacts to the environment, lesser structures and household to be relocated, lesser area to be acquired, lesser mangrove to be removed, lesser construction cost but best and early flood mitigation effect.

Tables 3.3 to Table 3.5 show the comparison of alignment of San Juan Diversion Channel and Maalimango Creek. These comparisons were examined and re-evaluated by the JICA team.

Table 3.3 Comparison of Alignment of San Juan Diversion Channel (1/2)

Item		Proposed Alignment in MP		Alternative 1	
Layout					
Feature		・ Length: 2.31km ・ Waterway Width: 105m ・ Crossing Road: 2 National Road, 2 Brgy Road ・ Crossing Cemetery ・ Crossing Church ・ On Existing Creek (downstream)		・ Length: 2.35km ・ Waterway Width: 105m ・ Inlet is moved to downstream side to avoid relocation of the church. ・ Efficiency of diversion may be worse since the diversion channel is connected to San Juan River at nearly normal. ・ Crossing Road: 2 National Road, 2 Brgy Road ・ Since existing bridge along national road is elevated and the diversion channel is close to the existing one, the new bridge on the diversion channel is directly connected to the existing one and the total length including approach road will be approx. 250m. ・ Temporary bridge is required for the bridge construction along EPZA diversion road ・ Diversion channel crosses Marseilla St. (northern national road) at orthogonal angle so that the length of bridge is shortened. ・ Crossing Cemetery ・ On Existing Creek (downstream)	
Impacts on Pollution	Pollution Risk	[Construction] ・ There is a concern of impacts by construction. Water pollution/ air pollution/ noise/ waste/ soil contamination/ offensive odor/ bottom sediment [Operation] ・ Condition of the status quo is maintained.		[Construction][Operation] ・ Same as MP	–

Natural Environmental Impact	Impacts on ecosystem	[Construction] ・ Impacts on ecosystem are minor as there are no rare species and fauna and flora to be protected in inland areas. ・ There is a possibility of impacting on mangrove forests at the mouths of San Juan river and diversion channel. [Operation] ・ There are no facilities to deteriorate the ecosystem.		[Construction][Operation] ・ Same as MP	–
	Impacts on hydrological situation and geographical features	[Construction] ・ There is a concern of impacts by construction. Hydrological situation (interference of watercourse by soil), geographical features (digging), soil erosion, groundwater (deep excavation) [Operation] ・ There is a concern of changes of geographical features by construction of structures. ・ Salt water may run up the new diversion channel during high tide. ・ On the other hand, as this is flood mitigation measures, it is expected to mitigate inundation.		[Construction][Operation] ・ Same as MP	–
Social Impact	Relocation and land acquisition	・ House relocation: 630 nos ・ Land Acquisition: 27.1 ha ・ Part of graveyards needs to be relocated. ・ Churches need to be relocated.		・ House relocation: 649 nos ・ Land Acquisition: 27.6 ha ・ Part of graveyards needs to be relocated. ・ There is a possibility of traffic congestion at the temporary bridge for EPZA diversion road over San Juan river. ・ Relocation of churches is not necessary.	○
	Local economy and conflicts of interests	[Pre-/Construction] ・ Conflicts among residents toward local employment of construction workers. ・ Concern of temporary loss of livelihood by relocation. ・ Employment generation by construction works and positive spread effects on related business. [Operation] ・ Maintenance and development of economic activities by flood mitigation measures.		[Pre-/Construction][Operation] ・ Same as MP	–
	Impacts on communities	[Pre-/Construction] ・ Changes of landscape by construction machineries and land use changes ・ Interference of river use (fishery and irrigation) during river improvement works. ・ Concern of traffic congestion by construction works and increase of traffic accidents. ・ Diversion routes are necessary for three sites of construction of bridges (It is possible for the		[Pre-/Construction] ・ Changes of landscape by construction machineries and land use changes ・ Interference of river use (fishery and irrigation) during river improvement works. ・ Concern of traffic congestion by construction works and increase of traffic accidents. ・ Diversion routes are necessary for three sites of construction of bridges (It is possible for the	△

		local road along San Juan river to be located in parallel with a bridge of the EPZA diversion road). [Operation] ・ Flood mitigation measures protect local property and facilitate development of local communities.		local road along San Juan river to be located in parallel with a bridge of the EPZA diversion road). ・ Temporary bridge is necessary to improve a bridge over San Juan river for the EPZA diversion road. [Operation] ・ Same as MP.	
Preliminary Cost Estimation		・ Direct Cost: 1.18 billion PHP ・ Compensation: 0.66 billion PHP	–	・ Direct Cost: 1.19 billion PHP ・ Compensation: 0.67 billion PHP	–
Evaluation		(comparison target)	–	almost equivalent to MP	–

Evaluation; ○: better than MP, —: almost equivalent to MP, △: not better than MP
Source: JICA Study Team

Table 3.4 Comparison of Alignment of San Juan Diversion Channel (2/2)

Item	Alternative 2	Alternative 3
Layout		

KRC ENVIRONMENTAL SERVICES
381 Sto. Rosario St., Angeles City
Tel. No. 09175262698;09175109892; 0917-5276352
Email: alot_avenido@yahoo.com; cqcapule@yahoo.com

Feature		・Length: 2.38km ・Waterway Width: 105m ・Inlet is moved to upstream side to avoid relocation of the church. ・Improvement of Ylang-Ylang River at the confluence will be required for diversion. ・Crossing Road: 2 National Road, 2 Brgy Road ・Since existing bridge along national road is away from the diversion channel, the elevation of the new bridge on the diversion channel is lowest and its length is shortest. ・Easy to make detours for bridge construction ・Diversion channel crosses Marseilla St. at orthogonal angle so that the length of bridge is shortened. ・Crossing Cemetery ・On Existing Creek (downstream)		・Length: 1.31km ・Waterway Width: 105m ・Additional San Juan River Improvement: 1.4km ・Additional brgy road improvement: 350m ・Inlet is moved to downstream side to shorten the diversion channel and avoid cemetery. ・Improvement of San Juan River will be required for diversion. ・Crossing Road: 2 National Road, 3 Brgy Road ・Improvement of barangay road along San Juan River will be required. ・Longest bridge is required on Marseilla St. with elevation of approach road	
Impacts on Pollution	Pollution Risk	[Construction][Operation] ・Same as MP	—	[Construction][Operation] ・Same as MP	—
Natural Environmental Impact	Impacts on ecosystem	[Construction][Operation] ・Same as MP	—	[Construction] ・Same as MP ・Affected areas of mangrove forests are bigger compared to other alternatives [Operation] ・Same as MP	△
	Impacts on hydrological situation and geographical features	[Construction][Operation] ・Same as MP	—	[Construction][Operation] ・Same as MP	—
Social Impact	Relocation and land acquisition	・House relocation: 654 nos ・Land Acquisition: 27.9 ha ・Part of graveyards needs to be relocated. ・Relocation of churches is not necessary.	○	・House relocation: 465 nos ・Land Acquisition: 26.3 ha	○
	Local economy and conflicts of interests	[Construction][Operation] ・Same as MP	—	[Construction][Operation] ・Same as MP	—
	Impacts on communities	[Construction][Operation] ・Same as MP	—	[Pre-/Construction] ・Changes of landscape by construction machineries and land use changes ・Interference of river use (fishery and irrigation) during river improvement works. ・Concern of traffic congestion by construction works and increase of traffic accidents. ・San Juan River channel improvement has to be carried out within a limited space in the overcrowded residential area. ・Elevation of existing national road at the cross section in front of Municipality hall on Marseilla	△

			St .is necessary. It makes it difficult to acquire land for diversion routes and may cause traffic congestion. [Operation] ・ Same as MP	
Preliminary Cost Estimation	・ Direct Cost: 1.18 billion PHP ・ Compensation: 0.66 billion PHP	—	・ Direct Cost: 1.14 billion PHP ・ Compensation: 0.75 billion PHP	—
Evaluation	Better than MP	○	Not better than MP	△

Evaluation; ○: better than MP, —: almost equivalent to MP, △: not better than MP
Source: JICA Study Team

Table 3.5 - Comparison of Alignment of Maalimango Diversion Drainage II and Affected Structure

Item	Proposed Alignment in MP	Alternative 1
Layout		
Feature	・ Length: 3.24km ・ Waterway Width: 11.0 m to 4.5m ・ Along EPZA diversion road ・ Crossing Road: 4 large roads, 7 residential roads, 1 maintenance road ・ Major Obstruction: 3 gas stations	・ Length: 3.52km ・ Waterway Width: 11.0 m to 4.5m ・ Along EPZA diversion road, circumventing residential structures and commercial facilities ・ Crossing Road: 4 large roads, 1 maintenance road ・ Constructing 31 bridges in approx. 100m interval for the access to the southeast plain field

Impacts on Pollution	Pollution Risk	[Construction] ・ There is a concern of impacts by construction. Water pollution/ air pollution/ noise/ waste/ soil contamination/ offensive odor/ bottom sediment [Operation] ・ Condition of the status quo is maintained.		[Construction][Operation] ・ Same as MP	–
Natural Environmental Impact	Impacts on ecosystem	[Construction] ・ Impacts on ecosystem are minor as there are no rare species and fauna and flora to be protected in inland areas. ・ There is a possibility of impacting on mangrove forests at the mouths of San Juan river and diversion channel. [Operation] ・ There are no facilities to deteriorate the ecosystem.		[Construction][Operation] ・ Same as MP	–
	Impacts on hydrological situation and geographical features	[Construction] ・ There is a concern of impacts by construction. Hydrological situation (interference of watercourse by soil), geographical features (digging), soil erosion, groundwater (deep excavation) [Operation] ・ There is a concern of changes of geographical features by construction of structures. ・ Diversion of small water channels (most of which are located in low-lying areas and depressed areas) crossing the EPZA diversion road. ・ On the other hand, as this is flood mitigation measures, it is expected to mitigate inundation.		[Construction][Operation] ・ Same as MP	–
Social Impact	Relocation and land acquisition	・ House relocation: 235 nos ・ Land Acquisition: 7.8 ha ・ Relocation of several commercial facilities including 3 gas stations.		・ House relocation: 96 nos ・ Land Acquisition: 8.7 ha ・ Direct access to the south-eastern backyard is disconnected (connected with small bridges in 100m intervals)	○
	Local economy and conflicts of interests	[Pre-/Construction] ・ Conflicts among residents toward local employment of construction workers. ・ Concern of temporary loss of livelihood by relocation. ・ Employment generation by construction works and positive spread effects on related business. [Operation] ・ Maintenance and development of economic activities by flood mitigation measures.		[Pre-/Construction][Operation] ・ Same as MP	–
	Impacts on comm...	[Pre-/Construction] ・ Changes of landscape by construction		[Pre-/Construction] ・ Changes of landscape by construction	○

		machineries and land use changes ・ Concern of traffic congestion by construction works and increase of traffic accidents. ・ Relocation of gas stations (underground tanks) is necessary. ・ Relocation of lifeline such as electric poles is necessary. [Operation] ・ Flood mitigation measures protect local property and facilitate development of local communities.		machineries and land use changes ・ Concern of traffic congestion by construction works and increase of traffic accidents. ・ Relocation of gas stations is not necessary. ・ Small possibility of relocation of lifeline. [Operation] ・ Same as MP.	
Constructio n Work		・ Relocation of gas stands (underground gas tank) requires attention in aspect of environment. ・ Utility lines such as electrical lines and poles become obstruction during construction.		・ No relocation of gas stations ・ Less possibility of interference of utility lines	○
Preliminary Cost Estimation		・ Direct Cost: 0.48 billion PHP (excluding relocation of utility lines) ・ Compensation: 0.20 billion PHP		・ Direct Cost: 0.57 billion PHP ・ Compensation: 0.13 billion PHP	△
Evaluation		(comparison target)		Better than MP	○

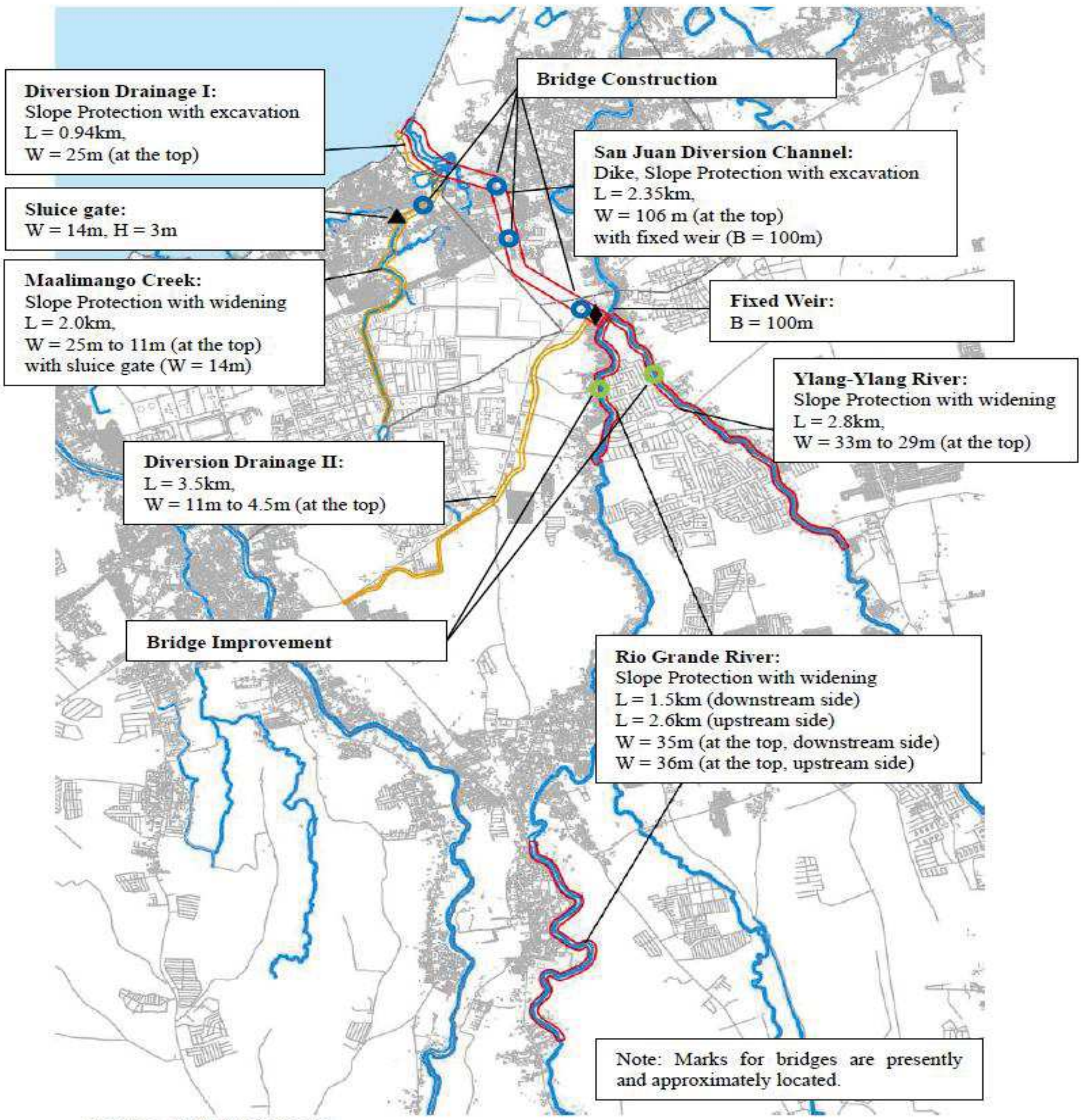
Evaluation; ◎; much better than MP, ○; better than MP, ー; almost equivalent to MP, △; not better than MP
Source: JICA Study Team

3.4 Project Component

The project will involve Improvement of San Juan River Basin and Drainage Improvement at Maalimango Creek.

The project shall be structurally composed of: a) River improvement Works of San Juan River, Rio Grande River and Ylang-Ylang River, b) Construction of Diversion Channel from the confluence of Rio Grande and Ylang-Ylang rivers to Manila Bay, and c) Dredging and widening of Maalimango creek and construction of Drainage channel.

As a consequence of the above project, there is a need to construct bridges that will traverse the San Juan Diversion Channel and the Maalimango Creek Drainage Diversion I and the replacement of the bridges affected by the improvements of Rio Grande and Ylang-Ylang Rivers as shown **in Figure 3.5.**



Source: JICA Study Team

Figure 3.5 Distribution of Target Structure for Priority Project

3.4.1 Project Summary

As a summary the project shall be composed of:

3.4.1.1 River Improvement of San Juan River Basin:

3.4.1.1.1 San Juan Diversion Channel (Sta. 0+000 ~2+380) L = 2.4 km

a. Excavation of Diversion Channel- 813,760 m^3
b. Dike Embankment – 104,750 m^3
c. Concrete Block Slope Protection - 78,320 m^2
d. Foot Protection – 2,380 m^3
e. Dredging – 41,610 m^3
f. Fixed Weir – 1 unit

Fixed Weir at San Juan Diversion Channel. **Table 3.6** summarizes the dimensions of the above mentioned fixed weir

Table 3.6 Summary of Fixed Weir

Structure	Dimensions
Weir Body	W: 100m, Weir height: 2.48m Elevation at crown of weir: 1.48m Type: Concrete Fixed Weir (w/Harold curve)
Energy Dissipation Structure	W: 100m, L: 4m, Thickness: 0.5m Type: Reinforced Concrete connected with Weir Body
Riverbed Protection	Channel Bed Protection A; W: 100m, L: 21m Type: Reinforced Concrete Channel Bed Protection B; W: 100m, L: 17m Type: Concrete Block (0.3m x 0.5m x 0.5m)

Source: JICA Study Team

3.4.1.1.2 Rio Grande River Improvement (Sta 4+808 ~6+389) L=1.6 km and Sta 10+600 ~ 13+200) L=2.6 km

a. River Excavation (Soil)– 80,790 m^3 , 96,440 m^3
b. River Excavation (Soft Rock)- 68,750 m^3, 152,210 m^3
c. Concrete Block Slope Protection – 26, 030 m^2 , 49,300 m^2
d. Foot Protection – 1,590 m^3, 2,600 m^3

3.4.1.1.3 Ylang-Ylang River Improvement(Sta 0+000 ~2+787) L=2.8 km

a. River Excavation (Soil)– $58,740^3$
b. River Excavation (Soft Rock) – $133,790^3$
c. Concrete Block Slope Protection – $51,340^2$
d. Foot Protection – $2,790^3$

3.4.1.2 Drainage Improvement at Maalimango Creek

3.4.1.2.1 Maalimango Creek Improvement (Sta 1+000~3+000) L=2.8 km

a. Drainage Channel Widening - $59,670^3$
b. Concrete Block Protection – $12,730^2$
c. Sluice Gate – 1 unit

A sluice gate on Maalimango creek is proposed. This is used to close the main stream and divert all of the flow into Diversion Drainage I during the wet season.

The specification and preliminary design of the sluice gate are shown in **Table 3.7**.

Table 3.7 Specification of the Sluice Gate at Maalimango Creek

Structure	Specification
Gate	W x H x nos = 14m x 3.6m x 1 nos Sluice Gate
Side Wall	L = 16m B = 1.65m

Source: JICA Study Team

3.4.1.2.2 Diversion Drainage I (Sta 0+000~0+944) L=0.9 km

a. Excavation for Diversion Channel – 57,800^3
b. Concrete Block Slope Protection – 9,390^2

3.4.1.2.3 Diversion Drainage II (Sta. 0+000~3+200) L=3.5 km

a. Excavation for Diversion Channel - 116,690^3
b. Concrete Block Slope Protection – 27,526 m^2

3.4.1.3 Construction of Dike

3.4.1.4 Coastal Area

a. Clearing and Grubbing
b. Pile Driving and Coping
c. Excavation for Soil Replacement Coffering and Riverside Excavation
d. Geotextile Tube
e. Riprap
f. Embankment
g. Slope protection
h. Vegetation Mattress and Pavement /Ditch

3.4.1.4.1 In inland

a. Clearing and Grubbing
b. Channel Excavation (around slope)
c. Pile Driving and Coping
d. Excavation for Soil Replacement and Channel
e. Embankment
f. Slope Protection (Concrete Block) and Gabion
g. Vegetation Mattress and Pavement/Ditch

3.4.1.5 Hydro Mechanic Work

a. Clearing and Grubbing
b. Excavation of Diversion Channel 1
c. Diversion of Existing Channel
d. Excavation and demolition of Existing Channel
e. Concrete works for gate
f. Back fill
g. Installation of Gate
h. Restoring

3.4.1.6 Improvement and Construction of Bridges (at least 7)

a. Detouring Road Access
b. Clearing and Grubbing
c. Demolition of Existing Abutment, Embankment and Road
d. Substructure (Bored Pile, Concrete Works for Piers) Super structures (Concrete Girder), Abutment (Retaining Wall, Backfill)
e. Loading of Girder and Road
f. Opening Road Access

Corresponding facility being served or connected: Bridge and Approach Road

The construction of the San Juan Diversion Channel and the Maalimango Creek Drainage Diversion I and the widening of Rio Grande and Ylang-Ylang Rivers necessitates construction of five (5) new bridges traversed by the diversion works and replacement of two (2) existing bridges affected by the river improvement. **Figure 3.6** and **Figure 3.7** show the locations and features of the proposed bridges.

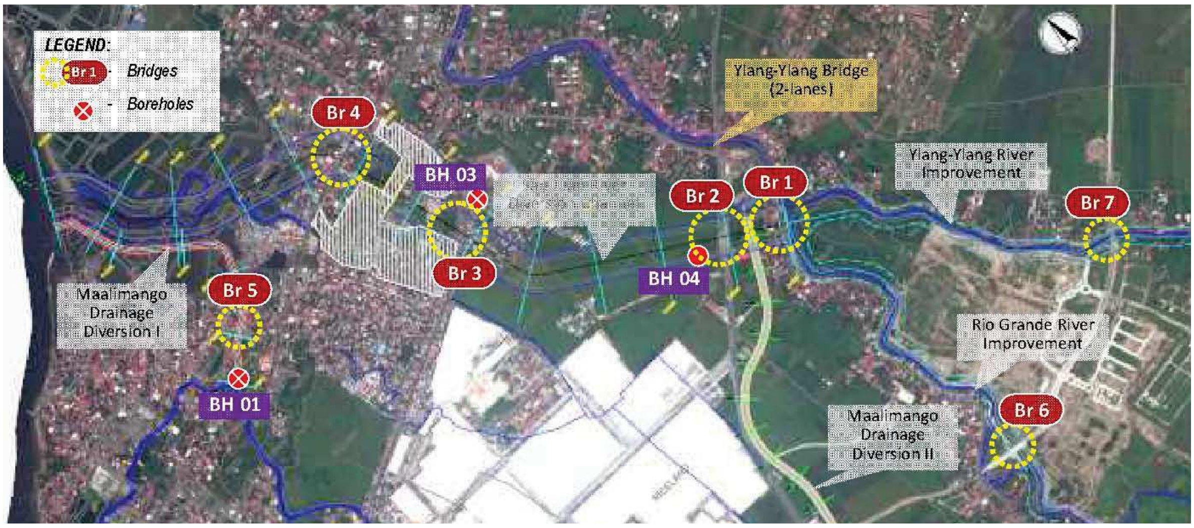
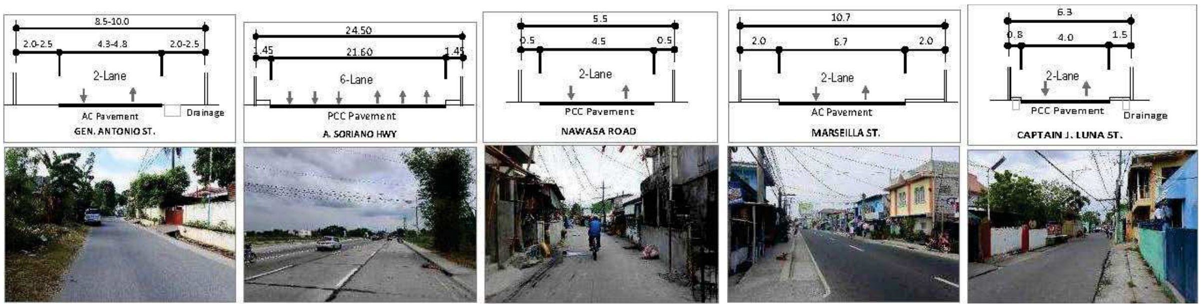
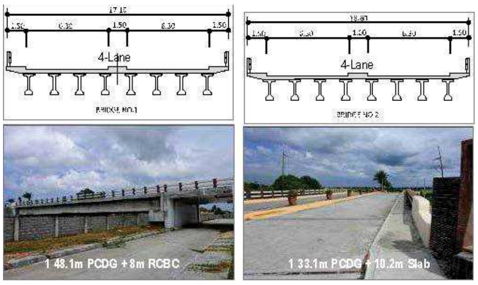


Figure 3.6 Location of Reconstructed Bridges





Bridge Br-6 Bridge Br-7

Bridge	Road/River Name	Road Class
1	Gen. Antonio St.	Local/Municipal
2	A. Soriano Highway	National (R-1)
3	NAWASA Road	Local/Municipal
4	Marseilla St.	National
5	Captain J. Luna St.	Local/Municipal
6	Rio Grande River Bridge (Mercury St. Bridge No.1)	Antel Grand Village access road
7	Ylang-Ylang River Bridge (Mercury St. Bridge No.1)	Antel Grand Village access road

Source: JICA Study Team

Figure 3.7 Present Features of Reconstructed Bridges

3.4.1.7 Support/Accessory Facilities

3.4.1.7.1 Waste management facilities

Disposal area shall be confirmed by DPWH before the commencement of the construction. Possible disposal areas have been selected in the Project as reference, for the cost estimation purpose.

Some local government has identified disposal site for the dredge material that is free from contamination. Said material shall be used as filling material in identified low lying area and covering material for the final closure of their former disposal site (Dump site).

Detailed discussion on waste management facilities are provided in Chapter 5.

3.4.1.7.1.1Devices to address solid waste materials

The project will use the existing landfill sites and find a new site in case of a lack of existing ones. In the new site, following devices will be operated like other landfill sites in the Philippines such as dump truck, landfill grader, landfill claw, etc.

3.4.1.7.2 Construction's Camp Site

These are staging areas and temporary facilities to house the labor force, bunk houses, warehouses, equipment yard and other support facilities. Temporary provision for power, water and sanitary facilities.

3.4.1.8 Pollution Control devices or equipment will not be applicable in the project. However, all activities presented in this study to control and mitigate pollution will be enforced.

3.4.2 Footprints and target structures

Table 3.8 summarizes the project components and each description.

Table 3.8 – Project Components

Project Component	Description
1. River Flood Mitigation	
a. San Juan Diversion Channel	2.2 km Length, 110 m width, 3m depth, 2m high revetment on each side
b. Rio Grande River improvement	Revetment reinforcement
c. Ylang-Ylang River Improvement	Revetment reinforcement
2. Drainage Facilities	
a. Maalimango Drainage Improvement	Widening, dredging
b. Diversion Drainage I	20 m width drainage with 10 m width dike on each side, Total of 40m width
c. Diversion Drainage II	Narrow Width is 5m + 5m buffer Widest Width is 12m +5m buffer
3. Bridges	
a. Improvement of bridges	Two of the existing bridges shall be replaced
b. Construction of bridges	There is a need to construct at least 5 additional bridges

The Target structures are shown in **Figure 3.5**.

3.5 Process/Technology Options

The design of all the structures and component of the Project shall be in accordance to international and local standards.

3.5.1 Project Design

3.5.1.1 River improvement in San Juan River Improvement

JICA will adopt the design flood of 1/25 years to attain the early flood mitigation effects. It is composed of:

- River improvement Works of San Juan River, Rio Grande and Ylang-Ylang River
- Construction of Diversion Channel from the confluence of Rio Grande and Ylang-Ylang rivers to Manila Bay

3.5.1.2 Drainage Improvement at Maalimango Creek

JICA has determined the design scale of drainage facilities as 10-year flood frequency considering the existing systems in the adjacent areas.. It is composed of:

- Drainage Improvement Works (dredging) of Maalimango Creek
- Drainage Improvement Works (widening) of Maalimango Creek
- Construction Of Diversion Drainage

JICA Study 2015 is summarized in **Table 3.9**.

Table 3.9 - Summary of Project Works

Item		Description	Length	Work Quantity
River Improvement in San Juan River Basin	San Juan Diversion Channel	- Excavation for Diversion Channel - Dike Embankment - Concrete Block Slope Protection - Foot Protection - Dredging - Fixed Weir	Sta. 0+000 ~ 2+457 (L=2.5 km)	1,215,000 m^3 39,800 m^3 46,300 m^2 600 m^3 9,500 m^3 1 nos
	Rio Grande River Improvement	- River Excavation (Soil) - River Excavation (Soft Rock) - Concrete Block Slope Protection - Foot Protection	Sta. 4+808 ~ 6+389 (L=1.6 km)	80,800 m^3 68,800 m^3 26,000 m^2 1,580 m^3
		- River Excavation (Soil) - River Excavation (Soft Rock) - Concrete Block Slope Protection - Foot Protection	Sta. 10+600 ~ 13+200 (L=2.6 km)	96,400 m^3 152,000 m^3 49,300 m^2 2,600 m^3
	Ylang-Ylang River Improvement	- River Excavation (Soil) - River Excavation (Soft Rock) - Concrete Block Slope Protection - Foot Protection	Sta. 0+000 ~ 2+787 (L=2.8 km)	58,700 m^3 133,800 m^3 51,300 m^2 2,800 m^3
Drainage Improvement at Maalimango Creek	Maalimango Creek Improvement	- Drainage Channel Widening - Concrete Block Slope Protection - Sluice Gate	Sta. 1+000 ~ 3+000 (L=2.0 km)	94,900 m^3 16,100 m^2 1 nos
	Diversion Drainage I	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~ 0+955 (L=1.0 km)	64,800 m^3 9,400 m^2
	Diversion Drainage II	- Excavation for Diversion Channel - Concrete Block Slope Protection	Sta. 0+000 ~ 3+520 (L=3.5km)	113,000 m^3 26,000 m^2

Source: JICA Study Team

3.5.2 Preliminary Design of Project Works

3.5.2.1 Design Alignment for River/Drainage Channel

The alignment for the river/drainage channel improvement will run along the existing river channel. However, some short-cut and realignment will be made in order to minimize the number of house relocations especially in the densely populated area.

The design alignment for river improvement in San Juan River basin is shown in Annex 3.1 to Annex 3.4. The design alignment for drainage improvement at Maalimango Creek is as shown in Annex 3.5 to Annex 3.7.

3.5.2.2 Design Longitudinal Profile

The following criteria are adopted to the longitudinal plan for river channel improvement:

- The design high water level at the river mouth is set at the Mean High Spring Water of 0.8m above Mean Sea Level; and

- The HWL is set in principle to be the same or below the hinterland ground level as described above. The freeboard above the HWL is set in accordance with the Design Guideline of DPWH as shown in **Table 3.10**.

Table 3.10 - Design Flood Discharge and Freeboard

Design Discharge (m^3/s)	Freeboard (m)
Less than 200	0.6
200-500	0.8
500-2,000	1.0
2,000-5,000	1.2

Source: Manual on Design of Flood Control Structures, DPWH

The design longitudinal profile for river improvement in San Juan River basin is as shown in Annexes 3.8 to Annexes 3.9. The design longitudinal profile for drainage improvement at Maalimango Creek is as shown in Annex 3.10 to Annex 3.11.

3.5.2.3 Design Cross Section

The cross section is designed as the single section in the same way as the sections of the existing river channel. The face of slope will take the gradients of 1 to 2 in principle and 1 to 0.5 in case of the very limited work space. The Design Flood Level is, in principle, set to be equal or below the hinterland ground level for the channel improvement sections except those along the area densely packed with houses and no adequate land for channel widening could be acquired. The design cross section for river improvement in San Juan River basin is as shown in Annexes 3.12 to Annexes 3.13. The design cross section for drainage improvement at Maalimango Creek is as shown in Annex 3.14

3.5.3 Preliminary Design of River Improvement in San Juan River Basin

3.5.3.1 Slope Protection

Recently, the major method of slope protection is reinforced concrete. With this protection, when the slope is very high the construction of wall will be difficult considering the period of coffer damming, forming and curing. Hence, the protection method is proposed to be applied by referring to the manual and basic policy in Japan.

Natural big rock materials are only obtained at the quarry site 40km to 50km away from the construction site. Therefore, the hauling schedule of natural big rock materials will be highly affected by the traffic conditions. In addition, it may cause the traffic congestion. Hence, natural rock material is not recommended to be utilized for the slope protection. The result of the selection of the slope protection is compiled in **Table 3.11**.

Table 3.11 Slope Protection

Slope	Velocity (m/s)	Structure
1:0.5	1.0 ～ 4.0	Concrete Block Protection with Backfilling Concrete
1:2.0, 1:3.0	1.3 ～ 5.3	Concrete Block Protection without Backfilling Concrete

Source: JICA Study Team

3.5.3.2 Foot Protection

Studying the site and the existing geologic columnar section, it was observed that the soft rock surface appears at the bottom of the river at 4km or upper area from the river mouth. Since the possibility of the scoring is less, foot protection with gabions was considered to be strong enough as the capping of the backfill. The lower section, which is from the river mouth to 6km upstream of the river mouth, tends to have sedimentation. However, considering the existing damaged revetment, temporary scoring might happen with floods. Hence, in addition to the gabions, steel sheet piles with the length of 2m are proposed to be installed. At around coastal areas, slope stability analysis was performed in order to calculate at the adequate length of the sheet pile.

3.6 Development Plan, Description of Project Phases

3.6.1 Pre-construction Phase

- Aside from meeting the requirements for the Issuance of Environmental Compliance Certificate (ECC) other studies, permits and clearances will be secured i.e. tree (mangrove) cutting permit, LGU clearances, etc);

- Simultaneous with the conduct of environmental impact assessment, the Resettlement Action Plan (RAP) is being conducted. This would include relocation of affected communities and the possible compensation.

- Implementation of RAP will be conducted prior to construction.

- Acquisition of right of way /right to use land

- JICA and DPWH to iron out the details of the projects, finalize detailed engineering design and review and approved of various studies and component

- Pre-qualification, Tendering and Awarding of contract

- Securing Financing for the Project

3.6.2 Construction Phase

Construction shall be contracted into four (4) packages namely:

Package 1: Construction of San Juan Drainage Channel including fixed Weir and Drainage Diversion I
Package 2: Improvement of Rio Grande River
Package 3: Improvement of Ylang-Ylang River
Package4: Drainage Diversion II, Sluice Gate and Maalimango Creek Improvement

The construction shall be from package 1 down to package 4 and expected to start in the year 2019 until 2022.

- Prior to the Main Works construction activities shall be the following:

1. Clearing and earthworks for the preparation of construction works;
2. Construction of staging areas and temporary facilities to house the labor force, bunkhouses, warehouses, equipment yard and other support facilities;
3. Provision of temporary power, water and sanitary facilities;

4. Mobilization of major construction equipment and tools (e.g. bulldozers, cranes, trucks, etc.) and manpower levels to accomplish the sequence of establishment activity;
5. Establish main site logistics and transport requirements;
6. Delivery of construction and other supplies

Main Works activities shall be the following:

1. San Juan Diversion Channel
   - Excavation of Diversion Channel
   - Dike Embankment
   - Concrete Block Slope Protection
   - Foot Protection
2. Diversion Drainage I
   - Excavation
   - Concrete Block Slope protection
3. Rio Grande River Improvement (Upstream and Downstream)
   - River Excavation (Soil)
   - River Excavation (Soft Rock)
   - Concrete Block Slope Protection
   - Foot Protection
4. Ylang-Ylang Improvement
   - River Excavation (Soil)
   - River Excavation (Soft Rock)
   - Concrete Block Slope Protection
   - Foot Protection
5. Maalimango Drainage Improvement
   - Drainage Channel Widening
   - Concrete Block Slope Protection

6. Diversion Drainage II
   - Excavation for diversion channel
   - Concrete Block Slope Protection

7. Finishing Works
   - Improvement and construction of bridges and other necessary facilities
   - Cleaning and landscaping (if necessary)

- Labor, equipment and most of the material shall be sourced locally except for large sluice gate and other related parts which will be source from Japan.
- Most of the construction includes concrete work and earth work that will require ready mixed concrete to be source locally.

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3.6.3 Operation Phase

This will involve mostly inspection and maintenance of the facilities to include rehabilitation if needed. However, it is expected that come rainy season of 2023, there will be improve flow/drain into the San Juan River basin and continuous containment and flow of heavy rain waters along the improved diversion channels.

3.6.4 Abandonment Phase

The project is infrastructures and considered as an enhancement project so abandonment (as in the context of manufacturing plant) seems not applicable.

Abandonment in this project would mean that upon completion of construction:

- Pulled-out equipment and other construction support facilities
- Hauling and disposal of scraps, construction debris, and other waste
- Cleaning/clearing all construction areas

3.7 Manpower Requirements

At least 2,070 skilled and non-skilled workers shall be employed during construction. **Table 3.12** shows the details of manpower requirements. Note that the presented figures are estimates per year. This may vary during actual works.

Table 3.12 – Manpower Requirements

<table>
<tr><th rowspan="2">Basin</th><th rowspan="2">Construction</th><th colspan="2">Manpower</th></tr>
<tr><th>Skilled</th><th>Unskilled</th></tr>
<tr><td rowspan="3">San Juan</td><td>SJ Diversion Channel</td><td rowspan="3">780</td><td rowspan="3">1,020</td></tr>
<tr><td>Rio Grande Improvement</td></tr>
<tr><td>Ylang-Ylang Improvement</td></tr>
<tr><td rowspan="2">Maalimango</td><td>Diversion Channel</td><td rowspan="2">250</td><td rowspan="2">320</td></tr>
<tr><td>Drainage Channel</td></tr>
</table>

Source: JICA Study Team

3.8 Project Cost

The summary of quantity and total project costs for the priority project are shown in **Table 3.13**, and **Table 3.14** (the detailed breakdown of the work quantity and cost are as shown in Annex 3.15).

Table 3.13 Summary of Quantity for Flood Mitigation Structure

Name of River Basin/ Catchment Area	Name of River / Drainage	Design Scale (year)	Works of Water Way			Works of Bridge		Area of Project Site (ha)	Number of House Relocations (houses)
			Length (km)	Width (m)	Excavation/ Dredging Volume (106m3)	Number of Bridges (Nos.)	Length (m)		
San Juan	Rio-Grande Rive	25	4.2	35~36	0.40	1	41	22.04	164
	Ylang-Ylang River	25	2.8	30~42	0.19	1	53	14.29	91
	San Juan Diversion	25	2.5	89~115	1.22	4	443	28.20	765
	Sub-total		9.5	-	1.81	6	537	64.53	1020
Maalimango	Maalimango Drainage	15	2	11.2~27.5	0.09	5	73	11.32	56
	Maalimango Diversion I	15	1	27.5~28.2	0.06	1	35	2.48	78
	Maalimango Diversion II	15	3.5	4.5~11.5	0.11	10	100	7.80	20
	Sub-total		6.5	-	0.27	16	208	21.60	154
Total			16	-	2.08	22	745	86.13	1174

Source: JICA Study Team

Table 3.14 Cost Estimation for Flood Mitigation Structure

Breakdown of Cost	Foreign Currency Portion (million PHP)			Local Currency Portion (million PHP)			Total (million PHP)		
	Total	ODA Portion	GOP Funds	Total	ODA Portion	GOP Funds	Total	JICA Portion	GOP Funds
San Juan River Div Channel + Maalimango Div 1	1,110	1,110	0	1,358	1,358	0	2,468	2,468	0
Rio Grande River	476	476	0	453	453	0	929	929	0
Ylang-Ylang River	340	340	0	320	320	0	661	661	0
Maalimango Drainage + Maalimango Div 2	575	575	0	387	387	0	962	962	0
Price Escalation	219	219	0	0	0	0	219	219	0
Physical Contingency	136	136	0	126	126	0	262	262	0
Consulting Services	521	521	0	348	348	0	868	868	0
Land Acquisition	0	0	0	1,739	0	1,739	1,739	0	1,739
Administration Cost	0	0	0	284	0	284	284	0	284

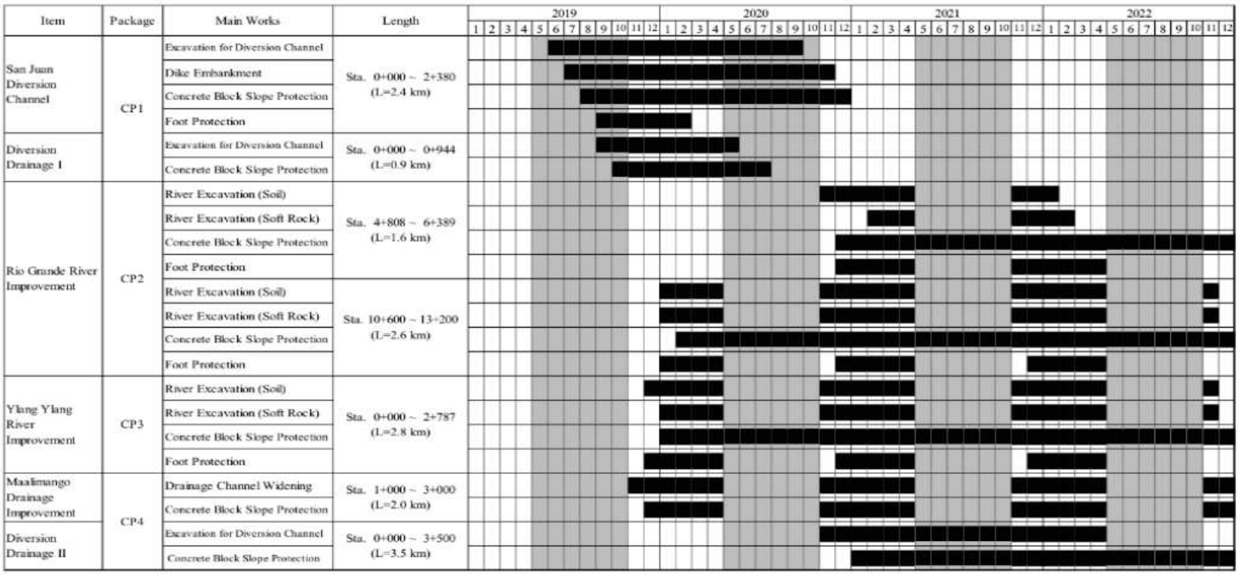
VAT	0	0	0	405	0	405	405	0	405
Import Tax	0	0	0	86	0	86	86	0	86
Interest during construction	21	0	21	0	0	0	21	0	21
Front End Fee	13	0	13	0	0	0	13	0	13
Total	3,412	3,378	34	5,506	2,992	2,514	8,918	6,370	2,548

Source: JICA Study Team

3.9 Project Duration and Schedule

Figure 3.8 presents the overall project schedule of the proposed flood mitigation in Cavite.

Figure 3.8 Overall Project Schedule



Source: JICA Study Team

Chapter 4

BASELINE ENVIRONMENTAL CONDITION, IMPACT ASSESSMENT AND MITIGATION

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CHAPTER 4.0: KEY ENVIRONMENTAL IMPACTS AND MANAGEMENT/ MONITORING PLAN

Figures

Tables

Annexes

4.0 BASELINE ENVIRONMENTAL CONDITIONNS

4.1 The Land

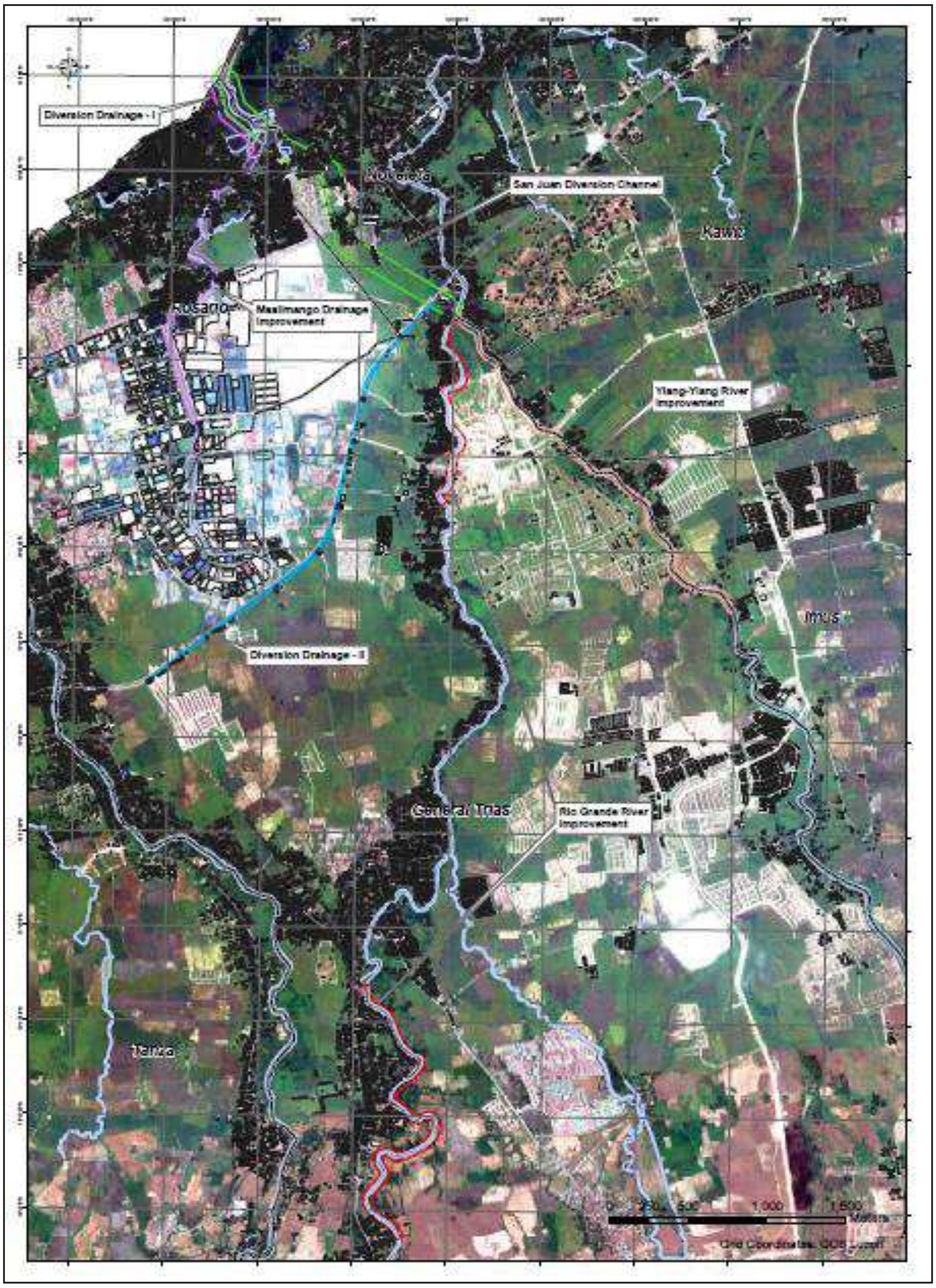
4.1.1 Project Description

The Government of the Philippines (GOP) has requested JICA to formulate the plan for the comprehensive flood mitigation projects which constitute combinations of structural and non-structural measures for three (3) river basins vulnerable to flood in the eastern part of Cavite province (**Figure 4.1**).

As summarized in **Table 4.1** the programmed measures and components will cover a total land area of 86.1 hectares with impact on 1,032 buildings, 1,912 households, and 8,341 people.

Table 4.1 – Project Scope

Measures	Components	Preliminary Estimation			
		Area(ha)	Building	Household	Population
River Flood Mitigation	San Juan Diversion Channel	28.7	579	1,210	4,598
	Rio Grande River Improvement	21.9	164	246	1,294
	Ylang-Ylang River Improvement	14.2	89	178	920
Drainage Facilities	Maalimango Drainage Improvement	21.3	200	278	1,529
	Diversion Drainage-I				
	Diversion Drainage-II				
Total		86.1	1,032	1,912	8,341
Source: JICA Study Team					



Source: JICA Study team

Figure 4.1: Project Area

4.1.1.1 Location and Accessibility

The province of Cavite is located in the southern shores of Manila Bay in Region IV-A. The region is composed of five (5) provinces, namely Cavite, Laguna, Batangas, Rizal, and Quezon collectively known as CALABARZON (**Figure 4.2**).The province is bounded by Batangas in the south, Laguna in the east, Rizal in the northeast, Metro Manila and Manila Bay in the north, and the West Philippine Sea in the west. Cavite is one of the most industrialized provinces in the country. The closest point to Manila is Bacoor City located approximately 15 km southwest of the metropolis.

The Project lies between geographic coordinates N $14^{0}22'0"$-$14^{0}26'0"$ Latitude and E $120^{0}51'40"$-$120^{0}54'0"$ Longitude (**Figure 4.3**). It covers the lowland municipalities of Kawit, Noveleta, Rosario, Imus and General Trias.

Travellers from Manila generally use the Aguinaldo Highway (Manila-Cavite Coastal Road) and the Las Piñas-Zapote Road as entry points to the province. The opening of the Cavite Expressway (CAVITEX) in 2011 lessened the heavy volume of vehicles along Aguinaldo Highway in Bacoor. The Muntinlupa–Cavite Expressway which was opened last 2015 reduced travel time from Daang Hari to Alabang Interchange as well as decongest traffic in Cavite, Las Piñas and Muntinlupa. There is a plan to extend the existing LRT Line 1 service southward to the cities of Parañaque, Las Piñas, and Bacoor. The 27-km route of the light railway system aims to serve approximately 1.9 million commuters from the aforementioned cities including the city of Pasay.

Figure 4.2: Location of CALABARZON Region.

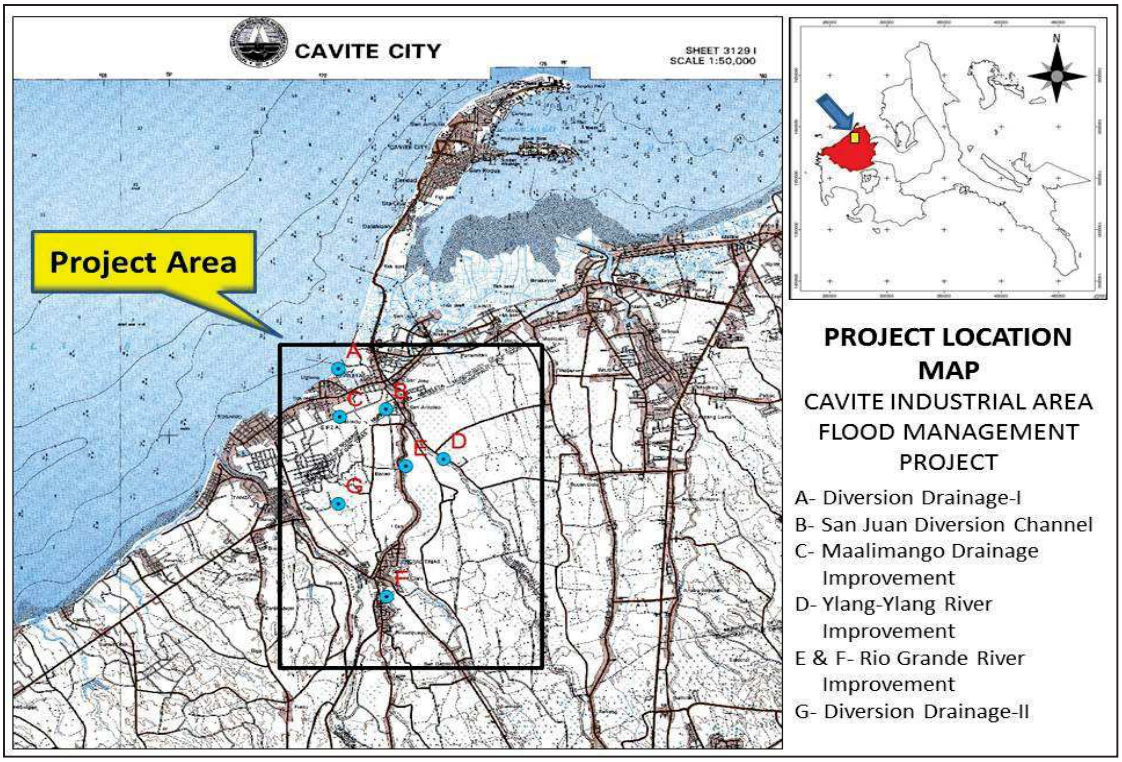


Figure 4.3: Project Location Map: (Base Map Source: NAMRIA Topographic Map Quad Sheet No. 3129-I Cavite City Scale 1:50,000).

4.1.1.2 Methodology

The study involves field reconnaissance and verification of existing secondary information. The fieldwork was guided by the geological map secured from MGB and the quadrangle topographic map published by the National Mapping and Resource Information Authority (NAMRIA). The geomorphologic characteristics of the project area were also verified including the evaluation of the presence of natural hazards such as erosion, active slope movement, flooding and seismic risk.

Nature and Source of Information

Bibliographic research and desk studies involving review of available relevant data from national agencies, local government units, and private entities form part of the report. These include the regional MGB office, NAMRIA, Philippine Institute of Volcanology and Seismology-Department of Science and Technology (PHIVOLCS-DOST), Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), and the provincial government of Cavite. Other pertinent information obtained from several literatures, published materials, and online sources are duly referred to in the report.

4.1.2 REGIONAL SETTING

4.1.2.1 Geologic Setting

The southwestern part of Luzon represents the southern segment of the West Luzon Volcanic Arc (WLVA) which is related to the eastward subduction of the South China Sea Plate at the Manila Trench.

Different kinds of rocks can be found in southwestern Luzon (**Figure 4.4**). The greater part of Cavite consists of volcanic materials, tuff, cinders, basalt, breccia, agglomerate and interbeddings of shale and sandstone.

The southern part occupied by Batangas Province likewise exhibits mixed rock types that include andesite, limestone, agglomerate tuff, alluvium, quartz-diorite, metavolcanics, metasediments, dacite, and shale. The general geology of Laguna shows alluvium, conglomerate, sandstone, tuff, andesite, basalt and volcanic breccia particularly in the southern shores of Laguna de Bay, western side of Mt. Makiling, Mt. Lagula, and Nagcarlan.

In Bondoc Peninsula, Polillo Island and other parts of Quezon Province, there is abundant distribution of limestone, diorite, granodiorite, basalt, andesite, metamorphic rocks, and clastic sedimentary rocks. For its part, the whole area of Rizal Province exhibits metavolcanics, diorite, clastic sedimentary rocks, gabbro, diabase and limestone (MGB Region IV-A CALABARZON).

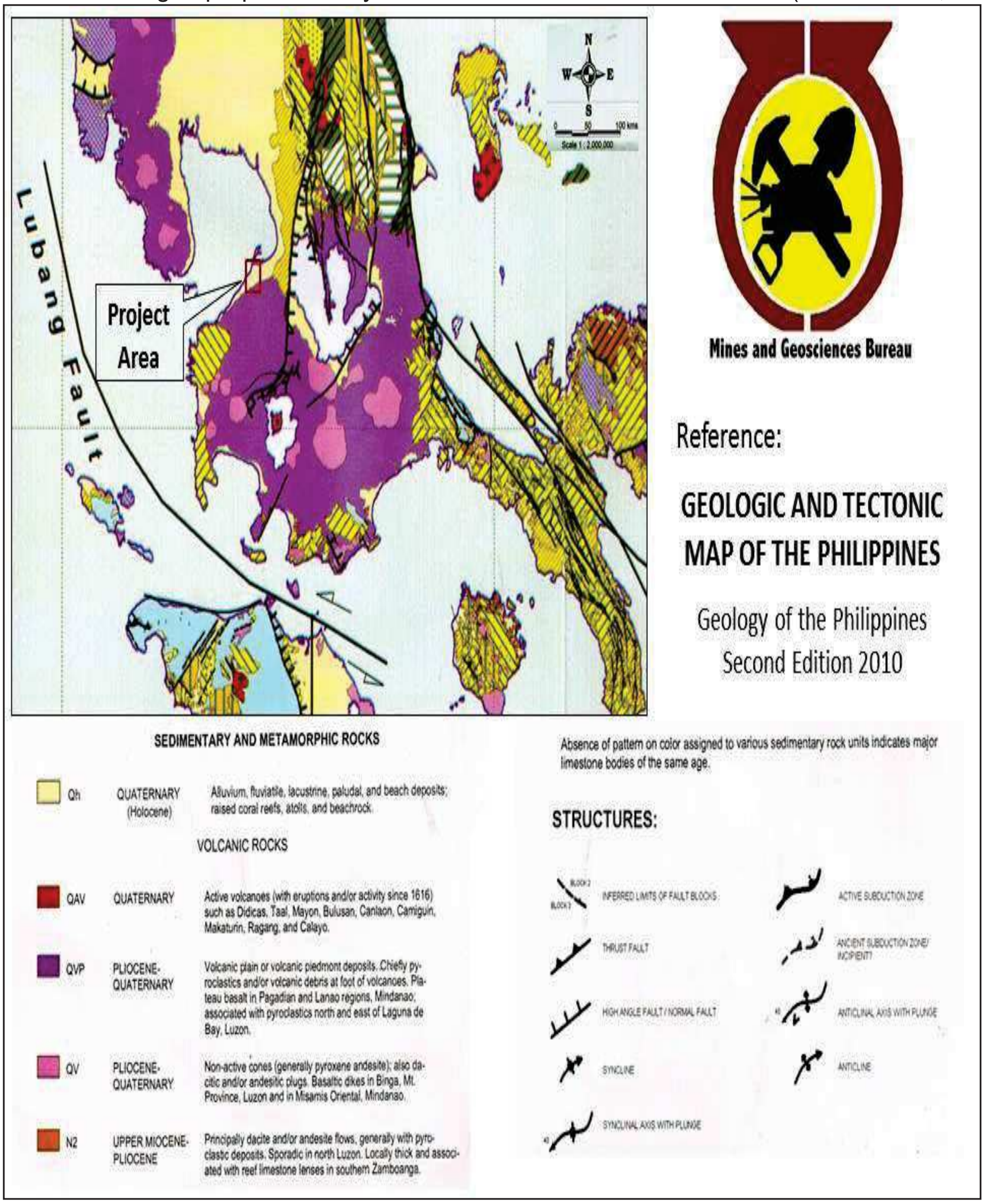
4.1.2.2 Tectonic and Seismicity

The Philippine archipelago is part of a broad zone of convergence between the Sundaland block, an independent part of Eurasian Plate and the Philippine Sea Plate. The west side of Luzon is characterized by the eastward subduction of the South China Sea Basin along the Manila Trench, the primary convergence zone between Eurasia and Luzon (Hayes and Lewis, 1984). The tectonic map covering the Project is shown in **Figure 4.5**.

The occurrence of a series of northwest-trending volcanic centers extending from central Mindoro to Zambales and along the western coastline of southern Luzon is likewise related to the subduction process.

The Verde Passage-Sibuyan Sea Fault, an east–west trending, left-lateral strike-slip fault traverses the central Philippines from the southern termination of the Manila Trench. The fault branches out of the Philippine Fault near Masbate and extends westward near the Manila Trench.

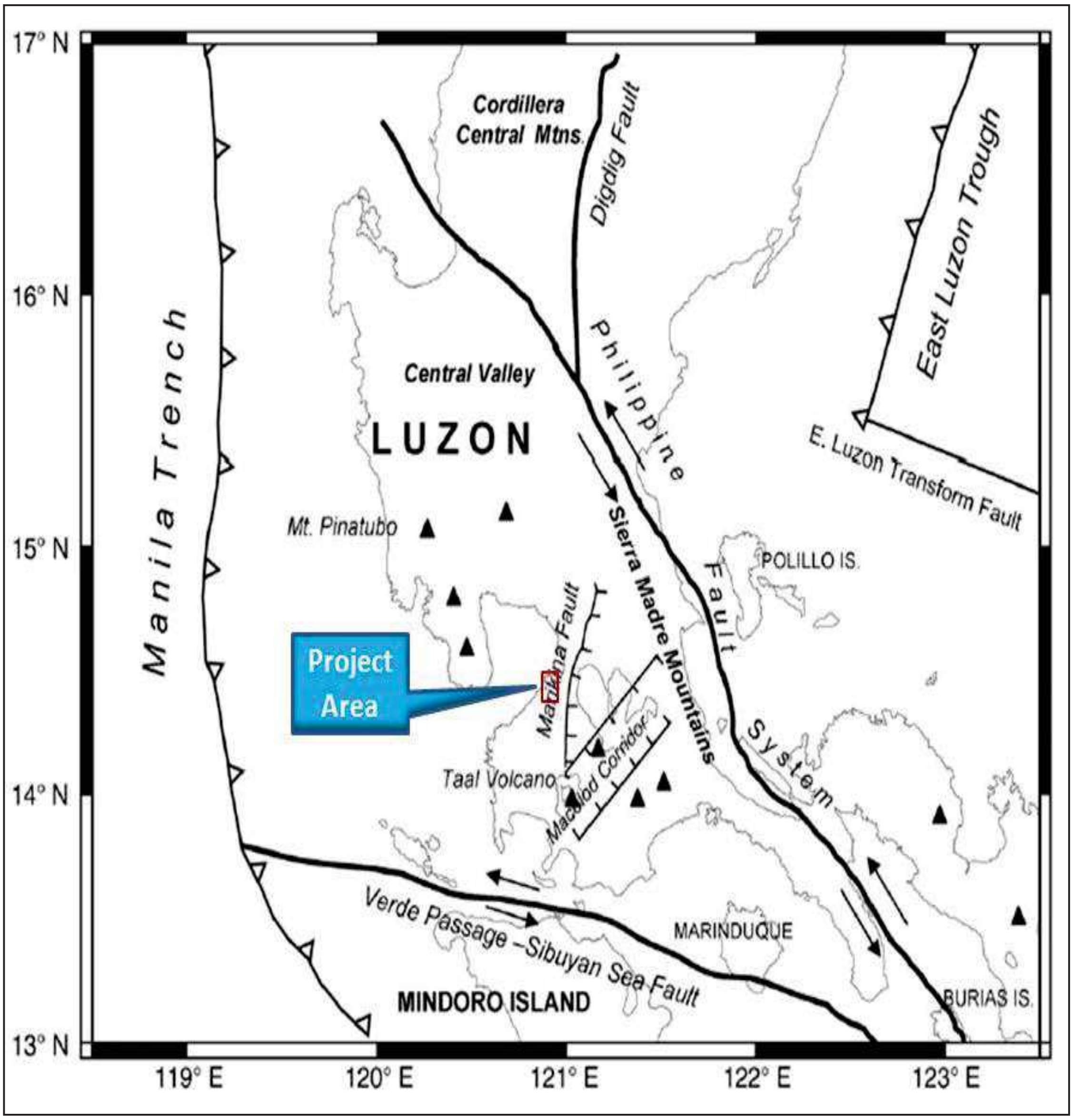
The Macolod Corridor is an approximately 40 km wide zone located in southwestern Luzon and pervaded by active intense Quaternary volcanism, faulting, and crustal thinning. It perpendicularly crosses Luzon in a NE-SW direction (Förster et al., 1990).



Source: DENR-MGB, 2010

Figure 4.4: Regional Geologic Map

The alignment of the corridor is at a right angle to the Manila Trench; and is distinguished from other active volcanic areas of Luzon which are aligned in one or two chains parallel to the Manila Trench (Yueh et al., 2009). According to Defant et al., (1988) the corridor is a northeast-southwest trending pull-apart rift zone that includes directional lineaments (northeast trending fracture lineaments) and volcanic centers.



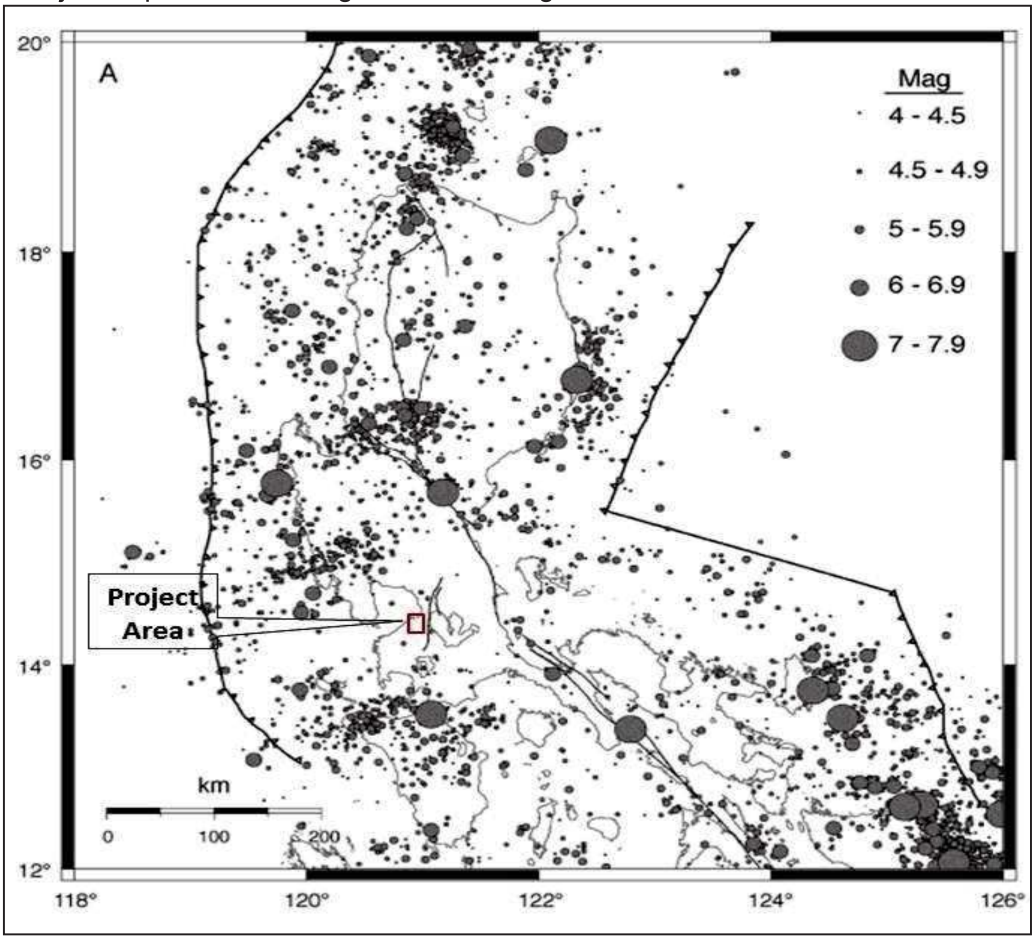
Source: Galgana et al., 2007

Figure 4.5: *Map of southwestern Luzon showing major tectonic structures. Prominent volcanic centers are marked with triangles*

The seismicity map of southwestern Luzon is shown in **Figure 4.6**. Magnitudes of shallow earthquake events (depth <70 km) are depicted by the circle diameters. The regional seismicity covering the Project is influenced by several earthquake generators that include the Philippine Fault, Manila Trench, Lubang Fault, and West Valley Fault.

4.1.2.3 Stratigraphy

The regional stratigraphic setting covering the Project features sedimentary and volcanic rock formations. The oldest rock consists of the volcanic flow of andesite and basalt which is intruded by cinder cones followed by the deposition of the volcanic tuff over the older rocks. The general stratigraphy of Cavite including the adjacent provinces of Laguna and Batangas are summarized in **Table 4.2**.



Source: Galgana et al., 2007

Figure 4.6: Seismicity Map (1973–2006) derived from the USGS National Earthquake Information Center (NEIC) catalogue. Magnitudes of these shallow events (depth <70 km) are depicted by the circle diameters

Table 4.2. General Stratigraphy of Laguna-Cavite-Batangas Region

Age	Formation Name	Lithological Description
Holocene *(11,700 years ago to present)*	Recent Alluvium	Alluvial, fluviatile, lacustrine, beach deposits and beachrock underlain by base surge and lava flows from eruptions of Taal Volcano.
Pleistocene *(2.588 million to 11,700 years ago)*	Guadalupe Formation	The formation has two members: a lower Alat Conglomerate and an upper Diliman Tuff. It unconformably overlies Miocene rocks. The GF is considered equivalent to the Laguna Formation.
Pliocene *(5.332 million to 2.588 million years ago)*	Pinamucan Formation	Poorly indurated but well sorted conglomerate; and well bedded sandstone and shale. The upper formation is intercalated with pyroclastic rocks (Lobo Agglomerate).
Middle Miocene *(16 million to 11.6 million years ago)*	Looc Volcanic Complex / Nasugbu Volcanic Complex	Agglomerate, tuff, andesite, dacite. Equivalent to the Talahib Andesite which is overlain by the Mapulo Limestone.
Late Miocene *(11.6 million to 5.3 million years ago)*-Early Pliocene *(5.3 million to 3.6 million years ago)*	Calatagan Formation	Lithology varies from soft tuffaceous marine siltstone to coralline limestone. Considered equivalent to the Mapulo Limestone
Oligocene *(33.9 million to 23 million years ago)*	San Juan Formation	Basalt, andesite, greywacke, shale, slate, paraschist, marble, hornfels.
Source: Geology of the Philippines, 2nd edition (MGB, 2010)		

4.1.2.4 Regional Structures

The Project is located in a region traversed by numerous active faults, trenches, volcanic belts and active volcanoes. The following geologic structures are critical as far as earthquake occurrences, tsunami events and volcanic activity that may affect the Project are concerned. **Table 4.3** presents the geologic structures proximate to the project area.

Table 4.3 - Geologic Structures Proximate to the Project Area

Geologic Structure	Description	Approximate Distance to Project Area
Philippine Fault (PF	Left-lateral strike-slip active fault that extends 1,200 km across the Philippine archipelago from northeast of Mindanao through central Philippines to northwestern Luzon. The PF has been associated with major historical earthquakes, including the M7.6 Luzon earthquake of 1990.	100 km NE of Project Area.
Manila Trench (MT)	Oceanic trench with depth of about 5,400 meters. The plate movements which gave rise to the MT are also responsible for the belt of volcanoes on the west side of Luzon, including Mount Pinatubo.	200 km W of Project Area.
Lubang Fault (LF)	Considered by some geologists as an extension of the MT. It runs through the eastern shore of Mindoro and extends farther east near Verde Island where it is termed as Sibuyan Verde Passage Fault. LF has been associated with the 1942 magnitude 7.6 and 1994 magnitude 7.1 Mindoro earthquakes.	78 km SW of Project Area.
West Valley Fault (WVF)	One of the two major fault segments of the Valley Fault System (VFS) a dominantly dextral strike-slip fault system that extends from Dingalan, Aurora in the north and runs through the cities of Quezon, Marikina, Pasig, Makati, Parañaque, Taguig and the provinces of Laguna and Cavite.	18 km E of Project Area.
Taal Volcano	A complex volcano ranked as the second most active volcano in the Philippines with 33 historical eruptions.	36 km SE of Project Area
Macolod Corridor (MC)	A NE-SW trending pull-apart rift zone and active Quaternary volcanic area that includes directional lineaments (northeast trending fracture lineaments) and volcanic centers.	17 km E of Project Area

4.1.2.5 Geomorphology

The region has one of the most varied land forms in the country which were shaped by large-scale faulting and volcanic activity. The topography of upland interior areas consists of slightly moderate undulating plains and rolling hills and mountains. The highlands include the volcanic peak of Mt. Banahaw which is considered active by PHIVOLCS. Another prominent highland is Mt. Makiling. Although it has no recorded historic eruption, volcanism is still evident through geothermal features like mud spring and hot springs.

Tagaytay Ridge is considered a part of the northern rim of the ancient Taal Caldera. Its northern slope gently rolls downslope until it reaches the sea level at Manila Bay. Taal Lake was formed by a series of catastrophic volcanic eruptions and other geologic processes whose character slowly evolved as the large basinal depression and the lake took form (Ramos, 2002). The Macolod Corridor was believed to be formed by large-scale faulting. GPS measurements conducted by Ohkura, et al., (2001) suggest that the corridor is a broad left-lateral fracture zone, an observation corroborated by Pubellier, et al., (2000).

The lowest lowland area in the region is the coastal plain while the lowland area consists of coastal and alluvial plains. The alluvial plain forms the transition area between the coastal plain and hilly area.

4.1.2.5.1 Vegetation

The lowland area of Cavite is planted to rice and corn. Mangrove areas within the Project Area are in decline due to the conversion of saline coastal sediment habitats to fishponds, salt-beds and built-up or settlement areas as well as charcoal-making. The central part of the province is cultivated to diversified farming such as upland rice, corn, sugarcane, root crops, coconut, coffee, mangoes and other fruit trees. Those in the upland are suited for orchard and pasture.

According to the website of the province (www.cavite.gov.ph) the existing forest area approximately totals to 8,625 hectares. The forest areas are classified as either national parks (Mts. Palay-palay in Ternate and Mataas na Gulod in Maragondon) or the unclassified forest along Tagaytay Ridge, Maragondon, Magallanes and Alfonso. Cavite's forest provides an abundance of different products and they must be safeguarded from the effect of rapid and uncontrolled urbanization.

4.1.2.5.2 General Nature of Rock Exposures

The Quaternary Alluvium formation consists of unconsolidated clay, silt, sand and gravel. It is dominant in the river plain and delta and along the coast fronting the northern part of the Project Area. Tuff breccia and tuffaceous sandstone are exposed within the river basins and along river channels.

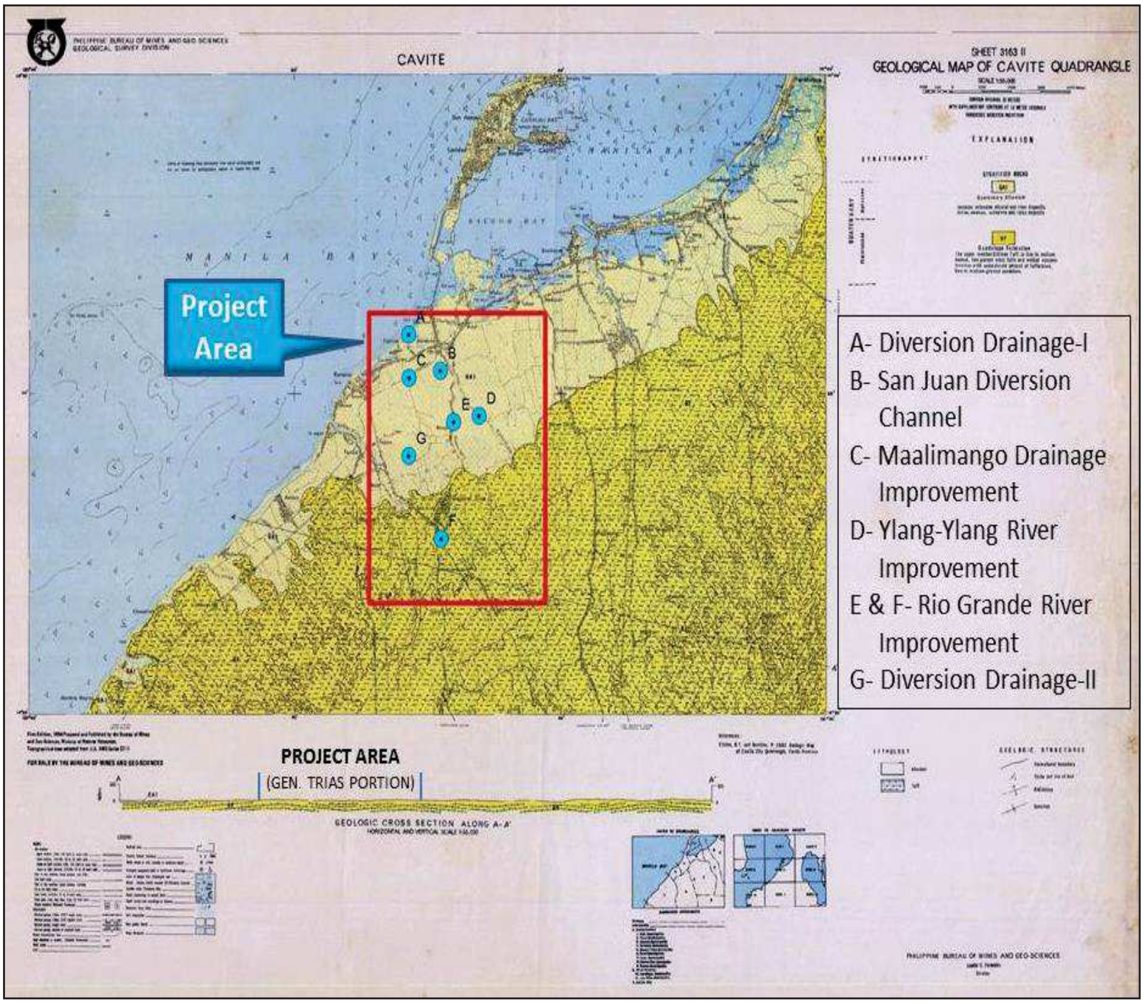
4.1.3 SITE GEOLOGY

The greater part of the Project will sit on Quaternary Alluvium. The southern portion of the Project is underlain by Diliman Tuff that represents the upper member of the Guadalupe Formation. The Diliman Tuff is described by MGB as thin to medium-bedded, fine grained vitric tuffs and welded volcanic breccias with subordinate amount of fine to medium grained tuffaceous sandstone. The geological map and cross-section is shown in **Figure 4.7**.

4.1.3.1 Topography

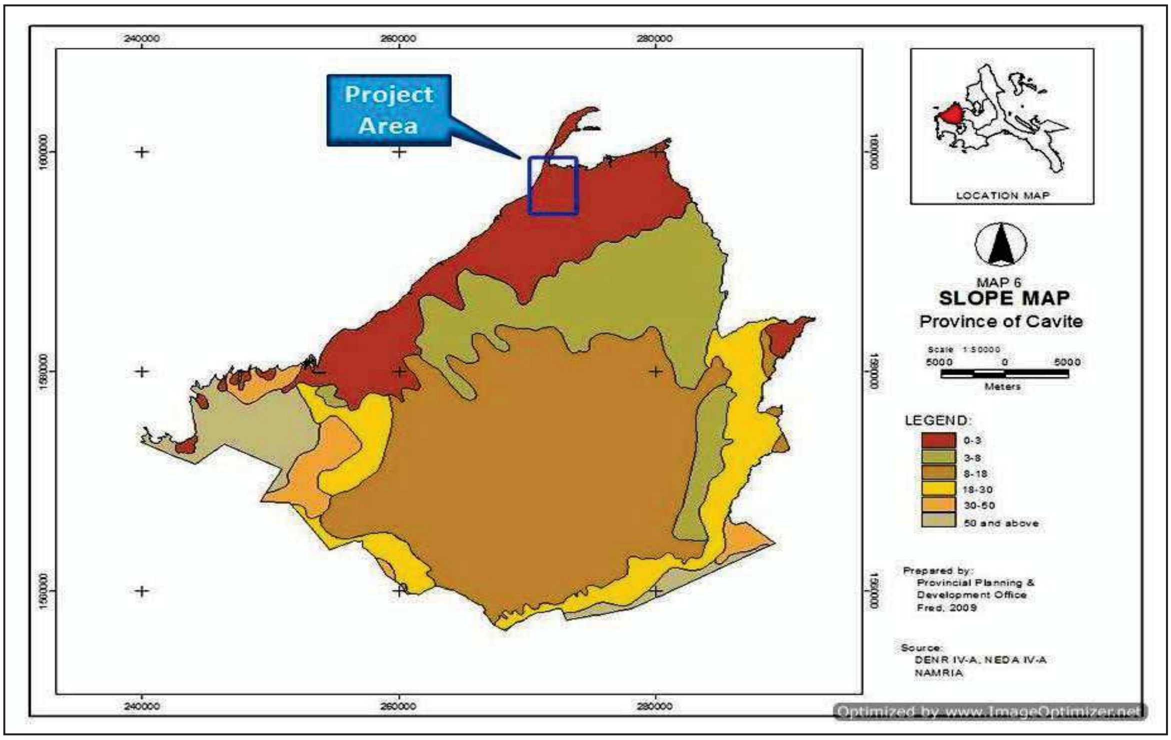
The slope map of Cavite is shown in **Figure 4.8**. The Project Area can be divided into two (2) physiographical areas, namely: the lowest lowland area along the coastal plains; and the lowland area within the coastal and alluvial plains. The lowest lowland area is situated along the coastal plains of Kawit, Noveleta, and Rosario. The area is susceptible to tidal inundation due to its almost flat and extremely low ground level of El. 0 to 2 meters (**Figure 4.9**). The Diversion Drainage-I is located at the left rear part of left photo. Dumping of garbage along the coast is prevalent as shown in right photo.

The lowland area consists of coastal and alluvial plains with ground elevation ranging from EL. 2 to 30 meters. The alluvial plain covers Imus, some parts of Kawit, Noveleta, Rosario, and the southern parts of General Trias The topography is largely flat created by the deposition of sediments coming from rivers in the highland areas. The lowland area forms the transition area between the coastal plain and the hilly area towards the central part of the province.



Source: Geological Map of Cavite Quadrangle Sheet No. 3163-II Scale 1:50,000, MGB 1984

Figure 4.7: Geologic Map of the Project Area



Source: Cavite PPDO, 2009

Figure 4.8: Slope Map of Cavite Province

Figure 4 .9:.Lowest lowland area situated along the coastal plain of Noveleta.

4.1.3.2 Bedrock Lithology

Bedrock exposures were observed along the channels of San Juan River, Ylang-Ylang River, and Rio Grande River in General Trias. These rivers are deeply entrenched into tuffaceous materials with interbedded sandstones of the Pleistocene

Guadalupe Formation. The tuffaceous sandstone is thickly bedded and forms deep river valleys (**Figure 4.10**).

Figure 4.10: Exposure of tuffaceous sandstone along the Ylang Ylang River Improvement Project (left photo). Deep river valley along the Rio Grande River Improvement Project (right photo).

4.1.3.3 Surficial Deposits

The thickness of overburden material is about 3.00 meters as observed from a construction excavation located east of Maalimango River (**Figure 4.11**). It consists of a mixture of clay, sand, silt, and gravel of volcanic/sedimentary origin underlain by tuffaceous sandstone. Boulders of tuff breccia were noted on riverbeds. The thickness of surficial deposits varies depending on ground elevation or terrain.

Figure 4.11: Construction excavation east of Maalimango River (left photo). Boulders of tuff breccia along Ylang-Ylang River Improvement Project (right photo).

4.1.3.4 Structural Features

There was no prominent geologic structure observed at the Project Area. The exposed member of the Guadalupe Formation exhibits little deformation features as observed during the field survey.

4.1.4 HAZARD ASSESSMENT

4.1.4.1 Geologic Hazard

4.1.4.1.1 Fault Related/Seismic Hazards

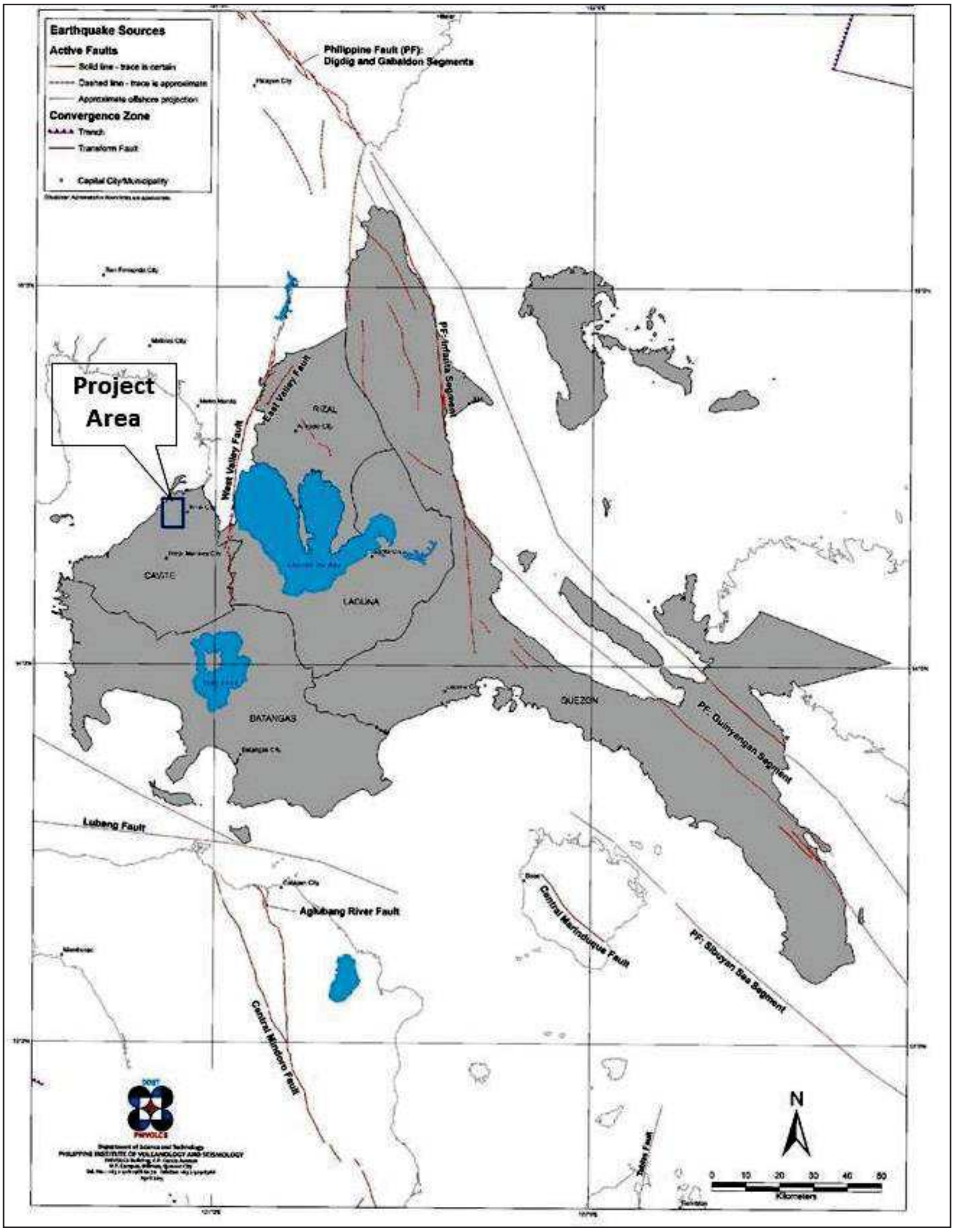
The Project is located proximate to major earthquake generators manifested by active trenches as well as major fault systems and lineaments (**Figure 4.12**). The tectonic movements along these geologic structures are critical to the Project as far as the occurrences of fault related/seismic hazards are concerned.

The West Valley Fault (WVF), one of the two major fault segments of the Valley Fault System (VFS) is located approximately 18 km east of the Project Area. **Table 4.4** shows the major earthquake generators and its distance to the project area.

Table 4.4. Major Earthquake Generators Proximate to the Project Area

Earthquake Generator	Approx. Distance to Project Area
Philippine Fault	100 km NE of Project Area
Manila Trench	200 km W of Project Area
Lubang Fault	78 km SW of Project Area
West Valley Fault	18 km E of Project Area

381 Sto. Rosario St., Angeles City
Tel. No. 09175262698;09175109892; 0917-5276352
Email: alot_avenido@yahoo.com; cqcapule@yahoo.com



Source: PHIVOLCS

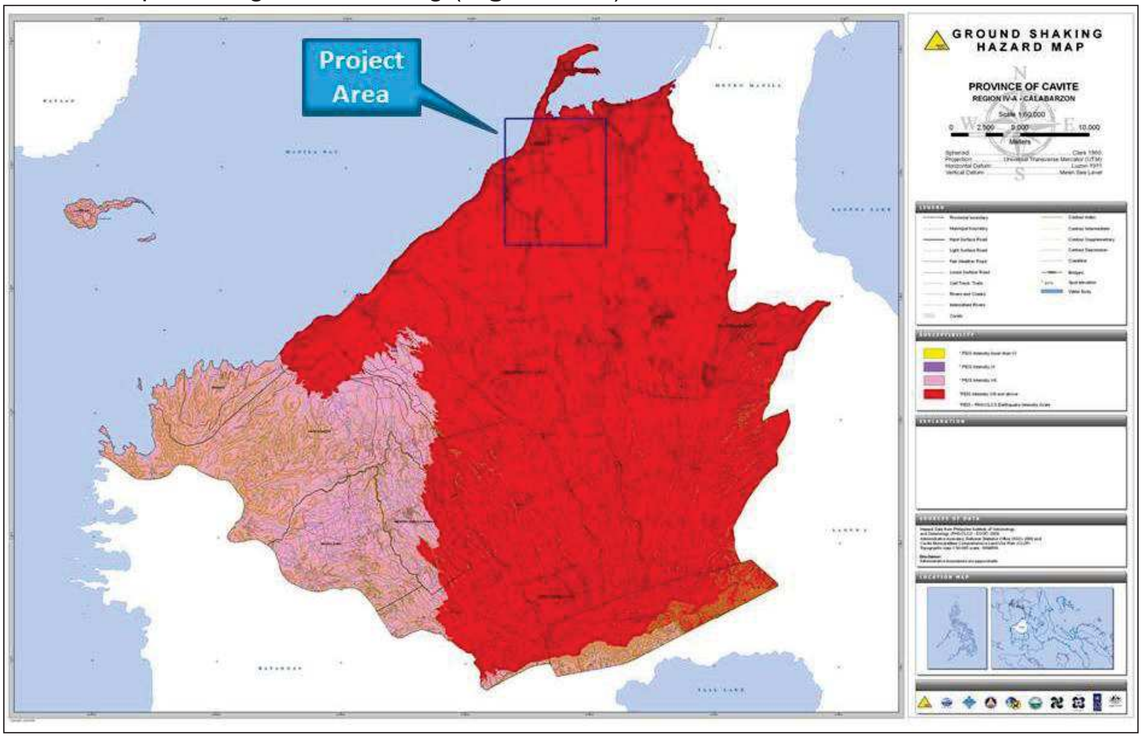
Figure 4.12: Distributions of Active Faults and Trenches in Region 4A

4.1.4.1.1.1 Ground Shaking

Strong ground vibration may cause damage to buildings and other rigid structures. The severity of the local effects of an earthquake in a particular area is influenced by the depth of earthquake source and the distance from the epicentral area. High level of shaking can be also induced by the transfer of the seismic motion from hard deep soils to soft superficial soils and to effects of seismic energy focalization owing to typical geometrical setting of the deposits. Ground-shaking is measured by ground acceleration, and the Peak ground acceleration (PGA) is equal to the maximum ground acceleration that occurred during earthquake shaking at a particular location.

A study conducted by Daligdig and Besana, (1992) assumed a magnitude 7.5 earthquake generated from the VFS. The PGA values may reach up to 1.0g within the epicentral area for areas underlain by soft soils, while those with bedrock close to the epicenter could experience PGA of about 0.4g. This is likely to be experienced in the northern and western coastline of Laguna de Bay; while nearer the Project, the area towards Zapote-Bacoor can experience PGAs of 0.4g to 0.8g.

The southern end of the WVF traverses the municipalities of Carmona, General Mariano Alvarez and Silang making the Project Area and most parts of Cavite highly susceptible to ground shaking (**Figure 4.13**).

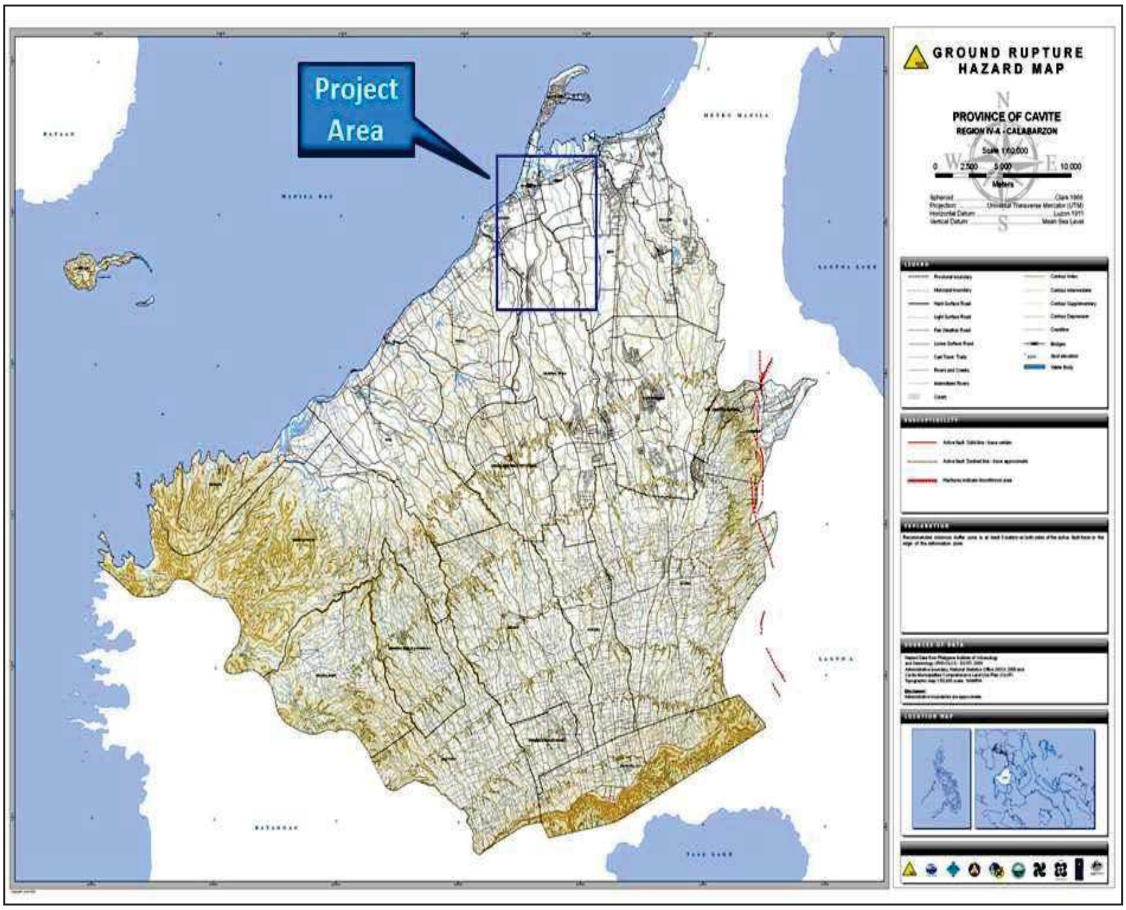


Source: PHIVOLCS-DOST, 2008

Figure 4.13: Ground Shaking Hazard Map of Cavite Province. Red color indicates high susceptibility to ground shaking under PEIS Intensity VIII and above

4.1.4.1.1.2 Ground Rupture

Ground rupture is the visible breaking and displacement along the trace of the fault during major earthquakes. Structures that directly straddles or located within a narrow zone of the active fault traces may collapse. In the case of the magnitude 7.6 1990 Luzon earthquake, the deformation zone from ground rupture ranges from 5-10 meters**.** As shown in **Figure 4.14**, the susceptibility to ground rupture is confined southeast of the Project in the municipalities of Carmona and Silang that are traversed by southern segment of the WVF. The recommended buffer zone is at least 5 meters on both sides of the active fault trace (solid and dashed red lines) and the edge of the deformation zone.



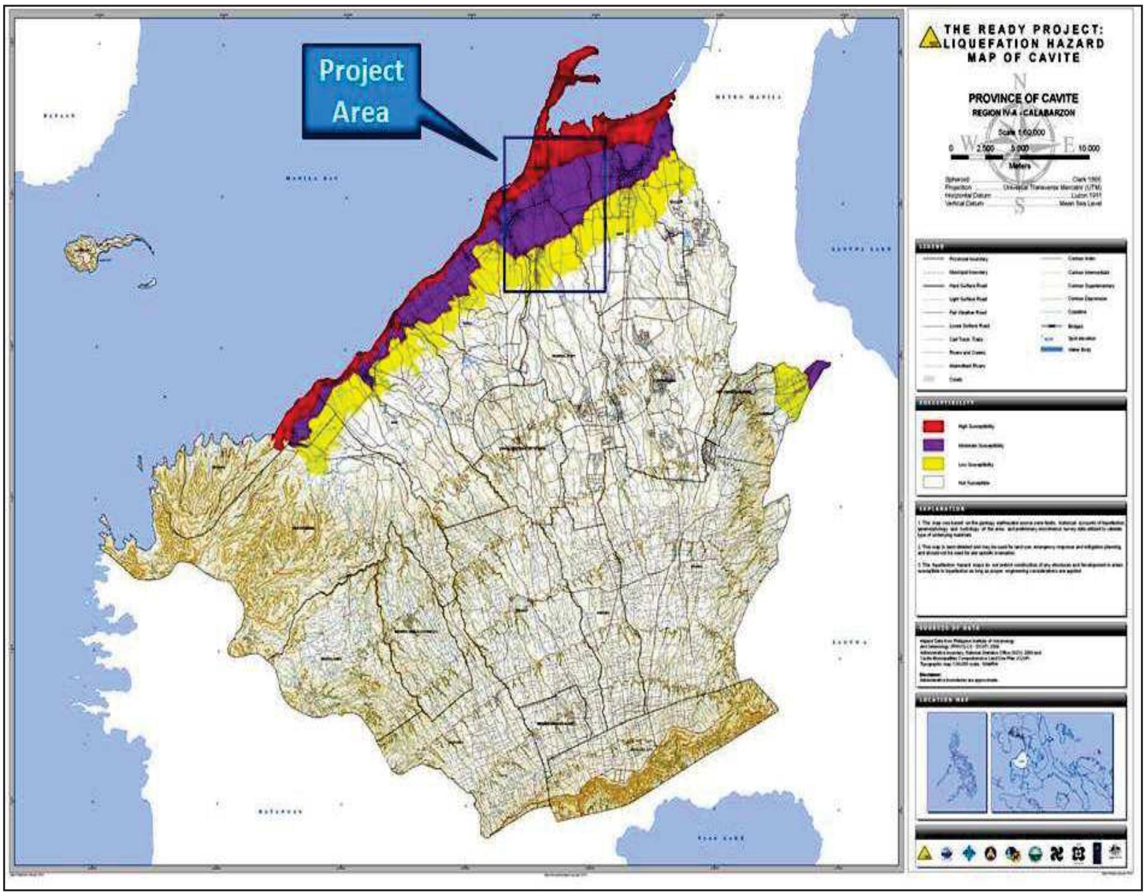
Source: PHIVOLCS-DOST, 2008

Figure 4.14: Ground Rupture Hazard Map of Cavite Province.

4.1.4.1.1.3 Liquefaction

Liquefaction is the rapid loss of shear strength in cohesionless materials subjected to dynamic loading, such as from an earthquake (Coduto, 1999). The occurrence of liquefaction is influenced by the magnitude of earthquake, ground acceleration, proximity to earthquake generator, duration of shaking, relative density, seismic history, and age of the deposit.

The unconsolidated deposits underlying the coastal municipalities of Kawit, Noveleta, and Rosario are considered highly susceptible to liquefaction. Comparatively, the soils in the inland municipalities of General Trias and Imus have moderate to low susceptibility due to its relatively deeper water table and with near-surface presence of bedrock overlain by relatively thin alluvial materials. The liquefaction hazard map of Cavite is shown in **Figure 4.15**. The liquefaction hazard characterization of the municipalities covering the Project is shown in **Table 4.5**.



Source: PHIVOLCS-DOST, 2008

Figure 4.15: Liquefaction Hazard Map of Cavite Province

Table 4.5. Liquefaction Hazard Characterization

Municipality/City	Susceptibility Level		
	High	Moderate	Low
General Trias		• Bacao I • Bacao II • Tejero	• Pinagtipunan • Prinza • Sta. Clara
Imus		• Alapan II-A	• Alapan II-B
Kawit		• San Sebastian	
Noveleta	• Salcedo I • Salcedo II • San Rafael I • San Rafael II	• Sta. Rosa I • Sta. Rosa II • San Antonio II	
Rosario	• Bagbag I • Ligtong I • Ligtong II	• Tejeros Convention • Ligtong III	
Source: Cavite Provincial Disaster Risk Reduction and Management Plan (PDRRMP) 2011-2016			

4.1.4.1.1.4 Differential Settlement

The unconsolidated deposits underlying the coastal municipalities of Kawit, Noveleta, and Rosario that possess high liquefaction potential may likewise be susceptible to ground settlement.

4.1.4.1.1.5 Landslides

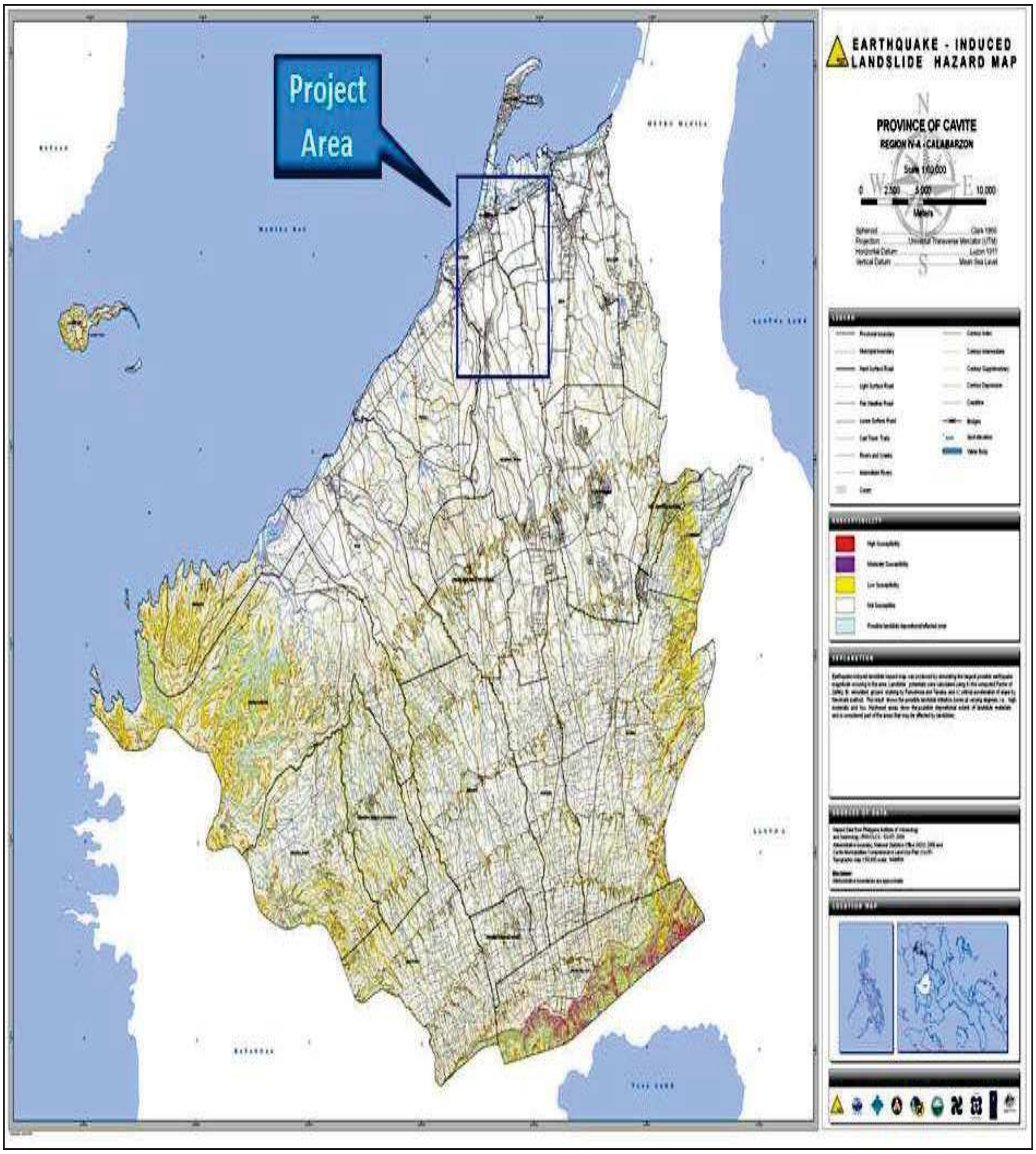
Intense ground shaking can trigger a landslide by loosening the cohesion that bonds the slope materials together thereby making it easier for gravity to pull it downwards. The Project Area is not susceptible to earthquake-induced landslide (**Figure 4.16**) due to its low relief which is inherent of coastal areas and alluvial plains.

4.1.4.1.1.6 Tsunami

A tsunami is a series of sea waves commonly generated by under-the-sea earthquakes and whose heights could be greater than 5 meters. Tsunamis can occur when the earthquake is shallow-seated and strong enough to displace parts of the seabed and disturb the mass of water over it.

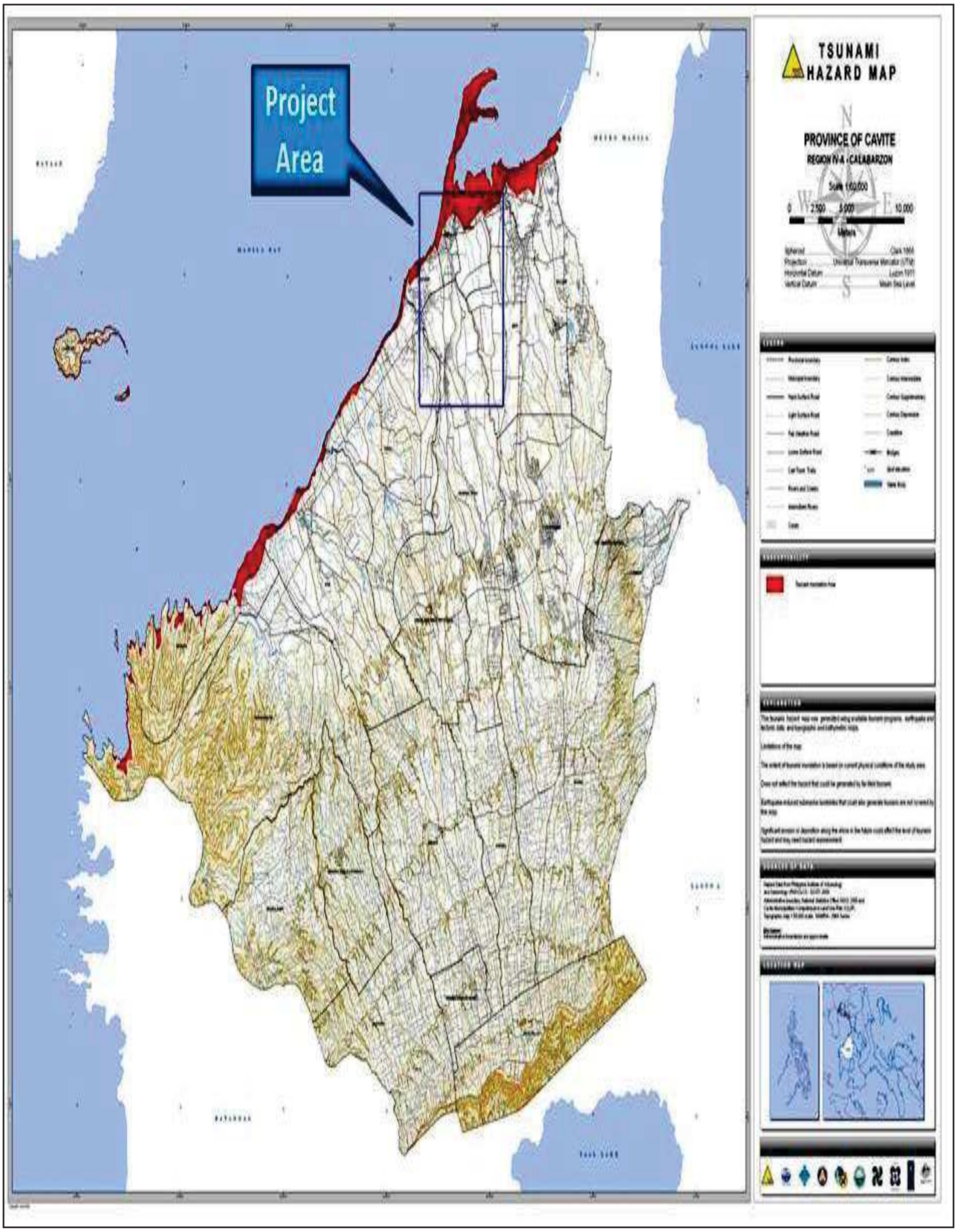
According to PHIVOLCS, a magnitude 8.2 earthquake generated by the Manila Trench could cause a tsunami up to 10 meters tall which could hit Cavite within minutes. The Manila Trench is located approximately 200 km west of the Project Area.

As shown in **Figure 4.17**, the coastal municipalities covered by the Project, namely Kawit, Noveleta, and Rosario are classified as highly susceptible to being hit by tsunami (PHIVOLCS-DOST, 2008). The tsunami hazard characterization of the municipalities and cities covering the Project is shown in **Table 4.6**.



Source: PHIVOLCS-DOST, 2008

Figure 4.16: Earthquake-Induced Landslide Hazard Map of Cavite Province



Source: PHIVOLCS-DOST, 2008

Figure 4.17: Tsunami Hazard Map of Cavite Province

Table 4.6. Tsunami Hazard Characterization

Municipality/City	Susceptibility Level		
	High	Moderate	Low
General Trias	No barangay affected.		
Imus	No barangay affected		
Kawit	No barangay affected		
Noveleta	San Rafael I San Rafael II		
Rosario	Ligtong I		
Source: Cavite Provincial Disaster Risk Reduction and Management Plan (PDRRMP) 2011-2016			

4.1.4.1.1.7 Recent Earthquake Occurrences

The PHIVOLCS Earthquake Bulletin during the period from 2015 to present shows three (3) seismic events of magnitude 5 and above which occurred in the neighboring province of Batangas (**Table 4.7**). These earthquakes are considered as moderately strong based on the PHIVOLCS Earthquake Intensity Scale (PEIS).

The historical record of earthquake events in Cavite is shown in **Table 4.8.**

Table 4.7 Occurrences of M5 Earthquake (2015 to present)

Date-Time	Depth (km)	Magnitude	Location	Reported Damage
18 Jan 2015 08:27 AM	102	5.0	021 km N 75° W of Calatagan, Batangas	None
17 Jan 2015 01:09 PM	118	5.3	019 km N 55° W of Calatagan, Batangas	None
11 Feb 2015 12:09 AM	109	5.0	022 km S 65° W of Nasugbu, Batangas	None

Table 4.8. Record of Historical Earthquakes in Cavite Province

Description	Areas Affected	Impacts
June 3, 1863 7:20 PM	Sangley Point Cavite City	A crater opened and emitted water and dirt. A barracks collapsed, the telegraph tower fell, and nearby all walls cracked. On the peninsula of Cañacao, fissures

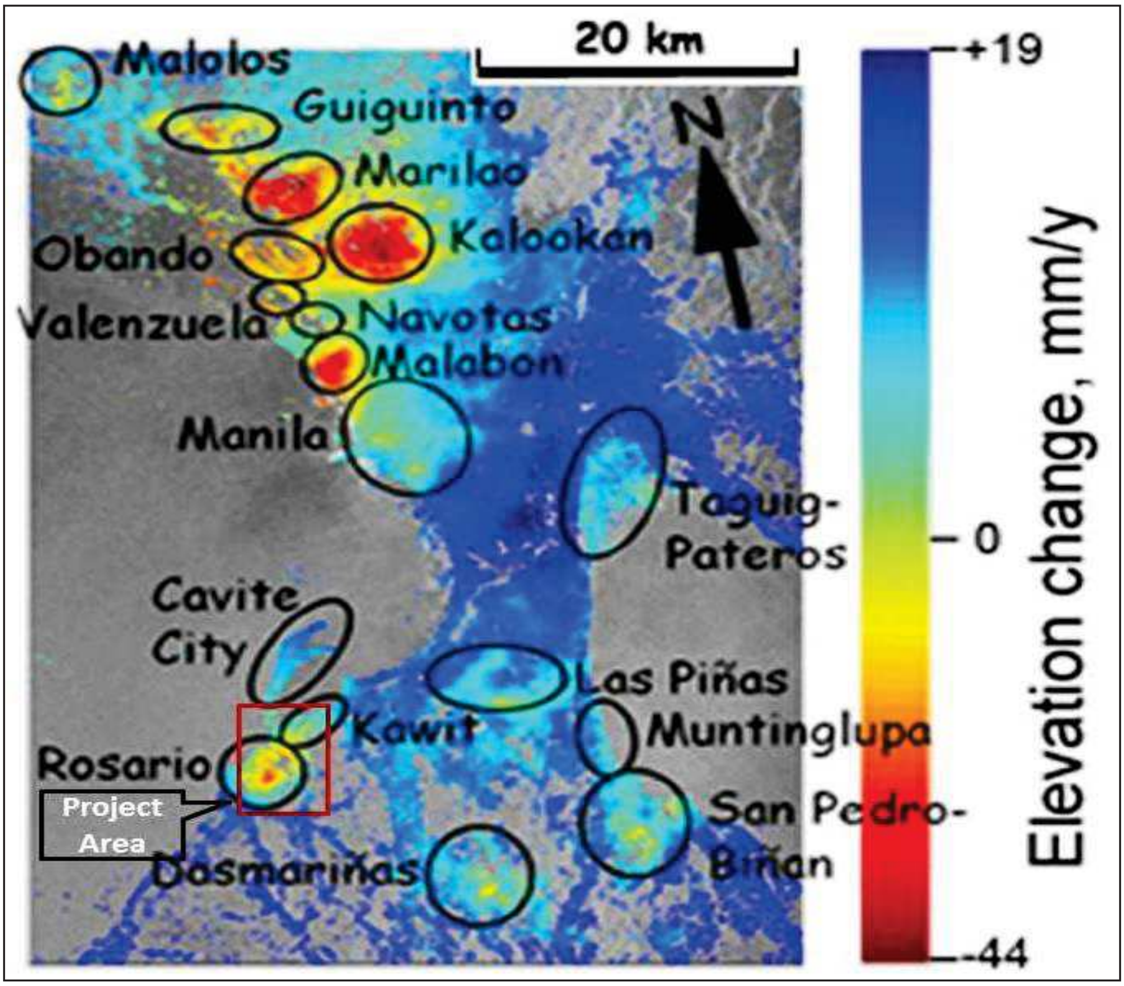
Description	Areas Affected	Impacts
	Bacoor and Maragondon	opened. Damage to church structures.
August 20, 1937 7:59 PM	Cavite City Mendez Nuñez and Silang	One person died due to fright when the quake struck. Several old buildings in the town collapsed. A building on Calle Colon collapsed. Some piers in the Navy yard cracked. One wall of a house in the Navy yard collapsed. Some cracks appeared in the walls of the churches
March 16, 1892 9:01 PM Great intensity, 50 seconds	Cavite City	
July 18, 1880 12:40 PM Oscillatory, strong, N-S, 55 seconds	Cavite City	The government house, church, rectory and telegraph office fell; in the shipyard the black sand rose around the piles.
September 16, 1852 – 6:30 PM	Cavite City	All the buildings in the town were damaged seriously, especially those of the arsenal and royal house. One of the eight sides of the telegraph building is cracked horizontally and there are two vertical cracks extending to the 2nd floor. In the infantry barracks, most of the posts have been dislodged. Some Earthquake Historical Record of Cavite 39 stones have been slightly moved, and three tie-beams in two rooms show cracks. The former church of the Jesuits was spared by the earthquake in spite of the fact that the bell tower, which leaned against the facade, was cracked from top to bottom. The house occupied by the supervisor was of very poor construction; through

Description	Areas Affected	Impacts
	Old Cavite Indang San Roque Imus	it the earthquake swept swiftly in all its walls, posts and partitions; the whole second floor is left in a very bad state, chiefly because its frame had been weakened by termites. One of the beams supporting the roof broke and this caused the last wall to break for a length of six varas (5 1/2 yards) and the west wall for ten varas. (about 9 yards). The town suffered much especially the town. Part of the chapel and walls of the cemetery were demolished. The parish house and church have sustained considerable damage.
December 7,1677 7:30 PM	West Coast of Cavite	Waves were raised
Source: SEASEE, as cited in *Cavite* PDRRMP 2011-2016		

4.1.4.1.1.8 Land Subsidence

Land subsidence is the loss in elevation due to gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials (http://water.usgs.gov/ogw/subsidence.html). Several meters of subsidence has been documented in many coastal lowlands around the world including major coastal cities such as Bangkok (Nair, 1988), Tokyo and Shanghai (Nichols, 1995).

One of the principal causes of ground subsidence is excessive groundwater withdrawal that consolidates water bearing geological strata or clayey sediments in the aquifer. In the Manila Bay area and vicinity (**Figure 4.18**), the rate of land subsidence due to groundwater abstraction has been estimated at 2 cm/year (Siringan, et al, 2010).



Source: Lagmay, 2011 and Eco et al., 2013 (Rodolfo, 2014)

Figure 4.18: Manila Bay subsidence in mm/y from 2003 to2006, as determined from satellite-borne Permanent Scatterer In-terferometric Synthetic-Aperture Radar (PSInSAR)

In the lowland areas covering the towns of Bacoor, Imus, General Trias, Dasmariñas, Naic, Tanza, Ternate, hundreds of artesian wells and deepwells provide water supply for both domestic and irrigation purposes. According to a JICA study, the groundwater in Cavite is depleting at a rate of 1 meter water level decrease per year.

Land subsidence may result in the collapse of buildings and other infrastructures, flooding of sewerage and storm drainage systems during high tides, and increase the dangers posed by flooding and sea-level rise. The lowering of the surface closer to sea level also delays runoff from rains and enhances both flooding and tidal incursions (Rodolfo, 2014).

4.1.4.2 *Volcanic Hazard*

The closest active volcano to the Project is Taal Volcano located about 36 km southeast of General Trias. Taal is the second most active volcano in the Philippines with 33 historical eruptions. The possibility of the Project being affected by the eruption of Taal is considered minimal, the most serious impact being the adverse effect of ashfall to human health and potential damage to infrastructures. The other active volcano in the region is Mt. Banahaw which is located approximately 75 km southeast of the Project Area. It has a record of three (3) historical eruptions the last being in 1843.

4.1.4.3 Hydrological / Hydrometeorological Hazards

4.1.4.3.1 Fluvial Hazard

Fluvial flooding, occurs when excessive rainfall over an extended period of time causes a river to exceed its capacity. In Cavite, fluvial flooding has two classifications: the River Overflow Flood and the Inland Flood (Ref. Provincial Disaster Risk Reduction and Management Plan of Cavite Province, 2011-2016).

4.1.4.3.1.1 River Overflow Flood

The River Overflow Flood is caused by inadequate river flow whenever channels are clogged by deposition of sediments and debris. Also contributing to river overflow flood is the narrowing of sections along waterways like canals, bridges, and culverts; and siltation of major rivers and their tributaries (**Figures 4.19 and 4.20**).

During typhoons and heavy rains, the lowland part of the province is highly prone to inundations. The runoff from the upland part contributes to the volume of water in the lowland rivers and tributaries. River overflow flooding could be also due to land conversion resulting from rapid population growth and industrialization.

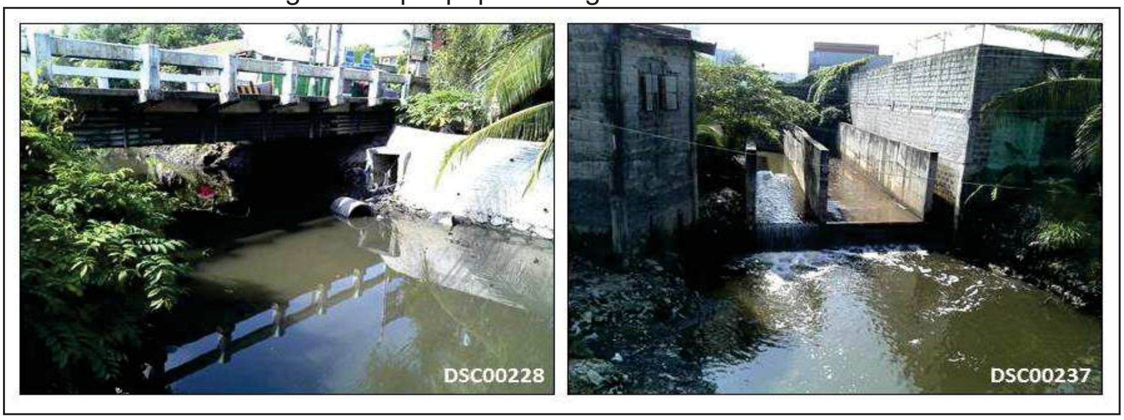


Figure 4.19: Clogging of drainage channels due to solid wastes along the Maalimango Drainage Improvement Project.

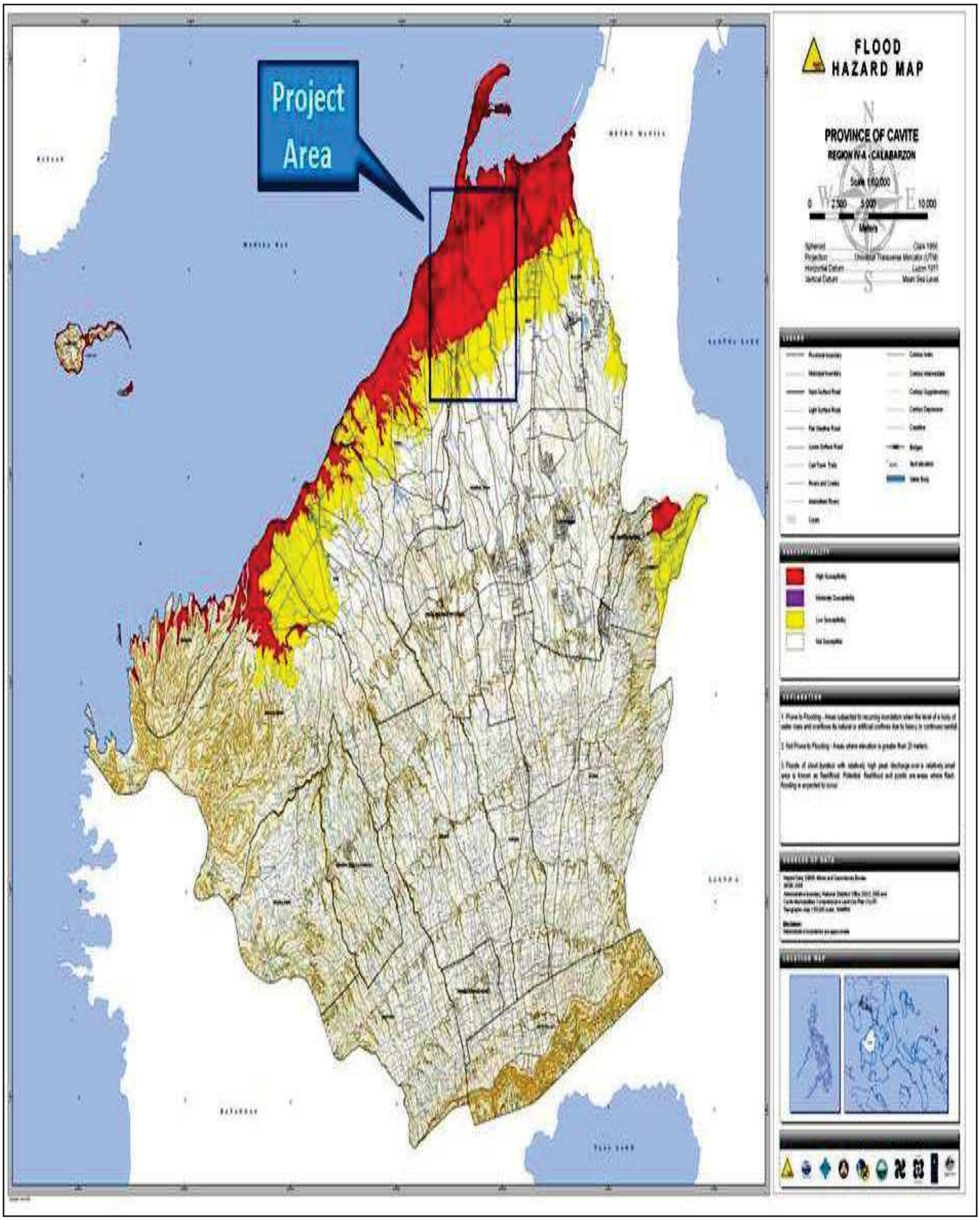
Figure 4.20: Narrowing of sections of waterways due to construction of residential houses along the Maalimango Drainage Improvement Project.

4.1.4.3.1.2 Inland Flood

The Inland Flood is caused by the stagnant of the storm rainfall and/or the overflow from the local drainage channel. Intrusion of seawater during high tide also causes inland flooding. The vulnerability of the Project to inland flooding is attributed to its lowest lowland physiographical category characterized by extremely low ground level of 0 to 2 meters elevation, compared to the high tide level of about 0.8 meter elevation from the Mean Sea Level (MSL). This observation conforms to a JICA study which states that the inland flooding in the coastal municipalities of Kawit, Noveleta, and Rosario is due to the following factors:

- Low elevated ground level below the tidal level;
- Inadequate capacities of existing drainage facilities;
- Clogging of drainage channels due to solid wastes;
- Illegal encroachment of structures in the drainage channels; and
- Reclamation of existing natural retarding basins and drainage channels.

Aside from the coastline municipalities, the inland towns of Gen. Trias and Imus were similarly included among the risk areas. The study likewise established that land development, land conversion, and inappropriate construction of structures along the coastlines or on the sea itself add up to the hazards of inland flooding.



Source: PHIVOLCS-DOST, 2008

Figure 4.21: Flood Hazard Map of Cavite Province

381 Sto. Rosario St., Angeles City
Tel. No. 09175262698;09175109892; 0917-5276352
Email: alot_avenido@yahoo.com; cqcapule@yahoo.com

The flood hazard map shown in **Figure 4.21** dictates that the Project Area is subject to recurring inundation and therefore has high susceptibility to flooding.

The flood hazard characterization of the municipalities covering the Project is shown in **Table 4.9**.

Table 4.9. Flood Hazard Characterization

Municipality/City	Susceptibility Level		
	High	Moderate	Low
General Trias	Bacao I Bacao II Tejero		Sta. Clara Prinza Pinagtipunan Portion of Pasong Camachile I
Imus	Alapan II-A		Alapan II-B
Kawit	All barangays of Kawit		
Noveleta	All barangays of Noveleta		
Rosario	All barangays of Rosario		
Source: Cavite Provincial Disaster Risk Reduction and Management Plan (PDRRMP) 2011-2016			

4.1.4.3.2 Coastal Hazard

4.1.4.3.2.1 Coastal Flooding

The coastline of Cavite stretches for about 123 km and could be found along the cities of Cavite and Bacoor, and the municipalities of Kawit, Noveleta, Rosario, Tanza and Naic. As shown in **Figure 4.21,** most barangays that are highly susceptible to flooding belongs to these localities. The coastal plain covering the Project Area in Kawit, Noveleta, and Rosario has extremely low ground level of EL. 0 to 2 meters, and the tidal flood often occurs in its substantial part even without storm rainfall. Such tidal inundation is being aggravated by the progress of land subsidence.

4.1.4.3.2.2 Coastal Erosion

Coastal erosion is the wearing away of land and the removal of beach or dune sediments by wave action, tidal currents, wave currents, drainage or high winds. Human activities such as inappropriate land use, alterations, and shore protection structures that wear away the beaches also contribute to coastal erosion. Erosion

381 Sto. Rosario St., Angeles City
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Email: alot_avenido@yahoo.com; cqcapule@yahoo.com

undermines and often destroys homes, businesses, and public infrastructure and can have long-term economic and social consequences (PEMSEA, 2012). Erosion in the beach areas of Cavite is most probably due to sand quarrying, (Perez et al., 1999).

4.1.4.3.2.3 Storm Surge

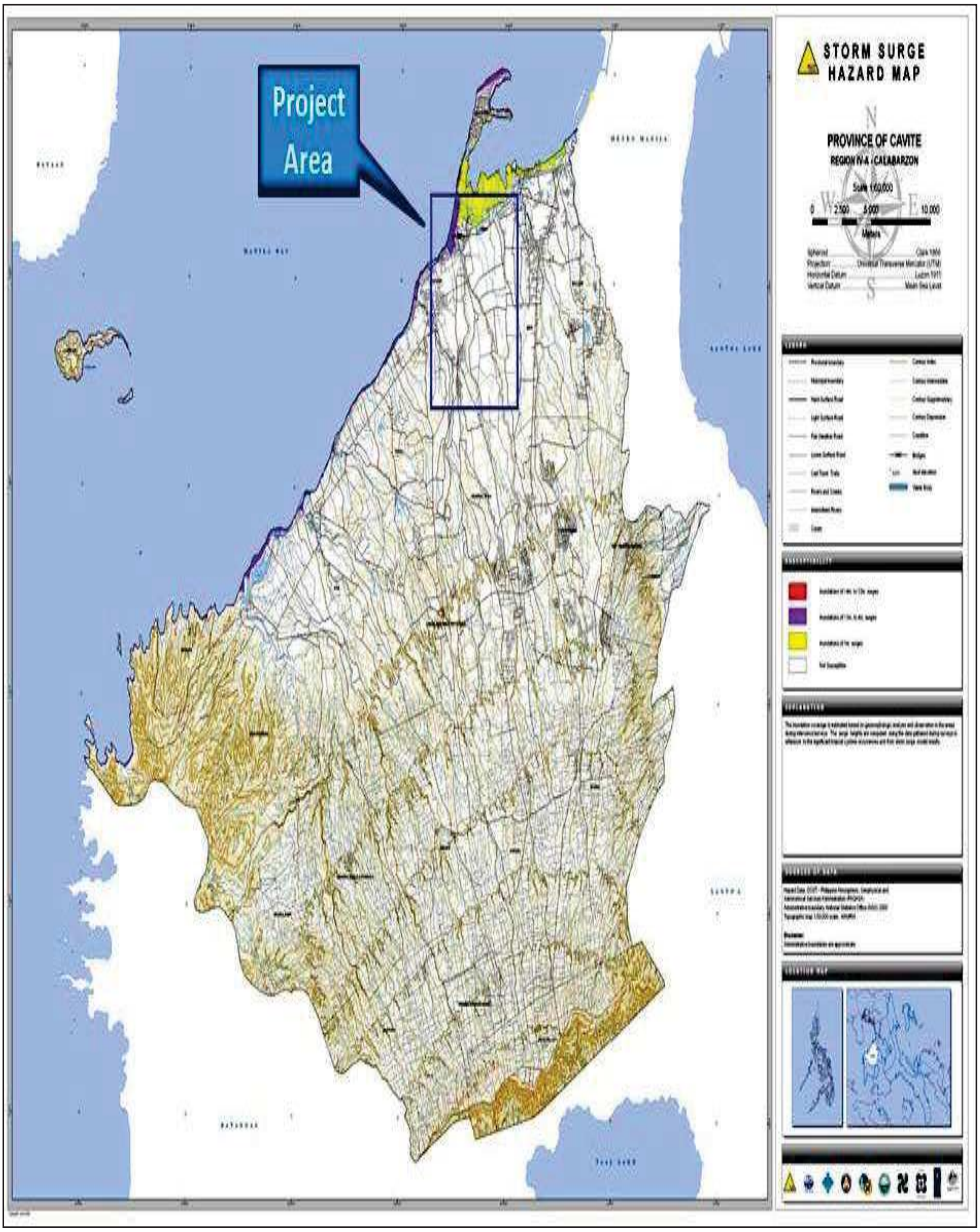
A storm surge is a coastal flood of rising water commonly associated with tropical cyclones. Strong typhoons with accompanying storm surges have been recorded in Cavite. One documented major storm surge with a height of 3-5 meters occurred on October 10-15, 1970 during the onslaught of Typhoon Sening (PAGASA, 2004).

As shown in **Figure 4.22**, the coastal area along the municipality of Kawit is susceptible to inundation of 1 meter surges, while the coastline along Noveleta and Rosario are exposed to inundations of > 1 meter to 4 meters surges.

PAGASA has also gathered anecdotal reports of typhoon surges up to 4 meters high affecting the coastal areas along Manila Bay (**Figure 4.23**). Depending on how long the typhoon winds last, and the timing and heights of the normal tides, a storm surge and the flooding it causes can last from hours to days (Rodolfo, 2014). The storm surge hazard characterization of the municipalities covering the Project is shown in **Table 4.10**.

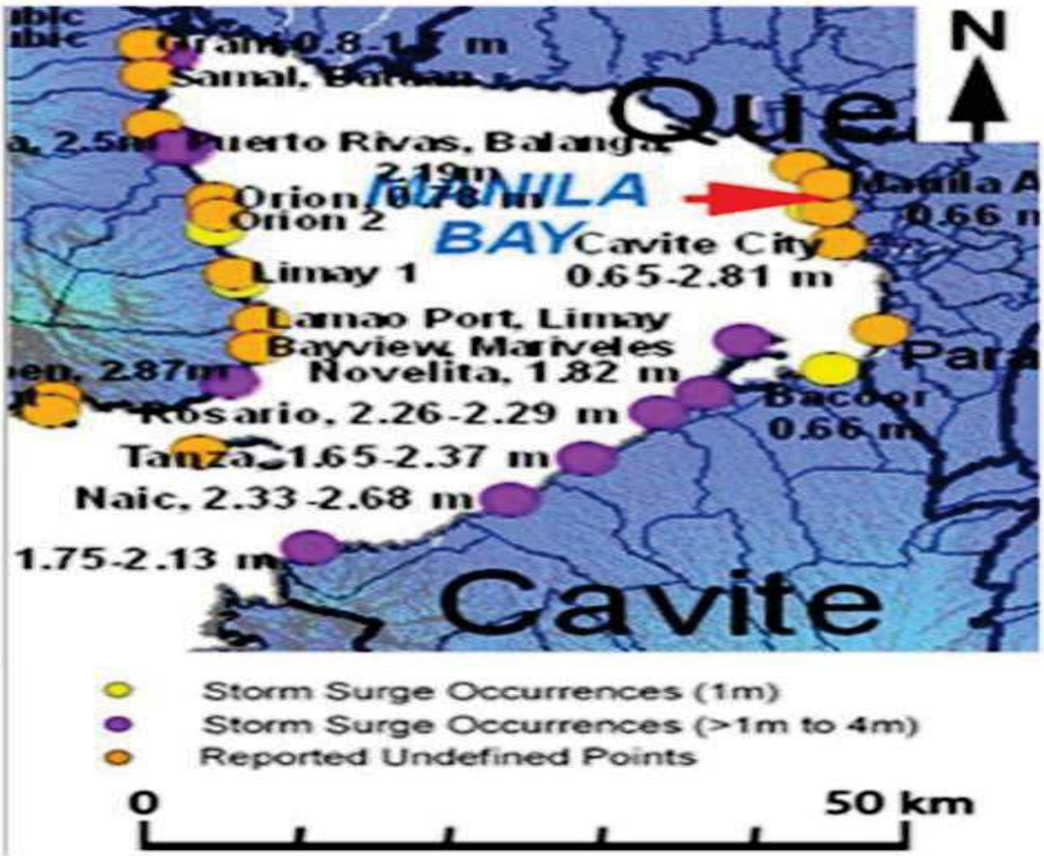
Table 4.10. Storm Surge Hazard Characterization

Municipality/City	Susceptibility Level		
	High	Moderate	Low
General Trias	No barangay affected.		
Imus	No barangay affected.		
Kawit	No barangay affected.		
Noveleta		San Rafael I San Rafael II Salcedo II	
Rosario		Ligtong I	
Source: Cavite Provincial Disaster Risk Reduction and Management Plan (PDRRMP) 2011-2016			



Source: PHIVOLCS-DOST, 2008

Figure 4.22: Storm Surge Hazard Map of Cavite Province



Source: Rodolfo, 2014

Figure 4.23: Manila Bay portion of the PAGASA compilation of historical storm surges. Reported undefined points include areas where typhoons Patsy in 1970 and Ora parked seagoing ships on Roxas Boulevard

4.1.4.3.2.4 *Sea-Level Rise*

Accelerated sea level rise (ASLR) is one of the outcomes of global warming. The physical effects of sea level rise include inundation of low-lying wetland and dryland areas, erosion, salt water intrusion, increased risk of flooding, and storm damage. These physical changes may cause substantial socio-economic losses of coastal structures, both natural and man-made, and dislocation of the population and change of livelihood. The same physical changes may bring about certain ecological consequences such as redistribution of wetlands, destruction of coral reefs, reduction in biological diversity and loss of wildlife, and changes in biophysical properties of the coastal zones (Perez, et al., 1999).

Most areas along the coast of Manila Bay including Cavite City, Noveleta, Kawit, Imus and Bacoor in the province of Cavite could succumb to a 1 meter sea level rise by 2100. Even inland areas would be affected, especially near riverbanks, when sea level rise reaches a height of 2 meters.

4.1.4.3.2.5 *Typhoons*

The Philippines is visited by an average of 19 to 20 tropical cyclones during June to October of every year (PAGASA) due to the country's location along the Pacific Typhoon Belt. About 16 percent of these typhoons pass through the middle part of the Luzon Island where the Project is located. Nonetheless, violent typhoons seldom pass over Cavite, although most tropical disturbances north to northeast of Cavite's landmass tend to increase rains coming from the southwest. Historically the occurrences of typhoons in the province (**Table 4.11**) are in the months of September and October, with a duration averaging about 4-6 days.

PAGASA classified these tropical cyclones into four (4) categories, TD (Tropical Depression) with maximum sustained winds from 45-61 kilometers per hour (kph); TS (Tropical Storm) with maximum sustained winds of 62-117 kph; TY (Typhoon) with maximum sustained winds of 118-239 kph and STY (Super Typhoon) with maximum sustained winds of more than 240 kph

Table 4.11. List of Typhoons which Passed Cavite Province

Description	Population/Areas Affected
Tropical Storm "Falcon" (Meari) June 21, 2011	Affected municipality: Kawit – 23 barangays, 4,438 families, 8,870 individuals
TS "Dodong" (Sarika) June 9, 2011	The municipality of Noveleta was affected by flooding. 20 families and 40 individuals were affected
Typhoon "Juan" (Megi) October 13-24, 2010 155kt	Affected municipalities: Tagaytay City – 1barangay, 15 families, 57 individuals Ternate – 1 barangay, 64 families, 315 Ind. Cavite City – 2 barangays 107 families, 428 Individuals
TY "Basyang" (Conson) July 11-18, 2010 75kt	All municipalities of Cavite were affected with 729 barangays, 49,678 families, 247,537 individuals
TY "Santi" (Mirinae) Oct. 27-Nov. 3, 2009 90kt	A total of 16 municipalities, 126 barangays, 4,141 families, 18,954 individuals were affected
TY "Pepeng" (Parma) Sept. 27-Oct. 14, 2009 130kt	A total of 5 municipalities, 470 families, 1,402 individuals were affected
TS "Ondoy" (Ketsana) Sept.25-30, 2009 90kt	A total of 19 municipalities, 442 bgys., 113,817 families, 534,209 individuals were affected
Flashflood – Pansol River September 21, 2009	Municipality of Dasmariñas, Barangay Paliparan and Sampaloc IV
TY "Isang" (Molave) July 15-19, 2009 65kt	Kawit, Rosario, Imus, Bacoor, Noveleta and Naic were affected with a total of 53 barangays, 16,993 families

Description	Population/Areas Affected
TY “Feria” (Nangka) June 22-27, 2009 45kt	A total of 3 municipalities, 8 barangays, 706 families, 3,484 individuals were affected.
TY “Frank” (Fengshen) June 18-26, 2008 95kt	A total of 12 municipalities, 166 barangays, 40,645 families, 206,827 individuals were affected
TY “Hana” (Lekima) Sept. 30 - October 4, 2007 70kt	The municipality of Rosario and Noveleta were affected with a total of 639 families.
TY “Egay” (Sepat) August 12-20, 2007 140kt	A total of 14 municipalities, 232 barangays, 53,090 families, 260,561 individuals
TY “Chedeng” (Pabuk) August 5-9, 2007 65kt	A total of 11 municipalities, 122 barangays, 87,920 families, 438,701 individuals
TY “Milenyo” (Xangsane) September 25, 2006 to October 2, 2006 Maximum sustained winds of 125kt	All municipalities of Cavite were affected with 463 barangays, 164,137 families, 794,339 individuals
TY “Florita” (Bilis) June 13, 2006	A total of 7 municipalities, 45 barangays, 2,260 families, 1,111 individuals affected.
TY “Inday” (Halong) July 2002	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 168,025 individuals were affected.
TY “Gloria” (Chataan) July 2002	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 173,075 individuals were affected.
TY “Reming” (**Xangsane)** October 2000	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 380,616 individuals were affected.
Source: NDCC, PDCC, PSWDO as cited in Cavite PDRRMP 2011-2016	

4.1.4.3.2.5.1 Habagat

The western part of Luzon including Cavite is shielded by mountain ranges but is open to rains brought in by the Southwest Monsoon locally known as “Habagat.” This natural phenomenon occurs when warm moist air flows over the country from the southwest direction that brings rain to the western portion of the country. Cavite was one of the provinces affected by the two consecutive-years of extreme flooding referred to as the “2012 and 2013 Habagat Floods” (Lagmay et al., 2014).

During the 2013 event, a total of 1,067.4 mm of rainfall was recorded in Sangley Point, Cavite. This was 125% or 2.25 times higher compared to average monthly rainfall of 475.4 mm in August, and 36% more rainfall compared to the 2012 Habagat event for this station. Habagat 2013 also covered a bigger area, practically the entire Luzon, spanning from Laguna and Cavite in the South to some parts of northern Luzon.

Cavite received more rain than in Metro Manila on the first day of the Habagat 2013. Rainfall was only 700.7 mm, 23% in the Port area of the city of Manila, less than the 2012 Habagat event, but still 62% more than the average rainfall recorded by this recording station for the month of August. In Science Garden, the rainfall total is 545.5 mm, 85% less than the 1007.4 mm of rainfall recorded for the 2012 Habagat event and 8% more than the average monthly rainfall of 504.2 mm in this area for August (Lagmay et al., 2014).

4.1.4.4 *Summary of Identified Geohazards*

The summary of identified geohazards that may affect the Project is tabulated in **Table 4.12** and **Table 4.13**, respectively.

Table 4.12 - Summary of Geologic Hazards

MUNICIPALITY	GEOLOGIC HAZARD							
	Fault-Related Seismic Hazards						Subsi-dence	Volcanic Hazard
	Ground Shaking	*Ground Rupture*	*Lique-faction*	*Differential Settlement*	*Land-slide*	*Tsunami*		
Kawit	✓		✓	✓		✓	✓	
Noveleta	✓		✓	✓		✓	✓	
Rosario	✓		✓	✓		✓	✓	
Imus	✓							
General Trias	✓							

Table 4.13 - Summary of Hydrologic / Hydrometeorological Hazards

MUNICIPALITY	HYDROLOGIC HAZARD						HYDRO-METEREOLOGICAL	
	Fluvial Hazard		Coastal Hazard				Typhoon	Habagat
	River Overflow	***Inland Flood***	***Coastal Flooding***	***Coastal Erosion***	***Storm Surge***	***Sea-Level Rise***		
Kawit	✓	✓	✓	✓	✓	✓	✓	✓
Noveleta	✓	✓	✓	✓	✓	✓	✓	✓
Rosario	✓	✓	✓	✓	✓	✓	✓	✓
Imus	✓	✓					✓	✓
General Trias	✓	✓					✓	✓

4.1.4.5 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the foregoing study, the following geological and geohazard evaluation are presented:

4.1.4.5.1 Change in Coastal Landscape

4.1.4.5.1.1 The greater part of the Project will encounter Quaternary Alluvium composed of unconsolidated clay, silt, sand and gravel. The southern portion of the Project is underlain by the Diliman Tuff composed of thin to medium-bedded, fine grained vitric tuffs and welded volcanic breccias with subordinate amount of fine to medium grained tuffaceous sandstone.

4.1.4.5.1.2 The coastal municipalities of Kawit, Noveleta and Rosario have already been subjected to several hazards such as flooding and storm surges during tropical cyclones and liquefaction and tsunamis during earthquakes.

4.1.4.5.1.3 In a study of the impacts of climate change in the Philippine coastal sector (Perez et al., 1999), shoreline changes have occurred especially in the Manila-Cavite areas due to reclamation for housing, coastal roads, buildings, and other urbanized developments. The study also shows that shoreline changes due to reclamation for coastal road project are quite significant over Las Piñas-Cavite area; while erosion is mostly evident in the beach areas of Cavite, most probably due to sand quarrying.

4.1.4.5.1.4 The overlying completely weathered rock and unconsolidated sediments could be removed by employing ordinary excavation methods. Mechanized excavation equipment may have to be used in excavating slightly fresh to slightly weathered rock formation. The lowering of the groundwater table in the surrounding area should be considered during excavation of the proposed diversion channel. This condition may adversely affect water well users in the vicinity. The groundwater quality may likewise be affected due to possible saline water intrusion through the diversion channel.

4.1.4.5.1.5 The cohesionless sandy materials in the riverbed may indicate high susceptibility to scour erosion from high velocity flood flows. The tuffaceous rocks are likewise easily eroded. Measures to mitigate the potential for damaging scour are recommended.

4.1.4.5.2 Change in Sub-surface / Underground Geomorphology

The greater part of the Project will encounter Quaternary Alluvium composed of unconsolidated clay, silt, sand and gravel. The southern portion of the Project is underlain by the Diliman Tuff composed of thin to medium-bedded, fine grained vitric tuffs and welded volcanic breccias with subordinate amount of fine to medium grained tuffaceous sandstone.

The unconsolidated deposits present in the coastal municipalities of Kawit, Noveleta, and Rosario could be subjected to extensive liquefaction, strength loss, and large deformations during major earthquakes.

The overlying completely weathered rock and unconsolidated sediments could be removed by employing ordinary excavation methods. Mechanized excavation equipment may have to be used in excavating slightly fresh to slightly weathered rock formation.

4.1.4.5.3 Inducement of Subsidence/ Collapse

One of the principal causes of ground subsidence is excessive groundwater withdrawal that consolidates water bearing geological strata or clayey sediments in the aquifer. The PEMSEA (2012) study of sea level rise and water extraction around Manila Bay shows that the relative mean sea level is proportional to the rate of groundwater abstraction. The study further stated that while the sea level is gradually rising, with the global rate due to sea surface temperature increase, the relative mean sea level is driven mainly by subsidence due to groundwater abstraction.

In the lowland areas covering the towns of Bacoor, Imus, General Trias, Dasmariñas, Naic, Tanza, Ternate, hundreds of artesian wells and deepwells provide water supply for both domestic and irrigation purposes. According to a JICA study, the groundwater in Cavite is depleting at a rate of 1 meter water level decrease per year. Consequently, subsidence has also occurred in the northern and central parts of Cavite.
.
The GOP through the National Water Resources Board (NWRB) could lessen over-extraction of groundwater resources by regulating pumpage in areas of high threat of saltwater intrusion, depletion, and with evidences of land subsidence.

4.1.4.5.4 Inducement of Landslides or Other Natural Hazards

Landslide - The Project is not susceptible to landslide due to its low relief which is inherent of coastal and alluvial plains.

Earthquake - The Project is located proximate to major earthquake generators that include the Philippine Fault, Manila Trench, West Valley Fault, and Lubang Fault. The tectonic movements along these geologic structures are critical to the Project as far as the occurrences of fault related/seismic hazards are concerned. The West Valley Fault (WVF), one of the two major fault segments of the Valley Fault System (VFS) is located approximately 18 kms east of the Project Area.

Ground Shaking – In the event of a magnitude 7.5 earthquake generated by the VFS, PGA values may reach up to 1.0g within the epicentral area for areas underlain by soft soils, while those with bedrock close to the epicenter could experience PGA of about 0.4g. This is likely to be experienced in the northern and western coastline of Laguna de Bay; while nearer the Project, the area towards Zapote-Bacoor can experience PGAs of 0.4g to 0.8g. The southern end of the WVF traverses the municipalities of Carmona, General Mariano Alvarez and Silang making the Project Area and most parts of Cavite highly susceptible to ground shaking.

Ground Rupture – The susceptibility to ground rupture is confined south of the Project in the municipalities traversed by southern segment of the WVF.

Liquefaction -. Ground improvement is recommended to mitigate the liquefaction hazard as regards to the unconsolidated materials underlying the coastal municipalities. The said measure will also increase resistance to seismic forces, and achieve satisfactory seismic performance of the proposed project.

Tsunami - Coordination with PHIVOLCS regarding tsunami alerts is recommended as the coastal municipalities covered by the Project, are classified highly susceptible to being hit by tsunami

Volcanic Hazard – The closest active volcano to the Project is Taal Volcano, located about 36 kms southeast of General Trias. The possibility of the Project being affected by the eruption of Taal is considered minimal, the most serious impact being the adverse effect of ash falls to human health and potential damage to infrastructures.

Flooding Hazard – The coastal plain covering the Project Area has extremely low ground level of EL. 0 to 2 meters, and the tidal flood often occurs in its substantial part even without storm rainfall. Such tidal inundation is being aggravated by the progress of land subsidence.

The vulnerability of the Project Area to inland flooding is attributed to its lowest lowland physiographical category, as well as to the following factors:

- Low elevated ground level below the tidal level;
- Inadequate capacities of existing drainage facilities;
- Clogging of drainage channels due to solid wastes;
- Illegal encroachment of structures in drainage channels; and
- Reclamation of existing natural retarding basins and drainage channels.

Storm Surge - The Project area is vulnerable to storm surge. The municipality of Kawit is susceptible to inundation of 1 meter surges, while the coastline along Noveleta and Rosario are exposed to inundations of > 1 meter to 4 meters surges. Measures to mitigate this hazard should be considered in the risk reduction and management plan of Cavite province.

PAGASA has also gathered anecdotal reports of typhoon surges up to 4 meters high affecting the coastal areas along Manila Bay. Depending on how long the typhoon winds last, and the timing and heights of the normal tides, a storm surge and the flooding it causes can last from hours to days.

An average of 19 to 20 tropical cyclones visits the Philippines during June to October of every year due to the country's location along the Pacific Typhoon Belt. About 16 percent of these typhoons pass through the middle part of the Luzon Island where the Project is located. Historically the occurrences of typhoons in the province are in the months of September and October, with a duration averaging about 4-6 days.

Cavite is shielded by mountain ranges but is open to rains brought in by the Southwest Monsoon locally known as “Habagat.” This natural phenomenon occurs when warm moist air flows over the country from the southwest direction that brings rain to the western portion of the country. Cavite was one of the provinces affected by the two consecutive-years of extreme flooding referred to as the “2012 and 2013 Habagat Floods.”

A multi-hazard mitigation and protection plan for natural coastal hazards should be developed. Similarly, awareness about climate change impacts on coastal zone systems such as coastal erosion, sea level rise, and flooding risks should be promoted with emphasis in the threat to life, structures, and economic production.

4.1.4.6 *Geotechnical Recommendations*

The cohesionless sandy materials in the riverbed may indicate high susceptibility to scour erosion from high velocity flood flows. The tuffaceous rocks are likewise easily eroded. Measures to mitigate the potential for damaging scour are recommended.

Subsurface study by drilling with Standard Penetration Test (SPT) is recommended to determine the type and succession of the underlying materials and their geotechnical properties needed for the appropriate engineering design and construction of the project facilities.

4.2 Terrestrial Assessment

Terrestrial Assessment is an important aid that will help to evaluate the significant impacts of the project to the environment, especially the ecosystem covered by the project development. Wherein, floristic and faunal species found within the project area will be evaluated relative to species conservation statuswith reference to the International Union for Conservation for Nature (IUCN) and The National List of Threatened Philippine Plants and their Categories and the List of other Wildlife Species or Known as DAO 2007-01. This is to be able to determine if there are any endangered nor threatened species in the proposed project area. Result of the study will also focus on the terrestrial biodiversity of the project area with an intention to identify significant environmental impacts and determine the appropriate mitigating measures. The study will also highlight the importance of the terrestrial ecosystem to people and among other ecosystems. Assessing areas of high biodiversity, especially in the project development areas that plays a vital role to determine the key areas for conservation and in establishing conservation priorities if any.

4.2.1 METHODOLOGY

Location of the Study

The assessment study was conducted within some areas of the municipalities of Imus, Kawit, Noveleta, Rosario and General Trias, Cavite. The sampling sites are located along the river, proposed drainage area and coastal site. The study of vegetation analysis focuses on the mangrove area covered by the project.

Preparatory Procedures

Terrestrial assessment was initiatedby an orientation in the sampling stations, coordination with the authorities, preparation of instruments, and the field work proper.

4.2.2 Terrestrial Assessment Procedures

4.2.2.1 Floral Survey

Sampling Method

Random sampling is generated to cover representative plant communities within the study area. Assigned sampling points were distributed per area of improvement (river channel and drainage). Sampling was undertaken following the channel alignments covering a length of 20 meters. . Relative to this, all species found within the sampling points are identified and listedfor tabulation and analysis.**Table 4.14** presents the distribution of established sampling points in the proposed drainage channels for improvements.Overall, there are 32 sampling points that were established covering the five proposed drain channels.

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Table 4.14. Sampling Points Distribution

Drain Channel	Dimension	Sampling
San Juan diversion Channel	2km by 100 meters width	10sampling points established with a dimension of 20 meterslength by 20 meters width
Ylang-Ylang river	7 km by 29-36 meters width	7 sampling points established with a dimension of 20 meters length by36 meters width (
Rio Grande Channel	7km by 29-36 meters	6 sampling points established with a dimension of 20 meters length by 36 meters width
Malimango creek	1.7 km by 8-21 m width	6 sampling points established with a dimension of 20 meters length by 20 meters width
Diversion Drainage II	3.2 km by 2.9 meters width	3 sampling points established with a dimension of 20 meters lengthby 3 meters width

Identification and Data Analysis

Plants and trees located within the project area and encountered outside the sampling plots were identified and photo documented as shown in Figure 4.24. Palms, bamboos and other plants were also tallied and recorded. The collected data were consolidated to form a species checklist indicating common name, scientific name and family name of the plants recorded. The diameter at breast height (dhb), and height of each tree were measured for the computation and analysis of species richness, evenness and distribution.

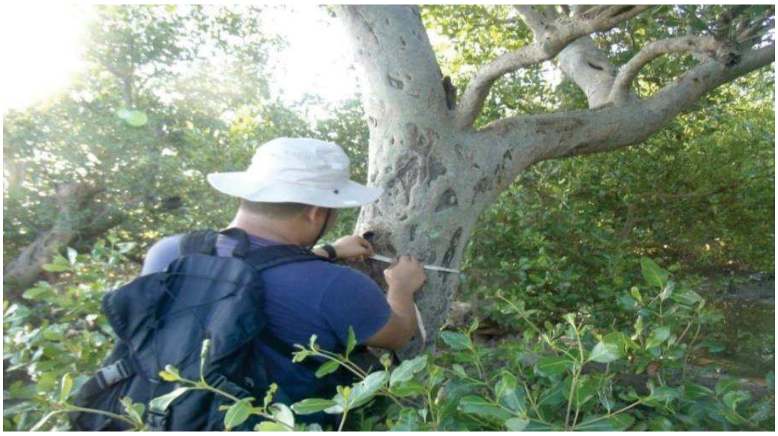

Figure 4.24. Diameter Measurement of a Bungalon (Avicennia marina (Forsk.) Vierh.), one of the Mangrove Species in the Proposed San Juan Diversion Channel

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The following formulas were used to compute the **Density, Relative Density, and Importance Value**:

BASAL AREA = 0.7854 (DBH)^2

$$\text{FREQUENCY} = \frac{\text{No. of occurrence of species among } n \text{ quadrant}}{n \text{ quadrants}}$$

$$\text{RELATIVE FREQUENCY} = \frac{\text{frequency of a species}}{\Sigma \text{ frequency of all species}} \times 100$$

$$\text{DENSITY} = \frac{\text{number of individuals of any species}}{\text{Area of the plot or quadrant}}$$

$$\text{RELATIVE DENSITY} = \frac{\text{density of a species}}{\Sigma \text{ density of all species}} \times 100$$

$$\text{DOMINANCE} = \frac{\Sigma \text{ basal area of species}}{\text{Area of the plot or quadrant}}$$

IMPORTANCE VALUE = relative density + relative dominance + relative frequency

For Diversity index (Shannon- Wiener index), the formula below is used:

$$H' = \sum_{i=1}^{s} pi \,(\mathrm{Log}\, pi)$$

where:

H' = information content of the sample, index of species diversity ordegree of uncertainty
s = number of species
pi=proportion of the total sample belongs to the *i*th species

4.2.2.2 Faunal Survey

Sampling Method

The assessed area covers the 5 drainage channels proposed for improvement that includes the San Juan Diversion Channel, Malimango Creek, Ylang-Ylang River, Rio Grande River, and the proposed drain channel coming from barangay Tejero General Trias to barangay Sta Rosa in the municipality of Noveleta. The total length of the proposed channels for improvement is about 20.9 kilometers with an estimated area of about 74 hectares that covers the municipalities of Noveleta, General Trias and Rosario in the province of Cavite.

The current land uses of the surveyed area arepatches of mangroves, grassland, along fish ponds, rivers and built up areas. Adjacent tot the delineated areas for improvement are aggregated of built up areas such as settlements, roads, business infrastructures and others.

The survey covers vertebrates which include the groups of avi-fauna, mammals, herpeto-fauna and amphibians. Prior to the conduct of sampling, general habitat assessment was undertaken to consider different ecosystem/habitat in the project area for the selection of areas for observation/sampling.

Within the transect line, random sampling was employed in which birds and other wildlife species were encountered along the transect line are counted. Established transect line has an average length of 170 meters that covers about 25 meters both side from the center line. Survey was undertaken during morning from 6:00am to 9:00 am and late afternoon from 3:00 pm to 6:00pm, when birds are most active and feeding. Observation during night time is also undertaken in two selected observation sites to cover any nocturnal species present in the area.

Identification and Data Analysis

The techniques employed during the survey include ocular and aural observation, identification through wildlife calls, foot prints and droppings, if any. Mist net was also employed with a dimension of 4 meters by 12 meters to catch volant mammals and bird species. Captured species through mist nets were immediately retrieved and released after identification and documentation.

Other species not encountered during the period of assessment is generated through interview with local informants to obtained vital information on the presence of other wildlife species not encountered throughout the survey. Photo documentation of every species observed was undertaken as much as possible. Though, not all of the observed species was documented due to bird mobility and limitation of equipment (i.e highly equipped camera).

Biodiversity measurements were computed and analyzed using the Shannon Diversity and Pielou's Evenness Indexes, with formulas illustrated below:

Shannon-Wiener Diversity	=	$H' = -\sum p_i \ln (p_i)$, where, "H'"- represents the symbol for the amount of diversity in ecosystem (species diversity) "p_i"- represents the proportion or relative abundance of each individual species to the total (measured from 0 to 1) "ln p_i" - represents the natural logarithm of p_i
Pielou's Evenness	=	$J = H'/Hmax = H=H'/\ln S$, where, "J" – represents the symbol for the species richness "H'" – species diversity "Hmax" – species maximum diversity "S" – number of species in the community

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The interpretation of the values obtained using the above formulas will be based on the Fernando Biodiversity Scale (1998) shown in **Table 4.15**.

Table 4.15. The Fernando Biodiversity Scale (1998)

Relative Values	Shannon –Wiener Biodiversity (H') Index	Pielou's (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

Based on the results of the flora and fauna survey, impacts of the project on terrestrial ecosystem were identified and mitigating measures for the identified impacts were formulated.

4.2.3 RESULTS AND DISCUSSIONS

4.2.3.1 Terrestrial Flora

About 32 sampling points were established to assess the vegetation condition of the project area. These sampling points are distributed from different municipalities and barangays to have representation of vegetation from the different areas of the project (**Figure 4.25**).

The conservation status of species identified on site was based on the International Union for Conservation of Nature (ver. 2.3, IUCN 1994) and DAO 2007-01 entitled "Establishing the National List of Threatened Philippine Plants and their Categories, and the List of other Wildlife Species ". Based on **Table 4.16**, out of the 112 species identified from the 32 sampling plots, only the Kamagong (*Diospyros blancoi A. DC.)* is critically endangered.

Table 4.16. List of species and its corresponding conservation status

SPECIES		FAMILY	CONSERVATION STATUS
COMMON NAME	SCIENTIFIC NAME		
Kamagong	*Diospyros blancoi A. DC.*	EBENACEAE	CR A1cd

Legend: CR- Critically Endangered Species

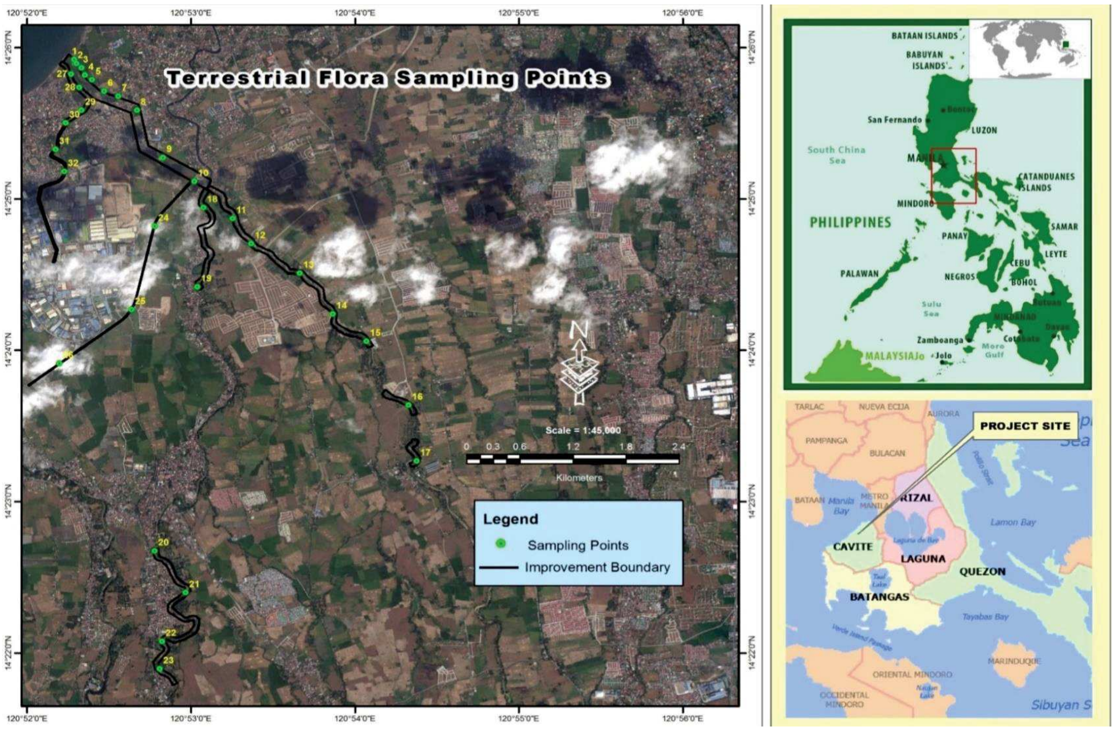


Figure 4.25. Flora Assessment Map

Figure 4.26. The kamagong (Diospyros blancoi) located along the Ylang-Ylang River in Barangay Alapan II in the municipality of Imus

4.2.3.1.1 Vegetation Composition

Vegetation composition can be defined by total vegetation based on species, by a group of similar species or by diameter class. As shown in **Table 4.17**, there are a total of 37 families containing 123 species from the 32 established 20mx20m sampling points in the project area. It also shows that the family Fabaceae with 13.01% has the highest number of species, followed by Moringaceae with 9.76%, while 16 out of the 37 families with 0.81% have the lowest vegetation composition.

Table 4.17. The families of identified species with the number of individuals and species identified in the 32 established 20m x 20m plots in Cavite

FAMILY	NUMBER OF INDIVIDUAL	SPECIES	PERCENTAGE OF THE TOTAL
AIZOACEAE	2	1	0.81%
AMARANTHACEAE	700	1	0.81%
BIGNONIACEAE	6	1	0.81%
CANNABACEAE	47	1	0.81%
CARICACEAE	24	1	0.81%
COMBRETACEAE	26	1	0.81%
CUCURBITACEAE	84	1	0.81%
EBENACEAE	1	1	0.81%
LOMARIOPSIDACEAE	6	1	0.81%
LYTHRACEAE	2	1	0.81%
Miscellaneous	88	1	0.81%
MUNTIGIACEAE	45	1	0.81%
MUSACEAE	75	1	0.81%
NYCTAGINACEAE	5	1	0.81%
PANDANACEAE	1	1	0.81%
PHYLLANTHACEAE	1	1	0.81%
ARECACEAE	105	2	1.63%
ASTERACEAE	98	2	1.63%
CONVOLVULACEAE	284	2	1.63%
LAURACEAE	10	2	1.63%
MELIACEAE	68	2	1.63%
MYRTACEAE	13	2	1.63%
SOLANACEAE	33	2	1.63%
ACANTHACEAE	192	3	2.44%
APOCYNACEAE	12	3	2.44%
ARACEAE	149	3	2.44%
RHIZOPHORACEAE	72	3	2.44%
URTICACEAE	83	3	2.44%
ANACARDIACEAE	48	4	3.25%
ANNONACEAE	16	4	3.25%
LAMIACEAE	41	5	4.07%
RUBIACEAE	39	5	4.07%
EUPHORBIACEAE	141	6	4.88%
MALVACEAE	109	6	4.88%
POACEAE	96	9	7.32%
MORACEAE	124	11	8.94%
MORINGACEAE	117	12	9.76%
FABACEAE	952	16	13.01%
	283	123	

4.2.3.1.2 Density and Relative Density

Density is defined as a measurement of the individuals' number in an area. This is computed by counting the numbers of any given species over the area of a sample plot. It is the degree of compactness of a species. It can be used for the thickness description of particular vegetation, extent regeneration and the extent of standing biomass or ground cover.

For better site analysis of the floral content of the site, the computed Density and Relative Density has two results. The first result is from the overall identified species in the 32 established plots which are composed of grass, shrubs, palms, and timber species. While the second result was the collected timber species with dbh ≥ 5cm from the 49 identified species.

4.2.3.1.2.1 Overall Identified Species

From the sampled thirty two (32) 20 meters x 20 meters plots, identified species were listed and computed. Based on the computed density, the *Pennisetum purpureum* has the highest value of 2,340. While *Premna odorata* Blanco, has the least density of 0 (see **Table 4.18**), Thus, the *Pennisetum purpureum* of Family Poaceae,has the 36.29% Relative density.

Table 1.18 - Density and Relative Distribution of Overall Identified Species in the Project Area

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
1	Okra	*Abelmoschus esculentus*	MALVACEAE	12	0.182%
2	Aroma	*Acacia farnesiana* (L.) Willd.	FABACEAE	23	0.364%
3	Bogus	*Acalypha amentacea* Roxb.	EUPHORBIACEAE	25	0.388%
4	Biga	*Alocasia macrorrhizos* (L.) G. Don	ARACEAE	2	0.024%
5	Batino	*Alstonia macrophylla* Wall. ex DC.	APOCYNACEAE	2	0.024%
6	Kulitis	*Amaranthus spinosus* L.	AMARANTHACEAE	547	8.483%
7	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	3	0.048%
8	Guayabano	*Annona muricata* L.	ANNONACEAE	2	0.024%
9	Atis	*Annona squamosa* L.	ANNONACEAE	2	0.024%
10	Bignai Pugo	*Antidesma pentandrum* (Blanco) Merr.	PHYLLANTHACEAE	1	0.012%
11	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	1	0.012%
12	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	55	0.860%
13	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *Rumphiana* (Hallier) Bakh.	ACANTHACEAE	92	1.430%
14	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	2	0.036%
15	Kawayan Tinik	*Bambusa blumeana* J.A.& J.H. Schultes	POACEAE	14	0.218%
16	Kawayan Kiling	*Bambusa vulgaris* Schrad.	POACEAE	9	0.133%
17	Bougainvillea	*Bougainvillea spectabilis* Willd.	NYCTAGINACEAE	4	0.061%
18	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	5	0.073%
19	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	5	0.085%
20	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	37	0.570%
21	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	2	0.024%
22	Caballero	*Caesalpinia pulcherrima* (L.) Swartz	FABACEAE	6	0.097%
23	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. f. &	ANNONACEAE	2	0.036%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
		Thoms.			
24	Papaya	*Carica papaya* L.	CARICACEAE	19	0.291%
25	Golden Shower	*Cassia fistula* L.	FABACEAE	2	0.036%
26	Golden Shower	*Ceiba pentandra* (L.) Gaertn.	FABACEAE	2	0.024%
27	Dilang Butiki	*Centrosema pubescens* Benth.	FABACEAE	80	1.248%
28	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	14	0.218%
29	Hagonoy	*Chromolaena odorata* (L.) R.M. King & H. Rob.	ASTERACEAE	70	1.079%
30	Kasupangil	*Clerodendrum intermedium* Cham.	LAMIACEAE	5	0.085%
31	Niog	*Cocos nucifera* L.	ARECACEAE	52	0.812%
32	Gabi	*Colocasia esculentum* (L.) Schott	ARACEAE	108	1.672%
33	Blue fern	*Cyclopeltis crenata* (Fee) C. Chr.	LOMARIOPSIDACEAE	5	0.073%
34	Lemon Grass	*Cymbopogon citratus*	POACEAE	2	0.024%
35	Talong Punay	*Datura metel* L.	SOLANACEAE	10	0.158%
36	Lipang Kalabau	*Dendrocnide meyeniana* (Walp.) Chew	URTICACEAE	1	0.012%
37	Mangasin	*Derris trifoliata* Lour.	FABACEAE	4	0.061%
38	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	1	0.012%
39	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	5	0.073%
40	Rain Tree	*Dracaena marginata* Lam.	RUSCACEAE	8	0.121%
41	Taparak	*Ervatamia mucronata* (Merr.) *markgr.*	APOCYNACEAE	6	0.097%
42	Tawa-tawa	*Euphorbia hirta*	EUPHORBIACEAE	34	0.521%
43	Bugauak	*Evodia confusa* Merr	RUTACEAE	2	0.024%
44	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	7	0.109%
45	Hagimit	*Ficus minahassae* (Teijsm. & de Vr.) Miq.	MORACEAE	2	0.036%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
46	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	10	0.158%
47	Pakiling	*Ficus odorata* (Blanco) Merr.	MORACEAE	1	0.012%
48	Hauili	*Ficus septica* Burm. f.	MORACEAE	34	0.533%
49	Marabotum	*Ficus subcordata* Blume	MORACEAE	1	0.012%
50	Is-is	*Ficus ulmifolia* Lamk	MORACEAE	23	0.364%
51	Payang-payang	*Flemingia strobilifera* (L.) Roxb. ex W. Aiton	FABACEAE	6	0.097%
52	Kakauate	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	FABACEAE	40	0.618%
53	Gmelina	*Gmelina arborea* Roxb.	LAMIACEAE	8	0.121%
54	Amorseco	*Idesmodium adscendens*	FABACEAE	63	0.969%
55	Cogon	*Imperata cylindrica* (L.) Beauv.	POACEAE	734	11.391%
56	Sweet potato	*Ipomea batatas* (L.) Lamk.	CONVOLVULACEAE	195	3.030%
57	Lambayong	*Ipomea pes-carpae* (L.) R. Br.	CONVOLVULACEAE	27	0.412%
58	Tubang bakod	*Jathropa curcas* L.	EUPHORBIACEAE	1	0.012%
59	Tan-ag	*Kleinhovia hospita* L.	MALVACEAE	1	0.012%
60	Lipang aso	*Laportea interrupta* (L.) Chew	URTICACEAE	4	0.061%
61	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	FABACEAE	134	2.084%
62	Alagasi	*Leucosyke capitellata* (Poir.) Wedd.	LAMIACEAE	13	0.194%
63	Sablot	*Litsea glutinosa* (Lour.)C.B. Rob.	LAURACEAE	7	0.109%
64	Bagan-Bagan	*Lycianthes biflora* (Lour.) Bitter	SOLANACEAE	6	0.097%
65	Mangga	*Mangifera indica* L.	ANACARDIACEAE	28	0.436%
66	Mangga	*Mangifera indica* L.	ANACARDIACEAE	9	0.145%
67	Cassava	*Manihot esculenta*	EUPHORBIACEAE	28	0.436%
68	Alim	*Melanolepis multiglandulosa* (Reinw. Ex Blume) Reichb. f. & Zoll.	EUPHORBIACEAE	16	0.242%
69	Uoko	*Mikania cordata* (Burm. f.) B.L. Rob.	ASTERACEAE	7	0.109%
70	Makahiya	*Mimosa pudica* L.	FABACEAE	77	1.188%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
71	Likod-likod	Miscellaneous	Miscellaneous	69	1.066%
72	Bangkoro	*Morinda citrifolia* L.	RUBIACEAE	1	0.012%
73	Malungai	*Moringa oleifera* Lamk	MORINGACEAE	9	0.133%
74	Mulbery	*Morus alba* Lour.	MORACEAE	4	0.061%
75	Datiles	*Muntigia calabura* L.	MUNTIGIACEAE	35	0.545%
76	Banana	*Musa* sp.	MUSACEAE	58	0.897%
77	Doña Aurora	*Mussaenda philippica* A. Rich var. *aurorae* Sulit	RUBIACEAE	2	0.024%
78	Nipa	*Nypa fruticans* Wurmb.	ARECACEAE	2	0.036%
79	Pandan banguhan	*Pandanus amaryllifolius* Roxb.	PANDANACEAE	1	0.012%
80	Carabao grass	*Paspalum conjugatum*	POACEAE	359	5.574%
81	Bantigi	*Pemphis acidula* J.R. & Forst.	LYTHRACEAE	2	0.024%
82	Napier	*Pennisetum purpureum*	POACEAE	2340	36.294%
83	Avocado	*Persea gratissima* Gaertn.	LAURACEAE	1	0.012%
84	Dalunot	*Pipturus arborescens* (Link) C.B. Rob.	URTICACEAE	60	0.933%
85	Kamachile	*Pithecellobium dulce* (Roxb) Benth.	FABACEAE	27	0.412%
86	Indian Lanutan	*Polyalthia longifolia* Benth. & Hook.f.	ANNONACEAE	7	0.109%
87	Bani	*Pongomia pinnata* (L.) Merr.	FABACEAE	7	0.109%
88	Alagau Dagat	*Premna integrifolia* L.	LAMIACEAE	5	0.085%
89	Alagau	*Premna odorata* Blanco	LAMIACEAE	0	0.03125
90	Guava	*Psidium guajava* L.	MYRTACEAE	6	0.097%
91	Narra	*Pterocarpus indicus* Willd.	FABACEAE	6	0.097%
92	Bayok	*Pterospermum diversifolium* Blume	MALVACEAE	2	0.024%
93	Kudzo	*Pueraria montana*. Lobata	FABACEAE	248	3.841%
94	Talahib	*Saccharum spontaneum* L.	POACEAE	60	0.933%
95	Santol	*Sandoricum koetjape* (Burm. f.) Merr.	MELIACEAE	2	0.036%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
96	Nilad	*Scyphiphora hydrophyllacea* Gaertn. f.	RUBIACEAE	19	0.291%
97	Ligas	*Semecarpus cuneiformis* Blanco	ANACARDIACEAE	5	0.073%
98	Dampalit	*Sesuvium portulacastrum* L.	AIZOACEAE	2	0.024%
99	Ayas-as	*Setaria palmifolia* (Koenig) Stapf.	POACEAE	51	0.788%
100	Kalios	*Streblus asper* Lour.	MORACEAE	14	0.218%
101	Mahogany	*Swietenia macrophylla* King	FABACEAE	19	0.291%
102	Duhat	*Syzygium cumini* (L.) Skeels	MYRTACEAE	4	0.061%
103	Pandakaki	*Tabernaemontana pandacaqui* Poir.	APOCYNACEAE	2	0.024%
104	Sampalok	*Tamarindus indica* L.	FABACEAE	2	0.036%
105	Talisai	*Terminalia catappa* L.	COMBRETACEAE	20	0.315%
106	Banalo	*Thespesia populnea* Soland.	MALVACEAE	9	0.133%
107	Tambo	*Thysonolaena latifolia* (Roxb. ex Hornem.) Honda	POACEAE	6	0.097%
108	Anabiong	*Trema orientalis* (L.) Blume	CANNABACEAE	37	0.570%
109	Kollo-Kollot	*Urena lobata* L.	MALVACEAE	61	0.945%
110	Yautia	*Xanthosoma violaceum* Schott	ARACEAE	7	0.109%
111	Tabigi	*Xylocarpus granatum* Koen.	MELIACEAE	51	0.788%
112	Melon Daga	*Zehneria indica* (Lour.) Keraudren	CUCURBITACEAE	66	1.018%

Source: EIS Team

Timber Species

From the sampled thirty two (32) 20 meters x 20 meters plots, there are 49 identified timber species with dbh ≥ 5cm. Based on the computed density; the *Avicennia marina* (Forsk.) Vierh.*var. rumphiana* (Hallier) Bakh.has the highest value of 52 followed by *Leucaena leucocephala* (Lam.) de Wit with density of 31. While 13 out of 49 species, have the least density of 1 as shown in **Table 4.19**. Thus, the *Avicennia marina* (Forsk.)Vierh.var. *rumphiana* (Hallier) Bakh.of Family Acanthaceae,has the 15.654% Relative density.

Table 4.19. **Density and Relative Density of the Timber species in the Project Area**

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
1	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	2	0.701%
2	Guyabano	*Annona muricata* L.	ANNONACEAE	1	0.234%
3	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	1	0.234%
4	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	23	6.776%
5	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *rumphiana* (Hallier) Bakh.	ACANTHACEAE	52	15.654%
6	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	2	0.467%
7	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	2	0.467%
8	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	1	0.234%
9	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	20	6.075%
10	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	2	0.467%
11	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. F. & Thoms.	ANNONACEAE	2	0.701%
12	Ameican Kapok	*Ceiba pentandra* (L.) Gaertn.	MALVACEAE	2	0.467%
13	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	7	2.103%
14	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	1	0.234%
15	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	2	0.701%
16	Rain tree	*Dracaena marginata* Lam.	RUSCACEAE	6	1.869%
17	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	5	1.636%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
18	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	2	0.701%
19	Hauili	*Ficus septica* Burm. F.	MORACEAE	4	1.168%
20	Is-is	*Ficus ulmifolia* Lamk	MORACEAE	1	0.234%
21	Kakauate	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	FABACEAE	26	7.710%
22	Gmelina	*Gmelina arborea* Roxb.	LAMIACEAE	1	0.234%
23	Tan-ag	*Kleinhovia hospita* L.	MALVACEAE	1	0.234%
24	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	FABACEAE	31	9.346%
25	Sablot	*Litsea glutinosa* (Lour.)C.B. Rob.	LAURACEAE	3	0.935%
26	Binunga	*Macarnga tanarius* (L.) Muell.-Arg.	EUPHORBIACEAE	4	1.168%
27	Mangga	*Mangifera indica* L.	ANACARDIACEAE	22	6.542%
28	Alim	*Melanolepis multiglandulosa* (Reinw. Ex Blume) Reichb. F. & Zoll.	EUPHORBIACEAE	2	0.701%
29	Mulbery	*Morus alba* Lour.	MORACEAE	1	0.234%
30	Datiles	*Muntigia calabura* L.	MUNTIGIACEAE	9	2.804%
31	Avocado	*Persea gratissima* Gaertn.	LAURACEAE	1	0.234%
32	Kamachile	*Pithecellobium dulce* (Roxb) Benth.	FABACEAE	16	4.673%
33	Indian Lanutan	*Polyalthia longifolia* Benth. & Hook.f.	ANNONACEAE	6	1.869%
34	Bani	*Pongomia pinnata* (L.) Merr.	FABACEAE	2	0.467%
35	Alagau Dagat	*Premna integrifolia* L.	LAMIACEAE	2	0.467%
36	Alagau	*Premna odorata* Blanco	LAMIACEAE	1	0.234%
37	Guava	*Psidium guajava* L.	MYRTACEAE	1	0.234%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DENSITY	RELATIVE DENSITY
38	Bayok	*Pterospermum diversifolium* Blume	MALVACEAE	1	0.234%
39	Santol	*Sandoricum koetjape* (Burm. F.) Merr.	MELIACEAE	2	0.701%
40	Nilad	*Scyphiphora hydrophyllacea* Gaertn. F.	RUBIACEAE	8	2.336%
41	Ligas	*Semecarpus cuneiformis* Blanco	ANACARDIACEAE	1	0.234%
42	Kalios	*Streblus asper* Lour.	MORACEAE	5	1.636%
43	Mahogany	*Swietenia macrophylla* King	MELIACEAE	5	1.402%
44	Duhat	*Syzygium cumini* (L.) Skeels	MYRTACEAE	4	1.168%
45	Sampalok	*Tamarindus indica* L.	FABACEAE	2	0.467%
46	Talisai	*Terminalia catappa* L.	COMBRETACEAE	5	1.636%
47	Banalo	*Thespesia populnea* Soland.	MALVACEAE	2	0.467%
48	Anabiong	*Trema orientalis* (L.) Blume	CANNABACEAE	18	5.374%
49	Tabigi	*Xylocarpus granatum* Koen.	MELIACEAE	17	5.140%

Source: EIS Team

4.2.3.1.3 Species Relative Frequency

Frequency is defined as the number of times the species occurs in a given number of small quadrants or sample points. It is expressed as a fraction of the total relative frequency (RF). It does not matter how many individuals of species occur in each quadrant since a single occurrence carries the same weight.

For better site analysis of the floral content of the site, the computed Relative Frequency has two results. The first result is from the overall identified species in the 32 established plots which are composed of grass, shrubs, palms, and timber species. While the second result was the collected timber species with dbh ≥ 5cm from the 113 identified species.

4.2.3.1.3.1 Overall Identified Species

The highest species with relative frequency (RF) is *Caesalpinia pulcherrima* (L.) Swartz with 4.595%. It is followed by *Cananga odorata* (Lamk.) Hook.F. & Thoms.With 4.376%.While 38 out of the 49 identified species got 0.129% which is the lowest computedvalue for relative frequency. **Table 4.20** presents the results of RF of the over all identified species.

Table 4.20. Relative Frequency of the over all Identified Species in the Project Area

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
1	Okra	*Abelmoschus esculentus*	MALVACEAE	0.031	0.219%
2	Aroma	*Acacia farnesiana* (L.) Willd.	FABACEAE	0.219	1.532%
3	Bogus	*Acalypha amentacea* Roxb.	EUPHORBIACEAE	0.094	0.656%
4	Biga	*Alocasia macrorrhizos* (L.) G. Don	ARACEAE	0.031	0.219%
5	Batino	*Alstonia macrophylla* Wall. ex DC.	APOCYNACEAE	0.063	0.438%
6	Kulitis	*Amaranthus spinosus* L.	AMARANTHACEAE	0.250	1.751%
7	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	0.031	0.219%
8	Guayabano	*Annona muricata* L.	ANNONACEAE	0.063	0.438%
9	Atis	*Annona squamosa* L.	ANNONACEAE	0.063	0.438%
10	Bignai Pugo	*Antidesma pentandrum* (Blanco) Merr.	PHYLLANTHACEAE	0.031	0.219%
11	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	0.031	0.219%
12	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	0.188	1.313%
13	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *Rumphiana* (Hallier) Bakh.	ACANTHACEAE	0.250	1.751%
14	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	0.031	0.219%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
15	Kawayan Tinik	*Bambusa blumeana* J.A.& J.H. Schultes	POACEAE	0.156	1.094%
16	Kawayan Kiling	*Bambusa vulgaris* Schrad.	POACEAE	0.125	0.875%
17	Bougainvillea	*Bougainvillea spectabilis* Willd.	NYCTAGINACEAE	0.031	0.219%
18	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	0.094	0.656%
19	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	0.094	0.656%
20	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	0.188	1.313%
21	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	0.063	0.438%
22	Caballero	*Caesalpinia pulcherrima* (L.) Swartz	FABACEAE	0.031	0.219%
23	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. f. & Thoms.	ANNONACEAE	0.063	0.438%
24	Papaya	*Carica papaya* L.	CARICACEAE	0.219	1.532%
25	Golden Shower	*Cassia fistula* L.	FABACEAE	0.031	0.219%
26	Golden Shower	*Ceiba pentandra* (L.) Gaertn.	FABACEAE	0.063	0.438%
27	Dilang Butiki	*Centrosema pubescens* Benth.	FABACEAE	0.250	1.751%
28	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	0.094	0.656%
29	Hagonoy	*Chromolaena odorata* (L.) R.M. King & H. Rob.	ASTERACEAE	0.156	1.094%
30	Kasupangil	*Clerodendrum intermedium* Cham.	LAMIACEAE	0.063	0.438%
31	Niog	*Cocos nucifera* L.	ARECACEAE	0.344	2.407%
32	Gabi	*Colocasia esculentum* (L.) Schott	ARACEAE	0.125	0.875%
33	Blue fern	*Cyclopeltis crenata* (Fee) C. Chr.	LOMARIOPSIDACEAE	0.031	0.219%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
34	Lemon Grass	*Cymbopogon citratus*	POACEAE	0.031	0.219%
35	Talong Punay	*Datura metel* L.	SOLANACEAE	0.125	0.875%
36	Lipang Kalabau	*Dendrocnide meyeniana* (Walp.) Chew	URTICACEAE	0.031	0.219%
37	Mangasin	*Derris trifoliata* Lour.	FABACEAE	0.031	0.219%
38	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	0.031	0.219%
39	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	0.125	0.875%
40	Rain Tree	*Dracaena marginata* Lam.	RUSCACEAE	0.125	0.875%
41	Taparak	*Ervatamia mucronata* (Merr.) *markgr.*	APOCYNACEAE	0.063	0.438%
42	Tawa-tawa	*Euphorbia hirta*	EUPHORBIACEAE	0.063	0.438%
43	Bugauak	*Evodia confusa* Merr	RUTACEAE	0.063	0.438%
44	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	0.156	1.094%
45	Hagimit	*Ficus minahassae* (Teijsm. & de Vr.) Miq.	MORACEAE	0.094	0.656%
46	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	0.188	1.313%
47	Pakiling	*Ficus odorata* (Blanco) Merr.	MORACEAE	0.031	0.219%
48	Hauili	*Ficus septica* Burm. f.	MORACEAE	0.375	2.626%
49	Marabotum	*Ficus subcordata* Blume	MORACEAE	0.031	0.219%
50	Is-is	*Ficus ulmifolia* Lamk	MORACEAE	0.281	1.969%
51	Payang-payang	*Flemingia strobilifera* (L.) Roxb. ex W. Aiton	FABACEAE	0.063	0.438%
52	Kakauate	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	FABACEAE	0.313	2.188%
53	Gmelina	*Gmelina arborea* Roxb.	LAMIACEAE	0.094	0.656%
54	Amorseco	*Idesmodium adscendens*	FABACEAE	0.031	0.219%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
55	Cogon	*Imperata cylindrica* (L.) Beauv.	POACEAE	0.219	1.532%
56	Sweet potato	*Ipomea batatas* (L.) Lamk.	CONVOLVULACEAE	0.031	0.219%
57	Lambayong	*Ipomea pes-carpae* (L.) R. Br.	CONVOLVULACEAE	0.031	0.219%
58	Tubang bakod	*Jathropa curcas* L.	EUPHORBIACEAE	0.031	0.219%
59	Tan-ag	*Kleinhovia hospita* L.	MALVACEAE	0.031	0.219%
60	Lipang aso	*Laportea interrupta* (L.) Chew	URTICACEAE	0.031	0.219%
61	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	FABACEAE	0.656	4.595%
62	Alagasi	*Leucosyke capitellata* (Poir.) Wedd.	LAMIACEAE	0.031	0.219%
63	Sablot	*Litsea glutinosa* (Lour.)C.B. Rob.	LAURACEAE	0.094	0.656%
64	Bagan-Bagan	*Lycianthes biflora* (Lour.) Bitter	SOLANACEAE	0.031	0.219%
65	Okra	*Abelmoschus esculentus*	MALVACEAE	0.031	0.219%
66	Aroma	*Acacia farnesiana* (L.) Willd.	FABACEAE	0.219	1.532%
67	Bogus	*Acalypha amentacea* Roxb.	EUPHORBIACEAE	0.094	0.656%
68	Biga	*Alocasia macrorrhizos* (L.) G. Don	ARACEAE	0.031	0.219%
69	Batino	*Alstonia macrophylla* Wall. ex DC.	APOCYNACEAE	0.063	0.438%
70	Kulitis	*Amaranthus spinosus* L.	AMARANTHACEAE	0.250	1.751%
71	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	0.031	0.219%
72	Guayabano	*Annona muricata* L.	ANNONACEAE	0.063	0.438%
73	Atis	*Annona squamosa* L.	ANNONACEAE	0.063	0.438%
74	Bignai Pugo	*Antidesma pentandrum* (Blanco) Merr.	PHYLLANTHACEAE	0.031	0.219%
75	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	0.031	0.219%
76	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	0.188	1.313%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
77	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *Rumphiana* (Hallier) Bakh.	ACANTHACEAE	0.250	1.751%
78	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	0.031	0.219%
79	Kawayan Tinik	*Bambusa blumeana* J.A.& J.H. Schultes	POACEAE	0.156	1.094%
80	Kawayan Kiling	*Bambusa vulgaris* Schrad.	POACEAE	0.125	0.875%
81	Bougainvillea	*Bougainvillea spectabilis* Willd.	NYCTAGINACEAE	0.031	0.219%
82	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	0.094	0.656%
83	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	0.094	0.656%
84	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	0.188	1.313%
85	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	0.063	0.438%
86	Caballero	*Caesalpinia pulcherrima* (L.) Swartz	FABACEAE	0.031	0.219%
87	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. f. & Thoms.	ANNONACEAE	0.063	0.438%
88	Papaya	*Carica papaya* L.	CARICACEAE	0.219	1.532%
89	Golden Shower	*Cassia fistula* L.	FABACEAE	0.031	0.219%
90	Golden Shower	*Ceiba pentandra* (L.) Gaertn.	FABACEAE	0.063	0.438%
91	Dilang Butiki	*Centrosema pubescens* Benth.	FABACEAE	0.250	1.751%
92	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	0.094	0.656%
93	Hagonoy	*Chromolaena odorata* (L.) R.M. King & H. Rob.	ASTERACEAE	0.156	1.094%
94	Kasupangil	*Clerodendrum intermedium* Cham.	LAMIACEAE	0.063	0.438%
95	Niog	*Cocos nucifera* L.	ARECACEAE	0.344	2.407%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
96	Gabi	*Colocasia esculentum* (L.) Schott	ARACEAE	0.125	0.875%
97	Blue fern	*Cyclopeltis crenata* (Fee) C. Chr.	LOMARIOPSIDACEAE	0.031	0.219%
98	Lemon Grass	*Cymbopogon citratus*	POACEAE	0.031	0.219%
99	Talong Punay	*Datura metel* L.	SOLANACEAE	0.125	0.875%
100	Lipang Kalabau	*Dendrocnide meyeniana* (Walp.) Chew	URTICACEAE	0.031	0.219%
101	Mangasin	*Derris trifoliata* Lour.	FABACEAE	0.031	0.219%
102	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	0.031	0.219%
103	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	0.125	0.875%
104	Rain Tree	*Dracaena marginata* Lam.	RUSCACEAE	0.125	0.875%
105	Taparak	*Ervatamia mucronata* (Merr.) *markgr.*	APOCYNACEAE	0.063	0.438%
106	Tawa-tawa	*Euphorbia hirta*	EUPHORBIACEAE	0.063	0.438%
107	Bugauak	*Evodia confusa* Merr	RUTACEAE	0.063	0.438%
108	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	0.156	1.094%
109	Hagimit	*Ficus minahassae* (Teijsm. & de Vr.) Miq.	MORACEAE	0.094	0.656%
110	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	0.188	1.313%
111	Pakiling	*Ficus odorata* (Blanco) Merr.	MORACEAE	0.031	0.219%
112	Hauili	*Ficus septica* Burm. f.	MORACEAE	0.375	2.626%

Source: EIS Team

Timber Species

From the sampled thirty two (32) 20 meters x 20 meters plots, there are 49 identified timber species with dbh ≥ 5cm. The highest species with relative frequency (RF) as shown in **Table 4.21** is *Pithecellobium dulce* (Roxb) Benth.with 7.735%. It is followed by *Mangifera indica* L. with 7.182%.While 14 out of the 49 identified species got 0.552% which is the lowest computed value for relative frequency.

Table 4.21. Relative Frequency of the timber species in the Project Area

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
1	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	0.03125	0.552%
2	Guyabano	*Annona muricata* L.	ANNONACEAE	0.0625	1.105%
3	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	0.03125	0.552%
4	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	0.25	4.420%
5	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *rumphiana* (Hallier) Bakh.	ACANTHACEAE	0.25	4.420%
6	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	0.03125	0.552%
7	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	0.09375	1.657%
8	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	0.03125	0.552%
9	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	0.1875	3.315%
10	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	0.0625	1.105%
11	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. F. & Thoms.	ANNONACEAE	0.0625	1.105%
12	Ameican Kapok	*Ceiba pentandra* (L.) Gaertn.	MALVACEAE	0.0625	1.105%
13	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	0.125	2.210%
14	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	0.03125	0.552%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
15	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	0.09375	1.657%
16	Rain tree	*Dracaena marginata* Lam.	RUSCACEAE	0.125	2.210%
17	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	0.15625	2.762%
18	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	0.0625	1.105%
19	Hauili	*Ficus septica* Burm. F.	MORACEAE	0.09375	1.657%
20	Is-is	*Ficus ulmifolia* Lamk	MORACEAE	0.0625	1.105%
21	Kakauate	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	FABACEAE	0.3125	5.525%
22	Gmelina	*Gmelina arborea* Roxb.	LAMIACEAE	0.03125	0.552%
23	Tan-ag	*Kleinhovia hospital* L.	MALVACEAE	0.03125	0.552%
24	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	FABACEAE	0.34375	6.077%
25	Sablot	*Litsea glutinosa* (Lour.)C.B. Rob.	LAURACEAE	0.09375	1.657%
26	Binunga	*Macarnga tanarius* (L.) Muell.-Arg.	EUPHORBIACEAE	0.0625	1.105%
27	Mangga	*Mangifera indica* L.	ANACARDIACEAE	0.40625	7.182%
28	Alim	*Melanolepis multiglandulosa* (Reinw. Ex Blume) Reichb. F. & Zoll.	EUPHORBIACEAE	0.09375	1.657%
29	Mulbery	*Morus alba* Lour.	MORACEAE	0.03125	0.552%
30	Datiles	*Muntigia calabura* L.	MUNTIGIACEAE	0.28125	4.972%
31	Avocado	*Persea gratissima* Gaertn.	LAURACEAE	0.03125	0.552%
32	Kamachile	*Pithecellobium dulce* (Roxb) Benth.	FABACEAE	0.4375	7.735%
33	Indian Lanutan	*Polyalthia longifolia* Benth. & Hook.f.	ANNONACEAE	0.125	2.210%
34	Bani	*Pongomia pinnata* (L.) Merr.	FABACEAE	0.03125	0.552%
35	Alagau Dagat	*Premna integrifolia* L.	LAMIACEAE	0.0625	1.105%
36	Alagau	*Premna odorata* Blanco	LAMIACEAE	0.03125	0.552%
37	Guava	*Psidium guajava* L.	MYRTACEAE	0.03125	0.552%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	FREQUENCY	RELATIVE FREQUENCY
38	Bayok	*Pterospermum diversifolium* Blume	MALVACEAE	0.03125	0.552%
39	Santol	*Sandoricum koetjape* (Burm. F.) Merr.	MELIACEAE	0.09375	1.657%
40	Nilad	*Scyphiphora hydrophyllacea* Gaertn. F.	RUBIACEAE	0.0625	1.105%
41	Ligas	*Semecarpus cuneiformis* Blanco	ANACARDIACEAE	0.03125	0.552%
42	Kalios	*Streblus asper* Lour.	MORACEAE	0.09375	1.657%
43	Mahogany	*Swietenia macrophylla* King	MELIACEAE	0.0625	1.105%
44	Duhat	*Syzygium cumini* (L.) Skeels	MYRTACEAE	0.15625	2.762%
45	Sampalok	*Tamarindus indica* L.	FABACEAE	0.0625	1.105%
46	Talisai	*Terminalia catappa* L.	COMBRETACEAE	0.1875	3.315%
47	Banalo	*Thespesia populnea* Soland.	MALVACEAE	0.0625	1.105%
48	Anabiong	*Trema orientalis* (L.) Blume	CANNABACEAE	0.25	4.420%
49	Tabigi	*Xylocarpus granatum* Koen.	MELIACEAE	0.21875	3.867%

Source: EIS Team

4.2.3.1.4 Species Dominance and Relative Dominance

Dominance value indicates the space or cover domination of a certain species. This can be used to predict changes that may occur in response to long-term precipitation changes or disease; and for further understanding of management options. Thus, this can be used in long-term monitoring programs to determine if management or preservation regimes are positively affecting the ecosystem. On the other hand Relative Dominance (RD) examines the dominant species in each layer of the plant community.

As shown in **Table 4.22** the species *Melanolepis multiglandulosa* (Reinw. Ex Blume) Reichb. F. & Zoll.Has the highest dominance (D) value of 2.231 and relative dominance (RD) value of 23.872% followed by *Pterospermum diversifolium* Blume 1.086 and 11.625%, while 5 out of 49 identified timber species got the lowest with 0.002 and 0.16%.

Table 4.22. Dominance and Relative Dominance of the timber species

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DOMINANCE	RELATIVE DOMINANCE
1	Piapi	*Avicennia marina* (Forsk.) Vierh.var. *Rumphiana* (Hallier) Bakh.	ACANTHACEAE	0.034	0.362%
2	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	FABACEAE	0.002	0.016%
3	Kakauate	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	FABACEAE	0.035	0.378%
4	Bungalon	*Avicennia marina* (Forsk.) Vierh.	ACANTHACEAE	0.241	2.583%
5	Mangga	*Mangifera indica* L.	ANACARDIACEAE	0.826	8.837%
6	Langarai	*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.	RHIZOPHORACEAE	0.014	0.152%
7	Anabiong	*Trema orientalis* (L.) Blume	CANNABACEAE	0.126	1.346%
8	Tabigi	*Xylocarpus granatum* Koen.	MELIACEAE	0.002	0.016%
9	Kamachile	*Pithecellobium dulce* (Roxb) Benth.	FABACEAE	0.342	3.662%
10	Datiles	*Muntigia calabura* L.	MUNTIGIACEAE	0.119	1.274%
11	Nilad	*Scyphiphora hydrophyllacea* Gaertn. F.	RUBIACEAE	0.086	0.925%
12	Malatangal	*Ceriops decandra* (Griff.) Ding Hou	RHIZOPHORACEAE	0.222	2.380%
13	Rain tree	*Dracaena marginata* Lam.	RUSCACEAE	0.091	0.976%
14	Indian Lanutan	*Polyalthia longifolia* Benth. & Hook.f.	ANNONACEAE	0.075	0.804%
15	Buta-Buta	*Excoecaria agallocha* L.	EUPHORBIACEAE	0.026	0.281%
16	Kalios	*Streblus asper* Lour.	MORACEAE	0.678	7.258%
17	Talisai	*Terminalia catappa* L.	COMBRETACEAE	0.122	1.307%
18	Mahogany	*Swietenia macrophylla* King	MELIACEAE	0.023	0.250%
19	Hauili	*Ficus septica* Burm. F.	MORACEAE	0.030	0.318%
20	Binunga	*Macarnga tanarius* (L.) Muell.-Arg.	EUPHORBIACEAE	0.002	0.016%
21	Duhat	*Syzygium cumini* (L.) Skeels	MYRTACEAE	0.211	2.260%
22	Sablot	*Litsea glutinosa* (Lour.)C.B. Rob.	LAURACEAE	0.032	0.347%

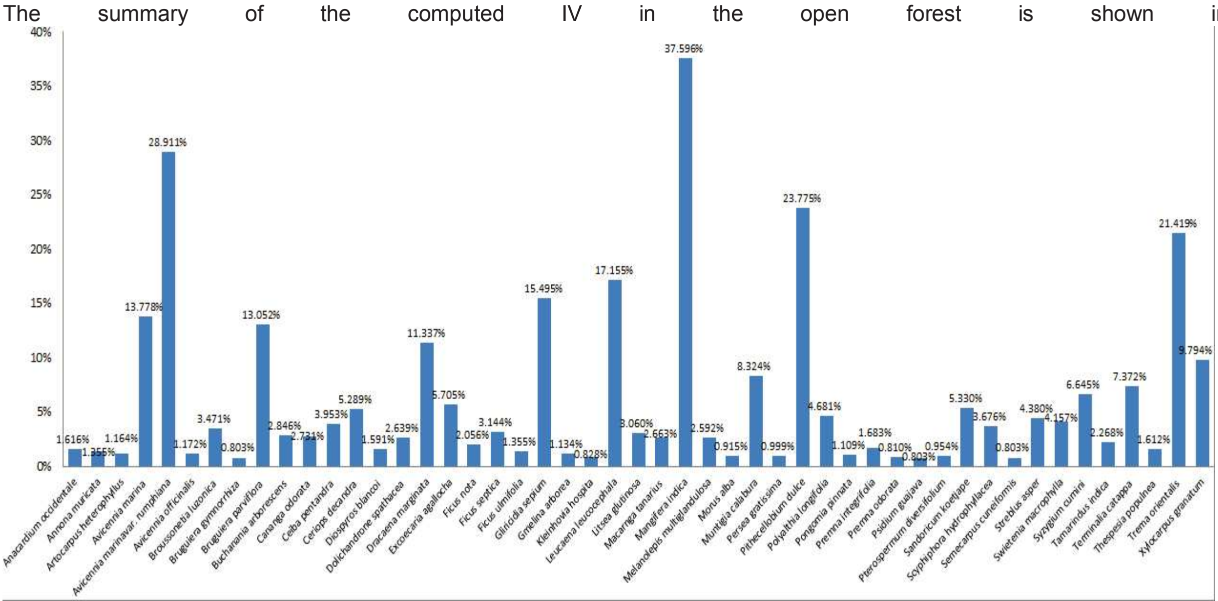
SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DOMINANCE	RELATIVE DOMINANCE
23	Kasoy	*Anacardium occidentale* L.	ANACARDIACEAE	0.004	0.042%
24	Ilang-Ilang	*Cananga odorata* (Lamk.) Hook. F. & Thoms.	ANNONACEAE	0.162	1.732%
25	Tui	*Dolichandrone spathacea* (L.f.) K. Schum.	BIGNONIACEAE	0.044	0.468%
26	Tibig	*Ficus nota* (Blanco) Merr.	MORACEAE	0.036	0.390%
27	Alim	*Melanolepis multiglandulosa* (Reinw. Ex Blume) Reichb. F. & Zoll.	EUPHORBIACEAE	2.231	23.872%
28	Santol	*Sandoricum koetjape* (Burm. F.) Merr.	MELIACEAE	0.022	0.234%
29	Api-Api	*Avicennia officinalis* L.	ACANTHACEAE	0.012	0.129%
30	Himbabao	*Broussonetia luzonica* (Blanco) Bur.	MORACEAE	0.051	0.548%
31	Balinghasai	*Buchanania arborescens* (Blume) Blume	ANACARDIACEAE	0.020	0.213%
32	Ameican Kapok	*Ceiba pentandra* (L.) Gaertn.	MALVACEAE	1.062	11.367%
33	Bani	*Pongomia pinnata* (L.) Merr.	FABACEAE	0.056	0.602%
34	Alagau Dagat	*Premna integrifolia* L.	LAMIACEAE	0.008	0.089%
35	Sampalok	*Tamarindus indica* L.	FABACEAE	0.010	0.111%
36	Banalo	*Thespesia populnea* Soland.	MALVACEAE	0.002	0.024%
37	Guyabano	*Annona muricata* L.	ANNONACEAE	0.002	0.016%
38	Nangka	*Artocarpus heterophyllus* Lam.	MORACEAE	0.016	0.168%
39	Busain	*Bruguiera gymnorrhiza* (L.) Lamk.	RHIZOPHORACEAE	0.278	2.971%
40	Kamagong	*Diospyros blancoi* A. DC.	EBENACEAE	0.022	0.234%
41	Is-is	*Ficus ulmifolia* Lamk	MORACEAE	0.002	0.016%
42	Gmelina	*Gmelina arborea* Roxb.	LAMIACEAE	0.102	1.087%
43	Tan-ag	*Kleinhovia 70ybrid70l* L.	MALVACEAE	0.154	1.650%
44	Mulbery	*Morus alba* Lour.	MORACEAE	0.254	2.715%
45	Avocado	*Persea gratissima* Gaertn.	LAURACEAE	0.065	0.696%

SPECIES NO.	SPECIES NAME	SCIENTIFIC NAME	FAMILY	DOMINANCE	RELATIVE DOMINANCE
46	Alagau	*Premna odorata* Blanco	LAMIACEAE	0.226	2.422%
47	Guava	*Psidium guajava* L.	MYRTACEAE	0.004	0.040%
48	Bayok	*Pterospermum diversifolium* Blume	MALVACEAE	1.086	11.625%
49	Ligas	*Semecarpus cuneiformis* Blanco	ANACARDIACEAE	0.073	0.786%

4.2.3.1.5 Importance Value

Importance value (IV) is the sum of relative density, relative frequency and relative dominance. The higher the importance value of a given species the more dominant it is in the given community.

The summary of the computed IV in the open forest is shown in



. For the complete list of computed IV, refer to annex tables. Based on **Figure 4.27**, it has the *Mangifera indica* L. the highest IV with 37.596% among the 49 timber species. It is followed by *Avicennia marina* (Forsk.) Vierh.var. *rumphiana* (Hallier) Bakh.Species with 28.911% and *Pithecellobium dulce* (Roxb) Benth.With 23.775%. While 3 out of the 49 identified timber species have the least IV of 0.803%. Thus, *Mangifera indica* L. is the most common species in the project site dominating the vegetation cover.

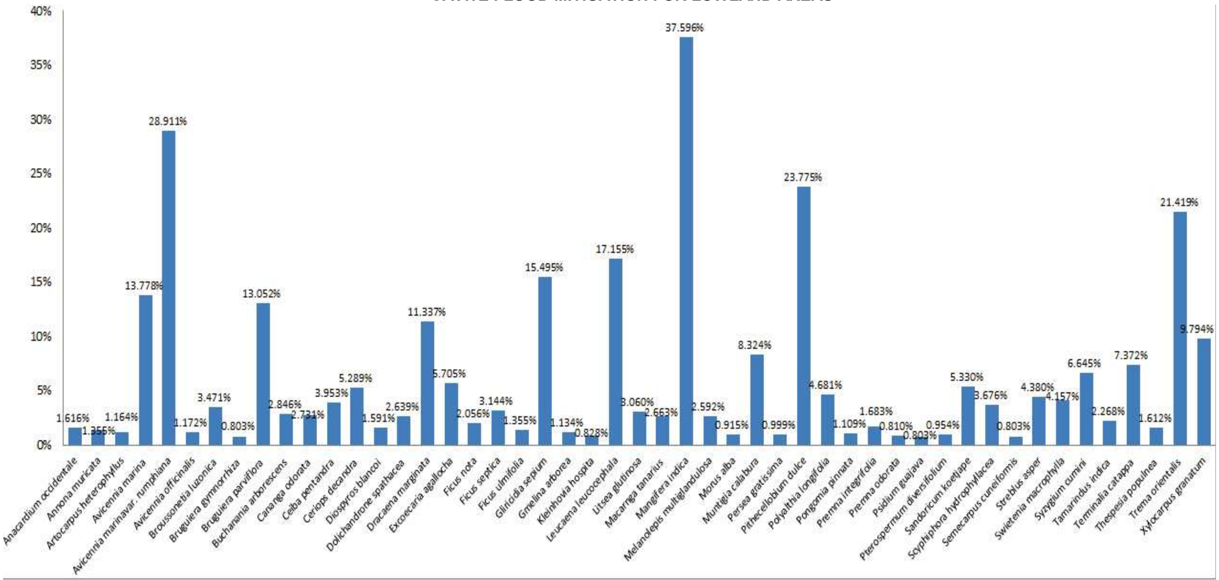


Figure 4.27. Importance Value of the 49 Timber Species in the 32 Established 20x20 Plots

4.2.3.1.6 Biodiversity Index

Species richness and evenness are the important factors in determining biodiversity of an area. Richness is defined as the total number of species present in a sample while evenness is the relative abundance of the species in a sample. Richness' takes on diversity is-the more different the species in a community, the more diverse the area. Evenness takes into account the number of the individual belonging to the same species. For evenness, a community is considered more diverse if the number of individual is relatively even for all the species present (www.countrysideinfo.co.uk).

Shannon index is used to compute the diversity index of the assessed area. For some, Shannon Diversity Index is considered more sensitive to species richness than evenness (Encyclopedia of Forest Sciences, 2004). Shannon-Wiener index ranges from 0 to infinity, with zero as no diversity. In practice, though, a value of 7 indicates an extremely rich community while values below 1 suggest a community with low diversity. Often values above 1.7 are taken to indicate a relatively diverse community. The higher the number of the index the more diverse the area is (Miras, 2014).

The overall result of the computed diversity index of the project sites shows a relative diverse community.**Table 4.23** shows that Rio Grande River is the the most diverse site with a diversity index value of 2.421,while the Diversion Drainage II has very low diversity with an index value of 1.908. With regard to species evenness the San Juan Diversion channel has the highest average value of 0.918, while Ylang-Ylang River has the less evenness of 0.853 (both values are under high species eveness).

In terms of plots diversity (H) index in every drain channels showed that in the proposed San Juan diversion channel plot 10 with diversity index of 4.33 located in Barangay San Antonio, Imus is the most diverse plot based on the Fernando Diversity Scale (1998),followed by plot 1 and 9 with diversity indices of 2.816 and 2.670 which are moderately diverse. In terms of evenness plot 10, 9 and 4 has the highest computed value of 1.422, 0.986 and 0.97, respectively. In the Ylang-Ylang Channel are plot 17 and 11 has the highest diversity and evenness with a corresponding values of 2.97 and 0.931. In the Rio Grande River are plot nos. 20 and 18 have the highest diversity index and evenness with a computed values of 2.752 and 0.941. The Diversion Drainage II is plot no. 24 with computed dversity value of 2.024 and evenness value of 0.879. While, in the Malimango creek, plot 27 has the highest diversity and evenness with estimated values of 1.716 and 0.745.

Table 4.23. Shannon diversity index

PROPOSED DRAIN CHANNEL FOR IMPROVEMENT	PLOT	SHANNON H (Species Diversity)	SHANNON J (Species evenness)
San Juan diversion Channel	1	2.816	0.940
	2	1.361	0.760
	3	1.402	0.674
	4	1.563	0.971
	5	1.480	0.826
	6	2.118	0.782
	7	2.989	0.917
	8	2.661	0.921
	9	2.670	0.986
	10	4.329	1.422
AVERAGE		**2.335**	**.918**
Ylang-Ylang River	11	2.232	0.931
	12	1.771	0.739
	13	2.373	0.821
	14	2.417	0.853
	15	2.332	0.884
	16	2.637	0.880
	17	2.927	0.869
AVERAGE		**2.384**	**.853**
Rio Grande River	18	1.956	0.941
	19	2.456	0.907
	20	2.752	0.918
	21	2.354	0.815

PROPOSED DRAIN CHANNEL FOR IMPROVEMENT	PLOT	SHANNON H (Species Diversity)	SHANNON J (Species evenness)
	22	2.644	0.883
	23	2.364	0.853
AVERAGE		**2.421**	**.886**
Diversion Drainage II Improvement	24	2.024	0.879
	25	1.807	0.869
	26	1.895	0.862
AVERAGE		**1.908**	**.87**
Maalimango creek	27	1.716	0.745
	28	2.047	0.854
	29	2.075	0.901
	30	2.583	0.894
	31	2.320	0.933
	32	2.182	0.878
AVERAGE		**2.153**	**.867**
AVERAGE (overall)		**2.240**	**.878**

Source: EIS Team

4.2.3.1.6.1. Presence of mangrove species within the project area

Presence of some mangrove species in aggregates with non-mangrove species are among of the significant species found in the project area specifically within the outlet portion of San Juan Diversion Channel and in Maalimango Creek.

Among of the species includes;Tabigi (*Xylocarpus granatum* Koen.), Langarai (*Bruguiera parviflora* (Roxb.) W. & A. ex Griff.), Bungalon (*Avicennia marina* (Forsk.)Vierh.) and Aroma (*Acacia farnesiana* (L.)Willd.). While, associated non-mangrove species identified onsite are Ipil-Ipil (*Leucaena leucocephala* (Lam.) de Wit), Kamachile (*Pithecellobium dulce* (Roxb) Benth.), Kawayan species (*Bambusa sp.*), Talisai (*Terminalia catappa* L.), Pandakaki (*Tabernaemontana pandacaqui* Poir.), and other common inland species. Relatively, thus aforementioned species are not among of the listed threatened species under the IUCN and or DAO 2007-01.

Fauna. Faunal species present within the mangrove areas are mostly common and no adverse impact is expected with the implementation of the proposed project. Further, faunal species are mobile in nature which during construction some of the species will just temporarily move in the adjacent areas due to temporary disturbance brought by machinery and workers present in the area. Noted that most of the faunal species observed in the surveyed areas are widespread, common and can thrive even in disturbed areas. Though, after the construction phase bird species will return and even new populations are expected to migrate in the area.

Mangrove species. Within the proposed San Juan Diversion channel and Malimango creek improvement some mangrove species in aggregates with non-mangrove species are expected to be impacted by the implementation of the proposed project. This is to be able to give way for the construction of drain channels that will abate flooding in the upstream municipalities.

Within the San Juan Diversion Channel and Malimango Creek improvement, presence of mangrove species are sporadically located along the fishponds, built up areas and settlements. It is dissected by natural drain channels including the maalimango creek. Further, it was observed that portions of the mangrove areas are already inhabited and even claimed as private/titled by some individuals. Portions are already converted into other land uses such as settlements and industrial area. Accordingly, with reference to the provincial land use map and land classification map, these areas are under built up zone and within the alienable and disposable land category.

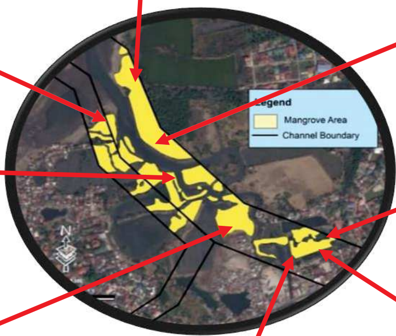
Figure 4.28. Photos of mangroves within the proposed project site

Congregates of mangrove species within the confluence of Malimango Creek and San Juan

Congregates of mangrove species near the San Juan Diversion channel outlet.Brgy. San Rafael 2 Noveleta

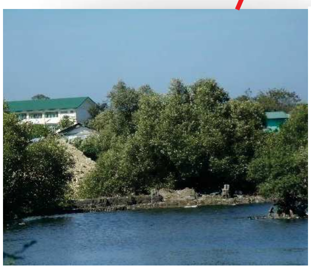
Mangrove species at the proposed San Juan Diversion channel in Brgy. San Rafael 2 Noveleta

Mangrove species at the proposed San Juan Diversion channel in Brgy. Ligtong 1 Noveleta.



Aggregates of Mangrove and non mangrove species at the proposed San Juan Diversion channel in

Mangrove species at the proposed San Juan Diversion channel in Brgy. San Rafael I



Aggregates of Mangrove species near a built up area in the proposed San Juan Diversion

Portion of Mangrove area subjected toland conversion.Claime d as private land by interviewed

4.2.3.1.7 Summary result per drain channel

4.2.3.1.7.1 San Juan Diversion channel

Generally, this channel is patchly vegetated with grasses, shrubs, small to medium size trees and aggregates of mangroves species covering an estimated area of about 28% of the total alignment area for improvement. Relative to the extent of remaining vegetation 10 sampling points were established starting from the outlet of the proposed diversion channel in barangays San Rafael II, San Rafael 1 and Sta Rosa I in the municipality of Noveleta. Of the 10 sampling sites, 7 sites has the record of the presence of mangrove species in association with other non-mangrove species.. Upstream portion of the proposed diversion channel are already located along the built up, industrial zone, and settlementareas.

Result of the assessment showed that there are about 70 plant species were identified from the 10 sampling points dominated by grass and shrubs species. Congregation of shrubs and grass species are comprised of 28 species or 40%. Among of the species are Napier (*Pennisetum purpureum*), Kudzu (*Pueraria montana*. Lobata), Kolitis (*Amaranthus spinosus* L.), Amorseco (*Idesmodium adscendens*), Gabi (*Colocasia esculentum* (L.)Schott) and other more. Other identified species dominant on the established sampling sites are the mangrove species which comprised of 30 % or 21 species dominated by Bungalon (*Avicennia marina* (Forsk.) Vierh).Other common mangrove species identified were Tabigi (*Xylocarpus granatum* Koen.), Bani (*Pongomia pinnata* (L.) Merr), Langarai (*Bruguiera parviflora* (Roxb.)W. & A. ex Griff.),Tui (*Dolichandrone spathacea* (L.f.) K. Schum.), Talisai (*Terminalia catappa* L.), Aroma (*Acacia farnesiana* (L.)Willd.) and other species. The remaining 21 species (30%) identified within the project segment are forest tree species such as Is-Is (*Ficus ulmifolia* Lamk), Tibig (*Ficus nota*), Ipil-Ipil (*Leucaena leucocephala* (Lam.) de Wit), Gmelina (*Gmelina arborea*) and other small to medium size trees growing along the river channel and settlements.

Relative to conservation status of identified species within the diversion channel, there are no rare nor endangered species as among of the species listed in the IUCN and or in DAO 2007-01.

Sampling covers an estimated area of 0.4 hectare or 6.9% of the estimated vegetated area within the proposed improvement site. Overall result of survey shows that vegetation cover is relatively diverse with high species evenness.The Shannon diversity index was used to compute species richness of every established sampling points as shown in table 10. Result of the 10 sampling sites in **Table 4.23** showed that sampling point number 10 has the highest diversity composition (4.329) followed by no. 7 and 1 with a diversity value of 2.989 and 2.816, respectively. While, in terms of species evenness (J) site no. 10 also has the highest values seconded by site no. 9 and 2. Accordingly, the computed diversity index with reference to the Fernandos Biodiversity scale (1998), the average species diversity is 2.335 with an species evenness of 0.918 which shows a relatively diverse community with high species evenness.

4.2.3.1.7.2.Ylang-Ylang River Improvement

Upstream the proposed San Juan Diversion Channel is the Ylang-Ylang River. Land cover of the proposed area for improvement is generally vegetated with grasses in association with shrubs and few tree species. Pertaining to areas with vegetation cover is estimated not more than 49 %, while the rest of the area is already part of inland water and built up areas. Adjacent the Ylang-Ylang River are road networks, settlements, subdivisions and farm lands.

Within the channel seven (7) sampling points were established. Result of the survey showed in **Table 4.23** that from the 7 sampling sites numbered as 11-17 has a total of 61 plant species dominated by forest tree species comprised of 34 species (55.7%). Among of the species are Ipil-Ipil (*Leucaena leucocephala* (Lam.) de Wit), Kakawate (*Gliricidia sepium* (Jacq.) Kunth ex Walp.), Datiles (*Muntigia calabura* L.), Anabiong (*Trema orientalis* (L.) Blume) and other small to medium size forest trees. Non-timber species comprised of 27 species (44.26%) dominated by grass species such as Napier (*Pennisetum purpureum*), Talahib (*Saccharum spontaneum*L.), Cassava (*Manihot esculenta*) and Cogon (*Imperata cylindrica* (L.) Beauv.).

Relative to conservation status of identified species only the Kamagong (*Diospyros blancoi*) is listed under the National list of threatened Philippine plants and their categories, and the list of other wildlife species or known as DAO 2007-1, under category of Critically Endangered species. Which under the DAO 2007-1 it is describe as "*species or subspecies facing extremely high risk of extinction in the wild in the immediate future. This shall include varieties, formae or other infraspecific categories".*

Relative to species diversity and evenness of sampled sites, the Shannon diversity index was used to compute species diversity index of every established sampling sites. Result of the 7 sampling sites reveals that site no. 17 has the highest diversity composition of 2.927seconded by no. 16 with a computed value of 2.637. While, in terms of species evenness site no. 11 has the highest value followed by site no. 14 with a computed evenness value of .853.

Based on the computed diversity index with reference to the Fernandos Biodiversity scale (1998), the average species diversity of the the Ylang-Ylang Channel is 2.384 with an evenness of .853 which shows a low diversity with high species evenness community.

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Figure 4.29. Sampling Site No 15. Situated in Alapan 1c Imus

4.2.3.1.7.3 Rio Grande River Improvement

The Rio Grande River is another segment of the project proposed for improvement. Dominant land cover of the area is inland water. Immediate the river banks are aggregates of settlements interpersed with grass, shrubs and some treespecies as vegetative cover of the area. Estimated area with remaining vegetative cover is only about 12% of the project area. Majority of the area are already covered by infreastructure developments including settlements. Adjacent the channel are road networks, farm lands, built up, and settlement areas.

Within this project segment six (6) sampling sites were established located in the municipalities of Imus and General Trias in Cavite. Two were located in Imus and four was in Gen. Trias. Result of the assessment from the 6 sampling sites numbered as 18-23 has a total of 51 plant species dominated by non-timber species comprised of 27 species or 52.97%. Among of the species are Napier (*Pennisetum purpureum*), Kudzu (*Pueraria montana*. Lobata), Cassava (*Manihot esculenta*), Banana (*Musa* sp.) and other shrub species.Relatively, the remaining 24 species or 47.1% are forest tree species dominated by Ipil-Ipil (*Leucaena leucocephala*).

Relative to conservation status of identified species, no endangered nor threatened species identified within the project segment.

Relative to species diversity and evenness, the Shannon diversity index was used to compute species diversity index of every established sampling sites as shown in **Table 4.23**. Sampling sites no. 20 and 22 reveals that it has the highest species diversity while, sites nos 18 and 20 has the highest species evenness. Based on the computed diversity index of this segment with reference to the Fernandos Biodiversity scale (1998), the average species diversity of the Rio Grande River is 2.421 with an evenness of .886 which shows a relatively diverse community with high species evenness.

4.2.3.1.7.4 Diversion Drainage II Improvement

The proposed diversion drainage straddles the municipalities of General Trias and Imus in Cavite. Location of the proposed drain channel is along the national highway which land cover is dominantly aggregates of grass species interpersed with built up areas. Which, vegetation cover of the area is only estimated to comprised less than 1% of the total project segment.

Relative to this, survey to flora is conducted in 3 sampling points only. Result of the assessment showed in **Table 4.23** that from the 3 sampling points numbered as 24 to 26 only generated a total of 17 plant species dominated by grass species that includes Carabao grass (*Paspalum conjugatum*), Cogon (*Imperata cylindrica*), Makahiya (*Mimosa pudica* L.) and other grass species. While, Kakawate (*Gliricidia sepium*) and Ipil-Ipil (*Leucaena leucocephala* (Lam.) de Wit) are the most common tree species in this alignment.

With regard to conservation status of identified species, no endangered nor threatened species within the project segment.

Relative to species diversity and evenness within this segment, the Shannon diversity index was used to compute species diversity index of every established sampling points 4.2.3.1. Based on the result shown in **Table 4.23** revealed that sampling site no. 24 has the highest species diversity and evenness. The overall average diversity index of this drain channel is 1.908 with an evenness of .87 which shows a relatively diverse community with high species evenness with reference to the Fernandos Biodiversity scale (1998).

4.2.3.1.7.5 Maalimango Creek Improvement

The proposed Maalimango Creek improvement is adjacent of the proposed San Juan Diversion channel. It straddles the municipalities of General Trias, Rosario and Noveleta in the province of Cavite. Land cover of the proposed improvement are patches of mangrove species near the outlet channel, grasses, trees and some crop species. Notably, vegetation cover observed within the channel are sporadically located which only covers an estimated area of not more than 40% of the total improvement area. Majority of the site are already part of the built up areas including settlements.

Sampling sites were established covering portions of mangrove area near the drain channel in barangays Ligtong 1 Noveleta and in some portions of the creek banks in brgy. Ligtong II. Survey in the upstream most part of the project segment is not undertaken due to limited access, likewise, creek banks are already occupied, concreted which vegetation is found to be very nill. Three (3) of the six (6) sampling sites conducted in this segment is located near the outlet channel, the rest are approximately near the mid-portion with remaining vegetations. **Figure 4.30** shows the sampling site.

Result of the assessment showed that only 37 plant species identified from the 6 sampled sites. Identified species from this segment includes a mangrove species comprised of 12 species, 14 tree species and 11 non timber species. Among of the identified mangrove species were Piapi (*Avicennia marina* (Forsk.) Vierh.var. *Rumphiana* (Hallier) Bakh.) and Tabigi (*Xylocarpus granatum* Koen.). While tree species includes;Anabiong (*Trema orientalis* (L.) Blume), Pakiling(*Ficus odorata* (Blanco) Merr), Is-Is (*Ficus ulmifolia* Lamk), Ipil-Ipil (*Leucaena leucocephala* (Lam.) de Wit) and Tibig (*ficus nota*).

With regard to conservation status of identified species,no endangered nor threatened species is identified within the project segment with reference to the IUCN and DAO 2007-01.

Relative to diversity index of this project segment, the Shannon diversity index was used to compute species richness of every established sampling sites shown in **Table 4.23.** Result showed that sampling site number 30 has the highest diversity composition of 2.583 seconded by site no. 31 with computed diversity of 2.320. While, in terms of species evenness site no. 31 have the highest eveness followed by site no. 29 with an evenness value of 0.933 and 0.901, respectively. Accordingly, the average species diversity and eveness of the project segment is 2.153 and 0.867 that implies a relatively diverse community with high species evenness with reference to Fernandos Biodiversity Scale (1998).

Figure 4.30. Sampling Point No. 32 Located in Maalimango Creek in Barangay Ligtong III in the Municipality of Rosario

4.2.3.2 Terrestrial Fauna

Relative to current habitat condition, wildlife in these areas are expected to be less due to disturbance and conversion of remaining habitats to other land uses. Thereby, biodiversity richness of the area is expected to be less with greater species evenness.

Initially, upon arrival to the proposed project area, site reconnaissance was undertaken prior to the identification of supposed sampling sites. Eighteen (18) sampling sites were selected within the project area based on the presence of remaining habitat for wildlife species specially birds.From the selected rivers, creeks and drain channels proposed for improvement a total of 18 sampling sites was identified. Distributions of sampling sites are as follows;

San Juan diversion channel	-	4 sampling sites
Malimango Creek	-	3 sampling sites
Ylang-Ylang River	-	4 sampling sites
Rio Grande River	-	4 sampling sites
Drain channel from General Trias to Noveleta	-	3 sampling sites

From the 18 sampling sites 5 is located in the mangrove area and the rest are along the river channels with patches of remaining vegetation cover. With regard to barangays covering the selected sampling sites are administratively distributed to 11 barangays namely: Barangays San Rafael III, San Rafael II, Salcedo I and Sta. Rosa I in Noveleta, barangays Ligtong 1, and Ligtong II in Rosario and barangays Barangay Tejero, Bacao, Sta Rosa II, Alapan I and II-A in General Trias.

The longest sampling point established is about 320 meters, while the shortest is about 130 meters with an average of 179 meters. Summarized hereunder are the corresponding location and geographical coordinates of each sampling sites-**Table 4.24**. Likewise, location map showing listed sampling sites is shown in **Figure 4.31**.

.

Table 4.24. Sampling Points Current Land Use and Geographical Coordinates

Sampling site	Location	Coordinates		Length of sampling points
		Starting point	End point	
1	San Juan diversion channel	14°25'52.89"N, 120°52'19.84"E	14°25'56.55"N, 120°52'17.75"E	150 meters
2	San Juan diversion channel	14°25'52.80"N, 120°52'17.40"E	14°25'47.25"N, 120°52'20.27"E	200 meters
3	San Juan diversion channel	14°25'41.90"N, 120°52'29.23"E	14°25'40.88"N, 120°52'33.88"E	150 meters

Sampling site	Location	Coordinates		Remarks
4	San Juan diversion channel	14°25'36.11" N, 120°52'37.84 "E	14°25'33.98" N, 120°52'41.60 "E	130 meters
5	Ylang-Ylang River	14°24'50.52" N, 120°53'16.78 "E	14°24'46.16" N, 120°53'19.00 "E	150 meters
6	Ylang-Ylang River	14°24'6.83"N – 120°54'0.78" E	14°24'1.92"N 120°54'5.78" E	130 meters
7	Ylang-Ylang River	14°23'39.35" N, 120°54'19.58 "E	14°23'35.22" N, 120°54'22.01 "E	150 meters
8	Ylang-Ylang River	14°23'19.15" N, 120°54'22.54 "E	14°23'15.10" N, 120°54'20.45 "E	180 meters
9	Rio Grande River	14°25'2.56"N , 120°53'4.65" E	14°24'54.72" N- 120°53'8.15" E	320 meters
10	Rio Grande River	14°22'41.07" N, 120°52'46.58 "E	14°22'37.89" N, 120°52'48.96 "E	150 meters
11	Rio Grande River	14°22'21.06" N, 120°52'53.94 "E	14°22'24.94" N, 120°52'59.43 "E	220 meters
12	Rio Grande River	14°22'0.97"N , 120°52'51.62 "E	14°22'7.29"N , 120°52'50.62 "E	150 meters
13	Drain channel from General Trias to Noveleta	14°25'8.53"N , 120°53'1.94" E	14°25'4.84"N , 120°52'58.49 "E	150 meters

14	Drain channel from General Trias to Noveleta	14°24'55.57" N, 120°52'49.79"E	14°24'51.06" N, 120°52'46.88"E	150 meters
15	Drain channel from General Trias to Noveleta	14°24'7.18"N, 120°52'27.61"E	14°24'1.43"N, 120°52'19.65"E	300 meters
16	Malimango Creek	14°25'47.17" N, 120°52'17.39"E	14°25'44.24" N, 120°52'21.45"E	150 meters
17	Malimango Creek	14°25'33.91" N, 120°52'19.85"E	14°25'37.14" N, 120°52'20.81"E	150 meters
18	Maalimango Creek	14°25'24.89" N, 120°52'12.41"E	14°25'18.08" N, 120°52'9.22" E	240 meters

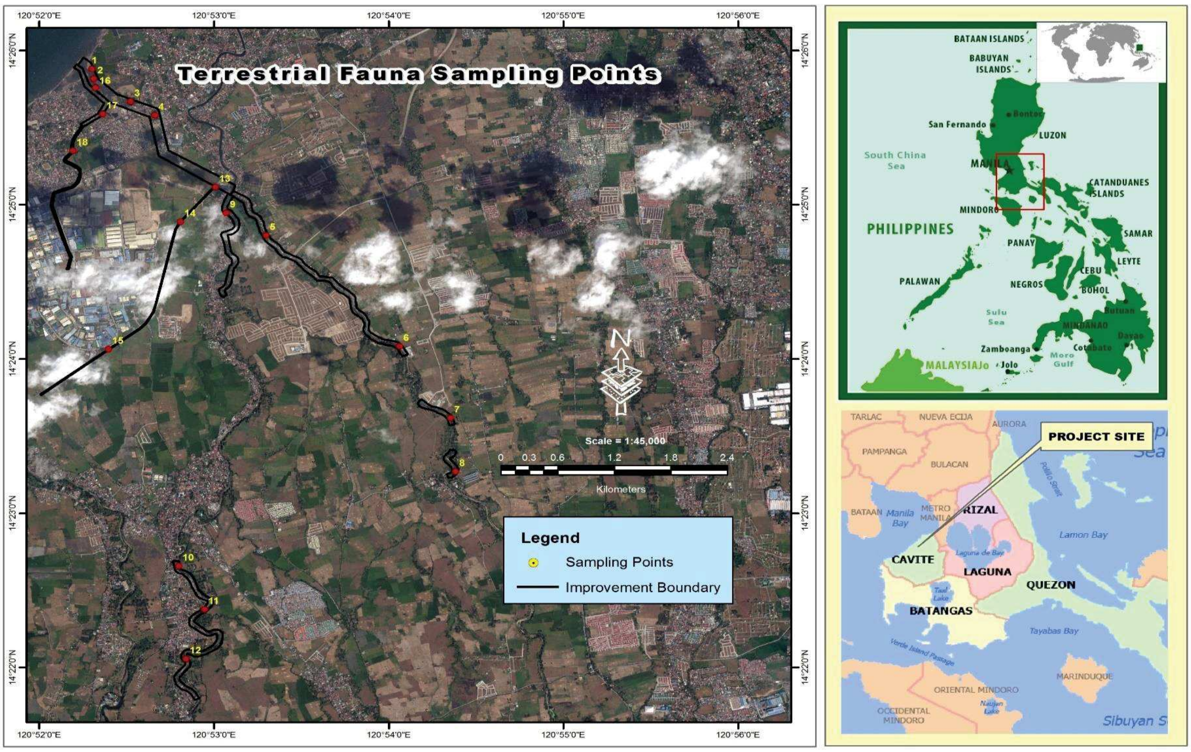

Figure 4.31. Location Map of Assessed Area

4.2.3.2.1Summary of Fauna Species

Result of the assessment revealed that a total of 50 wildlife species still thrives within the proposed project site (*including thus reported species*) dominated by bird species. From the total species list 38 or 76% are bird species, 4 or 8% are mammals, 6 or 12% are reptiles and 2 or 4% are amphibian species. Though, from the total enumerated species, 11 or 22% are reported or claimed to be present by interviewed key informants and based on secondary data. Thus observed species are noted to be common in lowland areas, along rivers, agricultural, shrub lands along and within settlements which could thrive even in highly disturb habitats including urban areas.

With regard to species conservation status, only the Philippine Cobra /Ulupong(*Naja philipinensis)* is categorically Nearly Threatened. Moreover, Reticulated Python or locally known as “Sawa” (*Python reticulatus*) is listed under the Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora, this species is 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 (cites.org).Relatively, DENR Administrative Order no. 2004-15 cited *Python reticulatus* as other threatened wildlife which means the species or subspecies is not critically endangered, endangered nor vulnerable but is under threat from adverse factors, such as over collection, throughout their range and is likely to move to the vulnerable category in the near future. Further, most of these species of about 84% are known to be common in the Philippines. Note that the abovementioned species are not directly observed species in the project area but it was reported/claimed by the interviewed local the existence of these species in their locality. Accordingly, the informant narrated that these species are sometimes observed specially within the woods along Ylang-Ylang River in Barangay Alapan 1A. Adjacent the area there are patches of farm lands and grass lands which is favorable habitat of such species. Thereby, possibility of species presence in the area is considered.

On the other hand the Marine Toad/Bullfrog (*Bufo marinus*) and Polynesian Rat (*Rattus exullans*) are known to be an introduced species in the Philippines. With reference to table below, it presents the summary of wildlife species in the proposed project site, their conservation status and corresponding geographical range (Source: http://www.iucnredlist.org/).

In terms of species population distribution as shown in **Table 4.25** revealed that majority of the bird species comprised of 29/39 or 74.35% are common species.Among of these species are Yellow vented Bulbul (*pygnonotus goiaver*), Golden Bellied Fly Eater (*Gerygone sulphurea*),Pied Bushchat (*Saxicola caprata*) and other more. Other species are locally common, uncommon and fairly common that only comprised of 5, 4 and 1 species, respectively. For the mammal, reptiles and and amphibian species are all under common category, though, the Polynesian Coconut Rat (*Rattus exullans*) and the Marine Toad (*Bufo marinus*) are introduced species into the country. Some photos of sited species during assessment is shown in **Figure 4.32**.

Relative to the overall computed biodiversity index of the assessed area using the Shannon-Wiener Index (H') has a result of 2.84 species richness. Conversely, computed species evenness using the Pielou's Index (J') has an evenness value of .78. Relatively, using the Fernando's Biodiversity Scale (1998), signified that results obtained showed a moderate biodiversity richness of the area with very high species evenness.

Figure 4.32. Photos of Some Bird Species Observed On Site

Pied fantail (*Rhipidura javanica*) perching on a kawayan species in Brgy. Alapan II Imus (sampling site no. 5)

The Black Winged Stilt (***Himantopus himantopus***) feeding in a shallow part of a fishpond in San Rafael II Novelita (Sampling

Group of little Egret (*Egretta garzetta) feeding on the shallow portion at the drain channel of Malimango creek in Brgy. Ligtong 1 Rosario (sampling site no. 16)*

Brown Shrike (*Lanius cristatus*) perching on top an Indian Mango tree in Brgy. Alapan 1 Imus (Sampling site no. 7)

Group of whiskered Tern (*Chlidonias hybrida*) resting on a bamboo poles along the bakawan area in San Rafael II Noveleta (Sampling site no. 1)

Species of Chesnut munia (*Lonchura mallaca*) resting on grass species. Along the Ylang-Ylang river in Alapan 2 Imus. Sampling plot no.8

A Yellow Vented Bulbul (Pynonotus goiaver)feeding on a Kamachile in brgy. Ligtong II Rosario. Sampling plot no.10 Along the Rio Grande River in brgy. Sta Clara Gen. Trias

A White Collared King Fisher (Halcyon chloris) spotted perching on electrical wire. Along the Ylang-Ylang river in Alapan 2 Imus.Sampling plot no.16 in Brgy Sta Rosa 1 Noveleta.

A Zebra dove (*Geopelia striata*) and Eurasian Tree sparrow (*Passer montanus*) sited beside a tree in brgy. San Rafael 2, Noveleta within sampling site no.4 in the proposed San Juan Drain Channel.

A House Swift (*Apus affinis*) sited along the Rio Grande River straddling sampling site no. 10.

A Pacific swallow (*Hirundo tahita*) sited resting on the electric wire along the Malimango Creek. Sampling site no. 18.

Table 4.25. Summary List of Terrestrial Fauna Species

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
Aves					
ARDEIDAE	Great Billed Heron	*Ardea sumatrana*	LC	Native: Australia; Brunei Darussalam; India; Indonesia; Malaysia; Myanmar; Papua New Guinea; Philippines; Singapore; Thailand; Timor-Leste; Viet Nam	Uncommon
ARDEIDAE	Great Egret	*Egetta alba*	LC	Afghanistan; Albania; Algeria; Angola (Angola); Anguilla; Antigua and Barbuda; Argentina; Armenia (Armenia); Aruba; Australia; Austria; Azerbaijan; Bahamas; Bahrain; Bangladesh; Barbados; Belarus; Belgium; Belize; Benin; Bhutan; Bolivia, Plurinational States of; Bonaire, Sint Eustatius and Saba; Bosnia and Herzegovina; Botswana; Brazil; Brunei Darussalam; Bulgaria; Burkina Faso; Burundi; Cambodia; Cameroon; Canada; Cayman Islands; Central African Republic; Chad; Chile; China; Christmas Island; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Costa Rica; Côte d'Ivoire; Croatia; Cuba; Curaçao; Cyprus; Czech Republic; Denmark; Dominica; Dominican Republic; Ecuador (Galápagos); Egypt; El Salvador; Eritrea; Ethiopia; Falkland Islands (Malvinas); France; French Guiana; Gabon; Gambia; Georgia; Germany; Ghana; Greece; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; Hungary; India; Indonesia; Iran, Islamic Republic of; Iraq; Israel; Italy; Jamaica; Japan; Jordan; Kazakhstan; Kenya; Korea, Democratic	Uncommon

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
				People's Republic of; Korea, Republic of; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Latvia; Lebanon; Lesotho; Liberia; Libya; Macao; Macedonia, the former Yugoslav Republic of; Madagascar; Malawi; Malaysia; Maldives; Mali; Martinique; Mauritania; Mayotte; Mexico; Micronesia, Federated States of ; Moldova; Mongolia; Montenegro; Montserrat; Morocco; Mozambique; Myanmar; Namibia; Nepal; Netherlands; New Zealand; Nicaragua; Niger; Nigeria; Northern Mariana Islands; Oman; Pakistan; Palau; Palestinian Territory, Occupied; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Poland; Portugal; Puerto Rico; Qatar; Romania; Russian Federation; Rwanda; Saint Kitts and Nevis; Saint Lucia; Saint Martin (French part); Saint Vincent and the Grenadines; Saudi Arabia; Senegal; Serbia (Serbia); Sierra Leone; Singapore; Sint Maarten (Dutch part); Slovakia; Slovenia; Solomon Islands; Somalia; South Africa; South Georgia and the South Sandwich Islands; South Sudan; Spain (Canary Is. – Vagrant); Sri Lanka; Sudan; Suriname; Swaziland; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tajikistan; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Trinidad and Tobago; Tunisia; Turkey; Turkmenistan; Turks and Caicos Islands; Uganda; Ukraine; United Arab Emirates; United States (Georgia); Uruguay; Uzbekistan; Venezuela, Bolivarian Republic of; Viet Nam; Virgin Islands,	

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
				British; Virgin Islands, U.S.; Yemen; Zambia; Zimbabwe	
ARDEIDAE	Intermediate Egret	*Egrette intermedia*	LC	Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Guam; India; Indonesia; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Micronesia, Federated States of ; Myanmar; Nepal; Northern Mariana Islands; Oman; Pakistan; Palau; Papua New Guinea; Philippines; Russian Federation; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Timor-Leste; Viet Nam	Locally common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
LARIDAE	Common Sandpiper	*Actitis hypoleucos*	LC	Afghanistan; Albania; Algeria; Andorra; Angola (Angola); Armenia (Armenia); Australia; Austria; Azerbaijan; Bahrain; Bangladesh; Belarus; Belgium; Benin; Bhutan; Bosnia and Herzegovina; Botswana; British Indian Ocean Territory; Brunei Darussalam; Bulgaria; Burkina Faso; Burundi; Cambodia; Cameroon; Cape Verde; Central African Republic; Chad; China; Christmas Island; Cocos (Keeling) Islands; Comoros; Congo; Congo, The Democratic Republic of the; Côte d'Ivoire; Croatia; Cyprus; Czech Republic; Denmark; Djibouti; Egypt; Equatorial Guinea; Eritrea; Estonia; Ethiopia; Finland; France; Gabon; Gambia; Georgia; Germany; Ghana; Gibraltar; Greece; Guam; Guinea; Guinea-Bissau; Hong Kong; Hungary; India; Indonesia; Iran, Islamic Republic of; Iraq; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Latvia; Lebanon; Lesotho; Liberia; Libya; Liechtenstein; Lithuania; Luxembourg; Macao; Macedonia, the former Yugoslav Republic of; Madagascar; Malawi; Malaysia; Maldives; Mali; Malta; Mauritania; Mauritius; Mayotte; Micronesia, Federated States of ; Moldova; Mongolia; Montenegro; Morocco; Mozambique;	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
LARIDAE	Whiskered Tern	*Chlidonias hybrida*	LC	Afghanistan; Albania; Algeria; Angola (Angola); Armenia (Armenia); Australia; Austria; Azerbaijan; Bahrain; Bangladesh; Belarus; Bosnia & Herzegovina Botswana; Brunei Darussalam; Bulgaria; Cambodia; Central African Republic;Chad; China; Côte d'Ivoire; Croatia; Cyprus; Czech Republic; Egypt; Equatorial Guinea; Ethiopia; France; Gambia; Germany; Ghana; Greece; Guam; Guinea; Guinea-Bissau; Hong Kong; Hungary; India; Indonesia; Iran; Iraq; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea; Kuwait; Lao People's Democratic Republic; Latvia; Lebanon; Liberia; Libya; Lithuania; Macedonia, the former Yugoslav Republic of; Madagascar; Malawi; Malaysia; Mali; Mauritania; Micronesia, Federated States of ; Moldova; Mongolia; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nepal; Niger; Nigeria; Northern Mariana Islands; Oman; Pakistan; Palau; Palestinian Territory, Occupied; Papua New Guinea; Philippines; Poland; Portugal; Qatar; Romania; Russian Federation; Saudi Arabia; Senegal; Serbia (Serbia); Sierra Leone; Singapore; Slovakia; Somalia; South Africa; South Sudan; Spain; Sri Lanka; Sudan; Swaziland; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tajikistan; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tunisia; Turkey; Turkmenistan; Uganda; Ukraine; United Arab Emirates; Uzbekistan; Viet Nam; Western Sahara; Yemen; Zambia; Zimbabwe	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
COLUMBIDAE	White Eared Brown Dove	*Phapitreron leucotis*	LC	Philippines	common
COLUMBIDAE	Zebra Dove	*Geopelia striata*	LC	Native in Brunei Darussalam; Cambodia; Indonesia; Malaysia; Myanmar; Philippines; Singapore; Thailand	common
CUCULIDAE	Brush Cuckoo	*Cacomantis variolosus*	LC	Australia; Indonesia; Malaysia; Myanmar; Papua New Guinea; Philippines; Singapore; Solomon Islands; Thailand; Timor-Leste	common
CUCULIDAE	Greater Coucal	*Centripus sinensis*	LC	Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Singapore; Sri Lanka; Thailand; Viet Nam	Locally common
ARDEIDAE	Little Egret	*Egretta garzetta*	LC	Afghanistan; Albania; Algeria; Angola (Angola); Antigua and Barbuda; Armenia (Armenia); Aruba; Australia; Austria; Azerbaijan; Bahrain; Bangladesh; Barbados; Belgium; Benin; Bhutan; Bosnia and Herzegovina; Botswana; Brunei Darussalam; Bulgaria; Burkina Faso; Burundi; Cambodia; Cameroon; Cape Verde; Central African Republic; Chad; China; Christmas Island; Congo; Congo, The Democratic Republic of the; Côte d'Ivoire; Croatia; Cyprus; Czech Republic; Denmark; Djibouti; Egypt; Equatorial Guinea; Eritrea; Ethiopia; France; Gabon; Gambia; Georgia; Germany; Ghana; Gibraltar; Greece; Guam; Guinea; Guinea-Bissau; Hong Kong; Hungary; India; Indonesia; Iran, Islamic Republic of; Iraq; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Kuwait;	Common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
				Lao People's Democratic Republic; Lebanon; Lesotho; Liberia; Libya; Macedonia, the former Yugoslav Republic of; Malawi; Malaysia; Mali; Malta; Mauritania; Micronesia, Federated States of ; Moldova; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nepal; Netherlands; New Zealand; Niger; Nigeria; Northern Mariana Islands; Oman; Pakistan; Palau; Palestinian Territory, Occupied; Papua New Guinea; Philippines; Poland; Portugal; Qatar; Romania; Russian Federation; Rwanda; Saudi Arabia; Senegal; Serbia (Serbia); Seychelles; Sierra Leone; Singapore; Slovakia; Slovenia; Solomon Islands; Somalia; South Africa; South Sudan; Spain; Sri Lanka; Sudan; Swaziland; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tunisia; Turkey; Turkmenistan; Uganda; Ukraine; United Arab Emirates; United Kingdom; United States (Georgia); Uzbekistan; Viet Nam; Western Sahara; Yemen; Zambia; Zimbabwe	
APODIDAE	Glossy Switflet	*Collocalia affinis*	LC	Brunei Darussalam; Christmas Island; India; Indonesia; Malaysia; Myanmar; New Caledonia; Papua New Guinea; Philippines; Singapore; Solomon Islands; Thailand; Timor-Leste; Vanuatu; Vagrant in Australia	Locally common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
APODIDAE	House Swiftlet	*Apus affinis*	LC	Afghanistan; Algeria; Angola (Angola); Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Congo; Congo, The Democratic Republic of the; Côte d'Ivoire; Djibouti; Egypt; Equatorial Guinea; Eritrea; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; India; Iran, Islamic Republic of; Iraq; Israel; Jordan; Kenya; Kuwait; Lebanon; Lesotho; Liberia; Libya; Madagascar; Malawi; Mali; Mauritania; Morocco; Mozambique; Namibia; Niger; Nigeria; Oman; Pakistan; Palestinian Territory, Occupied; Rwanda; Sao Tomé and Principe; Saudi Arabia; Senegal; Sierra Leone; Somalia; South Africa; South Sudan; Spain; Sri Lanka; Sudan; Swaziland; Syrian Arab Republic; Tajikistan; Tanzania, United Republic of; Timor-Leste; Togo; Tunisia; Turkey; Turkmenistan; Uganda; United Arab Emirates; Uzbekistan; Yemen; Zambia; Zimbabwe	Locally common
ALCEDINIDAE	Blue Eared King Fisher	*Alcedo meninting*	LC	Bangladesh; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Philippines; Singapore; Sri Lanka; Thailand; Viet Nam	Uncommon
ALCEDINIDAE	White Collared King Fisher	*Halchyon chloris*	LC	Philippines and south east 98ybri countries	common
AEGITHINIDAE	Common Iora	*Aegithinia tiphia*	LC	Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Singapore; Sri Lanka; Thailand; Viet Nam	Fairly common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
PYCNONOTIDAE	Yellow Vented Bulbul	*Pycnonotus goiavier*	LC	Southeast Asia; common in the Philippines, Singapore and Brunei;	common
ACANTHIZIDAE	Golden Bellied Fly Eater	*Gerygone sulphurea*	LC	Brunei Darussalam; Indonesia; Malaysia; Philippines; Singapore; Thailand	common
SYLVIIDAE	Lemon Throated Warbler	*Phylloscopus cebuensis*	LC	Philippines	common
SYLVIIDAE	Tawny Grass Bird	*Megalurus timoriensis*	LC	Australia; Indonesia; Papua New Guinea; Philippines; Timor-Leste	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
CISTICOLIDAE	Zitting Cisticola	*Cisticola juncidis*	LC	Albania; Algeria; Angola (Angola); Australia; Bangladesh; Belgium; Benin; Botswana; Burkina Faso; Burundi; Cambodia; Cameroon; Central African Republic; Chad; China; Congo; Congo, The Democratic Republic of the; Côte d'Ivoire; Croatia; Cyprus; Egypt; Equatorial Guinea; Eritrea; Ethiopia; France; Gabon; Gambia; Ghana; Gibraltar; Greece; Guinea; Guinea-Bissau; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Israel; Italy; Japan; Jordan; Kenya; Korea, Republic of; Lao People's Democratic Republic; Lebanon; Lesotho; Libya; Macedonia, the former Yugoslav Republic of; Malawi; Mali; Malta; Mauritania; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nepal; Netherlands; Niger; Nigeria; Pakistan; Palestinian Territory, Occupied; Philippines; Portugal; Rwanda; Saudi Arabia; Senegal; Serbia (Serbia); Sierra Leone; Singapore; Slovenia; Somalia; South Africa; South Sudan; Spain; Sri Lanka; Sudan; Swaziland; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tunisia; Turkey; Uganda; Viet Nam; Yemen; Zambia; Zimbabwe	common
RHIPIDURIDAE	Pied Fan Tail	*Rhipidura javanica*	LC	Afghanistan; Bangladesh; Cambodia; China; India; Indonesia; Iran, Islamic Republic of; Kazakhstan; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Papua New Guinea; Philippines; Sri Lanka; Tajikistan; Thailand; Timor-Leste; Turkmenistan; United Arab Emirates; Uzbekistan and	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
PACHYCEPHALIDAE	Mangrove Whistler	*pachycephala grisola*	LC	Bangladesh; Brunei Darussalam; Cambodia; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam	common
LANIIDAE	Brown Shrike	*Lanius cristatus*	LC	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; Russian Federation; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam	common
NECTARINIIDAE	Plain Throated Sunbird	*Antreptes melasensis*	LC	Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam	common
DICAEIDAE	Orange Bellied Flower Pecker	*Dicaeum trigonostigma*	LC	Bangladesh; Brunei Darussalam; India; Indonesia; Malaysia; Myanmar; Philippines; Singapore; Thailand	common
DICAEIDAE	Pygmy Flower Pecker	*Dicaeum pygmaeum*	LC	Balabac, Calauit, Culion and Palawan; *fugaensis*Calayan and Fuga; *salomonseni*northwest Luzon; *pygmaeum*Bohol, Boracay, Calag-an, Cebu, Corregidor, Gigantes, Guimaras, Leyte, Lubang, Central and Southern Luzon,Maestre de Campo, Marinduque, Masbate, Mindoro, Negros, Polillo, Romblon, Samar, Semirara, Sibay, Sibuyan, Sicogon, Siquijor, and Ticao; *Davao,* Camiguin Sur and Mindanao.	Common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
PASSERIDAE	Eurasian Tree Sparrow	*Passer montanus*	LC	Eurasia, China, Taiwan, Ryukus, SE Asia, Sumatra and Java, introduced lesser Sunda to Australia, including Mollucas, Sulawesi, Borneo and the Philippines- Batan, Biliran, Bongao, Calauit, Camotes, Carabao, Catanduanes, Leyte, Luzon, Mindanao, Mindoro, Negros, Olango, Palawan, Panay, Sabtang, SangaSanga, Sibuyan, Sicogon, Siquijor, and Tawi-Tawi.	Common
ESTRILDIDAE	Scaly Breasted Munia	*Lonchura punctulata*	LC	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	common
ESTRILDIDAE	Chestnut Munia	*Lonchura mallaca*	LC	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	common
RECURVIROSTRIDAE	Black winged Stilt	*Himantopus himantopus*	LC	Afghanistan; Albania; Algeria; Angola (Angola); Anguilla; Antigua and Barbuda; Argentina; Armenia (Armenia); Aruba; Australia; Austria; Azerbaijan; Bahamas; Bahrain; Bangladesh; Barbados; Belarus; Belgium; Belize; Benin; Bermuda;	Uncommon

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
LANIIDAE	Long Tailed Shrike	*Lanius schach*	LC	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	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
MOTACILLIDAE	Grey Wagtail	*Notacilla cinerea*	LC	Afghanistan; Albania; Algeria; Andorra; Armenia (Armenia); Austria; Azerbaijan; Bahrain; Bangladesh; Belgium; Bhutan; Bosnia and Herzegovina; Brunei Darussalam; Bulgaria; Cambodia; Central African Republic; China; Christmas Island; Congo, The Democratic Republic of the; Croatia; Cyprus; Czech Republic; Denmark; Djibouti; Egypt; Eritrea; Estonia; Ethiopia; Faroe Islands; Finland; France; Georgia; Germany; Gibraltar; Greece; Guinea-Bissau; Hong Kong; Hungary; Iceland; India; Indonesia; Iran, Islamic Republic of; Iraq; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Latvia; Lebanon; Libya; Liechtenstein; Luxembourg; Macao; Macedonia, the former Yugoslav Republic of; Malawi; Malaysia; Mali; Malta; Mauritania; Mongolia; Montenegro; Morocco; Myanmar; Nepal; Netherlands; Norway; Oman; Pakistan; Philippines; Poland; Portugal; Qatar; Romania; Russian Federation; Rwanda; Saudi Arabia; Serbia (Serbia); Singapore; Slovakia; Slovenia; Somalia; South Sudan; Spain; Sri Lanka; Sudan; Sweden; Switzerland; Syrian Arab Republic; Taiwan, Province of China; Tajikistan; Tanzania, United Republic of; Thailand; Timor-Leste; Tunisia; Turkey; Turkmenistan; Uganda; Ukraine; United Arab Emirates; United Kingdom; Uzbekistan; Viet Nam; Yemen	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
HIRUNDINIDAE	Pacific Swallow	*Hirundo tahita*	LC	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	common
MUSCICAPIDAE	Pied Bushchat	*Saxicola caprata*	LC	Afghanistan; Bangladesh; Cambodia; China; India; Indonesia; Iran, Islamic Republic of; Kazakhstan; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Papua New Guinea; Philippines; Sri Lanka; Tajikistan; Thailand; Timor-Leste; Turkmenistan; United Arab Emirates; Uzbekistan; Viet Nam	common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
ARDEIDAE	Cattle Egret	*Bubulcus ibis*	LC	Algeria; Angola (Angola); Anguilla; Antigua and Barbuda; Argentina; Armenia (Armenia); Aruba; Australia; Azerbaijan; Bahamas; Bahrain; Bangladesh; Barbados; Belize; Benin; Bermuda; Bhutan; Bolivia, Plurinational States of; Bonaire, Sint Eustatius and Saba (Saba, Sint Eustatius); Botswana; Brazil; Brunei Darussalam; Burkina Faso; Burundi; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; Central African Republic; Chad; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Costa Rica; Côte d'Ivoire; Cuba; Curaçao; Cyprus; Djibouti; Dominica; Dominican Republic; Ecuador (Galápagos – Introduced); Egypt; El Salvador; Equatorial Guinea; Eritrea; Ethiopia; Falkland Islands (Malvinas); France; French Guiana; Gabon; Gambia; Georgia; Ghana; Gibraltar; Greece; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Kuwait; Lao People's Democratic Republic; Lebanon; Lesotho; Liberia; Libya; Macao; Madagascar; Malawi; Malaysia; Maldives; Mali; Marshall Islands; Martinique; Mauritania; Mauritius; Mayotte; Mexico; Micronesia, Federated States of ; Montenegro; Montserrat; Morocco; Mozambique; Myanmar; Namibia; Nepal; Netherlands; New Zealand; Nicaragua; Niger; Nigeria; Northern Mariana Islands; Oman; Pakistan; Palau; Palestinian Territory, Occupied; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Portugal; Puerto Rico; Qatar; Réunion; Romania; Russian Federation; Rwanda; Saint Helena, Ascension and Tristan da Cunha; Saint Kitts and Nevis; Saint Lucia; Saint Martin (French part); Saint Vincent and the Grenadines; Sao Tomé and Principe; Saudi Arabia; Senegal; Serbia (Serbia); Seychelles; Sierra	Locally common

Family	Common Name	Scientific Name	Conservation Status	Geographic Range	Population Distribution
CUCULIDAE	Philippine Coucal	*Centripus viridis*	LC	Batan, Ivojos and Sabtang, Major Kalayan, Dalupiri, and Fuga, Camiguin Norte, Apo, Balut, Banga, Bantayan, Banton, Basilan,Biliran, Bohol, Boracay, Bohol, Boracay, Cagayancillo, Calagna-an, Calicoan, Camiguin Sur, CarabaoCatanduanes, Cebu, Cuyo, Dinagat, Gigantes, Guimaras, Jolo, leyte, Lubang, Luzon, Malamaui, Marinduque, Masbate, Mindanao, Negros, Olngo, (Magsalay et al 1993), Panay, Pan deAzucar, Polillo, Romblon, Samar, Siargao,Saisi, Sibuyan, Siquijor, Tablas, Talicud,, andTicao.	Common
CORVIDAE	Large Billed Crow	*Corvus macrorhynchos*	LC	Afghanistan; Bhutan; Cambodia; China; India; Indonesia; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Russian Federation; Singapore; Taiwan, Province of China; Thailand; Timor-Leste; Viet Nam	common
TURNICIDAE	Pugo **	*Turnix suscitator*	LC	All of India up to about 2500 m in the Himalayas; Sri Lanka; Bangladesh; Burma; Indonesia and most of Southeast Asia, Philippines.	Common
RALLIDAE	Barred Rail**	*Garillus torquatus*	LC	Philippines	common

Mammals					
PTEROPODIDAE	Short-Nose Fruit Bat	*Cynopterus brachyotis*	LC	Widespread species in SE; Native in Cambodia; China; India (Andhra Pradesh, Bihar, Goa, Karnataka, Maharashtra, Nagaland, Tamil Nadu); Indonesia (Sulawesi, Sumatera); Lao People's Democratic Republic; Malaysia; Myanmar; Singapore; Sri Lanka; Thailand; Timor-Leste; Viet Nam	Common
PTEROPODIDAE	Greater Musky Fruit Bat/ kabag	*Ptenochirus jagorii*	LC	The greater musky fruit bat is endemic to the Philippines, and occurs widely, except in the Batanes/Babuyan and Palawan Faunal Regions. It has been recorded from Biliran, Bohol, Bongao, Boracay, Caluya, Camiguin, Carabao, Catanduanes, Cebu, Dinagat, Leyte, Luzon (Abra, Albay, Aurora, Batangas, Benguet, Cagayan, Camarines Sur, Ilin (Gonzalez), Isabela, Kalinga, Laguna, Mountain province, Nueva Viscaya, Pampanga, Quezon, Quirino, Rizal, Sorsogon, Tarlac, and Zambales), Marinduque, Maripipi, Masbate, Mindanao (Agusan del Norte, Bukidnon, Davao del Norte, Davao del Sur, Davao Oriental, Lanao del Norte, Lanao del Sur, Misamis Occidental, Misamis Oriental, South Cotabato, Surigao del Sur, and Zamboanga del Sur provinces), Mindoro, Negros, Panay, Polillo Islands, Samar, Sanga-sanga, Semirara, Siargao, Sibay, Sibuyan, Siquijor, Tablas and Ticao (L. Paguntalan pers. Comm. 2006) (Alcala and Alviola 1970; Heaney *et al.* 1998, 2005). Its elevational range is 0-1,950 m asl (Heaney *et al*. 1998, 2005).	Common

MURIDAE	Polynesian coconut rat**	*Rattus exullans*	LC	The Polynesian rat is widespread throughout the Pacific and Southeast Asia	Common/ Introduced
MURIDAE	Large field rat **	*Rattus mindanensis*	LC	widespread throughout the Pacific and Southeast Asia	Common
Reptiles					
COLUBRIDAE	Common Rat snake**	*Elaphe erythrura*	LC		Common
COLUBRIDAE	Dahong Palay **	*Ahaetulla prasina*	LC	Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam	Common
ELAPIDAE	Ulupong/Phil. Cobra**	*Naja philippinensis*	NT	Philippines	Common
COLUBRIDAE	Common Snakes **	*Lycodon aulicus*	LC		Common
VARANIDAE	Monitor Lizard**	*Varanus salvator*	Least concern (IUCN 2015.2),Vulnerable (CITES app.2)	This species is extremely widespread throughout southern and Southeast Asia (Gaulke and Horn 2004). Bangladesh; Cambodia; China (Guangxi, Hainan, Yunnan); Hong Kong; India (Andaman Is., Nicobar Is.); Indonesia (Bali, Jawa, Kalimantan, Sulawesi, Sumatera); Lao People's Democratic Republic; Malaysia (Peninsular Malaysia); Myanmar; Singapore; Sri Lanka; Thailand; Viet Nam	Common
PYTHONIDAE	Reticulated Python/ Sawa **	*Python reticulatus*	Not evaluated (IUCN), Other threatened	Native in Asia; All over the Philippines	Common

			species (CITES app.2)		
Amphibian					
RHACOPHORIDAE	Common Tree Frog **	*Polypedates leucomystax*	LC	This species occurs throughout northeast India and Bangladesh, it is marginal in Nepal, and possibly occurs in Bhutan (although this requires confirmation). It is considered here to be present in western Yunnan, China. It also occurs throughout most of mainland southeast Asia, including islands large (e.g. Phuket (Frith, 1977) and Singapore (Lim and Lim, 1992 and Ming, 2000)) and small (e.g. vegetated rocks off Tioman and Redang), and is widespread (and introduced) throughout the Philippines, and is present in Borneo, Mentawai, Sumatra, Java, Sulawesi, Bali, Lombok, Natuna Islands, Anambas Islands, Sumbawa, Sumba, Flores, Timor and is introduced to Papua (not mapped here). It also is found in China. It is introduced to Japan and is found in Okinawajima, Tonakijima, Kurimajima, Miyakojima, Iejima, Iheyajima, Izenajima, Sesokojima and Yabuchijima. It is found up to 1,500m asl.	Common

BUFONIDAE	Marine Toad**	*Bufo marinus*	LC	**Native**: Belize; Bolivia, Plurinational States of; Brazil; Colombia; Costa Rica; Ecuador; El Salvador; French Guiana; Guatemala; Guyana; Honduras; Mexico; Nicaragua; Panama; Peru; Suriname; Trinidad and Tobago; United States (Florida – Introduced, Hawaiian Is. – Introduced, Texas); Venezuela, Bolivarian Republic **Introduced**: Antigua and Barbuda; Aruba; Australia; Barbados; Dominican Republic; Grenada; Guadeloupe; Guam; Haiti; Jamaica; Japan; Martinique; Montserrat; Northern Mariana Islands; Papua New Guinea; Philippines; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Solomon Islands; Taiwan, Province of China; Virgin Islands, U.S.	Introduced/ common

Source: The IUCN Red List of Threatened Species

Legend: *** Reported*
LC Least Concern
NT Near Threatened
Common- population of the species is widespread in different ecocystem
Uncommon- Population of the species is rare and in limited habitat/ecosystem
Fairly Common- Population of the species isfairly widespread in varieties of habitats/ecosystem
Locally common- Population of the species is widespread but in a certain region/locality

In terms of species richness of the assess area per project segment (Shown in **Table 4.26**), the proposed San Juan diversion channel revealed to have the highest biodiversity level with the presence of mangrove forest as habitat and feeding ground of several bird species. A total of 29 species of bird was generated from the 4 observation sites with a total population of 416 individuals representing 63.5% from the overall result of sampling. Species identified on this site was dominated by little Egret (*Egretta garzetta*), Whiskered Tern (*Chlidonias 111ybrid*) and Eurasian Tree Sparrow (*Passer montanus*) species. Though, these species are seems to be commonand under least concern in terms of their conservation status with reference to the IUCN red list. The least diverse site is in the proposed Diversion Drainage II having only a total count of 29 individuals which comprised of 6 species.

Table 4.26 Summary of Species Count Per Project Segment

NO.	Name of channel	Species count	Total no. of Individuals	Remarks
1	San Juan Diversion Channel	29	461	Biodiversity richness is moderate with high species evenness
2	Ylang-Ylang River	17	67	Biodiversity richness of the area is moderate with high species evenness
3	Rio Grande River	15	33	Biodiversity richness of the area is low with very high species evenness
4	Gen. Trias Noveleta drain channel	6	29	Biodiversity richness of the area is very Low with high species evenness
5	Malimango Creek	14	65	Biodiversity richness of the area is moderate with high species evenness
		81	**655**	

4.2.3.2.2.Faunal Distribution and Relative Frequency

From the 18 sampling sites established in the proposed project sites as being shown in **Table 4.27**, reveals that 37 bird species are observed on site with a population of 655 individuals. In terms of frequency, the Eurasian tree sparrow (*Passer montanus)* is the common species intercepted with a value of 8.67% relative frequency followed by the Yellow Vented Bulbul (*Pycnonotus goiavier)* with a relative frequency of 6.67%. Conversely, the Black winged stilt (*Himantopus Himantopus),* Greater Coucal (*Centripus sinensis),*Large Billed crow (*Corvus macrorhynchos) and* Grey Wagtail (*Notacilla cinerea)* are only intercepted once within the whole duration of assessment with a relative frequency of .067%.

Distribution of faunal species observed on site specially birds are widely distributed or can be found in wide range of habitats/ecosystems which is not limited in the project site. Moreso, most these species are resilient and can thrive even in a highly disturb areas. Mobility of these species is also an advantage which make them thrive even in highly urbanized areas. Though, availability of food sources is also among of the factors which dictates the actuality of faunal species in certain areas.

Table 4.27. Observed Fauna Species and Frequency

NO.	Common name	Scientific name	Total (no. of individuals)	No. times intercepted	Relative Frequency (%)
1.	Black winged stilt	*Himantopus Himantopus*	1	1	0.67
2.	Blue eared king fisher	*Alcedo meninting*	2	2	1.33
3.	Brown shrike	*Lanius cristatus*	8	6	4.00
4.	Brush cuckoo	*Cacomantis variolosus*	1	2	1.33
5.	Cattle egret	*bubulcus ibis*	6	4	2.67
6.	Chestnut Munia	*Lonchura mallaca*	26	5	3.33
7.	Common Iora	*Aegithinia tiphia*	10	3	2.00
8.	Common Sandpiper	*Actitis hypoleucos*	5	2	1.33
9.	Eurasian Tree Sparrow	*Passer montanus*	113	13	8.67
10.	Glossy Swiftlet	*Collocalia affinis*	30	7	4.67
11.	Golden Bellied fly eater	*Gerygone sulphurea*	2	2	1.33
12.	Great Billed Heron	*Ardea sumatrana*	4	2	1.33
13	Great Egret	*Egetta alba*	9	2	1.33
14.	Greater Coucal	*Centripus sinensis*	1	1	0.67
15.	Grey Wagtail	*Notacilla cinerea*	1	1	0.67
16.	House Swiftlet	*Apus affinis*	10	4	2.67
17.	Intermediate Egret	*egrette intermedia*	38	5	3.33
18.	Large Billed crow	*Corvus macrorhynchos*	1	1	0.67
19.	Lemon throated warbler	*Phylloscopus cebuensis*	13	3	2.00

NO.	Common name	Scientific name	Total (no. of individuals)	No. times intercepted	Relative Frequency (%)
20.	Little egret	*Egretta garzetta*	91	5	3.33
21.	Long tailed shrike	*Lanius schach*	3	3	2.00
22.	Mangrove whistler	*pachycephala grisola*	11	3	2.00
23.	Orange bellied flower pecker	*Dicaeum trigonostigma*	11	4	2.67
24.	Pacific Swallow	*Hirundo tahita*	3	3	2.00
25.	Philippine Coucal	*Centripus viridis*	2	2	1.33
26.	Pied Bush chat	*Saxicola caprata*	2	2	1.33
27.	Pied fan tail	*Rhipidura javanica*	11	8	5.33
28.	Plain throated sunbird	*Antreptes melasensis*	18	4	2.67
29.	Pygmy flower pecker	*Dicaeum pygmaeum*	22	5	3.33
30.	Scaly breasted Munia	*Lonchura puntulata*	3	2	1.33
31.	Tawny grass bird	*Megalurus timoriensis*	11	8	5.33
32.	Whiskered Tern	*Chlidonias hybrida*	92	5	3.33
33.	White collared king fisher	*Halchyon chloris*	20	8	5.33
34.	White eared brown dove	*Phapitreron leucotis*	8	5	3.33
35.	Yellow vented bulbul	*Pycnonotus goiavier*	54	10	6.67
36.	Zebra Dove	*Geopelia striata*	10	5	3.33
37.	Zitting Cisticola	*Cisticola juncidis*	2	2	1.33
		TOTAL	**655**	**150**	**100**

4.2.3.2.3.Result of Assessment per drainage channel

4.2.3.2.3.1. San Juan Diversion Channel

The proposed San Juan diversion channel has the highest biodiversity richness which about 461 individuals comprised of 29 species of avi-fauna was recorded from the 4 sampling sites (shown in **Table 4.28**). The area has aggregates of mangrove which serves as habitat to several fauna species. In terms of species dominance, the little Egret (*Egretta garzetta)*is the most dominant having a total count of 88 individuals followed by the Whiskered Tern (*Chlidonias hybrid)* and Eurasian tree sparrow (*Passer montanus)* with a population of 87 and 60 individuals, respectively.With reference to the International Union for Conservation of Nature (IUCN), no endangered species nor threatened species is recorded instead all of the species are under least concern category. Most of these species are common except for the Great billed Heron, Great egret, Black winged Stilt and the Blue Eared King Fisher which are uncommon species.

Computed biodiversity richness of the area using the Shannon-Wiener Index (H') has a result of 2.67 species richness. Contrary, computed species evenness using the Pielou's Index (J') has an evenness value of .79. With reference to the Fernando's Biodiversity Scale, 1998 signified that biodiversity richness of the area is moderate with a very high species evenness.

Table 4.28. List of observed species within the proposed San Juan Diversion Channel

No.	Species	No. of individuals					Conservation status (IUCN)
		sampling point no.1	sampling point no.2	sampling point no.3	sampling point no.4	Total	
1.	Great Billed Heron	3	1			4	Least Concern
2.	Great Egret	2	7			9	Least Concern
3.	Intermediate Egret	4	15			19	Least Concern
4.	Little Egret	21	55	12		88	Least Concern
5.	Common Sand Piper		4	1		5	Least Concern
6.	Whiskered Tern	60	25	2		87	Least Concern
7.	White Eared Brown Dove	2	1	1		4	Least Concern
8.	Zebra Dove		3		1	4	Least Concern
9.	Brush Cuckoo			1		1	Least Concern
10.	Greater Coucal				1	1	Least Concern
11.	Glossy Swiftlet	7	4	5		16	Least Concern
12.	House Swiftlet			4	2	6	Least Concern
13.	Blue Eared King Fisher		2			2	Least Concern
14.	White Collared King Fisher	4	6	3	1	14	Least Concern

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No.	Species	No. of individuals					Conservation status (IUCN)
		sampling point no.1	sampling point no.2	sampling point no.3	sampling point no.4	Total	
15.	Common Iora	2	5			7	Least Concern
16.	Yellow Vented Bulbul	12	3	8	14	37	Least Concern
17.	Golden Bellied Fly Eater		2			2	Least Concern
18.	Lemon Throated Warbler		6	5		11	Least Concern
19.	Tawny Grass Bird	1		1		2	Least Concern
20.	Pied Fan Tail	2	2	1	1	6	Least Concern
21.	Mangrove Whistler	3	5	3		11	Least Concern
22.	Brown Shrike	1	1	3	1	6	Least Concern
23.	Plain Throated Sunbird		8	5	2	15	Least Concern
24.	Orange Bellied Flower Pecker		2	1	6	9	Least Concern
25.	Pygmy Flower Pecker		5	8		13	Least Concern
26.	Eurasian Tree Sparrow		16	35	9	60	Least Concern
27.	Scaly Breasted Munia	2	1			3	Least Concern
28.	Chesnut Munia	5	10	3		18	Least Concern
29.	Black Winged Stilt	1				1	Least Concern
	TOTAL	**132**	**189**	**102**	**38**	**461**	

Source: EIS Team

4.2.3.2.3.2.Ylang-Ylang River Improvement

Sampling sites at the Ylang-Ylang River was undertaken in 4 designated areas with remaining vegetation as abode to some remaining wildlife species. **Table 4.29** shows that a total of 17 bird species was observed in the established sampling sites comprised of 67 individuals. From the 17 species the Eurasian Tree Sparrow followed by Yellow Vented Bulbul are the most dominant species found within, comprised of 17 and 9 individuals with a percentile equivalent of 25.4% and 13.4%, respectively. Conservation status of the observed species is all under Least Concern category based on the *IUCN red list.org*.

Computed biodiversity richness of the area using the Shannon-Wiener Index (H') has a result of 2.44 species richness. Contrary, computed species evenness using the Pielou's Index (J') has an evenness value of 0.86. With reference to the Fernando's Biodiversity Scale, 1998 signified that results obtained shows that biodiversity richness of the area is moderate with very high species evenness.

Table 4.29. Summary List of Observed Bird Species within the Ylang-Ylang River

No.	Species	No. of individuals					Conservation status (IUCN)
		sampling point no.5	sampling point no.6	sampling point no.7	sampling point no.8	Total	
1.	Intermediate Egret	1				1	Least Concern
2.	Little Egret				1	1	Least Concern
3.	White Eared Brown Dove		3		1	4	Least Concern
4.	Zebra Dove			2		2	Least Concern
5.	Philippine Coucal	1				1	Least Concern
6.	Glossy Swiftlet	3		3		6	Least Concern
7.	White Collared King Fisher	1			2	3	Least Concern
8.	Yellow Vented Bulbul	4		5		9	Least Concern
9.	Tawny Grass Bird	1		1		2	Least Concern
10.	Zitting Cisticola		1		1	2	Least Concern
11.	Pied Fan Tail	2			1	3	Least Concern
12.	Pygmy Flower Pecker		2		5	7	Least Concern
13.	Eurasian Tree Sparrow	8		3	6	17	Least Concern
14.	Chestnut Munia		5			5	Least Concern
15.	Pacific Swallow	1			1	2	Least Concern
16.	Large Billed Crow			1		1	Least Concern
17.	Long Tailed Shrike	1				1	Least Concern
	TOTAL	**23**	**11**	**15**	**18**	**67**	

Source: EIS Team

Reported species

Based on the result of interview to some locals, and secondary data gathered from previous studies/researches, revealed that some reptile species, mammals and amphibians still present in the upstream portion of the Ylang-Ylang River (within and adjacent the project segment) which are not encountered during the entire duration of assessment.Among of these species are Philippine Cobra/Ulupong (*Naja philipinensis*), Monitor Lizard/Bayawak (*Varanus salvator*), Reticulated phyton (*Python reticulatus*), Polynesian Coconut Rat (*Rattus exulan*), Large Field rat (*Rattus mindanensis*), Common Rat snake (*Elaphe erythrura*), Dahong Palay Snake (*Ahaetulla prasina*), Common Snake (*Lycodon aulicus*), Common Tree frog (*Polypedates leucomystax*), Marine Toad (*Bufo marinus*), Barred Rail (*Garillus torquatus*), Pugo (*Turnix suscitator*), Greater Musky Fruit Bat (*Ptenochirus jagori*) and Short nose fruit bats (*Cynopterus brachyotis*). Accordingly, these species are sometimes encountered by them especially along the river with remaining vegetation cover.

Conservation status of enumerated species falls within Least Concern species under the IUCN red list except for the Philippine Cobra which is under the category of Nearly Threatened species. Even though, the Monitor Lizard is classified as Least Concern in the IUCN (IUCN 2015.2), it is considered Vulnerable under CITES (CITES app.2). The Reticulated Phyton as well is not yet evaluated by the IUCN, it is classified as other threatened species under CITES (CITES app.2).

Presence, of bats in the area can be associated to the availability of some fruit bearing trees in the area such as the Langka, Duhat, Antipolo and other fruit bearing crops. During interview it was raised that Polynesian Ratand Large field Rat are prevalent in the area. These species of rat is among of the problem of some famers that feeds on young coconut fruits, root crops, vegetables and other crops.

4.2.3.2.3.3. Rio Grande River Improvement

Sampling sites in the Rio Grande River was established in 4 selected sites along the channel. Result of the survey is shown in **Table 4.30** having a total of 17 bird species comprised of 33 individuals.From the 17 species the Eurasian Tree Sparrow followed by Tawny Grass Bird are the most observed species with a total of 7 and 6 individuals with a percentile equivalent of 21.2 and 18.18%, respectively. Conservation status of the observed species is all under Least Concern category based on the *IUCN red list.org*.

Computed biodiversity richness of the area using the Shannon-Wiener Index (H') has a result of 2.4 species richness. Contrary, computed species evenness using the Pielou's Index (J') has an evenness value of .89. With reference to the Fernando's Biodiversity Scale, 1998 signified that biodiversity richness of the area is low with a very high species evenness.

Table 4.30. Summary List of Fauna Species Observed within the Rio Grande River

No.	Species	No. of individuals					Conservation status (IUCN)
		Sampling point no.9	sampling point no.10	sampling point no.11	sampling point no.12	Total	
1.	Zebra Dove				1	1	Least Concern
2.	Philippine Coucal			1		1	Least Concern
3.	House Swiftlet		2			2	Least Concern
4.	Yellow Vented Bulbul		1			1	Least Concern
5.	Tawny Grass Bird	3	2		1	6	Least Concern
6.	Pied Fan Tail			1		1	Least Concern

No.	Species	No. of individuals					Conservation status (IUCN)
		Sampling point no.9	sampling point no.10	sampling point no.11	sampling point no.12	Total	
7.	Brown Shrike		1			1	Least Concern
8.	Orange Bellied Flower Pecker				2	2	Least Concern
9.	Pygmy Flower Pecker			2		2	Least Concern
10.	Eurasian Tree Sparrow	2			5	7	Least Concern
11.	Chestnut Munia			3		3	Least Concern
12.	Long Tailed Shrike				1	1	Least Concern
13.	Cattle Egret			2	1	3	Least Concern
14.	Pied Bushchat		1			1	Least Concern
15.	Grey Wagtail	1				1	Least Concern
	TOTAL	**6**	**7**	**9**	**11**	**33**	

Source: EIS Team

4.2.3.2.3.4. Diversion Drainage II

Sampling sites in the proposed drain channel from Brgy. Tejero Gen. Trias to Brgy. Sta Rosa in Noveleta was undertaken in 3 selected sites along the national hi-way. The area is a highly disturbed area which presence of wildlife ispresumes to be limiting. Result of the assessment only registered a total of 6 bird species observed within the 3 sampling sites with a total of 29 individuals (refer to **Table 4.31**). All of the species observed is known to be common and dominated by the Eurasian Tree Sparrow representing 75.8% of the total population. Conservation status of the observed species is all under Least Concern category based on the *IUCN red list.org*.

Computed biodiversity richness of the area using the Shannon-Wiener Index (H') has a result of 1.025 species richness. In contrary, computed species evenness using the Pielou's Index (J') has an evenness value of .527. With reference to the Fernando's Biodiversity Scale, 1998 signified that results obtained shows that biodiversity richness of the area is very low with high species evenness.

Table 4.31. Summary list of species observed in the proposed Diversion Drainage II

Species	No. of individuals				Conservation status (IUCN)
	sampling site no.13	sampling site no.14	sampling site no.15	Total	
Tawny Grass Bird	1			1	Least Concern
Brown Shrike		1		1	Least Concern
Eurasian Tree	7	4	11	22	Least Concern

Species	No. of individuals				Conservation status (IUCN)
	sampling site no.13	sampling site no.14	sampling site no.15	Total	
Sparrow					
Long Tailed Shrike			1	1	Least Concern
Cattle Egret	2	1		3	Least Concern
Pied Bushchat			1	1	Least Concern
TOTAL	**10**	**6**	**13**	**29**	

Source: EIS Team

4.2.3.2.3.5.Maalimango Creek Improvement

Sampling sites in the proposed Malimango Creek was undertaken in 3 different sites covering portions of a mangrove area and in areas along the creek with remaining patches of vegetation as possible abode of remaining wildlife species. The area is a highly disturbed area surrounded by settlements and infrastructures which presence of wildlife is presume to be limiting. Though, result of the survey shown in **Table 4.32** that a total of 14 bird species was observed within the 3 sampling sites with a population of 65 individuals. Dominant species is the Intermediate Egret with a 27.7% over the total population. All of the observed species are known to be common and under least concern category with regard to their conservation status adopted from the IUCN redlist.org.

Computed biodiversity richness of the area using the Shannon-Wiener Index (H') has a result of 2.31species richness. In contrary, computed species evenness using the Pielou's Index (J') has an evenness value of .87. With reference to the Fernando's Biodiversity Scale, 1998 signified that biodiversity richness of the area is moderate with high species evenness.

Table 4.32. Summary list of species observed within the Malimango Creek

No.	Species	No. of individuals				Conservation status (IUCN)
		sampling point no.16	sampling point no.17	sampling point no.18	Total	
1.	Intermediate Egret	15	3		18	Least Concern
2.	Little Egret			2	2	Least Concern
3.	Whiskered Tern	4		1	5	Least Concern
4.	Zebra Dove		3		3	Least Concern
5.	Glossy Swiftlet	5		3	8	Least Concern
6.	House Swiftlet			2	2	Least Concern
7.	White Collared King Fisher	1	2		3	Least Concern

8.	Common Iora		3		3	Least Concern
9.	Yellow Vented Bulbul		4	3	7	Least Concern
10.	Lemon Throated Warbler	2			2	Least Concern
11.	Pied Fan Tail		1		1	Least Concern
12.	Plain Throated Sunbird			3	3	Least Concern
13.	Eurasian Tree Sparrow		2	5	7	Least Concern
14.	Pacific Swallow		1		1	Least Concern
	TOTAL	**27**	**19**	**19**	**65**	

Source: EIS Team

4.2.3.2.4.Significance of Terrestrial Fauna and Flora

Flora species are very important in lives of people in many aspects. People depend upon plants to satisfy such basic human needs as food, clothing, shelter, and health care.Along the project site, patches of remaining vegetations on siteserves as habitat of remaining faunal species such as birds, reptiles and rodents. Presence of some fruit bearing trees and crops within and along the project segments also serve as source of food for other wildlife species. Other plants in the area are also a good source of medicine, food, etc. On the other side, presence of vegetations along river banks also helps in the protection of soil against scourage resulting to the occumulation of sediments into the drain channels.

On the other hand, faunal species are good bio-indicator of the existing environment of certain ecosystem or area. They play a significant role in many aspects that includes enhancement of the ecological balance and food chain cycle and other natural environmental processes. Most of fauna species are alsoknown as natural agents in seed dispersal and pollination which aid in the transport of varieties of seeds in the environment. They also act as natural predators to some pest in our agricultural crops. Moreso,some species provide economic importance in various aspects, as source of food and medicines. Commercially, some wildlife species are being utilized as trade pets. They are also considered among of the aesthetic value of the ecosystem which they are economically important for tourism industry. Fauna species are also important in the field of science and research.

4.2.3.2.5. Threats to Remaining Flora and Fauna

4.2.3.2.5.1. Present threats without the project

Current threats to the existence of remaining flora and fauna within the project area includes continuous land use conversion into built up areas, encroachment, perennial flooding resulting to loss of some vegetations along the river banks and other manmade undertakings.

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Most of the faunal species are mobile in nature though, continuous loss of habitat due to shift of land use resulting to clearing of remaining vegetation cover will force them to migrate in other areas and new ecosystems. Significant decrease of habitat and disturbance will threaten the remaining species population and survival.

4.2.3.2.5.2. Anticipated influences with the project

Anticipated influences with the implementation of the project to the existing flora and fauna population within the project area is classified during construction and after construction phase.

During construction, anticipated influences of the project includes removal of patches of vegetation cover of channel banks. Though most of the species are grasses, shrubs, some agricultural crops and trees. Result of survey with regard to floristic composition of the project area showed that only the Kamagong tree species is under is considered as threatened species while the rest are least concern species. Clearing of vegetation cover will be undertaken to facilitate construction works within the channel banks.

On the other hand, during this phase will also incur disturbance to faunal species due to removal of remaining habitat and or source of food (e.i fruit trees). Some faunal species can be further exposed to hunting, persecution and trading. Wildlife offer a variety of commercial values and open several livelihood sources, its utilization are not being regulated as to case of illegal poaching and hunting and over collection. Likewise, temporary migration of other fauna species to new territory/ies is expected. Though, overall impact to fauna is minor and temporary due mobility of these species specially birds. Likewise, with reference to the identified species thriving on site are those species can thrive in wide range of habitats including urban areas that are highly exposed to disturbance.

Conversely, after construction phase improvement of the channels is completed other bird species will possibly return or new species will arrive on site. Improvements of the drainage channel provide oppurtunity to some species specicially those species reliant to river ecosystem as their feeding ground.

Vegetation along the drainage channel after construction can be enhance to give a better view of the channel. Landscaping activities is an oppurtnity to plant suited species for better scenery and protection of the channel. Likewise, planting of fruit bearing and flowering species can also encourage some faunal speciescomeback with the availability of food sources.

4.2.3.2.6.CONCLUSION AND RECOMMENDATIONS

Overall result of terrestrial assessment in the proposed project site is still considered a diverse community for having a 132 plant species identified belonged to 37 families identified within the 32 sampling plots. From the total plant species identified only 49 (37.12%) are tree species and the rest are aggregates of palms, shrubs, grasses and vine species.In terms of flora richness of assessed area the Rio Grande River channel is the most diverse with reference to the computed Shannon-Wiener Index.In terms of species richness, the proposed San Juan diversion channel revealed to have the highest biodiversity level.

Relative to faunal species, the proposed project site still host varieties of faunal (50) species. Most of these species are dominated by birds comprised of 76%. On the other hand, computed species richness and evenness using the Shannon-Wiener Index (H') and Pielou's Index (J') confirmed with the Fernando's Biodiversity Scale (1998) signified that biodiversity richness of the area is moderate with a very high species evenness.

With regards to conservation status, only the Kamagong *(Diospyros blancoi)* is known to be under Critically Endangered Species while the rest are under least concern and Other Threatened species in category. Within the sampled area the *Pennisetum purpureum and Avicennia marina* (Forsk.) Vierh.*var. rumphiana*(Hallier) Bakh. has the highest density and relative density, respectively. While, species with the highest relative frequency (RF) is *Caesalpinia pulcherrima*(L.) Swartz. The *Melanolepis multiglandulosa*(Reinw. Ex Blume) Reichb.f. &Zoll. On the other hand has the highest dominance (D) value of 2.231 and relative dominance (RD) value of 23.872%. Furthermore, the *Mangiferaindica*l.has the highest IV of 37.596% which is the most common species in the project site dominating the vegetation cover.

While *Naja philipinensis*is is categorized as nearly threatened species. The rest of the species are under least concern category. Further, most of these species of about 84% are known to be common in the Philippines. Though, the Marine Toad (*Bufomarinus*) and Polynesian Rat (*Rattusexullans*) are known to be an introduced species in the Philippines.

Presence of some tree species including mangroves that need to be cleared out with the implementation of the project needs to secure for a tree cutting permit from the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR) office pursuant to PD 705. Likewise, to consider in the project budgetary cost the replacement cost of trees to be cut as prescribed in the DPWH-DENR-DSWD Joint Memorandum Circular no.1 series of 2014 entitled "*Guidelines for the Implementation of the DPWH-DENR-DSWD Partnership on the Tree Replacement Project*".

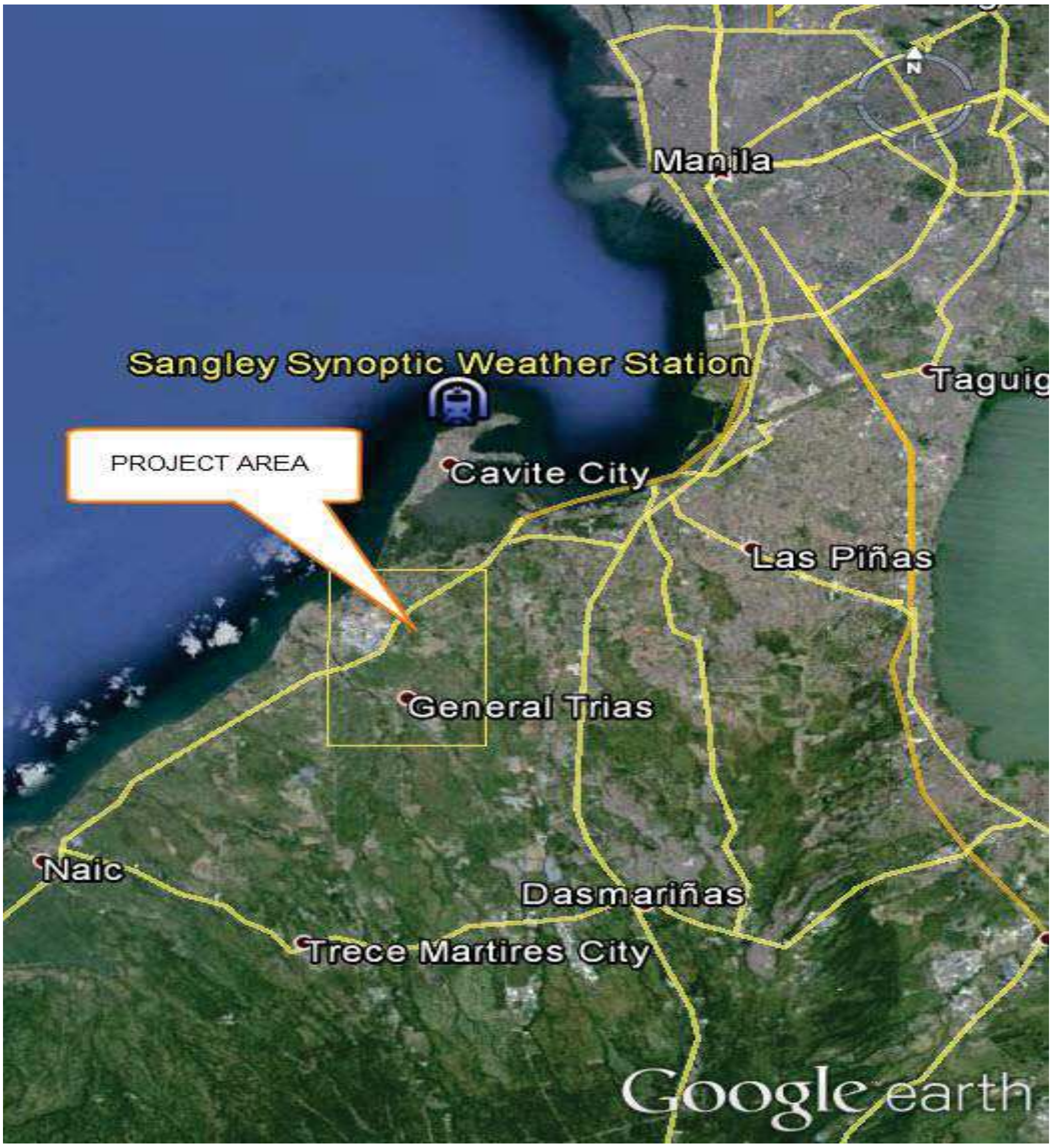
4.3 Baseline in Water

4.3.1 Hydrology

Data Collection and Assessment

Rainfall Data

There is a synoptic station within the vicinity of the project area, the Sangley Synoptic Weather Station and it is only about 10 km from the Project Site. **Figure 4.33** shows the location of the synoptic station near the project area. Meteorological characteristics of the aforementioned project area will be taken from this synoptic station.



Source: Google Earth

Figure 4.33: Synoptic Stations in the vicinity of the Project Area

Spatial Data

Topographic maps from NAMRIA and Google map from software were used to gather spatial data for this study. Basin parameters were derived from these maps.

4.3.1.1 Watershed Characterization

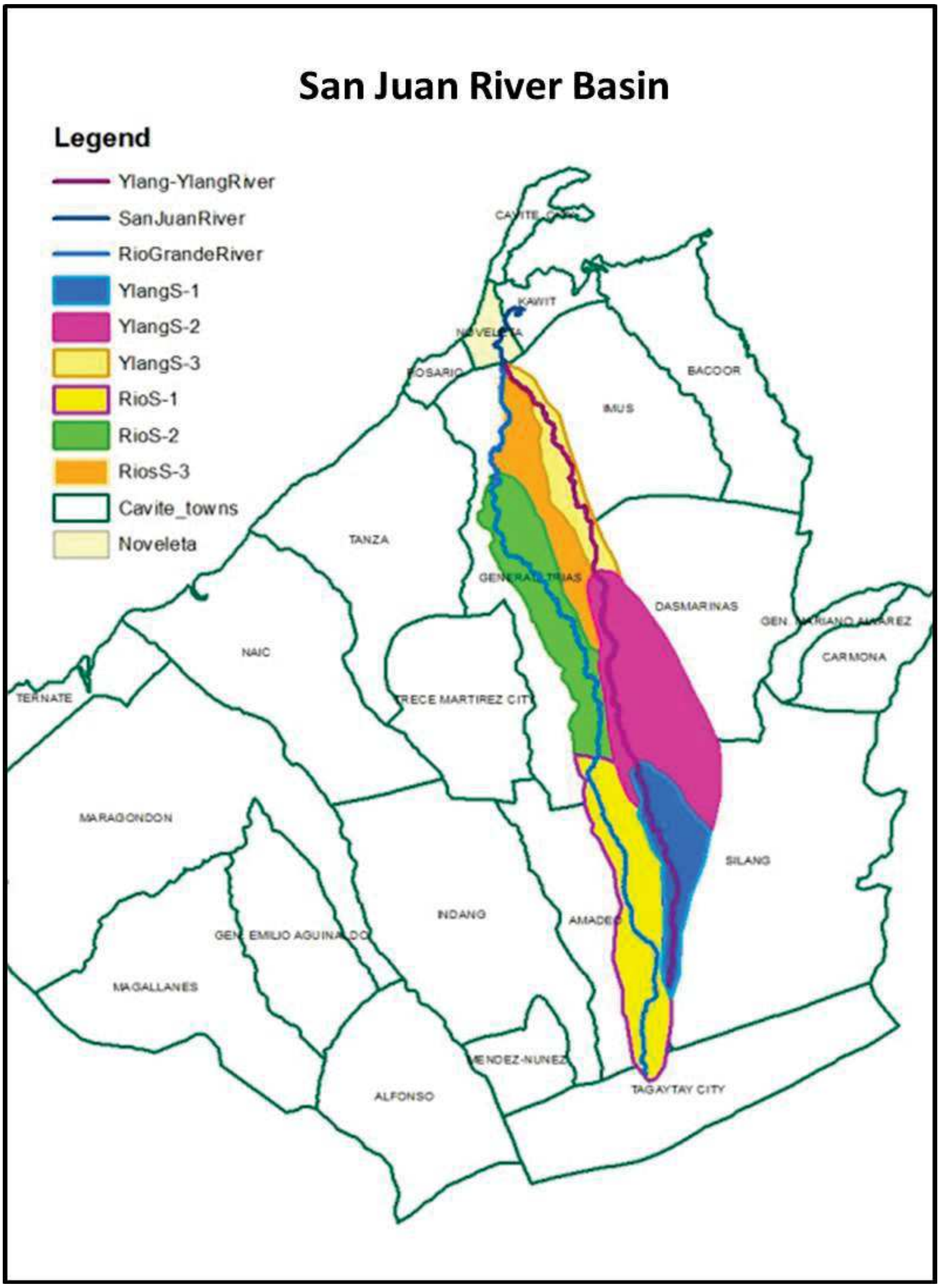
Description of Project Site Location

The proposed Cavite Industrial Area Flood Management Project is located 25 kilometers southeast of Manila. The area involves five municipalities namely; Noveleta, Kawit, Rosario, Imus and General Trias. Twenty three (23) barangays within these municipalities are affected by the proposed project.

4.3.1.1.1 Catchment Characteristics

Basin Description

The main river system that affects the project area is the San Juan River. Its waters are sourced from the Rio Grande River on the west which started in Maitim, Amadeo. It traverses northward passing Maitim, Lalaan I, Biclatan, Manggahan, Jaime Baker; Buenavista, Pasong Kawayan, Bacao, Gen. Trias; Sta. Rosa, Noveleta and Putol, Kawit. The other source of San Juan River is the Ylang-Ylang River on the east which also traverses in the same direction from Pasong Camachile River which started from Santiago and passing San Gabriel then connect with San Juan River; San Jose, Dasmariñas converging with San Juan River at Bacao, Gen. Trias. The San Juan River Basin has an area of about 134.28 square kilometers from the mouth at Noveleta to the farthest point at Maitim, Amadeo with a river length of 39 kilometers and discharges to Bacoor Bay in Kawit. **Figure 4.34** shows the San Juan River basin.

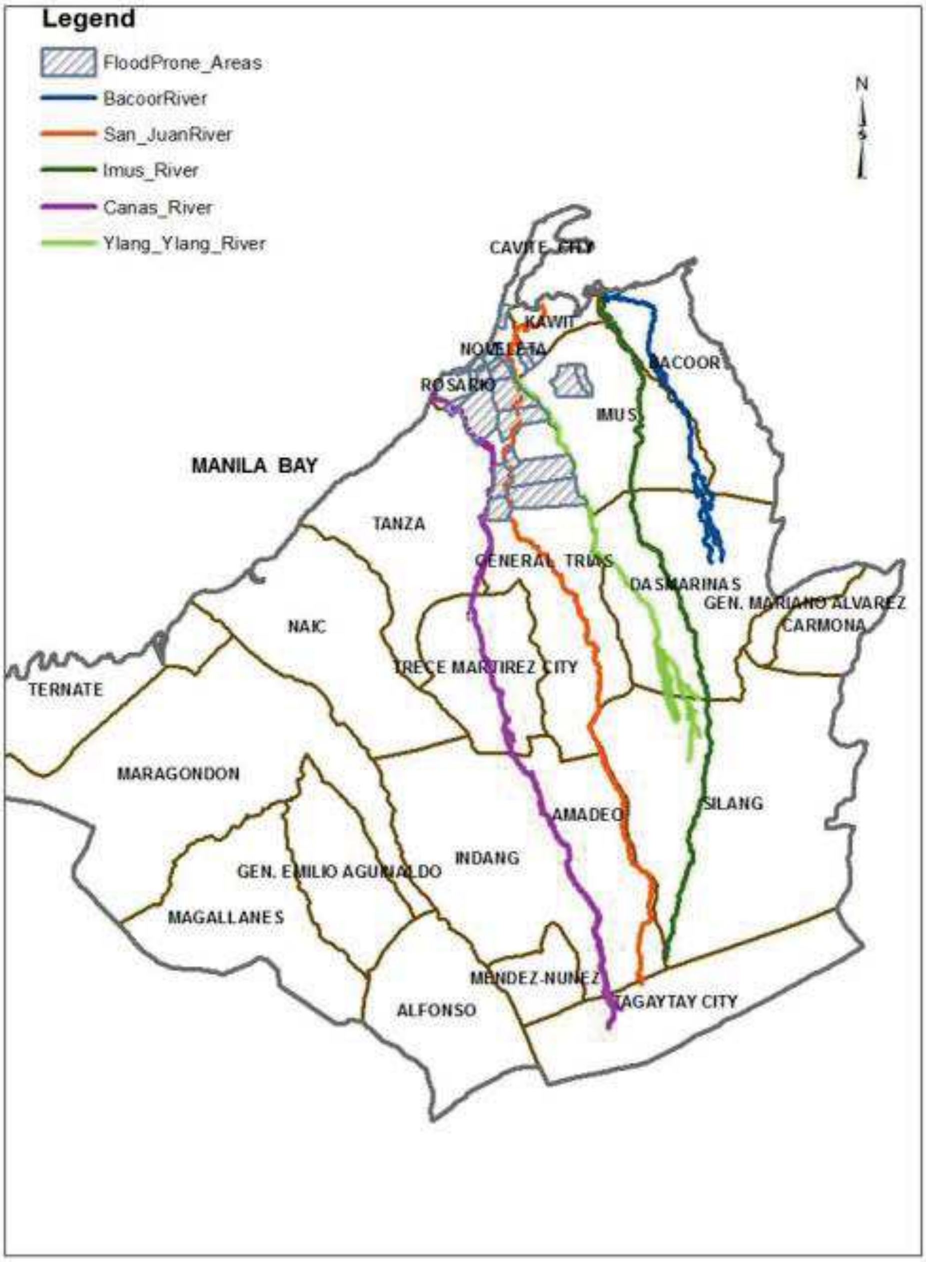


Source: PAGASA Meteorological Division

Figure 4.34: San Juan River Basin showing Sub-basins of Rio Grande and Ylang-Ylang Rivers

4.3.1.2 River System

Figure 4.35 shows other river systems that could also affect the project area which are the 6 Cañas River on the west and Imus River on the east. Cañas and Imus Rivers are 38.9 and 38.4 kilometers long respectively.



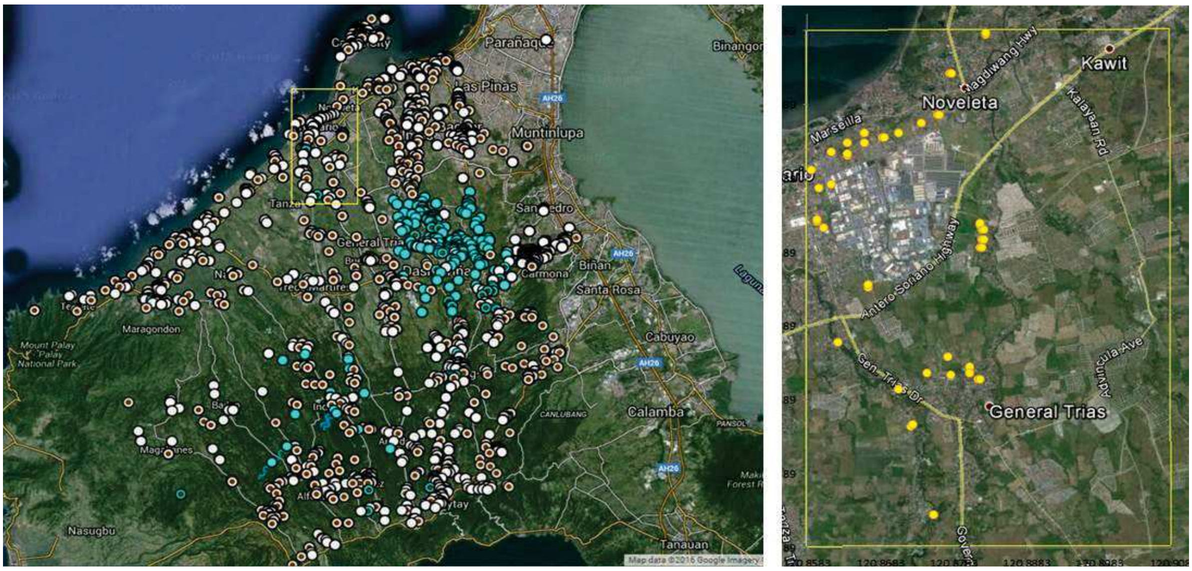
Source: PAGASA Meteorological Division

Figure 4.35: River Systems that could also affect the Project Area

4.3.1.3 Groundwater Resources

4.3.1.3.1 Location of Groundwater Wells

In 1982, the National Water Resources Council (NWRC) prepared a rapid assessment of water supply sources for the province of Cavite. The province was divided into three groundwater categories; a) shallow well areas, b) deep well areas, and c) difficult areas. Shallow wells generally consist or recent formations with slopes ranging from 0 to 3 percent. Most of these are located at elevation within 50 meters above mean sea level, like alluvial and coastal plains and river valleys. Deep well areas are generally sedimentary formations, 90 percent of which are water carriers. These are located in slopes reaching up to 10 percent, usually at elevations of more than 50 meters above mean sea level. Difficult areas have varying slopes, elevations and water depths. The water supply sources are mainly replenished by way of sheared rocks, i.e., thru fissures, cracks, and crevices. (Source: NWRC, Rapid Assessment of Water Supply Sources, May 1982). **Figure 4.36** shows the locations of well in the Province of Cavite; circles with dots in center indicate wells with strata logs, blue circles indicate wells installed by Water Districts and blue circles with tails indicate wells with spring source; right figure shows yellow dots indicating deep well locations within the project area.



Source: Google Earth

Figure 4.36: Location of Wells in the Province of Cavite; Wells in the Project Area

4.3.1.3.2 Groundwater Assessment

In 1982, there are 409 wells in the whole province of Cavite with depths ranging from 13 meters to 243 meters. In 2015, a total number of 2,673 wells are located in the province as per record from the Local Water Utilities Administration (LWUA). The average depth of wells in 1982 was 72.4 meters compared to the present average which is 155.6 meters. There are 63 wells located within the project area with an average depth of 155.6 meters. Depth of the wells ranges from 18.3 meters to 304.8 meters.

4.3.1.3.3 Groundwater Properties

At the project area, the average depth of wells is 112.16 m from a range of 18.30 m. to 304.80 m. The average surface water level is 5.20 m. from a range of 3.05 m. to 12.07 m. The average specific capacity is 1.23 L/s/m and the average specific discharge is 5.88 L/s.

4.3.1.3.4 Use of Groundwater

The number of families that uses groundwater in the project area can be estimated based on the number of water connections from the water district. There are 12 water districts for the whole of Cavite Province. The average monthly production of these water districts is 5,624,184 cubic meters with 219,122 service connections. These are categorized as 200,120 for residential, 377 for government and 18,624 for commercial. The nearest water district in the vicinity of the project area is Tanza Water District with an average monthly production of 273,934 cubic meters. The number of service water connections in the area as of April 2016 is 10,562. The average monthly consumption in this particular water district is 21.91 cubic meters or an average of 0.008 liters per second. **Table 4.33** shows the service connections and average monthly consumption in Cavite area.

As of March 31, 2016 there are 111,392 service accounts for the whole of Cavite area from Maynilad. Out of the 23 affected barangays within the project area, only 8 are serviced by Maynilad particularly the seven barangays in Noveleta and one in Kawit. (Source: Maynilad Website, Business Area in Cavite). Considering that only 35% of the affected barangays have service connections with Maynilad, it is estimated that groundwater is still the major source for domestic water supply at least within the project area.

Table 4.33: Service Connections and Average Monthly Consumption

	Water District	Province	Region	Bill Date	Monthly Production (m^3)	Service Connections				Average Consumption (m^3 / month)			
						Residential	Gov't	Comm'l	Total	Residential	Gov't	Comm'l	Total
1	Amadeo	Cavite	4	12/31/2014	122,216	6,000	0	93	6,093	15.62	0	15.62	15.62
2	Carmona	Cavite	4	12/31/2015	282,656	10,629	58	255	10,942	17.69	69.31	45.47	18.61
3	Dasmarinas	Cavite	4	12/31/2015	2,555,409	87,668	217	14,626	102,511	18.78	113.1	23.1	19.59
4	Gen. E. Aguinaldo	Cavite	4	12/31/2014	63,796	2,456	0	187	2,643	15.22	0	15.22	15.22
5	Gen. Mariano Alvarez	Cavite	4	12/31/2014	337,930	13,538	40	460	14,038	18	18	18	18
6	Indang	Cavite	4	12/31/2010	118,915	4,973	0	0	4,973	20.9	0	0	20.9
7	Maragondon	Cavite	4	2/29/2016	86,680	3,050	22	296	3,368	20	122.81	22.32	20.88
8	Mendez	Cavite	4	12/31/2014	130,827	4,005	0	146	4,151	17.69	0	17.69	17.69
9	Silang	Cavite	4	12/31/2014	828,194	31,130	0	1,304	32,434	19.25	0	19.25	19.25
10	Tagaytay City	Cavite	4	12/31/2014	498,861	12,508	0	911	13,420	32	0	32	32
11	Tanza	Cavite	4	12/31/2015	273,934	10,562	40	346	10,948	21.39	86.35	30.18	21.91
12	Trece Martires City	Cavite	4	12/31/2010	324,766	13,601	0	0	13,601	17.65	0	0	17.65

Source: LWUA Research Division

Table 4.34 shows the river system that affects mainly the project area is the San Juan River. The San Juan River is the result of the merging of two rivers, the Rio Grande on the west and the Ylang-Ylang River on the east. These two rivers met at the confluence in Barangay Bacao, General Trias. The joining of the flows from these rivers constitutes flooding in the area particularly in the Barangays of Bacao I and Bacao II and in most barangays in the municipality of Noveleta along the San Juan River.

Portions of the river banks at the Rio Grande and Ylang-Ylang were already developed although these may have been constructed without consideration on the amount of maximum flood waters. These structures may cause constrictions on the river flow and may cause localize flooding in the area. Local government intervention is necessary to correct the design of the river sections and or remove constrictions in some river banks.

Table 4.34 Selected Rivers in Cavite and drainage origin and location

Name of Rivers	Length, km	Point of Origin	Drainage Location
1. Bacoor River	12.3	Pinlong Gubat, Molino passing Tanzang Luma, Salinas and Panapaan	Bacoor Bay, Bacoor
2. Imus River	38.4	North of Tagaytay passing Balite, Sabulan, Biga, Palapala, City of Dasmarinas, Pasong Bayog, San Agustin connects to Pasong Bayog passing Salisan, Baluctot. Anabu II & Anabu I going to Tanzaong Luma, Palico, Imus down to Salinas and Mabolo, Bacoor toward drainage. Tributaries which started from Bucal going to San Agustin joins/connects Imus River in Pasong Bayog. Tributaries found in Baluctot also drain at Imus River.	Bacoor Bay, Bacoor
3a. San Juan River	39.0	Maitim, Amadeo passing Maitim, Lalaan I, Silang, Dagatan, Banaybanay, Calubcob, Panungyanan,Javalera, Biclatan, Manggahan, Jaime Baker; Buenavisa, Pasong Kawayan, Bacao, Gen. Trias; Sta. Rosa, Noveleta and Putol, Kawit. Tributaries are at Bucandala and Panamitan.	Bacoor Bay, Kawit
3b. Alang-Ilang River		Pasong Camachile River which started from Santiago passing San Gabriel connects with San Juan River; San Jose, City of Dasmarinas converging with San Juan River at Bacao, Gen. Trias	

The influx of deep wells not only in the project area but in the whole province of Cavite definitely constitutes a lowering of water table and the possibility of salt water intrusion. During this study however, there were no data available to support this theory. Data gathered were only those that were reported during the construction of the wells and most monitoring data were either stopped or discontinued.

There is a shortage of available data for the study of ground water levels in the project area. Available data from the research division of LWUA indicates that groundwater surface levels are between 2-5 meters below ground level. It was confirmed from the LWUA office that there are no continuous monitoring wells for the province of Cavite. In Tarlac for example some deep wells indicated lowering of ground water levels of up to 60 meters. It is therefore recommended that further research work shall be done to augment the present gathered data for confirmation of the ground water levels in the area.

4.3.2 Baseline on Water Quality

Grab sampling was used for groundwater, surface water and marine water quality measurement. Samples were collected during sunny weather on February 18-19, 2016. Stainless pale with rope was used to collect surface water samples. Samples were put in glass and plastic containers, properly sealed, labeled and preserved with ice at lower temperature inside coolers and transported to the laboratory.

The water samples were taken from the following sampling sites as presented in **Table 4.35 and Table 4.36**. **Figure 4.37 and Figure 4.38** show the sampling map of surface/coastal water and groundwater stations respectively.

Table 4.35 – Summary of Surface Water Sampling Sites, Coordinates, Weather condition, Date and Time of Samplings

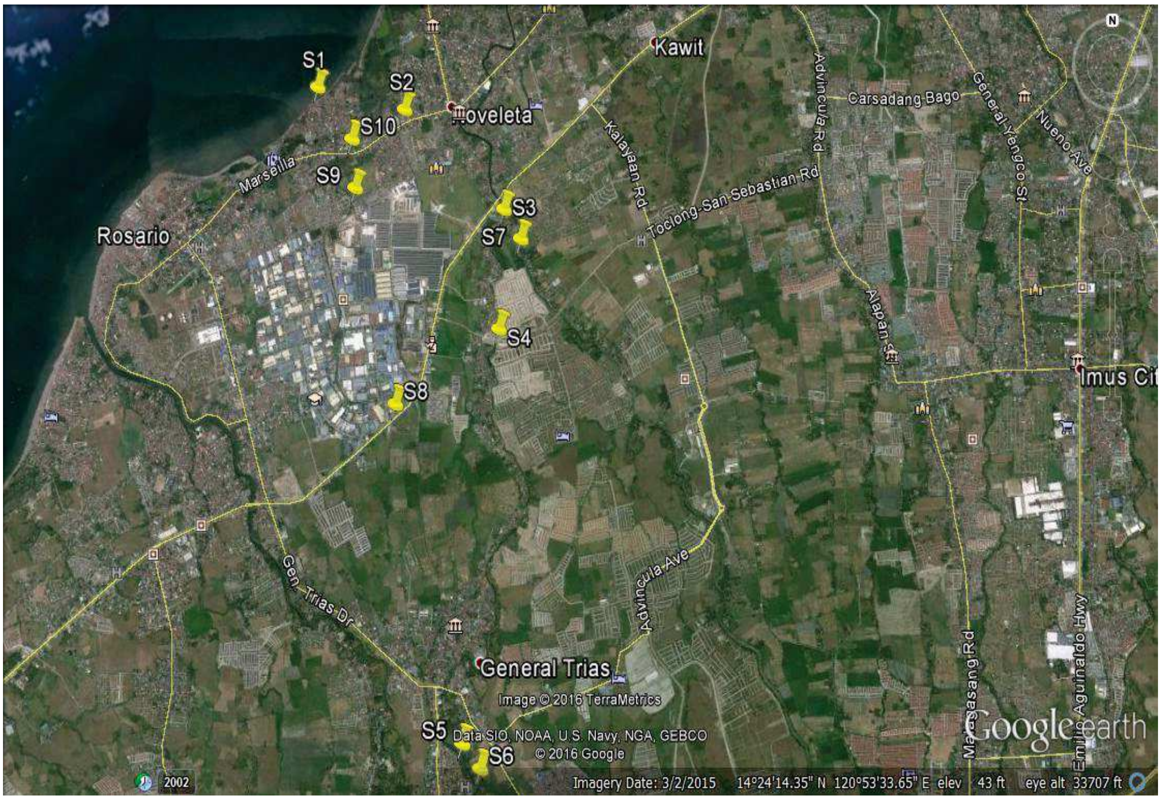
Station No.	Sampling Stations	Coordinates	Weather Condition	Date and Time of Samplings
S1	Brgy. Ligtong 1, Rosario, Cavite	14°25'42.1" N 120° 51' 59.9" E	cloudy	February 17, 2016 1005H
S2	Brgy. Salcedo II, Noveleta, Cavite (near Petron gasoline station)	14°25'35.3" N 120° 52' 30.6" E	cloudy	February 17, 2016 1045H
S3	Santa Rosa II, Noveleta, Cavite	14°25'05.5" N 120° 53' 05.7" E	sunny	February 17, 2016 1518H
S4	Purok 8, Bacao II, Gen. Trias, Cavite (Mario Delos Reyes compound/Saranglao)	14°24'30.4" N 120° 53' 04.2" E	cloudy	February 18, 2016 1246H
S5	Purok I, Brgy. Pinagtipunan, Gen. Trias, Cavite	14°22'33.7" N 120° 52' 52.8" E	sunny	February 18, 2016 1535H
S6	Purok II, Brgy. Pinagtipunan, Gen. Trias, Cavite	14°22'26.8" N 120° 52' 58.9" E	sunny	February 18, 2016 1606H
S7	Brgy. San Antonio II, Kawit, Cavite	14°24'56.8" N 120° 53' 11.6" E	cloudy	February 18, 2016 1204H
S8	Brgy. Tejero, Malabon, Gen. Trias, Cavite (Outside PEZA near Gate 4)	14°24'08.7" N 120° 52' 28.8" E	sunny	February 18, 2016 1320H
S9	Tramo Road, Bagbag I, Rosario, Cavite	14°25'11.9" N 120° 52' 13.7" E	sunny	February 17, 2016 1432H
S10	Marcella St. Brgy. Ligtong III, Rosario, Cavite	14°25'26.5" N 120° 52' 12.3" E	cloudy	February 17, 2016 1157H

Note: Sample at S1 is for seawater and others for river water.

Table 4.36 – Summary of Groundwater Sampling Sites, Coordinates, Weather condition, Date and Time of Samplings

Station No.	Sampling Stations	Coordinates	Weather Condition	Date and Time of Samplings
GW1	Love Memorial Park Salcedo II, Noveleta, Cavite	14°25'33.4" N 120° 52' 32.5" E	cloudy	February 17, 2016 1105H
GW2	Marcella St. Brgy. Ligtong III, Rosario, Cavite (Austria residence)	14°25'26.6" N 120° 52' 12.8" E	cloudy	February 17, 2016 1207H
GW3	409 Tramo Road Bagbag I, Rosario, Cavite (Boy Reyes Residence)	14°25'11.9" N 120° 52' 13.7" E	sunny	February 17, 2016 1445H
GW4	Poblacion, Noveleta, Cavite	14°25'26.1" N 120° 52' 43.4" E	sunny	February 17, 2016 1612H
GW5	Sta. Rosa II, Noveleta, Cavite	14°25'04.0" N 120° 53' 03.6" E	sunny	February 17, 2016 1540H

Attached hereto are the the pictures taken during the actual samplings.



Source: Google Earth

Figure 4.37 – Map of Surface/Coastal Water Stations

Source: Google Earth

Figure 4.38 – Map of Groundwater Stations

Groundwater sampling station 1 (GW1) was collected inside Love Cemetery in Salcedo II, Noveleta. The handpump was located near comfort rooms. GW2 was sampled at Albert Austria Residence in Rosario, Cavite. The source of water comes from handpump run by jetmatic which was installed a year ago. For GW3, collected sample came from handpump. Water is used for cleaning and washing. Potable water supply comes from Maynilad. GW4 was collected at Alcala's residence in Poblacion, Noveleta. The handpump was installed in 2015. Usually during dry season, occasional no flow of water was observed as per residents.

4.3.2.1 Methodology

The samples were submitted to CRL Environmental Corporation, a recognized DENR and DOH accredited laboratory. The approved test methods use by CRL are in accordance to DENR Administrative Order No. 93, Series of 1998 and DOH-Philippine National Standards for Drinking Water (PNSDW), Administrative Order No 07, Series of 2012. Field and Laboratory testing methods used are presented in **Table 4.37**.

These methods are based on Standard Methods for Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Waterworks Association (APHA/AWWA).

Table 4.37 – Parameters and Analytical Methodology

Parameter	Analytical Method
pH	Glass Electrode; pH Meter
Temperature	pH/Temperature meter
Turbidity	Nephelometric Method
Conductivity	Specific Conductance
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique) Titrimetry
Total Suspended Solids	Gravimetric Method
Dissolved Oxygen (DO)	Azide Modification (Winkler Method)
Salinity as Chloride	Argentometry Method

4.3.2.2 Results and Discussions

Table 4.38 shows the test results of the surface water samples and the corresponding DENR Administrative Order No. 34, Class C limits.

Table 4.38 - Summary of Test Results for the Surface Water Samples

Parameters, units	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	DAO No. 34, Class C Limits
pH	8.1	7.6	7.9	8.0	7.8	8.0	8.1	7.7	8.2	8.2	6.5 – 8.5
Temperature, °C	25.7	27.5	28.6	26.7	28.2	28.7	27.5	26.8	29.1	28.8	Not more than 3 deg. rise
Turbidity, NTU	34	31	6.0	1.7	24	3.5	10	12	13	8.4	---
BOD, mg/L	12	59	4	7	5	4	3	3	14	14	7 (10)
TSS, mg/L	276	40	11	20	38	12	21	22	29	17	Not more than 30 mg/L inc
DO, mg/L	6.6	<2.0	5.9	5.7	7.3	9.4	8.1	6.9	6.3	4.5	5.0 mg/L minimum
Salinity, mg/L	31,800	7,340	5,710	490	53	71	979	86	1,550	979	350 (as Cl)

The test results of the surface water samples were assessed based on DENR Administrative Order No. 34, Class C standards. According to DENR, Ylang-Ylang River, Rio Grande River and San Juan River are classified as Class C at present. Ylang-Ylang River and Rio Grande River are designated by DENR as a Water Quality Management Area (WQMA), DENR Administrative Order No 02, Series of 2013. **Figure 4.39, Figure 4.40** and **Figue 4.41** show the results of BOD, DO and TSS against standards respectively.

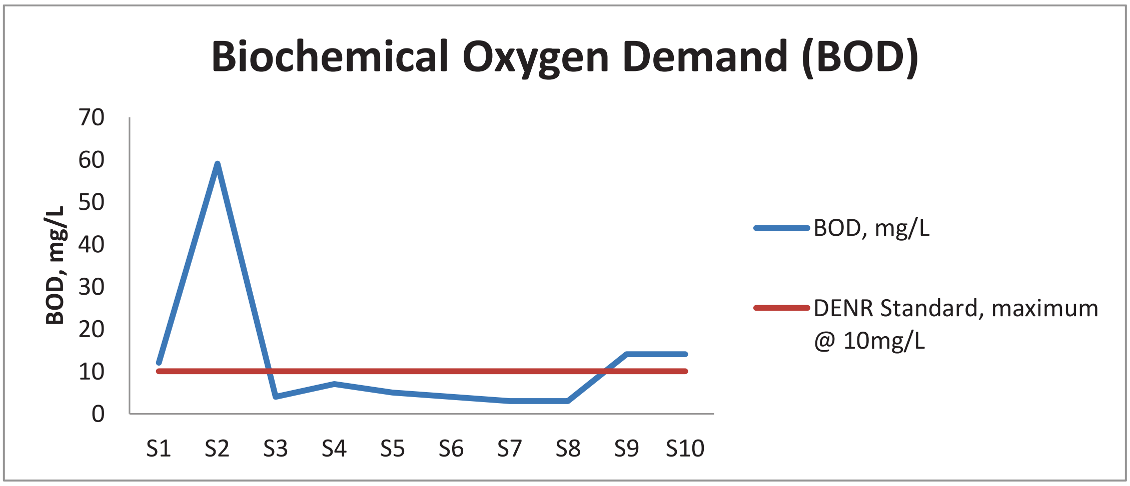


Figure 4.39 – Results of BOD compared to DENR standard

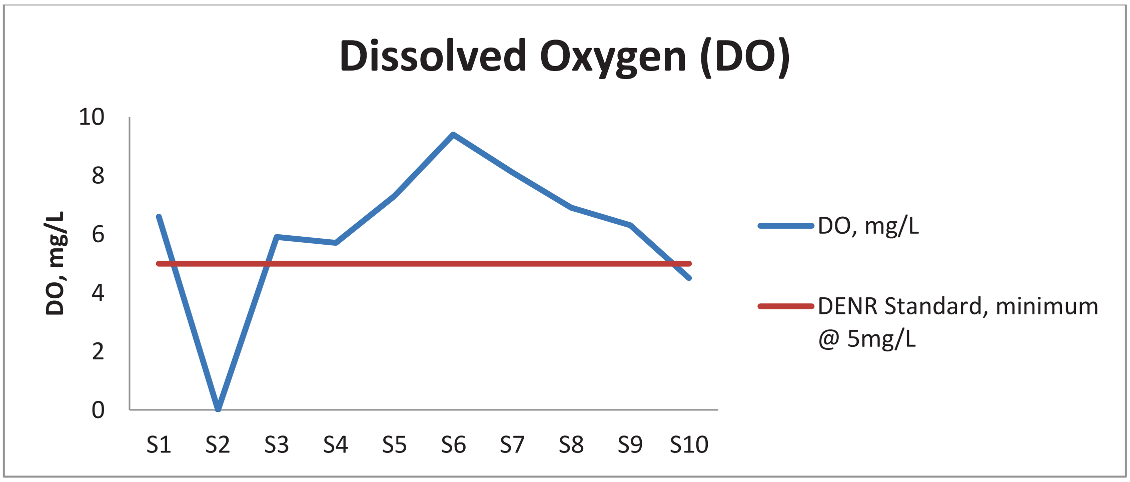


Figure 4.40 – Results of DO compared to DENR standard

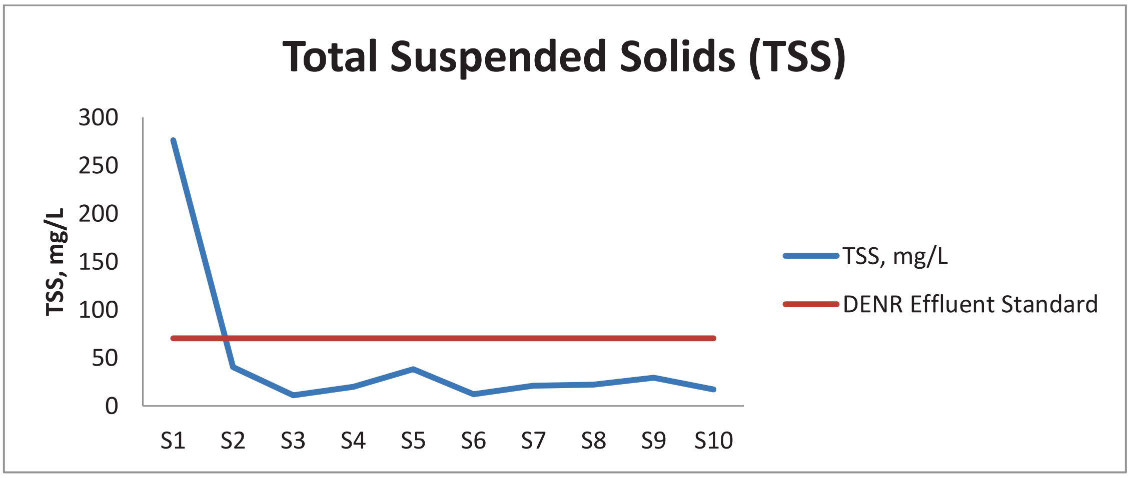


Figure 4.41 – Results of TSS compared to DENR standard

Based on the above results, the non-conforming parameters in some sampling stations are BOD,DO, and salinity. The S1, S2, S9 and S10 stations have failed results for BOD and salinity, while S3 and S6 have non-conforming results for salinity only. Stations S2 and S10 have DO levels below the required minimum. The stations S3, S4, S5 and S8 have satisfactory results based on the tested parameters.

DO is the amount of oxygen in the water used for respiration of aquatic animals. Enough level of oxygen should be maintained to ensure healthy aquatic environment. On the other hand, BOD measures the oxygen that will be consumed by the bacteria to decompose the organic pollutants present in the water. For surface waters, high BOD may lower the amount of oxygen that will be available to the fishes and other aquatic species. Thus, BOD is a good indicator of pollution level, the higher the BOD, the higher the amount of pollutants. Among all surface water stations, S2 showed oxygen depletion. It was observed during sampling at this station that the water was stagnant and water was highly turbid. It also turned out that the BOD was highest in this station which is an indicator of water pollution. S2 is the downstream of main rivers. Water pollution can be attributed to non-point sources of wastewaters directly discharging to different tributaries of river channels. Also, some houses observed have no septic tanks, thus, domestic wastewaters from households are directly discharging to river.

At present, the water quality guideline for TSS is not more than 30 mg/L increase based on background data. Since there are no baseline data taken on the same sampling points before, the results of TSS are compared against the Effluent Standards for Class C waters.High TSS result at S1 can be attributed to solid wastes dumped in the area and its nearby vicinity. Human and animal waste feces were also observed during sampling.

In addition, the salinity obtained is the measure of the amount of salts which is generally expressed as sodium chloride (NaCl). Salts may have come from salt water intrusion from Manila Bay or from natural sources such as dissolved minerals and weathered rocks. However, the value indicated in the regulatory limits is expressed as chloride. If the obtained salinity values are converted to chloridle, S1, S2, S3, S5, S7 and S8 stations have non-conforming results to chloride. High salinity of water may affect growing of crops and may lead to corrosion of infrastructures. It was obvioius that salinity at S1 was high because water sample is collected along Manila Bay.

For pH and temperature, all stations met the required limits. The maximum of 3 degree rise is the DENR allowable temperature increase over the average ambient temperature for each month. This rise shall be based on the average of the maximum daily temperature readings recorded at the site but upstream of the mixing zone over a period of one month. However, samplings in all sites were done once and there are no recorded monthly temperatures as required to become a basis for point comparison.

For the groundwater samples, the summary of results is presented in **Table 4.39**. The test results of the groundwater samples were evaluated based on the standards set by the Department of Health (DOH) Administrative Order (DAO) No. 2007 – 12: PNSDW 2007 and *World Health Organization (WHO) Guidelines, 1993.

Table 4.39 - Summary of Test Results for the Groundwater Samples

Parameters, units	GW1	GW2	GW3	GW4	GW5	PNSDW Limits
pH	7.2	7.8	7.6	7.2	7.4	6.5 – 8.5
Temperature, °C	29.0	28.8	28.6	27.8	28.0	---
Conductivity, µS/cm	996	610	624	1,720	1,070	250*
BOD, mg/L	1	2	2	3	4	---
Salinity, mg/L	734	359	441	473	441	250 (as Chloride)
Total coliforms, MPN/100mL	<1.1	<1.1	<1.1	16	<1.1	<1.1

It can be observed from the obtained data that only total coliform of GW4 has nonconforming result based on PNSDW limits. There are no limits for the other parameters analyzed. However, if the salinity results will be compared to Chloride standard, all groundwater stations exceeded the required limit of 250 mg/L. All water samples collected came from shallow well sources. High salinity content maybe an indication that there is a salt water intrusion in the areas affected.

Total coliform is a measure of potential water contamination from bacteria that can be found in soil, vegetation and feces of warm-blooded animals. Most coliform bacteria are generally harmless but they may also pose some health risk if there is presence of fecal coliform. Fecal coliforms are associated with human or animal wastes. Factors of bacteria contamination are pre-mature to conclude unless successive monitoring will be done to say that water supply is contaminated with bacteria.

There is no present guideline on BOD at Philippine Standards for Drinking Water and WHO.

4.3.3 Aquatic Ecology

The brackish-water (river / estuaries/ mangrove / abandoned fishpond) aquatic environment and biological resources of the proposed project site were assessed last March 2 and April 7, 2016. The primary purpose of the study is to establish what baseline environmental conditions of aquatic ecological and biological resources exist within the proposed project area. Secondary data were also gathered and reviewed to incorporate relevant information on the status of the environmental conditions and resources.

Plankton is a term used to describe collectively small, mostly microscopic organisms, which drift about passively in the water. Plant and animal members of the plankton are considered separately under the terms **phytoplankton** and **zooplankton**, respectively.

Phytoplankton (or photosynthetic micro-algae) is made up of representatives of at least five very diverse taxonomic groups within the plant kingdom. Like all plants, the photosynthetic phytoplankton converts light energy and carbon dioxide into organic material, and so represent the primary producers forming the base of the food web upon which almost all-aquatic animal life depends.

In contrast, zooplankton (or animal plankton) are consumer organisms and depend upon the phytoplankton, and to some extent on dead organic matter, for their source of food and energy.

The contribution made by phytoplankton to primary production within rivers / creeks is generally regarded to be low when compared to other types of aquatic habitats. However, the presence of plankton in rivers / creeks contributes to the nutrient balance and to the tropic requirements of some of the fish species (Welcomme, 1985).

Benthic or bottom dwelling animals are classified according to their habits. Those animals that burrow into soft bottom sediments are called infauna and those that are attached to hard substrates or live in or on the bottom substrate form the epifauna.

The soft bottom communities are one of the least studied biological components. These fauna, which are associated with soft bottom substrate, constitute as one of the most abundant major components of the food habits of many benthic or demersal (bottom dwelling) fishes and edible invertebrates. The soft bottom benthic communities are diverse and play an important role as support systems for the aquatic environment.

The factors influencing fisheries in rivers /creeks are very different from those of lake and marine fisheries, where the available area of water is greater. Three factors in particular give riverine fisheries their character: diffuseness in space, seasonality and diversity (Welcomme, 1985).

The survey, particularly on plankton and infaunal soft bottom benthos, conducted during this dry month, represent a snapshot of the biological conditions present in the study area at the time of sampling. Thus, the results cannot evaluate the effects of seasonality on the composition nor its abundance. The data obtained from this survey is an important reference for future monitoring studies and also useful for planning mitigating measures and implementing environmental management plans.

4.3.3.1 Methodology

4.3.3.1.1 Stations

Sampling activities were focused mainly along the proposed channel boundary with a total of 4 sampling stations. All the sampling stations are listed in **Table 4.40**, which also indicates their GPS coordinates, their locations, types of substrate, prevailing wind direction, and date and time of sampling.

The approximate locations of these sampling sites are shown in **Figure 4.42**. Coordinates of each of the stations sampled were determined using a GPS etrex Garmin. The following are the characteristic features (brief habitat descriptions) of the sampling stations.

Table 4.40. Sampling Station Data

Station	Location	Coordinates		Types of Substrate	Prevailing Wind Direction	Date / Time of Sampling (2016)
		Latitude North	Longitude East			
1	Abandoned Fishpond, Mangrove Area (Brgy. Ligtong II, Rosario)	14°25’39.7”	120°52’20.1”	Black mud	Light NE	2 March 08:30AM
2	Very Close to an Abandoned Fishpond, Creek within Mangrove Area, (Brgy. Salcedo I, Noveleta)	14°25’46.0”	120°52’26.8”	Black mud	Light NE	2 March 11:30AM
3	Creek within Mangrove Area along Maalimango River (Brgy. Ligtong	14°25’47.3”	120°52’16.4”	Black mud	E	7 April 09:30AM
4	Mouth of Maalimango River (Brgy. Ligtong 1, Rosario)	14°25’53.1”	120°52’14.7”	Black mud	Light NE	2 March 09:30AM

Source: Google Earth

Figure 4.42. Study Area Showing Plankton and Soft Bottom Infaunal Benthos Sampling Station

4.3.3.1.2 Locations

Station 1 - Brackishwater environment at Brgy. Ligtong II in Rosario (Lat. 14°25'39.7"N, Long. 120°52'20.1"E) (**Figure 4.43**). Still or standing (lentic) water at the sampling site which is located in an abandoned fishpond within a mangrove area; the other common vegetation species present is the small tree "aroma" (*Prosopis chilensis*); very shallow depth and clear water; bottom type usually deep muddy (black-colored soil); many species of fish reportedly found, dominated by "tilapia" and "banak"; lots of "tagak" (egret) were observed feeding in the area during the inspection (**Figure 4.44**); and presence of a lot of garbage on the bank of the mangrove shore (**Figure 4.45**).

Figure 4.43. Standing Water and Deep Muddy Bottom Type at Station 1 (Ligtong II, Rosario)

Figure 4.44. Lots of "Tagak" (Egret) Feeding along the Immediate Vicinity of Station 1

Figure 4.45. Lots of Garbage on the Bank of the Mangrove Shore at Station 1

Station 2 - Brackishwater environment at Brgy. Salcedo 1 in Noveleta (Lat. 14^{o}25’46.0”N, Long. 120^{o}52’26.8”E)(**Figure 4.46**). A standing water at the sampling site which is located in the creek channel of the mangrove area (close to the dike or embankment of an abandoned fishpond); shallow depth; clear water; muddy habitat (black-colored soil); many species of fish reportedly found, dominated by “tilapia” and “banak”; “alimango”, “buan-buan”, “bidbid”, and “hipon” also reportedly found; and many species of birds (both endemic and migratory) were observed at the sampling station and vicinities during the inspection.

Figure 4.46 Creek Channel along the Mangrove Area in Station 2 (Salcedo I), Noveleta

Station 3 - Brackishwater environment in Brgy. Ligtong 1 in Rosario (Lat. 14^{o}25’47.3”N, Long. 120^{o}52’16.4”E) (**Figure 4.47**). Standing water at the sampling site which is located in a small channel along the mangrove area; shallow depth; clear water; muddy habitat (black-colored soil); an abundant “tilapia” fingerlings were observed at the sampling station and immediate vicinities during the inspection; and lots of garbage were also observed on he bank of the mangrove shores.

Figure 4.47. Creek Channel along the Mangrove Area in Station 3 (Ligtong 1), Rosario

Station 4 - Brackishwater environment at the mouth of the Maalimango River, Brgy. Ligtong 1 in Rosario (Lat. 14^{o}25'53.1"N, Long. 120^{o}52'14.7"E) (**Figure 4.48**). A flowing water at the main channel was observed upstream and downstream of the sampling site; shallow; clear; substrate of main channel consists mainly of mud (black-colored soil); bottoms of riverbanks generally consists of sand; also presence of a lot of garbage; mangroves and other coastal vegetations lined the riverbanks upstream of the sampling site; and many different types of municipal fishing boats were present along the sandy beach of the barangay (**Figure 4.49**).

Figure 4.48. Station 3 Located at the Mouth of the Maalimango River, Brgy. Ligtong 1 in Rosario. a) Photo Showing Downstream Portion of the Sampling Site which is the Manila Bay, b) Another Photo Showing the Upstream Portion of the Sampling Site.

Figure 4.49 Different Types of Municipal Fishing Boats on the Sandy Beach Near Station 4

Plankton

Plankton samples were taken at each station by filtering 5, 1 liter samples into a composite sample for phytoplankton and zooplankton studies. Samples were filtered through a 20 um mesh sieve (**Figure 4.50**). All plankton samples were preserved in 10% formalin solution immediately after collection. Samples were then sent to a laboratory for counting and identification.

The numerical density of both phytoplankton and zooplankton organisms was determined using an aliquot. The samples in the aliquot were, at first, examined microscopically to determine the identity of the components represented and were, later, counted for organisms using a Sedgewick-Rafter cell. The densities of phytoplankton and zooplankton organisms were estimated, and then transformed to number per liter of water (no. of cells/L and no. organisms/L, respectively).

Figure 4.50. Sampling by Filtering 5, 1 Liter Samples Into a Composite Sample for Phytoplankton and Zooplankton (Station 1 – Ligtong II)

Soft Bottom Infaunal Benthos

Sediment samples for soft bottom infaunal benthos study were also taken at the same sampling stations for plankton. Single replicate sediment sampling was done with the used of hand trowel and a plastic basin from an estimated bottom area of 0.02 m^2 (**Figure 4.51**). Sediment samples collected were sieved into a 0.5 mm mesh right after each sampling (**Figure 4.52**). Retained sediments in the sieve were placed in properly labeled small plastic bags as containers, stained with Rose Bengal and fixed in 10% formalin.

Samples were processed in the laboratory where they were washed with tap water to get rid of excess formalin. Sorting of organisms from the sediments was done with the aid of a stereozoom microscope. Identified organisms were placed in vials containing 70% alcohol and classified to family level if possible.

Specimens sorted from the sediment samples were counted to analyze their density. Density was expressed in terms of individuals per square meter (indv/m^2). An index of diversity of benthic organisms (within major taxonomic group) using Shannon-Weaver Index was computed for the communities found in different stations in the study area. Biomass of the benthic fauna for each station was also measured and expressed in terms of wet weight in grams per square meter (wwt g/m^2).

Figure 4.51. Sediment Sampling with the Used of Hand Trowel and a Plastic Basin for Soft Bottom Infaunal Benthos Analysis

Figure 4.52. Sieving of Sediment Sample into a 0.5 mm Mesh (a) and Retained Sediment in the Sieve (b)

Types of Aquatic Life, Fisheries and Other Uses of the Aquatic Systems

Field observations and informal interviews with local residents, particularly the guide and persons who were encountered during the survey were conducted to obtain current information on the local fishery conditions, types of aquatic life, and other uses of the aquatic habitats.

Existing Conditions of the Aquatic Habitats and Biological Resources

Phytoplankton (Photosynthetic Microalgae)

Species Composition and Mean Relative Abundance

Species composition, density and relative abundance of phytoplankton components are shown in **Table 4.41**. As presented in **Figure 4.53**, the most conspicuous major group of phytoplankton consisted of diatoms (averaging 6,375 cells/L or forming 98.16% of the total phytoplankton catches). The least abundant were the blue-green algae (averaging 120 cells/L or forming only 1.84%). The diatoms were represented by 15 genera while the blue-green algae were represented by only 2 genera. Barsamin (1960) as cited in BFAR-FRD (undated) in his investigation on the fluctuations on the planktonic population of the estuaries of Navotas and Malabon also identified two groups of phytoplankters that were included in the samples. These are the diatoms and the blue-green algae.

Table 4.41. Composition, Density and Relative Abundance of Phytoplankton and Zooplankton Organisms Sampled from Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Taxa	Sampling Station				Mean Total Density (no./L)	Mean Relative Abundance (%)
	Sta. 1 (Ligtong II)	Sta. 2 (Salcedo I)	Sta. 3 (Ligtong I)	Sta. 4 (Ligtong 1-Rivermouth)		
A. PHYTOPLANKTON						
Diatoms (Bacillariophyceae)						
1. *Asterolampra*			40		10	0.15
2. *Bacteriastrum*			80		20	0.31
3. *Biddulphia*	4,400	1,400	1,040	200	1,760	27.10
4. *Chaetoceros*	200	100	160	100	140	2.16
5. *Coscinodiscus*	1,700	200	120	300	580	8.93
6. *Diploneis*		1,400	120	300	455	7.01
7. *Dictyocha*	100				25	0.38
8. *Gyrosigma*	500	700		400	400	6.16
9. *Licmophora*			680		170	2.62
10. *Microsphora*	100				25	0.39

11. Navicula			40	200	60	0.92
12. Pleurosigma	4,900	2,200	320	1,600	2,255	34.72
13. Rhizosolenia	100		80		45	0.69
14. Skeletonema	200	100	40	500	210	3.23
15. Surirella	400	200	80	200	220	3.39
Sub-total	*12,600*	*6,300*	*2,800*	*3,800*	*6,375*	*98.16*
Blue-Green Algae (Cyanophyceae)						
1. Trichodesmium	200	100	80		95	1.46
2. Oscillatoria				100	25	0.38
Sub-total	*200*	*100*	*80*	*100*	*120*	*1.84*
Total Phytoplankton	*12,800*	*6,400*	*2,880*	*3,900*	*6,495*	*100.00*
B. ZOOPLANKTON						
Ciliata						
Codonellopsis			40		10	8.33
Sub-total			*40*		*10*	*8.33*
Copepoda						
Nauplius larvae	200		40	100	85	70.84
Sub-total	*200*		*40*	*100*	*85*	*70.84*
Annelida						
Polychaete Larvae	100				25	20.83
Sub-total	*100*				*25*	*20.83*
Total Zooplankton	*300*		*80*	*100*	*120*	*100.00*

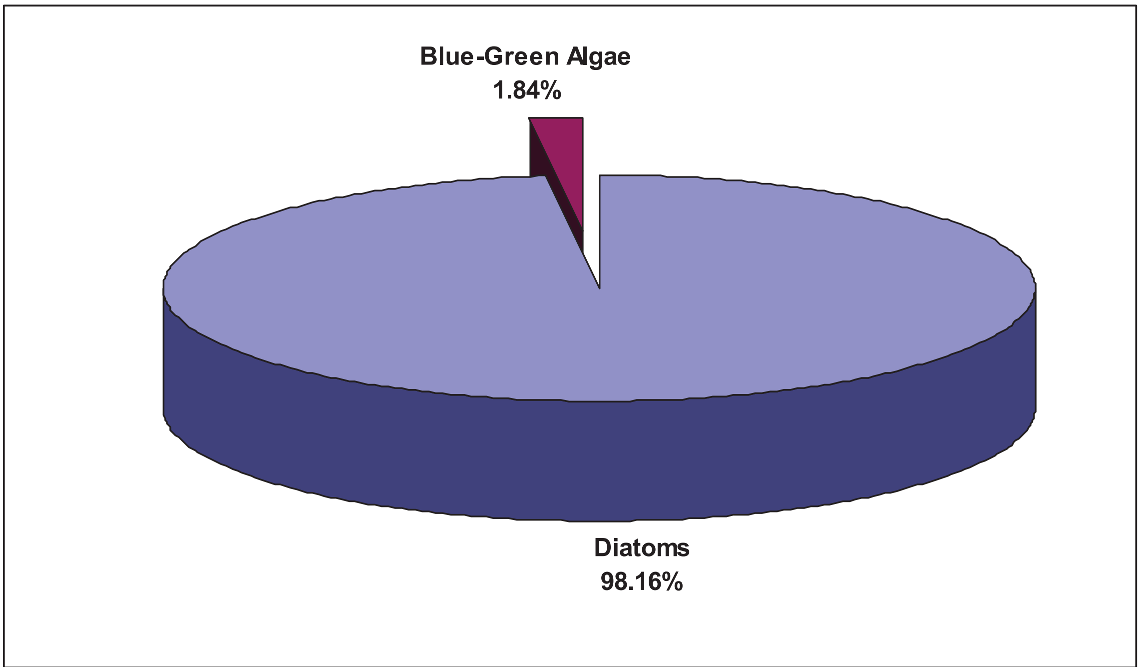


Figure 4.53. Mean Relative Abundance of Major Phytoplankton Groups of the Plankton Samples Collected from the Estuarine Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta
Abundance of Phytoplankton Components

In **Table 4.42** phytoplankton components are arranged in order of abundance (in terms of mean total number and mean relative abundance). *Pleurosigma* dominated most stations and were by far the most abundant organisms (averaging 2,255 cells/L or 34.72% of the phytoplankton catch), followed by *Biddulphia* (averaging 1,760 cells/L or 27.10%) and *Coscinodiscus* (averaging 580 cells/L or 8.93%) (**Figure 4.54**). They were present in every station. Other phytoplankton components such as *Surirella*, *Skeletonema* and *Chaetoceros* were also taken in all stations but never very numerous. *Diploneis*, *Gyrosigma* and *Trichodesmium* were also taken nearly in all stations. All the other forms (*Licmophora, Microsphora, Dicthyocha, Oscillatoria*, *Bacteriastrum*, *Asteriolampra, Navicula* and *Rhizosolenia*) were found absent in majority of the stations and were represented as rare or minor constituents in only one or two stations.

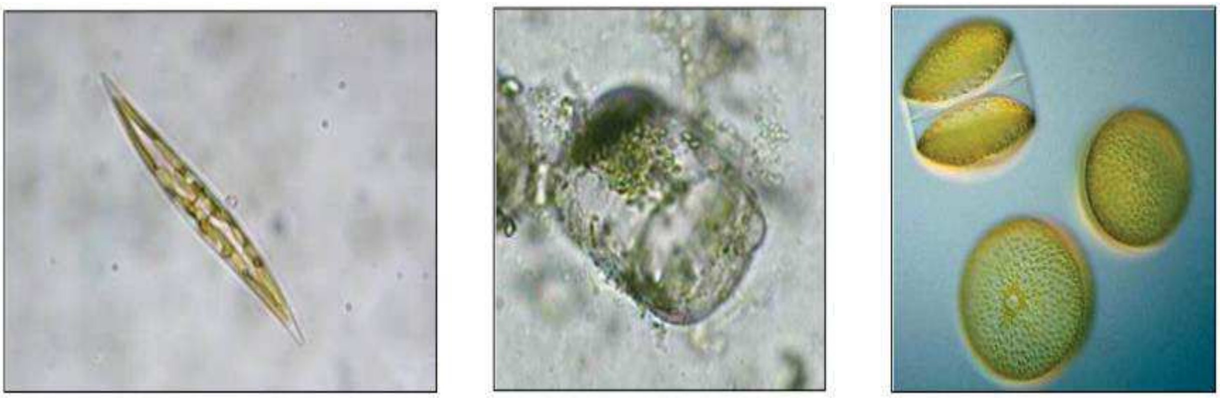
Bersamin (1960) as cited in BFAR-FRD (undated) observed the greatest percentage of appearance of *Coscinodiscus* and *Navicula* in all the plankton samples, followed by *Cycloptella*, *Pleurosigma, Nitzschia*, *Surirella*, *Melosira* and *Rhizosolenia* in the estuaries of Navotas and Malabon. MEAESCF (2013) also observed the diatom *Skeletonema* as the most abundant phytoplankton, followed by *Chaetoceros*, *Rhizosolenia*, *Coscinodiscus* and *Pleurosigma* in the estuaries (fishponds, mangroves and Meycauayan River) of Obando in Bulacan.

There was a great probability that these phytoplankton organisms must have been carried from the open seas by currents or incoming high tides although the physical and chemical factors of the area favored their development and multiplication.

Table 4.42. Abundance and Ranking of Phytoplankton Components

Phytoplankton Genera	Abundance (No./L) per Station				Mean Total Number /L	Mean (%) Relative Abundance	Ranking
	Sta. 1 (Ligtong II)	Sta. 2 (Salcedo I)	Sta. 3 (Ligtong I)	Sta. 4 (Ligtong 1-Rivermouth)			
Pleurosigma (D)	4,900	2,200	320	1,600	**2,255**	**34.72**	**1**
Biddulphia (D)	4,400	1,400	1,040	200	**1,760**	**27.10**	**2**
Coscinodiscus (D)	1,700	200	120	300	**580**	**8.93**	**3**
Diploneis (D)	-	1,400	120	300	**455**	**7.01**	**4**
Gyrosigma (D)	500	700	-	400	**400**	**6.16**	**5**
Surirella (D)	400	200	80	200	**220**	**3.39**	**6**
Skeletonema (D)	200	100	40	500	**210**	**3.23**	**7**
Licmophora (D)	-	-	680	-	**170**	**2.62**	**8**
Chaetoceros (D)	200	100	160	100	**140**	**2.16**	**9**
Trichodesmium (BG)	200	100	80	-	**95**	**1.46**	**10**
Navicula (D)	-	-	40	200	**60**	**0.92**	**11**
Rhizosolenia (D)	100	-	80	-	**45**	**0.69**	**12**
Microsphora (D)	100	-	-	-	**25**	**0.39**	**13**
Dictyocha (D)	100	-	-	-	**25**	**0.38**	**14**
Oscillatoria (BG)	-		-	100	**25**	**0.38**	**14**
Bacteriastrum (D)	-	-	80	-	**20**	**0.31**	**15**
Asterolampra (D)	-	-	40	-	**10**	**0.15**	**16**

D = Diatom BG = Blue-Green Alga; A dash (-) signifies absence in the sample



Pleurosigma **Biddulphia** **Coscinodiscus**

(Photo Source: Internet)

Figure 4.54. **The Most Dominant Phytoplankton Genera Sampled from Estuarine Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta**.

Total Phytoplankton

The total phytoplankton numbers varied among the stations sampled, from a maximum of 12,800 cells/L at Station 1, followed by a decrease up to a minimum of 2,880 cells/L at Station 3 then an increase in Station 4 (3,900 cells/L) (**Figure 4.55**). The average for all stations was estimated at 6,495 cells/L.

It is also clear, from **Figure 4.55**, that total phytoplankton numbers are relatively higher at the more inner or less brackishwater areas at Stations 1 and 2, as compared with the more brackishwater areas at Stations 3 and 4. Also, a large proportion of *Pleurosigma* accompanied by large numbers of *Biddulphia* was observed at Stations 1 and 2 and were found less abundant at Stations 3 and 4. There seems to be tendency for these diatom members to appear in large numbers at the same time in a less brackishwater environment.

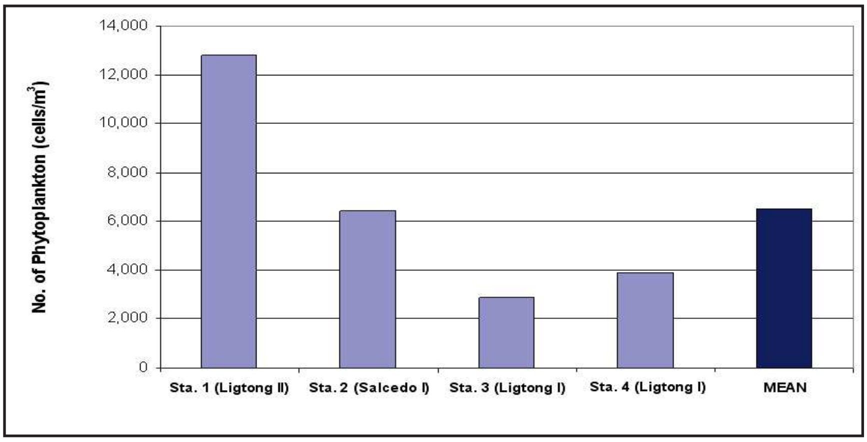


Figure 4.55. Total Numbers of Phytoplankton at Each of the Four Stations Sampled from the Brackishwater Areas (River / Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Zooplankton (Animal Plankton)

Species Composition and Relative Abundance

Species composition, density and relative abundance of zooplankton components are also shown in **Table 4.43**. The most conspicuous major group of zooplankton consisted of copepods represented solely by its nauplius larvae (averaging 85 organisms/L or forming 70.84% of the total zooplankton counts), followed by the annelids represented solely by its polychaete larvae (averaging 25 organisms/L or forming 20.83%) (**Figure 4.56**). The least obvious were the ciliates represented solely by *Codonellopsis* (averaging 10 organisms/L or forming only 8.33%).

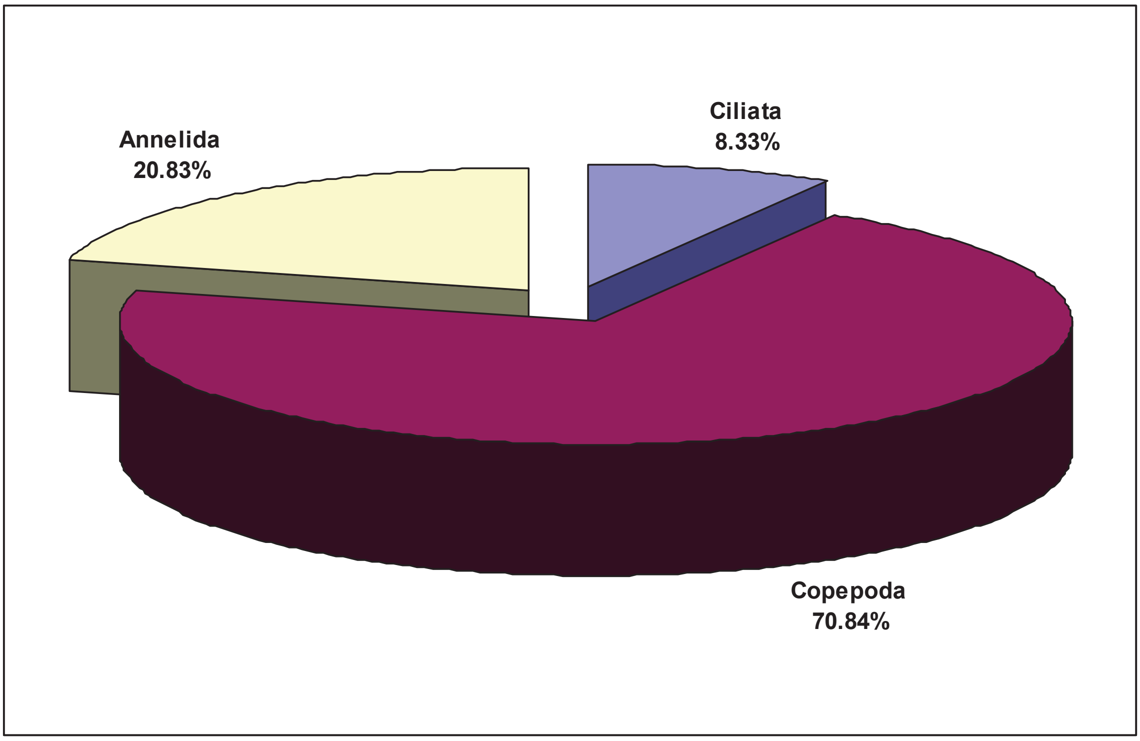


Figure 4.56 Mean Relative Abundance of Major Zooplankton Components of the Plankton Samples Collected from the Estuarine Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Abundance of Zooplankton Components

In **Table 4.43** zooplankton components are also arranged in order of abundance (in terms of mean total number and mean relative abundance). However, zooplankton was found absent in the samples taken at Station 2. The reason for this is unknown.

Copepod nauplius larvae (**Figure 4.57**) dominated most samples and were by far the most abundant zooplankton organisms (averaging 85 organisms/L or 70.84% of the total catch). The larvae of benthic animals (polychaete, see **Figure 4.57**) ranked next which were present only at Station 1 but much less abundant here (averaging 25 organisms/L or 20.83%). The ciliate *Codonellopsis* (see **Figure 4.57**) was the least abundant (averaging only 10 organisms/L or 8.33%), and it was only once present from Station 3. The observed dominance of copepod nauplius larvae is consistent with those findings in the estuaries of Obando in Bulacan where the copepod larvae were also the most abundant zooplankton in all stations sampled (MEAESCF, 2013).

Table 4.43. Abundance and Ranking of Zooplankton Components

Zooplankton Organisms	Abundance (No./L) per Station				Mean Total Number/L	Mean (%) Relative Abundance	Ranking
	Sta. 1 (Ligtong II)	Sta. 2 (Salcedo I)	Sta. 3 (Ligtong I)	Sta. 4 (Ligtong 1-Rivermouth)			
Copepod nauplius larvae	200	-	40	100	**85**	**70.84**	**1**
Polychaete larvae	100	-	-	-	**25**	**20.83**	**2**
Codonellopsis	-	-	40	-	**10**	**8.33**	**3**

A dash (-) signifies absence in the sample

Copepod Nauplius Larvae **Polychaete Larvae** ***Codonellopsis***

(Photo Source: Internet)

Figure 4.57. The Zooplankton Organisms Obtained from Brackishwater Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Total Zooplankton

The total populations of zooplankton also varied among stations, from a maximum of 300 organisms/L at Station 1 to a minimum of 80 organisms/L at Station 3. The mean density for all the stations sampled was estimated at 120 organisms/L (**Figure 4.58**).

The variation of the total zooplankton by sampling station (see **Figure 4.58**), except at Station 2 where zooplankton was found absent in the sample, followed more or less similar general trend with that of the total phytoplankton. This indicates that the variates increase and decrease together, *i.e.*, with high phytoplankton more zooplankton may be expected and with low phytoplankton, less.

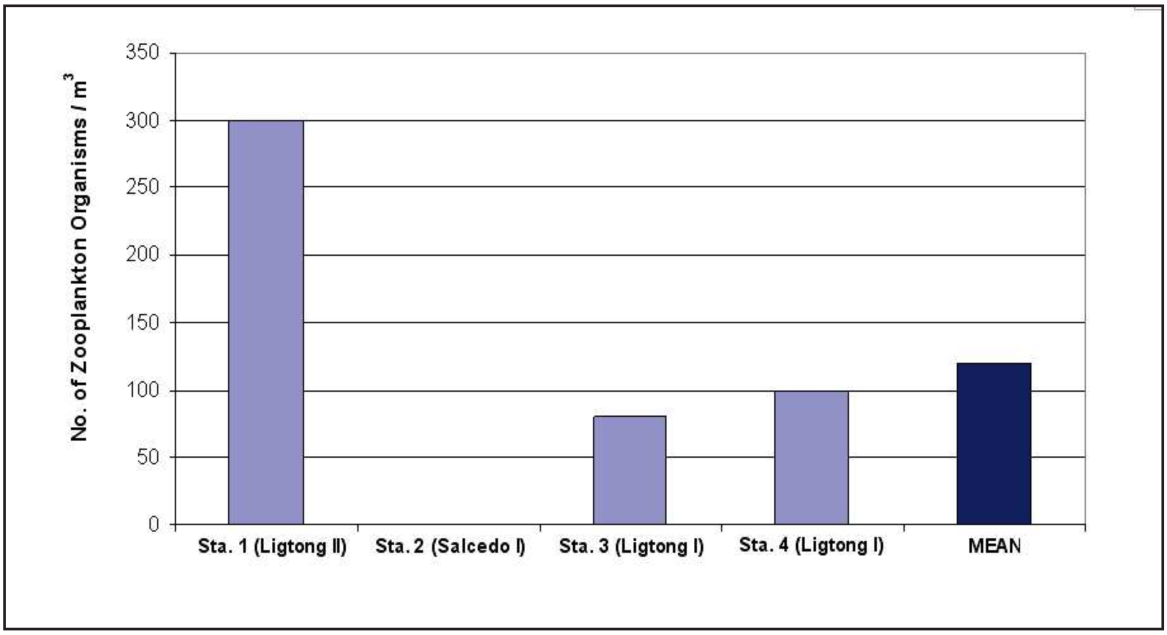


Figure 4.58 Total Numbers of Zooplankton at Each of the Four Stations Sampled from the Estuarine Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Mean Relative Abundance of Major Plankton Groups

The overall plankton organisms in this survey were dominated by phytoplankton (98.2% of the total plankton population while zooplankton accounted for only 1.8%). Normally, the preponderance of phytoplankton is to be expected, since they represent the primary producers forming the base of the food web. The present result indicates that the density of the phytoplankton in the area appears sufficient to support a substantial food base. Typically river / creek, lake, estuaries and nearshore plankton in the Philippines is dominated by phytoplankton.

Soft Bottom Infaunal Benthos

Species Composition and Relative Abundance

A total number of 114 benthic organisms were obtained from 4 samples taken at 4 sampling stations **(Table 4.44).** These organisms were represented by 13 taxa belonging to 3 major groups, namely; Polychaeta, Mollusca and Crustacea.

Table 4.44 Raw Count of Infauna Sampled from the Estuarine Areas (River/Creek, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Taxa	Stn.1 Ligtong II	Stn. 2 Salcedo I	Stn 3 Ligtong I	Stn. 4 Rivermouth Ligtong I	TOTAL
Phylum Annelida					
Class Polychaeta					

Family Spionidae	1	20		24	**45**
Family Capitellidae				2	**2**
Family Goniadidae				2	**2**
Family Nereidae				2	**2**
Phylum Mollusca					
Class Pelecypoda					
Family Tellinidae					
Tellina sp.				1	**1**
Family Veneridae					
Meretrix sp.				1	**1**
Family Mytilidae					
Modiolus sp.				2	**2**
Class Gastropoda					
Family Potamididae					
Telescopium telescopium		1			**1**
Family Cerithiidae					
Cerithidea sp.	1	2	1		**4**
Cerithium sp.		33	18		**51**
Phylum Arthropoda					
Subclass Crustacea					
Class Malacostraca					
Order Decapoda					
Family Penaeidae		1			**1**
Family Portunidae					
Thalamita sp.			1		**1**
Order Mysidacea				1	**1**
TOTAL	**2**	**57**	**20**	**35**	**114**

Table 4.45 presents the density and relative abundance of the major taxonomic groups of the benthic fauna sampled from the survey. The data was graphically presented in **Figure 4.59.** The most important groups of soft bottom fauna belong to Mollusca composing 52%, followed by Polychaeta constituting 45% of the total collection. The least was Crustacea with 3% only.

The polychaetes were represented by 4 families, namely Spionidae, Capitellidae, Glyceridae and Nereididae. The presence of these types of polychaetes which were dominated by the spionid worms was due to its proximity to the mangrove swamps that contribute nutrients for the growth and multiplication of detritus feeders in the community. The mollusks were represented by 6 species under 5 families with *Cerithium* sp. belonging to Cerithiidae, a gastropod family as the most common. The crustaceans were represented by Penaeidea and Mysidacea.

Table 4.45. Density and Relative Abundance of Infauna Sampled from Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Taxa Phylum Annelida	Stn.1 Ligtong II	Stn. 2 Salcedo I	Stn 3 Ligtong I	Stn. 4 Ligtong I	Mean Density (no./m^2)	% Mean Relative Abundance
Class Polychaeta						
Family Spionidae	44	889		1,067	500	39
Family Capitellidae				89	22	2
Family Goniadidae				89	22	2
Family Nereidae				89	22	2
Phylum Mollusca						
Class Pelecypoda						
Family Tellinidae						
Tellina sp.				44	11	1
Family Veneridae						
Meretrix sp.				44	11	1
Family Mytilidae						
Modiolus sp.				89	22	2
Class Gastropoda						
Family Potamididae						
Telescopium telescopium		44			11	1
Family Cerithiidae						
Cerithidea sp.	44	89	44		44	4
Cerithium sp.		1,467	800		567	45
Phylum Arthropoda						
Subclass Crustacea						
Class Malacostraca						
Order Decapoda						
Family Penaeidae		44			11	1
Family Portunidae						
Thalamita sp.			44		11	1
Order Mysidacea				44	11	1
TOTAL	89	2,533	888	1,556	1,267	100
No. of Taxa	3	5	3	8		
Species Diversity (H')	0.70	0.94	0.39	1.22		
Biomass (wet wt. in g/m^2)	8	2,621	885	76		
Types of Substrate	Muddy	Muddy	Muddy	Muddy		
Depth (meter)	0.2	0.2	0.2	0.2		

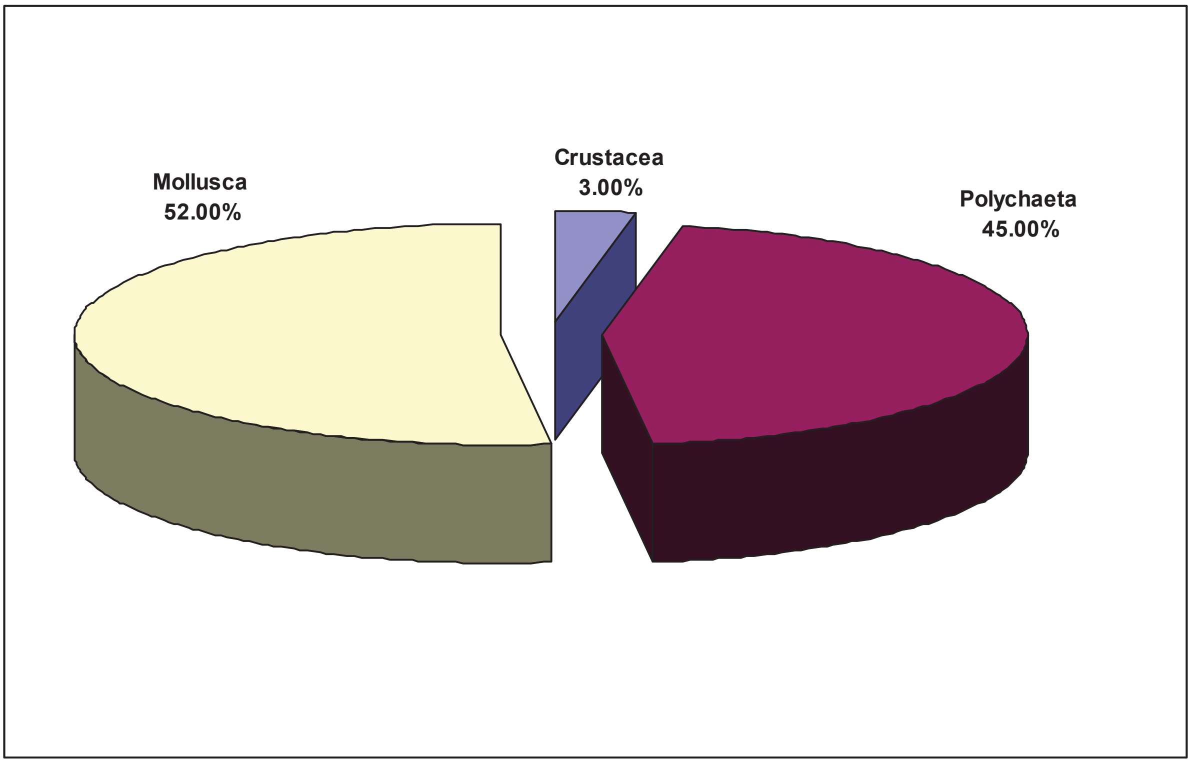


Figure 4.59 Mean Relative Abundance of Infaunal Soft Bottom Benthos Collected from the Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Abundance of Infaunal Benthos Components

The major contributors to the standing crop of the infaunal soft bottom benthos were gastropod mollusk *Cerithium* sp. (averaging 567 indv/m^2 or 45% of the total catch), the polychaete worms belonging to the Family Spionidae (averaging 500 indv/m^2 or 39%), and another gastropod mollusk *Cerithidea* sp. (averaging 44 ind/m^2 or only 4%). *Cerithium* sp. occurred only at Stations 2 and 3 while the spionid worms and *Cerithidea* sp. were taken in 3 stations. Other components which ranked fourth were the polychaetes Capitellidae, Goniadidae, Nereidae and the pelecypod mollusk *Modiolus* sp. They were all represented in only one particular station (Station 4). All the other forms (*Tellina* sp., *Meretrix* sp., *Telescopium telescopium*, Penaeidae, *Thalamita* sp. and Mysidacea) ranked fifth which also appear to have localized or restricted distribution due to their poor representation in the samples (occurring only at one station). **Table 4.46** presents the summary of abundance and ranking of soft bottom infaunal benthos. **Figure 4.60** shows the dominant infaunal benthic organisms taken in sampling stations.

Table 4.46. Abundance and Ranking of Soft Bottom Infaunal Benthos Components

Taxa	Abundance (no./m^2) per Station				Mean Density (no./m^2)	% Mean Relative Abundance	Ranking
	Sta. 1 (Ligtong II)	Sta. 2 (Salcedo I)	Sta. 3 (Ligtong I)	Sta. 4 (Ligtong 1-Rivermouth)			
Cerithium sp. (GM)	-	1,467	800	-	**567**	**45**	**1**
Spionidae (P)	44	889	-	1,067	**500**	**39**	**2**
Cerithidea sp. ((GM)	44	89	44	-	**44**	**4**	**3**
Capitellidae (P)	-	-	-	89	**22**	**2**	**4**
Goniadidae (P)	-	-	-	89	**22**	**2**	**4**
Nereidae (P)	-	-	-	89	**22**	**2**	**4**
Modiolus sp. (PM)	-	-	-	89	**22**	**2**	**4**
Tellina sp. (PM)	-	-	-	44	**11**	**1**	**5**
Meretrix sp. (PM)	-	-	-	44	**11**	**1**	**5**
Telescopium telescopium (GM)	-	44	-	-	**11**	**1**	**5**
Penaeidae (C)	-	44	-	-	**11**	**1**	**5**
Thalamita sp. (C)	-	-	44	-	**11**	**1**	**5**
Mysidacea (C)	-	-	-	44	**11**	**1**	**5**

GM = Gastropod mollusk PM = Pelecypod mollusk P = Polychaete worm C= Crustacea
A dash (-) signifies absence in the sample

Polychaete Worm (Family Spionidae)


Gastropod Mollusc *Cerithium* sp.

Figure 4.60. Dominant Infaunal Benthic Organisms Collected from the Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta (Photo Source: Internet)

Benthos Density

Density (number of all individuals per unit area or volume) is a useful quantitative estimation of standing crop. Standing crop is the total number or weight of a population in a given area or volume..
The population density of benthic organisms in this survey ranged from 89 to 2,533 indv/m^2. The mean density recorded for the four stations was 1,267 indv/m^2 **(Figure 4.61)**. The highest density was recorded at Station 2 located along the muddy mangrove area of Salcedo I, Noveleta with 2,533 indv/m^2. The gastropod, *Cerithium* sp., was the most abundant organisms found in this station followed by the spionid worms. The cerith snails are scavengers that eat any uneaten food, fish waste and detritus as well as algae. Spionid worms are deposit feeders. In Tokyo, Japan, some species of spionid worms are utilized as an indicator of organic pollution because of its high tolerance of organic pollution.

Station 4, established at the muddy substrate of a creek along Maalimango River ranked second with 1,067 indv/m^2. The polychaetes were the most abundant organisms found in this area dominated by the spionid worms. The closeness of the sampling site to the sea and the interference of the rising tide support the better migration of the polychaetes in this station than in the other sampling sites located more inward.

Ranked third in density was Station 3, at the muddy area of Ligtong 1, with 888 indv/m^2 dominated by *Cerithium* sp. Station 1, situated at the muddy mangrove area of Ligtong II, Rosario has the lowest density with 89 indv/m^2 only. The muddy bottom at this station which was consisted of black-colored soil could be the factor on the relatively poor density of soft bottom organisms considering its proximity to the disposal site of domestic wastes of the inhabitants in the vicinities.

The bottom substrate of all these study areas constituted mostly of black sediments. They served as catch basin of organic matters and silts coming from the nearby populated areas. This indicates an unfavorable condition for the organisms to thrive well. Kastoro *et al.* (1991) reported that the dominant macrobenthos inhabiting muddy sediments are usually polychaetes, bivalve mollusks and small crustaceans.

Among the adverse effects on the environment of soil runoff is increased sedimentation. The soil runoff empty into the swamp and these carry an unknown quantity of suspended sediments, which may contribute to smothering benthic fauna and affects the population density of the organisms. The sediment chokes aquatic life and reduces photosynthesis of plankton, thus reduces fishery production (Alcala, 1991).

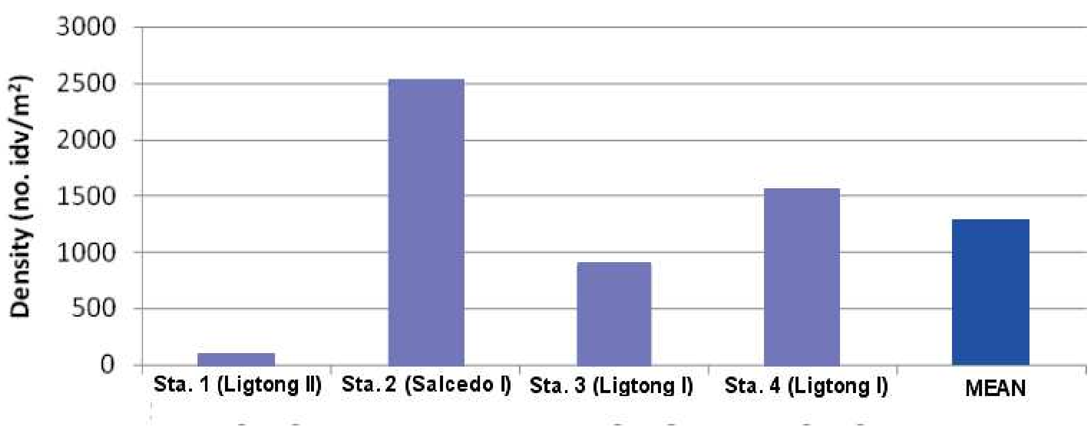


Figure 4.61. **Density of Soft Bottom Infauna Sampled at Each Station in Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta**

Species Richness and Diversity

An index of diversity of benthic organisms using Shannon-Weaver Index was computed for the communities found in different stations of the project area. The index both measures the variety and number of individuals per taxa. The species diversity (H') was highest at Station 4 (H'=1.22). It has also the highest number of taxa with 8. Station 2, with 5 taxa and Station 1, with only 2 taxa, have species diversity values of 0.94 and 0.70, respectively. Station 3 with 3 taxa had the lowest diversity with only 0.39.

Less stressful environment promotes high diversity. As stresses in the particular area increased, benthic infauna communities may be dominated only by few kinds. The low diversity of fauna indicates highly stressful environment and there is certain degree of selectivity among the animals on the choice of areas where there population could survive (Villoso and Palpal-latoc, 1996).

Biomass of the Benthic Infauna

Macrobenthos biomass (weight of organisms per unit area) is also a useful quantitative estimation of standing crop. Biomass of the benthic organisms at the different stations is also shown in **Table 4.46**. The data were graphically presented in **Figure 4.62**. The biomass ranged from 8 to 2,621 wwt g/m^2. Inter-station comparison shows Station 2 with the highest biomass due to the numerous occurrences of cerithiid species, particularly *Cerithium* sp. and the presence of a large gastropod, *Telescopium telescopium*. Station 3 has also a high biomass value of 885 wwt g/m^2 owing to the collection of *Cerithium* sp. Distant third was Station 4 with 76 wwt g/m^2. Least biomass was recorded at Station 1 with only 8 wwt g/m^2 due to poor representation of organisms. The mean biomass recorded for all the stations was 898 wwt g/m^2.

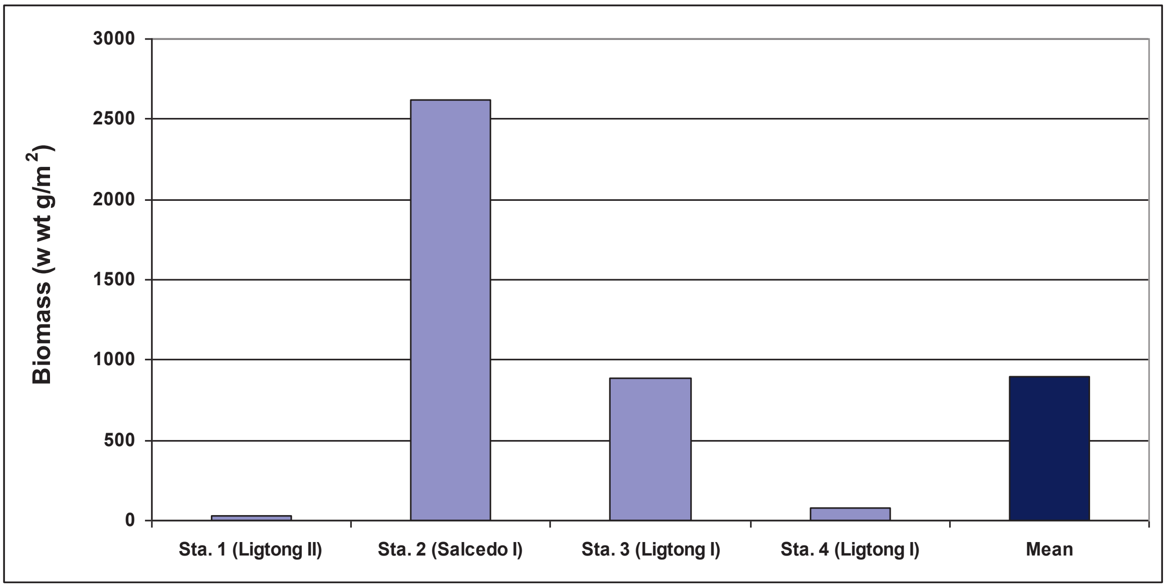


Figure 4.62 Biomass of Soft Bottom Infaunal Benthos at Each Station in the Estuarine Areas (River, Mangrove and Abandoned Fishpond) of Rosario-Noveleta

Summarily, Station 1 is the least populated area with a population density of only 89 indv/m^2 and yielded the lowest biomass of 8 wwt g/m^2 (see **Figure 4.61** and **Figure 4.62**, respectively). There were only two taxa represented in this area. The highly polluted bottom substratum of this area, due to the accumulation of large amount of waste materials, does not afford an environment suitable for these organisms. Further, this area is not a normal environment and is probably even detrimental.

Station 2 appears to be the most highly populated area (2,533 indv/m^2) which is about 2.8 times larger than Station 3 (888 indv/m^2) and 1.6 times larger than that of Station 4 (1,566 indv/m^2). It has also the highest benthic biomass of 2,621 wwt g/m^2, which is about 2.9 times as high as Station 3 (885 wwt g/m^2) and 35 times larger than that of Station 4 (76 wwt g/m^2). The highest density and biomass of benthic organisms at Station 1 were mainly due to the numerous presence of gastropod mollusk *Cerithium* sp. *Cerithium* sp. in particular may be considered as biomass contributors in view of their larger dimensions which contributed greatly to the biomass. The presence of a relatively large gastropod, *Telescopium telescopium* in Station 1, also contributed greatly to the biomass but little to the number.

The above findings show that variation of the benthos density by sampling station coincided with that of the variation pattern of the phytoplankton density, except in Station 1 where the recorded highest phytoplankton density showed a negative relationship with that of the benthos density. The lowest standing crop (density, biomass and number of taxa) of infaunal benthos as already explained earlier was may be due to the effect of heavy pollution of the bottom sediment at this station.

Fisheries and Other Types of Aquatic Life

The survey revealed that the aquatic systems supports traditional riverine / estuarine fishery. However, results from interviews with local residents and fishermen showed that the ecosystem and the harvestable community which it supported, is dependent upon seasonal rainfall. Throughout the flood season, the fish are usually dispersed and fishing is very minimal or none at all. Low water period is said to be the most productive for these river / estuarine fisheries. It was found out that majority of the riverine / estuarine inhabitants are only occasional fishermen, which mean that fishing is done only on certain times of the year. Such fisheries, therefore, are only produced essentially for family consumption and that the inhabitants concerned have very little dependence on the fishery. It was also found out during the inspection that some of the residents interviewed do not eat the fish caught from the river/estuaries because according to them the area is heavily polluted.

Table 4.47 shows the different types of fishes being caught at different stations surveyed in the area. The fish catch in the river consist of "tilapia", "banak" "biya", "buan-buan", "bidbid", "bagaong", "asohos", and "bangos". It was observed during the present survey that the fish in all the stations sampled was mostly "tilapia". Generally, the quality of fish obtained in the river /estuaries is quite poor due to the small size of the fish caught. Almost all of the fishes are inhabitants of shallow coastal habitats that enter the river or brackishwater / estuaries. Most of them are euryhaline, inhabiting coastal marine waters, brackish water lagoons, estuaries and may enter freshwaters (Carpenter and Niem, 1999). They can tolerate a wide range of temperature and salinity from highly saline to freshwater.

In addition to finfishes there are other aquatic animals reportedly found in the area (see **Table 4.47**). These include the shrimp or "hipon", mud crabs or "alimango", and blue swimming crabs or "alimasag". They are still caught at present in the area but in small quantities.

Table 4.47 Fish and Invertebrate Species and Other Aquatic Resources

Fish and Invertebrate and Species (Tagalog/English & Scientific Name)	Sta. 1	Sta. 2	Sta. 3	Sta.4
Fishes				
1. Tilapia (*Tilapia* spp.)	A	A	A	A
2. Biya (Goby / *Ctenogobius* sp.)	C	C	C	C
3. Buan-buan (Tarpon/ *Megalops cyprinoides*)	C	C	C	C
4. Bidbid (Ten pounder / *Elops machnata*)	C	C	C	C
5. Bagaong (Convex-lined Therapon / *Therapon jarbua*)	R	R	C	C
6. Asohos (Common asohos / *Sillago sihama*)	R	R	C	C
7. Bangos (Bangos / *Chanos chanos*)	R	R	C	C
8. Banak (Mullet / *Liza* spp. or *Mugil* spp.)	C	C	C	C
Shrimps				
1. Hipon (Shrimp / *Penaeus* spp.)	C	C	C	C
Crabs				
1. Alimango (Mangrove crab /Mud Crab (Scylla serrata)	C	R	R	R
2. Alimasag / Kasag (Blue swimming crabs / *Portunus pelagicus*)	R	R	R	R

Data Source: Direct observations and interviews
Legend:- A - Abundant : when the species are being caught in enormous quantities by the fishermen

C - Common: when the species are frequently seen or represented in the catch
R - Rare: when the species is seldom seen or caught and also very few in numbers

<u>Other Uses of the Aquatic Systems and Sources of Pollution</u>

Some portions of the estuaries / mangrove areas have been developed into brackishwater fishponds (probably leased from the government and / or privately owned). It was noticed during the inspection that almost all of these fishponds are already abandoned.

The aquatic systems are also obviously being used as a receiving water body of effluents or various types of pollutants / wastes generated from domestics / residential / households and commercial areas, agricultural and industrial establishments (and other land-based activities that discharge directly to the river or to the drainage system which eventually enter the river / estuary). Furthermore, residential areas along the banks of and near the river / creek also discharged their sewage and waste materials (plastic, wood, animal carcasses and all sorts of rubbish) directly into the aquatic systems.

4.3.3.2 <u>Analysis of Impact and Mitigation</u>

Drainage Improvement at Maalimango River

This section provides an assessment of the probable impacts of the proposed Maalimango Drainage Improvement project involving dredging, excavation and widening activities of drainage channel on the aquatic communities such as the plankton, soft bottom benthos, and fish. Each identified impact is categorized according to its development phase: a) construction phase; and b) operation phase. The corresponding mitigating measures are presented in *Italics* for each significant negative impact identified.

4.3.3.2.1 Construction

4.3.3.2.1.1 *On Bottom Surface Morphology*

The effects of dredging include the changes in the bottom surface morphology and alterations in the nature of the material constituting the upper layer of the bottom surface. In turn, benthic fauna (including fish and other aquatic resources) may be smothered or disturbed.

This impact has immediate localized and permanent effects on the bottom life and it cannot be avoided, therefore, there is no need for mitigation of impacts.

4.3.3.2.1.2 On Plankton

The major impact of dredging activities on plankton would be the expected increase in turbidity (levels of suspended solids) in the water column on local plankton community function. Turbidity would tend to limit light penetration in the water column which is essential in photosynthesis, a vital process in phytoplankton primary production. However, these effects are transitory (or temporary). While water column turbidity created by dredging or disposal is probably not of major environmental concern, it may be a very real aesthetic problem.

Increased turbidity would also lead to the irritation and clogging of gills of fish larvae and juveniles (ichthyoplankton) that could lead to their eventual smothering (Hirsch *et al.*, 1978). This adverse condition would slightly increase the mortality rates among fish larvae/juveniles including other planktonic organisms. Being planktonic, fry or juvenile cannot avoid turbidity impacts because of their inability to swim against currents.

These impacts, while significant, are localized and temporary. Turbidity of the water column is expected to decrease to normal levels immediately following the completion of the dredging activities.

To mitigate the aesthetic impacts and the impact among fish larvae/juveniles including other planktonic organisms, use of silt curtains is recommended.

4.3.3.2.1.3 On Soft Bottom Benthic Dwelling Organisms

Benthic habitats are susceptible to impacts during construction activities. Soft bottom benthic habitat elements include mud bottom epifauna and infauna. One of the significant impacts of the proposed project concerns the established soft bottom benthic communities of the dredging area. These construction activities will not only disturb the existing benthic fauna but will entail a complete smothering of all benthic organisms present in dredging area and immediate vicinity. There is no known remedy for this impact as the project construction activities, which are deemed very important, will be permanent in the area. However, benthic organisms can easily re-colonize in undisturbed and areas. Benthic re-colonization should be quite rapid and occur within a few months after construction, depending on the type of environment and biology of the animals affected. Complete recovery rates of soft bottom benthic communities are partly a function of habitat type and depth and could be attained within a year or two. Therefore, the expected negative impacts of these activities are expected to be minimal, short-term and localized.
For these communities the construction phase will destroy them and cannot be mitigated.

4.3.3.2.1.5 On Fishes and Other Types of Aquatic Life

The impacts of dredging and excavation operations on mobile organisms such as fish and other forms of aquatic life would be localized, temporary and minimal because of the inherent ability of these organisms to avoid disturbance. Increased suspended sediment levels and turbidity generated by dredging activities would cause adult fish in the dredging area to migrate to other suitable areas. However, smaller species that are unable to migrate would be chronically exposed to high turbidity may suffocate as their gills become clogged with sediments. Even low levels of resuspended fine sediment could also affect benthic larvae and juveniles of commercial clam, snail and shrimp populations. This impact is expected to occur within the vicinity of the dredging / excavation site. However, as the dredging activities are not continuous, impact on the fish resources is expected to be minimal.

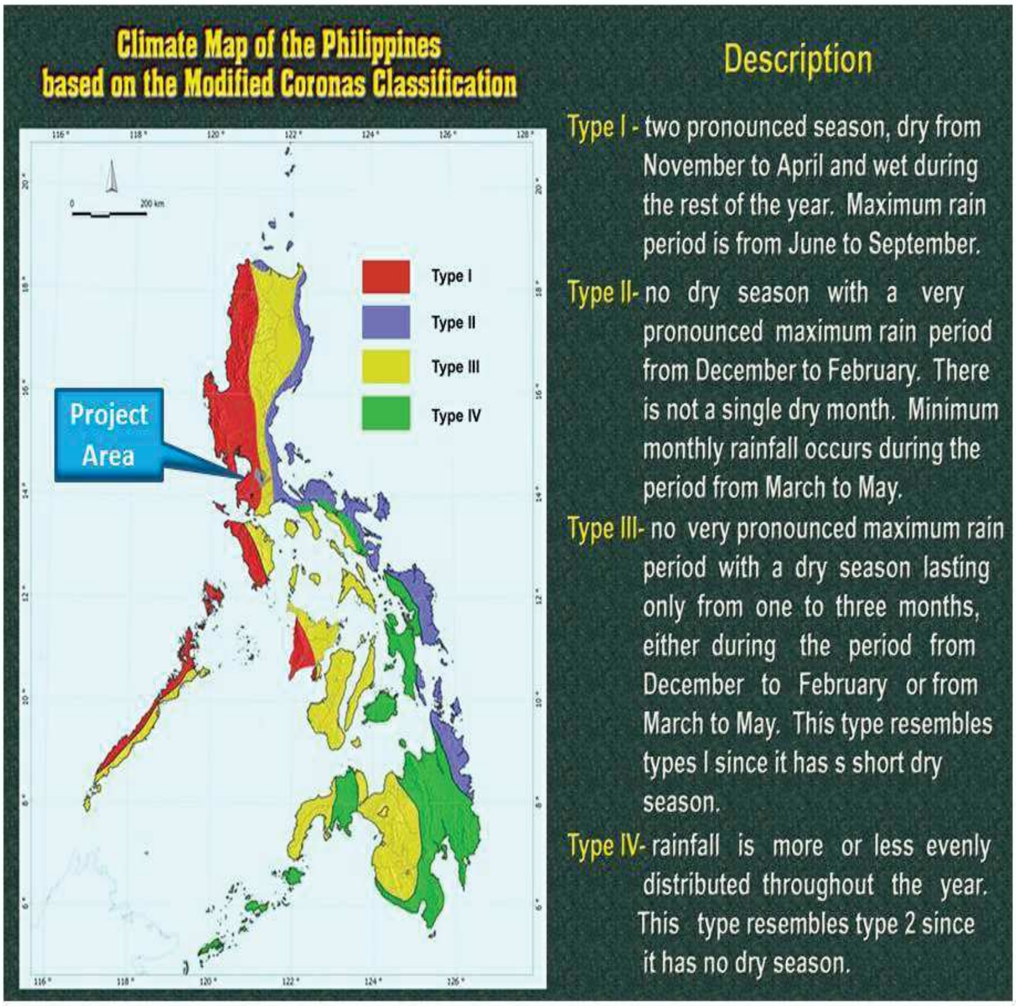
To mitigate the impact among smaller species, use of silt curtains is recommended.

4.4 Baseline in Air

4.4.1 Climate

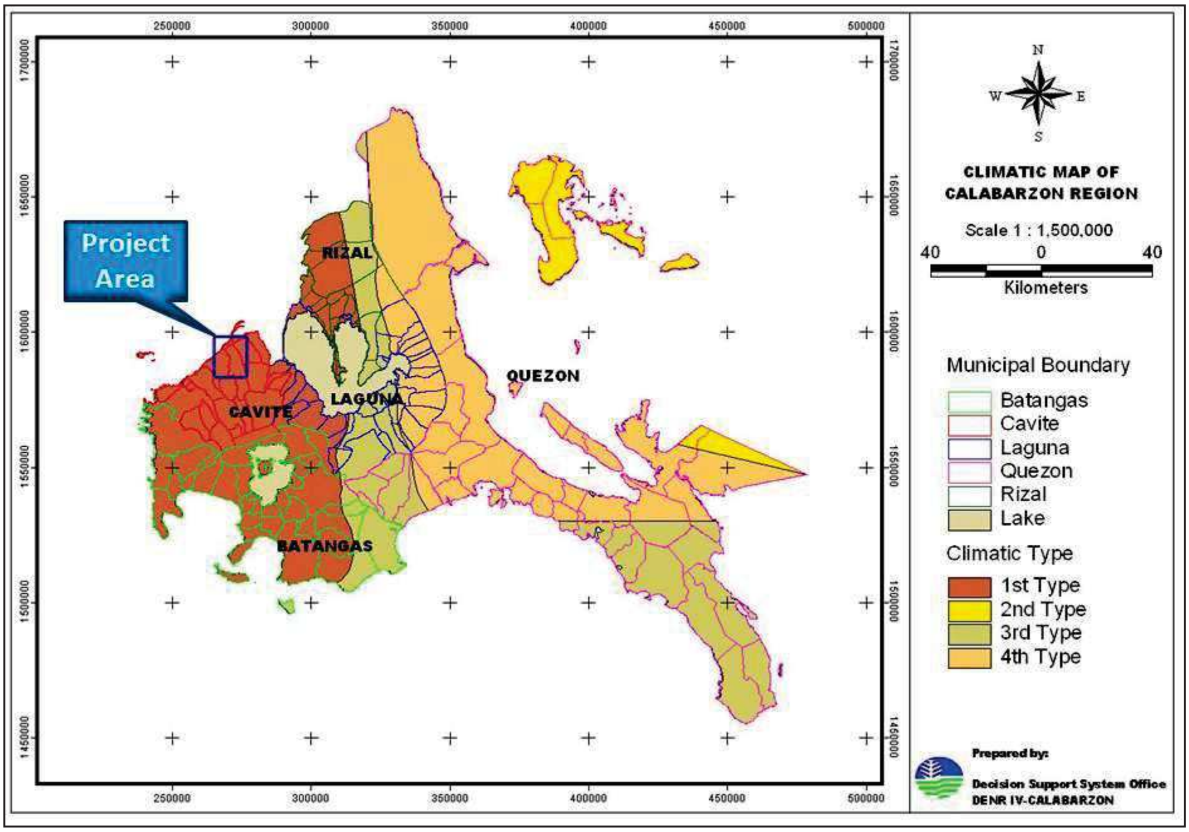
4.4.1.1 Regional Climatic Setting

The Climate Map of the Philippines based on the Modified Coronas Classification is shown in **Figure 4.63**. The basin under study belongs to Type I category. The southwestern part of Luzon including Cavite falls under Type I characterized by two (2) pronounced seasons, i.e. dry from November to April and wet throughout the rest of the year (**Figure 4.64**).



Source: PAGASA-DOST

Figure 4.63: Climate Map of the Philippines



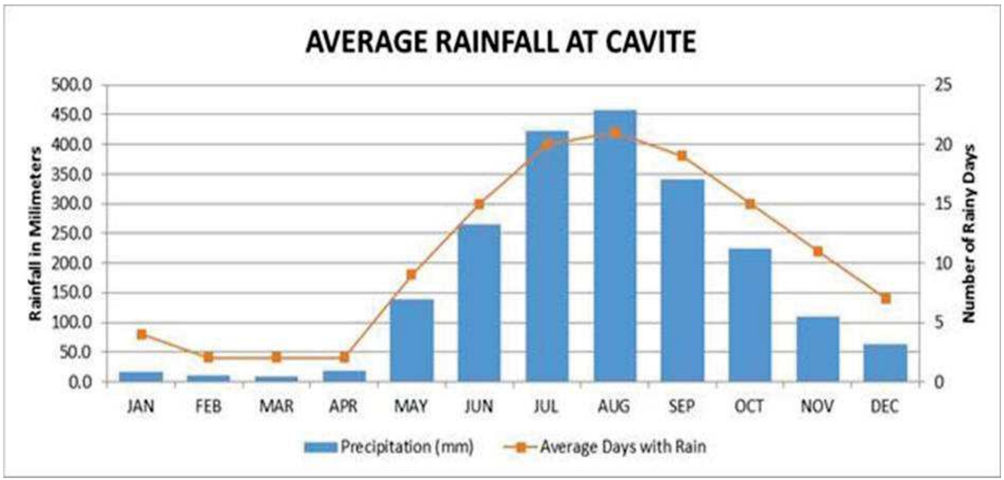
Source: Decision Support System Office, DENR IV-CALABARZON

Figure 4.64: Climatic Map of CALABARZON Region

4.4.1.2 Rainfall

The southwest monsoon is the main rainfall-causing weather system of the area. Tropical cyclones seldom, if not rarely, cross the project area. The rainy season in the area occurs from May to December while the rest of the year is relatively dry. The month of August is the wettest, with a monthly average rainfall of 457.2 mm. The month of March, on the other hand is the driest, with a mean monthly rainfall of 9.4 mm. The average annual rainfall recorded based on 30 years of data is 2078.4 mm.

Based on the climatological extremes of PAGASA, the highest rainfall amount was for a day as of 2014, was 475.4 mm which occurred on August 19, 2013 as shown in **Figure 4.65**.



Source: Sangley Synoptic Station

Figure 4.65: Average Rainfall at Cavite

4.4.1.2.1 *Climate Data Averages for 2015*

For the year 2015, the climate data covering the Project Area is shown in **Table 4.48**. The information was recorded at the Sangley Point station in the northern portion of the Cavite City peninsula.

Table 4.48. Cavite Climate Data for 2015

Month 2015	Ave. Temp. (^{0}C)	Ave. Rel. Humidity (%)	Total Rainfall (mm)	Total Days w/ Rainfall	Total Days w/ Thunderstorm
January	26.10	79.30	30.99	3	0
February	26.90	76.50	1.01	1	0
March	28.00	75.30	11.68	3	0
April	30.10	73.00	0.00	0	0
May	31.10	74.40	11.18	2	8
June	30.70	77.60	174.50	8	10
July	29.00	82.10	337.57	16	5

August	29.30	82.20	319.27	12	13
September	29.40	82.60	360.92	12	23
October	29.20	81.00	109.72	7	4
November	29.30	77.10	9.40	3	1
December	27.90	80.30	331.72	9	0
Source: http://en.tutiempo.net/climate/2015/ws-984280.html					

The annual temperature varies from 26^{0}C recorded in the coastal area to 31^{0}C in the lowland and hilly areas. January, February and December are the coldest months of the year, while the summer months of April and May are usually the hottest. Rainfall was concentrated during the wet season from May to October.

4.4.1.2.2 *Current Climate Trends in the Philippines*

Based on the study by PAGASA (2011), current climate trends in the Philippines have been reviewed as presented in **Table 4.49.**

Table 4.49. Climate Trends in the Philippines

Climate aspect	Description
Temperature	The temperature in the Philippines has increased like other regions in the world. During the period 1951 to 2010, an increase of 0.65 °C or an average of 0.0108 °C per year-increase was observed. Increases in maximum (or daytime) and minimum (or nighttime) temperatures have been 0.36 °C and 1.0 °C during the last 60 years, respectively. More hot days and warm nights and less cold days and nights were observed.
Rainfall	Observation records from 1951 to 2008 also indicate an increasing trend in the intensity and frequency of extreme rainfall events in most parts of the Philippines. These facts seem to be a slight decreasing trend in the frequency of tropical cyclones but a high inter-annual variability.
Sea Level	Historical data from a global and local perspective has shown that sea levels have been rising and may pose a hazard particularly to coastal ecosystems and

	settlements.
Tropical Cyclone	According to analysis of trends of tropical cyclone occurrence or passage within the so-called Philippine Area of Responsibility (PAR), an average of 20 tropical cyclones form and/or cross the PAR per year. The trend shows a high variability over the decades but there is no indication of increase in the frequency. However, there is a very slight increase in the number of tropical cyclones with maximum sustained winds of greater than 150 km/h and above (typhoon category) being exhibited during El Niño event.

Source: PAGASA-DOST

PAGASA has also forecasted the climate trend in the future such as:

- The Philippines ranks high among the countries that are at risk to climate change.
- Climate projections indicate increases in annual mean temperatures by 0.9-1.1 °C in the 2020s and 1.8-2.2 °C in the 2050s.
- Hot days and dry days are likely to be more frequent over the Philippines with more heavy rainfall days especially over Luzon and Visayas by 2020 and 2050.
- Reduction in rainfall in most parts of the Philippines is predicted during the summer (MAM) season. However rainfall increase is a trend during the southwest monsoon (JJA) until the transition (SON) season in most areas of Luzon and Visayas in 2020 and 2050.
- Heavy daily rainfall will continue to become more frequent, and extreme rainfall is projected to increase in Luzon and Visayas only. But number of dry days is expected to increase in all parts of the country in 2020 and 2050.

4.4.1.2.3 *Future Climate Trends in Cavite*

Based on the PAGASA study, the seasonal climate projections in 2020 and 2050 in Cavite Province for temperature increase, rainfall change and frequency of extreme events are shown in **Tables 4.50** to **Table 4.52**, respectively. The abbreviations used in the tables are as follows:

DJF - the northeast monsoon season from December to February;
MAM - the summer season from March to May;
JJA - the southwest monsoon season from June to August; and
SON - the transition season from September to November.

Table 4.50 Seasonal Temperature Increases in 2020 and 2050 in Cavite Province

Observed Baseline (1971-2000) °C				Change in 2020 (2006-2035) °C				Change in 2050 (2036-2065) °C			
DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
25.7	28.2	27.3	26.9	1.0	1.2	0.9	1.0	2.0	2.2	1.8	1.9

Note: Under medium-range emission scenario

Table 4.51 Seasonal Rainfall Change in 2020 and 2050 in Cavite Province

Observed Baseline (1971-2000) mm				Change in 2020 (2006-2035) %				Change in 2050 (2036-2065) %			
DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
124.9	242.8	985.7	579.0	-26.1	-28.2	13.1	0.4	-19.1	-30.5	24.2	5.9

Note: Under medium-range emission scenario

Table 4.52 Frequency of Extreme Events in 2020 and 2050 in Cavite Province

Station	No. of Days w/ Tmax > 35 °C			No. of Dry Days			No. of Days w/ Rainfall > 200mm		
	Obs (1971-2000)	2020	2050	Obs (1971-2000)	2020	2050	Obs (1971-2000)	2020	2050
Sangley	630	1,697	2,733	7,352	6,635	6,565	6	9	9

Note: Under medium-range emission scenario

To use the tables and arrive at values of seasonal mean temperature and seasonal rainfall in 2020 and 2050, the projections are added to the observed values (presented in each of the tables). For example, the projected values in 2020 are:

DJF mean temperature = (25.7 + 1.0) °C = 26.7 °C;
DFJ rainfall = (124.9 + 124.9(-26.1%)) mm = (124.9 – 32.6) mm = 92.3mm;
No. of days with Tmax > 35 °C during the 2006-2035 period (centered in 2020) = 1,697;
No. of dry days during the 2006-2035 period (centered in 2020) = 6,635; and
No. of days with rainfall > 200mm during the 2006-2035 period (centered in 2020) = 9.
Obs - Observed Baseline (1971-2000)

4.4.1.2.3.1 Temperature

For a period of 30 years (1981-2010), the average annual maximum temperature in the area is 31.8°C while the average minimum is 24.9°C. Maximum highest temperature of 38.5°C occurred in May 16, 1987 and the minimum of 18.0°C occurred in February 1, 1982. **Figure 4.66** shows the recorded average temperature in Cavite.

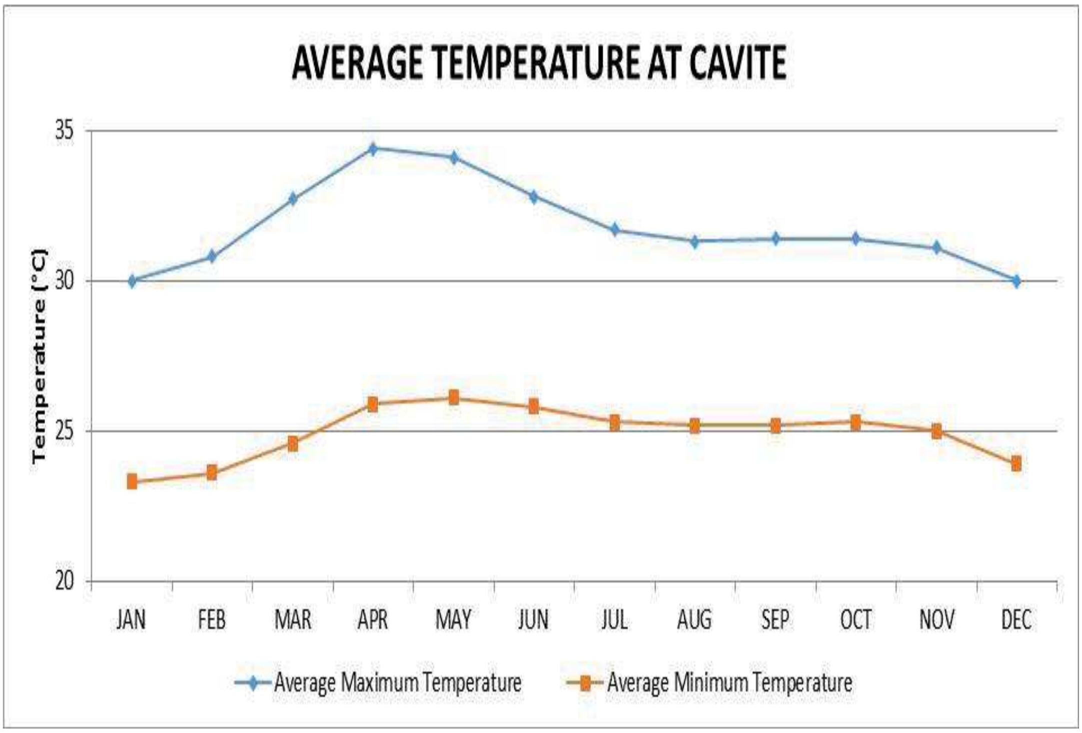


Figure 4.66: Average Temperature at Cavite (Source: Sangley Synoptic Station)

4.4.1.2.3.2 Relative Humidity

The relative humidity is a measure of the amount of moisture in the atmosphere relative to the saturation condition of the air at the same temperature and pressure. The mean annual relative humidity in the area is 78% occurring in the months of June. The least humid condition for the area is in summer month of April with an average amount of 71%.

4.4.1.2.3.3 Wind

As shown in the Climatological Normals table, the prevailing wind direction is east southeast with an annual average wind flow of 3 m/s occurring throughout the year.

Major Meteorological Systems

Based on the extremes data of the synoptic station, the maximum rainfall amount observed was 475.4 mm that occurred in August 19, 2013. The occurrence interval of this value is greater than 100 years. The rain event was caused by the presence of severe Tropical Storm "Maring" (**Figure 4.67**) and the enhanced southwest monsoon which greatly affected the western part of Luzon, including Cavite. During its passage, it was reported that several towns of Cavite were submerged in water.

According to the Disaster Risk Management Council of Bacoor City, three of the major rivers of the province; i.e, Bacoor River, Imus River and Zapote River, overtopped their banks, causing widespread flooding, especially In the coastal municipalities of Kawit, Rosario and Noveleta. (Source: Inquirer Southern Luzon). **Figure 4.68** shows the tropical cyclones pssing the Philippine Area from 1948 to 2010.

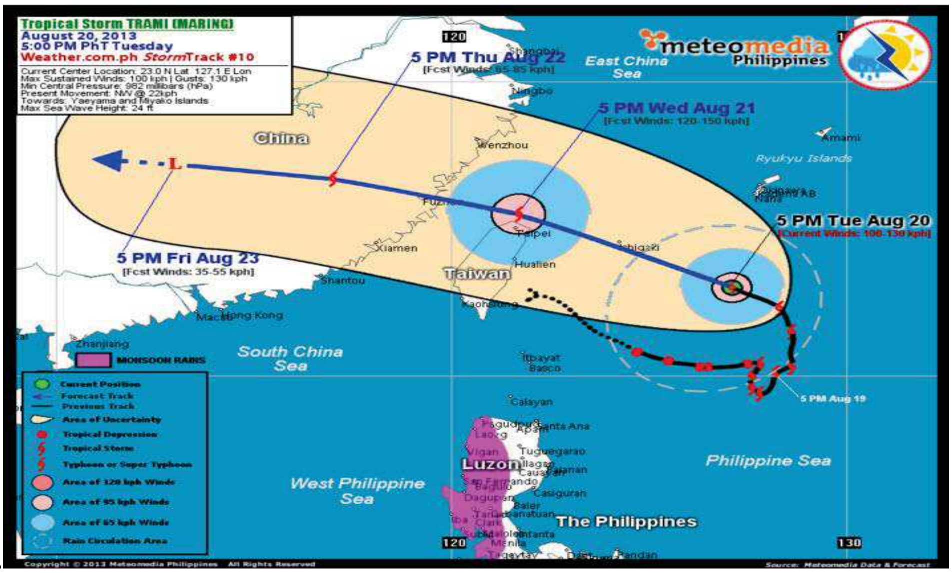


Figure 4.67: Path of Typhoon Maring in August 2013

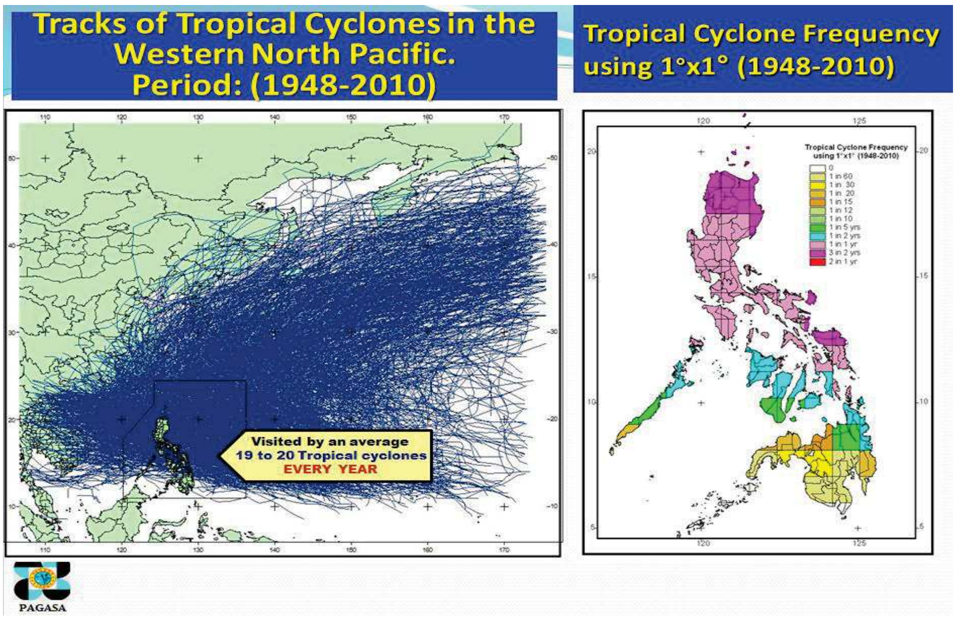


Figure 4.68: Tropical Cyclones Passing the Philippine Area

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4.4.2 Air Quality

The project includes ambient air and noise monitoring for 24 hours in terms of parameters listed on **Table 4.53**. Two (2) stations were measured for air quality and three (3) stations were collected for noise and vibration measurements.

Table 4.53. Sampling Location and Parameters Tested

Station No.	Sampling Station Name/Description	Parameters Tested*
		Ambient and Noise
Station A1	Sta. Rosa 1, Noveleta, Cavite, Molina's Compound	TSP, PM_{10}, NO_2, SO_2, CO, CO_2, Noise, vibration
Station A2	Pinagtipunan, General Trias, Cavite	TSP, PM_{10}, NO_2, SO_2, CO, CO_2, Noise, vibration
Station N3	Tejero, General Trias, Cavite	Noise and vibration only

*TSP = Total Suspended Particulate Matter; PM_{10} = Particulate Matter at 10µ; NO_2 = Nitrogen Dioxide; SO_2 = Sulfur Dioxide; CO = Carbon Monoxide; CO_2 = Carbon Dioxide

The air and noise quality baseline sampling were sampled by CRL Calabarquez Corporation at the proposed Flood Mitigation Project for Cavite Lowland Area located at the municipality of Noveleta and General Trias City of Cavite on February 22-25, 2016. The report will serve as a pertinent document for the firm's compliance with the Department of Environment and Natural Resources (DENR). The results are then compared with the DENR Standards under National Ambient Air Quality Guideline Values (NAAQGV) of Republic Act 8749 or known as the Philippine Clean Air Act of 1999.

4.4.2.1 METHODOLOGY

4.4.2.1.1 AMBIENT AIR QUALITY MONITORING

4.4.2.1.1.1 SAMPLING EQUIPMENT

There were four (4) types of ambient air sampler used (see **Table 4.54**).

Table 4.54 Ambient Air Monitoring Equipment Specifications

Equipment Name/Description	Brand/Model	Testing Capabilites
High Volume Sampler	Tisch Environmental	TSP, PM10
Personal Sampler	SKC	NO2, SO2
Direct Readout Analyzer	Testo	CO, CO2
Anemometer	Testo	Wind Speed

*TSP = Total Suspended Particulate Matter; PM_{10} = Particulate Matter at 10µ; NO_2 = Nitrogen Dioxide; SO_2 = Sulfur Dioxide; CO = Carbon Monoxide; CO_2 = Carbon Dioxide

The high volume sampler is equipped with all weather shelter timer and flowchart meter and is powered by electricity through external power sources. The personal sampler is equipped with flow meter powered by external/internal power sources and a low flow controller. It is attached to parallel tubing with two (2) pieces of midget impingers. For SO_2, the bubbler has a straight orifice nozzle while for NO_2 the bubbler has a fritted nozzle. While for the anemometer, it has a range of 0.4 m/s - 20.0 m/s and is calibrated against standards that are traceable to National Institute of Standards and Technology (NIST).

4.4.2.1.1.2 SAMPLING METHODOLOGIES

The ambient air quality monitoring conducted by CRL Calabarquez Corporation was performed at an elevation of at least two (2) meters above the ground level and sampling was strategically stationed within the proposed project sites. After sampling was conducted for each station, the gas samples were carefully recovered in the sampling bottles and preserved at low temperature and were immediately submitted to the laboratory for analysis.

4.4.2.1.1.1.1 FILTRATION METHOD BY HIGH VOLUME SAMPLER

TSP SAMPLING

Principle of Sampling - Ambient air was drawn through a glass fiber filter over a period of time. Particles having a diameter of 20-50 µm were collected ordinarily. The filter paper containing the sample was weighed; hence, the final weight of the sample over that of the standard volume of air sampled gave the concentration of TSP.

4.4.2.1.1.1.2 FILTRATION METHOD BY HIGH VOLUME SAMPLER

PM_{10} SAMPLING

Principle of Sampling - Ambient air, with particle size less than 10µm was entered in a Tisch Environmental 10µ inlet by means of vacuum system. The air passes through a venturi type casing resulting to a flow rate of approximately 40 cubic feet per minute. The particles were collected in a glass fiber filter and determined by measuring gravimetrically. The filter paper containing the sample was weighed hence the final weight of the sample over that of the standard volume of air sampled gave the concentration of PM_{10}.

4.4.2.1.1.1.3 ABSORPTION IN LIQUIDS FOR GASEOUS POLLUTANTS

NO_2, SO_2 SAMPLING

Principle of Sampling - A known volume of air (0.4L/min for NO_2, 0.5L/min for SO_2) was sampled with a wet-chemical system where a constant volume of air sample passes through a suitable reagent (absorbing reagent) that was reactive to the specific pollutant desired. As the air sample passes through the bubbler rack, the air diffuses forming air bubbles and slowly reacts to the chemical reagent forming a complex ion. The SKC personal sampler was calibrated with NIST traceable digital calibrator to assure its accuracy. The samples were then analyzed using prescribed and approved methods.

4.4.2.1.1.1.4 DIRECT READOUT

CO, CO_2 SAMPLING

Principle of Sampling - Testo brand direct readout analyzer was the equipment that was used to determine CO and CO_2. The detection limit of the electrochemical gas sensors are 0-2000 ppm for CO and 0-9999ppm for CO_2 with an increment of 1ppm. At least three trials were performed to ensure that the results were properly monitored.

4.4.3 AMBIENT NOISE QUALITY MONITORING

4.4.3.1 SAMPLING EQUIPMENT

A digital sound level meter with built-in data logger was used in the noise monitoring activity conducted by CRL Calabarquez Corporation. The sound level meter used was Lutron that meets the IEC 61672 standard, class 1. The equipment has A frequency weighting and fast time weighting with a measurement range of 30 dB to 130 dB and resolution of 0.1 dB.

4.4.3.2 SAMPLING METHODOLOGIES

The noise measurement was conducted within the three (3) stations. The noise levels monitored were continuously recorded in the data logger. The multiple sounds reading each station was recorded every minute for 24 hours and summarized by getting its equivalent noise level (L_{Aeq}) and median (L_{50}).

4.4.3.3 SAMPLING LOCATION

The three (3) sampling stations were positioned within the proposed project sites. These stations were pre-selected and were strategically distributed in order to evaluate the present air and noise quality in the said vicinity. The two (2) locations ambient air and the three (3) locations ambient noise were discussed with customer representative prior to the actual sampling. See sampling photos taken during the sampling, **Figure 4.69**, **Figure 4.70** and **Figure 4.71**. **Figure 4.72** shows the sampling map locations.

4.4.3.3 RESULTS AND DISCUSSIONS

4.4.3.3.1 Air Quality

Table 4.55- Observed 24-hour Ambient Air Concentrations of parameters listed on Table 4.56 in comparison with the prescribed limit under Republic Act 8749 (Clean Air Act) Implementing Rules and Regulations for National Ambient Air Quality Guideline Values (NAAQGV), in µg/Ncm. TSP and PM_{10} at Station A1 exceeded the NAAQGV guidelines at 230 µg/Ncm and 150 µg/Ncm respectively, while Station A2 in General Trias met the required limit. High results of TSP and PM_{10} at Sta. Rosa I, Noveleta, Cavite, Molina's compound may have been influeneced by the 305 light vehicles and 1,130 motorcycles and tricyles plying in the area. It was also observed that a smoke was seen coming from the dump site which is 400 meters away from Station A1. Meteorological factors such as the wind velocity and direction may also have contributed to the movement of dust from the road. For NO_2, SO_2, and CO, all stations met the required standard limits. For SO_2 results, the detection limit in each station is different since they have different sampling volumes. For CO, there is no standard limit set in Ambient Air Quality under Philippine Clean Air Act.

Table 4.55 – Results of Ambient Air Quality in selected stations at Cavite lowland Area

Station No.	Location	Date and Time of Sampling	TSP	PM_{10}	NO_2	SO_2	CO*	CO_2*
A1	Sta. Rosa 1, Noveleta, Cavite, Molina's Compound	February 22-23, 2016 1144H - 1144H	***433***	***153***	10.2	ND[1]	1.0	463
A2	Pinagtipunan, General Trias, Cavite	February 23-24, 2016 1342H - 1342H	134.0	73.7	9.5	ND[2]	ND	482
DENR Standard (NAAQGV), µg/Ncm		24-hr Sampling	**230**	**150**	**150**	**180**	**9****	**N/A**

N/A = Not Applicable; ND = Not Detected, below minimum Detection Limit of [1] 1.05µg/Ncm, [2]1.06 µg/Ncm (SO_2), CO = 1ppm, CO_2 = 1ppm
Ncm- Normal cubic meter; *units are in ppm, **Guideline value for 8-hr sampling

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Figure 4.69 – Station A1, Sta. Rosa I, Noveleta

Figure 4.70 – Station A2 Pinagtipunan, General Trias

Figure 4.71 – Station A3 Poro Point Parking Area

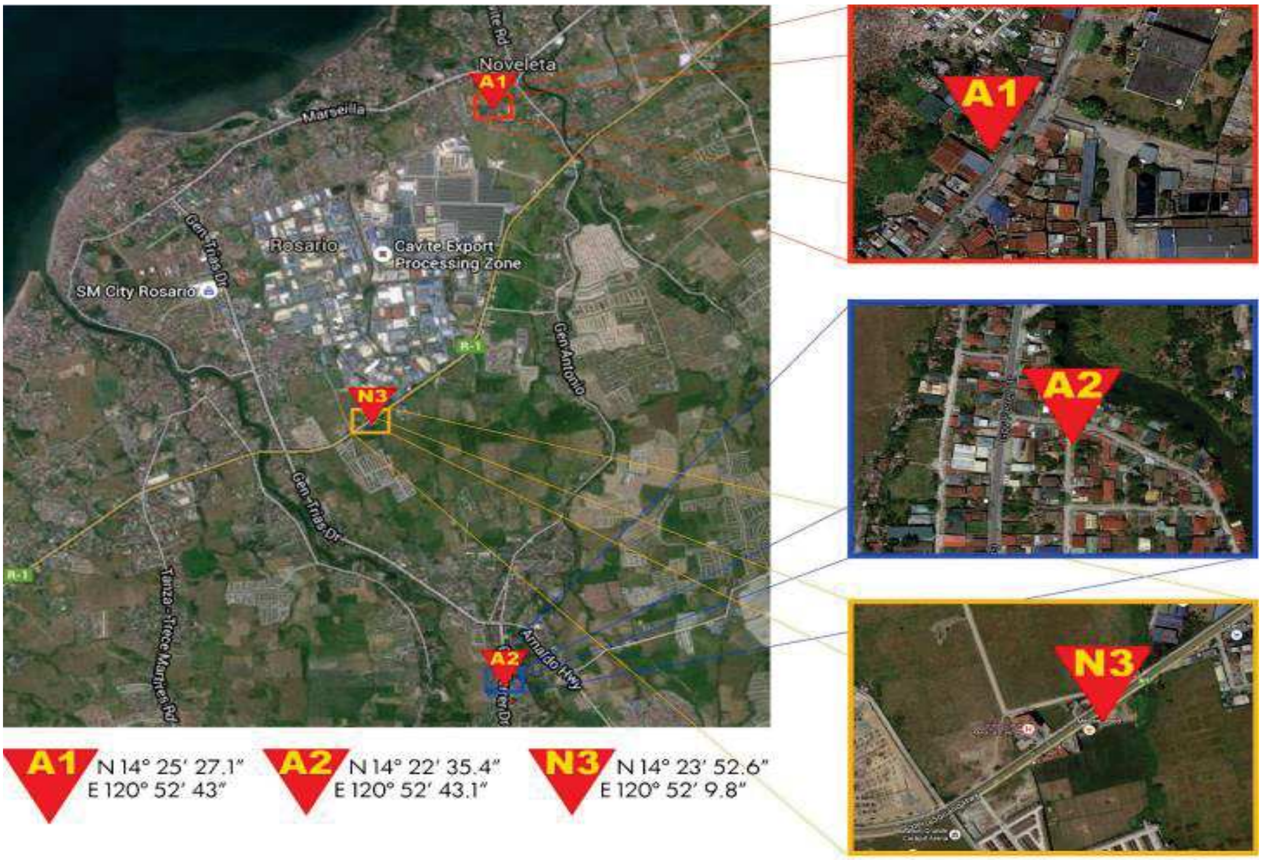

Figure 4.72 – Air and Noise Sampling Stations

4.4.3.3.2 Noise Quality

Noise measurements were conducted at an average time of one (1) minute per interval on a 24-hour monitoring. Monitoring was conducted on a sunny, partly cloudy and fair with rare light rain weather associated with light to moderate winds. The prevailing winds at the time of sampling came mostly from Northeast to Southwest (NE-SW) direction.

Table 4.56 presents the results of noise level monitoring conducted from the three (3) stations. The results of each station are summarized by getting the lowest (Min) and highest (Max) readings and by computing the equivalent continuous noise level in its logarithmic form (L_{Aeq}) for each time period. The 50-percent exceeded level or L_{50} is also obtained for each station by getting the midpoint of the noise readings. Note that the L_{Aeq} was computed using the readings in the data logger. Extreme noise peak was omitted. The results are compared with the DENR Ambient Noise Quality Standards Sec. 78 Chapter IV, Article 1 of National Pollution Control Commission (NPCC) Rules and Regulations, 1978 standard limits for Class A category. Major sources of max noise levels came from vehicles plying in the streets. Possible noise contribution was the operation of high volume samplers which was station few meters from the noise measurement. For Station N3, major noise sources also came from buses and heavy trucks.

Table 4.56- Observed 24-hour Noise Level Propagation in Decibels dB(A)

Station No.	Location	Date and Time of Sampling	Daytime 0900-1800H		Evening 1800H-2200H		Nighttime 2200H – 0500H		Morning 0500H – 0900H		Min	Max
			L_{Aeq}	L_{50}	L_{Aeq}	L_{50}	L_{Aeq}	L_{50}	L_{Aeq}	L_{50}		
A1	Sta. Rosa 1, Noveleta, Cavite, Molina's Compound	February 22-23, 2016 1144H - 1144H	72.9	60.0	71.4	60.5	59.9	57.5	68.0	60.7	53.0	99.4
A2	Pinagtipunan, General Trias, Cavite	February 23-24, 2016 1342H - 1342H	61.2	59.1	62.5	60.5	61.1	59.5	62.7	59.8	49.8	82.4
N3	Tejero, General Trias, Cavite	February 24-25, 2016 1450H - 1450H	69.6	62.3	66.6	62.0	69.2	68.7	71.9	65.8	47.9	100.5
DENR Standard *(NPCC)		(1) General Areas	**55**		**50**		**45**		**50**		---	
		(2) Area Directly facing a four-lane road	**60**		**55**		**50**		**55**			

**Noise standards for Class "A" (Residential Area);*
Note: Extreme noise (peak noise) was omitted. See Annex 2 for the complete noise level measurements

Table 4.57 presents the count of vehicular traffic which is conducted along a particular road at the three (3) stations. The data are obtained manually by visually counting and recording the traffic on a tally sheet.

Table 4.57 – Observed 24-hour Traffic Count

Station No.	Location	Vehicle Type					Total
		Bicycles	Motorcycles and Tricycles	Light Vehicles	Buses	Heavy Trucks	
A1	Sta. Rosa 1, Noveleta, Cavite, Molina's Compound	15	1,130	305	0	0	1,450
A2	Pinagtipunan, General Trias, Cavite	0	204	120	0	0	324
N3	Tejero, General Trias, Cavite	0	2,509	2,160	1,277	1,593	7,539

Note: See Annex 2 for the traffic count every 2 hours

Table 4.58 and **Table 4.59** present the meteorological conditions observed during air and noise measurements.

Table 4.58 – Station A1 Sta. Rosa 1, Noveleta, Cavite, Molina's Compound

Division of Twenty-four (24) Hours Sampling	Prevailing Wind Direction	Temperature °C	Barometric Pressure mmHg	Remarks
February 22-23, 2016 1144H	NE-SW	32.7	762.2	Sunny
1344H	NE-SW	34.1	761.0	Sunny
1544H	NE-SW	35.5	759.7	Sunny
1744H	NE-SW	30.1	760.6	Fair
1944H	NE-SW	27.6	762.0	Fair
2144H	NE-SW	25.9	761.8	Fair
2344H	NE-SW	25.7	760.7	Fair
0144H	NE-SW	23.8	760.3	Fair
0344H	NE-SW	23.6	759.7	Fair
0544H	NE-SW	25.9	761.5	Fair
0744H	NE-SW	27.0	762.2	Sunny, Partly Cloudy
0944H	NE-SW	30.0	762.4	Sunny, Partly Cloudy

Average Station wind velocity : 0.6 – 2.5 m/s

Table 4.59 – Station A2 Pinagtipunan, General Trias, Cavite

Division of Twenty-four (24) Hours Sampling	Prevailing Wind Direction	Temperature °C	Barometric Pressure mmHg	Remarks
February 23-24, 2016 1342H	NE-SW	34.0	758.3	Sunny
1542H	NE-SW	34.4	757.8	Sunny
1742H	NE-SW	30.9	758.4	Fair
1942H	NE-SW	29.5	759.4	Fair
2142H	NE-SW	26.7	760.3	Fair
2342H	NE-SW	25.5	760.0	Fair
0142H	NE-SW	23.4	760.1	Fair
0342H	NE-SW	24.7	761.5	Fair
0542H	NE-SW	26.9	762.3	Fair
0742H	NE-SW	26.3	761.1	Sunny, Partly Cloudy
0942H	NE-SW	32.5	761.0	Sunny, Partly Cloudy
1142H	NE-SW	34.4	760.1	Sunny

Average Station wind velocity : 0.5 – 2.9 m/s

4.4.4 Vibration Survey

Ground vibration surveys were conducted from February 22 to 25 of 2016 at three sites same with the noise quality measurement to monitor ground movement. Ground vibration readings were recorded in each sites' natural state. Triaxial accelerometers were used to record the ground vibrations and were positioned at 18 meters distance interval.

Ground vibration readings recorded were at an acceptable vibration level of less than 5 mm/s (0.5 cm/s). Peak movements recorded were caused by activities near each of the site such as vehicles passing. These activities were observed during the recording of ground vibration readings.

For each site, 144 records were captured with a time length of ten minutes for each record for 24 hour using the GEODE. The schedule of surveys performed is specified in **Table 4.60**.

Table 4.60 - Schedule of Surveys Performed

Site ID	Site Description	Date and Time of Survey
Site 1	Sta. Rosa 1, Noveleta, Cavite, Molina's Compound	February 22, 11:30am- February 23, 11:30 am
Site 2	Pinagtipunan, General Trias, Cavite	February 23, 1:30 pm- February 24, 1:30 pm
Site 3	Tejero, General Trias, Cavite	February 24, 3:00 pm – February 25, 3:00 pm

Note: vibration sampling locations were the same with the noise measurements

After data were captured, vibration data were processed analyzed and graphed. This report includes description of each site and assessment of the vibration data captured during the ground vibration survey.

4.4.4.1 Measurement Procedures

4.4.4.1.1 Equipment

Vibration survey at each sites were done using GEODE instrument with three triaxial accelerometers. The three triaxial accelerometers were set at a distance of 18 meters, each with a sample rate of 3333.33Hz. Ten minutes of ground vibration data were continuously captured for 24 hours. A total of 288 recordings per site were collected for the survey.

4.4.4.1.2 Data Processing

Ground vibration data from the survey equipment were preprocessed to segregate data from the three triaxial accelerometers. The files were graphed using the GEOGIGA SEISMIC PRO.

Based on the regional geologic information, there are two features seen in the area. The alluvium formation which consists of unconsolidated clay silt sand and gravel is dominant in the river plain and delta. The tuff breccia, a volcanogenic sedimentary rock consisting of angular to slightly rounded fragments of extrusive rocks and are cemented together by fine volcanic ash, which is covered by unconsolidated clay and silt. The tuff breccia is easily eroded and river forms deep valley. However, the exact site conditions would have to be determined though geotechnical studies and drilling.

4.4.4.1.3 Assessment Criteria

A vibration guideline according to the Australian and New Zealand Environmental Council (Technical Basis of Guidelines to Minimize Annoyance Due to Blasting Overpressure and Ground Vibration, 1990), 5mm/sec (0.5cm/s) is the maximum recommended ground vibration.

4.4.4.1.4 Scheme Evaluation

For each of the records captured during the ground vibration surveys for each site, the peak ground acceleration was noted. These peak ground acceleration values were then compared to the assessment criteria and are included in this report. **Table 4.61** shows the recorded peak acceleration, velocity and decibel per site.

Table 4.61: Recorded Peak Acceleration, Velocity and Decibel per Site

Site ID	Description	Recorded peak acceleration	Recorded peak velocity	dB
Site 1	Noveleta	0.001 cm/s/s	0.086 cm/s	50.6 dB
Site 2	General Trias	0.001 cm/s/s	0.686 cm/s	68.6 dB
Site 3	Centennial Road	0.001 cm/s/s	0.009 cm/s	30.9 dB

4.4.4.1.4.1 Ground Vibration from Environment

Ground vibration at the three target sites varies because of certain activities near each site. Site 1 and Site 2 are located within a compound recorded occasional passersby and vehicle motion. While Site 3 located beside a main road shows record of heavy vehicular ground motion.

4.4.4.1.4.2 Ground Vibration from Passing Cars

Activities near a site cause additional ground movement. All passing vehicles were continuously recorded during the whole duration of the survey.

4.4.4.1.5 Conclusion

For vibration survey, peak movements recorded during surveys were caused by activities such as passing of vehicles on the road or by an ongoing construction as these activities were observed while capturing ground vibrations. Peak ground vibration at each of the three sites did not exceed the assessment criteria of 5mm/sec (0.5 cm/sec).

The impact due to vibration may come in the form of annoyance to the residents of communities located along the highway. Annoyance and discomfort may come in the form of loss of sleep and rest, and may also be associated with social and personal loses associated with loud noises. In rare cases, vibrations have been sited to cause damage to structures including building. Usually, the levels at which annoyance occurs is far less than the levels tha may lead to structural damage of buildings.

The levels of vibration that are expected from the flood ways development will vary. The highest level to be expected shall be during the construction phase when the ground is disrupted by excavation and other heavy equipment operations. During such activities, it is recommended that the vibrations be kept at levels that do not exceed thosed described to be adverse in **Table 4.62** and **Table 4.63**.

Table 4.62 shows the vibration level indicated in the Gerrman Standard DIN 4150 Part 3 (1986) as maximum vibration levels measured in any direction at the building foundation below which damage due to vibration effects has not been identified. These values may therefore be viewed as the maximum allowable vibration level. **Table 4.63** shows the probabilities of damage to structures when exposed to vibration levels with given peak particle velocities, based on British Standard 7385 (1993). The standard, though non-specific due to the limited available data on vibration damage, gives guidance on the assessment vibration-induced damage in buildings due to various sources.

Table 4.62 – Vibration level indicated in the Gerrman Standard DIN 4150 Part 3 (1986) as maximum vibration levels

Type of Structure	Vibration Thresholds for Structural Damage (mm/s, ppv)			
	At Foundation		Uppermost Floor	
	0 to 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency Mixture
Commercial/Industrial	20	20 to 40	40 to 50	40
Residential	5	5 to 15	15 to 20	15
Sensitive/Historic	3	3 to 8	8 to 10	8

Note: When a range of velocities is given, the limit increases linearly over the frequency range.

Table 4.63 Probabilities of damage to structures when exposed to vibration levels with given peak particle velocities

Peak Particle Velocity (ppv)	Likelihood of Damage
< 1.0 mm/s	Damage unlikely but continuous vibrations should be avoided.
1.0 – 2.5 mm/s	Damage unlikely but continuous vibrations should be avoided as cosmetic damage may be possible to historic low rise structures.
2.5 – 5.0 mm/s	Poor quality or historic structures susceptible to cosmetic damage. Structural damage unlikely.
5.0 – 10.0 mm/s	Slight probability of cosmetic damage to low rise buildings or poorly fixed/secured paneling due to dynamic amplification. Poor quality structures susceptible to minor structural damage.
10.0 – 20.0 mm/s	High probability of cosmetic damage and slight probability of minor structural damage to low rise buildings.
>20.0 mm/s	Buildings susceptible to structural damage

Other vibration reduction measures can be implemented during the construction phase when more sources of vibration are operating. Vibration associated with heavy machineries during the construction may have values of 0.5 mm/s at a distance of 20 m. Road traffic has also been cited at less than 0.5 mm/s at 15 m distance in other locations where good road conditions prevail. The highest levels of traffic induced vibrations are generated by irregularities in the road surface causing vehicular induced shaking. **Figure 4.73** shows the perception of vibration by humans. Left panel shows observed levels of human sensitivity to blasting-induced vibration (USACE, 1972). The middle figure is reference levels for traffic-induced vibration (Barmeich, 1985) and right figure shows thresholds for vibration caused by pile driving (Atahanashouspoulos and Pelekis, 2000).

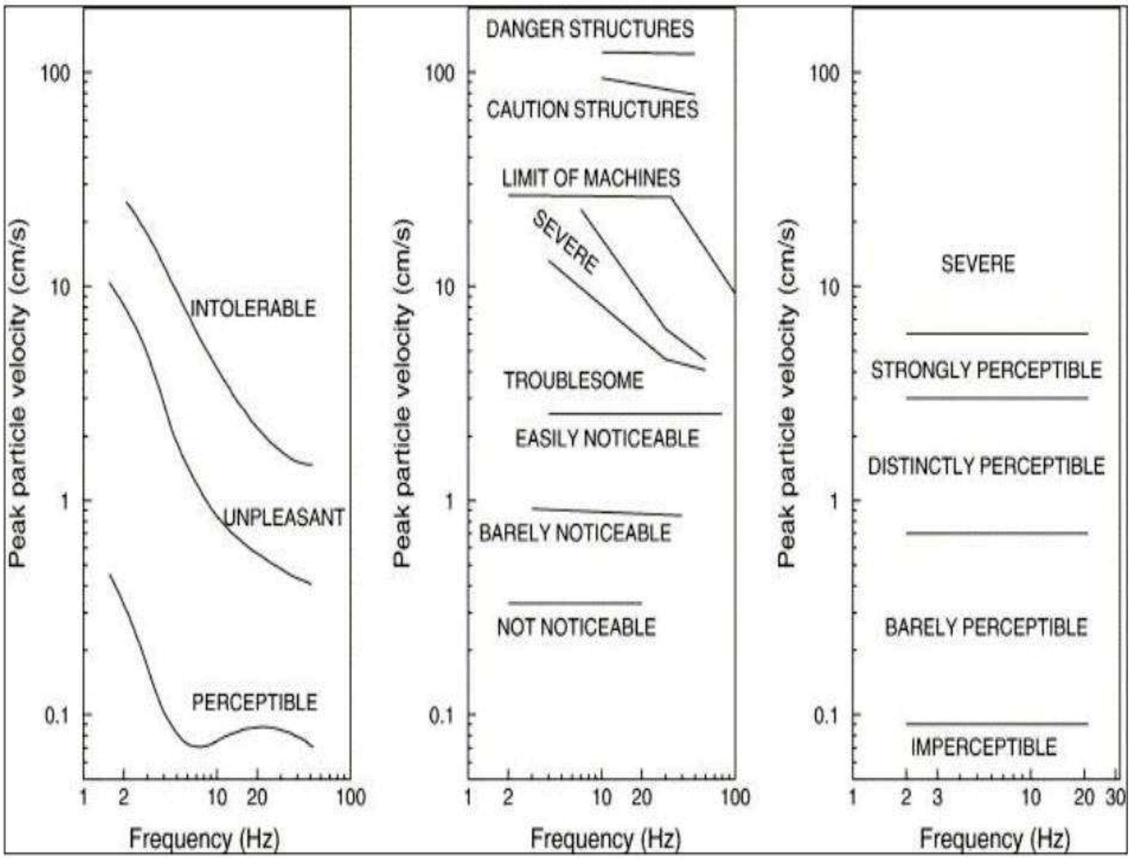

Figure 4.73 - Perception of Vibration by Humans

4.5 Baseline in Socioeconomic

In the Philippines, all private or public projects or activities which are envisaged to potentially have a negative impact on the environment are subject to an Environmental Impact Assessment (EIA) as mandated by the Philippine Environmental Impact Statement System (PEISS) or the PD 1586. Evaluation of the impact of the project covers four components of the environment: the land, air, water and people.

In this chapter, the Socio-Economic Assessment is presented to highlight one of the important aspects of the project- The People. Socio-Economic Assessment was conducted to gather relevant information on the communities that will be affected by the proposed Project. It defines the general social and economic conditions of the project area prior to the implementation of the Project. The knowledge and understanding regarding the proposed Cavite Flood Management Project and the perception and insights of the stakeholders (project's social acceptability) will likewise be covered. Socio-economic impacts were also determined so that management measures to prevent or address possible negative impacts and enhance positive ones can be planned and implemented in the most effective and efficient approach.

4.5.1 Methodology

This section details out the research methodology of the study. It explains suitable methodology in order to achieve the objectives of the socio-economic assessment of the project.

The assessment covers five municipalities of Cavite and 23 barangays within the aforementioned municipalities. These areas will traverse the improvement sites of the proposed project. **Table 4.64** shows the area considered in the assessment.

Table 4.64 Project Component and Covered Areas

Project Component	Municipalities/Barangays
Diversion Drainage-I	Rosario -Ligtong I, Ligtong II Noveleta- San Rafael I
Maalimango Drainage Improvement	Rosario- Ligtong III, Bagbag I, Tejeros Convention
San Juan Diversion Channel	Noveleta- San Rafael II, Salcedo II, Salcedo I, Sta. Rosa I, Sta. Rosa II, San Antonio II
Ylang Ylang River Improvement	Noveleta- San Antonio II Kawit- San Sebastian Imus- Alapan II-A & II-B
Rio Grande River Improvement	Gen. Trias - Brgy. Bacao I, Prinza Pob., Sta. Clara, Pasong Camachile, Pinagtipunan
Diversion Drainage II	Rosario- Tejeros Convention Gen.Trias- Tejero, Bacao II

4.5.1.1 Research Design

In order to attain valid and accurate result of the study, triangulation is applied. The study used secondary data, key informant interviews and random (purposive) survey as a data collection method. In the first phase of data gathering, documents such as Municipal Comprehensive Land Use Plans (CLUPs) and municipal and barangay profile are collected and reviewed. Primarily, the project covers 5 municipalities and 23 barangays. The second phase of the data gathering included Key Informant Interviews (KII) with the municipal staffs of Imus, Rosario, Noveleta, Gen. Trias and Kawit and some of the barangay officials directly covered by the project development. Public Consultations were conducted last February 11, 2016 and November 28, 2016, which also serve as additional means of data gathering.

The research used a non-probability sampling since the total affected people of the project area is not known and not yet accessible (separate study from RAP Team). Specifically, purposive sampling was adopted for this study. The purpose of the sampling strategy is to have a representative data collection and more critical case sampling. There were different perspectives and insights collected towards the implementation of the project. Impacts identified by the community covered by the project depend on their personal experience and perspectives.

4.5.1.2 Data Gathering Method

Secondary documents review

Secondary data collection refers to the review of existing information, and in the quantitative context, may involve the manipulation of statistical data. It was done in the first stage of the conduct of the research study. It provided a starting point for the analysis to gain background knowledge and understanding on the research subject. It serves as baseline information on the study. Examples of the secondary information acquired were: CLUPs and municipal and barangay profile of the project area. However, there are also some limitations on data acquisition (i.e. no available data, data is outdated).

***Key Informant Interviews* (KIIs)**

Interviews will be used to obtain the interviewee's perceptions and attitudes towards the project. In this study, informal and formal interviews will be conducted. Interviewees will include personnel of the offices mentioned above, community leaders, and other key players involved in the said project. They will be interviewed with semi-structured and open-ended interview questions.

The main objectives of the interview are to: 1) determine the current socio-economic environment, as well as solicit opinions, reactions, suggestions and recommendations of the households which would affected; 2) assess the Project's social acceptability; and 3) understand the community perceptions on problems, direct concerns and issues with the project implementation.

Random survey

Random (purposive) survey was conducted 3rd week of February 2016 to gather pertinent data and perceptions of the community covered by the project development. Communities residing within or near the project improvement area which were interviewed are; Diversion Drainage-I Area (barangays Ligtong I & II), Maalimango Drainage Improvement Area (barangays Ligtong III & Bagbag I), San Juan Diversion Channel Area (barangays Salcedo I, Salcedo II, Sta. Rosa I, San Rafael II, & San Antonio I), Ylang Ylang River Improvement (Barangays Alapan II-A & San Antonio II), Rio Grande River Improvement Area (barangays Bacao II, Pinagtipunan, & Tapia), and Diversion Drainage II Area (barangay Tejero Convension). Other barangays that are covered by the project which are not included in the survey are considered in the key informant interviews and secondary data gathering.

The survey was performed using the interview-administered approach. In the conduct of the household survey, a three page guided questionnaire was utilized by the interviewers. The data were analysed using both quantitative and qualitative approaches. The quantitative data were subjected to frequency and percentage distribution analysis, while qualitative methods were utilized in suggestion, reactions and perceptions.

4.5.2 Socio-Economic Profiles

General Profile of the Project Area

Land Use:

- Land use in the project area is classified into built-up and non-built-up areas. Built-up areas include residential, industrial, commercial area, infrastructure/utilities, institutional and others while non-built-up areas include agriculture, mangrove, among others. The data are generated in the Comprehensive Land Use Plan (CLUP) provided by the municipalities covered by the project.

- Based on **Table 4.65** presented, the majority of land use in the project area is classified as built-up areas. This may attribute to the growth of the Cavite economic zone and land conversion to give way for expansion of subdivisions.

Table 4.65 Land Use within the Project area

Municipal/City	Built-Up (has)	Non-Built-Up (has)	Total
Rosario	466.54	301.82	768.36
Gen. Trias	4,758.75	4,131.25	8,890
Noveleta	365.2	235.81	604.01
Kawit	837.11	901.13	1,738.24
Imus	2,359	2800	5,160

Population:

- Based on the National Statistics Office (NSO) in 2010, **Table 4.66** shows the population of the barangays along the improvement areas of the project. Total Population of the whole project area is 99, 421. The highest population with 17, 260 people is the barangay Pasong Camachile in Gen. Trias where the Rio Grande River Improvement will be undertaken, followed by barangay Tejeros Convention in Rosarion having 15, 013 population. The least populated area traversed by the project are Sta Rosa II in Noveleta (San Juan River Improvement) and San Sebastian in Kawit (Ylang Ylang River Improvement) with 896 and 897 population respectively.

Table 4.66 Population on areas traversed by the project development

Municipalities	Barangays	Population (2010)	Project Component
Rosario,Cavite	Ligtong I	4,106	Diversion Drainage-I
	Ligtong II	2,003	

	Ligtong III	5,092	Maalimango Drainage Improvement
	Tejeros Convention	15,013	
	Bagbag I	4,972	
Kawit, Cavite	San Sebastian	897	Ylang Ylang River Improvement
Gen. Trias, Cavite	Bacao I	5,366	Rio Grande River Improvement
	Bacao II	6,762	Diversion Drainage II
	Pasong Camachile I	17,260	Rio Grande River Improvement
	Pinagtipunan	6,312	
	Prinza	675	
	Sta. Clara	3,510	
	Tapia	2,553	
	Tejero	5,756	Diversion Drainage II
Noveleta, Cavite	Salcedo I	1,176	San Juan Diversion Channel Ylang Ylang River Improvement
	Salcedo II	3,653	
	San Antonio II	1,421	
	San Rafael I	2,278	Diversion Drainage-I
	San Rafael II	3,795	San Juan Diversion Channel
	Santa Rosa I	1,421	
	Santa Rosa II	896	
Imus, Cavite	Alapan II-A	2,878	Ylang Ylang River Improvement
	Alapan II-B	1,626	
Total Population		**99,421**	

- The population growth in the project area has largely been affected by in-migration brought about by the increasing number of industries at the Cavite economic zone and socialized housing projects, as well as increasing business and employment opportunities.

Income Source/Economic Condition:

- Major income source of the people within the proposed San Juan Diversion Channel and Diversion Drainage I is fishing since they lived near the coastal area. Fish processing is also part of their economic activity to increase their profit.
- Since the project is located in several areas of Cavite wherein industrial development is growing, most of the local people contribute to the labor enforcement of these industries.
- Agricultural activities are also one of the economic activities of the locals most especially in the area where Ylang Ylang River and Rio Grande River Improvement will be undertaken.

Health and Education:

- Health services are available in all areas where the project is located and easily access since there are various numbers of health facilities from public to private hospitals. There are health center on each barangay and a complement of municipal and barangay health workers.
- In terms of education, the project area is surrounded by school structures and facilities from the primary level to tertiary level. The literacy rate is high because of the accessibility of school facilities in the project area.

Transportation:

- The modes of transport in the project area are public buses, jeepneys, FX, tricycle, pedicabs and private vehicles.
- Heavy traffic congestion caused by inadequate road signage and systems, poor road maintenance, flooding and mixed vehicles.

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Housing:

- Majority of the dwellings within the project area (based on the survey conducted) are privately owned. Some are being rented, occupied free with the owner's consent while others settled without legal documents.
- Dwelling units are made by construction materials, some are made of wood, concrete/brick stone and half wood/galvanized iron asbestos, made up of nipa others are scrapped materials.

- Insistent informal settlers still thrive near or on swampy riverbanks and creeks, or in the vicinity that the LGU has categorized "Danger Zones."

Water Supply:

- Water is supplied by Maynilad Water Services Inc. (formerly Metropolitan Waterworks and Sewerage System), domestic deep well and shallow well are used to supply the needs of the populace.

Power:

- Most of the household in the project area is connected to MERALCO. There are also households that use generators, gas lamps, and batteries.

Waste Management:

- Waste generated in the project area are collected and dumped at the designated dump site. Some of the locals burned their waste in the backyard or dumped on the vacant lots. There are also waste that is being dumped in the rivers which results to the pollution of these water systems.

4.5.2.1 Rosario, Cavite

Location, Land Use, and Political Boundaries

Rosario, a coastal town, bounded on the North by Manila Bay, on the East by Noveleta, on the South by General Trias, and on the West by Tanza. It is geographically located 14° 4' 00" and 120° 50' 30" E. Rosario is 30 kilometres (19 mi) south of Manila, and 17 kilometres (11 mi) south-southwest of Cavite City. It covers 20 barangays with a total land area of 768.3640 hectares. **Table 4.67** shows the land use in Rosario, Cavite.

Rosario‟s agro-industrial character has given way for the municipality to become predominantly industrial. The combined area of the industrial and commercial zones account for about 216.40 hectares or 28.16 percent. The arrival of more investors and expansion in the Cavite Economic Zone, together with the number of commercial and business establishments‟ build-up along Gen. Trias Drive - the town‟s major thoroughfare, where PDMC, SM City Rosario and Costa Verde Subdivision are located, greatly induced the land uses in Rosario.

Residential areas is the next biggest land use with 207.3185 hectares or 26.98%, followed by Industrial. These are within all barangays or near the downtown area and its peripheries, but mostly in Barangays Tejeros Convention, Ligtong III and Sapa II.

Table 4.67 Land Use in Rosario, Cavite

Land use Category	Area (Has.)	Percentage to Total Area
Residential	207.3185	26.98
Commercial	17.6182	2.29
Institutional	13.8934	1.81
Industrial	198.7860	25.87
Parks/Plaza	3.8046	0.50
Cemetery	12.5570	1.64
Utilities	2.6604	0.35
Mangrove	3.1500	0.41
Tourism	3.5741	0.47
Non Built-Up	258.8127	33.68
Water Bodies (River/Creeks)	13.8581	1.80
TOTAL	**768.3640**	**100%**

Source: MPDC

4.5.2.1.1 Demographics

Population

Rosario has undergone significant population growth during 1903-2010. Between 1903 ~ 2007, its population grew from 6,601 to 92,253; an increase of over 1,398%. But the growth has not been consistent, such that between 2007 ~ 2010, the municipality experienced a drop of 1,975 in population. This corresponds to displacement of workers in Cavite Economic Zone setting an out-migration pattern. However, continued industrialization and commercial expansion suggest re-occurring increase akin to 2012 projected population. **Table 4.68** indicates population and household data on the barangays along the improvement areas of the project in Rosario, Cavite.

Table 4.68 Population of Barangays in Rosario Traversed by the Flood Management Project

Barangay	Actual Population (2010)	Household No. (2010)
Ligtong I	4,106	1,181
Ligtong II	2,003	975
Ligtong III	5,092	476
Tejeros Convention	15,013	3,566
Bagbag I	4,972	1,210

4.5.2.1.2 Population Growth

The population growth of Rosario is largely being affected by in-migration. In-migration was due to flock of workers from the Metro Manila and nearby provinces looking for more liveable, cost efficient and accessible locations for their residences. A significant number is also brought about by the efforts to eliminate informal settlers in other municipalities and cities. They are able to find decent dwellings in various localities in Cavite and/or cheap boarding houses around Rosario.

In the year 1903, Rosario had a little population of 6,601. This increased by 516 persons in censal year 1918. The biggest average growth was 3.91 percent recorded in 1970 where the population grows to 23,817. The trend continued up to 1980 where the persons indicated numbers to 33,312. Between 1980 and 1990, there was a rapid growth of population counted at 12,093 persons or 3.14% which were attributed to workers belonging to locators inside Cavite Economic Zone. Refer to **Figure 4.74**.

Since the year 1990 up to the last census done in the year 2007, the population growth rate of Rosario was highly ranged at 3.45%. However, in the year 2010, the population growth rate started to show a downward trend as exhibited by the decrease of 1,975. The average growth rate per annum is 2.27% (Source: NSO 2010) which is due to displacement of worker in the Cavite Export Processing Zone. These data on population growth rate shows the uniqueness of demography characteristics in the Municipality.

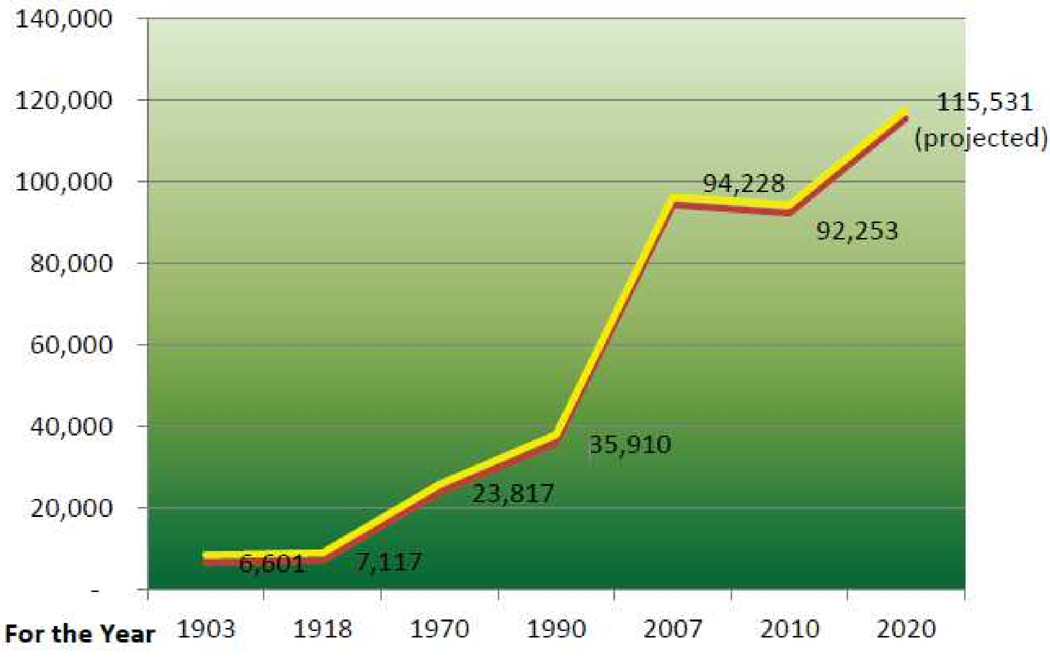

Figure 4.74 Population Growth Rate in Rosario, Cavite

4.5.2.1.3 Population Density

The Barangays of Sapa II, Tejeros Convention and Wawa III have become overpopulated due to the presence of informal settlers who were displaced in other places. Thus, it has a present population density of 120 per square hectare.

As to household population, Barangay Sapa IV has the least number of household at 229 while Barangay Tejeros Convention has the most, numbering to 3,566. The average family size of the municipality household is currently measured at 4.21.

4.5.2.1.4 Age and Sex Structure

Rosario"s population according to the 2010 NSO census totalled 92,253. Out of these entirety, 41,514 are males (45%) and 50,739 are females (55%) or a ratio of male for every 1.8 female.

The municipality has a very young population as per Age Distribution of the 2010 NSO census. An estimated 12.33% of the people are 14 years old and under (non-working group), not a healthy indicator of a productive generations to follow.

Those in the production age bracket (15-54 years old) registered a large 47,203 or 64.07 percent of the total population. The senior citizens (60 years and above) remained second at 21,771 (23.6%).

4.5.2.1.5 Income Source

Rosario was an agricultural town until the 1980’s with considerable portion of its land area where prime agricultural lands were mostly planted with traditional crops such as palay, corn crops and vegetables. Being a coastal town, fishing is one of the major source of livelihood and income of the people in the area. There is a commercial fish landing area in the municipality, which considered as one of the major fish port in the province. Fish sun drying, smoking or fermentation and salting of various species of fish are among the fish processing activities of the people for livelihood and for additional income to numerous “tinapa” vendors who sell this product on far areas like Metro Manila, Laguna and Batangas.

There is no extensive agriculture development program in the town. This may be due to the massive conversion of agricultural land to industrial and residential lots/subdivisions. Nevertheless, because Rosario is a coastal town, fishing is one of the major sources of livelihood and income of the people in the area.

Majority of local people are working in PEZA. Foreign nationals who invested in the industrial complex usually patronize the Mount Sea Hotel, Resort and Restaurant during tour of their respective companies. Other tourism attractions for the foreigners and local alike include Graceland, EM's Resort, Erlinda's Pavilion, San Isidro Beach Resort and scores of Koreans and Japanese Restaurant bars.

4.5.2.1.6 Labour Force

The total labour force (18 years old and over) in Rosario represents 31,023 or about 38.76% of the total population. Of this figure, 31,023 or 91.28% are considered economically-active. A meager 9% are unemployed. The female dominates the labour force as indicated. The unemployed were registered at 2,993 persons or about 8.44% of the economically-active population. **Table 4.69** shows the labor force in Rosario, Cavite from 2005 to 2010. **Table 4.70** presents the labor force poplation by sex and employment status.

Table 1.69 Labour Force in Rosario, Cavite

	2005	2006	2007	2008	2009	2010
THH Population	73,674	76,298	79,016	81,829	84,743	87,760
HH Pop'n 15 Yrs.	50,098	51,883	53,731	55,644	57,625	59,677
In the Labor Force	28,556	29,573	30,623	31,717	32,846	34,016
Employed	26,043	26,971	27,928	28,926	29,956	31,023
Unemployed	2,513	2,602	2,695	2,791	2,890	2,993
Not in the Labor Force	21,542	22,310	23,108	23,927	24,779	25,661

Source : PESO

Table 4.70 Labour Force Population by Sex and Employment Status, Rosario Cavite

Municipality of Rosario	Pop'n 18 yrs. And Over	Labor Force				Not in the Labor Force
		Employed	%	Unemployed	%	
Male	26,855	13,960	45	1,646	54.9	11,547
Female	32,822	17,063	55	1,347	45.1	14,114
Total	59,677	31,023	100%	2,993	100%	25,661

Source: PESO

4.5.2.1.7 Employment

Rosario has 34,015 (36.87%) of its population in the labour force. Of this, 31,023 91.28%) are employed. This attributed to the presence of Cavite Economic Zone, SM Prime Holding and the relative proximity to cities of Manila and Makati, which offers sufficient local work opportunities.

Rosario, component of the growth corridor area, has its minimum wage workers receiving 327 pesos (source: DOLE-National Wages and Productivity Commission).
Average Family Income and Expenditure vis-à-vis Poverty Level Family income sources are the salaries, wages, allowances etc. while expenditures are the expenses made for items to be consumed. Average family income in 2009 is 206 thousand pesos while the average family expenditures are Php176, 000.00. (These figures are as of 04 February 2011 of NSCB 2009 Family Income and Expenditure).

In the same manner, NSCB reports of Php166, 841.00 as the annual per Capita over threshold, meaning, families whose income falls below it are considered poor.

4.5.2.1.8 Education

Access to public education is provided in coordination with the district office through the Local School Board. There are eight (8) public elementary schools and two private elementary schools in the municipality. Secondary education is provided by two (2) National high schools, namely Rosario National High School and Bagbag High School; and by two (2) private high schools Rosario Institute and STI College Rosario. The Cavite State University-Rosario is a state university offering degree and non-degree courses. It also has a high school department. College education has become expensive and unaffordable for average income families because there is no extension or branch leading Metro Manila Colleges and Universities in the municipality.

4.5.2.1.9 Health Services

The Rosario Maternity and Medical Emergency Clinic (formerly Municipal Lying-In Clinic) provides for the post and pre-natal care and other health care services needed by the people of Rosario. There is one Mobile Hospital manned by one (1) Medical Technologist and one (1) X-Ray Technician. The Ratio is 1:92,253 populations per medical technology and X-ray technician population is similar. This mobile facility is available anywhere it may be deemed necessary, for service to the people of Rosario. **Table 4.71** shows the health facilities in Rosario, Cavite. **Table 4.72** shows the statistics of health personnel in Cavite.

Table 4.71 Health Facilities in Rosario, Cavite

Health Facilities	Public	Private
No. of Health Centers	*21*	-
No. of Hospitals	-	*2*
No. of Hospital-on-Wheels	*1*	-
No. of Medical Clinics	*1*	*4*
No. of Centers for Elderly	-	-
No. of Ambulance	*8*	*1*

Table 4.72 Health Personnel

Health Personnel	Public	Private
No. of Doctors	*7*	*16*
No. of Nurses	*17*	*28*
No. of Dentists	*3*	*10*
No. of Midwives	*25*	*5*
Others: X-Ray, Med Tech, etc.	*2*	*16*

4.5.2.1.10 Industry and Tourism

There are 12 banking and financial institutions, 16 pawnshops/ lending institutions mostly located along Rosario- Gen. Trias Drive, the Land Bank of the Philippines, a government-owned bank which is located inside the Cavite Economic Zone (CEZ) industrial area. Commerce and Trade transactions are concentrated inside Poblacion area, where the public market is located. The Municipal Market is located at the back of the Municipal Building on a one and a half hectare lot. Transactions of this kind are also made at the frontage of Cavite Economic Zone (CEZ) area where a handful of commercial establishments are situated.

The center of Tourism in Rosario is the historic Casa Hacienda – the venue of the famous Tejeros Convention which is the core of the Philippines' recognition as the first Republic in all of Asia. A commemorative building was erected in its original location during the centennial year of the Philippine Republic. There is also the largest major economic zone of the Philippines, the Cavite Economic Zone; a third-class hotel for lodging; and beaches for fun and relaxation. Recently, a potential beach attraction is being developed by the local government of Rosario - the *La Isla Bonita de Salinas*. It is a public beach at the shoreline of Barangay Silangan-I. It caters to residents and tourists from neighbouring town and cities.

4.5.2.1.11 Housing

There are about 85% (78,451) living on personally owned dwellings. These include single-detached units, multi-unit residences (apartments, condominiums and townhouses). In the 17 subdivisions and business district areas, other housing units such as row houses, commercial, and mixed-used are being used.

Areas that are considered danger zones for living are those located along Caňas River in Barangays Tejeros Convention; Wawa I, II and III; and along the coast in Barangays Sapa II, and III; Kanluran; Muzon I, and II; and Ligtong I, and IV. The Urban Poor Affairs Office (UPAO) has been addressing the needs of the marginalized and informal settlers to be relocated and acquire home lots through termed payment.

4.5.2.1.12 Transportation

Rosario is easily accessed by land means from neighbouring cities and towns. It is only 12 kms from the provincial capitol and 30 kms from Manila. Travelling is even more trouble-free as PEZA-Bacao Diversion Road is linked to Centennial Road towards Cavitex Entrance in Kawit.

National Roads traversing the municipality are interconnected with Marseilla St. and Gen. Trias drive. Combined, it has a length of about 4 kms. All roads totalling more than 32.331 kms.lead to 20 barangays. The municipality is likewise accessible by sea transportation passing through Manila Bay.

4.5.2.1.13 Communication

Telephone requirements are provided by PLDT, Globe Telecom, Digitel and Cell phone companies like Smart, Globe, and Sun Cellular phone services in the town is also manifested by the presence of a Globe transmission towers located in the barangay Tejeros Convention, Smart and Sun Cellular users are quite visible among the town residents. Radio and television programs originating from Metro Manila are clearly received in all area of the municipality. Printed newspapers, magazines and bulletin printed in the Metropolitan are readily available to local residents. The town maintains a local post office under the Philippines Postal Corporation. Courier services are provided by LBC, FedEx,UPS, OCS and DHL Companies which provide both local and international messengerial services.

4.5.2.1.14 Flooding

Flood that swamped throughout Rosario is one problem which maybe noted to occur but only during monsoonal downpour beginning at the 3rd quarter of the year. This is fuelled by seasonal monsoon rains and tropical storms. Usually, affected areas include most coastal barangays only, namely Ligtong I, II, and IV; Sapa II and III, Silangan I; Wawa I, II, and III; Kanluran; Muzon I, and II. The most devastating flood that hit the community was the typhoon "*Milenyo*" on 2006.

Three barangays are susceptible to low-to-moderate (0.5~1.0m) flooding - Poblacion, Sapa I and Sapa IV. The remaining 17 barangays are classified into moderate-to-high (1.0m above) flood susceptibility *(Source: Results of the Mines and Geosciences Bureau's 1:50,000 scale geo-hazard assessment and mapping of the Municipality of Rosario).*

4.5.2.1.15 Power

The Municipality"s power requirements are supplied by MERALCO. The demand for power supply has not shown a remarkable increase since the last five periods. Commercial sector is the second biggest consumer of electricity followed by residential sector.

4.5.2.1.16 Water Supply

Ground water is abundant in Rosario which is the major sources both commercial and industrial uses. Water is supplied by Maynilad Warter Services Inc. (formerly Metropolitan Waterworks and Sewerage System), domestic deep well and shallow well are used to supply the needs of the populace.

4.5.2.1.17 Waste Management

The garbage collection and disposal system being implemented by the municipal government is on contractual basis, renewable on yearly period, with an annual appropriate of 44 Million in the Municipal Annual Budget CY 2010, the amount includes payment for the maintenance of dumpsite, and rental of bulldozer and other heavy equipment.

Five (5) trucks are made available, all of which are owned by the municipality and the other two (2) trucks are owned and operated by a private contractor. Collection is done in all 20 component barangays on a daily basis. The current population of 92,253 can generate a conservative estimate of 16 metric tons of garbage a day. As stipulated in the contract, each truck has to haul at least 4 trips a day.

Some local households resort to composting and burning method of waste disposal. There is a proposed Material Recovery Facility (MRF) located at Barangay Kanluran The PEZA management operates its own separate solid waste management. The garbage of the factories are collected and disposed of by junkshop concessionaries operating in the complex.

4.5.2.2 Kawit, Cavite

4.5.2.2.1 *Location, Land Use, and Political Boundaries*

Kawit is within the Province of Cavite, Region IV-A (CALABARZON), west of the island of Luzon. It is particularly situated in the northern part of the province and is bounded by Cavite City and Bacoor Bay in the north, City of Bacoor in the east, City of Imus in the southeast, Municipality of Gen. Trias in the south and Municipality of Noveleta in the west. It has a distinctive hook-shaped coastline and famous for its Aguinaldo Shrine.

It is about 25 kilometers away southwest of Manila by land and about four (4) kilometers south of Cavite City across Bacoor Bay. With the opening of the new road named Cavite Expressway or CAVITEX, travel time from Manila to Kawit as now been reduced to only 20 minutes from the previous one and a half travel time. The CAVITEX has also helped decongest Aguinaldo and Tirona Highways.

Kawit is considered an urban area. The existing land use can generally be classified as built-up and agricultural. The total built-up area consists of residential, commercial, infrastructure/utilities, institutional, parks/playgrounds, industrial, tourism, cemeteries and waste management facilities. The total built-up area is 848.11 hectares or 48.79% of the total land area.

Table 4.73 presents the existing land uses in Kawit, Cavite. Out of the 890.13 hectares agricultural area, 560.26 hectares or 62.94% of which is used for rice, fruit and vegetable production with the remaining 329.87 hectares or 37.06% of total agricultural area comprising of municipal waters used for aquaculture, mangrove forests and mudflats.

Table 4.73 Existing Land Uses in Kawit, Cavite

Land Use Category	Area (in hectares)	% to total Land Area
Residential	539.85	31.06
Commercial/Business	212.28	12.21
Industrial	10.80	0.62
Infrastructure/Utilities	57.73	3.32
Institutional	13.75	0.79
Parks/Playgrounds/	2.70	0.15
Recreational Spaces		
Cemetery	8.00	0.46
Waste Management	2.00	0.12
Tourism	1.00	0.06
Agriculture	890.13	51.21
TOTAL	**1,738.24**	**100%**

4.5.2.2.2 Demographics

Population

Kawit is composed of 23 Barangays. It is both an inland and coastal municipality. Per Year 2010 Census, the Municipality of Kawit has a total population of 78,209 which account for 2.53% participation share of the total provincial population . The percentage participation rate of Kawit to the Province of Cavite. The population has been decreasing from 1990 indicating that other areas in Cavite have been urbanizing more than Kawit . **Table 4.74** presents the population in Kawit as of 2010.

There are 8 barangays which are thickly populated. These are:Binakayan, Manggahan-Lawin, Pulborista, Congbalay-Legaspi, Aplaya, Samala-Marquez, Bisita-Balsahan, Tramo-Bantayan, Kanluran-Lola Neneng which consists of 41.16% of the total projected population. Aside from the barangays located in Binakayan Area, the most populous barangay as of 2011 Projected Population is Toclong. This is primarily due to the increase of dwellers in the newly opened subdivisions. Based on the land area distribution, Toclong has the largest area and since most of it was an undeveloped agricultural area, it has been attractive to real estate developers. As of today, Toclong has a total of 9 subdivisions and this includes the Municipal Housing Project. The significant contribution of Binakayan, Panamitan, Tabon I, Putol and Sta. Isabel to the total population of Kawit may be attributed to the concentration of various commercial establishments, major institutions and the public market in these areas. These barangays are also traversed by the two (2) major thoroughfare of Kawit, the Tirona Highway and Centennial Road upon which public transport vehicles journey daily.

Table 4.74 Population of Barangay in Kawit Traversed by the Flood Management Project

Barangay	Population (2010)	Household No.(2010)
San Sebastian	897	205

San Sebastian and Poblacion post the lowest population at 897 and 931 respectively. The small population of Poblacion is attributed mainly to the use of about 93 % of its 97.58 has. land area by marine ponds.

4.5.2.2.3 Population Growth

According to the 2010 Census, the Municipality of Kawit has a total population of 78,209. Kawit experienced its highest growth rate during the period from 1990 to 1995 at 3.87%. The growth rate of the Municipality from 1995 to 2000 dropped tremendously to 2.08 % which was lower than the national growth rate then of 2.36 % per annum. It however tagged behind the provincial growth rate, which shot up to a high of 5.45 %. The succeeding 7 years, from 2000 to 2007 saw a sudden increase growth rate for the Municipality at 2.81% but still falling behind the provincial growth at 4.59% but higher than the national growth rate at 2.04%. Based on 2000 and 2010 Census of Population, the projected population for the Year 2011 is 79,970 at 2.23% growth rate.

The growth of Kawit in 2011's was reflective of the growth surge experienced and being experienced by Cavite due to its established direction as part of the CALABARZON. **Table 4.75** shows the comparative growth rate of Kawit, Cavite.

Table 4.75 Historical Population Growth Rate, Kawit Cavite

YEAR	POPULATION	INCREASE OR DECREASE	GROWTH RATE KAWIT	GROWTH RATE CAVITE
1990	47,755			
1995	56,993	9,238	3.87%	6.46%
2000	62,751	5,758	2.08%	5.45%
2007	76,405	13,654	2.81%	4.59%
2010	78,209	1,804	2.23%	4.04%

SOURCE: NSO 2010, CENSUS OF POPULATION

4.5.2.2.4 Population Density

The population density of Kawit increased by 2.22% from 45 persons/hectare to 46 persons/hectare in Year 2011. The highest densities are found in Brgy.Tramo-Bantayan – 289, Manggahan-Lawin – 259 and Samala-Marquez-232, all these brgys. are situated in Binakayan Area. The least dense are Brgy. San Sebastian and Poblacion.

4.5.2.2.5 Age and Sex Structure

Age and sex are two of the most important demographic characteristics both from demographer and planner point of view.

A very young population resides in Kawit. ages 0 to 24 comprise 50.05 % of the total population. The population contribution of each group gets smaller as it gets older. The highest contribution of the population comes from the age group 0-4 years old at 10.89%. The productive population or the working age group approximately from ages 15 to 64 represents 64.35 % of the population.

There is a relative balance on the male and female population at 49.67% and 50.33%, respectively. The sex ratio of male to female is 1:1.0137

4.5.2.2.6 Labour Force

On the other hand, as of 2011, the total labour force is 51,508. By Year 2022, the municipality would have a projected labour force of 65,546.

4.5.2.2.7 Education

The municipality has a total of eleven (11) public and ten (10) private elementary schools as of SY 2011-2012.

In SY 2011-2012, there are 192 public and 83 private teachers in elementary level. The private schools met the standard teacher student ratio of 1:35 while almost all public elementary schools failed to meet the standard ratio. Kawit has a total of 245 classrooms both public and private elementary schools. Based on the total enrollees for the public elementary level of 8,226 and total classrooms of 164 and considering the standard ratio of 1:40, there is a shortage of 42 classrooms.

At present, the municipality has two (2) public and five (5) private secondary schools with a total enrollees of 5,641 and 686 respectively. In the public sector, Tirona High School met the standard teacher-student ratio of 1:40 while Binakayan National High School teachers are handling more students than the standard teaching capacity.
For SY 2011-2012, the public high school particularly Binakayan National High School fell below the standard ratio of one classroom per 40 students. Due to the high number of enrolees there is a shortage of around twenty nine (29) classrooms.

4.5.2.2.8 Health Services

As of 2011, there are two (2) hospitals, 16 medical clinics, two (2) Rural Health Units, 19 Barangay Health Stations and 1 Diagnostic Clinic operating in the municipality. Primary Public Health Care is rendered depending on the necessity. Midwives are the primary health care facilitators on the health care station. Moreover, doctor and nurses managed the two (2) major Health Centers and also visit and attend to the Health Care Stations as scheduled. The Municipal Government of Kawit was able to build one – 25 beds secondary government hospital which was named KawitKalayaan Hospital and is being operated by the Provincial Government of Cavite for the past 16 years. There is only one (1) private hospital in the municipality named Kawit Maternity and General Hospital located at Brgy. Kaingen, Kawit, Cavite.

4.5.2.2.9 Industry and Tourism

For the past 5 years (2007-2011), there are only 3 industrial firms existing in the municipality namely R.M. Handog Merchandising, A.M. Rieta Chemicals Trading and Caimol Marketing Inc.

The Municipal Government has redirected its thrusts for tourism development by way of restoring and preserving some of its significant tourist attractions that projects the Municipality's' cultural heritage and its illustrious role in the Philippine history being the cradle of the Philippine Independence

Tourist arrivals both foreign and locals reaches 113,399 in 2011. However, the average foreign tourist arrival in the municipality for the past 5 years accounted for only 1% of the total tourist arrivals in the municipality. To further boost the tourism industry in Kawit, tourism-related projects, plans, programs and strategies must be implemented.

Historical landmarks all over Kawit weigh the most in current Tourists' Arrival quantity. Foremost is the Gen. Emilio Aguinaldo Shrine which features the vast Freedom Park in Barangay Kaingen; seconded by the Battle of Binakayan Site in Barangay Pulvorista-Bianakayan; and the Baldomero Aguinaldo Shrine in Bisita St., Binakayan. Volume of tourists is greater for students who are Philippine History enthusiasts.

The density of Local and Foreign Tourists account for those regular visits so that most famous cultural landmark in Kawit – The Kawit Roman Catholic Church (or the St. Mary Magdalene Parish Church) which was built in 1817 by Spanish priests, partially destroyed during the World War II bombings, and at the opening of the second millennium – restored to its original greatness and grandeur.

4.5.2.2.10 Housing

Based on the 2007 survey of dwelling units by construction materials, only 22.10 % of dwelling units are made of wood. Dwelling units made up of concrete concrete/brick stone and half wood/galvanized iron asbestos comprise of 72.29 % while 1.28 % are made up of nipa and 4.01 % are makeshift.

As to the tenurial status of the lots, statistic shows that 63.08% of the household are owned or being amortized the lot they are occupying, 20.18% are being rented and 7.5% are being occupied for free but with consent of the owners. Only 8.75% are being occupied for free of charge and without the consent of the owner, thus they are considered as squatters

Up to now, insistent informal settlers still thrive near or on swampy riverbanks and creeks, or in the vicinity that the LGU has categorized "Danger Zones." These areas are vulnerable and open to hazards, and the most probable places to encounter disasters. Thus, the LGU had adopted measures, plans, and programs that would mainly address the problem to assure the people's total safety and protection.

4.5.2.2.11 Transportation

The Municipality of Kawit has two (2) major roads that interlink to Metro `Manila in the north and into the industrial part of Cavite in the south. These are the Tirona Highway-Highway 25 and Cavite Toll Expressway (CAVITEX) Centennial Road.

The Tirona Highway and Highway 25 are two adjoining roads which serves the coastal part and historic centre of Kawit where the previous Town Hall was constructed besides the St Mary Magdalene Church and the Aguinaldo Shrine.

The Covelandia and Cepza Roads are also two adjoining roads recently constructed to be used as the main thoroughfare to the Industrial Zones of Cavite (CEPZA) and the Port Area of Manila vice versa.

Data gathered from the Engineering Office reveals that there is a total of about 35.259 kilometres of roads in the entire municipality of which 13.700 km. are national road, 2.296 km provincial road, 0.809 km are municipal road and 18.454 are barangay roads.
In terms of traffic congestion, chokepoints are the intersection and routes along the stretch of Marseilla St. in Barangays Ligtong III, and IV; Bagbag I, and II; Silangan I; Poblacion, and along the length of Gen. Trias drive in Barangays Poblacion and Tejeros Convention.

4.5.2.2.12 Communication

The Philippine Long Distance Telephone Company (PLDT) and GLOBE Telecommunications, both private firms are the franchise holder of the telephone system in Kawit, Cavite.

4.5.2.2.13 Flooding

There are four (4) barangays namely Poblacion, Kaingen, Wakas I and II that are directly affected by the increase of sea level. Some barangays on the outskirt that are near the rivers experienced occasional increase during high tide. Tidal rise level during lunar cycle has increased through the years and some barangays experience the water rising from the waterways, when years before, the same levels of high tide were unnoticeable.

There are about six (6) more barangays this past two (2) years that were experiencing the same level rise during high tide and much higher on rainy season. These are Barangays Tabon I, Tabon II, Gahak, Marulas, Panamitan and Magdalo (Putol). A maximum sea level rise of almost two (2) feet from normal high tide rise of 3 to 4 feet has been recorded.

Eleven (11) barangays out of 23 barangays in the Municipality of Kawit are now feeling the impacts of higher tide level. This translates to more than 30,000 people affected comprising more than 40 percent of the total population.

There are five (5) barangays in the municipality that are directly affected by floods every storm season. They are all located in the lowest lying areas in Kawit and include Barangays Kaingen, Poblacion, Wakas I and II and Magdalo (Putol). A big flood event occurs once in a span of five (5) years.

4.5.2.2.14 Power

The Manila Electric Company (MERALCO) is the franchise holder of the power utility service of Kawit, Cavite. The built up area which are concentrated in the northern portion as well as the eastern and western boundaries which are also becoming built-up areas respectively are provided with electricity with an aggregate length of power lines, mostly installed along municipal and other major roads of approximately forty (40) linear kilometers.

4.5.2.2.15 Water Supply

Water for human consumption is being supplied by Maynilad Water System Inc. (MWSI) and about one hundred fifty (150) public artesian wells/deep wells located sparsely in the built up areas as well in agricultural areas.

The MWSI water services are extended to the consumers through an aggregate length of 18.39 linear kilometres of pipelines, mostly installed in the built-up areas in the northern part of the municipality.

There are six (6) MWSI pumping stations serving the residents of the municipality. Considering an average consumption of 107 liters/capita/day (residential), the present demand of water supply, based on existing population, is about 8,556,790 liters/day or

8,556 cubic meters /day. The extent of MWSI is limited to areas installed with the pipeline system.

4.5.2.2.16 Waste Management

The Municipality needs to find a permanent solution to its solid waste problem. Option is very restricted because of the municipality's limited budget, topographical location and a very limited land area. The only option left is to recycle and to convert residual waste materials into other commercially useful products.

At present, the municipality has utilized a vacant lot, two (2) hectares situated at Barangay Batong Dalig as its disposal area for all collected garbage. As this is an open dumpsite, the municipality needs to work out possible options to replace the present open dumpsite with a sanitary landfill to comply with Republic Act 9003.

4.5.2.3 General Trias, Cavite

4.5.2.3.1 Location, Land Use, and Political Boundaries

General Trias is an inland municipality with a total land area of 8,890 hectares. The municipality straddles the northeastern part of the province and its Poblacion is located at 14°23'12" latitude and120°52'46" longitude. It is 32 kilometers southwest of Manila and is 18.27 kms. distant from the Provincial Capitol in Trece Martires City.

General Trias is subdivided into 33 barangays, ten (10) of which are located within the vicinity of the Poblacion. The largest barangay is San Francisco followed by Santiago and the smallest is Barangay Governor Ferrer.

Based on the 2011 Existing Land Use tabulation as shown in **Table 4.76**, the municipality is predominantly agricultural comprising 46.47% of the total land area. It may be noted that the total agricultural area (4,131.25 hectares) exceeds the total built up area (3,950.48 hectares) by 180.77 hectares or 2.03 percent of the total land area. The total agricultural area is comprised by the land uses identified as agricultural (2,565.34 hectares), forest park (8.58 hectares), agro-industrial (264.64 hectares), open/vacant lands (1,292.69 hectares). The open or idle land estimated for the current year approached just about one-third (32 percent) of the total agricultural land.

Table 4.76- 2011 Existing Land Use in Gen. Trias

Land Use Classification	Land Area (hectares)	% to Total Area
Agricultural	**4,131.25**	**46.47**
Agricultural (cultivated)	2,565.34	28.86
Agro Industrial (Livestock/Poultry/Fishponds)	264.64	2.98
Forest Park (Agri-nursery)	8.58	0.10
Grassland/Pasture/Open/Vacant Lands	1,292.69	14.54

Urban Use Areas	**3,950.48**	**44.44**
Resid Residential	1,512.20	17.01
Industrial	437.75	4.92
Commercial	211.05	2.37
Institutional	56.72	0.64
Parks/Playgrounds	156.65	1.76
Utilities/ Roads	871.26	9.80
PUD/Reclassified Lands with Pending Development	704.85	7.93
Other Uses/Categories	**66.31**	**0.75**
Cemeteries	24.77	0.28
Dumpsite	13.77	0.15
Easement/Buffer Zones	27.77	0.31
Rivers	**419.03**	**4.71**
Quarrying	**5.56**	**0.06**
Tourism	**317.35**	**3.57**
Total	**8,890.0**	**100.00**

4.5.2.3.2 Demographics

Population

The 2010 population data indicates that the most populated areas of General Trias were barangays San Francisco, Pasong Camachile I and II, Pasong Kawayan II and Manggahan accounting for around 55 percent of the town's aggregate population. **Table 4.77** presents the population in General Trias, Cavite as of 2010.

Table 4.77 Population of the Barangays in Gen. Trias Traversed by the Flood Management Project

Barangay	Total Population (2010)
Bacao I	5,366
Bacao II	6,762
Pasong Camachile I	17,260
Pinagtipunan	6,312
Prinza	675
Barangay	**Total Population (2010)**
Sta. Clara	3,510
Tapia	2,553
Tejero	5,756

Source : NSO Census of Population 2010

4.5.2.3.3 Population Growth

The City of General Trias registered a total population of 243,322 in 2010. From 107,691 in 2000, it increased by around 126 percent over a ten-year period. The population almost doubled during the ten-year period with an average annual growth rate of 8.49 percent. The AAGR for this period is more than double of the 4.5 percent from 1990 to 1995. **Table 4.78** presents the total population and annual growth rates from 1975-2000.

Table 4.78 Total Population and Annual Growth Rates: 1975-2000

Census Year	Total Population	Average Annual Growth Rate (%)
1975 (1 May)	34,807	3.0
1980 (1 May)	39,745	2.7
1990 (1 May)	52,888	2.9
1995 (1 Sept)	66,837	4.5
2000 (May 1)	107,691	10.0
2010 (May 1)	243,322	8.49

Source: NSO, 2000 and 2010 Census on Population and Housing

The surge in growth rate has mainly been attributed to in-migration brought about by the development of economic and socialized housing projects as well as increasing business and employment opportunities. The city population growth rate during the said period almost doubled to that of the provincial rate calculated at 4.12 percent. Refer to **Table 4.79** on population growth trends in Gen. Trias against Cavite Province.

Table 4.79 Population Growth Trends, General Trias vs. Cavite Province, 1975-2000

Censal Year	AAGR (%)	
	Cavite	Gen. Trias
1975 (1 May)	3.9	3.0
1980 (1 May)	4.2	2.7
1990 (1 May)	4.1	2.9
1995 (1 Sept)	6.5	4.5
2000 (May 1)	5.5	10.0
2010 (May 1)	4.12	8.49

Source: General Trias CLUDP 2000-2015 and NSO, 2000 Census on Population and Housing

The city had the second fastest growing population in the province following Trece Martires which had 9.64 percent AAGR. In terms of population size, General Trias ranked fourth compared to the four cities and 19 municipalities comprising the province.

4.5.2.3.4 Population Density

The city's population density is at 27.37 persons per hectare based on the Census of 2010. It increased by 14.99 from 12.38 persons/hectare in 2000 and is almost 21 percent higher than that of the provincial average estimated at 21.66 persons/hectare.

The 2010 census data indicates that the most densely populated areas of General Trias were Barangays Arnaldo with 246.1 persons per hectare. Governor Ferrer followed with 158 persons per hectare. The lowest population densities were recorded at Barangay Alingaro at 4.124 persons per hectare followed by Javalera with 7.292 persons per hectare. **Table 4.80** shows the land area and population gross density in Gen. Trias.

Table 4.80 Land Area and Population Gross Density, 2000 & 2010, Gen. Trias

Barangay Name	Land Area in Hectares		Population		Population Gross Density Persons/hectare	
	2000	2010	2000	2010	2000	2010
(Pob. 1) Gov. Ferrer		1.973	426	312		158
(Pob. 2) Sampalucan		18.46	1,085	1083		58.66
(Pob. 3) Dulongbayan		8.472	1,071	901		106.3
(Pob. 4) San Gabriel		6.23	1,485	1913		307
(Pob. 5) Bagumbayan		8.142	1,312	1060		130.1
(Pob. 6) Vibora	5.098	8.696	1,223	1026	57.84	117.9
(Pob. 7) Arnaldo		3.725	1,105	917		246.1
(Pob. 8) Prinza		6.494	839	675		103.9
(Pob. 9) 1896		4.294	662	592		137.8
(Pob. 10) Corregidor		7.568	1,067	1139		150.4
Alingaro	698.324	678.8	1,756	2800	2.51	4.124
Bacao I	337.326	355.8	3,463	5366	10.27	15.07
Bacao II	337.326	282	3,600	6762	10.67	23.97
Biclatan	390.588	465.7	3,534	11358	9.05	24.38
Buenavista I	284.064	363.3	1,034	3194	3.64	8.789
Buenavista II	272.23	268.1	2,657	7244	8.4	27.01
Buenavista III	224.88	170.2	2,757	5982	9	35.14
Javalera	686.488	698.7	2,931	5095	9.76	7.292
Manggahan	520.784	571.8	5,398	13482	10.37	23.57

Navarro	532.62	534.2	2,277	7526	4.28	14.08
Panungyanan	343.244	327.9	1,239	2430	3.61	7.41
Pasong Camachile I	301.818	395.2	3,206	17260	10.62	43.67
Pasong Camachile II	450.02	443.7	5,994	20942	4.8	47.19
Pasong Kawayan I	254.474	179.6	2,321	3358	9.12	18.69
Pasong Kawayan II	621.39	593.9	3,703	17135	5.96	28.84
Pinagtipunan	118.36	106.9	4,671	6312	39.46	59.01
San Francisco	834.438	934	25,446	63877	30.49	68.38
San Juan I	65.098	37.6	4,162	4951	63.93	131.6
San Juan II	71.02	97.39	2,975	3634	32.4	37.31
Santiago	739.496	846.5	4,721	13177	13.29	15.56
Sta. Clara	189.376	99.67	2,516	3510	6.38	35.21
Tapia	153.868	195.9	1,620	2553	10.53	13.02
Tejero	207.13	168.3	5,435	5756	26.24	34.19
Total	**8,700**	**8,890**	**107,691**	**243,322**	**12.38**	**27.37**

Source: Municipal Planning and Development Office

4.5.2.3.5 Income Source/Labour

Table 4.81 presents the labor fource and dependent population in 2010. The population in the labor force (or economically active population) which are the proportion of population 15-64 years old who are either employed or unemployed but looking for work in relation to the population, was registered at 153,557 persons. This implies that 63 percent of the total population in 2010 were in their economically productive years. The labour force (ages 15-64) constitutes 73,751 males and 79,806 females which comprises 30.3 and 32.8 percent of the total population, respectively.

Table 4.81 Labor Force and Dependent Population, Year 2010

Age Group	Census 2010 Both Sexes	Male		Female		Sex Ratio
		Number	Percent to total	Number	Percent to total	
Labor Force (15 to 64)	153,557	73,751	30.3	79,806	32.8	92.4
Dependent population	89,765	44,934	18.5	44,831	18.4	100.2
Young (0-14)	82,395	41,949	17.2	40,446	16.6	103.7
Old (65-over)	7,370	2,985	1.2	4,385	1.8	68.1
Total Population	243,322	118,684	48.8	124,638	51.2	95.2

Source: Computed based on 2010 NSO Total Population and 2000 Census on total population by Age-Group using interpolation technique.

4.5.2.3.6 Education

Formal education is provided through a network of schools strategically located in the Poblacion area and in the different barangays of the town. **Table 4.82** gives a breakdown of the number of educational institutions into public and private by level of education.

Table 4.82 Number of Public and Private Schools by Level, 2011

School level	Public	Private	Total
Elementary	27	51	78
Secondary	7	28	35
Tertiary	0	2	2
Vocational / Technical Schools	1	2	3
Day Care Center	55	0	55
Pre – School	25	57	82
Total	115	140	255

Source : Office of the MPDC

There is a total of 255 educational institutions according to the level of education it offers. These include Day Care Centers which provide pre-school trainings. Of these,140 are private institutions, while 115 are government operated. It is good to take note of, that school that offers both pre-elementary and elementary levels is counted as one pre-elementary and one elementary school. Likewise, a school that offers both elementary and secondary levels is counted as one elementary and one secondary school.

4.5.2.3.7 Health Services

Public health services are delivered through a Municipal Health Center or Rural Health Unit (RHU), manned by 61 personnel, 28 Barangay Health Stations (BHS) and a complement of municipal and barangay health workers. The RHU fully implements the restructured health care delivery system serving mostly the residents of the Poblacion and adjoining areas. Among the services offered are general medical services, minor surgery, laboratory services like sputum examination, pap smear, urinalysis, fecalysis and dental services

Alternatively, primary health care services are fulfilled by the 28 Barangay Health Stations (BHS) located in different barangays. Common services offered by the BHS are control of locally endemic diseases, immunization, nutrition program (feeding and operation timbang), treatment of some diseases and provision of basic medications. There is a total of 147 Barangay Health Workers in the municipality. Among the barangays, San Francisco, with a total of 54 health workers, has the highest number employed.

The General Trias Medicare Hospital with its 10-bed capacity is the only public hospital that complements the primary level services in the field by providing in-patient and out-patient primary level services. Hospital-based maternal and child health care is also augmented by the privately-run General Trias Maternity and Pediatric Hospital and Divine Grace Medical Center.

4.5.2.3.8 Industries

The development of industrial parks in the municipality brought about a shift from an economy focused on agriculture to one focused on industry and real estate development. This shift gave way to the rise of the financial status ofthe municipality. As of December 2010, a total of 123 firms have located in General Trias, 92 percent of which have located in the following industrial estates. **Table 4.83** presents the list of industrial estates in Gen. Trias, Cavite as of 2010.

Table 4.83 List of Industrial Estates, 2010, Gen. Trias, Cavite

Name of Industrial Estate	Location (Barangay)	Land Area Hectares)	Name of Developer	No. of Firms
1. Gateway Business Park	Javalera	164.851	Gateway Property Holdings, Inc	20
2. New Cavite Industrial City	Manggahan	57.0	Stateland Investment Corp.	20
3. Cavite Export Processing Zone	Bacao II	117.375	~	73
4. Golden Gate Business Park	Buenavista II	65.1550	Just Realty Inc.	0
5. Golden Gate II Industrial Estate	Panungayanan	16.58	Just Realty Inc.	0
6. Majestic Industrial Estate	Bacao II	20.3498	Majestic Technical Skills and Devt. & Landscape Corp.	Approved for development

7. Others	Along Governor's Drive, Manggahan and San Francisco	10.2174 10.6594		10
Total				**123**

Source: Municipal Planning & Development Office; Actual Survey

There are 10 industrial firms located outside industrial estates and which produce the following products – processed meat, dairy products, sanitary wares, ceramics, glass containers, beverage cans, moulds, garments, among others.

4.5.2.3.9 Transportation

General Trias may be reached by all modes of land transportation such as jeepneys, tricycles, private cars and trucks. Tricycles serve most secondary roads and town communities while passenger jeepneys link the town to the rest of the province. Mini-shuttle vans also serve provincial towns.

All national, provincial and municipal roads are of the all-weather type as these are paved with either concrete or asphalt. However, more than 28 kilometres (33%) of barangay roads remain unpaved. Traffic congestion is experienced in several nodal points such as the Manggahan junction, Tejero and Poblacion area.

4.5.2.3.10 Communication

The telephone service providers in the municipality are Philippine Long Distance & Tel. Co.(PLDT), Digital Telecommunication Phil., Inc. (Digitel) and Globe Telecoms. PLDT has the largest share of subscribers particularly in the Poblacion and the majority of the barangays. In 2010-2011, PLDT registered a total number of 884 subscribers while Globe had 505 in 2009-2010 and Digitel had 682 in 2009-2010 .**Table 4.84** shows the inventory of telephone connections in Gen. Trias as of 2010.

Table 4.84 Inventory of Telephone Connection, 2009-2010, Gen. Trias, Cavite

Service Provider	Residential	Commercial	Industrial	Institutional	Total
Globe (2009-2010)	445	29	1	30	505
PLDT (2010-2011)	627	146	83	28	884
Digitel (2009-2010)	597	69	6	10	682
Total	**1,669**	**244**	**90**	**68**	**2,071**

Source: Municipal Planning & Development Office

Cellular services are provided by three (3) cellular companies namely Smart Communications, Globe Telecom and Digitel/Sun Cellular with 41 cell site stations for cellular/mobile communication services.

The availability of the Internet Service Providers (ISPs) made the people of General Trias ready to access the technological advances of the computer based technology in communication and exchange of information. The ISPs operating in the town are PLDT myDSL, Bayantel DSL, Globe Broadband, Smart and Sun DSL.

Reception of television is good enough to cover all local TV stations aside from cable television being provided by the Cavite cable Corporation, Home Cable, Cignal TV and Sky Cable. Other communication services available in the municipality include postal services and messengerial/courier services being provided by LBC Express.

4.5.2.3.11 Power

All barangays are presently energized and have 24-hr. electricity. MERALCO provides the main energy source for households and other uses with 58,900 customers as of October 2011. There are about 56,369 house connections while commercial and industrial connections/customers are placed at 2,419 and 49, respectively. NPC generates power and transmits this to the MERALCO's power distribution system. The total energy sales of Meralco as of October 2011 was309, 153,531 kilo-Watt hours. **Table 4.85** shows the electric connections statistics from 2009-2011.

Table 4.85 Electric Connections and Sales Statistics, 2009-2011, Gen. Trias, Cavite

Year	Residential	Commercial	Industrial	GHMS & Flat Streetlight	Total
2009	51,649	2,179	49	57	53,934
2010	54,140	2,319	49	61	56,569
As of October 2011	56,369	2,419	49	63	58,900

Source: MERALCO, Ortigas, Pasig City
Note : GHMS means Government Hospitals and Metered Streetlights.

4.5.2.3.12 Water Supply

In terms of Level III water systems, the town is served by General Trias Water Corporation (GTWC) and several privately-owned systems serving the industrial estates and residential subdivisions. The GTWC provides the town with potable water supply and has about 28,402 residential and 727 commercial type of water service connections. It sources its water from deep wells located in different barangays. A 250,000-gallon ground reservoir is located in Barangay Tapia.

At present, there are 29 Level III wells with the capacity of 39,618.12 cubic meters per day and actual production of 24,749.06 cubic meters per day. Based on **Table 4.86**, the averages of water sales per day of residential and commercial uses were 22,524.83 and 2,224.23 cubic meters, respectively.

Table 4.86 Number of Connections and Average Water Sales by Type of Consumer, 2011, Gen. Trias, Cavite

Type of Use	No. of Connections	Water Sales (m^3 per day)
Residential	28,402	22,524.83 cu.m.per day
Commercial	727	2,224.23 cu.m.per day
Institutional	–	–
Industrial	–	–

Sources: General Trias Water Corporation

The industrial estates are served by independent Level III systems operated and maintained by the industrial estates' operators. Deep wells are tapped to supply the water requirements of the industries. The total allowed extraction rate is around 174.6 liters per second or about 15,083 cubic meters per day.

4.5.2.3.13 Waste Management

Alongside industrial developments were emerging environmental issues such as air, land and water pollution. Focusing on the goal for a cleaner and greener General Trias and taking on the responsibility as good steward of the environment, the city has initiated the implementation of various environmental projects to prevent the adverse effects of development to the nature.

The City Environment and Natural Resources Office (CENRO) has implemented a new and improved system of garbage collection and solid waste management. In the efforts of the local government to maintain balance between industrialization and environmental preservation, it continuously expands its green ares through a series of tree planting activities, planting more than 1,000 different species of trees. To further support its advocacy in environment preservation, awareness through the conduct of Solid Waste Management Seminars, regular clean-up drives, annual celebration of Earth Day were being observed. These activities have won the participation of more than a thousand volunteers from different sectors.

With the increasing population and the considerable growth of commercial and industrial establishments in the municipality, solid waste management would continue to pose serious problems if no appropriate action is taken. The local government should identify and develop a sufficient landfill that would cater to the bulging wastes generated by the municipality.

General Trias has its own 1.5 hectare controlled dumpsite located in Barangay Tapia. It is 1.5 kilometer from the barangay proper and about 3.93 kms. from the Poblacion According to 2010 data, the collection equipment used are 16 units of elf trucks, two (2) units dump truck and one unit forward truck. Their total garbage capacity amounts to 134 cubic meters or 44,095.93 kilograms.

4.5.2.4 Noveleta, Cavite

4.5.2.4.1 Location, Land Use, and Political Boundaries

The municipality of Noveleta is located in the north-western portion of Cavite province within the 120' 52' to 12054' east longitude and 14' 25' to 14'28' north latitude. It is bordered on the north by Cavite City, on the west by Manila Bay, on the southwest, by Rosario, on the south, by General Trias, on the east, by Kawit, and on the northeast, by Bacoor Bay. It is 26 km from Manila and 20.4 km from Trese Martires City.

Noveleta has a total land area of 604.0145 hectares and is politically divided into 16 barangays. Among the 16 barangays, San Rafael IV, is the largest with 169.01 hectares, second is San Rafael III which comprises 86.48 hectares. The smallest barangay is Poblacion 5.88 hectares. **Table 4.87** shows the existing land use in Noveleta.

Table 4.87 Existing Land use of Noveleta Cavite

Land Use	Area
Residential	362.20 hectares
Agricultural	53.70 hectares
Saltbeds and fishponds	71.50 hectares
Industrial use	3 hectares
Others	113.61 hectares

4.5.2.4.2 Demographics

Population

The total population of the municipality of Noveleta is 37,865 with a total number of household of 7,940. **Table 4.88** shows the total population of Noveleta as of 2010.

Table 4.88 Population of the Barangays in Noveleta Traverse by the Flood Management Project

Barangay	Total Population	Number of Household
Salcedo I	1,176	401
Salcedo II	3,653	813

San Antonio II	1,421	294
San Rafael I	2,278	460
San Rafael II	3,795	789
Santa Rosa I	1,421	298
Santa Rosa II	896	207

4.5.2.4.3 Population Growth

Results of the 2010 census of population of Noveleta at 41,678 , an increase of 6.07% from 39,294 in 2007. Based on this increase, the average annual growth rate is 1.98% which is lower than the provincial growth rate of 4.127 %. This growth can be attributed to natural birth and in migration which was influenced by the increasing number of industries at the Cavite economic zone and the nearby municipalities and the influx of people from the congested city of Cavite and other nearby town.

4.5.2.4.4 Population Density

The growth gross density of about 63 person for every hectare in a total land area of 604.01 hectares. Poblacion has the biggest population density at 424 person per hectare, followed by San Juan I at 235 person per hectare. San Rafael 4 has the smallest population density at 7 persons per hectare.

4.5.2.4.5 Age and Sex Structure

Noveleta's population is composed mainly of young people as the top 3 or most numbered age groups which are 0-4 group with 9.82% or 4.095 persons, the 5-9 group with 10.43% or 3,932 persons and the 20-24 group with 9.36% or 3,904 persons. The present population distribution consists predominantly of the productive or working age group with ages 15-64 which totalled 28.041 or about 67.26% of the total household population. As to child and youth (ages under 1 to 24) it consists of 19,353 or 46.42% of the total population.

4.5.2.4.6 Income Source/Labour

Out of the total population of the municipality, more than half or 56.78% belong to the labour force. The 26,106 strong labour force defined as those 15 years and over is comprise of 12,646 male and 13,460 female.

4.5.2.4.7 Education

The literacy rate of the population 5 years old and over was very high at 95.5%. Among the age groups, the population 35 years old and over has the highest percentage of literacy rate at 33.26%. Regarding to the highest level of educational attainment of 33,514 population aged 5 years old and over, 1,072 or 3.2% finished pre-school, 5,148 or 15.36% completed elementary education, while the number of population who completed high school totalled 8,767 or 26.16 percent. Academic degree holders comprise 4,082 or 12.18% while 40 or 0.12% completed post baccalaureate studies. Population with no grade completed totalled 1,387 or 4.14%. The remaining 0.37% or 124 where population with no stated educational attainment.

4.5.2.4.8 Health Services

Presently, the available health services and facilities serving the municipality consists of a rural health unit located at Poblacion with 9 barangay health stations. The medical force provided by the government is composed of 1 doctor, 1 nurse, 7 midwives who are assigned in different barangays, 1 dentist, 2 sanitary inspectors, and 20 barangay health workers. The medical force is supported by the barangay nutrition scholars. The facilities found in the municipal health center include 3 beds, dental and laboratory facilities and first aid equipment. There is 1 private hospital located at Salcedo II. There are 3 ambulances in the locality to provide logistic support to the municipal medical course.

4.5.2.4.9 Industry

At present, the municipality has 3 major industries. These are Noveca Industries Inc., ICEL Manufacturing Inc., and ARTIF and Company, all located in a 3 hectare lot at Bgy. Sta Rosa I. These industrial establishments produce tops and bottoms for local market. They have capitalization of 2.5 million, 0.75 million and 0.25 million pesos respectively and employ a total of 530 skilled and non-skilled personnel.

4.5.2.4.10 Transportation

The modes of transport in the municipality are public buses, jeepneys, FX, tricycle, pedicabs and private vehicles. The Noveleta Junction in Poblacion is considered as the crossroads for vehicles travelling to the municipalities of Rosarion, Gen. Trias, Tanza, Kawit, Cavite ity and Metro Manila and even Olongapo City and Baguio. For short/long distance travel within the municipality, tricycle and pedicabs are available. Pedicabs may be found at the entrance of selected subdivisions and barangay roads, while tricycles have terminals in the Poblacion and selected corners of municipal and barangay roads.

4.5.2.4.11 Communication

There is one postal office managed by the Philippine Postal Corporation located in the municipal building. Mail delivery within the area is efficiently handled by three mail carriers. In addition, a private company LBC is located at barangay Magdiwang which accepts and delivers mail and parcels within the munipality and the different localities in the country. This is complemented by the presence of high technology communication facilities such as fax and internet services.

On the other hand, the PLDT Company, Globe Telecoms and Digitel Telephone Company provide telephone services in the municipality.

4.5.2.4.12 Drainage and Sewerage

Regarding drainage and sewerage system, the municipality's rivers serve as main drainage and sewerage system. The Ilang-Ilang river which traverses from north to south anf the Calero River between barangay San Rafael III and San Rafael IV are good drainage outfalls. Moreover, two rivers, one from Imus and other from General Trias, converge into the Ilang-Ilang Rivert that causes flooding in the municipality during continuous heavy rains coupled with the inflow of high tide from Bacoor Bay, aside from inadequate drainage system. Siltation also in these rivers is noticeable and causes flooding in some areas of the municipality.

4.5.2.4.13 Power

The MERALCO supplies the power requirements of the municipality. Correspondingly, the average monthly power consumption based on the report of MERALCO is 173.04 Kwh for residential uses, while the commercial and industrial purposes utilize 930.61 kwh and 1,348.36 kwh, respectively and 1,511.58 kwh for streetlights. Generally, the power service being provided is adequate. However, powr rate schedule is considerably high with the inclusion of Power Purchase Adjustment (PPA) for all types of uses. The area is sometimes experiencing brown-outs.

4.5.2.4.14 Water Supply

At present, the municipality is under the coverage of the Maynilad Water Services Inc.(MWSI). However, only ten out of the municipalitys barangays are being served by the water utility. As to Level I water supply facilities, there is a total of 1,190 units in the municipality. There are 336 public wells and 854 private wells (shallow and deep wells).

4.5.2.4.15 Waste Management

Of the total waste generated, about 80% are collected and dumped at the designated dumpsite. The remaining 20% are either burned in the backyards or dumped in the vacant lots. There are five collection vehicles used in daily hauling of wastes.

It is estimated that about 30% are biodegrable and about 67% are recyclable. The remaining 3% are classified as non-recyclables. With the increasing number of population, and commercial establishments, the municipal government exerts efforts to contain the increasing volume of garbage which incurs considerable amount of money in hauling these unwanted wastes.

4.5.2.5 Imus, Cavite

4.5.2.5.1 Location, Land Use, and Political Boundaries

Imus is geographically located at 14'24 N and 120'56' E and about 19km. from Metro Manila. It is founded by municipalities of Kawit and Noveleta to the north and General Trias to the west, by the cities of Bacoor to the east and Dasmarinas to the south. It is composed of 97 barangays. Imus covers a land total area of 6,470 hectares or 64.70km^2, approximately 6.8% of the total land area of Cavite which is 1,427.06 km^2.

4.5.2.5.2 Demographics

Population

Among of the 17 municipalities of Cavite, the city of Imus ranked 3rd in terms of population according to the 2010 records of the National Statistics Office. In 2010, population of Imus was recorded at 301,624. This absorbed 9.76% of the total population of the province recorded at 3,090,691. **Table 4.89** shows the population of affected barangays in Imus as of 2010..

Table 4.89 Population of the Barangays in Imus Traversed by the Project Development

Barangay	Total Population
Alapan II-A	2,878
Alapan II-B	1,626

4.5.2.5.3 Population Growth

A study of the demographic trends form 1903 to 2012, reveals that the city experienced the biggest growth path of 8.17% in 1995. From the 1990 total population of 119,783 , the level rose to 177,408 in 1995. This was 14 times the count of the first census recorded by the NSO taken in 1903. In 1903, the population in Imus was registered at 12,912. Over the fifteen-year period between 1903 to 1918, the percentage if increase was only 8%. Census records in 1939, 1948 and 1960 showed a 2% increase per census year from 29%, 31% and 33%, respectively. In 1970, the percentage of increase was 38%, a 5% increase in 1960. In 1975, the percentage of increase dropped to 11% and rose to 21% by 1980. Figures in 1990 exhibited the biggest increase of 102%. The level then decreased by 48% in 1995 and further fell down by 10% in 2000. In 2010, the level moved up by 54% in 2010 for an average annual growth of 4.43%.

The high growth in population during the period 1980 to 1990 could be attributed to the influx of new settlers and increasing rate of in migration to the locality. Being near to the National Capital Region, the city absorbed most of the overspill population of the metropolis. This is evident in the development of a number of residential subdivisions which started during the decade of 80's. The increase could also be due to the booming economic activity in Imus as part of CALABARZON growth corridor.

4.5.2.5.4 Economy

Imus is the foremost banking center of Cavite with numerous financial institution and also an excellent banking infrastructure is being propagated by the present government to spearhead the development of the city. The city of Imus has shown a steady rise in its income earning a first-class income classification. In 1993, Imus had 1,369 commercial establishments, 200 manufacturing establishment and 41 financial institutions. Ten years, hence, it has 6,636 licensed business establishments that include 4,376 commercial establishments, 300 manufacturing establishments and 190 financial institutions.

The city of Imus provides an atmosphere conducive to business and the climate of optimism and buoyancy for investors. Eighteen major industrial establishments with a total capitalization of 1.311 Billion pesos has established their base at the Imus industrial state providing local employment to an estimated of 13,478 people.

However, heavy traffic congestion caused by inadequate road signage and systems, poor road maintenance and mixed vehicles.

4.5.2.5.5 Transportation

The modes of transport in the municipality are public buses, jeepneys, FX, tricycle, pedicabs and private vehicles.

4.5.2.5.6 Communication

The PLDT Company, Globe Telecoms and Digitel Telephone Company provide telephone services in the municipality.

4.5.2.5.7 Power

The MERALCO supplies the power requirements of the municipality.

4.5.2.5.8 Water Supply

At present, the municipality is under the coverage of the Maynilad Water Services Inc.(MWSI).

4.5.3 Results of the Assessment

A total of 199 households were interviewed (survey & KII) covering all areas of improvements of the project (Diversion Drainage 1, Maalimango Drainage Improvement, San Juan Diversion Channel, Ylang Ylang River Improvement, Rio Grande River Improvement, and Diversion Drainage II). Key Informant Interviews (KIIs) were also conducted which composed of officials and staffs of barangays (17) and municipalities (5) within the project area. Results of the public consultation were also considered in the analysis of the study. Appendix 4 shows the details and minutes of public consultation.

4.5.3.1 Respondents Profile

Table 4.90 shows the respondents distribution. Out of 199 respondents, 39.7% are male while 60.3% are females. Age of the respondents ranges from 20-30 years old are 17%, 31-40 years old are 22%, 21 % are composed of respondents ranges 41-50 years old, 51-60 years old are 11% and those 61 years old above are 29% from the total respondents. It shows that majority of the interviewed residents are elders.

Majority of them (17%) resides in the area for about 5 to 10 years while the lowest number of respondents (6%) came from the respondent who has resided for 11 to 15 years. Longest years of stay are 30 years and above which is at 15% of the total respondents. Average household size is six.

Table 4.90 Respondents Distribution

Respondents	No. of Respondents						Total	%
	Diversion Drainage 1	Maalimango Drainage Improvement	San Juan Diversion Channel	Diversion Drainage II	Ylang River Improvement	Rio Grande River Improvement		
Male	21	9	18	13	11	7	79	39.7
Female	15	11	70	2	9	13	120	60.3
Total	36	20	88	15	20	20	199	100

Overall tally shows that construction works are among the primary source of income of the residents in the project area (22%). This manifests the increasing development works (economic, infrastructure, etc.) not only in the five municipalities covered by the project (Imus, General Trias, Noveleta, Rosario and Kawit) but also in the whole province of Cavite. However, in terms of per area of development, majority of the livelihood of the respondents in the Diversion Drainage 1 are engaged on fishing. This may attribute to the location of the area which is close to the sea. Other source of income indicated are vendors, fishnet selling, retirement pensioners, house painter, dispatcher, factory worker, maid, labourer, driver, office employee and others. On the other hand, thirteen percent (13%) of the respondents are jobless or does not have a permanent work. **Figure 4.75** and **Figure 4.76** show the actual photos taken during the conduct of survey.

Figure 4.75: Actual survey of respondents

Figure 4.76: Conduct of household survey with the affected household guided by a Brgy. Official in San Rafael II

4.5.3.2 Household Profile

One of the important considerations in the project development is the access of the affected households to basic facilities such as source of electricity, water resource, toilet system, garbage disposal system and cooking fuel used.

4.5.3.3 Access to Electricity

Most of the respondents (79%) are connected to MERALCO in terms of power supply, 3% uses gas lamps as their light source, 2% uses battery, 5% do not have source of electricity .There are also cases that households taps illegal power connections in their neighbours. The remaining respondents did not indicate the source of power they are using. **Figure 4.77** shows the photo of electric connection per household.

This result indicates that the majority in the area are capable of acquiring and paying for power connection. However, respondents who are not capable of acquiring power connection can be attributed to their economic and land status (informal settlers).

Figure 4.77: Sample photo of electrical connection (MERALCO) per household

4.5.3.4 Access to Water

Sixty one percent (78%) of the respondents use mineral water as their drinking supply while 22% obtained their drinking water from underground water pump (poso). Meanwhile, majority of the domestic supply rely on water pipe connection from Maynilad while the remaining sourced out water from a water pump (poso).

Type of Toilet System

Survey result shows that 76% of the respondents have their own private toilet system. About 4% uses public toilet, and 8% directly dispose human waste to the river/sea. This contributes to the contamination of the water quality in the area. Since there are numbers of settlers located within the water system (river/sea), this condition is common/ expected. Considering also the fact that the river/sea also used for fishing, bathing and washing clothes, problem on health and sanitation may arise. The remaining said that they don't have their own toilets but did not indicate where they dispose their human waste. **Figure 4.78** shows the present toilet system of household without a private toilet.

Figure 4.78: Toilet System of individual household without private toilet

Type of Garbage Disposal

In terms of garbage disposal, 48% of the respondents mentioned that their household wastes are being collected. On the other hand, 32% dispose of their garbage through burning in their own backyards. However, garbage in the river system is observed during the assessment which contributes to the pollution of water in the said areas. The remaining respondents did not indicate where they dispose their waste. **Figure 4.79** shows the garbage disposed in the river system.

Figure 4.79: Garbage observed within the river

Cooking Fuel

The most commonly-used cooking facility used by the respondents is gas stove (48%). Others use electric stove (32%) and fuel wood (26%) . **Figure 4.80** shows the use of fuelwood for as fuel for cooking.

Figure 4.80: Fuelwood stacked by the households

Use of Sea/River Water

Based on the survey conducted, use of river indicated is for bathing, fishing, washing clothes, and others. Majority, however, said that the river don't have use for them but seen as a source of threat due to flood and health reasons.

Figure 4.81: Fish pens

Land Status

According to the survey conducted, 65% of the respondents are land owners while 22% are tenants. The remaining states that they owned the land, however, does not have legal documents to prove their claim.

House Type

Among the respondents, 64% of them have concrete house structures, 11% are made of pawid while the remaining are made of woods and other scrapped materials. Estimated cost of materials which is 50,000 pesos below are about 63% of the respondents, 51,000 to 100,000 pesos are 6%, house costs ranges from 100,000 to 150,000 pesos are 14%,7% costs 151,000 to 200,000 pesos, 201,000 to 250,000 have 3%, another 3% for houses costing 251,000 to 300,000, while the remaining 1% cost 500,000 and above.

Figure 4.82: Household structures along the river/proposed drainage site

Income Expenditures

Based on the occupation or source of income of the respondents, most of them depend on construction and fishing. In fishing, income however depends on the volume of fish or other water resources that they catch. As per interview, 28% have a total monthly income of 5,000 below, 33% are 5,000 to 10,000 pesos, 22% earned 11,000 to 15,000 pesos, 14% have an income of 16,000 to 20,000 pesos, 3% for income earner of 21,000 to 25,000 pesos and 2% earned 26,000 pesos and above.

On the total monthly expenditure, most respondents (38%) spend 5,000-10,000 pesos followed by 28% who spends less that 5,000 pesos a month. About 17% of the respondents states they spend 11,000 to 15,000 pesos, 16,000 to 20,000 pesos are spend by 8%, and the other 1% spends 31,000 pesos and above. It was observed that the highest household expenditure item is on food and there is least or no allocation for clothing and footwear even entertainment. Based from their allocation of income, we can clearly picture that respondents live simply, matching with their earnings.

Gender Roles

In terms of gender role in the community, results from the household survey and key informants interviews show that in the activity profiling, fishing are dominantly performed by men, including construction activities. Reproductive activities such as childcare, home maintenance, food preparation, and other household choirs are done by women. On the other hand, based on gender access and control, the economic aspect in households is equally controlled by both genders.

Community Condition

Majority of the respondents (81%) stated that flooding is yearly encountered in their area. This is due to strong rains/storms, high tides and clogged river/drainage. Peace and order is not much a problem. Eighty one percent (81%) said that there is minimum crime cases occurrence. According to the respondents, peace and order in the area is due to good governance of the barangay officials and good cooperation of the community. Eighty nine percent (89%) said that there are no known historical sites in the direct development area.

The problem faced related to the environment includes strong winds during heavy rains in the coastal area, garbage, foul smell of the river and flood. In the economic aspect, joblessness and no capital for business are the main concern. There are also illegal fishing activities in the sea/river which greatly affect the livelihood of the fishermen. On the other hand, social problem includes petty crimes and teenage rumble.

Traffic congestion is observed at the main road of barangays and central business areas.

4.5.3.4 Social Acceptability/Perception Survey

The social acceptability survey was conducted to gather pertinent information on the socio-economic conditions of the people that will possibly affected as well as their perception on the proposed project.

Knowledge on the proposed Cavite Flood Management Project

Only 30% of the respondents are aware of the flood management project. According to them, they learned about the project during seminar, barangay/municipal officials, consultants and neighbours. Another source of information was the public consultation conducted last February 11, 2016. The remaining 70% didn’t have information about the project and only knew the details during the conduct of the survey.

4.5.3.4.1 Perceived Negative Effects

When respondents were asked to identify possible problems in the establishment of the Project in the area, they said that it may affect the livelihood that depends on the river/sea. Other major concern of the respondents is the houses that may be affected by the proposed project. These may relate to the fact that the target sampling respondents lives near or within the rivers subject for improvement and proposed diversion drainage areas.

Based on the results of the survey, those households that will be possibly affected should be coordinated and communicated properly as well as compensated accordingly.

4.5.3.4.2 Perceived Positive Effects

Among the positive effects of the proposed project identified during the survey are mitigation of flood and improvement of drainage system. The rivers subject for improvement are consists of garbage such as plastics, human waste, dead animals, and others which results to water clogging during heavy rains. Project implementation may have positive effects on the economic aspect of the residents especially those engaged on business. Ttraffic congestion as a result of flooding during rainy season will be minimized, thus delivery of basic services will become easier at any time.

4.5.3.4.3 Project's Favourability

The results of the survey show that 65% of the respondents said that they are in favour of the implementation of the project. About 11% however said that they are not in favour of the project because their houses might be affected/ removed and they don't have any possible place to relocate. The remaining percentage said that they are uncertain whether they are favourable or not since they still can't perceive the implication of the project.

Considerations on the implementation of the project from the respondents are also acquired during the survey. Twenty five percent (25%) said that there should be in-depth discussions between them and the project implementers. About 20% said that project proponent should consider the needs of the people that will be affected. Just compensation on the affected houses should also be settled as well as consider the livelihood of those income that will be affected. Appropriate implementation of the project should be considered so that the positive effects of the project will be realized.

4.5.3.5 Summary of the Survey Conducted

In summary and conclusion of the survey and consultation conducted, the positive effects of the project are recognized by the concerned communities. They are aware that the proposed project may facilitate good drainage system which will minimize flood occurrence in the area. Frequent flooding events results traffic congestion and low productivity in terms of their economic activities.

Based on the perception survey conducted, it can be concluded that the proposed project is socially acceptable at this stage. However, some are hesitant because of the fact that their settlements might be affected during the project implementation. According to them, it is not easy to give up their properties (house, etc.) adding to the fact that they have lived in the area for a number of years. It is possible that the residents will change their mind if extensive consultation and transparent communication are undertaken to discuss issues and concerns with the proponent, owner, tenants, informal settlers and LGUs and the measures to address such issues and concerns.

4.5.4 Potential Impacts and Mitigating Measures

4.5.4.1 Pre-Construction Phase

Apprehension of Locals towards the Project

During pre-construction phase, significant impact identified is the apprehension of locals towards project development. This may attribute to the loss of their land, crops and other properties that might possibly be affected by the implementation of the proposed project. Information dissemination in the community about the project through coordination with LGU's, PO's, NGO's, barangay officials and other concerned community groups should be conducted. This program will introduce the proposed project in the area and avert negative perception of people towards the project. It will also serve as an initial step in the formulation of Education, and Information and Campaign (EIC) Plan.

4.5.4.2 Construction Phase

Influx of Migration

The proposed project will employ a substantial number of workers during the construction phase. The migrant workers will definitely add to the existing population size within the project area, especially so if they bring in members of their family. If these migrant workers take temporary residence in the project area, these will add to the general population size. Some may be transient workers who will opt to commute daily and will therefore impact only on the day-time population size. Whichever case, demand for resources especially food and water at the minimum, and services attendant to these, will increase.

To avoid influx of migration in the area where the Project is located, qualified residents of Barangays that the project will traversed and other neighbouring barangays/municipalities near the project area must be given priority in the hiring of construction personnel. This must be coordinated with the LGU and barangay officials.

Increase in Business/Economic Activities

The construction work will create a multiple effect where various economic activities will either be created or the existing ones will experience growth. This will lead to the creation of more jobs. In relation to this, disposable income will also increase. The potential for economic opportunity and growth will arise, leading to the generation of more jobs. In effect, a growing cycle of economic growth and employment generation will arise.
The Project's purchases of supplies and materials from local establishments, together with expenditures by project workers typically result in increased business activity and employment in the local trade and service sectors.

Increased Generated Waste at the Project Site

Workers will be brought to the area and worker camps will be constructed. This could generate industrial and domestic waste such as engine parts, tires, garbage, sewage etc. Poor waste disposal could lead to the generation of foul odor, litter on the site and potential contamination of water from the leachates.

The project should implement proper waste management. Installation of Material Recovery Facility (MRF) for waste segregation and compost pits must be provided in the construction and workers campsite/bunkhouses.

Waste treatment facilities such as septic tanks or portable toilets must be installed on site during construction. The project should ensure that no untreated human waste should be allowed to enter any water course where this will affect rivers' water quality, aquatic environment, and human health. Likewise, proper clean up and abandonment of the site after completion of the project, such as removal of temporary bunkhouses, stock yard and other unnecessary structures should be undertaken.

Health and Safety of Construction Workers

Accidents and hazards may occur on sites thus there are risks facing both skilled and unskilled workers. Personal protective equipment (PPE) should be strictly implemented during construction activities. Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. This is to reduce employee on the exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels. The contractor must also provide a first aid kit and availability of health worker to attend to any immediate health needs of workers and in case of untoward incidents. Hiring of medical staff is also recommended to ensure that there will be professional staff that will cater those who are injured or ill.'

Public Health and Safety

These hazards may also be experienced in adjoining communities and activities that will generate noise pollution and dusts, hence, development activities would have to adopt proper measures to ensure public health and safety. Also, migration of some workers on site and nearby community will increase possible spread of communicable diseases and accumulation of domestic wastes.

To protect health host community/ies against possible spread of communicable diseases, routine medical check-up to workers must be undertaken. Observe disinfection of water logged areas and provision of drainage facilities to avoid creation of disease vectors habitat.

Increase Traffic Congestion

Hauling of construction materials and movement would be significant since there is heavy traffic in the some section of the project area. However, as a pro-active measure, the project proponent in coordination with the local government units will devise a contingency traffic management scheme to assist the local government units in case of occurrence of traffic-related problem near and around the project area. Posting of traffic related advisory will be a component of the traffic management scheme.

Loss of Land and Properties

The project will acquire lands and at the same time may affect settlements/properties located within the river/riverside and improvement areas (diversion drainage). This loss of land and properties to give way to project development will affect numbers of settlers/households in the area. Affected people are composed of private owners, tenants and informal settlers. In acquiring the land for project development, a just compensation package based on the fair market value should be implemented. In the case of the tenants, the final agreement should be done between the land owner and the tenants. Informal settlers on the other hand have a different approach in settling this issue. The involvement of the concerned LGUs in this matter is very essential.

Parallel to this assessment, a focus study on the resettlement for project affected people is on-going. Resettlement Action Plan or RAP will be formulated undertaking 100% inventory of affected people and properties including the compensation scheme. In addition, livelihood programs and trainings should be implemented with those directly affected people.

Operation Phase

Minimize Flood Problems

The main objective of the project is to prevent flood problems within the project areas. Improvement of river system along these areas will result to the continuous flow of water during rainy season hence; prevent clogging of water in the river and minimize flooding occurrence in the said areas. Waste and garbage which also causes flooding will also remove.

Chapter 5

IMPACT MANAGEMENT PLAN AND INDICATIVE SOCIAL DEVELOPMENT FRAMEWORK PLAN

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Chapter 5 – Impact Management Plan and Indicative Social Development Framework Plan

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5.0 ENVIRONMENTAL MANAGEMENT PLAN

The objective of this chapter is to describe and evaluate the expected anticipated impacts of the proposed development on the relevant environmental components, identify applicable mitigation measures and evaluate the significance of the impact once the proposed mitigation measures have been implemented.

The environmental impacts associated with the activities during the construction phase have taken into the account the existing environmental conditions. It is assumed that the proposed flood mitigation site and services in the area meet the requirements of the project.

5.1 Impact Management Plan during Construction Phase

5.1.1 Impacts on Land

5.1.1.1 Loss/Deterioration of Current Vegetation Cover

The project will require land clearing result to the removal of remaining vegetation to give way for the improvement of river banks, widening and construction of flood protection infrastructures/dikes. This entails to further disturbance of wildlife, loss of habitats and reduction to biodiversity composition of the area.

Vegetation will be permanently removed from sites designated for the improvement of rivers and construction of drainage. Trees in adjacent areas may either be damaged or removed.

5.1.1.1.1 Mitigation Measures

Replacement of trees cut due to land clearing

Land clearing will be limited to designated sites only. As much as possible, removal/clearing of mangrove species shall be avoided as these serve as buffer zone against strong winds, tsunami, soil from soil erosion, and others. The mangrove area will be protected to serve as habitat of remaining faunal species and the species genepool.

Prior to project implementation the proponent must coordinate with the DENR to seek clearance for the identification of required documents for the issuance of needed tree cutting permit (PD 705). To compensate the loss vegetation, the proponent should replace the number of trees removed/cut and plant them to nearby areas or in accordance with

Department of Public Works and Highways (DPWH), Department of Environment and Natural Resources (DENR) and Department of Social Welfare and Development (DSWD) Joint Memorandum Circular No. 01 Series of 2014 dated July 3, 2014 entitled "Guidelines for the Implementation of the DPWH-DENR-DSWD Partnership on the Tree Replacement Project".

With the implementation of the proposed project impact to flora and fauna are more on the mangrove areas covered by the San Juan Diversion channel and Maalimango creek. In order to lessen the impact on mangrove, cutting should be minimized by avoiding these species in the final design and location of the improvements. When cutting is inevitable, the proponent should coordinate with LGUs and DENR for the tree cutting permit. Replace the trees cut as prescribed by the DPWH-DENR-DSWD Joint Memorandum Circular.

To compensate for the removal of some important vegetation, the Proponent shall replace every tree cut. As per DENR Memorandum Order No. 05 of 2012 mandates 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*".

Mangrove species

The proponent may also provide support to the existing mangrove rehabilitation program in the area or may initiate a mangrove rehabilitation program as part of commitment of the project in the protection of the environment. These should be coordinated with the LGU and the DENR for the National Greening Program activities in the area.

To minimize impact of the project to remaining patches of mangrove in the area, it is recommended to only clear areas that will be traversed by the project development. In any case that removal of mangrove species cannot be avoided, tree replacement should be undertaken to compensate such losses. Hence, the proponent should coordinate to the DENR to secure a tree-cutting permit. Mangroves and other vegetation present in nearby areas must be enhanced as natural buffer to tidal waves and high tides. This will promote biodiversity protection as well.

5.1.1.2 Habitat Loss and Displacement of Wildlife Species

Vegetation clearing to give way to project development facilities would drive away highly mobile wildlife species (e.g. birds, bats and large mammals). Those which are less mobile or have a limited dispersal ability (amphibians, reptiles) would have difficulty escaping any changes and would be subjected to disturbances caused by the project. Also, the loss of vegetation due to land clearing may result in loss of habitat and food for survival. Likewise, wildlife disturbance due to noise generated during construction brought about by the operation of heavy equipment. Therefore, faunal species would migrate to other or nearby areas/habitat where disturbance is less.

As much as possible, development activities shall be confined to the intended infrastructure coverage only. Fortunately, there will be no endangered wildlife that will be affected, however the protection of the present fauna in the area should be also ensured.

5.1.1.2.1 Mitigating Measures

Development activities shall be confined, as much as possible, to the intended coverage only. Workers must be warned and not be allowed to undergo wildlife poaching. Instead wildlife protection shall be encouraged. Promote wildlife protection using innovative means such as putting up of warning signage's on strategic areas for public information.

Gradual clearing and removal of vegetation is encouraged to provide sufficient time for wildlife species to transfer to the nearby habitat. Further, existing mangrove forests within the project area shall be protected to serve as refuge and forage/feeding area for wildlife species. Planting of naturally-grown species in the designated areas might encourage the wildlife species to return in the future. To minimize impact of the project to mangrove areas, only clear areas that will be traversed by the project development. In between the dike alignment, mangroves and other vegetation must be enhanced as natural buffer to tidal waves and high tides. This will promote biodiversity protection as well.

Concerning the impact of the project to faunal species it is recommended that minimizing the removal of flora species also minimizing impact to faunal species. During construction, the contractor should ensure to prohibit his employee's/workers to engage in any mode of wildlife collection and/or hunting, rather, it should promote the conservation and protection of remaining wildlife species in the area.

Faunal monitoring is also recommended to be undertaken in different project phases-during construction and abandonment phase to determine if there are any adverse/positive changes in faunal species and population within the project area.

5.1.2 Increased Noise and Traffic during re-channeling and river widening

During construction of the re-channeling and river widening, increased noise and traffic levels will be significant due to heavy construction vehicles moving to and from the site. Increased traffic will be a result of trucks to and from the site for construction material deliveries and site clearing. Noise that will be generated will be through site clearing activities using soil scrappers and construction workers on site.

It is anticipated that construction and operation will take approximately three (3) years. Due to the limited construction and operation period and the fact that there are residential areas in the immediate vicinity of the site, the impact is considered significant.

However, the impact will be managed through the implementation of the mitigation measures below.

5.1.2.1 Noise generating activities will be restricted to normal working hours, thus limiting noise levels at nighttime to minimize the effect on the residents in the affected areas.

5.1.2.2 Contractors shall be required to ensure that construction equipment and vehicles are in a good state of maintenance.

5.1.3 Increased Air Pollution

During the construction phase of the project, access roads and the operation of construction equipment and vehicles will be the main sources of pollution.

Fugitive dust and combustion emissions will be generated. The primary sources of fugitive dust emissions will include construction activities such as land clearing and preparation of re-channeling and river widening in the area, grading of access roads, excavation, and increased vehicle traffic on unpaved roads. The amount of dust generated will be a function of construction activities, soil type, moisture content, wind speed, frequency of precipitation, vehicle traffic, vehicle type, and roadway characteristics.

Fugitive emissions will be highest during drier periods in areas of fine-textured soils. During the dry season, dust suppression will be applied as needed (such as watering of disturbed or exposed areas). A dust control plan will be implemented and regular maintenance of vehicles and equipment will be carried out.

The primary sources of combustion emissions include the operation of diesel or gasoline-powered construction equipment such as graders, dozers, trucks, and other mobile sources. These sources produce sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), and Carbon Dioxide (CO_2). Air emissions from construction and operation activities will occur over a period of three years and will affect populations in lowland Cavite area so the impact to air quality will be minor (low severity to medium likelihood).

5.1.4 Increase in Solid Waste and Hazardous Waste Generation

The solid waste generated during construction will consist of (a) domestic waste and construction waste from work camps, and (b) hazardous waste from work sites and dredged materials in the rivers. Improperly-managed wastes could accumulate into unsightly piles or small dumpsites. These dumpsites become breeding grounds for pests and other vectors and contribute to onsite sanitation problems. Leachate from these dumps could contaminate local groundwater and surface water bodies.

The project contractors shall be required to implement a waste management program. Waste receptacles/bins shall be provided in strategic locations within the work areas. There shall be an identified designated area for the temporary disposal of domestic and construction wastes.

Biodegradable waste materials can be composted while the non-biodegradable wastes shall be collected separately and temporarily stored at the waste area until collected for proper final disposal in a government-approved disposal site. Recyclable construction waste materials such as wood, steel, and other related materials may be reused by the contractors.

Hazardous wastes such as used oil, busted lamps, used batteries etc. shall be collected and stored onsite in approved facilities according to DENR standards. Hazardous wastes shall then be removed from the site to approved DENR accredited treatment and storage disposal (TSD`) facilities.

It is necessary to evaluate the toxicity characteristics of the riverbed sediments to be dredged/excavated in Maalimango Creek, Rio Grande River and Ylang Ylang River. There will be a separate study on characterizations and evaluations of disposal sites of these dredge/excavated materials. Proposed disposal sites will be provided and designated by LGUs within the project areas. . **Table 5.1** shows the potential disposal sites during construction and dredging works. If these dredged materials found to be non-hazardous, it can be used as backfills. This can be disposed to existing open dumpsites as soil cover which undergo rehabilitation for permanent closures, housing development projects etc In case the solid wastes found to contain hazardous substances via TCLP test, this should be treated by accredited Treaters by the DENR. This can be disposed then to accredited sanitary landfill for final disposal.

Obnoxious odors may be emitted from these dredged/excavated sediments especially in Maalimango creek. Proper handling and containment in enclosed dump trucks should be observed. Immediate transport and disposal of these dredged materials are required to prevent prolong exposure and further odor emissions that will initiate complaints in affected communities.

Table 5.1 – Proposed Disposal Sites of Solid and Hazardous Wastes

<table>
<tr><th>No.</th><th>Site Name</th><th>City or Municipality</th><th>Barangay</th><th>Land Area</th></tr>
<tr><td>1</td><td>LGU lot</td><td rowspan="3">General Trias</td><td>Navarro</td><td>0.5 hectares</td></tr>
<tr><td>2</td><td>LGU lot (near Public transport terminal)</td><td>San Juan I</td><td>1.5 hectares</td></tr>
<tr><td>3</td><td>Open dumpsite</td><td>Tapia</td><td>1.5 hectares</td></tr>
<tr><td>4</td><td>Open dumpsite</td><td>Noveleta</td><td>Salcedo I (near Love Cemetery)</td><td>to follow</td></tr>
<tr><td>5</td><td>Open dumpsite</td><td>Kawit</td><td>Batong Dalig</td><td>0.01 hectares</td></tr>
<tr><td>6</td><td>Sanitary Landfill</td><td>Trece Martires</td><td>De Ocampo</td><td>0.15 hectares</td></tr>
<tr><td>7</td><td>Sanitary Landfill</td><td>Calamba, Laguna</td><td>to follow</td><td>this is the current landfill use by GenTrias for its solid waste disposal</td></tr>
</table>

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5.1.5 Soil Erosion and Sedimentation

At the study area where the soil is clayish, the soil particles are difficult to detach especially when wet, but can be easily transported on flat lands by air and water. Soil erosion is a major agricultural problem. Abnormal rainfall causes the soaking of soil and increases the amount of water and its velocity, thus increasing its load capacity. Soil material that will be transported can cause blockage of water channel ways, which eventually results in flooding.

Soil erosion impacts can be minimized by clearing only small tracts of land at a time, and by minimizing the length of time that the cleared areas for industrial use are void of vegetation or for agriculture use not under active cultivation. Following these mitigation measures, the impact of the Project on soil erosion would be insignificant (low severity; low likelihood).

Sedimentation predictions can be done accurately if there is sufficient understanding of the physical processes based on field measurements to be conducted by experienced personnel. The following field activities are suggested relative to the surveying and monitoring for countermeasures against sand deposition along the coastal area:

5.1.5.1 Hydrodynamic measurements

- 5.1.5.1.1 Water level recordings.
- 5.1.5.1.2 Current velocity at fixed positions.
- 5.1.5.1.3 Discharge measurements across main channels.
- 5.1.5.1.4 Float tracking of curved streamlines.
- 5.1.5.1.5 Wave field close to shore.

5.1.5.2 Sediment transport measurements

- 5.1.5.2.1 Types and composition of sediment.
- 5.1.5.2.2 Settling velocity.
- 5.1.5.2.3 Bed load transport.
- 5.1.5.2.4 Sediment concentrations at various levels above bed.

5.1.5.3 Morphology

- 5.1.5.3.1 Bathymetric survey on a regular basis for the next 2 or 3 years. This is to determine the impact of sedimentation at the coastal area where the mouth of the river channel is located and then formulate possible river maintenance if necessary. Sediment deposition in the mouth of the channel if not monitored can cause serious flooding upstream of the river channel because it can constrict the river flow.

5.1.5.3.2 Bed form tracking
Sedimentation and erosion volumes from bathymetry data.
Numerical and physical modeling maybe considered but are not particularly cheap to carry out as many runs are required to get a good feeling of the most important parameters and uncertainties involved.

5.1.5.3 Establishment of monitoring areas

Monitoring stations in every project segment prior to construction phase as basis for monitoring during and after the construction stage. Establish current river bed elevation and record geographic coordinates as reference for monitoring.

5.1.6 Impact on Water

5.1.6.1 Generation of Domestic and Industrial Wastewater

Workers, equipment and vehicles will be brought to the area and worker camps and stockyard will be constructed. This could generate domestic and industrial wastewater in the form of sewage, waste water from cleaning and maintenance of equipment and vehicles, water contaminated with oil and grease, etc.

Waste treatment facilities such as septic tanks or portable toilets must be installed on site during construction. The project should ensure that no untreated human waste should be allowed to enter any water course where this will affect rivers' water quality, aquatic environment, and human health. There shall be provision for oil and grease trap, or outside maintenance of equipment and vehicles

5.1.6.2 Discoloration of River water

With the dredging and widening of River there will be temporary discoloration of the river water, increase run off and soil erosion.

There must be provisions for temporary rechanneling of river flow and construction of settling ponds to contain inflow of muddy waters. No clearance or establishment works shall be undertaken during heavy rainfall conditions to reduce the risk of sediments loss to the environment.

5.1.6.3 Aquatic Ecology

Drainage Improvement at Maalimango River

This involves the assessment of the probable impacts of the proposed Maalimango Drainage Improvement project involving dredging, excavation and widening activities of drainage channel on the aquatic communities such as the plankton, soft bottom benthos, and fish. Each identified impact is categorized according to its development phase: a) construction phase; and b) operation phase. The corresponding mitigating measures are presented in *Italics* for each significant negative impact identified.

5.1.6.3.1 Construction

5.1.6.3.1.1 *On Bottom Surface Morphology*

The effects of dredging include the changes in the bottom surface morphology and alterations in the nature of the material constituting the upper layer of the bottom surface. In turn, benthic fauna (including fish and other aquatic resources) may be smothered or disturbed.

This impact has immediate localized and permanent effects on the bottom life and it cannot be avoided, therefore, there is no need for mitigation of impacts.

5.1.6.3.1.2 *On Plankton*

The major impact of dredging activities on plankton would be the expected increase in turbidity (levels of suspended solids) in the water column on local plankton community function. Turbidity would tend to limit light penetration in the water column which is essential in photosynthesis, a vital process in phytoplankton primary production. However, these effects are transitory (or temporary). While water column turbidity created by dredging or disposal is probably not of major environmental concern, it may be a very real aesthetic problem.

Increased turbidity would also lead to the irritation and clogging of gills of fish larvae and juveniles (ichthyoplankton) that could lead to their eventual smothering (Hirsch *et al*., 1978). This adverse condition would slightly increase the mortality rates among fish larvae/juveniles including other planktonic organisms. Being planktonic, fry or juvenile cannot avoid turbidity impacts because of their inability to swim against currents.

These impacts, while significant, are localized and temporary. Turbidity of the water column is expected to decrease to normal levels immediately following the completion of the dredging activities.

To mitigate the aesthetic impacts and the impact among fish larvae/juveniles including other planktonic organisms, use of silt curtains is recommended.

5.1.6.3.1.3 *On Soft Bottom Benthic Dwelling Organisms*

Benthic habitats are susceptible to impacts during construction activities. Soft bottom benthic habitat elements include mud bottom epifauna and infauna. One of the significant impacts of the proposed project concerns the established soft bottom benthic communities of the dredging area. These construction activities will not only disturb the existing benthic fauna but will entail a complete smothering of all benthic organisms present in dredging area and immediate vicinity. There is no known remedy for this impact as the project construction activities, which are deemed very important, will be permanent in the area. However, benthic organisms can easily re-colonize in undisturbed and areas. Benthic re-colonization should be quite rapid and occur within a few months after construction, depending on the type of environment and biology of the animals affected. Complete recovery rates of soft bottom benthic communities are partly a function of habitat type and depth and could be attained within a year or two. Therefore, the expected negative impacts of these activities are expected to be minimal, short-term and localized.

For these communities the construction phase will destroy them and cannot be mitigated.

5.1.6.3.1.4 *On Fishes and Other Types of Aquatic Life*

The impacts of dredging and excavation operations on mobile organisms such as fish and other forms of aquatic life would be localized, temporary and minimal because of the inherent ability of these organisms to avoid disturbance. Increased suspended sediment levels and turbidity generated by dredging activities would cause adult fish in the dredging area to migrate to other suitable areas. However, smaller species that are unable to migrate would be chronically exposed to high turbidity may suffocate as their gills become clogged with sediments. Even low levels of resuspended fine sediment could also affect benthic larvae and juveniles of commercial clam, snail and shrimp populations. This impact is expected to occur within the vicinity of the dredging / excavation site. However, as the dredging activities are not continuous, impact on the fish resources is expected to be minimal.

To mitigate the impact among smaller species, use of silt curtains is recommended.

5.1.7 Impact on People

5.1.7.1 Displacement of Residents/Loss of Land in the Project Site and Within Its Vicinity

The project development will affect people physically and economically. There will be acquisition of land which will result in the displacement, loss of land and properties of a number of occupants.

There is a private cemetery within the project site. Measuring approximately 100 square meters, the local cemetery will be affected/removed in the implementation of the project. This should be properly addressed by the Proponent. Consultation with the affected families should be intensively undertaken to come up with proper agreements.

Formulation of an equitable compensation and acquisition scheme will be designed to ensure that affected people will have a just compensation for the land, crops and other properties that will be affected by the project.

5.1.7.2 Peace and Order Concerns

To maintain peace and order during the construction phase, coordination with the local governments and police should be undertaken. Cooperation of the community is necessary to keep peace and order in the project area, thus a good relationship between the DPWH/CTI and affected communities will be maintained. Regular monitoring of community complaints must be documented to address them properly.

Implementation of security management will likewise be undertaken. Also, as additional safety measure will be secured with a perimeter fence equipped with safety features and the appropriate number of security personnel.

5.1.7.3 Increase in Employment Opportunities

The construction of the project will generate employment opportunities for the local residents as well as migrant workers. It will bring increased income to those who will be employed. Local manpower may have to compete with migrant labor for employment. Employment of local residents during the construction stage shall be given priority, particularly those from families in the Direct Impact Area.

5.1.7.4 Increase in Livelihood and Business Opportunities

There will be livelihood and business opportunities for the local residents such as sari-sari stores, food services, vehicle maintenance services, etc. during the construction phase. Whenever possible, the sources of construction materials and services shall be from the locality. The increase in the economic activities during construction will moderately improve the current income of the local residents and businesses/enterprises.

5.1.7.5 Increase in Local Revenues

As a result of this project, the revenues of the Local Government Unit (LGU) will increase due to the purchase of locally available materials and equipment for construction, which will translate to additional taxes. Business establishments should be properly registered and payment of the required taxes shall be monitored by the LGU.

5.1.7.6 Potential Health and Sanitation Problems

With the influx of construction workers to the project area, there will be an increase in the volume of sewage and solid waste generation. If not properly managed, these wastes will create unsanitary conditions in the area, which can cause local outbreak of diseases. This will be aggravated if there are no provisions for temporary bunkhouses for workers and other sanitary facilities.

The construction contractors will be required to provide temporary housing for their workers, with provision for adequate water and toilet facilities. Construction workers will be oriented to strictly observe proper hygiene and sanitation practices at the construction site. Contractors will be required to provide basic medical services to ensure that the health and sanitation of workers are protected.

5.1.7.7 Safety and Public Health Hazards

Workers at the construction area will be exposed to construction-related hazards. Accidents can happen and cause minor and/or major injuries as well as disability if there are no adequate provisions for the safety of workers and visitors. A Safety Officer is required during the construction activities to ensure effective implementation of safety measures to avoid accidents and protect workers. Provision of appropriate Personnel Protective Equipment (PPE) shall be required within the construction premises to ensure safety of the staff and workers. In order to avoid accidents, proper signages/warnings shall be placed in construction work areas. Health precautions will be undertaken to minimize health risks to construction workers and nearby residents.

The main objective of the project is to prevent flood problems within the project areas. Improvement of river system along these areas will result to the continuous flow of water during rainy season. Hence, prevent clogging of water in the river and minimize flooding occurrence in the said areas. Waste and garbage which also cause flooding will also be removed.

In summary, a positive impact on flood control and mitigation are foreseen once the construction and widening are done which will minimize business interruptions, traffic congestion as a result of flooding during rainy seasons, loss of properties brought about by floods. With the reduce flood problem, local economic activities will be sustained and developed. Expect more productive land use and utilization of local resources.

5.2 Impact Management Plan During Operation

The main objective of the project is to prevent flood problems within the project areas. Improvement of river system along these areas will result to the continuous flow of water during rainy season. Hence, prevent clogging of water in the river and minimize flooding occurrence in the said areas. Waste and garbage which also cause flooding will also be removed.

In summary, a positive impact on flood control and mitigation are foreseen which will minimize business interruptions, traffic congestion as a result of flooding during rainy seasons, loss of properties brought about by floods. With the reduce flood problem, local economic activities will be sustained and developed. Expect more productive land use and utilization of local resources.

5.3 Impact Management Plan During Abandonment Phase

The abandonment activities involve the demolition and restoration of disturbed areas to a landform that approximates and blends in with the surrounding landform, minimal impacts to the soils are expected. The rehabilitation process will involve primarily the demolition and revegetation of disturbed areas to native species, controlling erosion, controlling invasive non-native plants, and monitoring results.

Table 5.2 presents the matrix of mitigation and enhancement measures for each type of activity.

Table 5-2 - Impact Management Plan

Project Phase/ Environmental Component Likely to be Affected	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
I. Pre-Construction Phase	This will be addressed during implementation of RAP as resettlement is expected to be done prior to project implementation or prior to construction.					
II. Construction Phase						
The Land	The Land	Change in land use Destabilization of slope Removal of vegetation and habitat disturbance Soil erosion Increase run off	• Set-up temporary fence around the construction area • Conduct slope stability analysis and construct silt trap and spoils disposal area • Ensure solid waste management plan prior to mobilization of project; proper segregation and disposal shall be included in the program; Strictly require contractors and their workers to observe proper waste disposal and sanitation • Cutting Permit will be secured if there are trees that will be affected during construction • Limit land clearing in designated sites only. Avoid the removal/ clearing of mangrove species that will serve as buffer zone against strong winds, tsunami, soil from soil erosion, and others. The mangrove	Proponent/ Contractors	Included in the Construction cost	ECC MMT

			area will be protected to serve as habitat to remaining faunal species and species genepool • Establishment of a small nursery as source of planting materials using the endemic species and fruit-bearing trees found onsite for the replacement of trees to be cut or removed • Gradual clearing and removal of vegetation to provide sufficient time for wildlife species to transfer to the nearby habitat. Further, the existing mangrove forest within the project area shall be protected to serve as refuge and forage/feeding area for wildlife species. Planting of naturally-grown species in the designated areas might encourage the wildlife species to return in the future.			
Environmental Aspect # 2	The Water	• Increase in run-off -Generation of domestic wastewater -Generation of wastewater from cleaning of construction equipment, vehicles and regular watering activities • Contamination of surface water with oil and grease	• Site clearing will be limited to areas needed and restricted to acceptable weather conditions • No clearance or establishment works will be undertaken during high rainfall conditions to reduce the risk of sediment loss to the environment • Set up adequate toilet facilities; ensure sufficient washrooms for workers • Construction of settling ponds to contain inflow of muddy waters	Proponent/ Contractors	Included in the operating cost	ECC, MMT

		• Marine & terrestrial habitat disturbance	• Installation of oil traps and proper storage of used oil			
Environmental Aspect # 3	The Air	• Dust generation during clearing of the site and stockpiling of soil • Dust generation during opening up of pits, associated with movement of vehicles and machinery and excavation, transportation and emplacement of rock and soil • Dust generation during construction of the processing plant, power plant and storage facility, associated with movement of vehicles and machinery and excavation, transportation and emplacement of rock and soil • Exhaust fumes and noise from vehicles	• Roads will be watered especially during hot and dry weather. Regular water spraying by water sprinklers (road tank watering) during construction. • Regulate speed of delivery/ hauling trucks • Provide equipment with ear plugs, mufflers and proper scheduling of noise-generating activities	Proponent/ Contractors	Included in the operating cost	ECC,MMT
Environmental Aspect #	The People	• Increase in	• Alleviate economy and generation	Proponent	Included in the	ECC

4		livelihood and business opportunities • Increase in revenues • Provide job opportunities for construction workers • Health Risk	of income to hosts and nearby barangays • Increased LGU revenues resulting from the purchase of locally available materials and equipment for construction, translating to additional taxes. Business establishments should be properly registered and payment of the required taxes shall be monitored. • The construction of the project will generate employment opportunities for local residents as well as migrant workers. It will bring increased income to those who will be employed. Local manpower may have to compete with migrant labor for employment. Employment of local residents during the construction stage shall be given priority, particularly those from families in the Direct Impact Area. • Use of appropriate PPE and proper training of workers		operating cost	

Environmental Aspect #5	Solid and Hazardous Wastes	Used oil, paint wastes, scrap metals, busted lamps, and spent fuels	• Ensure a Solid Waste Management Plan to cover proper segregation, waste handling, waste storage and a waste disposal system. • Employ waste management strategies on reduce, re-use and recycle programs - Reduce – Reduction of waste through less packaging by promoting bulk purchasing without packaging; less single-use devices - Reuse – Choose water supply, office supplies that are re-usable, e.g. use printer inks that are refillable - Recycle – Composting the water supply and kitchen waste is a very useful form of recycling -Waste receptacles/bins shall be provided in strategic locations within the work areas. There shall be an identified designated area for the temporary disposal of domestic and construction wastes -Proper handling, transport and storage of chemicals such as used oil, used batteries, busted lamps etc. must comply with local regulations -Selling of scrap metals and used oil will adhere to local regulations • Material Safety Data Sheet will be in	Proponent/ Operator / Contractors	Included in the Operating cost	ECC

			place • Climate Change Adaptation: - Reduction of greenhouse emissions from energy used in offices by using green energy power or use of lighting that is environment friendly such as LED lights. - Implementation of rain water harvesting - Recycle office paper, newspapers, beverage containers, electronic equipment and batteries. Reducing, reusing and recycling in the office helps conserve energy, and reduce pollution and greenhouse gases from resource extraction, manufacturing, and disposal. Reduce, reuse, and recycle in the office can be done by using two-sided printing and copying, buying supplies made with recycled content, and recycling used printer cartridges. For old electronics, donate used equipment to other organizations or sold to accredited scrap buyers.			

III. Operation Phase A positive impact on flood control and mitigation are foreseen which will minimize business interruptions, traffic congestion as a result of flooding during rainy seasons, loss of properties brought about by floods. With the reduce flood problem, local economic activities will be sustained and developed. Expect more productive land use and utilization of local resources.						
IV. Abandonment Phase						
	The Land	• Land degradation • Damage to access and hauling roads • Loss of livelihood	• Preparation and implementation of comprehensive abandonment management plan • Proper clean-up and decontamination of affected site • Proper dismantling of equipment • Disposal of hazardous waste • Maintenance and rehabilitation of roads with drainage system in place • Retrenchment packages for displaced employees • Provision of alternative livelihood	Proponent	Included in operating cost	ECC

5.3 SOCIAL DEVELOPMENT FRAMEWORK

The indicative Social Development Framework (SDF) of the project is aligned with the Proponent's vision to support the affected barangays of lowland Cavite area and the local government units so as to help improve the economic status and quality of life of its constituents and to realize its mission to be the first and leading state-of-the-art bioethanol plant in the Philippines.

The construction, operation and management of the flood mitigation project shall comply with both local and International standards on safety and environmental regulations.

The indicative SDF of the company is anchored and aligned with the Host Barangays' framework for social development. It is the company vision to support the community by complementing barangay efforts and resources in improving the delivery of services to its residents.

5.3.1 Objective

The purpose of the SDF is to identify the doable supports of the Project to the Host Barangays subject to the company's policy on community services and according to the priorities within the Project's vicinity. It shall cover the construction, operation and abandonment phase of the project.

Below is a summary of the company's community relations and development programs.

Table 5.3 details the SDMP Plan/Framework for lowland Cavite area pursuant to DENR AO 2003-30.

5.3.2 Programs

a] Information Education Campaigns
b] Community Development Projects and Community Relations Programs
c] Health
d] Donations
e] Baseline study

Table 5.3: Cost Estimates for SDMP Framework

Item	*Amount (PhP)*
Municipality & Barangay Development Funds	1,500,000.00
Medical Mission, Health Programs, Clinic	1,000,000.00
Infrastructure (community projects)	2,000,000.00
Livelihood Programs (farming, fingerlings, fishing, etc.)	1,000,000.00
Socio-cultural, Clean & Green Activities	1,000,000.00
Donations	500,000.00
TOTAL	7,000,000.00

5.3.3 Program/Project/Activity Implementation

To ensure that it meets, and wherever possible, surpasses its legal, environmental and social obligations, DPWH/CTI will observe the following corporate policies:

a] Sustainability policy
b] Environment policy
c] Community relations policy

DPWH/CTI Management will actively work with the local community and the Local Government Units (LGUs) to establish formal policies, systems and procedures for managing the SDMP programs, projects and activities. Projects are typically generated through a Memorandum of Agreement (MOA), such as the Community MOA wherein programs to promote local social development shall include, among others

a] Human resource development and institution building
b] Enterprise development and networking.

Each project/program will be submitted for DPWH approval as part of detailed annual barangay development plan and implemented through a monthly program. DPWH/CTI will monitor the progress/projects on a daily and weekly basis. The community and the Local Government Units (LGUs) are responsible for implementing the programs/projects with DPWH/CTI support.

The MOA will stipulate that a minimum of 80% of the funds to be provided are used on the project/program and that only not more than 20% may be used for administration. No funds are to be used for honoraria to community members unless they hold a working position in implementing the program/project.

5.3.4 Monitoring of Programs / Projects / Activities

Key Performance Indicators

DPWH will require each program/project to agree or comply with a series of Key Performance Indicators (KPIs) prior to inception of each program. These indicators will be used to establish agreed points of success, goals or milestones throughout each program. This will ensure that each program/project has clearly identified goals and targets and that money spent will be well directed.

Table 5.4 presents the summary of DPWH/CTI's SDF plans and framework.

Table 5.4 : Social Development Plan (SDP) /Framework for Lowland Cavite Area

Concern	Responsible /Community Member/Beneficiary	Government Agency/NGO/and Services	Proponent	Indicative Timeline	Source of Fund
1. Relocation Land Purchase/ Resettlement	1. Barangay Chairman 2. Project's affected tenants 3. Land Owner	*LGU Municipal Assessor based on cadastral surveys *City Planning and Development Office *DSWD *DPWH (facilitating demolition of structures and transfer of affected families)	DPWH/CTI through Property Owner Community Relations Officer; Resettlement Specialist	Pre-construction	DPWH/CTI
2. Gender a] Responsive Livelihood / Employment for Men, Women, Youth & the Elderly livelihood skills a] High-value crops for farmers b] Employment - Job priority skills training for qualified workers	1. Association Chairperson 2. Qualified Project affected men, women, youth and elderly	1. LGU City Planning Office 2. LGU City Social Welfare & Dev. Office TESDA/TLRC - Various skills training courses DA/BFAR ▪ Technical training farming methods	Community Relations Officer (CRO)	Operation	LGU / DPWH/CTI (according to the budget in table 5.2)
3. Health and Safety a] Improvement/ Renovation of Brgy.	1. Barangay Kagawad for Health 2. Project's affected	1. City Health Officer 2. Barangay Disaster Management Committee	Community Relations Officer (CRO)	Operation	LGU/ DPWH/CTI (according to

Health Center b] Health services c] Potable water (bio-sand filter project) d] Supplemental feeding program for malnourished children e] Assistance to senior citizens and persons with disability	community				the budget in table 5.2)
4. Education & Recreation	1. Barangay Kagawad for Education/SK; Barangay PTA 2. Project affected families	Department of Education ▪ Scholarship program for qualified students ▪ Literacy programs & non-formal education programs City Engineer's Office ▪ Identification of appropriate project site, design, provide funding support, organize & implement related educational and recreation activities	Community Relations Officer (CRO)	Construction Operation	LGU/ DPWH/ CTI NGAs NGOs/ POs (according to the budget in table 5.2)
5. Environment & Sanitation ▪ Brgy. Solid Waste Management Plan ▪ Bio-sand water filters	1. Barangay Kagawad for Environment 2. Project's affected community	CENRO ENRO /MHO 1. Formulate training in SWM 2. Reforestation (tree planting) 3. Establishment of forest nurseries 4. Environmental monitoring	Community Relations Officer (CRO)	Pre-construction Construction Operation	LGU/ DPWH/ CTINGAs/ NGOs/ POs (according to the budget in table 5.2)

		5. Health programs 6. Provide bio-sand water filters CHO and/or DOH			
6. Peace & Order	1. Barangay Kagawad for Peace & Order 2. Project's affected community	LGU PNP - Capacity-building & strengthening of barangay tanods in peacekeeping - Maintenance of peace and order and respond to security concerns	Chief Security Officer	Pre-construction Construction Operation	LGU/ DPWH/ CTI (according to the budget in table 5.2)
7. Spiritual	Barangay Assigned Catholic priest, or pastor of different denomination	Parish Priest for Catholics or Pastor for Non-Catholics and Non-Muslims	Community Relations Officer (CRO)	Construction Operation	LGU/ DPWH/ CTI (according to the budget in table 5.2)
8. Infrastructure	*LGU: City and Barangays * Barangay Kagawad for Infrastructure * CPDO	* DPWH/ City Engineer's Office * CPDO * LGU: City and Barangays * Repair/Improvement /Expansion of Barangay Road	Community Relations Officer (CRO)	Pre-construction Construction Operation	LGU/ DPWH/ CTI (according to the budget in table 5.2)

5.4 INFORMATION, EDUCATION AND COMMUNICATION PLAN FRAMEWORK

The Information, Education, and Communication Plan of DPWH/ CTI shall focus on the Project's information dissemination, predicted impacts of activities to the environment particularly to the people and their inherent resources, the benefits that the community and the people may derive, and the cost and benefit analysis of the operations with regards to environmental protection, and the future of the community after the abandonment of the project.

The proposed IEC will include public consultations which will allow DPWH/CTI to report on its environmental performance and at the same time solicit feedback and suggestions from community members on how to improve and enhance its environmental protection and enhancement activities. **Table 5.5** describes the IEC Plan/Framework of the company.

Table 5.4 - IEC Plan/Framework of DPWH / CTI

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
1. Directly and indirectly affected population: LGUs with focus on Barangays affected	-The EIA process -The construction of the project	-Barangay Assemblies -FGD -Public consultations; -Information desk -Community meetings	1 Illustrative Primer/ Brochure (pictograms) about the Project - The EIA's process illustrated and simplified in the language of the affected community This includes ▪ The project description ▪ A graphic illustration about the process of bioethanol operation with WTE power plant using RDF and the mitigating measures ▪ Major process activities, the structural, supporting and non-structural measures for the successful implementation of the project; ▪ Location map indicating the exact location of the major activities ▪ Frequently Asked Questions (FAQs) about the project; the identified	-Prior to start of project construction -Continuing Regularly or as needed; at least on an annual basis	The cost includes meals, venue, IEC materials, transport, design, layout, printing cost salaries, honoraria etc. Project cost is estimated at **PhP 500,000 per annum**
	The renumeration for identified land areas to be used by the project				
	-The consequential impacts on the residents of the community				
	The benefits of the project on their socio-cultural/ economic and bio-physical environment of the affected residents as they address the major issues of air and water pollution using IEC Proposed Corporate Social Responsibility Programs and Projects such as				

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
	farming, skills and other livelihood trainings, Mangrove protection and management		impacts and mitigations; health and safety measures related to construction and operation of the project and correct behavior in relation to the Project ▪ The residents who will be affected by the Project's activities showing their right to complain for violations of ECC conditions		

			a] Group discussions for the identified tenants regarding their rights and responsibilities in relation to land purchase c/o the land owner and prior to land acquisition b] Group discussions with sectorial groups which will be affected with the activities, the legal processes with the application of priority job placement, and other benefits 2. Workshops to cover the preparation of IEC materials and campaigns		
			3. Posters and pictograms on EIA in local language		

Chapter 6

ENVIRONMENTAL COMPLIANCE MONITORING

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Chapter 6 – ENVIRONMENTAL COMPLIANCE MONITORING

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6.0 ENVIRONMENTAL COMPLIANCE MONITORING

The Environmental Compliance Monitoring Plan is prepared to ensure the company's compliance to environmental regulations, thereby minimizing adverse effects of the Project to its immediate surroundings and protecting the health of the affected public.

6.1 Environmental Monitoring Plan (EMoP)

The proposed Environmental Monitoring Plan with Environmental Quality Performance Levels (EQPLs) is shown in **Table 6.1** using the recommended format in Annex 2-20 of RPM DAO 2003-30. However this will be finalized once the ECC has been issued.

Objectives:

1. Ensure that all emissions, effluent and other wastes generated as a result of the Flood Mitigation Project are in accordance with DENR Rules and Regulations which include, but is not limited to, Presidential Decree 1586 (the *Philippine Environmental Impact Statement System*), Republic Act 8749 (*Clean Air Act*), RA 9275 (*Clean Water Act*), RA 9003 (*Ecological Solid Waste Management Act*), RA 6969 (*Philippine Chemical & Chemical Substances and Hazardous & Nuclear Waste Control Act*), PD 984 (*Pollution Control Act*)
2. Define monitoring mechanisms and identify monitoring parameters
3. Validate the changes in the various environmental media as discussed in the Impact Assessment Plan
4. Provide mitigation measures and performance levels
5. Provide early warning on any unacceptable environmental conditions.

6.2 ECC Compliance Reporting

After the issuance of the ECC, the company through its Pollution Control Officer will ensure that regular reporting of compliance to DENR standards and other regulatory industries will be undertaken. The Self-Monitoring Reports (SMR) detailing status of compliance with ECC and other environmental regulation shall be submitted quarterly to DENR-EMB Region 4A.

6.3 Multi-sectorial Monitoring Team (MMT)

An MMT for the project may opt to be formed during construction only, based on the requirements of DENR Administrative Order 2003-30, Annex 3-4.

Table 6.1 – Environmental Monitoring Plan (EMoP) with Environmental Quality Performance Levels (EQPLs)

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL MANAGEMENT SCHEME					
								EQPL Range			Mgt. Measures		
			METHOD	FREQUENCY	LOCATION			Alert	Action	Limit	Alert	Action	Limit
CONSTRUCTION PHASE													
Environmental Aspect	Fresh Surface Water Quality Stations: Rio Grande River Ylang-Ylang River Maalimango creek San Juan River Manila Bay	Surface Water Total Suspended Solids (TSS), pH, BOD, DO, Oil & Grease, Color, turbidity	Grab Sampling RA 9275	Monthly	Upstream; midstream and downstream -For Manila Bay, sampling point to be monitored should be within the project site	Pollution Control Officer (PCO)	500,000	Siltation Surface Water: TSS- 25 mg/L increase pH: 6.4-8.4 BOD: 7mg/L DO: 4.9 mg/L Oil & Grease: 1.9 mg/L Color: slight change to natural background	Siltation Surface Water: TSS- 30 mg/L increase pH:6.5-8.5 BOD: 7 mg/L DO: ≥5.0 mg/L O/G: 2.0 mg/L Color: discolaration; no standard for turbidity	DAO 34, Class C TSS: 30mg/L increase pH: 6.5-8.5 BOD: 7 mg/L DO: ≥5.0 mg/L O/G: 2.0 mg/L Color: discoloration; no standard for turbidity			RA 9275/ DAO 34
	Riverbed Sediments	-Heavy metals (As, Ba, Cd, Cr, Cu, Pb, Hg,Se,F), OCPs, OPPs	RA 6969	Quarterly	Same stations with fresh surface water quality								RA 6969
	Air Quality Proposed site locations -General Trias -Rosario -Noveleta	Total Suspended Particulates (TSP) & PM_{10}, CO, SO_2, NO_2, CO	1-hr Sampling per RA 8749	Quarterly	Construction area; downwind; NSEW direction	PCO	400,000	Fugitive dust		RA 8749		Regular sprinkling activities	RA 8749
	Noise Proposed site	Ambient Noise and Vibration (especially during drilling activities)	Grab sampling	Monthly/ Weekly during drilling, and when required	Pre-determined specially in areas near	PCO	800,000	Intermittent noise		NPCC 1978		Ear plugs/ ear muffs as necessary	NPCC 1978

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Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL MANAGEMENT SCHEME					
								EQPL Range			Mgt. Measures		
			METHOD	FREQUENCY	LOCATION			Alert	Action	Limit	Alert	Action	Limit
	locations -General Trias -Rosario -Noveleta				immediate receptors, construction site ; NSEW direction								
	Solid Wastes	Construction debris, papers, plastics, biodegradable waste	Grab/ landfill	Daily	Construction site / SW storage area	PCO	60,000			RA 9003		Imposition of fines due to improper disposal	RA 9003
	Wastewater (domestic)	TSS, BOD, pH, Oil & Grease (canteen)	Grab Sampling RA 9275	As necessary	Common septic tanks for toilets & canteens	PCO	25,000	Wastewater from toilets, washings		RA 9275		Ensure portalets & septic tanks are in placed	RA 9275
	Chemicals & Hazardous Wastes	Used oil, busted lamps Used paints, spent solvents	Individual segregation & collection	As necessary	Storage Area/ Motorpool	PCO	50,000~100,000/annum	Oil spills		RA 6969		Instigate measures per regulatory requirements	RA 6969
	Socio-economic	Displacement of informal settlers; relocation Recruitment/hiring for manual labor & other skills available within the Host Barangay & nearby communities			Project location	Community Relations Officer (CRO)						Relocation Job opportuni-ties	
	Terrestrial Flora & fauna Impacts	Flora- species dominance within quadrants in terms of total cover, relative ground cover, absolute density, absolute frequency, relative density and relative	Line transect/ quadrat / trap	Annual	Within project vicinity and its affected barangays	PCO	Included in the operating costs						Other applicable local & international standards

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL MANAGEMENT SCHEME					
								EQPL Range			Mgt. Measures		
			METHOD	FREQUENCY	LOCATION			Alert	Action	Limit	Alert	Action	Limit
		frequency of individual species Fauna – species diversity index, dominance index, and evenness index Soil Nutrients, Plant Tissue Nutrients											
	Social Impacts	1. Income comparison for relocated households before & after relocation 2. Number of immigrants attracted by the project 3. Proportion of direct employment to residents of impact barangays to total direct employment provided by the Project and distribution of employed residents per impact barangay 4. Number of alternative means of livelihood	Interviews	Annual	Brgys. affected	PCO	Included in the operating costs						

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Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL MANAGEMENT SCHEME					
								EQPL Range			Mgt. Measures		
			METHOD	FREQUENCY	LOCATION			Alert	Action	Limit	Alert	Action	Limit
		created and number of people actually benefited 5. Income comparison for brgys. and municipality before and during the project 6. Ratio of income gained and income lost											
	Health Impacts	1. Health impacts 2. Morbidity, mortality 3. Health profile of receptor communities 4. Vital health indices 5. Malnutrition Environmental Quality and Health 6. Environmental Sanitation ▪ OHS records of employees ▪ Interviews and medical examination of high-risk groups ▪ Inspection of facilities, control devices, PPEs, and working conditions	Interviews	Annual		Health & Safety Officer (HSO)	Included in the operating costs						DOH/ WHO

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL MANAGEMENT SCHEME					
								EQPL Range			Mgt. Measures		
			METHOD	FREQUENCY	LOCATION			Alert	Action	Limit	Alert	Action	Limit
		▪ Health data-basing for most vulnerable public groups											
ABANDONMENT PHASE (IMMEDIATE AFTER CONSTRUCTION)													
Environmental Aspect	Land (Disposal Site) Clearing of construction debris; removal of construction equipment	-Heavy metals (As, Ba, Cd, Cr, Cu, Pb, Hg,Se,F) OCPs, OPPs	Systematic sampling: Several Grab and composite Sampling	As prescribed	Designated disposal sites	PCO	2,000,000	TCLP Metals: As, 0.8 ppm Ba, 65 ppm Cd, 0.2 ppm Cr, 4 ppm Pb, 0.8 ppm Hg, 0.08 ppm Se, 0.08 ppm F, 95 ppm	TCLP Metals: As, 1 ppm Ba, 70ppm Cd, 0.3 ppm Cr, 5 ppm Pb, 1 ppm Hg, 1 ppm Se, 1 ppm F, 100 ppm	TCLP Metals: As, >1 ppm Ba,>70ppm Cd,>0.3ppm Cr, >5 ppm Pb, >1 ppm Hg,>0.1 ppm Se, >1 ppm F,>100ppm		Reme-diate/ clean up the contami-nated area	RA 6969

Chapter 7

EMERGENCY RESPONSE POLICY AND GENERIC GUIDELINES

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Chapter 7 – EMERGENCY RESPONSE POLICY AND GENERIC GUIDELINES

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7.0 Emergency Response Program

DPWH/CTI will have a comprehensive Emergency Response Plan which describes programs and actions in response to various major events such as terrorism, disasters and catastrophes like earthquakes, flash floods, fires, explosion regardless of cause and landslides.

For effective implementation of the emergency and contingency procedures, effective management structures shall be in place. The structures must clearly define the duties and responsibilities of all personnel involved in the emergency organization.

The emergency response plan describes policies, the members of the team, its roles and responsibilities, operating procedures, personnel safety, property protection and monitoring. Audit and inspection reports are included in the plan. Trainings on emergency response and safety are programmed annually.

Identification of risk assessment in construction and operation of the project is planned.

7.1 Contingency/Emergency Response Plan

Each type of emergency shall have a documented procedure which shall be strictly followed during emergency situations. Intensive training and drills on the procedures shall be undertaken regularly. Each procedure shall be reviewed and updated regularly.

7.1.1 Fire

Fire prevention, awareness and firefighting programs shall be established. All necessary fire prevention, warning, suppression, control equipment shall be provided and available in good condition. Fire extinguishers will be strategically located and everyone shall be trained to use them. Exit areas shall always be clear from clutter and with visible signages.

Handling and storage of flammable materials such as paints shall be covered by fire emergency procedures.

7.1.2 Chemical and oil Spills

Procedures in handling, storage, transport and use of oil and liquid materials shall incorporate steps in preventing spillages and leakages. Secondary containment for all liquid materials shall be in place.

There shall be enough available equipment and materials to control and clean-up any spillages or leakages when these arise. Any collected spills or leaks shall be stored and disposed of properly in accordance with Republic Act 6969.

Good housekeeping practices will be observed in the work place at all times. MSDS shall be strategically located where necessary.

7.1.3 Earthquakes, Storm surges and Other Catastrophes

Each type of catastrophe should have its own emergency procedures. Open channels of communication to concerned government agencies in the formulation of the emergency procedures is necessary. Readiness to implement evacuation procedures when needed shall be ensured.

7.2 Occupational Health and Safety

The company shall subscribe to a pro-active program of pursuing a healthy, safe and environment-friendly operation. It shall push for the adoption of industrial hygiene programs to ensure a work environment that is consistent with internationally-accepted norms of industrial operations.

A Loss Control Program, allied to the pursuit of the safety program, shall also be implemented and overseen by the Safety Officer. The Safety Officer shall be designated and together with the Pollution Control Officer (PCO), shall undergo health, safety and environment training programs.

Company guidelines on health and safety programs will be made clear to contractors and all employees during construction and operation. Strict compliance with these guidelines will be part of the Employee's Code of Conduct; sanctions will be imposed upon violators. An annual program of safety evaluation within the plants will be conducted with the aim of continuously improving safety conditions.

Plant Management will conduct annual health examination of employees by an external physician for health maintenance, in addition to the continuous availability of medical attention for sickness and medical emergencies as required by Philippine labor laws. Provision for first-aid shall be available at the site.

Chapter 8

ABANDONMENT/ REHABILITATION PLAN

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8.0 Abandonment/ Rehabilitation Plan

The abandonment in the context of a plant is not applicable in this type of project. The project is enhancement projects that will address the flood problem in the lowland areas of Cavite thus abandonment is a remote possibility unless force majeure occurs.

The Abandonment and Rehabilitation plan in this type of project would mean abandonment and rehabilitation during the end of construction period. Once the ECC is issued, among the conditions will be the abandonment plan. This shall be prepared ninety (90) days prior to abandonment of the area and will be submitted to DENR-EMB Region IVA. Activities will include the following:

1. On-site inspections of the following
    a. Project site
    b. Equipment and support facilities
    c. Remaining construction materials and supplies
    d. Waste generated

2. Clean-up, remediate (if any) contaminated areas (soil or water) cause by the project implementation;
3. Rehabilitate environment disturbed by the project
4. Pull out equipment and remaining supplies and materials
5. Dismantling and pull out of temporary construction support facilities
6. Disposal of waste generated during construction
7. Cleaning and Clearing of construction site

Abandonment will also mean the disposal of the riverbed sediments and other dredge materials that will be generated during the widening of the river and dredging of the drainage channel. These dredge materials shall undergo toxicity evaluation prior to their disposal in areas designated by the local government officials. All materials found to be free from hazardous component shall be used for back filling or as soil cover for open dumpsite subject for permanent closure and rehabilitation. However, dredge materials with obnoxious odors shall be immediately treated and disposed in pre-identified sites. All materials found to contain hazardous components shall be treated and disposed by DENR accredited TSD facility.

Department of Public Works and Highways (DPWH)
In Partnership with Japan International Cooperation Agency (JICA) CTI Engineering International Co. Ltd.
CAVITE FLOOD MITIGATION FOR LOWLAND AREAS

Chapter 9

INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

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Chapter 9 – INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

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9.0 Institutional Plan

The Institutional Plan is the establishment of a body that will implement the proposed Environmental Management Plan (EMP) whose main thrust is to ensure that environmental, socio-economic, political and public health issues are properly address in a timely manner. It provides necessary mechanism that will strengthen the organizational relationship of the proponent with the host community, concern government agencies and other stakeholders.

9.1 DPWH's Environmental Unit

DPWH thru the Unified Project Management Office (UPMO) – Flood Control Management Cluster, being the proponent shall coordinate with the Environmental Unit of DPWH. The project engineers of the UPMOs shall be responsible in the monitoring of the project in coordination with the DPWH - Environmental and Social Safeguards Division (ESSD), under the Planning Service. Enough resources/budget shall be appropriated to support the different environmental programs.

The UPMO shall designate an acting pollution control officer among the project engineers who shall have the following functions:

Plan and implement the environmental management plan;

- Monitor compliance of contractors implementation of the EMP;
- Identify sources of pollution;
- Monitor and evaluate the effectiveness of mitigating/enhancement measures;
- Plan, propose, and implement modifications, or additional environmental measures that are deemed necessary to more effectively protect the environment;
- Coordinate with relevant oversight agencies and other stakeholders including the local government and the community to ensure their effective participation in the implementation of the environmental management plan.

DPWH may designate a separate Health and Safety Officer or PCO may act concurrently as the Health & Safety Officer.

The PCO and Safety Officer shall report directly to the UPMO's head, while the head shall coordinate with the ESSD. The head shall be responsible for the overall environmental management program. The PCO should be given enough authority and competence on decision-making with reference to environmental management. The PCO shall be responsible for LAND, AIR, WATER, SOLID and HAZARDOUS WASTE components. The Safety Officer shall be responsible for the health and safety component, while the Security Officer shall be in-charge of Peace and order to include security risk management and emergency responses. The Community Relations Officer

(Comrel) who will be designated from among the project engineers, shall handle the PEOPLE and shall be responsible for plans and implementation of social development programs, IEC activities and implementation and monitoring of RAP.

The Manager, PCO, Safety Officer, Comrel and Security Officer shall have appropriate educational background and/or experience and training on environmental, community organization and development, health and safety and security risk regulations and practices.

9.2 ECC Compliance Reporting

After the issuance of the Environmental Compliance Certificate (ECC), the company -- through its Environmental Unit -- will ensure that regular reporting of compliance to DENR standards and other regulatory agencies will be undertaken. The Self-Monitoring Reports (SMR) detailing status of compliance with ECC and other environmental regulations shall be submitted quarterly to DENR – EMB Region IV-A.

9.3 Health and Safety

The company shall subscribe to an active program of pursuing a health, safe and environment-friendly operation. It shall push for the adoption of industrial hygiene programs to ensure a work environment that is consistent with internationally-accepted norms of industrial operations.

A Loss Control Program, allied to the pursuit of the safety program, shall also be implemented and overseen by the Safety Officer. A Safety Officer shall be designated and together with the Pollution Control Officer (PCO) as well as UPMO's Manager shall undergo health and safety training programs.

Company guidelines on health and safety programs will be made clear to contractors and all employees during construction. Strict compliance with these guidelines will be part of the Employee's Code of Conduct; sanctions will be imposed upon violators. Regular program of safety evaluation within the construction area will be conducted with the aim of continuously improving safety conditions. Provisions for first-aid shall be available at the site.

9.4 Contractor's Accountability

Since the construction of the project will rely on the contractors, DPWH shall ensures that the contractors be bound by rules of conduct, practice, and accountabilities, which carry the different Environmental and Safety program of the project.

The accountabilities of contractors must include:
• Full disclosure of product information relating to safety and environmental impact;

• Safe transport and delivery of products;
• Minimum pollution and risks in the delivery of products and services; and
• Immediate response to environmental incidents.

The DPWH shall ensure that the contractors shall be legally and financially liable to the Environmental Management Plan. The DPWH and the contractors shall be accountable for any damages that may occur to human beings, property, and or environment caused by their operations. The contract may be terminated and or the contractor will be included in the blacklist once taken the penalty for negligence, bad housekeeping, disregard the environmental policy of the company, and unsound practice.

The essential knowledge and awareness of the contractors regarding their responsibilities and accountabilities must be assured and incorporated in the contract signed by both the DPWH and contractor for every activity.

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