Masinloc Power Plant Project (Unit 4 Increase in Capacity and Unit 5 Expansion)

Draft EPRMP Report

December 2020

EXECUTIVE SUMMARY

List of Tables

List of Figures

List of Plates

List of Annexes

Executive Summary

Project Fact Sheet PD Summary

Project Information

Name of Project : Masinloc Power Plant Expansion Project (Unit 4 Increase in Capacity and Unit 5 Expansion) shall be known as *the**"Project"***

Project Location : Barangay Bani, Municipality of Masinloc, Province of Zambales

Nature of Project : Energy (Coal-Fired Thermal Power Plant)

Project Size : Unit 1: 324 MW (No Change)

Unit 2: 324 MW (No Change)

Unit 3: 300 MW (No Change)

Unit 4: 315 MW (Increase in capacity from 300MW)

Unit 5: 315 MW (New Unit/Expansion Project)

Proponent Profile

Proponent Name	:	**Masinloc Power Partners Co. Ltd**., a subsidiary of SMC Global Power Holdings Inc**. (SMCGPH)**
Proponent's Address		
Corporate	:	19th Floor San Miguel Properties Centre, No. 7 St. Francis Avenue, Mandaluyong City, Metro Manila
Plant Site	:	Barangay Bani, Municipality of Masinloc, Province of Zambales
Contact Persons		
Plant Site	:	**Mar Tuazon** Plant Manager
Contact Number	:	(+6347) 307-4000
E-mail Address	:	mrtuazon@mppcl.sanmiguel.com.ph
EPRMP Consultant	:	RHR Consult Services, Inc.
Consultant's Address	:	Unit 606 FSS Bldg. 2, No. 18 Scout Tuason, corner Scout Castor, Diliman, Quezon City
Contact Person	:	**Ryan Filiberto Pollisco-Botengan** Managing Director
Contact Number	:	09451957833 (02) 8503-5505
E-mail Address	:	botenganryan@gmail.com

DENR issued the Environmental Compliance Certificate (ECC) to the National Power Corporation (NPC) for the Masinloc Coal-Fired Thermal Power Plant (***"MCFTPP" or referred to in this document as Masinloc Plant***) on December 18, 1992. The power plant commenced operation in 1998. The Masinloc Plant is a 2 x 300MW baseload power plant connected to the Luzon Grid. On 16 April 2008, the Masinloc Plant was acquired by Masinloc Power Partners Co., Ltd. (***"MPPCL"***) from the Power Sector Assets and Liabilities Management Corporation (***"PSALM"***), the latter having offered the highest bid in a competitive bid conducted by PSALM pursuant to the mandate of Republic Act 9136 otherwise known as the Electricity Power Industry Reform Act (***"EPIRA"***).

MPPCL, a subsidiary of the AES Corporation (***"AES"***) is a global power company that serves 100 million end user customers in 29 countries across 5 continents. AES owns and controls 14 regulated utilities and 121 power stations with an installed capacity of 39,659 MW. AES is based in the United States and is publicly listed on the New York Stock Exchange under the ticker symbol AES.

The Project will be built on the existing Masinloc Plant facility located in Barangay Bani, Municipality of Masinloc, Province of Zambales (15°34'00" N, 119°55'20" E). The Project is located approximately 250 kilometers (km) NW of Manila and occupies ≈138.5 ha of land (**Figure ES-1**).

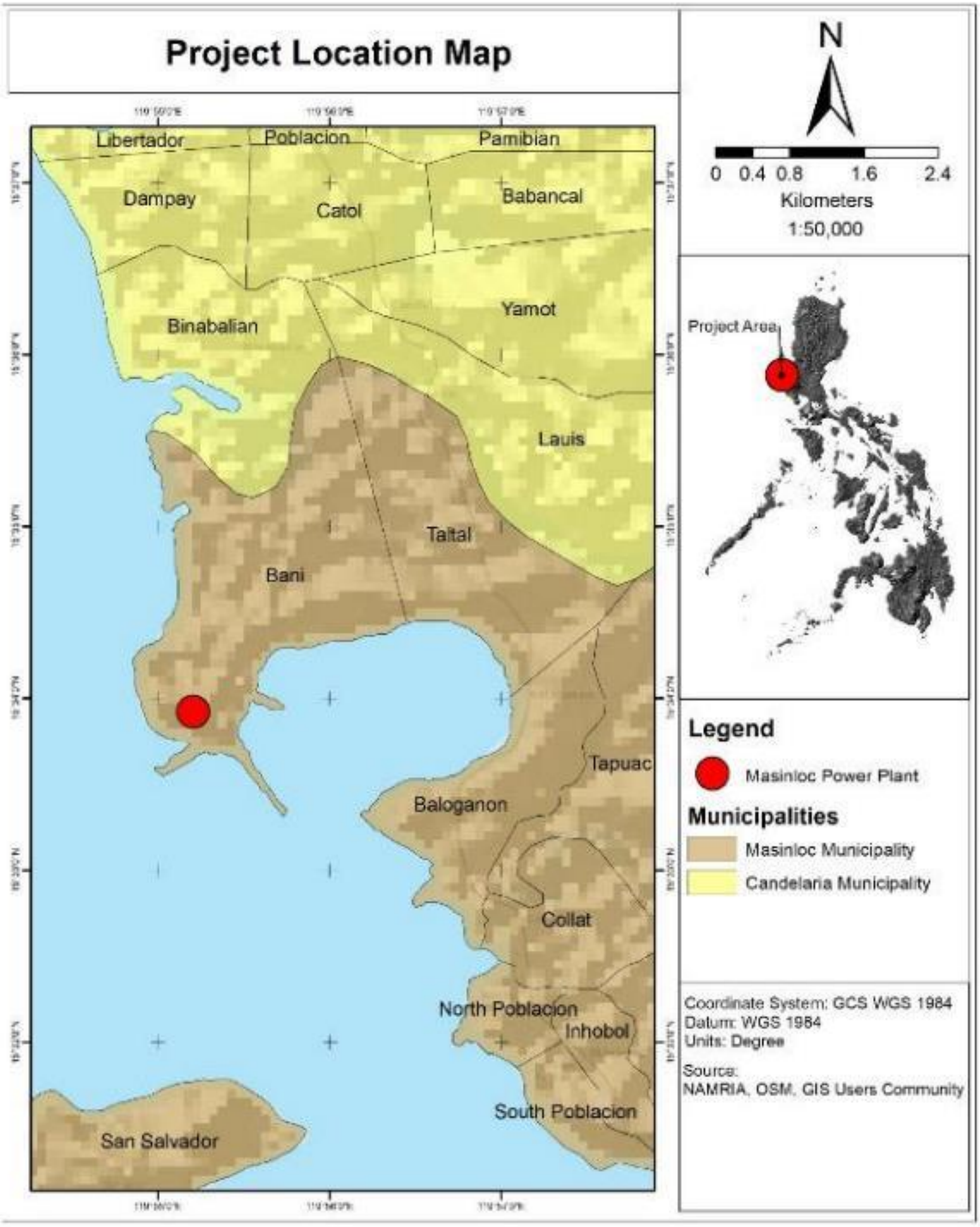


Figure ES-1: Location of Masinloc Plant

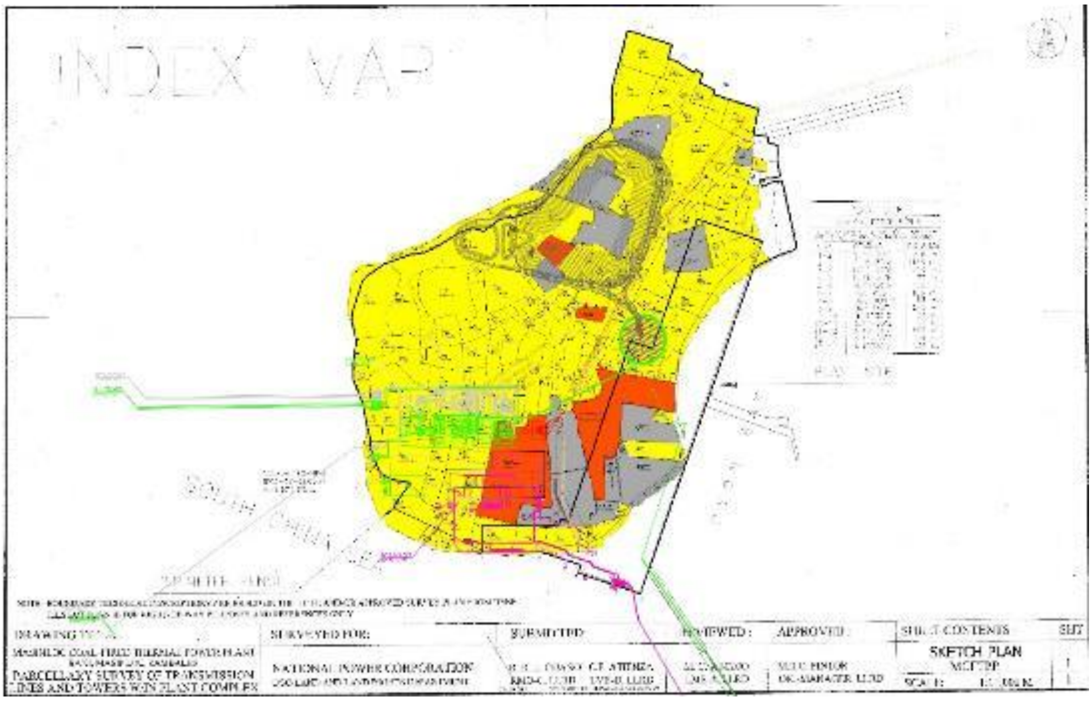
The Project intends to use similar structures, system specifications and equipment of Masinloc Plant's existing facilities to ensure effective inter-plant coordination and to reduce the environmental impact of the Project on the overall footprint of the Masinloc Plant.

A description of the Project's modifications relative to the existing plant is summarized in **Table ES-1** and presented in **Figure ES-2**.

Table ES-1: Summary Scope of Proposed Modifications

Components	Existing	Modification/Addition	Final Project Scope
Rated Capacity	2 x 324 MW (Units 1 and 2)	No change	2 x 324 MW
	1 x 300 MW (Unit 3)	No change	1 x 300 MW
	1 x 300 MW (Unit 4: For Development)	Increase capacity to 315 MW	1 x 315 MW
		1 x 315 MW (Unit 5: For Expansion)	1x 315 MW
Project Area	138.5 ha	138.5 ha	138.5 ha
Annual Production	8,746 GWh/year (in operation)	105 GWh/year by 2024 2,207 GWh/year by 2025	8.851 GWh/year by 2024 11,059 GWh/year by 2025

a)



b)

Figure ES-2: Layout of the Project

General Description of Unit 5

The Project shall employ separate sourcing of water from the sea which will be processed for plant use via a desalination process. Seawater will be taken as a slipstream from the new cooling water system to be constructed for Unit 5. The Project also involves the construction of additional treatment capacity to the existing system.

An additional intake water system dedicated to Unit 5 that is similar in specifications to the existing system shall be constructed. Additional capacity for the existing chlorination system will be constructed. The Project shall use the same cooling water outfall structure as the existing plant.

The Project will utilize Seawater Flue Gas Desulfurization (SFGD) technology to control the SOx emissions of Unit 5. SFGD started to be installed in commercial-size power plants in late 1980's for the control of the emissions of SOx. SFGD is considered acceptable by the World Bank and other international finance institutions and is included in the Environmental, Health and Safety Guidelines for Thermal Power Plants published by the International Finance Corporation (IFC) which is part of the World Bank. **Figure ES-3** shows the SFGD process that utilizes the ability of seawater to absorb and neutralize SOx present in the untreated flue gas. Flue gases from the boiler containing dust are directed to an electrostatic precipitator or a fabric filter. Then, the flue gas is directed to a seawater SOx absorber.

Utilizing efficient combustor technology, the Project will attain emissions that comply with currently prescribed maximum limits under the Clean Air Act.

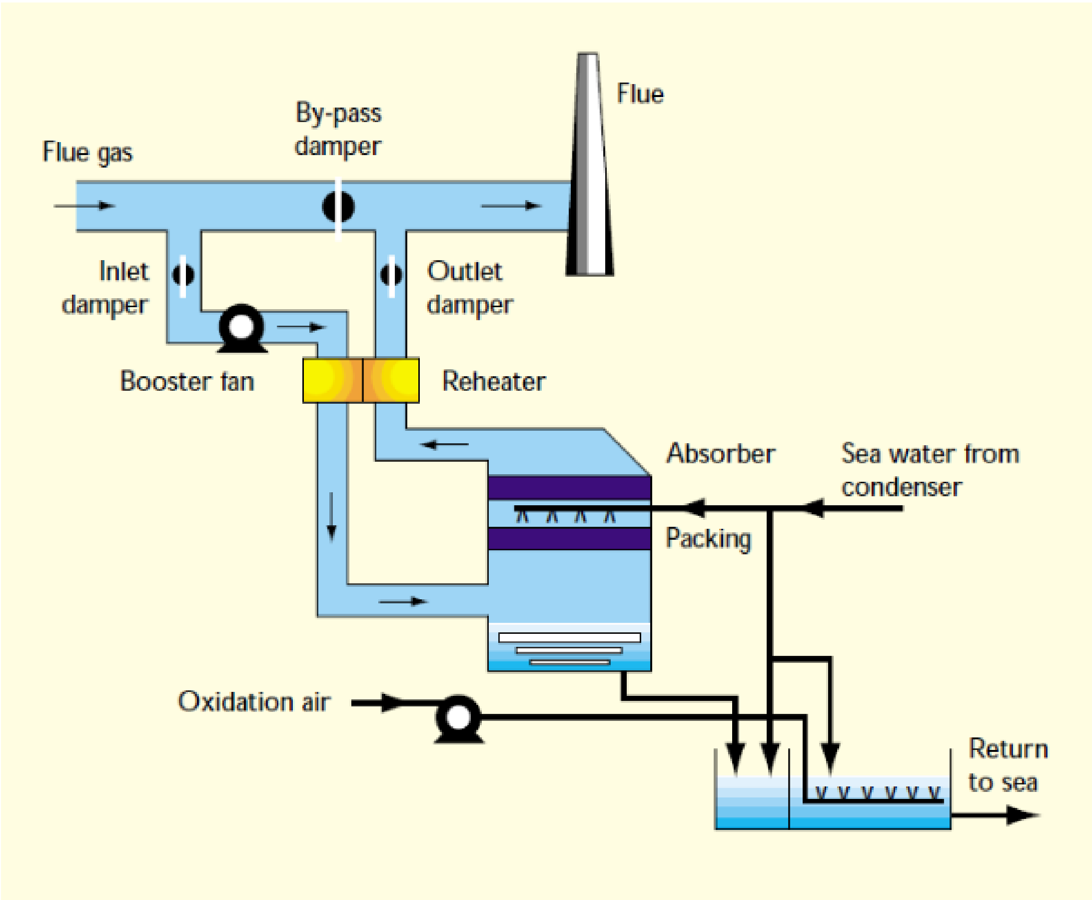


Figure ES-3: Seawater Flue Gas Desulfurization (SFGD) Process

Process Documentation of the Conduct of EIA

The EIA Team

The members of the multi-disciplinary team of researchers that conducted the Environmental Impact Assessment (EIA) study and their corresponding fields of expertise are shown in**Table ES-2**.

Table ES-2: EIA modules

Module
Team Leader/Peer Reviewer
Project Description, Environmental Performance-Engineering
Project Description
Geology/Hydrogeology
Soils and Land Use
Terrestrial Flora and Fauna
Freshwater Biology/Freshwater Quality
Hydrology
Marine Biology
Marine Water Quality and Chemical Oceanography
Physical Oceanography
Thermal Plume Dispersion Modeling
Meteorology and Air/Noise Quality
Socio-Economics
Environmental Health Impact Assessment
Air Dispersion Modeling/Environmental Risk Assessment

EIA Study Area

The EIA study area consists of the ≈138.5 ha original property of the Masinloc Plant since land disturbance and soil erosion would have most likely occurred in this area resulting from the activities of the Project. This also includes the areas where monitoring has been conducted, such as, rivers and the coastal areas of Masinloc Bay. In as much as the impact areas have been established in the previous Environmental Impact Statement (EIS), perception surveys were limited to the Direct Impact Areas (DIA) that include Barangays Bani, Taltal and Baloganon in the Municipality of Masinloc. The spatial extent of the study also covers the Indirect Impact Areas (IIA), which include Barangays Binabalian and Lauis in the Municipality of Candelaria.

EIA Methodology

The following paragraphs discuss the methodology used in each of the study module of the EIA.

Geology, Soils and Land Use

The environmental setting relative to Geology and Soils were established bythe 1994 EIA for the Masinloc Plant prepared by the National Power Corporation (NPC). The data from the previous EIS and other compliance reports were used in this report. Ground truthing was conducted and existing data were re-validated for the preparation of the Environmental Performance Report and Management Plan (EPRMP) for the Project.

Terrestrial Ecology

Terrestrial Flora

The five plots for Terrestrial Flora were located through established markers such as PVC pipes and paint markings. The method used for the monitoring event is the nested quadrat sampling technique, which requires the use of main plots and subplots. Main plots have dimension of 10 m x 10 m to monitor the climax species (DBH > 10 cm). Inside the main plots, sub-plots were randomly established with dimensions of 3m x 3m for the intermediate layer (5cm > DBH < 10 cm), and 1 m x 1 m for the understory layer (DBH < 5cm). Transect Walk was also performed in the study area as a rapid biodiversity assessment technique that employs a hike/walk within the area assessed (outside the sampling stations) and recording of species observed. It is classified as a "walk through" sampling (Dove and Sajise 1998, SUAN 1998). The flora team started out on a hike through the area following access roads to the sites. Species were listed down as the team traverses the area. No replicates of species were recorded. This way, species not included in the sampling points may still be included in the overall description/characterization of the sites.

Terrestrial Fauna

Sampling methodologies included mist-netting for flying fauna such as birds and bats, cage traps for ground dwelling fauna such as rodents and small mammals, visual/opportunistic observations for birds, and searching for amphibians and reptiles.

Field investigations focused on four animal groups/taxa: amphibians, birds, reptiles and mammals. These four are general indicators of the health of an ecosystem because they each function as prey or predator within the ecosystem/habitat. The general abundance of species, habitat association and presence were recorded and discussed in this report.

Three monitoring stations were located for the terrestrial fauna and traps such as mist-nets and cage traps were established along the transect line (same as the transect line for terrestrial flora). Day-sampling was conducted for Birds and Mammals while opportunistic sampling at night was conducted for herpetofaunal (reptiles and amphibians) groups. For non-volant (flying) mammals, baited live traps were set randomly near the mist-nets during the afternoon, and then re-baited the following day, also in the afternoon. For amphibians and reptiles, opportunistic night sampling was conducted wherein all encountered herps were listed. Transect survey was conducted from 6:00 AM – 10:00 AM and 4:00 PM – 6:00 PM. Night sampling on the other hand was conducted from 6:00 PM to 7:00 PM.

Indirect transect faunal identification was also done, such as identification through tracks, signs and auditory cues. Microhabitat was also searched in the immediate vicinities of the transect line, 5 meters to the left and 5 meters to the right, to ascertain the presence of small and/or cryptic species of wildlife.

Hydrology

Historical data on the hydrological characterization of the area was used. This included the streamflow measurements that were previously conducted during the preparation of the Final Masinloc Plant (First Phase) EIS in 1994. Spot discharge measurements were done in April 1989 and May 1990. Various measurements were likewise made in April 1993.

Actual spot streamflow measurements were conducted during the visit last October 14, 2010, where a portion of the Lauis River was diverted to the existing freshwater intake structure of the Masinloc Plant in Barangay Taltal, Masinloc. Float-Area Method or Float-Velocity Method was used in conducting the streamflow measurements.

In the absence of sufficient historical streamflow records for Lauis River that could be used to determine the dependable flow, data from Nayom River was transposed to Lauis River (ungauged) using the Basin-Factor Ratio method. Considering that the two rivers have generally the same geologic formation and are influenced by the same climate type, it was assumed that the two rivers have the same hydrologic responses.

Oceanography

Thermal Plume Dispersion modeling was conducted by using available information.

Water Quality

Freshwater Quality

The area has two major river systems, Lauis River which drains north of the Masinloc Plant and Masinloc River which drains southeast.

Water quality of the Masinloc River was monitored in two stations: LR-1 (Upstream of the freshwater intake); and LR-2 (Near the river mouth/nursery). The parameters measured were the following: ammonia, arsenic, barium, BOD, cadmium, chromium, color, dissolved copper, dissolved oxygen, fluoride, iron, lead, manganese, mercury, nickel nitrate, oil and grease, pH, phosphate, selenium, sulfate, temperature, total suspended solids, and zinc.

Monitoring of the water quality of the Lauis River was conducted from one station: LR-3 (Under Collat Bridge). The same parameters measured for the Masinloc River were applied to Lauis River.

Groundwater

Nine areas were identified as sampling stations to monitor the following: arsenic, cadmium, lead, mercury, chromium Hexavalent, pH, conductivity, chloride, sulfate, sodium, total hardness. All parameters were compliant with DENR standards.

Domestic Water

Parameters measured for the domestic water and analyzed in the laboratory were the following: pH, turbidity, total suspended solids, arsenic, cadmium, chromium, lead and mercury. All parameters were compliant with DENR standards.

Marine Water Quality

The EMB requires the semi-annual water quality monitoring program for the Masinloc Plant. Monitoring is implemented to ensure the effectiveness of pollution control measures and ensure that the DENR water quality limits are not violated. Twelve (12) monitoring stations (M1 to M12) were covered during all the sampling events.

Wastewater Quality in the Masinloc Plant

The effluents originating from different facilities, such as the Wastewater Treatment Facility (WTF), Coal Sedimentation Basin (CSB), Ash Sedimentation Basin (ASB), and Storm Drain Canal (SDC), were monitored from various significant sampling points. Parameters considered were: arsenic, BOD, boron, cadmium, chemical oxygen demand, chromium Hexavalent, conductivity, dissolved copper, dissolved oxygen, lead, mercury, nickel, oil and grease, pH, sodium chloride, temperature, turbidity and zinc. Most of the parameters are within acceptable limits of the DENR standards for DAO 2016-08.

Water Ecology

Freshwater Ecology

Phytoplankton, zooplankton, benthic organisms and other faunal species were collected from the Lauis River in pre-determined sampling stations during the wet and dry seasons using standard sampling and transport procedures. A 6-Liter Van Dorn Water Sampler was used to collect samples for the Freshwater Ecology. The samples were labelled accordingly and sealed. Periphyton/phytoplankton samples were preserved in Lugol's solution, while the macroinvertebrates were preserved in a 5% formalin solution. Key informants from the community were interviewed for the fish observed in the river water.

Marine Ecology

Seagrass Meadows

Efforts exerted to relocate approximate locations of the seagrass sampling stations were in order to replicate results of the previous monitoring reports. The seagrass survey was conducted at seven sampling stations (SG1, SG2, SG3, SG4, SG5, SG6 and SG7) using the transect-quadrat method described by English *et al*. (1994; 1997), to determine the species composition, density, percentage cover and biomass of seagrass in the area.

Soft-bottom Infaunal Benthos

Collection of sediment samples for the analysis of soft bottom infaunal benthos was by the use of an Ekman bottom grab sampler. Sampled sediments were sieved in situ to retain macrobenthos which is then collected in 60ml plastic bottles and preserved with 10% formaldehyde solution. It was labeled and transported to the team's home base for marine laboratory analysis. Small amount of "Rose Bengal" stain was added to the solution to make the macro-organisms visible with the use of a magnifying glass, under a stereoscope or a microscope, whatever is available. Benthic infauna was sorted manually, placed on a tray under sufficient light and classified up to major taxa or down to the genus level if possible. Magnifying glasses were often used for the identification of the organisms in the absence of a stereoscope, which can serve better for its higher magnification level. Abundance of macro-benthic fauna was calculated in the number of individuals per square meter.

Plankton

Water column and bottom sediment sampling activities were focused mainly around the power plant facility where a total of five (5) stations were each surveyed and sampled for phytoplankton, zooplankton and soft bottom infaunal benthos. All these stations sampled are listed and their locations, coordinates, wind direction, and sea condition at the time of sampling indicated.

Corals

Replicating previous survey stations, the team relocated the position of the seven (7) sampling stations previously established and designated as sampling stations C/F1, C/F2, C/F3, C/F4, C/F5, C/F6 and C/F7 to determine the percentage cover of living corals (both hard and soft), dead corals, algae and bare substrates. All sampling stations tabulated together with the station coordinates, location and sampling date/time.

Demersal and Coral Reef Fishes

Replicating previous survey stations, the team relocated the position of the seven (7) sampling stations previously established and designated as sampling stations C/F1, C/F2, C/F3, C/F4, C/F5, C/F6 and C/F7 for the conduct of Fish Visual Census to determine the speciation, composition, density, distribution and biomass of the demersal fisheries in the seawaters adjacent to the Masinloc Power Plant.

Reef Associated Macro-Invertebrates

Quantitative macroinvertebrate survey was conducted using a standardized comprehensive monitoring protocol using SCUBA. Stations covered were those established for the corals and fish visual census survey. Transects laid for coral and fish survey were also used for the conduct of the macroinvertebrate survey. Transect was modified as a transect belt one meter wide on both sides of the transect line. Macroinvertebrates encountered were identified down to the species level and counted as to the number of occurrences within the belt.

Meteorology/Climatology

Discussions on meteorology were lifted from the Air Dispersion Modeling Report. Meteorological data used in the modeling are wind direction, wind speed, mixing height, and atmospheric temperature. Data from the PAGASA station at Cubi Point, Subic Bay, Olongapo City, Zambales and EMB data from Clark Air Force Base, Pampanga were used.

Air Quality and Noise

Ambient air quality derived from parameters such as NOX (as NO2) and SOX (as SO2) were monitored from January 1, 2015 to September 30, 2020 using CEMS at the stacks of Units 1, 2, and 3.

Air Dispersion Modeling

The source inputs are the information or data related to the locations and heights of the stacks (existing and proposed units) and the emission rates. The other model inputs are the a) building dimensions and heights, b) receptor coordinates, elevation, and hill heights, and c) meteorological data.

A license AERMOD View Air Dispersion Model (Version 9.9.0) with Serial No. AER0006927 was used to predict the dispersion of air emissions emanating from project (existing and proposed sources). AERMOD View is Graphical User Interface (GUI) software for U.S.EPA's AERMOD, which was developed by the American Meteorological (AMS/U.S.EPA Regulatory Model Improvement Committee (AERMIC). It is one of the regulatory models prescribed in the DENR MC 2008-003 (Guidelines for Air Dispersion Modelling).

Socio-Economic Study

The socio-economic study and perception survey for the Project applied the methodology of triangulation of the quantitative and qualitative techniques in research. Triangulation is defined as the use of multiple observers, methods, interpretive points of view, and levels and forms of empirical materials in the construction of interpretations. The combination of two or more different research strategies in the study of the same empirical units were achieved the best of each and overcome deficiencies.

In order to gather primary information as well as determine awareness and perception of the Project, a Perception Survey was conducted using a questionnaire designed to determine basic demographic, health and environmental information about the local community.

Public Participation

Focus Group Discussions (FGD) and Key Informant Interviews (KII) were conducted to supplement the results of the survey and identify issues and concerns of key sectors. Local government officials, particularly barangay officials, were interviewed as well as leaders of the local people's organizations, being the most significant sector most likely to be affected by the Project.

A series of public consultation meetings were conducted between October 13, 2010 to March 30, 2011 to gather issues and concerns that the stakeholder communities may have towards the Project. A cross-section of the stakeholders, including LGU representatives, religious groups, educational institutions and other socio-civic organizations, were consulted.

A public consultation was conducted to validate issues and concerns that the stakeholder communities have raised during the previous consultations. The event was attended and witnessed by representatives from EMB and the EIA Review Committee.

Summary of Baseline Characterization, Key Environmental Impacts, Management & Monitoring Plan, Environmental Monitoring Fund (EMF), and Environmental Guarantee Fund (EGF) Commitments

The Land

Two land use units were identified and delineated within the Masinloc Plant area prior to its development. These are Open Grassland Area and the Agricultural Areas, consisting of a mix of Mango trees and other crops. After the construction of the Masinloc Plant, five land use units were identified and delineated within the Project area. These are the Built-up Area, Tree Crops Area, Man-made Forest Area, Open Grassland Area and the Ash Storage Facility (ASF).

The Built-up areas cover the Masinloc Plant including the coal yard, and the work area plus the camp site north of the existing ASF. The Trees are mainly mango orchards or plantations plus other fruit-bearing and non-fruit-bearing trees. The area near the coastline (west and southwest coastline) are mixed with coconut, bani, talisay, kamachile and agoho, while the area towards the inland (north of the ASF) are mixed with fruit bearing trees like cashew, santol, tamarind, guava, jackfruit, duhat, banana and macopa.

Geology/Geomorphology

Core samples from the Masinloc Plant revealed the existence of dense silt and silty sand underlying marine deposits which indicated a firm bearing stratum. In addition, borings were conducted on land to confirm the stability of the rock foundation and showed an N value of greater than 50 which was judged to have sufficient bearing capacity. The constructed structures were designed to achieve reliability, sufficient rigidity, and strength against possible settlement. The design seismic coefficient for the Masinloc Plant is 0.2 g based on the calculation result of seismic acceleration on the bedrock.

The Project is located about 8 km and 85 km, from Iba Fault and Manila Trench, respectively. The estimated peak ground acceleration (PGA) at the Project is 0.19g and 0.11gin hard soil for the East Zambales Fault and Manila Trench, respectively. Probabilistic estimate of the PGA by Thenhaus (1994) with 10% probability of exceedance in 50 years is about 0.22g for rocks.

The Project will be constructed within the established property of the Proponent. This area has been previously developed. Minimal grading, cut and fill activities will be required.

No subsidence or any changes in subsurface morphology is expected due to the construction of the foundations. No mass-movement hazards like landslides or subsidence are expected in the surrounding terrain and no ground rupture is expected. The Project site is exposed to the open sea and susceptible to tsunami should a major seismic event enough to trigger a tsunami occur along the Manila Trench. However, the ground elevation is at least two meters above sea level and San Salvador Island sits at the mouth of Oyon Bay, both reducing an impact from a tsunami.

Pedology

The study on soils of the Project was started with the review of the relevant literature and maps like the Soil Survey Report of Zambales Province with soil maps, and the EIS Report of the Masinloc Plant.

Three distinct soil groups are represented in Zambales Province. These are: soils of the swamps and marshes (hydrosols), soils of the plains (sand, sandy loam, clay to clay loam), and soils of the upland hills and mountains (clay to sandy clay with pebble inclusions).

Two soil types were identified and characterized in the Project, the Bani clay on the hills and ridges and the Quingua silt loam on the lowland adjacent to the Lauis River.

Erosion is not critical for the Project since construction will be done within relatively leveled premises of the Masinloc Plant. Minimal erosion may occur during the excavation phase which will be managedand only temporary. During plant operation, erosion will be prevented by soil/slope stabilization, landscaping, revetments and similar embankments. These will be maintained as well as the green areas established around the plant area. Reforestation was done in the north-western part of the property to provide added protection for the ASF. This area are will be maintained as well.

Terrestrial Biology

Construction activities such as clearing of ground cover and subsequent earthworks, excavation, site levelling, grading, and trenching affected the terrestrial ecosystem found in the 48.9 ha of the main process areas of the Masinloc Plant and 65.8 ha of the ASF. Vegetation cover that was cleared to give way to the Masinloc Plant and ASF were mostly agricultural crops and grasses characterized by low species diversity.

Overall, there were 94 individuals of flora species listed in the monitoring plots with 18 species and 14 families Based on the table, the least number of individuals are found in the intermediate layer while the highest number of individuals are seen with the canopy layer. In terms of species richness, the understorey obtained the highest number of species and the highest number of families. This indicates that although there are many individuals present in the canopy layer, there are less species in the canopy layer which will replace those trees in the canopy layer. This further shows that ecological succession may not be attained once the climax or canopy species are naturally or anthropologically felled. Furthermore, diversity value is moderate at H' = 2.45 while evenness is Very High at J' = 0.847.

Fauna species observed in the monitored site totals to 290 individuals, majority of which are birds with 281 individuals. Out of the 290 individuals, 48 species in 32 families were identified, with High overall diversity of H' = 3.33 and a Very highly even distribution at J' = 0.86. .

The Water

Hydrology

Streamflow measurements were previously conducted during the preparation of the Masinloc Plant EIS in 1994. Spot discharge measurements were made in April 1989 and May 1990. Various measurements were also made in April 1993.These months are the driest months for Type I climate. The measurements yielded discharge values ranging from 2-4 m^3/s.

The daily streamflow data of Nayom River were subjected to probability/flow duration analysis to determine the percentage of time that the flow is equalled or exceeded for the period of records. The dependable flow is 80% of the time available and this is the value adopted by the NWRB in granting water permits.

Lauis River has a dependable flow of 3,000 L/s or 3 m^3/s which is available 80% of the time. The present requirement of the NIA of about 0.405 m^3/s and the proposal to expand the irrigation system requires a maximum flow of 1.53 m^3/s

Oceanography

Drift observations were conducted in eight stations within Oyon Bay. Drift trajectories during the period of observation were directed towards the northwest with speeds ranging from 3 to 9 cm/s. Drift trajectory near the intake pipe was directed towards the southwest at a speed of 8 cm/s. In stations outside the bay area, westward drift was observed with speeds ranging from 8 to 16 cm/s. Dominant drift trajectories were noted towards the north and outside of the bay. Taking into consideration the results of the dispersion modeling, tidal and monsoonal variation of the drift observations will be conducted as part of the mixing zone monitoring program.

Thermal Plume Modeling

The principal aim of this modeling work is to determine the dispersion of heated effluent from the Project on the marine environment surrounding the Masinloc Plant. The model assumes a 50% increase of the existing

6°C temperature rise giving a maximum of 40°C effluent temperature. Prediction of the expected rise in the ambient water temperature due to the discharge of cooling water is the goal of this modeling work. Changes in the excess temperature field due to seasonal winds and various tidal phases are considered in the present modeling work.

During the Northeast (NE) Monsoon Season, the potential influence of the thermal effluents from the plant is considered insignificant. It is shown by the model results that the elevated temperature is mostly located in a small area above the outfall and may not pose a serious threat to organisms.

On the other hand, simulated dispersion patterns of thermal effluents during the SW Monsoon season show a localized spatial extent. The mixing zone and the area affected by the overall thermal plume are shown only near the outfall. This is due to both the effect of the southwest monsoon winds and the very weak currents during this season. There is a very sharp decrease in the simulated water temperature both during tidal ebbing and flooding thereby showing a limited area of influence. It should be noted that during this season, the occurrence of storms and other extreme weather conditions further limits the dispersion of the thermal effluents. Cooling of the thermal effluents is expected to be fast during this season and the potential for recirculation of the cooling water is improbable since plume dispersion will be directed away from the intake.

Freshwater Quality

Results show that the water quality from the freshwater sampling stations is within the DENR Water Quality Guidelines under DAO 2016-08. A slight exceedance, however, was observed in LR-1 for the 3rd 2019 monitoring period for pH. The recorded pH for the said sampling period was measured at 8.6 with the DENR WQG for pH at 8.5.

Marine Water Quality

Results show that most samples taken from the monitoring stations are compliant with the DENR WQG. One exceedance was noted for Iron during the 1st quarter 2019 monitoring for station M4. The recorded iron level for that period and station is at 5 mg/L while the DENR standard is at 1.5 mg/L.

Effluents

Parameters considered were: arsenic, BOD, boron, cadmium, chemical oxygen demand, chromium Hexavalent, conductivity, dissolved copper, dissolved oxygen, lead, mercury, nickel, oil and grease, pH, sodium chloride, temperature, turbidity and zinc. Most of the parameters are within acceptable limits of the DENR standards for DAO 2016-08.

Freshwater Ecology

Phytoplankton was collected from the Lauis River during the wet and dry seasons. The wet season was dominated by pinnate diatoms with three species namely: Navicula, Pleurosigma and Pinnularia and corresponding relative abundance are 30%, 17.5 % and 10%, respectively. The dry season on the other hand was dominated by Lyngbya which belonged to the Cyanophyta.

Also noted during the third and fourth quarter marine ecology monitoring of Oyon bay were two potentially harmful species found during its sampling period. The *Pseudonitzschia spp*is capable of producing toxins associated with Amnesic Shellfish Poisoning while the *Dinophysis caudate* is capable of producing toxins associated with Diarrhetic Shellfish Poisoning.

The calanoid copepods were the most abundant group of zooplankton during the wet season (76.9%). Of lesser abundance were *Lucifer, Siriella* and *Abyla* with relative abundances of 11.5%, 7.6% and 3.9%, respectively.

Melanoides was noted during the wet and dry seasons but was more abundant during the latter. In the dry season the relative abundance of *Melanoides* was79.4%. Additional species such as *Thiara, Calcarina, Mitra* and *Narita* were also noted.

Both freshwater shrimp species, *Macrobrachium* and *Palaemonitis,*were also observed.

Marine Ecology

Seagrass Meadows

The December 2019 seagrass survey yielded the same species composition and occurrence in all the seven (7) stations under observation. The species Halophila minor observed in Station SG6 and recorded in the October 2019 survey increasing the number of species accounted to nine (9) compared to the eight (8) recorded in the December 2018 and March 2019 records were still observed and recorded in the latest survey as well as the other species accounted, to wit: Enhalus acoroides, Halophila ovalis, Thalassia hemprichi, Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninervis and Syringodium isoetifolium.

Soft Bottom Infaunal Benthos

A total of 212 benthic animal organisms were recorded in the samples taken from the five (5) stations for infauna assessment, which was higher than the sampling survey of October 2019 with 175 individual organisms and June 2019 with 201 ind/m^2 but lower than the March 2019 survey that accounted for 239 ind/m^2.

The density of benthic organisms was variable among the sampling stations, and ranged from 1,024 to 2,763 ind/m^2. The mean density recorded at 1,932 ind/m^2 was higher than the survey made on October 2019 with a mean density of 1,575 ind/m^2 and on June 2019 with a mean density of 1,787 ind/m^2.

An index of diversity of benthic organisms using the Shannon-Wiener Index for the communities found in the different stations in the study area showed the following. The index both measures the variety and number of individuals per taxa. Species diversity (H') ranged from 1.84 to 2.70, with mean diversity of H' = 2.8 which is higher than the previous survey periods.

Plankton

Phytoplankton population consisted mainly of only two (2) major groups: diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae). The diatoms represented by fourteen (14) genera/taxa, again appeared to be the most dominant phytoplankton group with an average of 1,596 cells/L or 83.0% of the total estimated phytoplankton population.

The December 2019 plankton survey showed a change in the population density with the Tintinnids at the top of the count, which with an average projection of 84 individuals/L from five survey stations occupies 28.9% of the population density ratio of the area under study.

Relative average density of the total plankton population to cover both the phytoplankton and the zooplankton for the five survey stations is 2,212 ind/L. Of this, 1,922 ind/L is composed of the phytoplankton which roughly covers at least 87% of the total with the remaining 13% composed of the zooplankton community accounted for in the survey. This is more or less of similar proportion to the October 2019 survey which also exhibits an 87:13 ratio though the population count of both survey periods differs quantifiably

Corals

Live hard coral cover was determined per established station. Comparative analysis of the seven (7) stations surveyed as of December 2019 showed that the station designated as C/F3 had the highest LHC cover with 46.37%, which could be rated as Excellent based on the category index established by Licuanan et al.

The live hard corals categorized into composite lifeforms showed that of the 31.03% LHC the non-acropora branching corals have the highest percentage composition at 13.79% followed by the non-acropora massive corals at 13.18%.

Eighty-eight (88) of these species have so far been identified during the sampling period of October 2018 at the seven transect sites and immediate vicinity. Station C/F7 has the highest number of coral species with 43 encountered, followed by Stations C/F3 with 35, C/F5 with 31, C/F2 with 23, C/F6 with 19, and C/F4 with 17, respectively.

Demersal and Coral Reef Fishes

Station surveys conducted in December 2019 has recorded a total of 101 species belonging to 18 families which is somewhat similar to the October 2019 survey result. In terms of fish density, highest count of indicator species for coral health was recorded in both Station C/F1 and Station C/F7 with 13 indv/500m2. This was followed by Station C/F3 with 6 indv/500m2, Station C/F6 with 5 indv/500m2, Station C/F5 with 4 indv/500m2. Stations C/F2 and C/F4 have the lowest number at 2 indv/500m2.

In the case of biomass recorded, estimated values as a result of the surveys showed that most of the survey stations rated Poor in biomass when compared to the standard values set by Hilomen *et al.* in metric tons per square kilometer. It is only in Station C/F7 that an acceptable level of biomass values was rated High in biomass while Station C/F2 having the lowest biomass value was rated Very Poor.

Data collected in December 2019 showed that Shannon Index (H') ranged from 0.8 to 1.8, Simpson Index ranged from 0.2 to 0.6 and Evenness Index value ranged from 0.1 to 0.2 88304. Diversity index value was consistently higher in Station C/F6 (Oyon Point), Station C/F7 (San Salvador Island) and Station C/F3 (Between Intake and Outfall Area).

The Air

Meteorology/Climatology

The Masinloc Plant is located in a Type I climate based on the Modified Coronas Classification of the Philippine Climate. A Type I climate has two pronounced seasons: dry from December to May and wet from June to September. Areas characterized by this climate type are generally exposed to the southwest monsoon. Wind frequency data showed that the prevailing wind directions are in the North-East and South-West sectors with a prevailing wind speed range of one to four meters per second.

Ambient Air Quality

Measured one-hour average stack gas concentrations of SOX and NOX were generally within the emission standards for existing sources set at 1500 mg/Nm3 (797.3 ppm) for NOX (as NO2) and 1500 mg/Nm3 (573.05 ppm) for SOX. (as SO2). As per MPPCL, there were values greater than the said emission standards at Units 1 and 2 due to equipment malfunction or the need for calibration and when the unit is on start up.

Ambient noise level readings in all stations were within the acceptable standards for residential areas (the dominant land-use in the vicinity of the Project) except for occasional exceedances during night measurements in some stations, which could be attributed to noise emanating from social gatherings. Public areas were typically noisy. The ambient noise level measurements are typical of rural settings with noise emanating mostly from residents (e.g. singing and chatting), animals and road noise from the National Highway.

Air Dispersion Modeling

A license AERMOD View Air Dispersion Model (Version 9.9.0) with Serial No. AER0006927 was used to predict the dispersion of air emissions emanating from project (existing and proposed sources). AERMOD View is Graphical User Interface (GUI) software for U.S.EPA's AERMOD, which was developed by the American Meteorological(AMS/U.S.EPA Regulatory Model Improvement Committee (AERMIC). It is one of the regulatory models prescribed in the DENR MC 2008-003 (Guidelines for Air Dispersion Modelling)

Meteorological data used in the modeling were wind speed, wind direction, atmospheric temperature, stability, and mixing height. In the absence of on-site meteorological measurements, data from the PAGASA Station at Cubi Point, Subic Bay, Olongapo City, Zambales and EMB data from Clark Air Force Base, Pampanga were used.
The predicted GLCs using the Subic Meteorological Station data are likely to be observed due to similar terrain characteristics and location of the PAGASA station and the Masinloc Plant, in addition to having conservative values for residual management.**Table ES-3** shows a comparison of the highest peak GLCs values using the data from the Subic and the Clark Air Force Base (AFB) Meteorological Station.

Table ES-3: Highest Peak GLC Values for Modeled Pollutants

Pollutant	Peak GLC Values, 1-hr		CAA Standard	GLC/CAA Ratio	
	Subic Met	Clark AFB Met	(1-hr)	Subic Met	Clark AFB Met
SOx	260	448	340	0.76	1.32
NOx	251	818	260	0.97	3.14
TSP	143	164	300	0.48	0.55

The model runs using the SM and CAFB met data resulted in the following highest peak 1-hr GLCs ranges:

- SOx: 260-448 µg/NCM
- NOx: 251-818 µg/NCM
- TSP: 143-164 µg/NCM

Sensitivity runs showed that the exit stack gas temperature is the parameter that needs to be adjusted in controlling GLC/CAA ratios assuming all other parameters are unchanged. It also showed that Tier 3 runs are needed for the pollutants NOx and SOx.

Based on stack sampling data from 2015 to 2019, which was conducted by DENR-accredited stack testing companies and emissions data from CEMS, it appears that the highest emission rate was that of SO_X (as SO_2), particularly for the existing units (Unit 1 and Unit 2). Thus, initial simulations focused on SO_2 because if predicted SO_2 concentrations will be within ambient guideline value (NAAQG), then predicted dispersed concentrations of other primary air pollutants (NO_2, TSP and CO) may also likely be within the corresponding guideline values.

Results show that the predicted concentrations of SO_2, NO_2, TSP, and CO emanating from the existing sources (Units 1, 2 and 3) and from the existing and proposed sources (Unit 4 and 5) were within the corresponding ambient air quality guideline values. Note that for Units 4 and 5, simulations were based on emission rates derived from emission standards, i.e., 700 mg/Nm^3 for $SO_{2,}$, thus, it follows that emission rates that are within the guaranteed values, i.e., 200 mg/Nm^3 for SO_2, will be lower in predicted concentrations as compared to those derived from emission limits or standards.

The People

Average Number of Household Members and Dependency Ratio

The average number of members of the household is 5. The dependency ratio of the 3 barangays ranges between 0.57% to 0.72%, with Barangay Bani having the highest. The dependency ratio gives an insight into the number of non-working age (young and old dependents) compared to those of working age. A high ratio means those of working age face a greater burden in supporting the non-working or dependent population.

Furthermore, the high ratio leads to additional pressure to the communities to provide for additional employment opportunities.

Highest Educational Attainment Achieved

In terms of highest educational attainment achieved by respondents, majority have completed high school and reached or completed college education. The matrix below shows the proportion of respondents completing high school education and reaching/completing college education (**Table ES-4**).

Table ES-4: Highest Educational Attainment

Indicators	Barangay Bani	Barangay Taltal	Barangay Baloganon
Finished high school education	47.14%	43.75%	46.88%
Reached College level	17.14%	14.58%	11.90%
Finished College education	8.57%	11.46%	23.96%
Total	**72%**	**69.79%**	**82.74%**

Barangay Baloganon achieved the highest proportion of respondents completing high school and completing college education (23.96%) in comparison to the two other barangays.

Socio-economic Profile

In terms of economic profile the following matrix (**Table ES-5**) summarizes the status of the three barangays:

Table ES-5: Economic Indicators

Economic Indicators	Barangay Bani	Barangay Taltal	Barangay Baloganon
Not Employed	22.60%	17.90%	31.76%
Employed	18.27%	35.19%	19.59%
Self-employed	11.06%	21.60%	25.00%
Farming	3.37%	13.58%	3.04%
Fishing	16.35%	7.41%	17.23%
Other Indicators			
Average Monthly Income	PhP 9,304	PhP 8,394	PhP 7,484
Average Monthly Expense	PhP 7,059	PhP 7,473	PhP 6,550
Annual per capita Poverty Threshold for the Province (NSCB,2007)	PhP 15,295	PhP 15,295	PhP 15,295
Minimum Household Income to meet basic requirements for 5-member household (2007)	PhP 6,372	PhP 6,372	PhP 6,372
% living below poverty Threshold(Food and Non-food items)	56.89%	55.00%	63.08%

Despite registering the highest proportion of college completion among its respondents, Barangay Baloganon registered the highest unemployment at 31.76%.Likewise, registered unemployment in Barangay Bani is 22.60% and Barangay Taltal, accounting for the lowest with 17.90% of its respondents.

In terms of regular employment, Barangay Taltal recorded the highest 35.19%, seconded by Barangay Baloganon, 19.59% and Barangay Bani, 18.27%. On the other hand, Barangay Baloganon has the highest number of self-employed respondents with 25%, followed by Barangay Taltal at 21.60% and lastly, Barangay Bani at 11.06%.

Barangays Bani and Baloganon have bigger proportion of respondents engaged in fishing, 16.35% and 17.23%, respectively compared to Barangay Taltal at 7.41%.However, there are more respondents engaged in farming in Barangay Taltal (13.58%) compared to Barangays Bani and Baloganon with 3.37% and 3.04%, respectively.

Household Monthly Income and Poverty Threshold (NSCB, 2007)

Among the three barangays, Barangay Bani has the highest average monthly household income at PhP 9,304 followed by Barangay Taltal with PhP 8,394. The lowest average monthly household income is accounted for the respondents in Barangay Baloganon with PhP 7,484.

With a minimum monthly income of PhP 6,273as a requirement for a 5member household to meet food and non-food needs (NSCB, 2007), Barangay Baloganon registered the highest number of respondents living below the poverty line with 63.08%, followed by Barangay Bani with 56.89% and Barangay Taltal with the lowest at 55%.All of the three barangays registered more than half of the respondents are living below the poverty line.

Access to Social Amenities/Social Services

Most of the respondents have access to social services including health and education. Rural Health Units (RHUs) and public hospitals are accessible to most respondents. In terms of school attendance of ages 6 to 24, majority are in school and only about 10% are not, due to financial difficulties. Educational expense is next to food expense in terms of households' prioritization of expenses.

Water and electricity are accessible to majority of respondents except that some would want their electric bills reduced or their water sources improved.

Recreational facilities such as the TV and VCD/DVD are owned and enjoyed by majority of respondents in the comfort of their homes.

Despite half of the households experiencing low income status, generally, the respondents are living fairly and meeting their basic food and non-food requirements.

Project Awareness, Perceived Benefits and Support

In terms of project awareness and support, the matrix (**Table ES-6**) below summarizes the status of the three impact barangays:

Table ES-6: Project Awareness, Perceived Benefits and Support

Indicators	Barangay Baloganon	Barangay Taltal	Barangay Bani
Project Awareness/Knowledge	70.65%	45.83%	57.14%
Sources of Information	Local officials-40.45% Proponent-12.31% NGO/PO-12.36% Radio/Newspaper-10.24%	Local officials-45.45% Proponent-34.09% NGO/PO-6.82% Radio/ Newspaper-4.54%	Local officials-75% Proponent-6.82% Radio/TV-4.56% NGO/PO-4.65%
Perceived Project Benefits	48.41%	44%	74.29%
Perceived Project Negative Impacts (preventableandavoidable)	86.84%	62.50%	70.83%

Generally, more than half of all respondents are aware of the Project with Barangay Baloganon registering the highest proportion of respondents, 70.65%. On the other hand, the local officials are the biggest source of information followed by the Proponent and the rest from radio/newspapers and NGOs/POs. Looking at this scenario, the local officials have been active partners of the Proponent in information dissemination and educating the people about the Project.Among the three barangays, Barangay Bani accounted for the biggest proportion of respondents perceiving Project benefits while Barangays Baloganon and Taltal registered only less than half of the respondents.

In terms of the possibility of preventing negative impacts, a great majority believed that it can be done by the Proponent's following safety procedures, observing environmental laws, using modern technology to improve environmental protection and regular monitoring of environmental compliance.

Overall, Barangay Bani has the largest percentage of respondents pushing for Project implementation (62%) while Barangays Baloganon and Taltal account for almost half of the respondents wanting for the Project to push through.

Summary of Issues, Concerns, and Proponent's Responses

Consultation meetings were conducted in each of the impact barangays, Municipality of Masinloc, and Provincial Government of Zambales by the proponent and EIA consultants. There were 257 participants who attended such consultations representing Barangay Baloganon (84), Barangay Bani (126), BarangayTaltal (47), Municipality of Masinloc (18), and Province of Zambales (35). The participants were comprised of the major stakeholders particularly, the Barangay Council, Barangay Health Workers (BHWs), RHU personnel, teachers, barangay residents, Municipal Council, Provincial Board Members, Mayors, Vice-Mayors, the Governor, and the Vice-Governor.

The following issues and concerns were raised by residents who attended the public consultations (**Table ES-7**):

Table ES-7: Summary of Issues and Concerns

Project Benefits -Guarantee the employment of local residents -Priority for local residents training -Unpaid benefit/compensation from NPC -Reduced electricity costs -Status of rehabilitation of schools - Real Property Tax - Improve water supply and street lighting -Assistance to vulnerable population - Access to medical services and medications - Livelihood projects - Eligibility for MPPCL trade school - Use of ER 1-94 funds - Local water usage fees - Access to fly ash
Environmental/Health Issues -Increase in vibration, noise, and odor - Worsening agricultural crop yields (mangoes and rice), and declining fish catch - Plant emissions and relationship to respiratory illnesses - Use of Semirara coal
Public Participation -Possible NGOpartnership -Participation of NGOs during consultations -Regular dialogue between community and Masinloc Plant - Access to Project details

All these concerns and issues were responded to by MPPCL. Some concerns have been attended to by the Proponent. Solutions to certain issues will be reviewed and included in the formulation of the Social Development Plan (SDP).

Environmental Risk Assessment

Risk Screening (RS) was conducted as a component of the EPRMP. The RS in the context of the Philippine EIS System is primarily concerned with safety risks associated with the usage of substances and/or materials in terms of their reactive, flammability, and toxic properties as compared to geological risks covered by the Engineering Geological and Geohazard Assessment Report (EGGAR) requirement of the Mines and Geosciences Bureau (MGB) and health risks assessed in the Environmental Health Impact Assessment (EHIA) of the Department of Health (DOH) mandate.

The RS provides an initial assessment of the physical and chemical risks posed by the substances and materials in the existing power plant and the proposed expansion which can be used as basis for the Quantitative Risk Assessment (QRA) during the operation phase.

The RS Report will follow the prescribed format in Annex 2-7e of the Revised Procedural Manual (RPM) of Department of Environment and Natural Resources Administrative Order No. 30, Series of 2003 (DAO 2003-30).

Summary of Major Findings

- Possible toxic vapor off-site effects of unbunded scenarios for Hydrochloric acid (HCl) and Sodium hydroxide (NaOH) largest storage tanks based on the National Institute for Occupational Safety and Health (NIOSH) Immediately Dangerous to Life or Health (IDLH) limits. The results also showed that the off-site effects are significantly reduced by containing the pool, i.e., providing bunds for the tanks.
- Minimal hazard from Unconfined Vapor Cloud Fire resulting from worst-case release of the industrial diesel oil (IDO).
- Possible radiant heat off-site effects of unbunded scenarios for IDO but providing bunds will significantly reduce the hazard zones by containing the burning pool.

Recommendations

Three strategies for risk management are recommended by the World Bank (1988):

- Reduction of the consequences or effect distances may be achieved through reduction of inventories of the hazardous material, modification of process or storage conditions, outright elimination of the hazardous material from the process, or improvement of shut-down mechanism or secondary containment;
- Reduction of the probability of release of the hazardous materials;
- Reduction of impacts measures are undertaken to lessen the impacts in case the accident happens.

Environmental Guarantee Fund (EGF) Commitments

The Masinloc Plant was established by NPC and was originally required to be covered under NPC's Environment Guarantee Fund ("EGF") which was earmarked for NPC's fleet of power plants. NPC's EGF was initially composed of a Trust Fund of PhP 49.5 MM and a Cash Fund of PhP 0.5 MM. As of March 29, 2004, the Cash Fund component's balance was approximately PhP 530,000. Since the Masinloc Plant was sold to MPPCL, MPPCL is currently working with NPC and the DENR Region III to establish an EGF for the Masinloc Plant.

The Proponent proposes funding the EGF in the amount of PhP 8.0 MM and providing a cash-bond of PhP 2.0 MM in order to cover the Masinloc Plant and the Expansion Project (Units 1 through 4).

Summary of the Environmental Management Plan

Table ES-8 and **Table ES-9**are summaries of the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP), respectively.

The "1993 MOA between NPC, Zambales and Masinloc", is the MOA establishing the MMT for the Masinloc Coal-Fired Thermal Power Plant. MPPCL assumed all responsibilities in the MOA when it acquired the Plant in 2008.

Table ES-8: Summary Matrix of Environmental Management Plan

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Construction/Pre-Operations Phase						
Land	Geology/Soil	Project foundation work may affect Masinloc Plant	• Drilling was conducted and implemented at the Masinloc Plant facilities to confirm the stability of rock foundation. The rock formations have N values greater than 50 which are judged to have sufficient bearing capacity • Confirmatory drilling and soil investigation would be done for the Project	MPPCL/EPC	Part of the construction cost	EMP, EMoP
		Erosion in areas with cut slopes	• Construction of appropriate engineering structures such as gabions, retaining walls, and concrete plastering. A buffer area is provided and will be maintained with natural surroundings • Proper spoils management	MPPCL/EPC	Part of the construction cost	EMP, EMoP
		Minimal erosion during Project preparation	• Revetments, embankments will be constructed to contain soil stockpiles. Exposed surface areas will be revegetated (using cover crops) after construction	MPPCL/EPC	Part of the construction cost	EMP, EMoP
	Terrestrial Flora and Fauna	Temporary disturbance of wildlife due to construction activities	• Preservation of areas serving as alternative habitat and sanctuary for faunal species • Revegetation and maintenance of suitable areas outside Masinloc Plant and Project for alternative habitat and sanctuary of faunal species	MPPCL	Part of the construction cost	EMP, EMoP
		Loss of vegetation	• Limit clearing to construction site only • Landscaping and revegetation to restore ecological and aesthetic conditions around the Masinloc Plant and Project • Use Oliva (*Cycas revoluta*) and Ilang ilang (*Cananga odorata*) for revegetation of bare and disturbed areas	MPPCL	Part of the construction cost	EMP, EMoP
Water	Freshwater Quality	Sediments can join the run off into the river	• Proper management and maintenance of existing intake facility	MPPCL	Part of the construction cost	EMP, EMoP
	Freshwater Ecology	Impact on the periphyton/ phytoplankton with corresponding effect				

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		on the food chain				
	Marine Ecology	Destruction of seagrass covered intertidal zones, coral reefs and other marine habitat due to dredging for new cooling intake structures	• Use of impermeable floating turbidity barriers (silt curtains)	MPPCL/EPC	Part of the construction cost	EMP, EMoP
		Oil spill, sewage and wastewater effluents from construction activities will contaminate receiving body of water	• Provision and maintenance appropriate oil spill, sewage and wastewater treatment facilities	MPPCL/Coal supplier	Part of the construction cost	EMP, EMoP
Air	Air Quality	Earth movement will generate dust	• Surfaces, especially unpaved roads, will be watered frequently. Compaction to required density will be strictly monitored for tight soil surface adhering to best practice of construction management • Restrict speed limit to 20 kph in populated areas to prevent induction of dust on roadway	MPPCL/EPC	Part of the construction cost	EMP, EMoP
	Noise	Operation of heavy equipment and vehicular movement will increase noise and vibration levels in the area	• Speed limit shall be restricted to 20 kph near populated areas to attenuate engine noise • Implement traffic management plan • Construction plan shall allow maximum attenuation distance for critical equipment as far as possible	MPPCL/EPC	Part of the construction cost	EMP, EMoP
People	Health	• Adverse health impacts during construction • Workplace Safety	• Strict implementation of Occupational Health and Safety Policy • Proponent to conduct continuing Information, Education and Communication (IEC) efforts on Project developments	MPPCL	Part of the construction cost	EMP, EMoP
	Employment	Construction of the Project will need skilled and unskilled workers • Access to employment opportunity • Access to MPPCLtrade school	• Qualified residents in the Direct Impact Area (DIA) and Indirect Impact Area (IIA) shall be given priority during hiring of the workers • Conduct man power trainings in order to develop residents in the DIA and IIA for better employment opportunities Ensure equitable access to trade school	MPPCL	Part of the construction cost	EMP, EMoP
	Population	The influx migrant construction workers will induce the proliferation of service	• Positive impact; no mitigation needed	MPPCL	Part of the construction	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		establishments. (food eateries, lodging houses)			cost	
	Commerce and Industry	There will be high demand for construction materials which will intensify production and increase employment in cement, metal, wood, and chemical industry	• Positive impact; no mitigation needed	MPPCL	Part of the construction cost	EMP, EMoP
	Social Acceptability	Only 50% of the residents in the area in favour of the project implementation	• Creation or Strengthening of the Community Relations Office (COMREL) to address the concerns and issues of various stakeholders of affected communities • Conduct more Project acceptance campaigns • Implement Information and Education Campaign(IEC) activites	MPPCL	Part of the construction cost	EMP, EMoP
Operations Phase						
Land	Geology/Soil	Erosion of the ASF embankment	• Maintenance of implemented embankment erosion control measures	MPPCL	Part of the Operation cost	EMP, EMoP
		The proximity of earthquake generators may affect the power plant structures due to ground deformation and vibration during earthquakes	• Masinloc Plant and Project designs are per applicable structural codes	MPPCL	Part of the Operation cost	EMP, EMoP
	Terrestrial Flora and Fauna	Emission of SOx, NOx and particulate matter may cause damage to plants in the vicinity of the Masinloc Plant	• Biological monitoring program for crop production is implemented and on-going to determine effects of long-term exposure to various levels of emissions fromMasinloc Plant	MPPCL	Part of the Operation cost	EMP, EMoP
		Accumulation of ash	• Ash shall be stored in theASF • Groundwater monitoring wells installed around the ASF area shall be regularly monitored	MPPCL	Part of the Operation cost	EMP, EMoP
Water	Freshwater Quality	Particulate matter can settle on the river systems	• Water quality monitoring • Use of Best Available Control Technology (BACT) for stack emissions	MPPCL	Part of the Operation cost	EMP, EMoP
	Marine Ecology	Cooling water system (intake water structure) will cause entrainment and impingement of marine organisms	• Installation of vertical cap to reduce entrapment of various marine organisms • Biological/ecological monitoring will be undertaken to determine possible effects of new structures	MPPCL	Part of the Operation cost	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		Discharge of thermal effluents may have ecological effects to the marine organisms	• Project cooling water discharge through the existing 650 m open canal will minimize effects of thermal effluents • Constrution of cooling ditches for thermal effluents prior to discharge to the 650 m open canal • Derate the plant			
		Chlorination of cooling water will have non-selective biocidal effects on various marine organisms	• Chlorine injection within the cooling water system will be properly managed • Compliance with DAO-34 limits	MPPCL	Part of the Operation cost	EMP, EMoP
	Freshwater Flora and Fauna	Particulate matter can settle in the river systems	• Monitoring of biological indicators • Use of BACT for stack emissions	MPPCL	Part of the Operation cost	EMP, EMoP
Air	Air Quality	Coal dust is dispersed during coal unloading from ships, stacking, and reclaimingoperations	• Use of screw-type coal unloader and water sprayers to suppress coal dust generation. • Covered coal conveyor is used to avoid dust dispersion during coal transport from the pier to the coal yard to the power plant • Water sprayers are installed at the coal stockyard • The height of fall of coal from stacker shall be made as low as possible during stacking • Reclaimers/stackers shall be operated only at safe wind speeds. • Maintenance of trees planted within and around Masinloc Plant to serve as wind breakers	MPPCL	Part of the Operation cost	EMP, EMoP
		Spontaneous combustion may occur at the coal stockyard emitting smoke and smoldering smell.	• Coal inventory at the plant site shall be strictly controlled to prevent too long storage of coal (45-60 days). Coal utilization shall be "first-in-first-out "basis. • Regular re-piling and water spraying of coal file shall be undertaken.Coal pile portion where spontaneous combustion occurs shall be compacted by bulldozer.	MPPCL	Part of the Operation cost	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		SOx, NOx, and particulate matter emissions	• Utilize coal with low sulfur and ash content to reduce SOx, NOx and particulate matter emissions. • Utilize efficient ESPs to reduce fly ash emissions. • Utilize efficient combustion technology to reduce NOx emissions 220m stacks will be installed for Unit 3 and Unit 4 to diffuse the flue gases and achieve ground level pollutant concentrations within acceptable ambient standards • Seawater Flue Gas Desulfurizer (SFGD) shall be utilized for Unit 3 and Unit 4 to reduce SOx emissions • InstallContinuous Emission Monitoring System (CEMS) and regularly monitor stack emissions per the Philippine Clean Air Act of 1999 • Regular monitoring of Ambient SOx, NOx and particulate matter at strategic locations. • Installation of anon-site meteoroligal station to validate the air dispersion model	MPPCL	Part of the Operation cost	EMP, EMoP
	Noise	Noise will be generated during the operation of the power plant and its facilities	• Practical use of noise abatement systems • Regular monitoring of noise levels in the established ambient noise monitoring stations aroundthe Masinloc Plant during plant operation • Maintain a tree buffer area around the plant	MPPCL	Part of the Operation cost	EMP, EMoP
People		The operation of Masinloc Plantand Project will add a total of 1200 MW to the Luzon grid.	• Positive impact, no mitigation required	MPPCL	Part of the Operation cost	EMP, EMoP
	Vulnerable Groups	Assistance to Persons with Disabilities/Senior Citizens	• Provision of assistance specifically in meeting their needs such as medicines and other requirements	MPPCL	Part of the Operation cost	EMP, EMoP
	Basic Services	Insufficient supply of medicines/Access to health facilities	• Medical missions and provision of medicines are currently undertaken by the Proponent • Provide better access to health care	MPPCL	Part of the Operation cost	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		Water supply system	• Proponent to facilitate assistance in the use and access to ER1-94	MPPCL	Part of the Operation cost	EMP, EMoP
	Employment and Livelihood	Benefits of Employment (How to ensure fair distribution of available work/jobs and prioritization of local residents • Equitable access to employment • Access to livelihood opportunities • Access to other development programs	• Proponent will include in its procurement and contracting procedures to prioritize qualified local hiring. • Advertise job opportunities to all affected communities. • In coordination with contractors, open job fairs would be conducted.	MPPCL	Part of the Operation cost	EMP, EMoP
		Enhancing competency and competitiveness of local residents to improve access to Proponent's job and manpower requirements	• The Proponent is in the process of establishing a welding school which will train interested residents who may be hired after graduation. • The Proponent is currently coordinating with Technical Education and Skills Development Authority (TESDA) for appropriate curriculum design, the LGU for the site of the training center and contractors as trainers with TESDA. The Proponent will supply the facilities and equipments. • Provision of scholarship and allowance to trainees shall be studied and implemented	MPPCL	Part of the Operation cost	EMP, EMoP
		Livelihood Opportunities for Women	• Proponent shall implement livelihood projects such as "rag making" for women • The Proponent shall assess and identify what possible company requirements can be sub-contracted to women and other groups such as (i) supply of food requirements (i.e., vegetables, fruits, meat, eggs, chicken, etc.) which can be possibly grown in the barangays, (ii) uniforms, (iii) lawn maintenance, (iv) food vending for workers during construction, among others	MPPCL	Part of the Operation cost	EMP, EMoP
Abandonment/Decommissioning Phase						
Land			• The Proponent will implement	MPPCL		

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Water Air			decommissioning using best industry practices • A detailed decommissioning or abandonment plan will be developed one year prior to the end of the Project operating life in compliance to DAO 2003-30			
People	Community Assistance	Continuity /sustainability of development interventions	• Evaluation of effectiveness of intervention activities • MPPCL to conduct continuing IEC efforts on Project developments	MMT/SDP committee	Part of Operation Cost	EMP, EMoP

Table ES-9: Summary Matrix of Environmental Monitoring Plan and Environmental Quality Performance Level

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Construction/Pre -Operations Phase													
Land													
Terrestrial Flora and Fauna	Clearing of vegetation in planned areas of construction Removal of vegetation would decrease habitat of small fauna and decrease food source (for seed-eaters, insectivores)		Visual observation only	Semi-annual for every year of construction		MPPCL/3rd party	300,000			-			
Water													
	Freshwater (River)	DO	Water quality checker (ion probe), AAS method	Quarterly	LR-1 (Upstream of the freshwater intake) and LR-2 (Near the river mouth/nursery), MR-1 (Under Collat Bridge)	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	
		BOD						75%	90%	5.0 mg/L		IEC	
		Temperature						75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Copper						75%	90%	0.05 mg/L		IEC	
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater	pH	Water quality checker (ion probe), AAS method		Established groundwater monitoring wells					-			
		SO_4								-			
		Conductivity								-			
		Salinity								-			

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Hardness								-			
		Metals								-			
	Plant Effluents												
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH						75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	
		Cr^{+6}						75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature		Weekly	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling water discharge canal/condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e. low tide, high tide)	Construction sites within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water Quality	Deterioration of water quality due to construction activities Oil spill	DO	Gravimetric method; *in-situ*	Monthly	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani;	MPPCL/ MMT		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Cadmium			Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas			75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to construction activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Flourometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)		MPPCL/ MMT/ 3rd party	2,000,000						
Air													
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation	MPPCL/ MMT	400,000	75%	90%	340 µg/NCM		4*	
		Ambient NO_2	Griess Saltzman for NO_2					75%	90%	260 µg/NCM		5*	
		Ambient TSP	High Volume sampling for particulates B and K instruments					75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)			75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
Operations Phase													
Land													
Ash Storage Facility	Soil contamination	Arsenic	Heavy metal analysis	Quarterly	Ash Storage Facility	MPPCL/ MMT	50,000	75%	90%	5 ppm***		7*	
		Cadmium						75%	90%	5 ppm***		7*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Chromium						75%	90%	5 ppm***		7*	
		Lead						75%	90%	5 ppm***		7*	
		Mercury						75%	90%	0.2 ppm***		7*	
Terrestrial Flora and Fauna	SOx gas emission on plants would catalyze growth of plants since sulfur is a macronutrient that is a component of amino acids and proteins which would increase the tolerance of plants to drought. High concentration of SOx when absorbed by the plant would damage the plant tissues / disrupt plant growth Noise and emissions would disrupt daily routines of fauna especially during feeding time	Visual observation of sulfur – related symptoms of diseases in plants such as Dwarfing; Stunted growth; General chlorosis for young and mature leaves Presence / absence of endangered species	Tissue analysis of selected plants located around the power plant Pay particular attention to populations of endangered species (flora and fauna) Sampling of permanent plots for both flora and fauna	Twice a year until project completion or termination	Established Sampling Points	MPPCL/ 3rd party	750,000			-			
	Agricultural productivity (Rice and Mango)	Yield, soil pH, organic matter, Phosphorus, and Potassium	Yield measurement, soil sampling and analysis	Yearly for the 1st 2 yrs then every five years	Masinloc and Candelaria	MPPCL/ MMT/ Municipal Agriculture Office	150,000						
Water													
	Freshwater (River)	DO	Water quality checker (ion probe), AAS method	Quarterly	LR-1 (Upstream of the freshwater intake) and LR-2	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	
		BOD						75%	90%	5.0 mg/L		IEC	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Temperature			(Near the river mouth/nursery), MR-1 (Under Collat Bridge)			75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater contamination	pH	Water quality checker (ion probe), AAS method		Established groundwater monitoring wells					-		7*	
		SO_4								-		7*	
		Conductivity								-		7*	
		Salinity								-		7*	
		Hardness								-		7*	
		Arsenic						75%	90%	0.1 ppm****		7*	
		Cadmium						75%	90%	0.003 ppm****		7*	
		Chromium						75%	90%	0.05 ppm****		7*	
		Lead						75%	90%	0.01 ppm****		7*	
		Mercury						75%	90%	0.001 ppm****		7*	
	Plant Effluents												
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH		Quarterly Weekly	Ash Neutralization Basin, WWT Facility, Discharge			75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Cr+6			Canal, Coal Sedimentatiion Oil-water separator			75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling Water Discharge Canal/Condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e., low tide, high tide)	Facilities within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Monthly	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-	MPPCL/ MMT		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		1*	
		Arsenic						75%	90%	0.5 mg/L		1*	
		Cadmium						75%	90%	0.1 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.2 mg/L		1*	
		Lead						75%	90%	0.5mg/L		1*	
		Total Mercury						75%	90%	0.005 mg/L		1*	
		Oil and grease						75%	90%	10.0 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to operation activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Flourometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)	Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas	MPPCL/ MMT/ 3rd party	2,000,000			-			
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation	MPPCL/ MMT	400,000	75%	90%	340 µg/NCM		4*	
		Ambient NO_2	Griess Saltzman for NO_2					75%	90%	260 µg/NCM		5*	
		Ambient TSP	High Volume sampling for particulates B and K instruments					75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)	MPPCL/ MMT		75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
	Stack Emissions	SO_2 Emission	Pararosaniline for SO_2	Continuous stack emission monitoring/	Boiler	MPPCL/ 3rd party	1,000,000	75%	90%	700 mg/NCM		4*	
		NO_2 Emission	Griess Saltzman for NO_2					75%	90%	1,000 mg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		TSP Emission	High Volume sampling for particulates B and K instruments	Quarterly reporting				75%	90%	200 mg/NCM		1*	
People													
	Health and Socio-economic	As stated in the Memorandum of Agreement (MOA)	Monitor existing socio-economic projects and identify strengths and weaknesses	Quarterly	Affected barangays and on-going projects	MPPCL	500,000			-			
			Evaluation of accomplishment/ performance	Annually									
Abandonment Phase													
Land													
Terrestrial Flora and Fauna	Establishing vegetative cover in the area	Number of planted seedlings % survival % mortality No. of seedlings produced	Sampling technique could be used for monitoring of plant survival and presence / absence of fauna species	One year until complete conversion		MPPCL	250,000			-			
Water													
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Quarterly for one year duration	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front	MPPCL		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		TDS								-			
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	
		Cadmium						75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Copper			of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas			75%	90%	0.05 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Nutrients										1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
People	Sustainability of socio-economic projects	Number of socio-economic projects that are still operating either sustained by community organizations/cooperatives or supported by LGUs and others Network and linkages established internally and externally/decreased dependency from proponent	Monitor and evaluate outcome of projects and programs annually Review operations /capacity of existing network organized	One year Semi-annually for one year	Barangays affected Barangays affected	MPPCL	500,000						

Legend:

IEC – Information Education Campaign
1* - Maintenance of pollution control equipment and increase frequency of monitoring
2* - Derate the plant
3* - Provide LGU with the test results
4* - Coal blending/Derate the plant/Procurement of low Sulfur content
5* - Operation/Calibration of over fire control dampers

6* - Maintenance of plant buildings/equipment
7* - Install lining
***For Soil Contamination: Heavy metals to be monitored:

Arsenic	= 5ppm
Cadmium	= 5ppm
Chromium	= 5ppm
Lead	= 5ppm
Mercury	= 0.2ppm

Note: Limits as per RA6969

****For Groundwater Contamination: Heavy metals to be monitored:

Arsenic	= 0.1ppm
Cadmium	= 0.003ppm
Chromium	= 0.05ppm
Lead	= 0.01ppm
Mercury	= 0.001ppm

Note: there is no DENR limit for groundwater, above limits were as per PNSDW for comparison purposes and test results are also compared to the baseline data

1 PROJECT DESCRIPTION

Project Information

Name of Project	:	Masinloc Power Plant Project (Unit 4 Increase in Capacity and Unit 5 Expansion)
Project Location	:	Barangay Bani, Municipality of Masinloc, Province of Zambales
Nature of Project	:	Energy (Coal-Fired Thermal Power Plant)
Project Size	:	Unit 1: 324 MW (No Change) Unit 2: 324 MW (No Change) Unit 3: 300 MW (No Change) Unit 4: 315 MW (Increase in capacity from 300MW) Unit 5: 315 MW (New Unit/Expansion Project)

Proponent Profile

Proponent Name	:	**Masinloc Power Partners Co. Ltd**., a subsidiary of SMC Global Power Holdings Inc**. (SMCGPH)**
Proponent's Address		
Corporate	:	19th Floor San Miguel Properties Centre, No. 7 St. Francis Avenue, Mandaluyong City, Metro Manila
Plant Site	:	Barangay Bani, Municipality of Masinloc, Province of Zambales
Contact Persons		
Plant Site	:	**Mar Tuazon** Plant Manager
Contact Number	:	(+6347) 307-4000
E-mail Address	:	mrtuazon@mppcl.sanmiguel.com.ph
EPRMP Consultant	:	RHR Consult Services, Inc.
Consultant's Address	:	Unit 606 FSS Bldg. 2, No. 18 Scout Tuason, corner Scout Castor, Diliman, Quezon City
Contact Person	:	**Ryan Filiberto Pollisco-Botengan** Managing Director
Contact Number	:	09451957833 (02) 8503-5505
E-mail Address	:	botenganryan@gmail.com

Masinloc Power Partners Co., Ltd (MPPCL), a subsidiary of SMC Global Power Holdings, Inc. (SMCGPH), currently owns and operates the existing Masinloc Coal-Fired Thermal Power Plant with coal-fired power generation units (Units 1, 2, and 3 in operation, and Unit 4 under development) located at Barangay Bani, Municipality of Masinloc, Province of Zambales. The generated power from the units is delivered to the Luzon grid via two transmission lines running from Masinloc to Kadampat substation.

The existing site has enough space and physical facilities to support the operation of an additional unit. MPPCL decided to install Unit 5 between the Ash Storage Facility and Unit 4. Prior to the acquisition of MPPCL by SMC Global in 2018, the former applied for an Environmental Compliance Certificate (ECC) for the power plant expansion in 2011, and an Environmental Performance Report and Management Plan (EPRMP) was submitted to the Environmental Management Bureau (EMB) and issued an amended ECC (ECC No. 1111-0020) covering the existing and expansion project on April 23, 2012, allowing construction of Units 3 and 4. In March 2017, the Amendment of ECC (111-0020) was issued wherein the following changes were approved: change from sub-critical technology to supercritical technology for Units 3 and 4, change in stack height from 200 m to 150 m for Units 3 and 4, and increase in capacity for Unit 2 from 300 MW to 324 MW. In September 2020, another amendment was requested and approved to increase the capacity of Unit 1 from 300 MW to 324 MW.

1.1 Project Location and Area

The Project is located in Barangay Bani, Municipality of Masinloc, Province of Zambales (15°34’00” N, 119°55’11” E). The Project is located approximately 250 kilometers (km) NW of Manila and occupies approximately 138.5 ha of land (**Figure 1-1)**. The Municipality of Masinloc is politically subdivided into 13 barangays and has a population of 47,719 people composing 9,739 households (2015 census). Direct Impact Areas (DIA) have been identified as Barangays Bani, Taltal and Baloganon, Municipality of Masinloc. Indirect Impact Areas (IIA) have been identified as Barangays Binabalian and Lauis, Municipality of Candelaria (**Figure 1-2).**

1.2 Project Rationale

In recent years, there has been an increasing demand for electricity, at the same time reducing CO2 emission by adopting supercritical technology with higher steam pressure and temperature. To reduce CO2 emission and improve power generation, MPPCL has decided to utilize the same supercritical technology for Unit 5.

There is a global shift in power generation from high carbon intensive fuel such as coal to cleaner fuel such as natural gas and to renewables such as solar, wind and hydro, in favour of reduced emission of carbon dioxide gas, which is a major cause of global warming. Due to slower demand growth and better load management, an additional single unit was considered. Meanwhile smaller supercritical units are getting more and more popular and the availability of 315 MW size supercritical boiler and turbine has also increased in recent time, making it feasible to build 315 MW class supercritical units cost effectively.

MPPCL is also committed to cleaner energy generation wherever such opportunity occurs. Also, financial institutions are showing more interest in providing loans to supercritical units than subcritical units. It is getting difficult to justify investment in coal fired power plant unless there is clear effort in reducing carbon dioxide emission by increasing plant efficiency by adopting higher steam pressure and temperature.

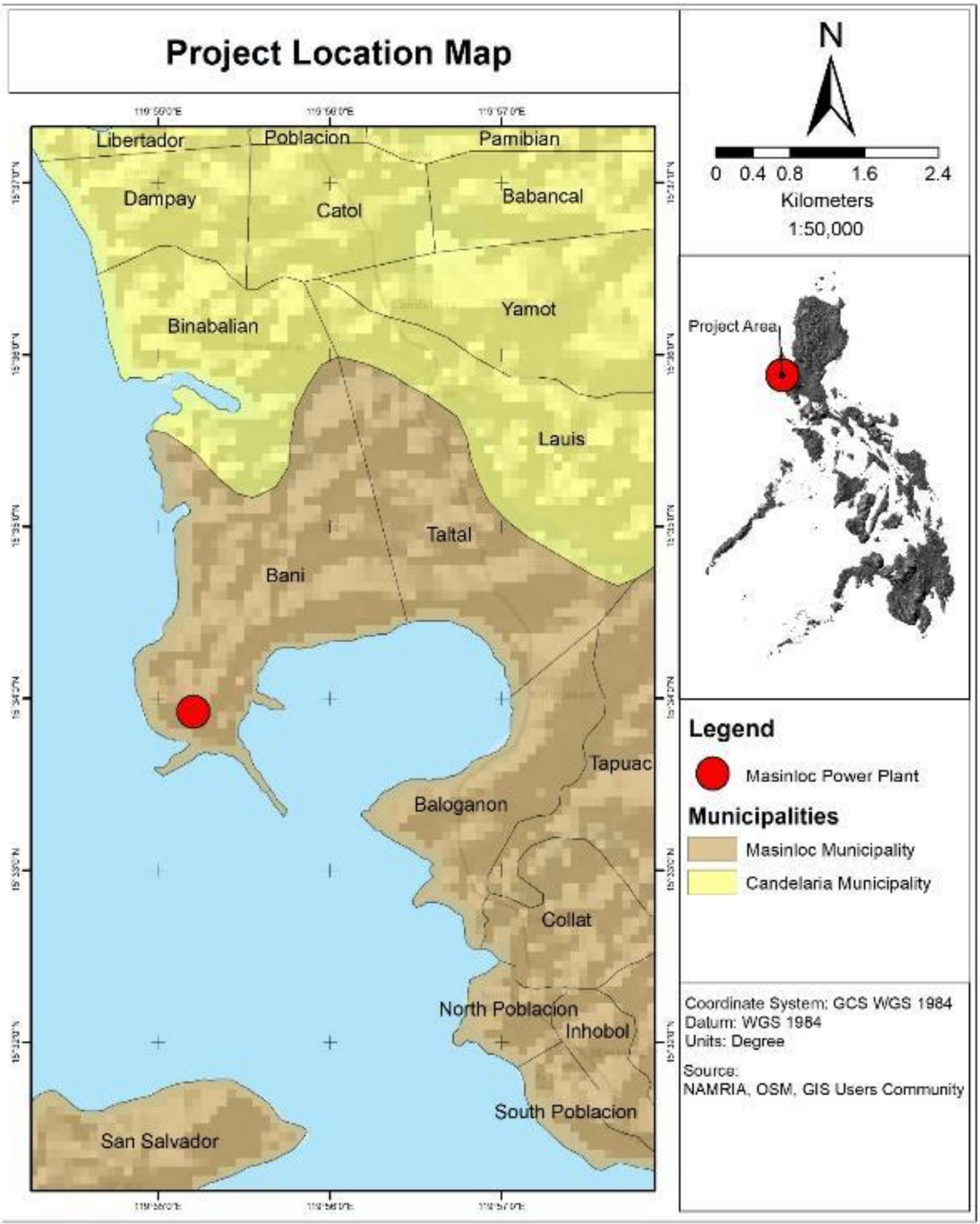


Figure 1-1. Project Location Map

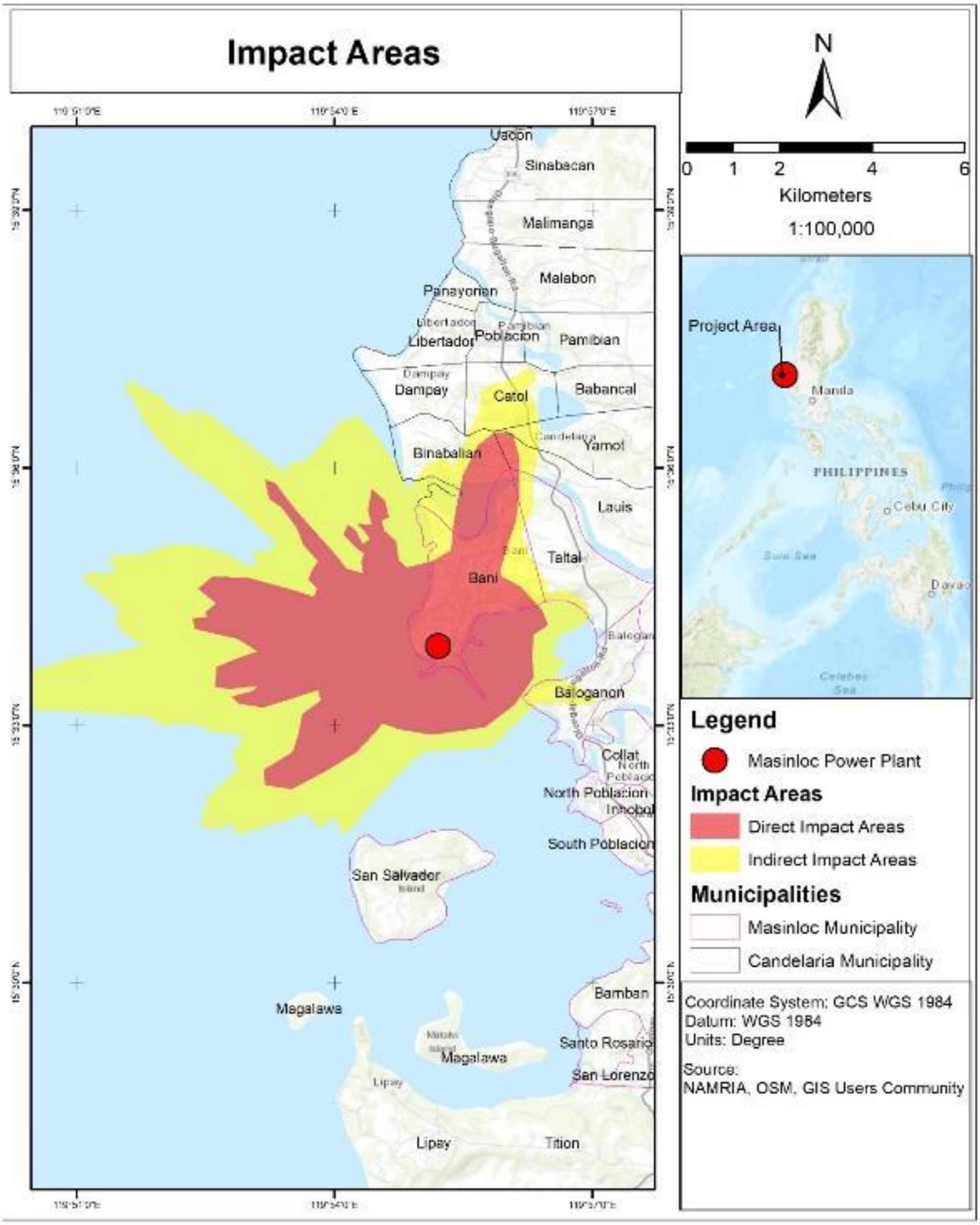


Figure 1-2. Direct and Indirect Impact Areas of the Project

1.3 Project Alternatives

The key difference between supercritical and subcritical plant is the operating pressure and temperature of the steam-water cycle. A steam cycle is called supercritical if the operating pressure and temperature are more than critical pressure and critical temperature of water (221.2 bar and 373 ºC), when the water loses distinction between liquid and vapour phases. In supercritical power plant, the boiler is once through type and has no drum **Figure 1-3**).

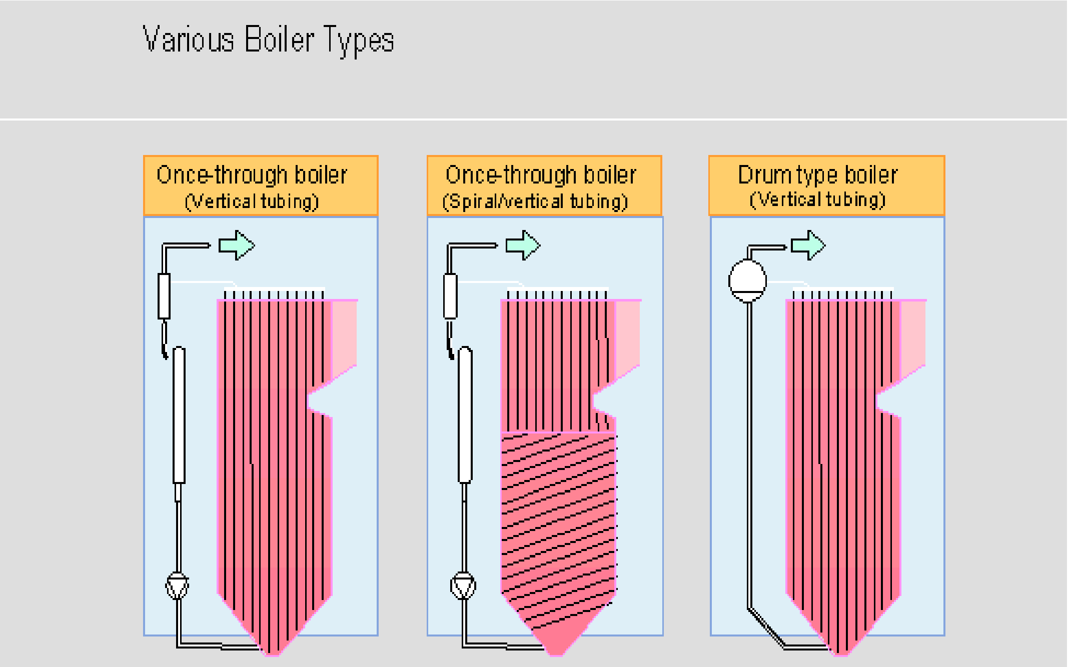


Figure 1-3: Various Boiler Types

Additionally, the supercritical boiler is provided with steam water separators used during start-up until supercritical pressure is reached (also known as Benson Point). Since water pressure below Benson Point is subcritical, water does not fully evaporate until Benson Point is reached. During boiler start-up steam-water is separated in a vertical separator and the water is returned to economizer inlet using recirculation pump.

Supercritical boiler water wall can be constructed of spiral tubes at the lower furnace and vertical tubes around the upper furnace, or entirely of vertical tubes. The former is known as high mass flux design and the latter is called low mass flux design. Masinloc expansion unit being smaller in size, will use spiral wound tubes at furnace bottom and vertical tubes around the top furnace. Vertical tube design is relatively new technology and emulates the concept of natural circulation principle of drum type boiler which uses vertical tubes along the entire furnace wall.

There is no difference in construction of steam turbines of subcritical and supercritical boiler. Because supercritical boiler uses high steam pressure and temperature, the materials of construction of high pressure (HP) and intermediate pressure (IP) turbines are adjusted to withstand higher pressure and temperature. As supercritical plant generally operates at higher pressure and temperature, the materials of construction of boiler pressure parts shall use more high chrome alloy and stainless steel than used in subcritical plant.

Supercritical units have several distinct advantages over subcritical ones namely:

a) Higher Efficiency

The key objective of using supercritical technology in power generation are lower net plant heat rate, higher efficiency, and lower fuel consumption rate. The higher the steam temperatures and pressures at turbine inlet, the higher is the efficiency. Therefore, the drive has been to increase steam temperature and pressure to increase plant efficiency. However, higher steam temperature is limited by the material of construction of boiler tubes and headers and steam piping. Within the currently available high temperature material, the maximum steam pressure and temperature are now limited to 320 bar and 620 ºC steam temperature respectively for long proven operation. However, research is ongoing to develop tube materials which can be applied to steam temperature up to 700 ºC.

The main steam temperature and pressure have been conservatively selected as 240 bar (a) and 566 ºC at high pressure turbine inlet. To enhance plant efficiency, the reheat cycle steam pressure and temperature are fixed at 43.31 bar (a) and 595 ºC at intermediate pressure turbine inlet. Many supercritical units with these steam pressures and temperatures have been in successful operation for many years and the boiler tube and piping materials for these temperatures have been found proven in operation.

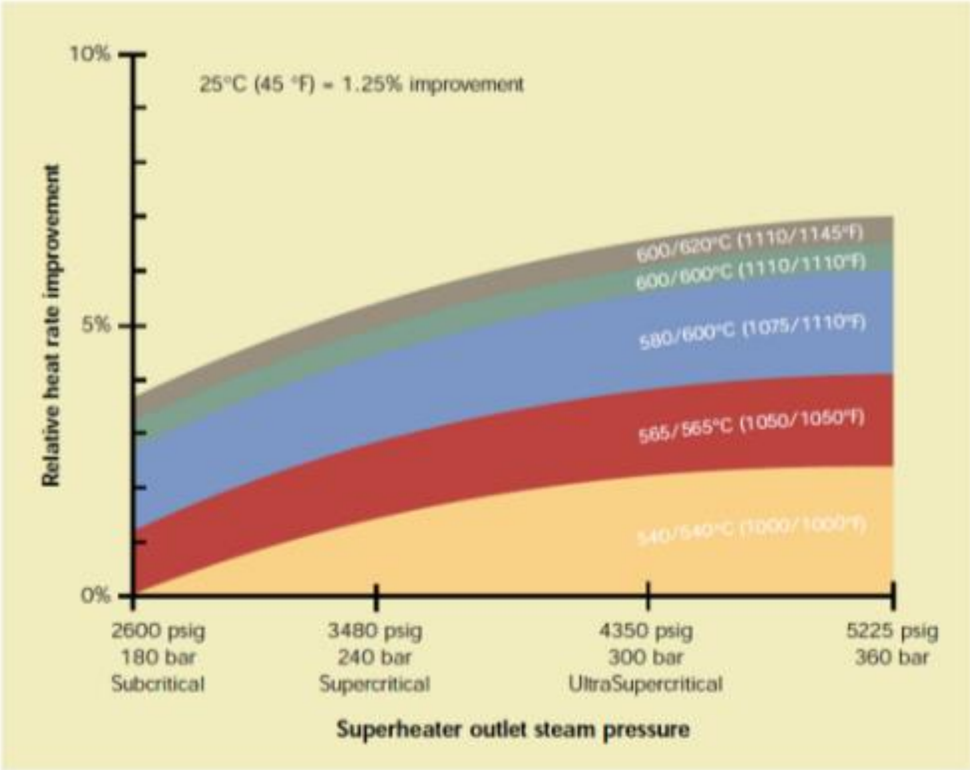
Supercritical units are operated at sliding pressure mode at full and partial loads down close to minimum load. This enables the units to realize higher part load efficiency compared to subcritical units, which are subjected to constant pressure operation near full load and near low loads.

Table 1-1 shows the comparison of heat rate of subcritical and supercritical technologies for Unit 5 on new and clean condition basis.

Table 1-1: Comparison of Heat Rate of Subcritical and Supercritical Technologies

	Unit	Subcritical	Supercritical	% Improvement (+) / Reduction (-)
Performances:				
Net Output	MW	300	300	
Auxiliary Power Consumption	MW	26.44	30.6	
Net Output	MW	308.56	304.4	
Main Steam Pressure	Bar	168	240	
Main Steam Temperature	°C	565	566	
Reheat Steam Pressure	Bar	38.44	51.5	
Reheat Steam Temperature	°C	565	595	
Turbine Heat Rate	kJ/kWh	7640.7	7334	-4.01%
Net Plant Heat Rate	kJ/kWh	9543	9175	-3.86%
Efficiency	%	37.73	39.24	+4.00%
Coal Consumption Rate	Tons/hr	133.5	126.6	-5.2%

The following charts (**Figure 1-4**) shows relative heat rate improvements for various main and reheat steam temperatures and pressures.



Source –Alstom Power

Figure 1-4: Heat Rate Improvement vs. Steam Conditions (Single Reheat)

The above chart shows the progressive increase in heat rate improvement with increase in main and reheat steam temperatures and pressures in supercritical plant compared to subcritical plants with main and reheat steam temperature of 540 °C and main steam pressure of 180 bar. For main steam pressure of 240 bar and main steam/reheat steam temperatures of 565 °C/565°C, the relative heat rate improvement is found slightly below 3% in the above chart. Since Unit 5 will use main steam pressure and temperature of 240 bar and 566°C and reheat steam temperature of 595°C, the heat rate improvement is above 3.0% and is consistent with the actual heat rate improvement shown in **Table 1-1** above.

The above chart shows that for an ultra-supercritical unit adopting main steam pressure of 300 bar and main and reheat steam temperatures 600°C/600°C, heat rate can be improved by 6% when compared to subcritical unit. Large size coal fired units (600 to 1000MW) built in recent years are adopting ultra-supercritical steam parameters.

b) Lower Emission Rates

Due to lower coal consumption rate, quantities of combustion products and wastes such as carbon dioxide (CO2), carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx), and particulate matters (PM) also decrease resulting in net reduction of air emissions and ash generation. When SOx and NOx emissions are controlled, consumptions of reagent for SOx control (limestone, lime or sea water) and reagent for NOx control (ammonia or urea) are also reduced due to reduction of SOx and NOx production.

Table 1-2 shows the comparison of estimated emission rates for subcritical and supercritical technologies for Unit 5 on a new and clean condition basis. Emission numbers are based on fuel consumption at boiler maximum rating (BMCR) and per generating unit. The comparison used emission data received from the EPC contractor at bidding stage, for different equipment vendors for subcritical and supercritical technologies.

Table 1-2: Comparison of Estimated Emission Rates for Subcritical and Supercritical Technologies

	Unit	Subcritical	Supercritical	% Improvement (+) / Reduction (-)
Emissions after Control:				
Carbon Dioxide (CO_2)	tons/hr	282.50	265.50	-6.02%
Sulphur Dioxide (SO_2) (after Flue Gas Desulfurizer)	kg/hr	218.53	203.75	- 6.76%
Nitrogen Dioxide (NO_2)	kg/hr	419.70	391.16	- 6.80%
Particulate Matter (After ESP)	kg/hr	54.63	50.94	- 6.75%

Carbon dioxide (CO_2) emission from coal fired power plant is identified as the main greenhouse gas, contributing to global warming and seal level rise. Use of supercritical technology will reduce the CO_2 emission by around 17 tons/hr from Unit 5. Assuming that the unit will be operating with 90% availability, annual CO_2 emissions may be reduced by 133,765 tons per year or 4.0 million tons in 30 years lifetime. Similarly, the annual reduction of SO_2, NO_2 and PM emissions will be around, 117 tons, 262 tons and 29 tons respectively, as a result of choosing supercritical technology. Actual emission reduction will be around 80 to 90% of the above numbers due to expected dispatch at lower loads. This represents around 9.2% reduction of circulating water flow and thermal emission into the sea

c) Lower Operating Cost

Supercritical plant consumes lower fuel than subcritical plant. This results in significant fuel cost saving. This also results in lower amount of combustion wastes such as ash, pyrites. Therefore, annual cost for handling of solid wastes like ash and pyrites also decreases.

Supercritical boiler does not need regular blow down to control dissolved solids in boiler water due to use of condensate polisher for removal of dissolved solids. This reduces boiler make-up water demand. This means the production of boiler make-up water by desalination of sea water is also reduced.

d) Faster Load Ramping Rates and Lower Minimum Load Operation

Generally, supercritical units have faster ramp rates due to absence of boiler drum. This makes supercritical units more suitable for markets where grid demand fluctuates during day and night time or where operation at low load during night time and holidays are necessary.

e) Shorter Start-up Time

Supercritical units take shorter time to start up due to the absence of boiler drum and faster ramp rates. This makes the supercritical units suitable for two shift operation compared to subcritical units.

1.4 Project Components

1.4.1 Major Project Components

The Project intends to use similar structures, system specifications and equipment of Masinloc Plant's existing facilities to ensure effective inter-plant coordination and to reduce the environmental impact of the Project on the overall footprint of the Masinloc Plant.

A description of the Project's modifications relative to the existing plant is summarized in **Table 1-33** and presented in **Figure 1-5.**

Table 1-3: Summary of Existing Components and Proposed Modifications

Unit	Existing Components (ECC-Ref. No. 1111-0020)	Proposed Modification
Unit 1	324 MW	No change
Unit 2	324 MW	No change
Unit 3	300 MW	No change
Unit 4	300 MW (currently under site development)	Increase capacity to 315 MW
Unit 5		New Unit with capacity of 315 MW The same with unit 4 technical specifications except for the following: • Elevation @15 meters elevation • New coal yard (dome type), shared facility • Separate seawater intake and discharge channel • Extended coal unloading jetty; and • New transmission line

Figure 1-5: Map delineating Site Development and Proposed Modifications for Units 4 and 5

1.4.2 Support Facilities and Pollution Control Devices

1.4.2.1 Ash Handling System

Ash is a major by-product of the combustion of a coal-fired power plant. Ash is classified as bottom ash and fly ash. Bottom ash is the ash collected in the boiler while fly ash is collected in the economizer, air heater and electrostatic precipitator. The total amount of ash generated is dependent on the characteristics of the fuel (calorific value and ash content) used. The Project was designed to consume coal of varying characteristics.

Unit 1, 2, and 3 of the Masinloc Plant currently use an Ash Handling System with the following specifications:

Table 1-4: Ash Handling System Specifications for Unit 1 and Unit 2

Component	Units 1 and 2	Units 3
Bottom Ash Conveyor	11.7 t/h per Unit	7.8 t/h per Unit
Bottom Ash Silo Capacity	300 m^3 per Unit	800 m^3 per Unit
Fly Ash Pneumatic System	24 t/h per Unit	24 t/h per Unit
Fly Ash Silos – 2 installed per Unit (1 fine and 1 coarse)	1,500 m^3 each	1,200 m^3 (fine ash silo) each 1,200 m^3(coarse ash silo) each

The ECC for Unit 5 include the construction of Ash Handling System and its specification is shown in **Table 1-5**.

Table 1-5: Ash Handling System Specifications for Unit 4 and 5

Component	Unit 4 and 5
Bottom Ash Conveyor	7.8 t/h per Unit
Bottom Ash Silo Capacity	800 m^3 per Unit
Fly Ash Pneumatic System	24 t/h per Unit
Fly Ash Silos – 2 installed per Unit (1 fine and 1 coarse)	1,200 m^3 (fine ash silo) each 1,200 m^3(coarse ash silo) each

1.4.2.2 Ash Storage Facility

The existing ASF has an area of 24 ha and is designed to contain ash for the 18.8 year service life (assuming 50% of Fly Ash is hauled out) of MPPCL. It adopts an inland ash disposal method. The existing ASF which is adjacent to the west side of the existing plant has hills and ridges 15 to 25 m high. These hills and ridges serve as a natural embankment on the eastern, southern and western (seaside) sides of the ASF.

Ash generated that is not hauled offsite, is transported to the ASF by dump trucks where bulldozers handle the ash by levelling and compacting. To contain the ash, embankments have to be constructed in advance of several years of disposal. As the level of ash disposed becomes higher, additional embankments have to be constructed .The same procedure will be applied for the remaining operational life of the ASF.

The ASF has a regulating reservoir, a sedimentation basin and a necessary pH control system facility and discharge pump pit. Improvements to the design of the existing ash disposal facility was undertaken to ensure proper ash containment and prevention of adverse environmental impacts. Particular attention will be given to the slope protection of the embankments.

The cumulative production of ash from 2008 to 2019 is at 1,695,291 metric tons and by Unit 2 is 559,856 metric tons or a total of 1,106,698 metric tons by two units. Around 921,717 MT or 54% of this ash has been disposed at the ASF storage facility (fly and bottom ash). The Provincial Environment Office (PEO) has hauled a total of 739,030 metric tons (44%) from 2008-2019. (**Table 1-6**).

Table 1-6: Ash Production from 2008 to 2019

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Coal Consumption	572,446	907,044	1,513,008	1,508,292	1,667,511	1,680,124	1,734,956	1,758,246	1,862,366	1,807,634	1,693,332	2,290,272	18,995,231
Ash Production													
Fly Ash	63,886	77,318	107,517	95,286	94,245	74,018	105,894	156,512	114,651	136,082	151,809	121,944	1,299,162
Bottom Ash	17,157	27,690	39,218	45,877	44,903	38,652	28,503	34,135	27,417	23,682	34,351	34,543	396,129
Total	81,043	105,008	146,735	141,163	139,148	112,670	134,397	190,647	142,068	159,764	186,160	156,487	1,695,291
Ash Taken Out by Provincial Environment Office (PEO)	38,233	53,175	88,912	15,397	43,020	70,883	78,301	85,740	91,995	73,920	61,050	38,404	739,030
Ash Disposed to Ash Storage Facility (ASF)	42,810	51,832	57,823	125,766	96,128	41,787	56,096	104,907	50,073	85,844	125,110	83,540	921,717
% of Ash Taken Out by PEO	**47%**	**51%**	**61%**	**11%**	**31%**	**63%**	**58%**	**45%**	**65%**	**46%**	**33%**	**25%**	**44%**
% of Ash Disposed to ASF	**53%**	**49%**	**39%**	**89%**	**69%**	**37%**	**42%**	**55%**	**35%**	**54%**	**67%**	**53%**	**54%**

All units in metric tons

The existing ASF and future ASF can accommodate the ash from both the existing Plant and the expansion Project given the design capacity. The mass balance for coal and ash is based upon the following assumptions:

- Ash content of coal = 10%;
- Ash disposal rate from Plant to ASF = a) 55.8% (average disposal rate from 2010-2015); (b) 65%, (c) 75% and 100% (worst case)
- Ash Density = 1.385 metric tons/m^3;
- Unit 1 and Unit 2 COD = ~1998;
- Unit 3 COD = ~2019
- Unit 4 COD = ~ 2024;
- Unit 5 COD = ~2025
- Current volumetric design of the Ash Storage Facility (ASF) - Area 1 – 4,500.000 m^3 (existing) and Area 2 = 3,093,098 m^3 (if necessary) , Total-9,000,000 m^3;
- Design and ash deposition operations build upon already deposited ash prior to 2012; and
- Design of ASF Area 1 is ~24 hectares in area with a final ash deposition level of 34.5 meters (relative level). ASF Area 2 – 24 hectares.

The site development of the existing ASF is shown in **Figure 1-6** and its profile showing layer of natural clay is presented in **Figure 1-7** and **Figure 1-8**. With the current ash removal rate from the site, it is estimated that beneficial use of the ASF will be only around 18.8 years assuming 50% of Fly Ash is hauled out.

With a steady ash removal rate of ash from the site, the ASF design capacity will be able to accommodate the full production of ash from both the existing Plant and the expansion Project well beyond the life expectancy of the entire plant. In the worst case scenario (100% disposal rate to ASF), Ash Storage Facility Area 1 will be filled-up by 2029, hence, there is a need to utilize the 2nd ASF prior to maximizing the capacity of Area 1.

1.4.2.3 Ash Transporting Trucks

Dump trucks (25ton class) are utilized to transport ESP ash and clinker ash. One truck can handle 110 t/h ash for the ESP and 67 m^3/h for clinker ash and can make two round trips in an hour. The amount of ash that can be transported is 840 tons in 8 hours for the ESP ash and 267 m^3 in 4 hours for clinker ash. Two trucks are used in each system with another two trucks kept as back-up. Other machines/facilities used in the handling of ash include: (i) one bulldozer to work in the ASF, (ii) a fuel storage facility for trucks and bulldozer and (iii) a garage for ash disposal trucks and bulldozer.

The Project shall purchase and utilize equipment with the same specifications for ash transportation.

1.4.2.4 Drainage System within the ASF

Rainwater falling inside and outside the ASF is routed to the sedimentation basin (with a capacity of 60,000 m^3) by a water channel in the ash disposal area. After the ash particles have settled, water is discharged to the sea at the west side.

1.4.2.5 Back-up Electrical System

An emergency diesel generator is provided to supply power for the emergency load of the turbine and boiler to assure an orderly shutdown of the plant in the event of a total loss of station AC power.

The diesel generator set is located in the emergency diesel room located on the first floor of the powerhouse. The generator is of the rotating field synchronous type, rated 460V, 3-phase, 60 Hz, 0.85 power factor. It is totally enclosed and directly connected to the diesel engine.

The Project contemplates the purchase and utilization of equipment with the same specifications.

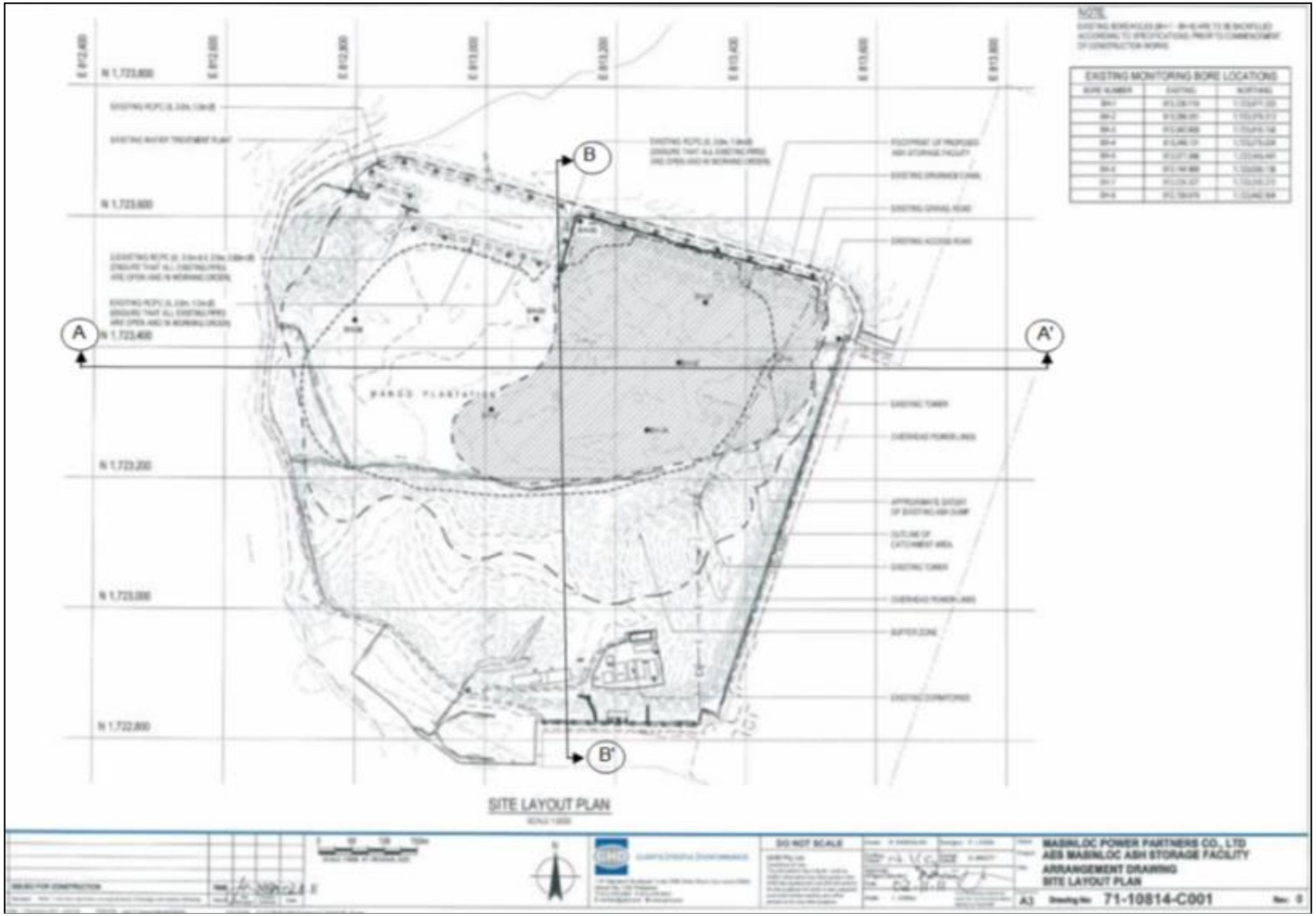


Figure 1-6: Site Development Plan of the Ash Storage Facility

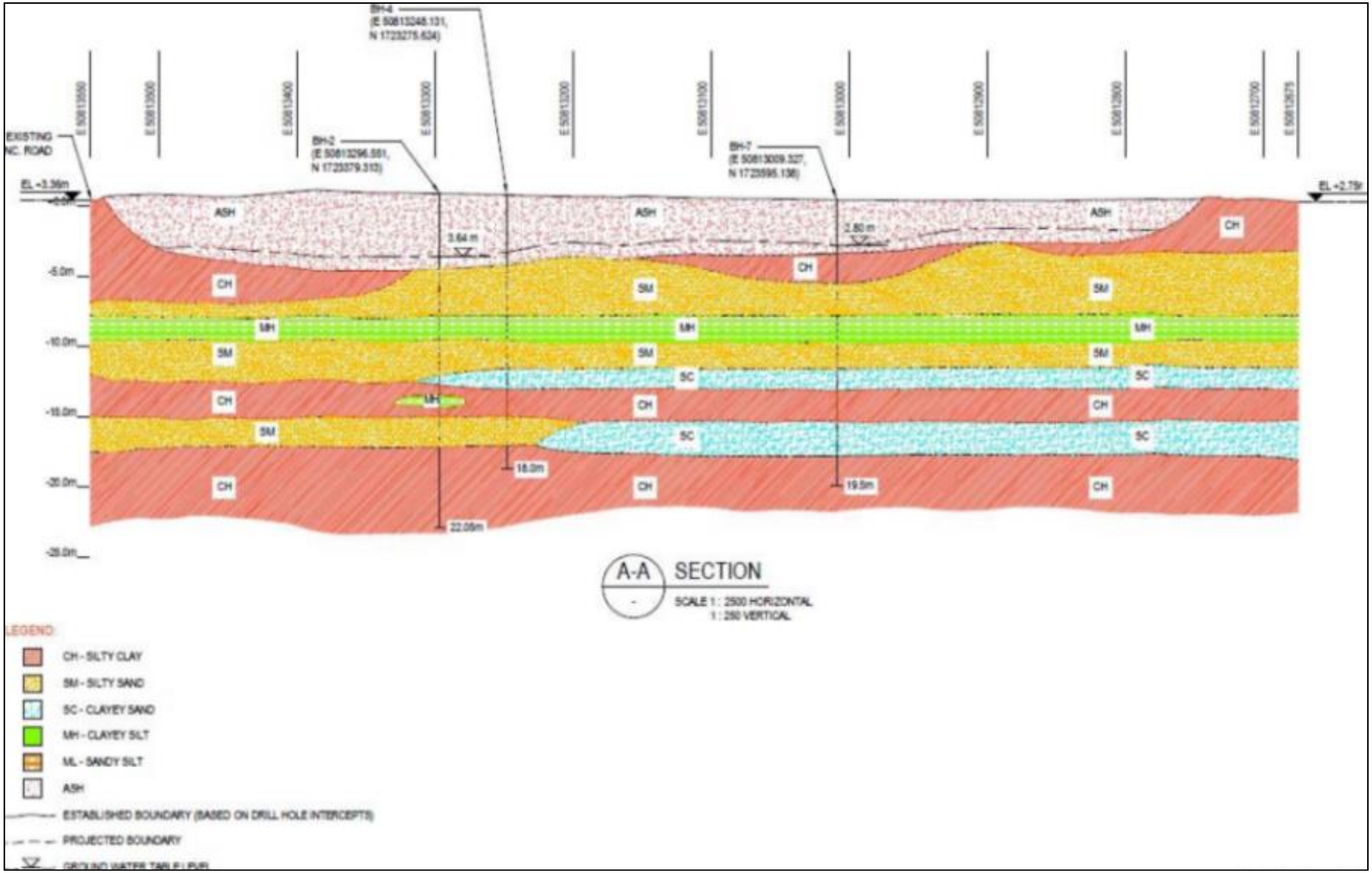


Figure 1-7: Profile of ASF Showing Location of Natural Clay Soil Section A-A'

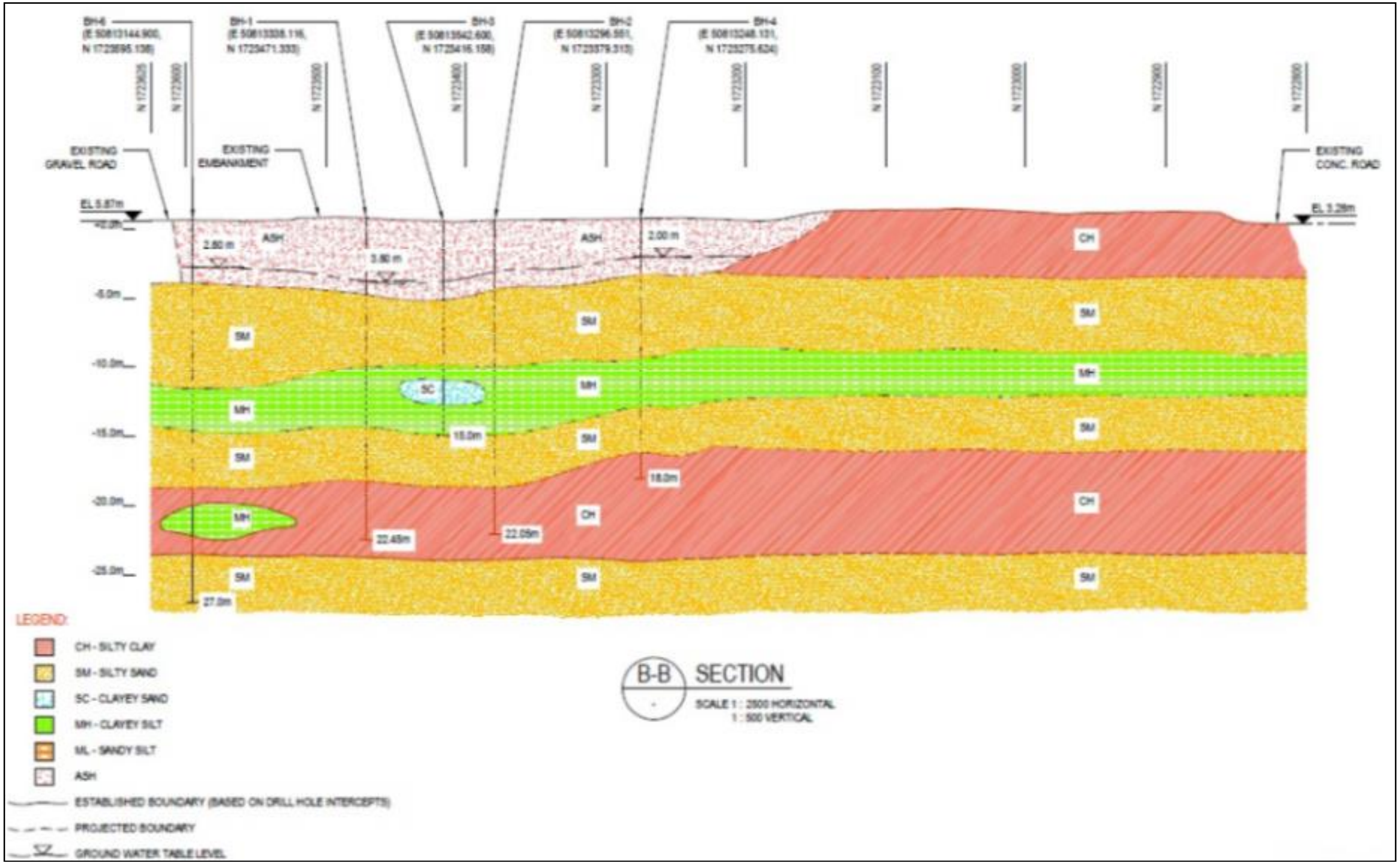


Figure 1-8: Profile of ASF Showing Location of Natural Clay Soil Section B-B'

Table 1-7: Projected Ash Storage Requirement for Various Assumed Disposal Rates

PLANT	DESIGN TYPE	CAPACITY		CURRENT VOLUME DUMPED		REMAINING VOLUME	ASH GENERATION B/A + F/A			VOLUME DEPLETIO N	ASH GENERATION B/A Only F/A Haul Out(100%)			VOLUME DEPLETION	ASH GENERATION B/A Only F/A Haul Out (50%)			VOLUME DEPLETION
MASINLOC POWER PLANT		MT	CUM	MT	CUM	CUM	B/A	F/A	Total	Years	B/A	F/A	Total	Years	B/A	F/A	Total	Years
ASF Existing Site	Progressive type		4,500,000		2,500,000	2,000,000	14,400	68,000	82,400	**24.3**	14,400	-	14,400	**138.89**	14,400	34,000	48,400	**41.32**
		With Unit 4				2,000,000	24,400	106,000	130,400	**15**	24,400	-	24,400	**81.97**	24,400	53,000	77,400	**25.84**
		With Unit 5				2,000,000	34,400	144,000	178,400	**11**	34,400	-	34,400	**58.14**	34,400	72,000	106,400	**18.80**
MASINLOC POWER PLANT		MT	CUM	MT	CUM	CUM	B/A	F/A	Total	Years	B/A	F/A	Total	Years	B/A	F/A	Total	Years
New Site	Progressive type		3,000,000		-	3,000,000	14,400	68,000	82,400	**36.4**	14,400	-	14,400	**208.33**	14,400	34,000	48,400	**61.98**
		With Unit 4				3,000,000	24,400	106,000	130,400	**23**	24,400	-	24,400	**122.95**	24,400	53,000	77,400	**38.76**
		With Unit 5				3,000,000	34,400	144,000	178,400	**17**	34,400	-	34,400	**87.21**	34,400	72,000	106,400	**28.20**

1.4.2.6 Fuel Oil System

Fuel oil is required for ignition, warming-up and support fuel. The unloading and storage system of fuel include the following;

a) Fuel unloading pumps from the jetty and trucks to the oil storage tanks shall include unloading pumps with driving motors , air separators, duplex strainers, pulse generative flow meter with local indicator, oil recovery tank and pump, valves, pipes, and fittings and necessary accessories;
b) Fuel oil storage system includes two tanks, level indicators, pipes, valves and fittings; and
c) All necessary instrumentation

Unloading of oil is via trucks and is designed based on the pumping rate of not less than 20 m^3/h. The system includes two 50% duty unloading pumps with driving motors, two 75 mm diameter x 5 m long flexible hoses with connectors.

The Project contemplates utilization of the existing fuel oil unloading storage system. One fuel oil tank is required to supply the start-up needs of the Masinloc Plant and another tank is required to supply the start-up needs of the Project. Either tank can supply the needs of either the Masinloc Plant or the Project as the tanks are interconnected.

1.4.2.7 Chemical Feed System

A chemical feed system is provided for optimum scale and corrosion control. This system will be used for dosing of amine at the condensate pump discharge to maintain pH at a high level so that iron pick-up is minimum, dosing carbohydrazide solution at the boiler feed pump to prevent oxygen corrosion and dosing of phosphate into the boiler drum to protect from scaling.

The Project will require the purchase and utilization of equipment with the same specifications.

1.5 Process/Technology Options

1.5.1 General Description of Process

Unit 5 will use imported coal as the primary fuel, the same as the existing units. Coal is delivered to the plant in Panamax vessels and unloaded to the coal storage yard by using four coal unloaders on the unloading jetty. The coal is conveyed onshore by conveyers and stored in the coal storage yards using stacker-reclaimers.

The support fuel is diesel oil and purchased from the markets and stored in fuel oil storage tanks. The support fuel is used during the start-up of a unit. Coal is fed by stacker-reclaimer from coal yard and conveyed to coal crushers. The crushed coal is then fed to the traveling tripper via conveyors for filling coal silos of the boiler. Coal is fed from coal silos to coal pulverizers to pulverize coal to fine particles and fed to coal burners mounted on boiler walls.

Necessary combustion air is sucked from the atmosphere by primary air (PA) fans and forced draft (FD) fans and then heated in an air-preheater by flue gases exiting the boiler. The air coming from the FD fans is fed to the coal burners for combustion of pulverized coal, whereas the air coming from the PA fan is diverted to pulverizers for drying the coal and transporting the pulverized coal to coal burners. The combustion products called “flue gases” are cooled down over superheaters, reheaters, and economizer, located in the top and back pass of the boiler and then in the air-preheater, before entering the Electro-Static Precipitator (ESP). The flue gases leave the air pre-heater at around 144 °C.

The ESP is divided into two chambers (flow paths). In the ESP, dust particles are charged by high voltage DC current and then collected into dust hoppers. The ESP will remove dust to the target dust emission limit of 50 mg/Nm^3.

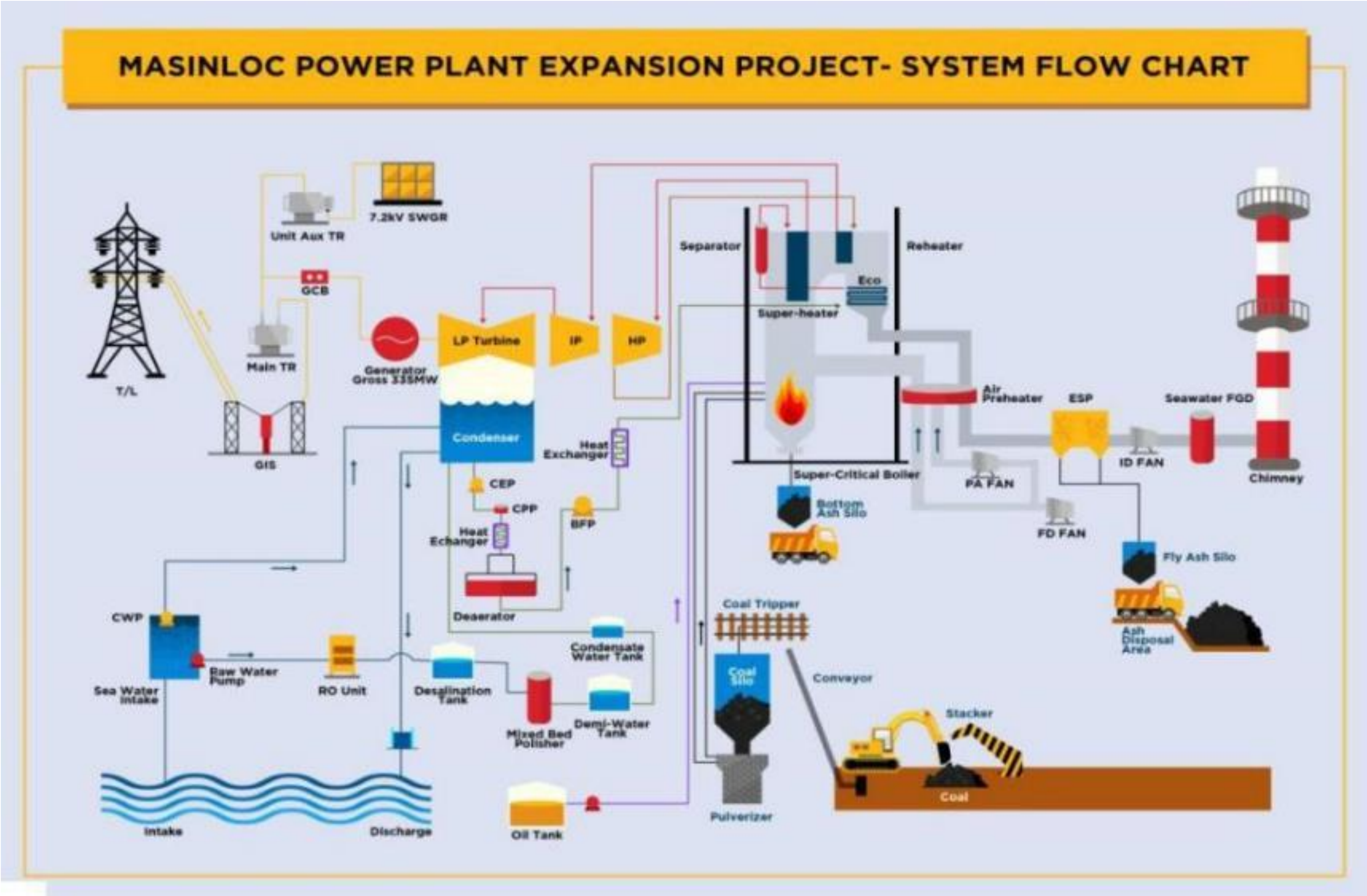


Figure 1-9: Process Flow Diagram

The flue gases then flow to flue gas desulphurizer (FGD) tower where they come in contact with seawater. The seawater coming from condenser is pumped to FGD absorber tower. The alkalinity of sea water reacts with SO_2 in the flue gases and reduces SO_2 in flue gases to 200 mg/Nm^3 at FGD outlet. The FGD system is provided with a gas-gas heater (GGH) where outgoing wet flue gases from the absorber are heated back to ≥85 °C by the flue gases entering the FGD absorber. The flue gases then pass to the chimney for venting into the atmosphere. Inducted draft (ID) fans located between ESP and FGD, boost up the flue gases pressure required for venting through the stack.

Feedwater is fed to boiler economizer for heating and then distribution to water walls on four sides of the boiler combustion chambers. Feedwater evaporates as it passes inside the water wall tubes and the generated steam then passes to primary, and secondary superheaters before admitting into the High Pressure (HP) turbine at 24.5 MPa(a) and 566 ±5°C. The exhaust steam from the HP turbine is returned to boiler reheaters (primary and final) where it is heated and then admitted into the Intermediate Pressure (IP) turbine at 4.51 MPa(a) and 596 ±5°C.

The steam coming from the IP turbine is fed to Low Pressure (LP) turbine at around 5 bar and 283.3 °C. The exhaust steam from the LP turbine passes to the condenser where the steam condenses and it's heat is exchanged with the cooling water.

The pressure of condensate coming from the condenser is boosted up by condensate extraction pumps and then it is passed through condensate polishers to remove dissolved ions and corrosion products to maintain high purity level demanded by supercritical boiler and steam turbine. The condensate from the condenser is heated up in four low pressure feedwater heaters, deaerator and three high pressure feedwater heaters with steams extracted from different stages of the steam turbine. The extracted steam condenses in shell side of the feedwater heaters, and exchanges heat with the condensate flowing inside heater tubes. The feedwater pressure is raised by boiler feed water pumps (BFP) after the deaerator and then heated in HP feedwater heaters to 300 °C.

The cooling water is supplied to cooling water pumps located on the sea water intake structure. The cooling water gains 5.6°C temperature rise in the condenser and other smaller coolers. Part of the cooling water is passed to FGD absorber by booster pumps to absorb the sulphur dioxide (SO_2) and then returned to a mixing basin to mix with the remaining cooling water. Sea water FGD increases the cooling water temperature. To maintain cooling water temperature rise to 5.6°C, dilution water is supplied from cooling water intake by pumps to the mixing basin. The total cooling water, dilution water and the moisture condensed in the FGD absorber is 59,462 m^3/hr per Unit and is returned to the sea.

The freshwater demand for the expansion project will be met by desalinating seawater in two stage reverse osmosis (RO) plant.

The power generated by the expansion Unit 4 and 5 will be delivered to substations located at the plant.

1.5.2 Waste Management Measures

1.5.2.1 Noise, Wastes, Emissions and Effluent

1.5.2.1.1 Noise

Design of the Masinloc Plant is constructed to operate with the least amount of noise. Acoustic treatments have been provided ensuring that when the plant is operating at any load, the sound pressure level does not exceed values on the Noise Rating Curve ISO 85 at a distance of 1 m from the machine or enclosure. Boiler start-up, other pressure reducing devices operating during emergency and other safety valves will exceed standard limits.

The Project will utilize the same design specifications for the equipment and systems.

1.5.2.1.2 Wastes

Construction and operation of the Project will generate wastes such as construction material debris, garbage and refuse of construction workers and employees of the Project. These wastes will be hauled to an appropriate dumping site. During operation, the plant will generate wastes such as ash and soot during the combustion process. Sludge, resin and other suspended solids shall be generated during water treatment. Sewage will be treated in a septic tank before it is discharged into the sea.

1.5.2.1.3 Effluent

The operation of the Masinloc Plant will entail waste water classified into constant waste water (daily effluent) and occasional wastewater (effluent at annual inspection). Constant wastewater involves sewage (from offices, powerhouse and port water treatment facility, oil water and effluent during boiler blowdown. Sewage will be purified and treated before it is discharged. Occasional wastewater is the generated effluent during commissioning test and annual inspection. This effluent comes from the condenser (condensate chamber) boiler tube water flushing, deaerator water flushing, electrostatic precipitator water cleaning, air heater water cleaning, chemical cleaning of boiler, and water cleaning for oil during ash and deposit. The effluent will be treated prior to disposal. The wastewater at the outlet of the wastewater treatment shall have the following quality before discharging to Oyon Bay;

pH	5.5 to 9.0
COD	Below 50 mg/L
SS	Below 10 mg/L
Fe	Below 1 mg/L
Ni	Below 1 mg/L
Mn	Below 1 mg/L
Oil	Below 10 mg/L

The Project contemplates the construction of an additional treatment facility of wastewater and effluents with the same specifications as the existing systems.

The following effluent characteristics are expected with the SFGD:

Seawater Flow rate	51,650 t/h
Seawater Temperature	38°C
pH	>= 6
COD	<= 2.5 mg/L
DO	>= 2.7 mg/L
Sulfates content:	increase by about 5%

1.5.2.1.4 Emissions

The Masinloc Plant emits SOx, NOx and particulate matter as products of combustion. To meet the DENR emission standards, less than 1% sulfur coal is burned by the Masinloc Plant. In addition, coal blending of different sourced coal is done to ensure compliance with emission regulations. The Project will utilize SFGD technology to control the SOx emissions.

The Project will utilize SFGD technology to control the SOx emissions of Unit 5. SFGD is considered acceptable by the World Bank and other international finance institutions and is included in the Environmental, Health and Safety Guidelines for Thermal Power Plants published by the International Finance Corporation (IFC) which is part of the World Bank.**Figure 1-10** shows the SFGD process that utilizes the ability of seawater to absorb and neutralize SOx present in the untreated flue gas. Flue gases from the boiler containing dust are directed to an electrostatic precipitator or a fabric filter. Then, the flue gas is directed to a seawater SOx absorber.

Utilizing efficient combustor technology, the Project will attain emissions that comply with currently prescribed maximum limits under the Clean Air Act.

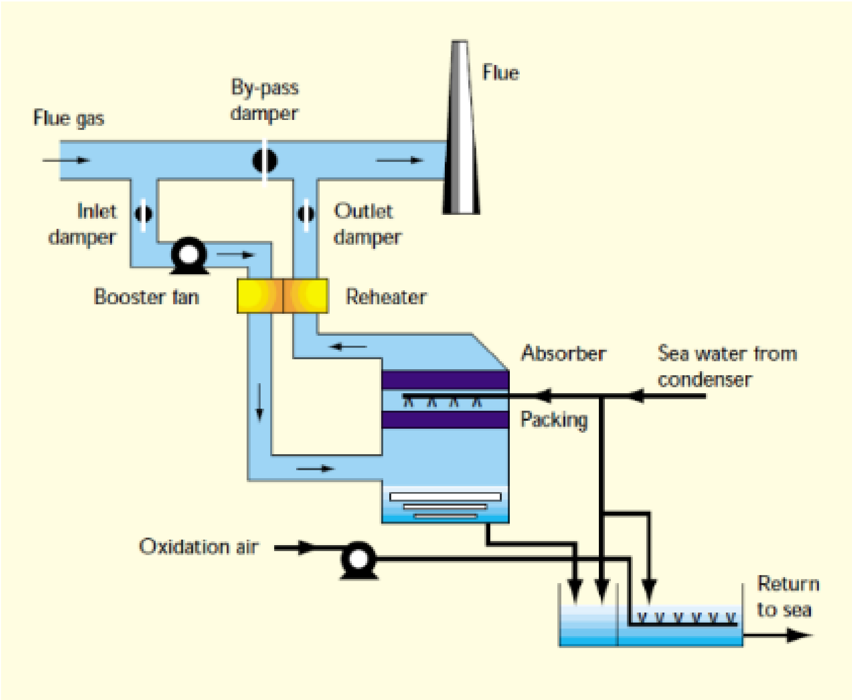


Figure 1-10: Seawater Flue Gas Desulfurization (SFGD) Process

The Project will install an efficient ESP with particulate emissions less than 200mg/NCM in compliance with DENR standards.

The Project plans the purchase and construction of BACT to ensure compliance with all regulatory emission requirements concerning NOx, SOx and PM.

1.5.2.2 Pollution Control Devices

The Project intends to install pollution control devices for Unit 5 with the following specifications and shall meet the DENR emission standards:

SOx	BACT
NOx	BACT
Particulate Matter	BACT

1.6 Project Size

Table 1-8 below summarizes the scope of the proposed Masinloc Expansion.

Table 1-8: Existing, Proposed Project and Resulting Total Capacity/Project Scope

Components	Existing	Modification/Addition	Final Project Scope
Rated Capacity	2 x 324 MW (Units 1 and 2)	No change	2 x 324 MW
	1 x 300 MW (Unit 3)	No change	1 x 300 MW
	1 x 300 MW (Unit 4: For Development)	Increase capacity to 315 MW	1 x 315 MW
		1 x 315 MW (Unit 5: For Expansion)	1x 315 MW
Project Area	138.5 ha	138.5 ha	138.5 ha
Annual Production	8,746 GWh/year (in operation)	105 GWh/year by 2024 2,207 GWh/year by 2025	8.851 GWh/year by 2024 11,059 GWh/year by 2025

1.7 Development Plan, Description of Project Phases and Corresponding Timeframes

The Proponent estimates that the Project will take approximately 54 months to: (i) secure governmental and regulatory approvals, (ii) site development, (iii) construction, and (iv) testing and commissioning. **Table 1-9** and **Table 1-10** show the project schedule for Unit 4 and Unit 5.

Table 1-9: Unit 4 Project Schedule

UNIT 4																				
Project Activity	2020				2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Permitting																				
Site Development																				
Construction																				
Testing and Commissioning																				
Commercial Operation																				

Table 1-10: Unit 5 Project Schedule

UNIT 5																				
Project Activity	2020				2021				2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Permitting																				
Site Development																				
Construction																				
Testing and Commissioning																				
Commercial Operation																				

1.8 Manpower

The following is a summary of the manpower requirements of the Project during various phases:

Construction Stage	
Manpower Requirements	Construction personnel – supervisory, skilled and labor
Expertise/Skills	Civil engineers, structural engineers, pipe fitters, electricians, carpenters and masons
Number of Jobs	≈200 per unit (total estimated)
Sourcing Scheme	Local and national sources, subject to qualifications
Operation Stage	
Manpower Requirements	Operations and Maintenance
Expertise/Skills	Plant and system-specific
Number of Jobs	≈Unit 4: 38 and Unit 5: 64 (estimated)
Sourcing Scheme	Local and national sources, subject to qualifications

Table 1-11 give the breakdown of the current Masinloc Plant employees based upon employment status, departments and residences. For the regular employees, ~52% are from Bani, Masinloc or the Province of Zambales.

For the construction of the expansion, an estimated 200 additional personnel will be employed by the selected EPC Contractor. Personnel will be sourced locally and nationally depending upon skills required. If a conservative estimate of 20% of manpower needs is sourced locally, this will provide 40 local residents employment for 3 to 4 years due to the phased approach of the expansion.

For the expansion operations and maintenance, an estimated 38 regular employees for Unit 4 and 64 regular employees for Unit 5 are contemplated. Sourcing will also be from local and national resources. Depending upon skills and base knowledge available, as high as ~50% or 60 personnel could be employed from local resources.

Table 1-11: Regular Employees

DEPARTMENT	BANI	MASINLOC	ZAMBALES	NON - ZAMBALES	Grand Total
Plant Managers Office				1	1
Operations				1	1
Unit 1	1	3	3	15	22
Unit 2		3	5	13	21
Unit 3	3	1	9	11	24
Water Treatment	4	3	2	6	15
Materials Handling			1		1
Ash Handling	5	9	7	5	26
Coal Handling	17	11	1	5	34
Maintenance				1	1
Electrical Maint.	1	4	8	10	23
I & C / IT Maint		1	2	17	20
Mechanical Maint.	9	4	3	21	37
ESH		1		4	5
HR / Admin / CSR	1	1	2	2	6
Procurement	3		1	3	7
Technicial Services Department	1	4	3	11	19
Total	**45**	**45**	**47**	**126**	**263**
%	**17%**	**17%**	**18%**	**48%**	**100%**

1.9 Indicative Project Cost

The estimated cost of the Project of Unit 4 and Unit 5 are Php30 billion and Php 43 billion, respectively.

2 ANALYSIS OF KEY ENVIRONMENTAL IMPACTS

2.1 The Land

2.1.1 Land Use and Classification

2.1.1.1 Impact in terms of Compatibility with Existing Land Use

AWSRC agreed to lease the area to MPPCL (**Annex A**). Within and near the vicinity of MPPCL, 5 land uses were identified which include Built-up areas/ Open areas, Grasslands, and Man-made forests/ trees (**Figure 2-1**). The Built-up areas cover the Masinloc Plant including the coal yard, and the work area plus the camp site north of the existing ASF. The Trees are mainly mango orchards or plantations plus other fruit-bearing and non-fruit-bearing trees. The area near the coast line (west and southwest coastline) are mixed with coconut, bani, talisay, kamachile and agoho, while the area towards the inland (north of the ASF) are mixed with fruit bearing trees like cashew, santol, tamarind, guava, jackfruit, duhat, banana and macopa.

2.1.1.2 Impact on Compatibility with Classification as an Environmentally Critical Area

The Proposed expansion for Unit 5 will be constructed within the established property of the Masinloc Plant, which is classified as an industrial zone. There will be no encroachments in Environmental Critical Areas (ECAs) and no CARP related issues. However, the construction of Unit 5 shall entail the clearing of the man-made forests/ trees.

2.1.1.3 Impact in Existing Land Tenure Issue/s

There will be no land tenure issues since the Project will be constructed within the established property of the Masinloc Plant.

2.1.1.4 Impairment of Visual Aesthetics

Visual aesthetics will not be impaired since there are already units operating on the Property of the Masinloc Plant.

2.1.1.5 Devaluation of Land Value due to Improper solid waste management and others

There will be no devaluation of land value since the Plant has an existing waste management system being implemented.

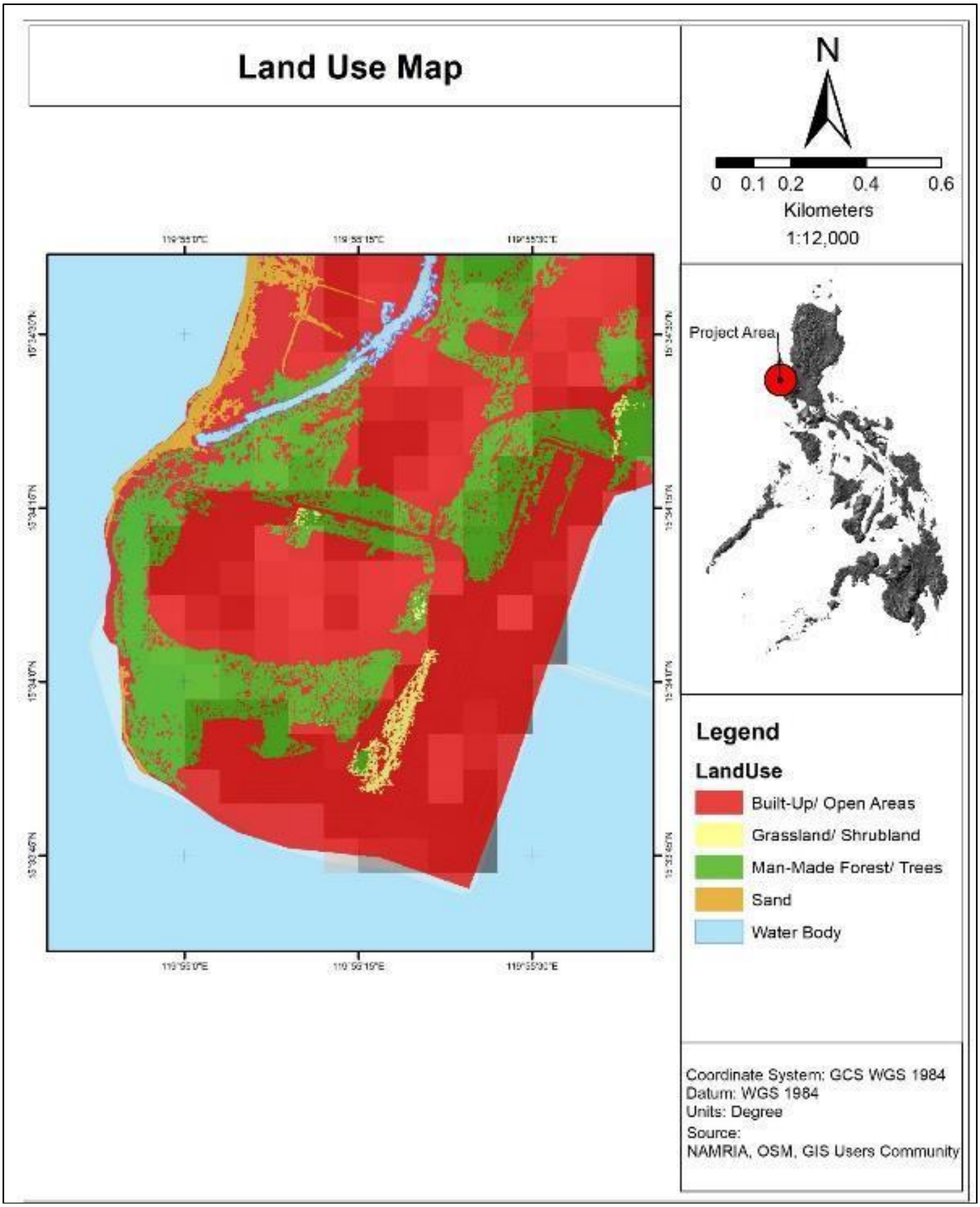


Figure 2-1: Present Land Use Map

2.1.2 Geology/Geomorphology

2.1.2.1 Change in Surface Landform/Topography/Terrain/Slope

The Project will be done within the established property of the Proponent. This area has been previously developed/modified. Minimal grading and cut and fill will be required. The slope map is presented in Figure 2-2.

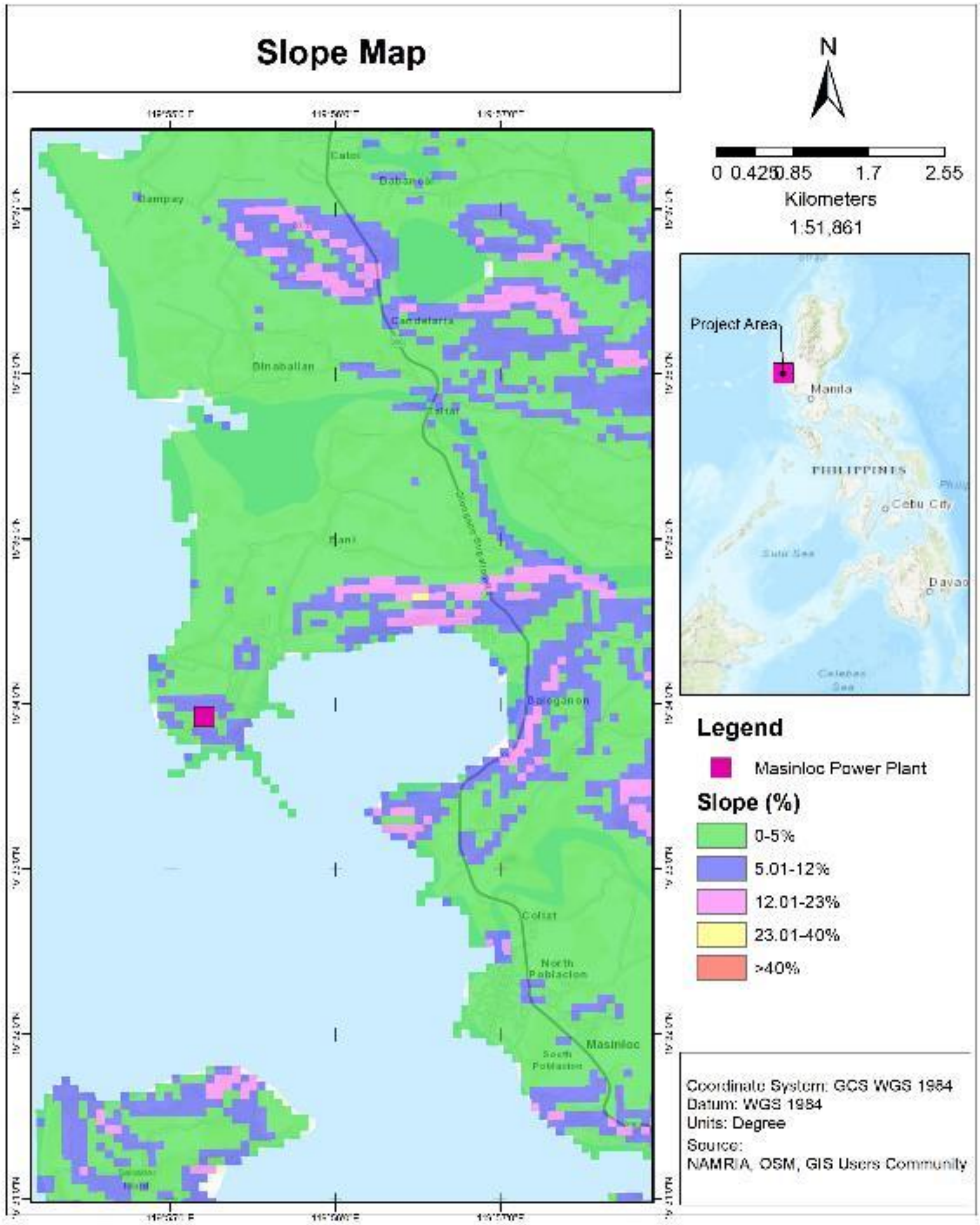


Figure 2-2. Slope Map

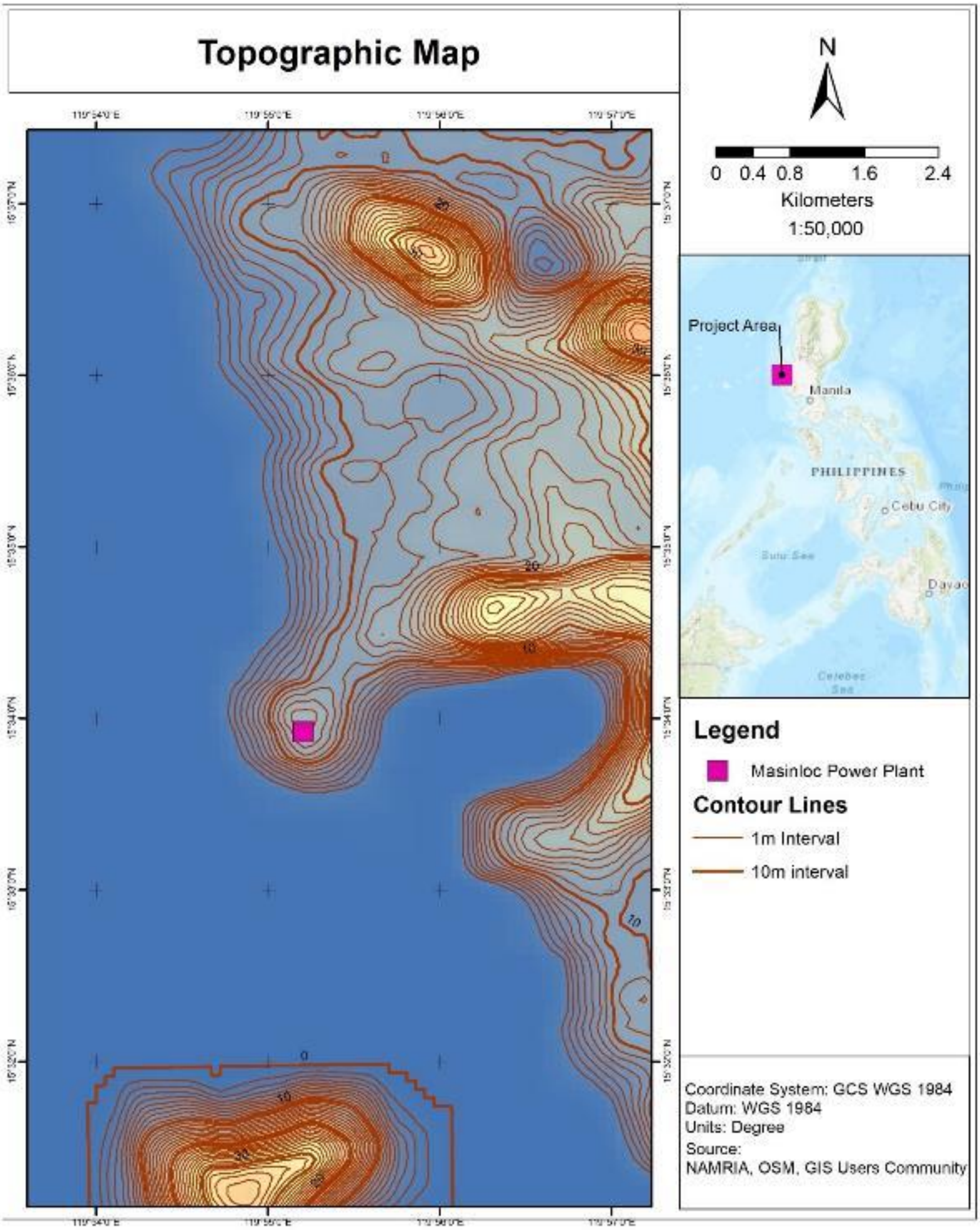


Figure 2-3. Topographic Map

2.1.2.1.1 Site Geology

The project area is underlain by Middle to Late Miocene Zambales Formation and include tuffaceous sandstone and shale (**Figure 2-4**), interbedded with conglomerate and limestone. The northern portion is mostly Quaternary Alluvium deposits along Lauis Riverwhich have deposits consisting of unconsolidated to semi-consolidated deposits of clay, silt, sand and occasional gravel.

2.1.2.1.2 Foundation and Seismicity

A geotechnical investigation was conducted by Mitsubishi Corporation in 1995. Three offshore drilled core samples from the cooling water intake and jetty revealed the existence of dense silt and silty sand underlying marine deposits (). These deposits have firm bearing stratum and showed an N value of 50 or more. In addition, 4 more borings were conducted on land at the boiler, stack, coal stock yard, and at the ASF for confirmation of the stability of the rock foundation. The bedrock was found to be of sandstone and siltstone formation showing an N value of greater than 50 which are judged to have sufficient bearing capacity.

The Masinloc Plant is protected from seismic disturbances that may be triggered by nearby earthquake generators proximal to the site that may adversely affect the existing structures due to ground deformation and vibration during major earthquakes by appropriate design measures. The design seismic coefficient for the Masinloc Plant is 0.2 g based on the calculation result of seismic acceleration on the bedrock.

A geotechnical investigation study was completed covering the area of the Expansion Project. This study will be used in conjunction with the geotechnical study of Mitsubishi Corporation conducted in 1995 for the design and construction of the Expansion Project.

2.1.2.2 Change in Sub-surface/Underground Geomorphology

Philippine active faults and trenches are shown in **Figure 2-5**. Iba fault is situated around 8 km from the plant while the Manila trench is approximately 85 km away from the Project site. Movements along tectonic boundaries (Trenches) and active faults are main sources of high-level seismicity, making the area prone to various types of seismic-related hazards.

Seismic activitiy from three (3) zones of earthquake generators were identified nearest the Project Area which include East Zambales Fault, Manila Trench, and Philippine Fault.

Figure 2-6shows the epicenter of the earthquakes with magnitude 6.0 and above, around the project area. **Table 2-1**shows the interval of earthquakes from three (3) zones of generators – Iba Fault and East Zambales Fault, Manila Trench and Philippine Fault. Estimates of the recurrence interval for earthquakes of a given range of surface magnitude (Ms) were calculated using the annual rates of earthquake activity values by Thenhaus. These earthquake generators are of Seismic Source Type A, as classified in the National Structural Code of the Philippines (NSCP).

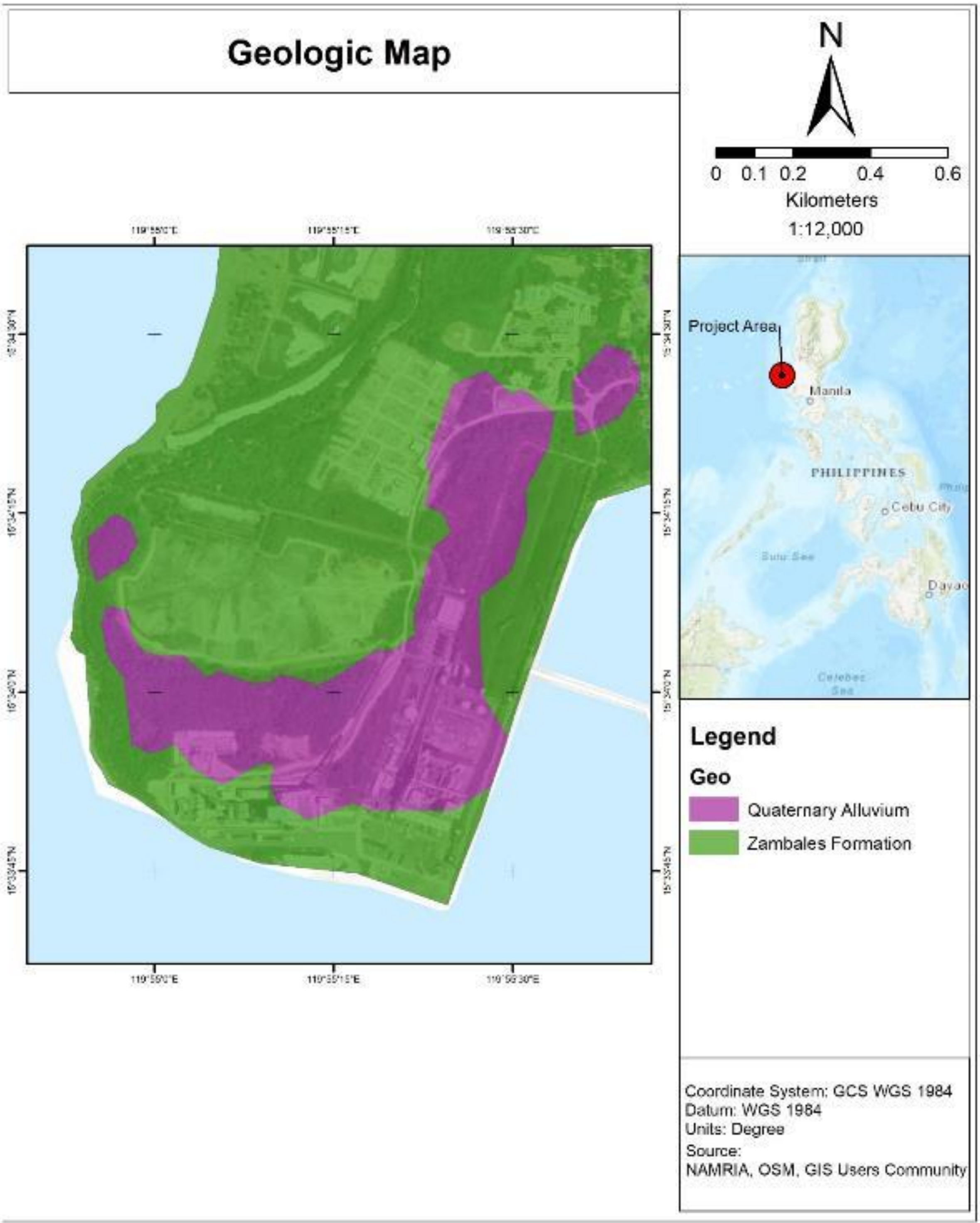


Figure 2-4: Geologic Map

Table 2-1: Yearly Interval of Seismic Activity

Zone	Ms = 5.2-5.8	Ms = 5.8-6.4	Ms = 6.4-7.0	Ms = 7.0-7.3	Ms = 7.3-8.2
East Zambales Fault	3	8	22	59	158
Manila Trench	4	12	35	101	293
Philippine Fault	4	12	32	85	227

Modified from Thenhaus (1994)

2.1.2.2.1 Peak Ground Acceleration

The passage of seismic waves during a seismic event causes strong ground motion. The intensity of the ground shaking is measured by horizontal acceleration and depends on the magnitude of the earthquake, distance of the site from the earthquake generator, and the soil condition.

Using the ground motion attenuation equation and correction factors from mean ratio computations by Fukushima and Tanaka (1990), and considering a surface wave magnitude of 7.0 and 7.8 from East Zambales Fault and Manila Trench, the estimated peak ground acceleration (PGA) at the Masinloc Plant is0.19g and 0.11g, respectively, in hard soil. The thickness and age of underlying sandstone is considered a hard soil. A correction factor from mean ratio computations also by Fukushima and Tanaka was applied in the computation. On the other hand, probabilistic estimate of the PGA by Thenhaus (1994) with 10% probability of exceedance in 50 years is about 0.22g for rocks.

The latest geotechnical report indicates that the project site is generally underlain by hard soil and/or soft rock that are consistent with the geology of the area. The estimated peak ground accelerations in the EPRMP remain the same - 0.19 g based on a seismic event from East Zambales Fault and a 0.22 g probabilistic estimate. The conservative value of 0.22 g may be adopted.

The acceleration is expressed in terms of the acceleration of gravity, *g* ($9.81 m/sec^2$).

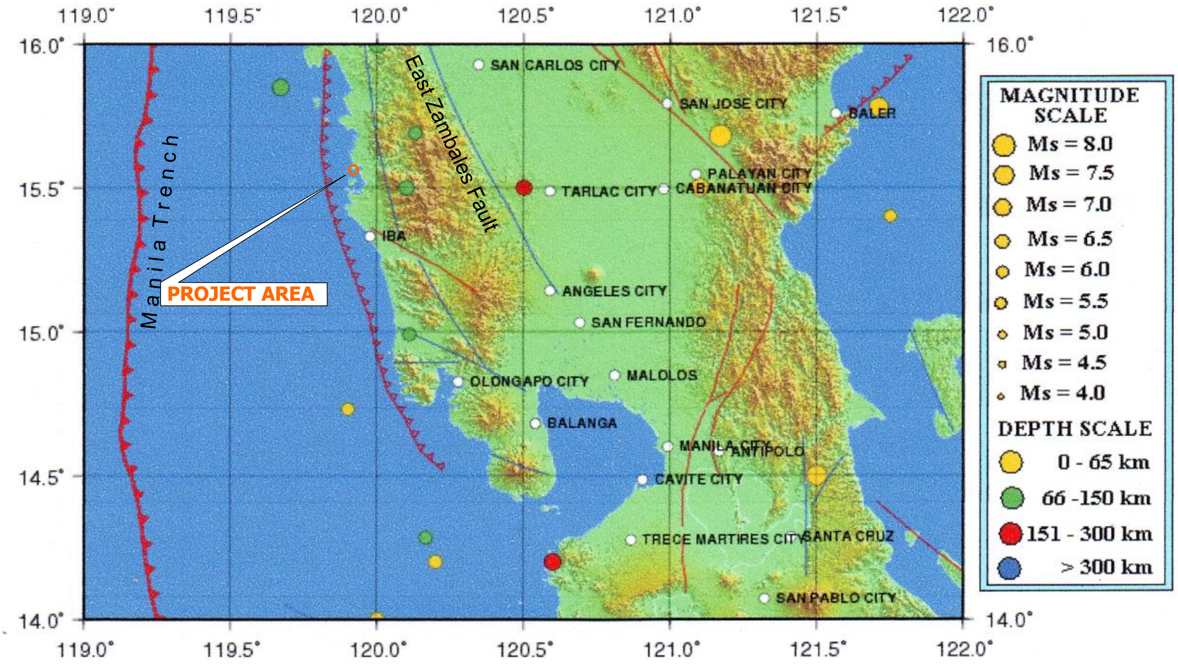
2.1.2.3 Inducement of Subsidence/Collapse

The foundation system of the Project will rest on the competent tuffaceous sandstone underlying the Masinloc Plant. The rock mass of the tuffaceous sandstone is a Bieniawski fair rock with safer bearing pressure of more than one(mega Pascal) MPa. No subsidence or any changes in subsurface morphology is expected due to the construction of the foundations.

No evidence of subsidence or collapse has been observed in the area, particularly at the main power plant. The project site is underlain by Class III rock mass with an intact rock strength of 10 to 50 MPa, making it a fairly competent rock. Thus, no liquefaction is expected within the project site. **Figure 2-7**is a liquefaction susceptibility map showing that the project site is not within a liquefaction area.

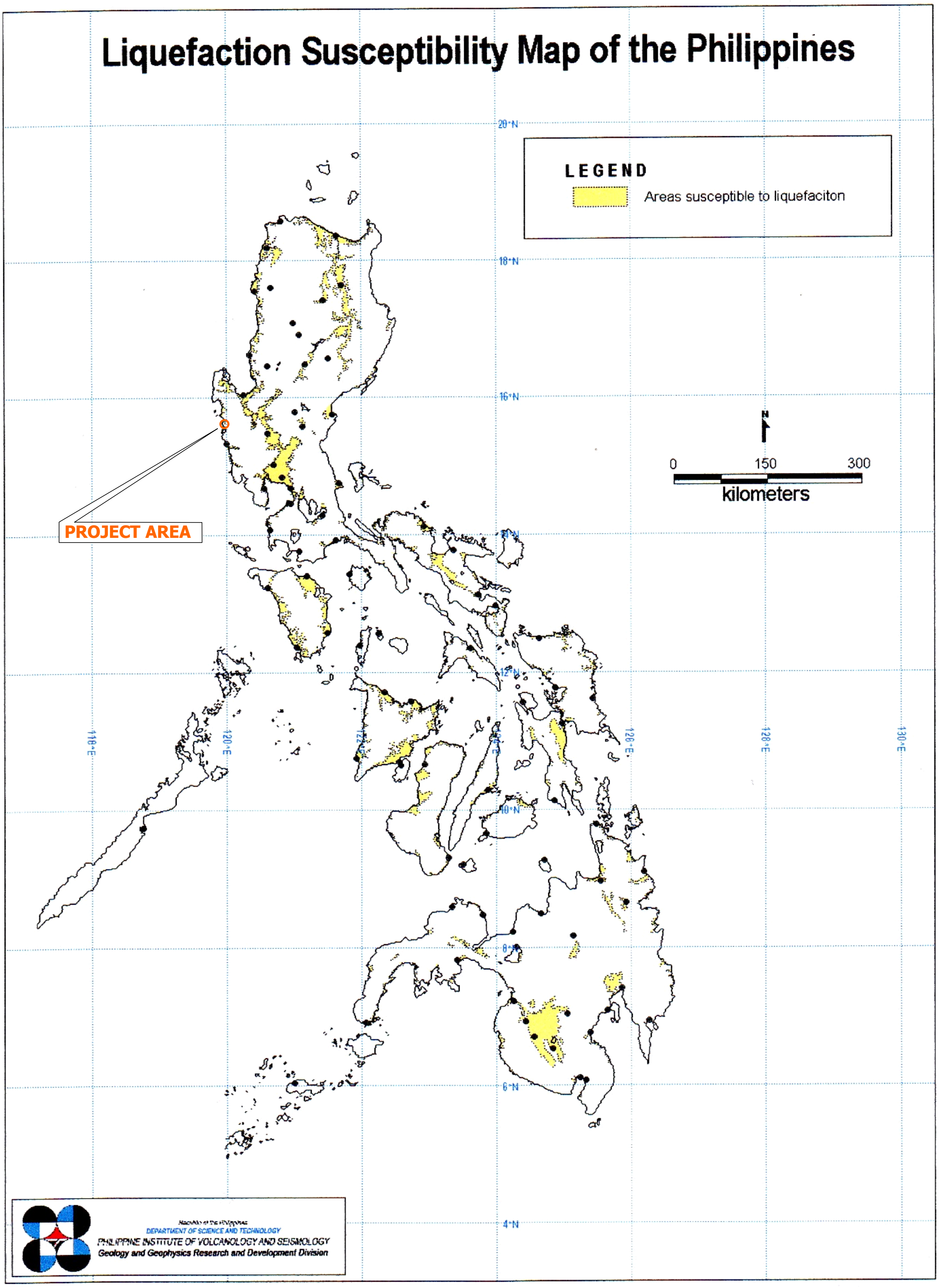
Source: Philippine Institute of Volcanology and Seismology (PHIVOLCS)

Figure 2-5: Active Faults and Trenches in the Philippines



Source: Philippine Institute of Volcanology and Seismology (PHIVOLCS)

Figure 2-6: Seismicity Map at Magnitude 6.0 and Above



source: PHIVOLCS

Figure 2-7: Liquefaction Susceptibility Map

2.1.2.4 Inducement of Landslides or Other Natural Hazards

The Project will involve minor cut-and-fill operation to attain the desired grade and finished elevation. The general terrain within and around the site will be maintained, including the direction of natural drainage flow. No mass-movement hazards like landslides or subsidence are expected in the surrounding terrain.Moreover, the same rock properties give the area low susceptibility to earthquake-induced and rain-induced landslides, as shown in **Figure 2-8** and **Figure 2-9**, respectively.

2.1.2.4.1 Ground Rupture

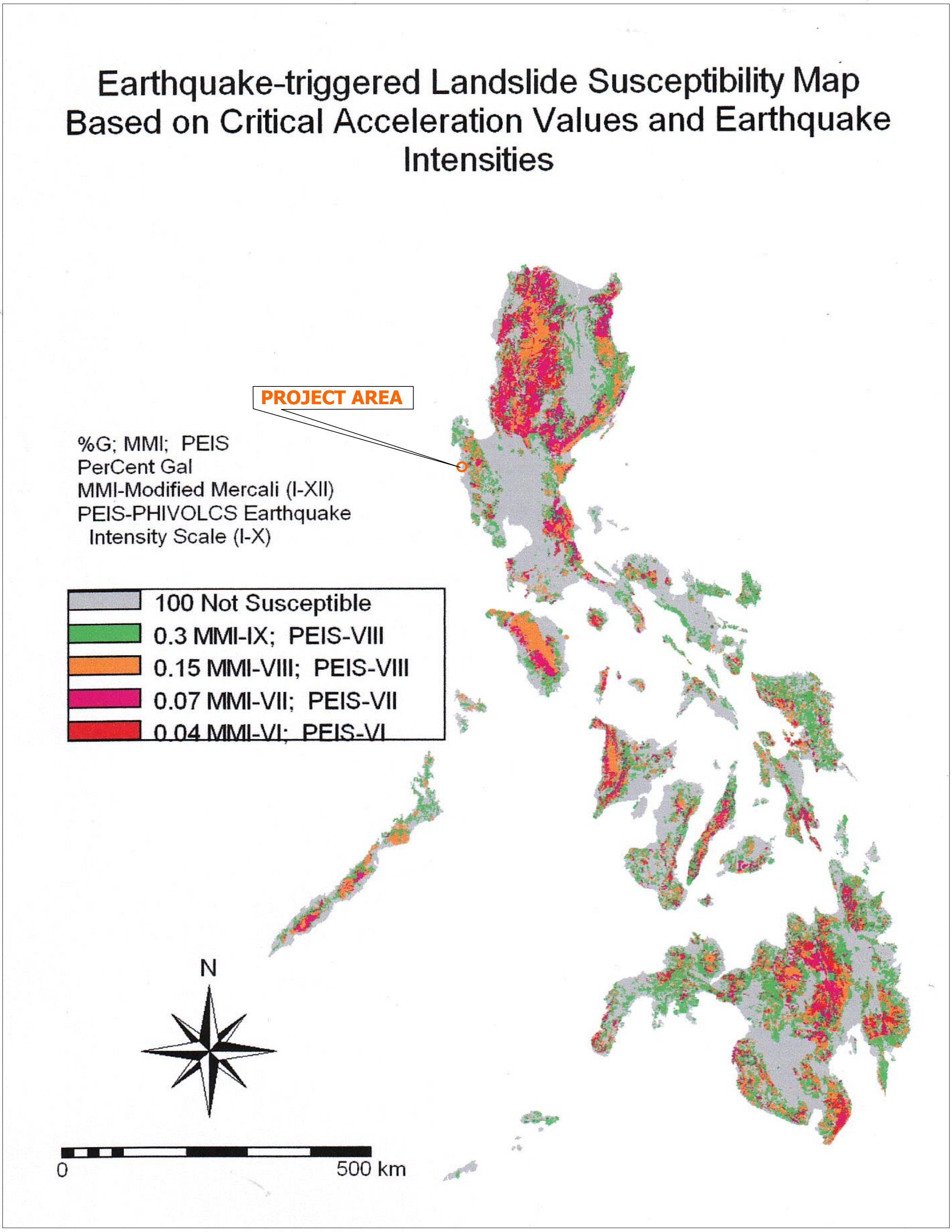
Surface and subsurface investigation indicate that no fault or major fractures are discernible at the site of the Project. Therefore, no ground rupture is expected.

2.1.2.4.2 Volcanic Hazard

Most of the hazards associated with volcanic eruptions, with the exception of ashfall, are localized and usually confined within the immediate vicinity of the volcano.

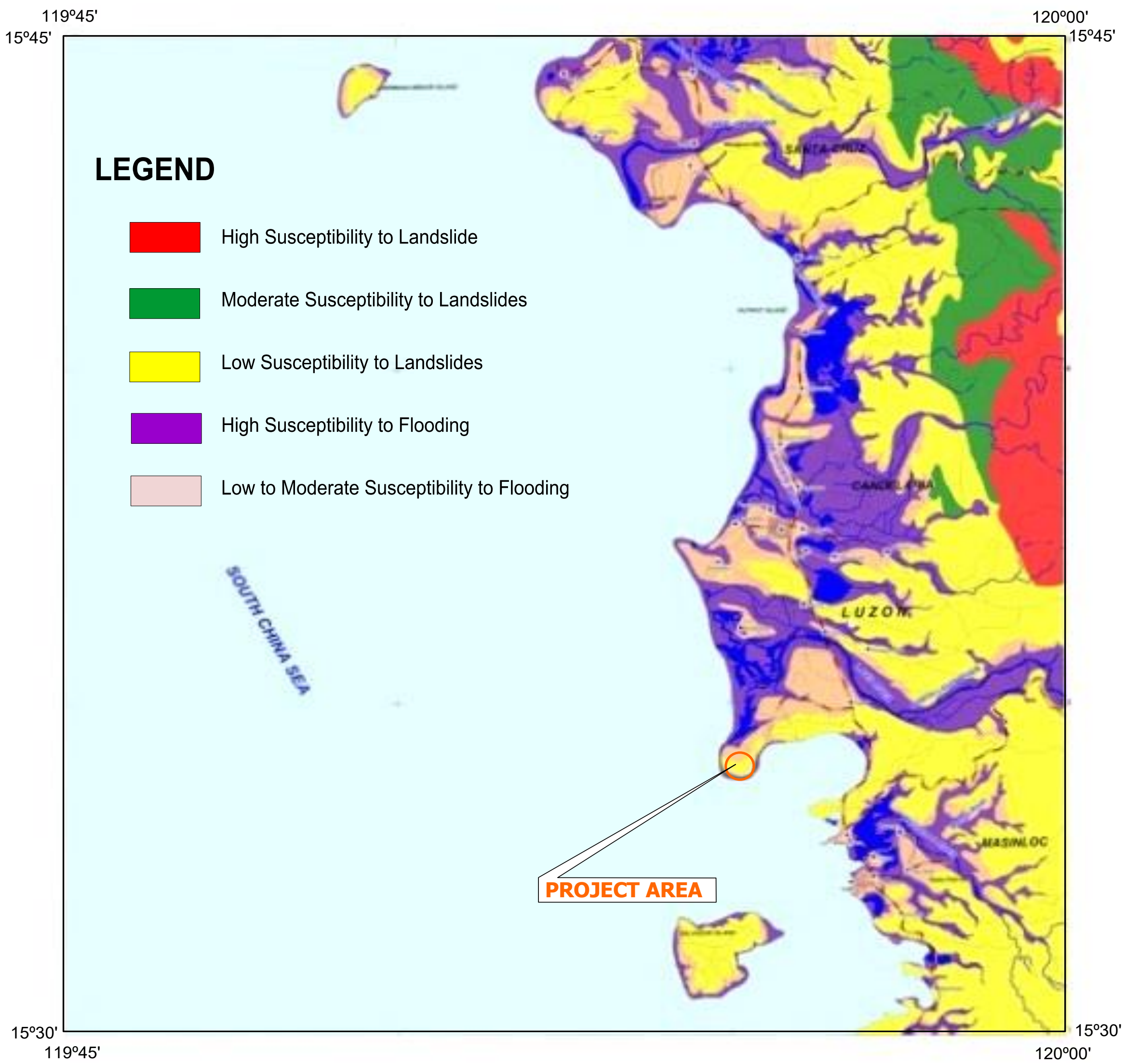
Mount Pinatubo about 66 km southeast of the project site is the nearest active volcano and has 3 historical eruptions. During its latest eruption in June 1991, mudflows (lahar) flowed out in all its radial drainage lines. The nearest that the mudflow could get to the project is 35 km at Bucao River in Botolan, Zambales. See **Figure 2-10**. Ashfall at the project site was estimated at less than 1 cm.

The only volcanic hazard to the project site is ashfall from Mount Pinatubo, if it erupts again. Assuming that the eruption is the same as in 1991, less than a centimeter of ashfall will be expected.



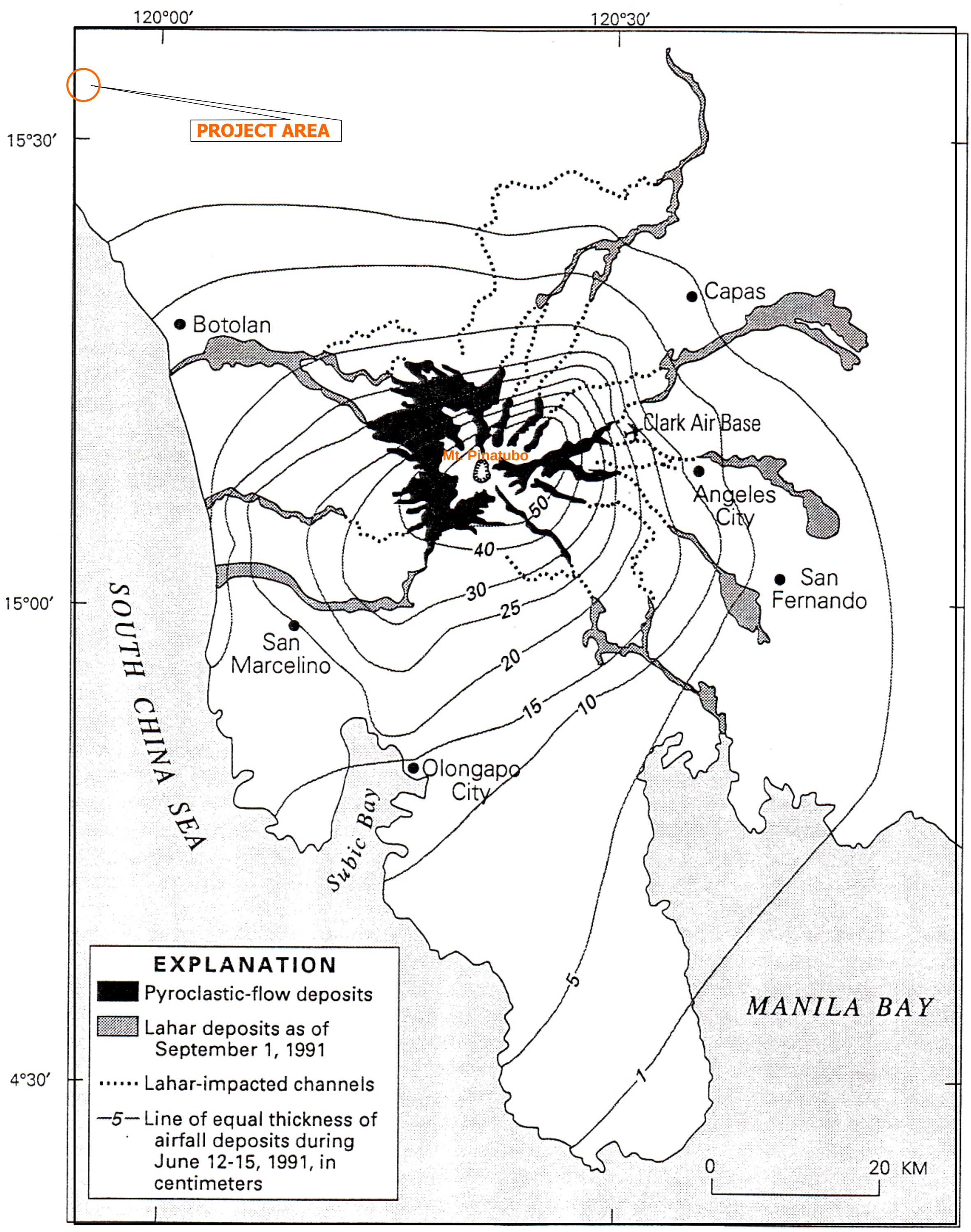
source: PHIVOLCS

Figure 2-8: Earthquake-Induced Landslide Hazard Map



source: MGB

Figure 2-9: Rain-Induced Landslide Hazard Map



source: Pierson (1992)

Figure 2-10: Pinatubo Hazard Map

2.1.2.4.3 Tsunami

The Project is exposed to the open sea and susceptible to tsunami should a favorable seismic event occurs along the Manila Trench. Probable vertical and horizontal run-up is 1 m and 10 m, respectively. However, the ground elevation is at least two meters above sea level and San Salvador Island sits at the mouth of Oyon Bay, both reducing an impact from a tsunami.

The project site has a high potential for tsunami hazard considering that it faces the Manila Trench about 70km out into South China Sea. Studies by PHIVOLCS indicate that the tsunami wave height may reach about 9.80 m, near the project site. The project site will be inundated as it stands at least 2 m above sea level. The lowlands north of the project site will likewise be inundated. See**Figure 2-11**.

Emergency Response Procedures for Tsunami (part of MPPCL's ERCP and Integrated Management System) is appended as **Annex I**.

.

2.1.2.4.4 Hydrologic and Coastal Hazard

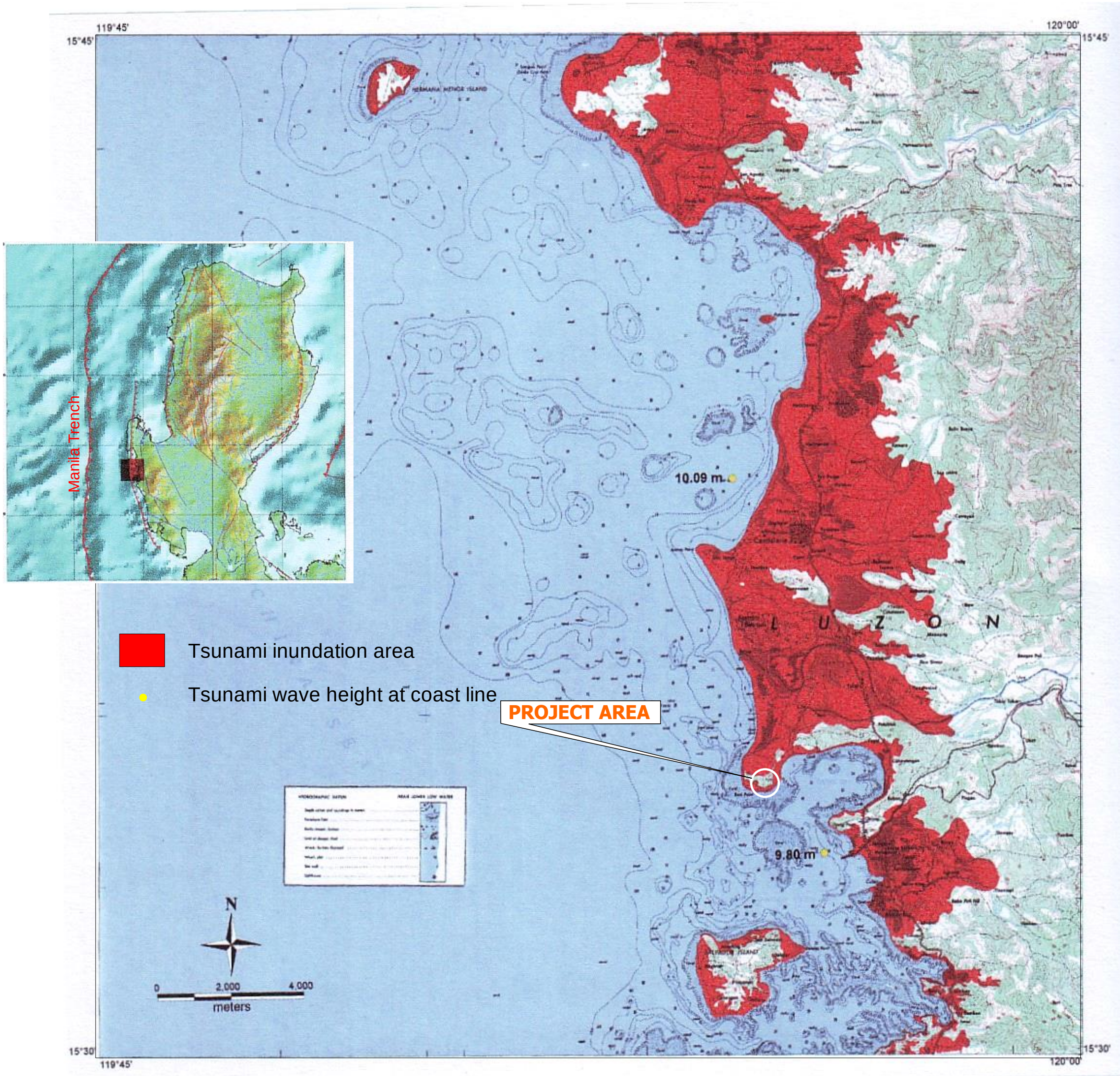
Although the Project is along the coast, the site elevation stands at least two meters above sea level and may be exposed to a storm surge. Sea level will rise due to decreased atmospheric pressure as the storm approaches land; winds pile up the water to raise the sea level even higher, whereby the sea sweeps inland. For every one millibar drop in atmospheric pressure, the sea level will rise by one centimeter.

The project site will be exposed to a storm surge when a typhoon approaches. Sea level will rise due to decreased atmospheric pressure as the storm approaches land; winds pile up the water to raise the sea level even higher, whereby the sea sweeps inland. For every 1 millibar drop in atmospheric pressure, the sea level will rise by 1 cm. The amplitude of the storm surge is also dependent on many variables such as wind velocity, angle of entry to the coastline and the shape of coastline.

Studies show that storm surge reaches as high as 2.50 m in Bataan, as in the case of Typhoon Bebeng in 1983 (Mendoza, 2006). However, since typhoons' tracks generally come from the east, the maximum height occurs at the eastern coast of Bataan Peninsula, not at the western side as in the case of the west-facing project site in Zambales. Nevertheless, an extreme scenario of 2.50 m may be adopted at the project site.

This hazard is exacerbated when the event coincides with the high tide. Based on the predicted tides at Subic Bay, the maximum high tide during the 2011 wet season is 1.28 m above mean lower low water (MLLW). Thus, if a typhoon will directly cross the project site, the maximum sea level is estimated at 3.78 m.

There is no flooding hazard due to overflow, sheetflow or tidal-related. The expansion project is situated at an elevation of about 2 m, and not near a natural drainage line. Increase in sea level due to storm surge and tidal influence is estimated at 3.78 m, and not detrimental to the seawater intake pump and outfall. The pump design is and should be designed based on low tide level. On the contrary, rise in water level reduces the pump lift and improves pump efficiency. **Annex I** outlines MPPCL's Emergency Response and Contingency Plan (ERCP) in the event of natural hazards (including tsunami and storm surge).



source: PHIVOLCS

Figure 2-11: Tsunami Hazard Map

2.1.3 Pedology

Three distinct soil groups are represented in Zambales Province. These are as follows: 1) hydrosol, 2) plains consist of sand, sandy loam, clay to clay loam, and 3) mountain soils characterized by clay to sandy clay with pebble inclusions.

The Masinloc Plant is covered with hydrosol in the western and eastern sections of Bani Point. These were onceutilized as fish ponds prior to the establishment of the Masinloc Plant. The most predominant soil type is sandy loam. The existing hills are covered with Bani clay.

2.1.3.1 Soil Erosion/ Loss of Topsoil/ Overburden

Generally, the Project site is flat and erosion will not be critical since construction will be done within the level premises inside the property of the Masinloc Plant. Minimal erosion may occur during the excavation activities during the construction phase and considered only temporary.

During Masinloc Plant operation, erosion is being prevented by soil/slope stabilization and landscaping, revetments and similar embankments. These are being maintained as well as the green buffer areas established around the Masinloc Plant. Revegetation was done in the property to provide added protection for the ASF.

2.1.3.2 Change in Soil Quality/Fertility

2.1.3.2.1 Soils of the Project Area

Two soil types were identified and characterized in the Masinloc Plant, the Bani and the Quingua silt loam (**Figure 2-12**). Bani clay developed from weathering of sedimentary rocks particularly shale with sandstone and occasionally with limestone, while Quingua silt loam developed from weathering of alluvium.

Quingua silt loam is a moderately well drained, deep silt loam soil (**Table 2-2**). Soil reaction is neutral with pH 6.6. Nitrogen and phosphorus are both very low with 0.08% and 3.78ppm, respectively. Potassium is low with 103ppm. All the heavy metals are below the contamination levels of the Dutch Standards Intervention Values. Natural fertility of this soil is low.

Bani clay is well drained, deep clay soil. Soil reaction is slightly acidic with pH 6.3. Phosphorus and potassium are both low with 5.45 and 149ppm, respectively. Nitrogen is very low with 0.05%. All the heavy metals are below the contamination level of the Dutch Standards Intervention Values. The natural fertility of this soil is low.

Table 2-2: Soil Physico-chemical Properties of the Project Area

Soil Properties	Quingua Silt Loam	Bani Clay
Physical Properties		
Drainage*	Moderately well drained	Well-drained
Texture*	silt loam	Clay
Soil Depth (cm)*	120	150
Chemical Properties		
pH*	6.6	6.3
Nitrogen (%)**	0.08	0.05
Phosphorus (mg/kg)**	3.78	5.45
Potassium (ppm)**	103	149
Heavy Metals (ppm)**		
Arsenic	1.59	1.16
Barium	96	55
Cadmium	ND	ND

Soil Properties	Quingua Silt Loam	Bani Clay
Chromium	310	330
Copper	56.90	31
Lead	7.89	10.20
Mercury	0.108	0.087
Zinc	158	142

ND = not detected

Dutch Standards Intervention Values (mg/kg soil):

Arsenic	=55	Copper	= 190
Barium	= 625	Lead	= 530
Cadmium	= 12	Mercury	= 10
Chromium	= 380	Zinc	= 720

Sources:
*Soil Survey Report of Zambales Province
**Masinloc Plant EIS Report, 1994

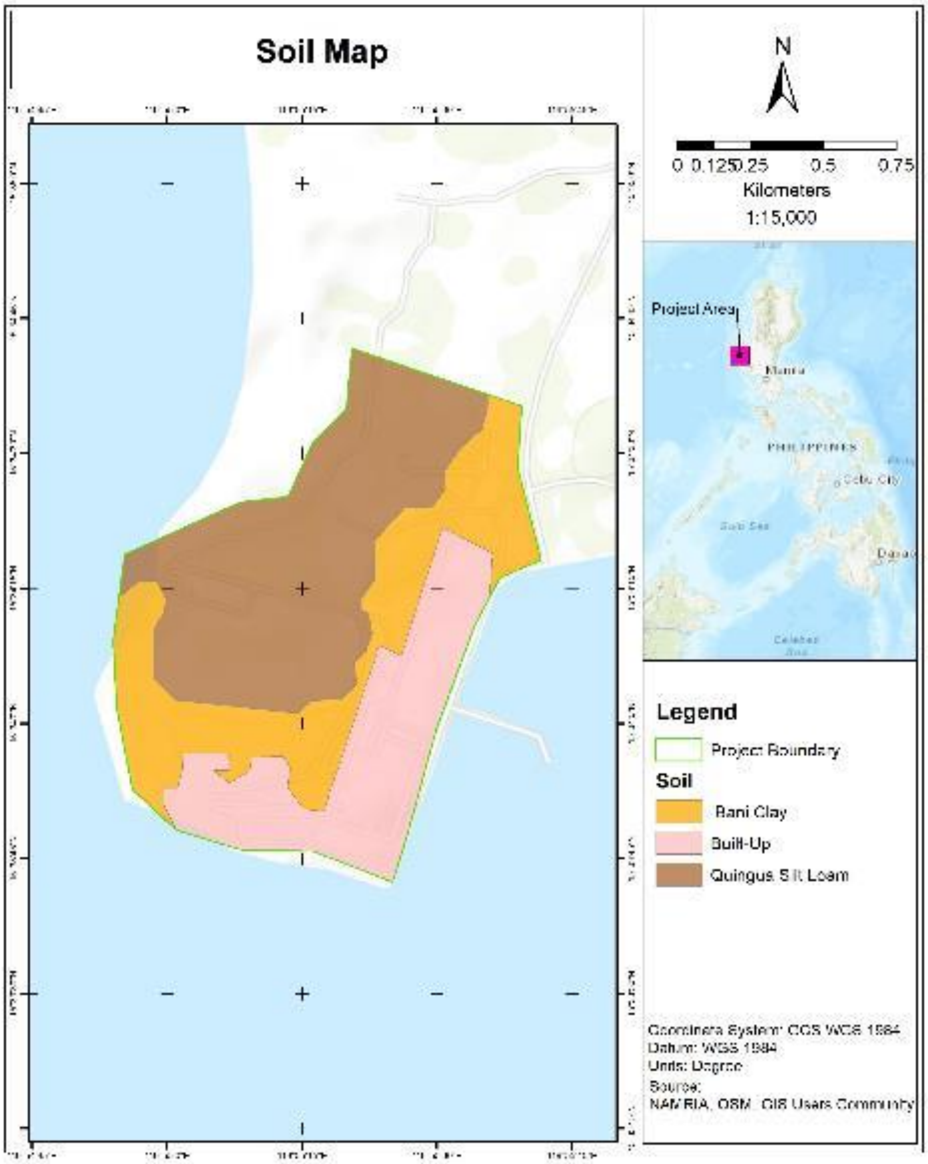


Figure 2-12: Soil Map

2.1.4 Terrestrial Ecology

2.1.4.1 Vegetation Removal and Habitat Loss

Checklist of species from secondary data was used to compare the seasonal variation flora and fauna species within the area using abundance values, diversity indices, importance values, geographic distribution and conservation status.

Survey briefing to guides and laborers was first conducted prior to the conduct of the activity. Then, the previously established permanent plots and transect line for Terrestrial Flora and fauna, respectively, were used. The transect line had 3 trap locations for terrestrial, basically positioned near the Terrestrial Flora permanent plot (**Table 2-3**). The geographical coordinates for terrestrial flora and fauna are shown in **Figure 2-13** and **Figure 2-14** overlain in Google Map.

Table 2-3: Geographical Coordinates of Sampling Stations for the Terrestrial Flora and Fauna Monitoring.

Module	Sampling Plots	Coordinates		Description
		N	E	
Flora	TFL 1	15°34'00.50"	119°55'15.20"	Secondary Growth Forest
	TFL 2	15°34'01.10"	119°55'05.70"	Plantation Area
	TFL 3	15°34'00.60"	119°54'58.50"	Plantation Area
	TFL 4	15°34'04.80"	119°54'54.80"	Plantation Area
	TFL 5	15°34'17.60"	119°55'01.60"	Plantation Area
Fauna	TFN 1	15°34'00.46"	119°55'15.05"	Secondary Growth Forest
	TFN 2	15°34'01.10"	119°54'58.97"	Plantation Area
	TFN 3	15°34'17.20"	119°55'00.47"	Plantation Area
	Transect Line Start	15°33'53.09"	119°55'12.73"	Secondary Growth Forest
	Transect Line End	15°34'17.09"	119°55'02.36"	Plantation Area

Figure 2-13: Location of Terrestrial Flora Permanent Monitoring Plots.

Figure 2-14: Location of Terrestrial Fauna Transect Line and Monitoring Stations.

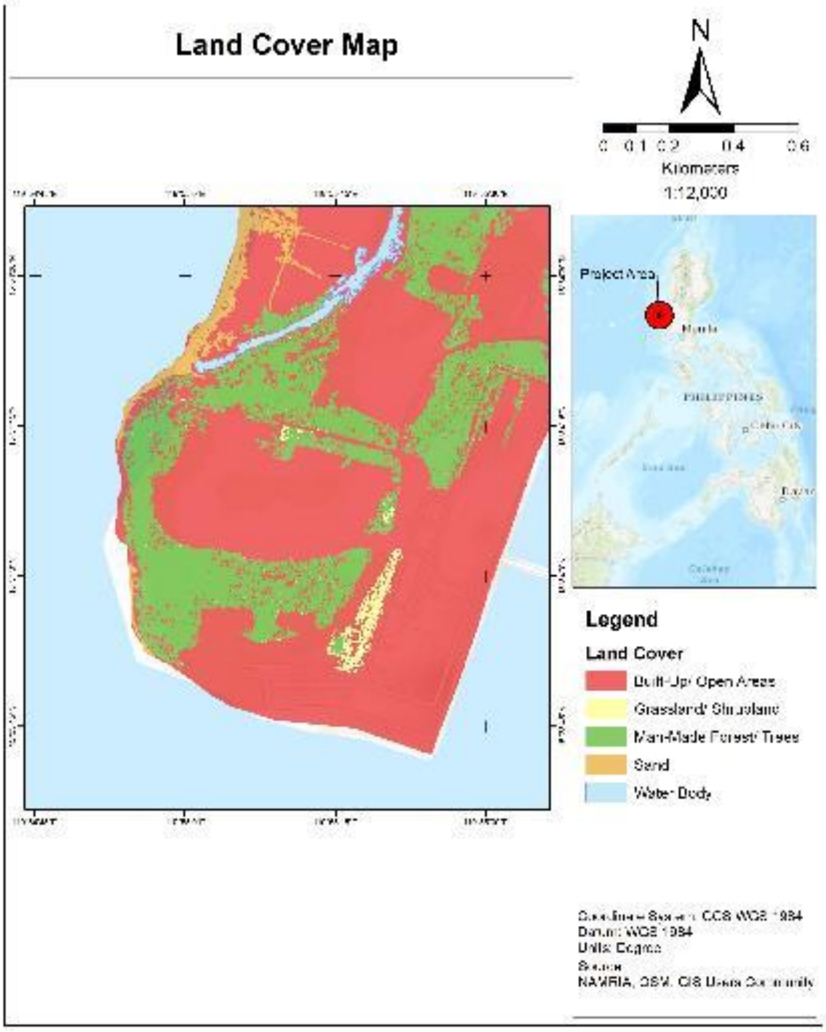


Figure 2-15: Land Cover Map

2.1.4.1.1 Methodology

Terrestrial Flora

The five plots for Terrestrial Flora were located through established markers such as PVC pipes and paint markings. The method used for the monitoring event is the nested quadrat sampling technique, which requires the use of main plots and subplots. Main plots have dimension of 10 m x 10 m to monitor the climax species (DBH > 10 cm). Inside the main plots, sub-plots were randomly established with dimensions of 3m x 3m for the intermediate layer (5cm > DBH < 10 cm), and 1 m x 1 m for the understory layer (DBH < 5cm).

Transect Survey was also conducted, listing species inside and outside the permanent plots. This will be further used in the determination of Species Richness, over-all diversity value, and updating of the checklist of species. **Figure 2-16** shows views and photographs taken for each permanent plot.

Terrestrial Fauna

The fauna survey was focused on four terrestrial vertebrate groups of wildlife; birds, mammals, and herps (amphibians and reptiles). Standard field methods and procedures were used for each taxon during the monitoring survey.

Three monitoring stations were located for the terrestrial fauna and traps such as mist-nets and cage traps were established along the transect line. Day-sampling was conducted for Birds and Mammals while opportunistic sampling at night was conducted for herpetofaunal (reptiles and amphibians) groups. For non-volant (flying) mammals, baited live traps were set randomly near the mist-nets during the afternoon, and then re-baited the following day, also in the afternoon. For amphibians and reptiles, opportunistic night sampling was conducted wherein all encountered herps were listed. Transect survey was conducted from 6:00 AM – 10:00 AM and 4:00 PM – 6:00 PM. Night sampling on the other hand was conducted from 6:00 PM to 7:00 PM. **Figure 2-17** shows the activities conducted for the terrestrial fauna monitoring.


a) TFL 1


b) TFL 2


c) TFL 3


d) TFL4


e) TFL 5

Figure 2-16: Plots assessed in the mobilization of flora and fauna teams in the Project Site.

a)  b) 

c) 

Figure 2-17: Fauna survey activities which include a) establishment of Mist Nets for Birds and Volant Mammals, b) Baiting of Cage Traps for Non-Volant Mammals, and c) Night Sampling for Herps.

Direct and indirect transect faunal identification were also done such as identification through tracks, signs and auditory cues. Microhabitat was also searched in the immediate vicinities of the transect line, 5 meters to the left and 5 meters to the right, to ascertain the presence of small and/or cryptic species of wildlife.

Birds

The transect line was readjusted based on the accessibility of the site to observe birds. Observations were taken once in the morning at 6:00-10:00AM, and once in the afternoon from 3:00-6:00 PM. Mist netting was employed kto confirm species occurrence and distribution, photo-documentation and identification of cryptic species of birds. For each of the identified site, nets were set in a series along the transect line. These nets were also used to catch volant mammals during the night. Nets were checked before noon and at 5:00 pm or an hour before dusk. Identification, nomenclature, classification and conservation status were determined based on Kennedy et al (2000), Rosell (2010) and Allen et al (2013).

Mammals

Mist netting of volant species and live trapping of rodents were the two main techniques employed in the survey of mammals. Mist nets were set in a series and positioned in strategic points near the sampling sites (e.g., flyways, across established trails, forest edges, openings and forest interior) away from human habitations. Net watching for insectivores was done from 6:00 to 8:00pm.

Live traps were baited with roasted coconut laced with peanut butter and were laid near the vicinity of the mist nets, far from human habitations and foot trails, under roots of trees, rocks and near mist nets. Traps were checked for any capture early in the morning of the next day.

Tracks and sign identification (e.g. droppings, wallowing areas, dens) and direct sighting techniques were used for terrestrial and arboreal (but non-volant) species.

Identification, nomenclature, classification and conservation status were determined based on Heaney et al (1998).

Reptiles and Amphibians (Herps)

The Visual Encounter Survey was used in the inventory of herps while doing the transect walks. Any amphibian or reptile seen were identified and recorded. Frogging was done for two hours within the MPPCL area from 6:00-8:00pm. Visual and auditory cues along microhabitats in the sampling sites were used to identify species of herps were then recorded.

Identification, nomenclature, classification and conservation status were determined based on Brown and Alcala (1978, 1980).

2.1.4.1.2 Parameters

Transect line within the MPPCL area was established to characterize the floral species within the vicinity of the Project area. The methodology used was the Nested-Quadrat method involving the establishment of 10 m x 10 m main plots for the climax species (>10cm dbh). Within the main plots were randomly placed sub-plots with dimensions of 3 m x 3 m and 1 m x 1 m for the intermediate (> 5 cm, < 10cm dbh) and understory layers (< 5cm dbh), respectively. Floral species within the plots were identified, counted and listed for diversity analysis. In addition, the Transect Walk (TW) method was conducted to cover for those species not found within the sampling plots. Floral species were only listed once for the determination of species richness and computation of diversity values.

The parameters used for the assessment include the relative values of Density, Frequency and Dominance, as well as the computed Importance Values. The importance values determine the ranks of the species within the sampled area and would identify which of them would be exerting the most influence to the ecosystem in terms of nutrient cycling, energy transfer, and micro-climatic effects.

The following parameters and their respective formulae are as follows:

a) Abundance (Abund) = Number of Individuals in a Species

b) Density (Dens) = Number of individuals in a species for a given area

c) Frequency (Freq) = $\frac{\text{Number of times a species occurred in all plots}}{\text{Total number of plots}}$

c) Dominance (Dom) = $\frac{\text{Basal Area in a species}}{\text{Total Basal Area}}$

d) Relative Abundance (RAbund) = $\frac{\text{ABUND}}{\text{Total ABUND}} \times 100$

e) Relative Density (RDens) = $\frac{\text{DENS}}{\text{Total DENS}} \times 100$

f) Relative Frequency (RFreq) = $\frac{\text{Freq}}{\text{Total Freq}} \times 100$

g) Relative Dominance (RDom) = $\frac{\text{Dom}}{\text{Total Dom}} \times 100$

h) Importance Value (IV) = $\frac{\Sigma \text{ of Relative Values}}{\text{\# of Relative Values Used}}$

For plant diversity, relative values of Density, Frequency and Dominance shall be used to compute the Importance value. For fauna diversity, Relative values of Abundance and Frequency shall be used to determine the Importance values.

Diversity and evenness indices were computed and include the following:

Shannon-Weiner Index (H'). It is a measure of the average degree of "uncertainty" in predicting to what species an individual chosen at random from a collection of *S* species and *N* individuals will belong (Magurran 1988).

$$H' = -\sum_{i=1}^{S} \left[(n_i / N) \ln (n_i / N) \right]$$

Pielou's Evenness Index (J') - expresses H' relative to the maximum value that H' can obtain when all of the species in the sample are perfectly even with one individual per species (Magurran 1988).

$$J' = \frac{H'}{\ln(S)}$$

Plant form or habit, ecological status, conservation status and economic uses were also assessed in the area. These were identified through the use of several technical references.

Indices for plant species diversity, dominance and evenness were classified into relative categories as shown in **Table 2-4**.

Table 2-4: Fernando Biodiversity Scale.

Relative Values	Shannon (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 & below	0.05-0.14

2.1.4.1.3 Terrestrial Flora Biodiversity

Overall, there were 94 individuals of flora species listed in the monitoring plots with 18 species and 14 families (**Table 2-5**). Based on the table, the least number of individuals are found in the intermediate layer while the highest number of individuals are seen with the canopy layer. In terms of species richness, the understorey obtained the highest number of species and the highest number of families. This indicates that although there are many individuals present in the canopy layer, there are less species in the canopy layer which will replace those trees in the canopy layer. This further shows that ecological succession may not be attained once the climax or canopy species are naturally or anthropologically felled. Species in the intermediate layers are the ones to replace those of the canopy layers, as such, enhancement planting should be done on-site.

Table 2-5: Summary of parameters obtained for terrestrial flora.

Parameters	Understory	Intermediate	Canopy	Overall
# of Individuals	27	9	58	94
Species Richness	10	6	9	18
# of Families	10	5	7	14

Shannon's Diversity Index	1.832	1.735	1.938	2.45
Pielou's Evenness Index	0.796	0.968	0.882	0.847

Accordingly, diversity values in the vegetative layers range from Very Low to Moderate, while Evenness index exhibit values ranging from High to Very High for each layer. Overall, diversity value is moderate at H' = 2.45 while evenness is Very High at J' = 0.847. Increasing the diversity values entail planting of diverse species which are indigenous, endemic and/or globally threatened. A checklist of the Flora species found in the monitored sites are shown in **Table 2-6**. The checklist can be used as basis for choosing the most appropriate planting materials for the site.

Table 2-6: Checklist of Flora Species

Family	Scientific Name	Common Name	Plant Form
Acanthaceae	*Strobilanthes reptans*	-	Herb
Anacardiaceae	*Buchanania arborescens*	Balinghasai	Tree
Anacardiaceae	*Buchanania microphylla*	Palinlin	Tree
Anacardiaceae	*Mangifera indica*	Mangga	Tree
Anacardiaceae	*Semecarpus cuneiformis*	Ligas	Tree
Annonaceae	*Annona squamosa*	Atis	Tree
Annonaceae	*Cananga odorata*	Ilang-ilang	Tree
Annonaceae	*Uvaria rufa*		Tree
Annonaceae	*Uvaria sp.*	-	Tree
Apocynaceae	*Anodendron sp.*	-	Vine
Apocynaceae	*Tabernaemontana pandacaqui*	Pandakaki	Shrub
Apocynaceae	*Telosma procumbens*	-	Shrub
Apocynaceae	*Tylophora sp.*	-	Vine
Araceae	*Tacca palmata*	-	Herb
Arecaceae	*Caryota rumphiana*	Takipan	Palm
Arecaceae	*Saribus rotundifolius*	Anahaw	Palm
Asteraceae	*Chromolaena odorata*	Hagonoy	Shrub
Asteraceae	*Mikania cordata*	Uoko	Shrub
Bignoniaceae	*Radermachera sp.*	-	Tree
Boraginaceae	*Ehretia microphylla*	Tsaang-gubat	Shrub
Byttneriaceae	*Commersonia bartramia*	Kakaag	Tree
Calophyllaceae	*Calophyllum sp. 1*	-	Tree
Calophyllaceae	*Calophyllum sp. 2*	-	Tree
Cannabaceae	*Celtis sp.*	-	Shrub
Cannabaceae	*Trema tomentosa*	Anaginong	Tree
Cannaceae	*Canna sp.*	-	Herb
Casuarinaceae	*Casuarina equisetifolia*	Agoho	Tree
Celastraceae	*Gymnosporia trilocularis*	-	Shrub
Clethraceae	*Clethra canescens* var. *novoguineensis* (Kaneh. & Hatus.) Sleum.	Apiit	Tree
Combretaceae	*Terminalia catappa*	Talisay	Tree

Family	Scientific Name	Common Name	Plant Form
Connaraceae	*Cnestis palala*	-	Vine
Convolvulaceae	*Distimake tuberosus*	Wood rose	Vine
Cyperaceae	*Scleria scrobiculata*	Sarat	Grass
Dilleniaceae	*Tetracera scandens*	Katmon baging	Vine
Dioscoreaceae	*Dioscorea flabellifolia*	-	Vine
Euphorbiaceae	*Claoxylon sp.*	-	Tree
Euphorbiaceae	*Macaranga grandifolia*	Takip-asin	shrub
Euphorbiaceae	*Macaranga tanarius*	Binunga	Tree
Euphorbiaceae	*Melanolepis multiglandulosa*	Alim	Tree
Fabaceae	*Acacia auriculiformis*	Auri	Tree
Fabaceae	*Acacia mangium*	Mangium	Tree
Fabaceae	*Enterolobium cyclocarpum*	Earpod	Tree
Fabaceae	*Leucaena leucocephala*	Ipil-ipil	Tree
Fabaceae	*Millettia pinnata*	Bani	Tree
Fabaceae	*Mucuna sp.*	-	Vine
Fabaceae	*Pterocarpus indicus*	Narra	Tree
Lamiaceae	*Gmelina arborea*	Gmelina	Tree
Loganiaceae	*Fagraea sp.*	-	Tree
Meliaceae	*Swietenia mahogani*	Large leafed Mahogany	Tree
Moraceae	*Artocarpus blancoi*	Antipolo	Tree
Moraceae	*Ficus pseudopalma*	Niog-niogan	Tree
Moraceae	*Ficus ulmifolia*	Is-is	Tree
Moraceae	*Streblus asper*	Kalios	Tree
Myrtaceae	*Syzygium cumini*	Duhat	Tree
Myrtaceae	*Syzygium sp.*	-	Tree
Myrtceae	*Eucalyptus deglupta*	Bagras	Tree
Orchidaceae	*Geodorum sp.*	-	Orchid
Orchidaceae	*Habenaria sp.*	-	Orchid
Passifloraceae	*Passiflora foetida*	Pasyonaryang mabaho	vine
Phyllanthaceae	*Bridelia sp. 1*	-	Shrub
Phyllanthaceae	*Bridelia sp.2*	-	Shrub
Phyllanthaceae	*Glochidion sp.*	-	Shrub
Piperaceae	*Piper sp. 1*	Piper	Vine
Piperaceae	*Piper sp. 2*	Piper	Vine
Piperaceae	*Piper sp. 3*	Piper	Vine
Pittosporaceae	*Pittosporum pentandrum*	Mamalis	Tree
Poaceae	*Dendrocalamus merrillianus*	Bayog	Bamboo
Poaceae	*Phragmites sp.*	-	Grass
Rubiaceae	*Hypobathrum sp.*	-	Shrub
Rubiaceae	*Ixora luzoniensis*	-	Shrub

Family	Scientific Name	Common Name	Plant Form
Rubiaceae	*Mitragyna diversifolia*	Mambog	Tree
Rubiaceae	*Morinda citrifolia*	Bangkoro	shrub
Rubiaceae	*Mussaenda sp.*	-	Tree
Rutaceae	*Micromelum compressum*	Tolibas-tilos	Tree
Rutaceae	*Murraya paniculata*	Kamuning	Shrub
Salicaceae	*Flacourtia sp.*	-	Tree
Sapindaceae	*Allophyllus sp.*	-	Tree
Sapindaceae	*Guioa sp.*	-	Tree
Sapotaceae	Caimito / Star Apple	*Chrysophyllum cainito*	Tree
Smilacaceae	*Smilax sp. 1*	-	Vine
Smilacaceae	*Smilax sp. 2*	-	Vine
Sterculiaceae	*Sterculia foetida*	Kalumpang	Tree
Taccaceae	*Tacca leontopetaloides*	Tacca	Herb
Verbenaceae	Lantana camara	Coronitas	Shrub
Vitaceae	*Ampelocissus sp.*	-	Vine
Vitaceae	*Leea guineensis*	Mali-mali	Tree
Zingiberaceae	*Globba marantina*	-	Herb

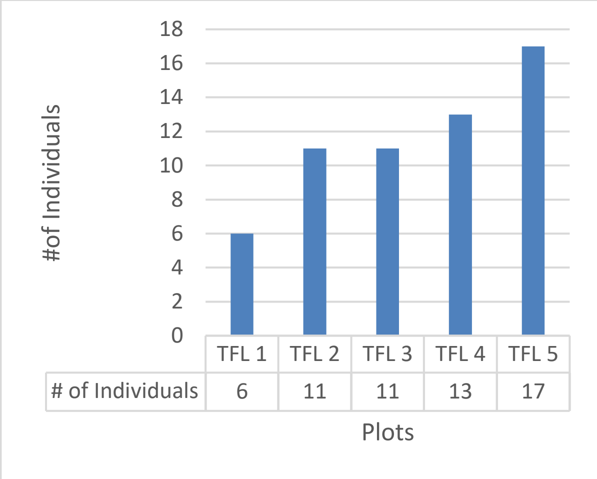
2.1.4.1.4 Canopy

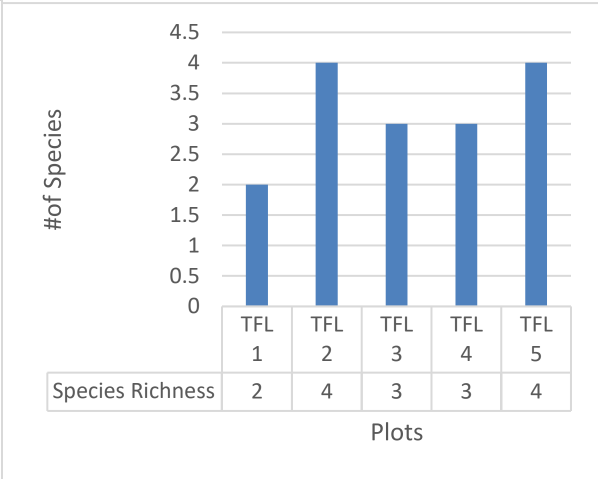
As seen in **Figure 2-18**, the different parameters for diversity in the canopy layer is presented which include: Abundance, Species Richness, Diversity Indices, and Evenness Indices.

The Abundance is highest in TFL 5 with 17 individuals (**Figure 2-18a**) still mostly composed of Gmelina (*Gmelina arborea*), Ipil ipil (*Leucaena leucocephala*), and Binunga (*Macaranga tanarius)*. Only 1 Gmelina was recorded for mortality in the canopy layer of TFL 5. It is then followed by TFL 4 with 13 individuals present, dominated by Gmelina (*G. arborea*), Auri (*Acacia auriculiformis*) and Mahogany (*Swietenia macrophylla*). TFL 2 and TFL 3 are both ranked 3rd with 11 individuals each, while TFL 1 exhibited the least number of individuals with 6. Two Mahogany Trees were recorded for mortality in TFL 1.

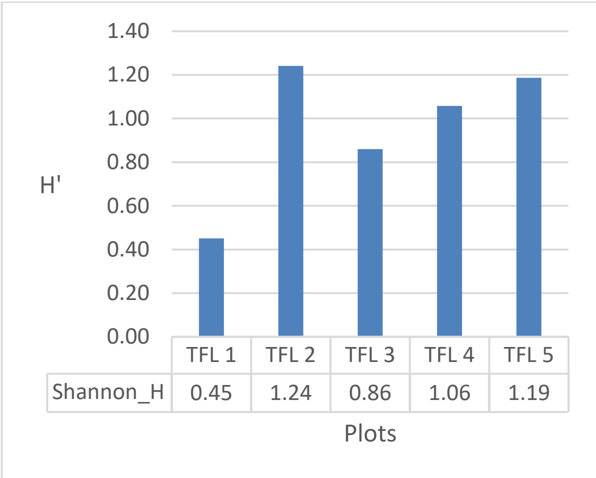
For species richness (**Figure 2-18b**), on the other hand, the highest number of species can be observed in both TFL 2 and TFL 5, both still having 4 tree species each. Plots TFL 3 and TFL 4 both had 3 tree species each, while TFL 1 had only 2 species. Less species indicates less diverse fauna within the area. Having less species interaction will hamper ecological processes such as nutrient cycling, energy transfers, pollination and food web among others will be restricted.

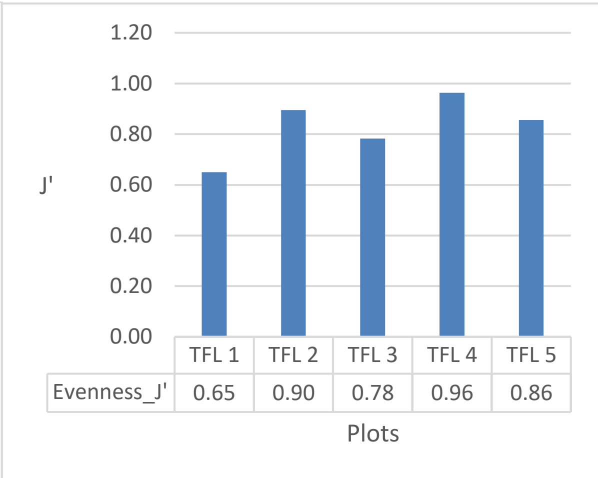
Given the limited number of individuals and the decreasing trend of species and individuals in the canopy layer, all plots also generally exhibited Very Low diversity values. Diversity is highest in TFL 2 with Very Low diversity at H'=1.24. It is then followed by TFL 5 with Very Low diversity index of H' = 1.19. The plot with the least diversity value is in TFL 1, also with Very Low diversity value of H' = 0.45 (**Figure 2-18c**). Evenness, lastly, indicates how species are distributed within the monitored plots(**Figure 2-18d**). Evenness ranged from High in TFL1 at J' = 0.65, to Very High in all other plots. This signifies that tree species are evenly distributed within the area with less clustering of species all throughout.





a) Individuals b) Species Richness





c) Diversity Index d) Evenness Index

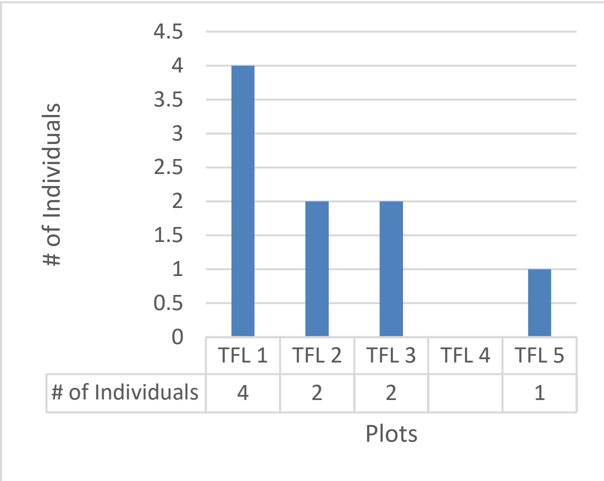
Figure 2-18: Diversity Parameters of flora species per plot in the canopy layer.

The canopy layer in the plots serve as buffer for dust. However, mortalities are being listed either due to natural means or brought about by damages due to typhoon or extreme weather conditions. Once the canopy layer is devoid of vegetation, the canopy layer as buffer to dust will not be met. As such, enrichment planting is recommended for sites with decreasing number of species and number of individuals in the canopy layers. Indigenous, endemic and globally threatened tree species are recommended to be planted in the monitoring plots.

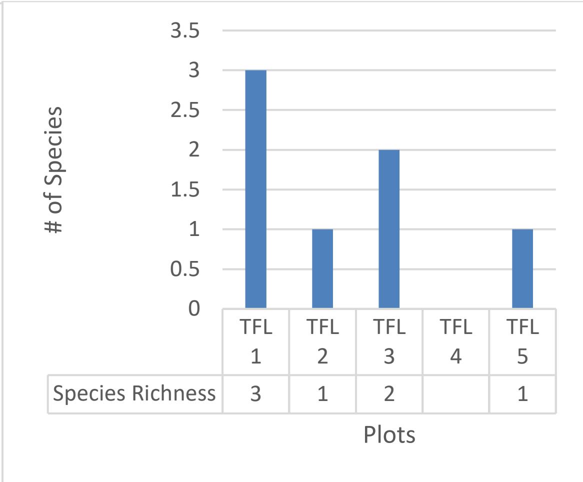
2.1.4.1.5 Intermediate Layer

The highest values for the intermediate layer can be observed in TFL 1, the plot where the secondary forest is located. A total of 4 individuals were observed in TFL 1, but there were no trees in the intermediate layer of plot TFL 4 and only 1 species can be observed in TFL 5 **Figure 2-19a** and **Figure 2-19b**. This indicates that enrichment planting is needed for both plots TFL 4 and TFL 5 to further ensure that large trees can be replaced if trees become injured and die off.

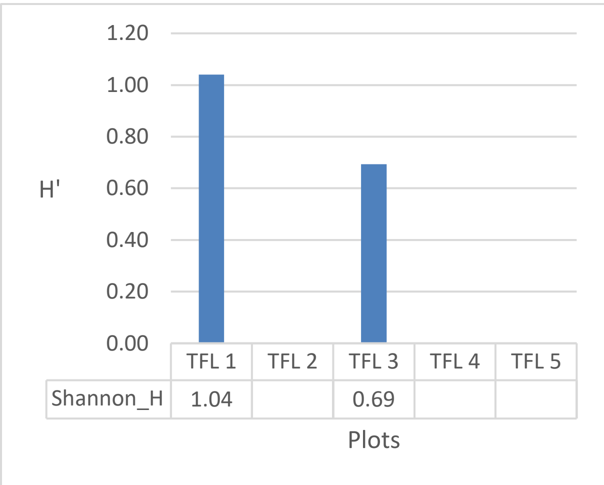
In terms of diversity and evenness, the highest values in the intermediate layer can be observed in TFL 1 with H'=1.055 and TFL3 with H'=0.69. The least diversity is seen in TFL 2, TFL 4 and TFL 5. With only a few individuals found in the intermediate layer, evenness value for TFL 2, TFL 3 and TFL 5 all have J' = 1, meaning that the number of individuals is equal to the number of species. In TFL 4, since no species were found in the plot, evenness is J’ = 0. Graphs of the parameters discussed are shown in **Figure 2-19**.



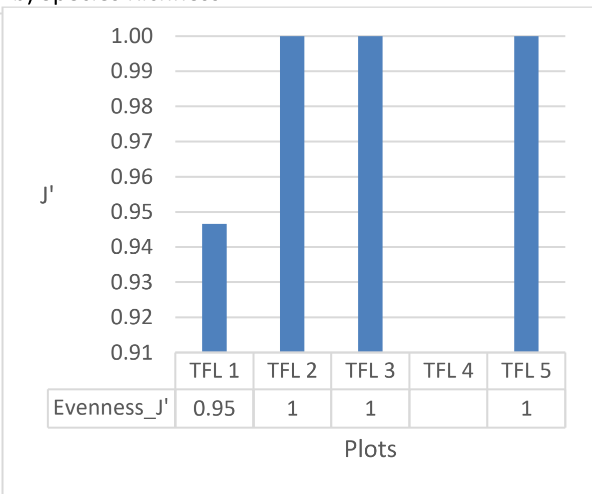
a) # of individuals



b) Species Richness



c) Diversity Indices



d) Evenness Indices

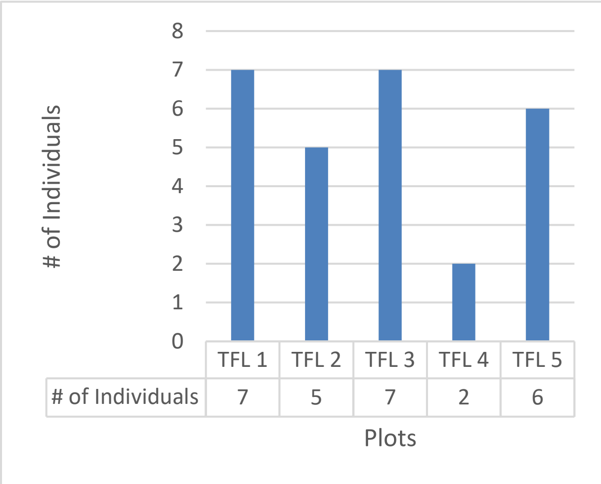
Figure 2-19: Diversity parameters of flora species per plot in the intermediate layer.

It is further recommended that in Plots TFL 2, TFL 4, and TFL 5, a more diverse approach of planting may be implemented. Different species can be planted to increase the diversity values within the areas identified. Diversifying planted trees not only increases the diversity of trees, but also the diversity of faunal assemblages. When faunal assemblages are diversified, the integrity of ecological processes shall be improved, further strengthening the ecosystem’s health and further improving the provision of ecosystem services.

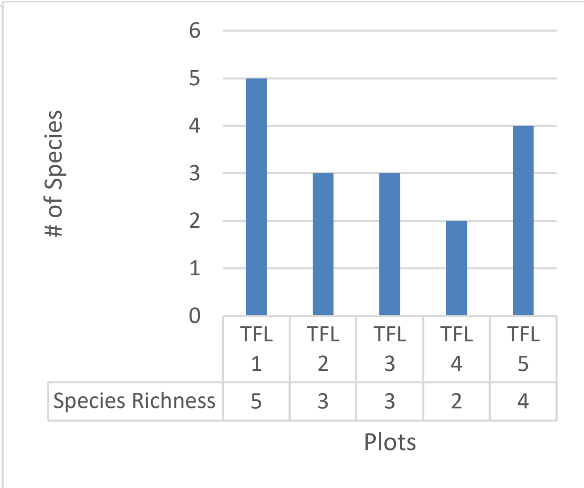
2.1.4.1.6 Understory Layer

In terms of abundance and species richness, TFL 1 obtained the highest value with 7 and 5 respectively. The highest number of individuals was Malakatmon (*Tetracera scandens*), with Narra (*P. indicus*), Mahogany (*Swietennia macrophylla*) and Antipolo (*Arthocarpus blancoi*). Although during the wet season, Payung payungan (*Tacca palmatai)* was dominant, there were no individuals present in the dry season. The least number was observed in TFL 4 with only 2 individuals and 2 species present. In the understorey layer of TFL 4, only Mahogany (*S. macrophylla*) and Kamuning (*Murraya paniculata*) were listed.

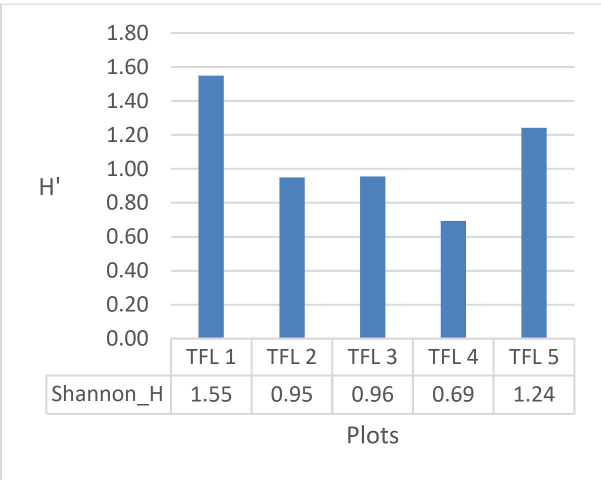
Diversity was lowest in TFL 4 with diversity index value of Very Low at H’ = 0.69. The highest was in TFL 1 with a Low value of H’ = 1.55. Evenness on the other hand was Very High in all the plots ranging from J’ = 0.87 to J’ = 1. This signifies that all species are evenly distributed within the plots The diversity parameters are shown in **Figure 2-20**.



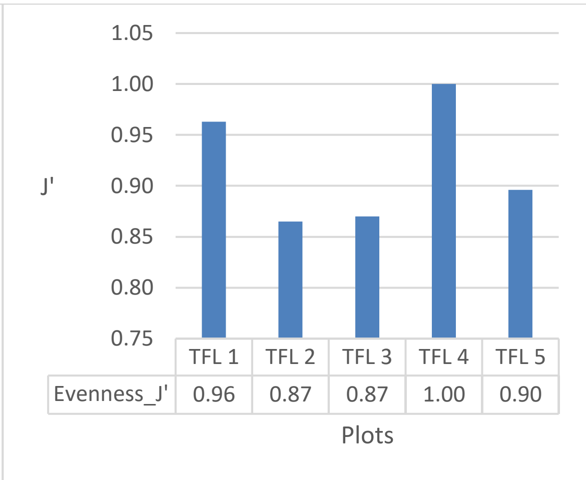
a) # of individuals



b) Species Richness



c) Diversity Index



d) Evenness Index

Figure 2-20: Diversity parameters of flora species per plot in the understory layer.

2.1.4.1.7 Computed Importance Values

The importance value was computed using the relative values of 3 parameters which include Abundance, Frequency and Dominance. **Table 2-7** shows the computed values in descending order. Species with the highest values influence the environment as well as being enfluenced the most by the environment. Mangium (*Acacia mangium*) si the highest with a computed importance value of 25.66, which is then followed by Narra (*P. indicus*). It is then followed by Gmelina (*Gmelina arborea*) at IV = 11.43. These species were mostly reforestation species and planted to serve as buffer for noise and dust. Most of the species which ranked top are those with larger basal areas as indicated by their dominance values.

Table 2-7: Computed Importance Values using Abundance, Frequency and Dominance values.

Common Name	Scientific Name	Abund	RA	Freq	RF	Dom	RD	IV
Mangium	*Acacia mangium*	14	14.89	0.60	9.09	0.38	52.99	25.66
Narra	*Pterocarpus indicus* forma *indicus*	16	17.02	0.80	12.12	0.06	7.88	12.34
Gmelina	*Gmelina arborea*	13	13.83	0.40	6.06	0.10	14.41	11.43
Mahogany	*Swietenia mahogani*	8	8.51	0.60	9.09	0.06	7.97	8.52
Auri	*Acacia auriculiformis*	7	7.45	0.40	6.06	0.08	11.70	8.40
Malakatmon	*Tetracera scandens*	12	12.77	0.80	12.12	0.00	0.00	8.30
Takipan	*Caryota rumphiana*	5	5.32	0.60	9.09	0.01	0.72	5.04
Ipil-ipil	*Leucaena leucocephala*	5	5.32	0.20	3.03	0.01	1.98	3.44
Binunga	*Macaranga tanarius*	3	3.19	0.20	3.03	0.01	2.05	2.76
-	*Ixora luzoniensis*	2	2.13	0.40	6.06	0.00	0.00	2.73
-	*Flacourtia* sp.	2	2.13	0.20	3.03	0.00	0.00	1.72
Talisai	*Terminalia catappa*	1	1.06	0.20	3.03	0.00	0.31	1.47
Gonoy	*Chromolaena odorata*	1	1.06	0.20	3.03	0.00	0.00	1.36
takip-asin	*Macaranga grandifolia*	1	1.06	0.20	3.03	0.00	0.00	1.36
Bangkoro	*Morinda citrifolia*	1	1.06	0.20	3.03	0.00	0.00	1.36
Kamuning	*Murraya paniculata*	1	1.06	0.20	3.03	0.00	0.00	1.36
Antipolo	*Artocarpus blancoi*	1	1.06	0.20	3.03	0.00	0.00	1.36
-	*Piper* sp.	1	1.06	0.20	3.03	0.00	0.00	1.36
		94	100.00	6.60	100.00	0.72	100.00	100.00

2.1.4.1.8 Plant Form

Including species found in the Flora checklist, there are a total of 87 flora species listed in the area. Plant forms were assessed using classification which include: Vines, Bamboo, grass, orchid, palm, shrub and trees. Distribution of plant forms is highest in trees at 52% and followed by shrubs at 19%, then by vines at 16%. Herbs were only 6% with orchids, palms and grasses tied at 2% and the least was bamboo at 1%. This indicates that there are still more tree species found in the monitored site. Interestingly, vines ranked 3rd indicating their proliferation. **Figure 2-21** shows the distribution of plant forms for the flora species found in the monitored area.

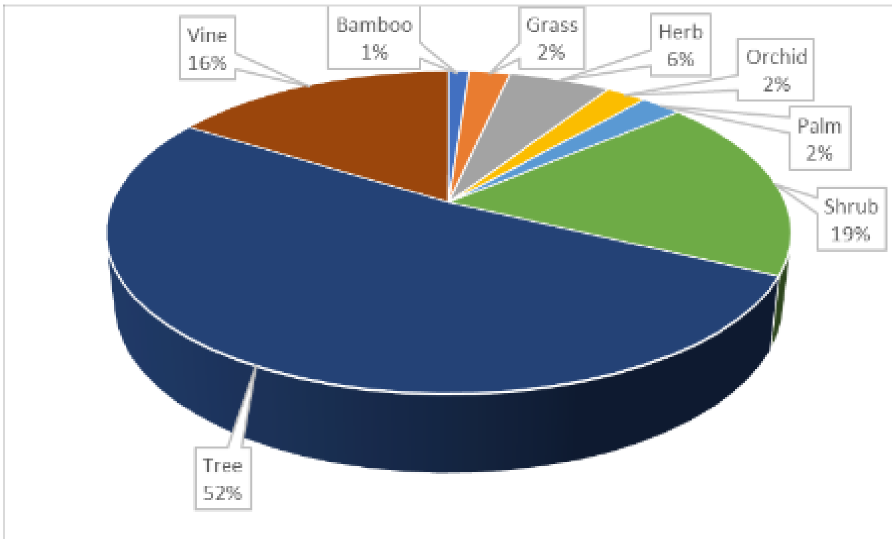


Figure 2-21: Plant forms observed *in-situ*.

2.1.4.1.9 Terrestrial Fauna Biodiversity

Individuals observed in the monitored site totals to 290, majority of which are birds with 281 individuals. Out of the 290 individuals, 48 species in 32 families were identified, with High overall diversity of H' = 3.33 and a Very highly even distribution at J' = 0.86. The summary of parameters is shown in **Table 2-8**.

Table 2-8: Summary of Parameters for Fauna Species

Parameters	Birds	Mammals	Herps	Overall
Abundance	281	3	6	290
Species Richness	44	1	3	48
# of Families	28	1	3	32
Shannon's Diversity Index	3.25	-	0.87	3.33
Pielou's Evenness Index	0.86	-	0.79	0.86

2.1.4.1.10 Birds

In total, 281 individuals in 44 species and 28 families were identified. The highest number of birds is the Yellow-vented bulbul (*Pycnonotus goiavier*) obtaining 49 individuals and was present in all the transects. It is then followed by the Asian glossy starling *(Aplonis panayensis*) with 23 individuals, also appearing in all the transects. Little egret (*Egretta* garzetta) ranks third in terms of importance value and then followed by the Blue-tailed bee-eater (*Merops philippinus*) and the White-Breasted Wood-Swallow (*Artamus leuchorynchos*). These species dominate in the area during the dry season which greatly expresses the energy transfers and food web on the project site during this time of the year. Table 2-9 shows the bird species found in the monitored site.

Table 2-9: List of Bird species found in the monitored area.

Family	Scientific Name	Common Name	Abund	RA	Freq	RF	IV
Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented Bulbul	49	17.44	1	3.53	10.48
Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	23	8.19	1	3.53	5.86
Ardeidae	*Egretta garzetta*	Little Egret	18	6.41	1	3.53	4.97
Meropidae	*Merops philippinus*	Blue-tailed Bee-eater	15	5.34	1	3.53	4.43
Artamidae	*Artamus leucorynchus*	White-breasted Wood-swallow	12	4.27	1	3.53	3.90
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	12	4.27	1	3.53	3.90
Laniidae	*Lanius cristatus*	Brown Shrike	11	3.91	1	3.53	3.72
Nectariniidae	*Cinnyris jugularis*	Olived-backed Sunbird	9	3.20	1	3.53	3.37
Alcedinidae	*Todiramphus chloris*	White-collared Kingfisher	9	3.20	1	3.53	3.37
Apodidae	*Collocalia marginata*	Grey-rumped Swiftlet	12	4.27	0.67	2.35	3.31
Zosteropidae	*Zosterops meyeni*	Lowland White-eye	12	4.27	0.33	1.18	2.72
Rhipiduridae	*Rhipidura nigritorquis*	Pied Fantail	5	1.78	1	3.53	2.65
Estrildidae	*Lonchura atricapilla*	Chestnut Munia	11	3.91	0.33	1.18	2.55
Accipitridae	*Haliastur indus*	Brahminy Kite	4	1.42	1	3.53	2.48
Hirundinidae	*Hirundo tahitica*	Pacific Swallow	7	2.49	0.67	2.35	2.42
Phasianidae	*Gallus gallus*	Red Junglefowl	7	2.49	0.67	2.35	2.42
Raliidae	*Porzana cinerea*	White-browed Crake	3	1.07	1	3.53	2.30
Oriolidae	*Oriolus chinensis*	Black-naped Oriole	5	1.78	0.67	2.35	2.07
Hirundinidae	*Hirundo rustica*	Barn Swallow	5	1.78	0.67	2.35	2.07
Columbidae	*Geopelia striata*	Zebra Dove	4	1.42	0.67	2.35	1.89
Acanthizidae	*Gerygone sulphurea*	Golden-bellied Gerygone	4	1.42	0.67	2.35	1.89
Dicaeidae	*Dicaeum australe*	Red-keeled Flowerpecker	4	1.42	0.67	2.35	1.89
Cuculidae	*Centropus viridis*	Philippine Coucal	3	1.07	0.67	2.35	1.71
Picidae	*Yungipicus maculatus*	Philippine Pygmy Woodpecker	3	1.07	0.67	2.35	1.71
Estrildidae	*Lonchura oryzivora*	Java Sparrow	3	1.07	0.67	2.35	1.71
Alcedinidae	*Halcyon smyrnensis*	White-throated Kingfisher	2	0.71	0.67	2.35	1.53
Ardeidae	Ardea intermedia	Intermediate Egret	2	0.71	0.67	2.35	1.53
Columbidae	*Chalcophaps indica*	Common Emerald Dove	2	0.71	0.67	2.35	1.53
Columbidae	*Spilopelia chinensis*	Spotted Dove	2	0.71	0.67	2.35	1.53
Phylloscopidae	*Phylloscophus cebuensis*	Lemon-throated Leaf-Warbler	2	0.71	0.67	2.35	1.53
Ardeidae	*Nycticorax nycticorax*	black-crowned Night Heron	2	0.71	0.67	2.35	1.53
Passeridae	*Passer montanus*	Eurasian Tree sparrow	3	1.07	0.33	1.18	1.12
Ardeidae	*Bubulcus coromandus*	Eastern Cattle Egret	2	0.71	0.33	1.18	0.94
Corvidae	*Corvus macrorhynchos*	Large-billed Crow	2	0.71	0.33	1.18	0.94
Laniidae	*Lanius schach*	Long-tailed Shrike	2	0.71	0.33	1.18	0.94
Muscicapidae	*Muscicapa griseisticta*	Grey-streaked Flycatcher	2	0.71	0.33	1.18	0.94
Ardeidae	*Ardea purpurea*	Purple Heron	1	0.36	0.33	1.18	0.77
Campephagidae	*Lalage nigra*	Pied Triller	1	0.36	0.33	1.18	0.77
Muscicapidae	*Saxicola caprata*	Pied Bush Chat	1	0.36	0.33	1.18	0.77
Accipitridae	*Nisaetus philippensis*	Philippine Hawk Eagle	1	0.36	0.33	1.18	0.77
Alcedinidae	*Alcedo atthis*	Common Kingfisher	1	0.36	0.33	1.18	0.77

Ardeidae	*Ardea alba*	Great Egret	1	0.36	0.33	1.18	0.77
Columbidae	*Phapitreron leucotis*	White-eared Brown Dove	1	0.36	0.33	1.18	0.77
Turdidae	*Zoothera aurea*	White Thrush	1	0.36	0.33	1.18	0.77
			281	100	28.3	100	100

2.1.4.1.11 Mammals

During the monitoring event, only 1 species of mammals was observed in the monitoring site. This is the Short-nosed fruit bat (*Cynopterus brachyotis*), exhibiting 3 individuals in the whole area. The decrease in number of individuals and number of species may have been due to the availability of food sources at the time of monitoring. Since only a few species of trees were flowering and fruiting, other identified bats such as the Nectar Bat (*Eonycteris spalaea*) were not observed.

2.1.4.1.12 Herps

Forherps, a total of 6 individuals were observed in 3 species and 3 families were observed. The reptiles observed include the Water Monitor Lizard *(Varanus salvator*) and the Tokay Gecko (*Gekko gecko*). The amphibian observed in the dry season is the Giant Toad (*Rhinella marina*). Table 2-10 shows the herps observed in the Monitoring site.

Table 2-10: Reptiles observed in the monitoring site.

Family	Scientific Name	Common Name	Abund	RA	Freq	RF	IV
Gekkonidae	*Gekko gecko*	Tokay Gecko	4	66.67	0.25	50.00	58.33
Bufonidae	*Rinella marina*	Giant Toad	1	16.67	0.25	50.00	33.33
Varanidae	*Varanus salvator*	Water Monitor Lizard	1	16.67	0.25	50.00	33.33

2.1.4.2 Threat to existence and/or loss of important local species

2.1.4.2.1 Endemicity

Based on the checklist of species for flora and fauna, 18 species were found to be endemic to the Philippines, 11 species are plants while 7 species are mostly birds. For plants, the endemic species include: Bayog (*Dendrocalamus merrillianusi), Balinghasai (Buchanania arborescens), Takipan (Caryota rumphiana) Niog-niogan (Ficus pseudopalma), Kalios (Streblus asper*), *Ixora luzoniensis, Takip asin (Macaranga grandifolia*), Antipolo (*Artocarpus blancoi)* and Is-is (*Ficus ulmifoliai).* For fauna species, endemic species include Philippine Coucal (*Centropus viridis*), Philippine Pied Fantail (*Rhipidura nigritorquis*), Pygmy swiftlet (*Collocalia troglodytes*) and Red-keeled Flowerpecker (*Dicaeum austral*) to name a few. Table 2-11 shows the list of endmic flora and fauna species found within the monitored site.

Table 2-11: List of endemic Flora and Fauna Species found in the monitoring site.

Group	Family	Scientific Name	Common Name
Flora	Poaceae	*Dendrocalamus merrillianus*	Bayog
Flora	Anacardiaceae	*Buchanania arborescens*	Balinghasai
Flora	Arecaceae	*Caryota rumphiana*	Takipan
Flora	Asteraceae	*Mikania cordata*	Uoko
Flora	Moraceae	*Ficus pseudopalma*	Niog-niogan
Flora	Moraceae	*Streblus asper*	Kalios

Flora	Rubiaceae	*Ixora luzoniensis*	-
Flora	Rutaceae	*Micromelum compressum*	Tolibas-tilos
Flora	Euphorbiaceae	*Macaranga grandifolia*	Takip-asin
Flora	Moraceae	*Artocarpus blancoi*	Antipolo
Flora	Moraceae	*Ficus ulmifolia*	Is-is
Birds	Cuculidae	*Centropus viridis*	Philippine Coucal
Birds	Rhipiduridae	*Rhipidura nigritorquis*	Philippine Pied Fantail
Birds	Apodidae	*Collocalia troglodytes*	Pygmy swiftlet
Birds	Dicaeidae	*Dicaeum australe*	Red-keeled Flowerpecker
Birds	Columbidae	*Phapitreron leucotis*	White-eared Brown Dove
Birds	Apodidae	*Aerodramus amelis*	Ameline Swiftlet
Birds	Anatidae	*Anas luzonica*	Philippine Duck

2.1.4.2.2 Conservation Status

Five flora species and 2 fauna species found in the monitored site are classified as globally threatened by the International Union for the Conservation of Nature (IUCN 2020-1). Four flora species were classified as vulnerable while 1 species is classified as endangered. For fauna species, the 2 birds identified were Vulnerable. Table 2-12 shows the list of globally threatened species found in the monitored sites.

Table 2-12: List of globally threatened species found in the monitored site.

Group	Family	Scientific Name	Common Name	IUCN
Flora	Fabaceae	*Pterocarpus indicus*	Narra	Endangered
Flora	Euphorbiaceae	*Macaranga grandifolia*	Takip-asin	Vulnerable
Flora	Moraceae	*Artocarpus blancoi*	Antipolo	Vulnerable
Flora	Moraceae	*Ficus ulmifolia*	Is-is	Vulnerable
Flora	Meliaceae	*Swietenia mahogani*	Large leafed Mahogany	Vulnerable
Birds	Anatidae	*Anas luzonica*	Philippine Duck	Vulnerable
Birds	Estrildidae	*Lonchura oryzivora*	Java Sparrow	Vulnerable

2.1.4.3 Threat to Abundance, Frequency and Distribution of Important Species

Endangered species identified is the Narra (*Pterocarpus indicus*). The species is threatened by resource extracition and habitat degradation. As such, this species is recommended as choice species for revegetation of bare and disturbed areas. Other species found to be Vulnerable, as cited by IUCN are the takip-asin (*Macaranga grandifolia*), Antipolo (*Artocarpus blancoi*), and Is-is (*Ficus ulmifolia*). These are the species found in the Project site which may be affected by the expansion. As such, the policy of 1 tree to be cut: 100 seedlings to be planted should be followed accordingly in the clearing for the construction of Unit 5.

2.1.4.4 Hindrance to Wildlife Access

Access will be affected with the construction of both Units 4 and 5 during the construction phase due to vegetation clearing and earthworks activities at the construction site. Fauna species shall be displaced from the forest with birds being able to migrate to areas with more suitable conditions. Mammals and herps on the other hand shall become displaced near the remaining vegetation cover at the Unit 5 construction site.

2.2 The Water

2.2.1 Hydrology/Hydrogeology

For the Masinloc Plant, the nearest surface water is the Lauis River, located a few kilometres (km) North-North-East from the Masinloc Plant. Lauis River has no historical streamflow records that could be used to determine the dependable flow available for water requirements. The river is currently being utilized by the National Irrigation Administration (NIA) for irrigation purposes and used by Masinloc Plant by abstracting water from theLauis River at the rate of 0.029 m^3/s which was granted by the National Water Resource Board (NWRB) at the diversion point which is downstream of the NIA dam. Streamflow Measurements
Streamflow measurements were previously conducted during the preparation of the Masinloc PlantEIS in 1994. Spot discharge measurements were made in April 1989 and May 1990. Various measurements were also made in April 1993.These months are the driest months for Type I climate. The measurements yielded discharge values ranging from 2-4 m^3/s.

An actual spot streamflow measurement was conducted where a portion of Lauis River was diverted to the existing intake structure of the Masinloc Plantin in Barangay Taltal, Masinloc.The Float-Area Method or Float-Velocity Method was used in conducting the streamflow measurements.

Discharge measurement by wading using a calibrated stake to determine the depth of each subsection of the river was employed during the flow determination. The most appropriate sites where flows are laminar were selected to attain high accuracy measurements. A tagline was laid across the river to determine the exact width of the river and also served as a guide to obtain the depth of each subsection of the river.The width of each section depends on the total width of the river channel. A distance parallel to the center line of the stream was measured and marked along the bank. Specially prepared floats were used to measure the velocity. Two locally hired laborers who served as observers were stationed at each end of the measured range. The floats were released into the stream a few meters from the upstream station. The upstream observer signalled to the second (downstream) observer when the float passedthe upstream marker. The downstream observer marked the time using a stopwatch upon the signal of the upstream observer. The timer was stopped when the float passed the downstream station. Ten trials were conducted along uniform intervals across the width of the stream. The total of recorded times was averaged by dividing it by the number of trials (n). Then,average surface velocity (V_{ave}) was calculated bydividing the distance (D) between the upstream and downstream stationsby the average time (t_{ave}) the float travelled from the upstream observer to the downstream observer as shown below:

$$V_{ave} = \frac{D}{\frac{t_1+t_2+t_3\ldots+t_n}{n}}$$

Then, the total area (A_T) of the channel (measuring section) was obtained by getting the sum of the total area of its subsections as reflected below:

$$A_T = A_1 + A_2 + A_3 + \cdots + A_n$$

Since the surface of the stream moves faster than the average velocity at the vertical, the float velocity is multiplied by 0.80 to give the average velocity at the vertical. The average discharge (Q_{ave}) is then computed by using the following formula:

$$Q_{ave} = V_{ave} \times A_T \times 0.80$$

The measurements yielded the following results:

Date of measurement	:	October 14, 2010
Start of measurement	:	1:42 pm
End of measurement	:	2:07 pm
Width	:	38.800 m
Area	:	17.962 m^2
Velocity	:	0.770 m/s
Discharge	:	11.000 m^3/s

2.2.1.1 Hydrologic Analysis of Nayom River and Lauis River

2.2.1.1.1 Mean Monthly Flow

All the daily available streamflow data (fragmentary) of Nayom River were collected and the mean monthly flow values were determined. The results are shown in **Table 2-13**. The resulting mean monthly flows of Nayom River were transposed to Lauis River using the Basin-Factor Ratio method of interpolation.

Table 2-13: Mean Monthly Average Discharge of Nayom and Lauis River

Month	Nayom River	Lauis River
	Mean Discharge (m^3/s)	Mean Discharge (m^3/s)
January	2.334	7.385
February	2.090	6.613
March	1.531	4.840
April	1.485	4.700
May	3.100	9.800
June	5.620	17.780
July	15.175	48.010
August	18.220	57.650
September	16.900	53.470
October	9.110	28.820
November	5.000	15.820
December	2.930	9.270
Total	**83.495**	**264.578**
Mean	**6.9580**	**22.050**

2.2.1.1.2 Probability/Flow Duration Analysis

The daily streamflow data of Nayom River were subjected to probability/flow duration analysis to determine the percentage of time that the flow is equalled or exceeded for the period of records. The dependable flow is 80% of the time available and this is the value adopted by the NWRB in granting water permits. The results of the analysis for Nayom River areshown in **Table 2-14**.The results were transposed to Lauis River using the same method in obtaining the mean monthly flow of the said river.

Table 2-14: Discharge of Various ExceedanceProbabilities of Nayom River

Exceedance	Nayom River	Lauis River
Probabilities (%)	Discharge (m^3/s)	Discharge (m^3/s)
5	22.000	69.610
10	15.000	47.460
20	8.000	25.300
30	5.000	15.800
40	3.450	10.900
50	2.600	8.230
60	1.800	5.700
70	1.500	4.750
80	**0.950**	**3.000**
90	0.500	1.580
100	0.078	0.247

2.2.1.1.3 Flood Frequency Analysis

Nayom River was subjected to a flood frequency analysis. Annual peaks were ranked according to their magnitudes and arranged in descending order. The mean of the annual peaks, the standard deviation as well as the plotting position were calculated using Gumbel extreme type I distribution (**Table 2-15**).The results of the analysis are shown in**Table 2-16**.Likewise, the results were interpolated using the Basin-Factor Ratio method.Theseare shown in**Table 2-17**. The resultswere vital inputs to the design of intake/diversion structure at the Lauis River.

Table 2-15: Point Flood Frequency Analysis of Nayom River, 1956-1979

Year	Peak Q	Rank	Descending Order	(x- ave. Q)^2	Plotting Position
1956	690	1	1,896.88	2,353,831.00	**25.000**
1957	1,896.88	2	960.00	356,815.10	12.500
1958	412.80	3	791.84	183,561.00	8.300
1959	135.20	4	690.00	107,151.50	6.250
1960	200.00	5	566.08	41,379.70	**5.000**
1961	84.16	6	412.80	2,514.00	4.167
1962	254.24	7	309.36	2,841.00	3.570
1963	192.60	8	288.16	1,482.25	3.125
1964	791.84	9	273.76	7,903.20	2.778
1965	95.76	10	254.24	11,755.00	2.500
1966	288.16	11	252.80	12,069.22	2.270
1967	130.56	12	250.00	12,692.30	2.080
1968	190.96	13	230.32	17,540.40	1.920
1969	566.08	14	200.80	26,199.00	1.786
1970	309.36	15	200.00	26,458.30	1.667
1971	252.80	16	192.60	28,920.40	1.560
1972	273.76	17	190.96	29,481.00	1.470
1973	52.80	18	145.04	32,986.00	1.390
1974	960.00	19	135.20	51,738.00	1.316
1975	100.40	20	130.56	53,870.00	1.250
1976	250.00	21	100.40	68,780.30	1.190
1977	145.04	22	95.76	71,235.60	1.136
1978	200.80	23	84.16	77,562.00	1.080
1979	230.32	24	52.80	96,013.20	1.040
Total	**8,703.72**			**3,674,779.87**	
Mean	**362.66**				
Standard Deviation	**399.72**				

Table 2-16: Flood Values with Different Recurrence Interval of Nayom River, 1956-1979

Mean Annual Flood (MAF)/Return Period (year)	Peak Flow (m^3/s)
2.23	340
5	600
10	997
25	1,900
50	2,800
100	4,300
200	7,100

Table 2-17: Flood Values with Different Recurrence Interval of Lauis River

Mean Annual Flood (MAF)/ Return Period (year)	Peak Flow (m^3/s)
2.23	1,076
5	1,896
10	3,155

Mean Annual Flood (MAF)/ Return Period (year)	Peak Flow (m^3/s)
25	6,296
50	8,854
100	13,605
200	22,464

2.2.1.1.4 Minimum Flow Frequency Analysis

Table 2-18: Minimum Flow Frequency Analysis of Nayom River, 1956-1979

Year	Minimum Q	Rank	Ascending Order	(x – ave. Q)^2	Plotting position
1956	0.660	1	0.060	1.158	25.000
1957	0.720	2	0.090	1.151	12.500
1958	0.400	3	0.220	0.889	8.300
1959	0.840	4	0.260	0.8150	6.250
1960	0.950	4	0.260	0.8150	6.250
1961	0.860	5	0.280	0.780	5 .000
1962	0.930	6	0.400	0.582	4.167
1963	0.220	7	0.550	0.376	3.570
1964	0.280	8	0.660	0.253	3.125
1965	1.300	9	0.720	0.1962	2.778
1966	0.840	10	0.780	0.1467	2.500
1967	0.780	11	0.800	0.1318	2.270
1968	5.350	12	0.840	0.1043	2.080
1969	0.930	12	0.840	0.1043	2.080
1970	0.550	13	0.860	0.0920	1.920
1971	0.260	14	0.930	0.0543	1.786
1972	0.090	14	0.930	0.0543	1.786
1973	0.80	15	0.940	0.0450	1.667
1974	0.260	16	0.950	0.0454	1.560
1975	0.940	17	1.300	0.0188	1.470
1976	0.060	18	2.700	2.362	1.390
1977	3.700	19	3.500	5.462	1.316
1978	3.500	20	3.700	6.440	1.250
1979	2.700	21	5.350	17.530	1.191
Total	**27.920**			**39.606**	
Mean	**1.163**				

Table 2-19: Minimum Flow Values with Different Recurrence Intervals of Nayom River, 1956-1979

Return Period (year)	Minimum Flow (m^3/s)
2	0.850
5	0.280
10	0.1760
25	0.0682
50	0.040
100	0.0232
200	0.0134

Table 2-20: Minimum Flow Values with Different Recurrence Intervals of Lauis River

Return Period (year)	Minimum Flow(m^3/s)
2	2.700
5	0.8860
10	0.557
25	0.2158
50	0.1270
100	0.0734
200	0.0424

Based on the results of the flow duration analysis, Lauis River has a dependable flow of 3,000 L/s or 3 m^3/s which is available 80% of the time. The present requirement of the NIA of about 0.405 m^3/s and the proposal to expand the irrigation system requires a maximum flow of 1.53 m^3/s. If the Project sources its water needs from the river,an estimated amount of 0.058 m^3/s can be diverted, which is twice the estimated Project requirement. There would still be a net available flowof 1.065 m^3/s. The present total water use of the river for the Masinloc Plantand municipal irrigation totals 0.434 m^3/s,which is lower than the minimum flow of 0.557 m^3/sestimated to recur on the average once in every tenyears (**Table 2-20**).The total possible water requirement for the Masinloc Plant, Project, and irrigationwill reach 1.993 m^3/s, which is slightly lower than 2.700 m^3/sestimated to recur on the average once in every two years.

2.2.1.2 Potential Groundwater Contamination

The ash generated by the Masinloc Plantis transported by trucks to the designated ASF located NW of the Masinloc Plant adjacent to the coal storage area. Embankments are provided around the ash disposal area to contain the ash, the accumulated rainwater and sprinkled water. Surface run-offis directed to the sedimentation basin viathe excavated water channel built in the ASF. After the ash particles have settled in the sedimentation basin, clear water will be discharged into the sea on the west side.

Prevention of groundwater contaminationis facilitated by a naturally existing clay liner underneath the ashpond, which is impermeable to the the passage of water and potential contaminants. Groundwaterwells were constructed at the northern portion of the ASFfor the monitoring of level of groundwater contamination in the low-lying areas. The monitoring results are presented in **Annex G.**

2.2.2 Oceanography

2.2.2.1 Thermal Plume Dispersion Modeling

2.2.2.1.1 Introduction

The location of the Project, discharge outfall and intake system are shown in **Figure 2-22** below. The existing temperature at the discharge outfall ranges from 32°C to 34°C. With an additional 600 MW, the maximum flow rate and water temperature at the outfall is expected to rise further. The present design is to construct an additional intake system near the existing intake and to use the existing outfall to discharge the additional load of heated effluent.

Oyon Bay is relatively shallow with depths ranging from 1 m to 30 m. However, an abrupt bathymetric change occurs westward with water depths ranging from 100 m to 700 m within a few kilometers to the west. The coastal geometry around the Project is rather complex with slightly curved coastlines with islets and intervening shallow areas to the south.

Figure 2-22: Location of the Cooling Water Outfall of the Masinloc Plant

2.2.2.1.2 Technical Description of the Model

Coastal Hydraulics Model

The principal goal of the hydrodynamic modeling task is the investigation of the coastal hydraulics in the vicinity of the Project. The present hydraulic modeling study aims to quantify the spatial and temporal changes in the water level and flow velocities that may result due to changes in the seasonal winds. The hydrodynamic effects of the prevailing northeast and southwest monsoonal seasons corresponding to the dry and wet seasons are included in the analysis. A description of the hydrodynamic model used in the dispersion modeling is given below.

Wind and Tide-Driven Circulation Model

The PEERS[1] Coastal Ocean Model (PCOM) is an oceanographic tool for the simulation and prediction of horizontal and vertical profiles of currents and sea surface elevation. PCOM is a quasi-3D hydrodynamic model that is utilized. A quasi-three-dimensional (Q3D) non-linear numerical model of the wind-driven circulation is a simple yet powerful tool to study the time and space variation of the wind-driven currents (and surges) in coastal seas. The modified circulation model of Koutitas (1988) was extended in PCOM to include horizontal momentum diffusion and a modification in the bottom stress formulation.

In addition, PCOM allows for the simulation of partial transmission and reflection of tides and currents near obstacles such as islands and headlands. The present formulation includes non-linear interaction between the wind and the tide. The governing equations of the wind and tide-driven circulation model are written in the Cartesian coordinate system as:

[1] Hymetocean Peers Co. (peerscom@yahoo.com)

$$p\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + \left(0.2u + \frac{a_x}{40}\right)\frac{\partial u}{\partial x} + \left(0.2v + \frac{a_y}{40}\right)\frac{\partial u}{\partial y} = pfv$$
$$- p^2 g\frac{\partial \zeta}{\partial x} + p\frac{\tau_{sx}}{\rho h} - \left(k\frac{u}{h}\sqrt{u^2+v^2} - 0.5\frac{\tau_{sx}}{\rho h}\right) + pE_h\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) \quad (1)$$

$$p\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + \left(0.2u + \frac{a_x}{40}\right)\frac{\partial v}{\partial x} + \left(0.2v + \frac{a_y}{40}\right)\frac{\partial v}{\partial y} = -pfu$$
$$- p^2 g\frac{\partial \zeta}{\partial y} + p\frac{\tau_{sy}}{\rho h} - \left(k\frac{v}{h}\sqrt{u^2+v^2} - 0.5\frac{\tau_{sy}}{\rho h}\right) + pE_h\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) \quad (2)$$

$$p\frac{\partial \zeta}{\partial t} + \frac{\partial[u(h_o+\zeta)]}{\partial x} + \frac{\partial[v(h_o+\zeta)]}{\partial y} = 0 \quad (3)$$

where u and v represent the depth-averaged current components (m/s) in the x and y-axes respectively, p is the PEERS porosity coefficient (non-dimensional coefficient ranging from 0.1-1.0) which allows for the simulation of partial transmission and reflection of tides and currents near obstacles such as islands and headlands, ζ is the sea surface elevation (m), f is the Coriolis parameter (/s), g is the gravitational acceleration (m/s^2), τ_s is the wind stress acting over the sea surface (N/m^2), ρ is the seawater density (kg/m^3), h_o is the still water depth (m), k is a bottom friction coefficient, and E_h is the horizontal eddy viscosity coefficient (m^2/s). Partial transmission and reflection are important physical oceanographic processes that had been included in PCOM. The variable a (m/s) is related to the wind stress as in (Koutitas 1988):

$$a = \frac{\tau_s h}{\rho \upsilon} = 16.6\sqrt{\frac{\tau_s}{\rho}} \quad (4)$$

where the fluid viscosity υat the surface is assumed as a function of the surface stress and the depth of the water column (i.e., $\upsilon = \lambda h\sqrt{\frac{\tau_s}{\rho}}$ in which λ is assumed equal to 0.06).

The horizontal eddy viscosity coefficient can be assumed constant or parameterized using the Smagorinsky turbulence scale approach. Here, horizontal viscosity is dependent on the gradient of the horizontal velocity components as in:

$$\nu_h = \upsilon A\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2 + \frac{1}{2}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right)^2\right]^{1/2} \quad (5)$$

where$\upsilon$is constant (0.01-0.5) and A is the area of a grid element.

The effect of the earth's rotation (e.g., Coriolis force) is also considered in PCOM by including it in the momentum equations. In higher latitudes, the Coriolis force can have a significant effect on the horizontal currents and may therefore affect the coastal circulation.

The surface stress terms in Equations (2-3) are assumed as quadratic functions of the wind W measured at anemometer level with components in the x and y-axes given by:

$$\tau_{sx} = \rho_a c_d W_x W \quad , \quad \tau_{sx} = \rho_a c_d W_y W \quad (6)$$

Whereρ_a is the air density, c_d is a drag coefficient and $W_{x,y}$are the wind components in the *x* and *y*-axes, respectively.

Equations (1) and (2) define the current accelerations in the *x* and *y*-axes respectively. The first terms on the left of both equations represent the local change of the flow velocities. The following terms on the left side of the equation represent changes in the fluid acceleration due to advection of momentum. The additional advective terms involving the stress variable *a* are corrections imposed on advection to include non-uniformity in the vertical current profile. On the right hand side of both equations (in the order written), effects due to earth's rotation (Coriolis acceleration), sea surface elevation gradient, surface stress and bottom frictional effects, and horizontal momentum diffusion provide the necessary physical factors affecting coastal circulation. Basically, these equations represent conservation of momentum in the coastal sea. Current velocities are predicted using these equations.

On the other hand, Equation (3), which is simply the equation of mass continuity, represents conservation of water mass. It predicts the evolution of the water level or sea surface elevation (e.g. storm surge) from known current velocities due to the wind and the tide. While written in two-dimensional forms, Equations (1-3) can be used to assess the three-dimensional structure of the horizontal flow velocities. In its derivation, it was assumed that the current profile in the vertical is a quadratic function of the water depth, i.e.,$u(z) = az^2 + bz + c$, in which *z* is the vertical coordinate. With boundary conditions adopted from Koutitas (1988), it can be shown that the flow velocity components vary in the vertical according to:

$$
\begin{aligned}
u(z) &= \left[\frac{3}{4}a_x - \frac{3}{2}u\right]\left[\left(\frac{z}{h}\right)^2 - 1\right] + a_x\left[\frac{z}{h} + 1\right] \\
v(z) &= \left[\frac{3}{4}a_y - \frac{3}{2}u\right]\left[\left(\frac{z}{h}\right)^2 - 1\right] + a_y\left[\frac{z}{h} + 1\right]
\end{aligned} \tag{7}
$$

The present circulation model is thus quasi-three dimensional (Q3D) in the sense that currents at any depth can be estimated from model calculations using Equation (6). The surface current components can be easily estimated from this equation using:

$$
\begin{aligned}
U_{surface} &= 1.5u + a_x / 4 \\
V_{surface} &= 1.5v + a_y / 4
\end{aligned} \tag{8}
$$

These are used in the quantification of surface pollutant transport due to thermal plume dispersion bythe Project.

In addition to its capability of predicting the coastal currents, PCOM can be used to predict the occurrence of storm surges in a coastal area of interest. It should be noted that the time-dependent continuity equation (3) determines the sea surface elevation (storm surge) due to both wind and tide. A storm may be introduced into the computational domain and the temporal evolution of the sea surface due to stormy winds can be calculated. An appropriate typhoon model that gives spatial distribution of the wind field may be used to force the storm surge model. On the other hand, actual wind observations can also be used.

Model Input and Boundary Conditions

The foremost data information needed by the hydraulic model is a digitized bathymetric map giving the depth contours. In the absence of a large-scale bathymetric survey around the area, the depth data from CMAP nautical chart was interpolated for a spatial resolution of 100 m. The coastal boundaries are established and a rectangular computational domain is used in the hydrodynamic model. A number of grid cells along the two horizontal directions are drawn and the depths were determined inside the grid cells. This comprises the bathymetric data that the coastal hydraulic and dispersion models used (**Figure 2-23**).

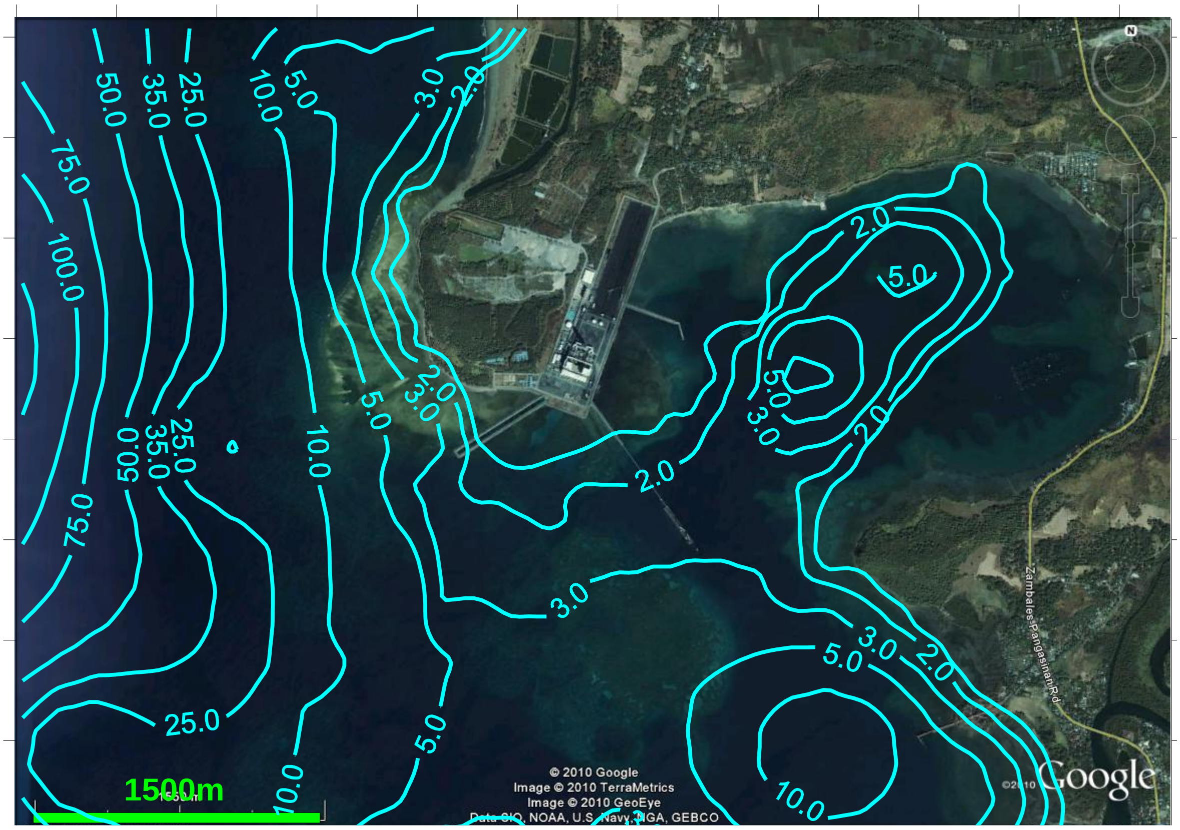


Figure 2-23: Bathymetry and Coastal Geometry around the Masinloc Plant

The wind is a main driving force for most coastal processes and therefore constitutes the second most important information for the hydrodynamic model. The action of the wind normally modifies the tide-driven motion of the coastal sea and therefore requires accurate information. The temporal variation of a uniform wind is normally used in the model but a spatially varying wind-speed can also be used.

The open boundaries of the rectangular computational domain require information of the water level variation or the flow velocities. In the present model, either the sea level or the current or a combination of both can be prescribed. For water level boundary condition, the tidal amplitudes and phases especially of the major tidal constituents are necessary to run the model. Currents at the open boundaries are estimated by the model using the pseudo-implicit form of the Orlanski Radiation Condition (Rivera 1997). This boundary condition, whether it is used for sea level and currents, prevents the back-reflection of an outgoing disturbance and therefore avoids errors introduced at the open boundaries.

The effect of the tide in the coastal circulation model has been included by the propagation of a long-gravity wave at the open boundaries of the computational domain. The surface elevation field, varying in time, is prescribed at the open boundaries with tidal forcing derived from actual tidal observations around the area. A truncated Fourier series derived for the four major tidal constituents is used in PCOM, i.e.:

$$\zeta(t) = \tfrac{1}{2} a_0 + a_1 \cos(\omega_1 t - \Phi_1) + a_2 \cos(\omega_2 t - \Phi_2) + a_3 \cos(\omega_3 t - \Phi_3) + a_4 \cos(\omega_4 t - \Phi_4)$$

where $\zeta(t)$ is the sea surface elevation due to the tide at the open boundary as a function of time t, a's represent the amplitudes with a_o as the mean value, ω's are the frequencies, and p's are the phases of each of the four tidal constituents (O_1, K_1, M_2, and S_2, respectively). The amplitudes and phases of the major tidal constituents in the area were estimated from actual observations.

2.2.2.1.3 Thermal Plume Dispersion Model

The principal aim of this modeling work is to determine the dispersion of heated effluent from the proposed 1,200 MW Project on the marine environment surrounding the Masinloc Plant. The model assumes an increase of the existing 6°C temperature rise giving a maximum of 40°C effluent temperature. Prediction of the expected rise in the ambient water temperature due to the discharge of cooling water is the goal of this modeling work. Changes in the excess temperature field due to seasonal winds and various tidal phases are considered in the present modeling work.

Thermal Plume Model

The water quality model used considers the Eulerian transport and dispersion of thermal effluents from the proposed Project. Thermal effluent dispersion and dissipation is accomplished by three major processes in coastal areas. These processes include advection and diffusion by coastal currents, and atmospheric cooling by the wind. In most applications concerning mid-field to far-field modeling studies, the time-dependent advection-diffusion equation is solved to determine the evolution and fate of the cooling water after discharge. The dispersion of the thermal plume as it is transported by wind and tide action is subject to atmospheric cooling. This is present as an additional term in the governing partial differential equation as a loss or decay term. It represents the cooling effect of the wind and is dependent on the magnitude of the wind speed, ambient water temperature and the effective water density. It should be noted that water density decreases with an increase in temperature. Therefore, water density needs to be updated as is the case in present modeling work.

The present dispersion model is dynamically coupled to the hydrodynamic model. Computed current magnitudes and directions are used as input into the water quality model. The partial differential equation defining the water quality changes due to thermal effluents is given by:

$$\frac{\partial c}{\partial t} = -u\frac{\partial c}{\partial x} - v\frac{\partial c}{\partial y} + K_x\frac{\partial^2 c}{\partial x^2} + K_y\frac{\partial^2 c}{\partial y^2} - Fc \qquad (11)$$

Where c is the excess temperature in °C, u and v are the components of water current in the x and y-axes, K_x and K_y are the dispersion coefficients in the same axes assumed constant and F is a decay coefficient representing the heat exchange with the atmosphere.

The decay term F is primarily dependent on the wind speed, the water density and the ambient temperature and is parameterized according to the modified heat dissipation formula given by;

$$F = \left[4.6 - 0.09\left(T + \Delta T\right) + 4.06W\right]\exp\left[0.033\left(T + \Delta T\right)\right] / \rho c_p h \qquad (12)$$

where ΔT is the thermal effluent or excess temperature given by c, ρ is the water density, c_p is the specific heat of water, h is the instantaneous water depth, T is the ambient temperature, which is assumed variable in time and W is the wind speed at the surface (anemometer level). The water density is assumed as a function of the water temperature as in:

$$\rho = \rho_o - 0.088(T + \Delta T) \qquad (13)$$

in which ρ_o is the initial water density. The water density is therefore decreased, with an increase in the ambient temperature due to thermal effluent discharges.

The numerical method used to solve Equation 11 is based on a 4th-order accurate explicit finite difference method which is computationally efficient. Called the PEERS Pollution Model (PPM), the higher order truncation error terms are included such that the advection terms are centered in space to include the third-order terms. On the other hand, the diffusion terms include the 4th-order truncation error terms. If the temperature rise is represented by the pollutant concentration *c,* Equation (11) is written in PPM as:

$$\frac{\partial c}{\partial t}+u\frac{\partial c}{\partial x}+v\frac{\partial c}{\partial y}=K_x\frac{\partial^2 c}{\partial x^2}+K_y\frac{\partial^2 c}{\partial y^2}+u\frac{\Delta x^2}{6}\frac{\partial^3 c}{\partial x^3}+v\frac{\Delta y^2}{6}\frac{\partial^3 c}{\partial y^3}$$
$$-K_x\frac{\Delta x^2}{12}\frac{\partial^4 c}{\partial x^4}-K_y\frac{\Delta y^2}{12}\frac{\partial^4 c}{\partial y^4}+\frac{S-D}{h} \tag{14}$$

Where*c* is now the excess temperature field (i.e., temperature rise) and *D* (= *Fc*) is the decay term representing atmospheric cooling. *S* is a source term representing the outfall discharge temperature rise, whereas K_x and K_y are dispersion coefficients which were assumed to depend on the current components. It should be noted that this assumption will result in extra terms containing product of derivatives of the absolute values of the flow velocities and derivatives of the excess temperature.

Numerical Solutions of the Coupled Models

The numerical solution of the hydrodynamic model is based on an explicit finite difference schemes with the unknown variables staggered in space (Arakawa C-Grid). The variables are solved with the sea surface elevation and water depth at the center of a grid cell. The depth-averaged flow component in the *x*-axis is located at the center of a *y*-directed side (left and right of the grid mesh) and the flow component in the *y*-axis is located at the center of an *x*-directed side.

The numerical integration proceeds by the calculation of the continuity equation and the specification of the open boundary condition. The derivatives of the momentum components in the continuity equation are solved first. Using the newly computed wave height and water depths, the momentum equations are then solved. Here, the *u*-component of the flow is solved throughout the computational domain using a centered difference scheme for the advective terms in the hydrodynamic model. This is followed by the calculation of the *v*-component of the flow using the same numerical scheme for the advective terms.

On the other hand, the water quality model was integrated using a highly accurate numerical scheme.Fourth order accurate finite differences were used for the first-order derivatives in the advective terms of the water pollutant (i.e., thermal effluent given by *c*). Prediction of the temporal and spatial variation of the excess temperature field is obtained using a forward time numerical scheme and using updated velocity fields given by the hydrodynamic model PCOM.

2.2.2.1.4 Model Implementation and Results

The hydrodynamic and thermal plume dispersion models operate under realistic bathymetric and coastal geometric conditions. In addition, it can use as input realistic hourly wind and tide conditions as external forcing mechanisms. However, to capture the mean dispersion conditions during the seasons, mean winds and derived tidal harmonics were used as input. The models are quasi-3-dimensional but due to the highly buoyant character of the effluent under consideration, the surface current conditions are determined and used and the resulting elevated temperature fields are determined at the surface. The numerical simulations carried out in this study used as input the following conditions:

- Model Grid Distance: 100 m
- Time Interval for the Hydraulic Model: 0.5 second
- Time Interval for the Water Quality Model: 60 seconds
- Mean wind condition: 3 m/s from NE and SW (Average Monsoon Conditions)
- Tidal condition: Amplitudes and phases of O_1, K_1, M_2 and S_2 tides
- Maximum temperature at outfall: 40°C (12°C above the ambient temp of 28°C)
- Eddy viscosity coefficient (constant along x and y): 1.0 m^2/s
- Thermal plume diffusivity coefficient: current-dependent (see description above)

Two case studies representing the expected changes during the northeast and southwest monsoon seasons were undertaken. A schematic illustration of the overall modeling work implemented for the coastal area of interest is shown in **Figure 2-24**. The hydrodynamic model is run first using assumed meteorological conditions and digitized bathymetry of the computational domain. The domain extends a few kilometers away from the Masinloc Plant as shown in **Figure 2-22**. The hydrodynamic model computes depth-averaged currents and surface currents. The surface currents are then used to force the water quality model for positively buoyant thermal effluents. In the water quality-dispersion model, the ambient water temperature is included. Changes in the water temperature due to the thermal effluents are used to calculate the new density field.

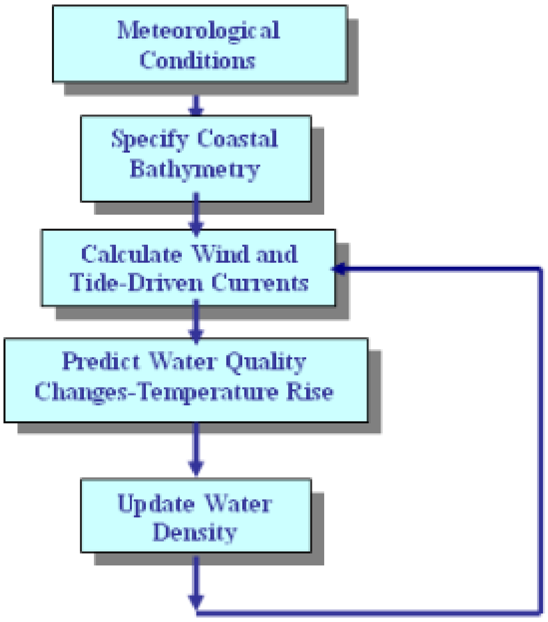


Figure 2-24: Schematic Illustration for the Dispersion Modeling Work Implemented for the Proposed Project

Results of the Modeling Study

Northeast (NE) Monsoon Season

The results of the dispersion model for the NE Monson Season (December-May) are shown in **Figure 2-26** to **Figure 2-29**. For easy comparison, maps were plotted at different tidal stages as shown in **Figure 2-25**. The occurrence of a predominantly diurnal tide is noticeable with one high and one low water level in a tidal day. The results for a 24-hour simulation were taken during a three day period of simulation. In this case, the plume dispersion during transient tidal flooding and ebbing and during slack tides is considered.

The results show that before peak flood (Hours 54 and 72), the flood currents are relatively weak but increases near the Masinloc Plant. This is due to the opposite direction of the wind that comes predominantly from the northeast during this season. Using the surface current field which is normally stronger, the dispersion pattern is predicted to be somewhat opposite of the weak depth-averaged currents and towards the west of the Masinloc Plant. The effect of the northeast wind dominates the dispersion towards the southwest and the west. The extent of the mixing zone is shown by the red contour lines to be limited in a small area around the outfall.

During ebbing, the currents in the study area flow in a reversed direction, i.e., towards the southern opening of the bay. With this condition, the thermal effluents tend to be strongly dispersed towards the southwest due to the deflection caused by the currents and the northeast wind (**Figure 2-27**). The ebb currents also become stronger due to the additional push from the wind. The thermal effluents therefore may reach longer distances. However, the spatial extent of water temperature exceeding 33 °C is limited in the vicinity of the outfall. This local effect is due to both the abrupt cooling by atmospheric effect and the limited discharge rate by the plant.

At the turn of the tide during the next tidal flooding, reversal of the currents is expected to occur. However, the thermal plume dispersion is only slightly affected by the weak currents that are opposed by the wind. The resulting thermal dispersion is shown to be directed away from the Masinloc Plant towards the deeper portions. This is also true during the succeeding tidal stages. Even during slack water, the thermal plume is dispersed by the wind away from the Masinloc Plant. Recirculation of the cooling water is therefore avoided since the heated effluents hardly reach the intake location.

It should be noted that it is during this season (March-May) that ambient water temperatures may go over 30°C, especially during the afternoon. Therefore, the potential influence of a 33°C temperature due to the Project is considered insignificant. It is shown by the model results that the elevated temperature is mostly located in a small area above the outfall and may not pose a serious threat to organisms.

<u>Southwest (SW) Monsoon Season</u>

The thermal plume dispersion during the southwest monsoon season has been simulated using constant wind but transient tides. A uniform wind of threemeters per second coming from the southwest was used in this case by the numerical models. A 24-hour simulation with rising and falling mixed tide level was conducted and the results are presented every six hours. The model is run for a three day period. The results shown in the figures correspond to Hour 54 until Hour 72. Therefore, the snapshots cover most of the interesting dispersion patterns that may be expected during transient tidal flooding and ebbing and during slack waters.

The model results show that currents which are responsible for the dispersion of thermal effluents in the area are generally weak. At the surface, currents are also weak to moderate and range only from 3 to 13 cm/s during ordinary breeze conditions. The expected dispersion therefore during moderate southwest wind conditions without storms is spatially limited.

As shown in **Figure 2-30** to **Figure 2-33**, the simulated dispersion patterns of thermal effluents during the SW Monsoon season show a localized spatial extent. The mixing zone and the area affected by the overall thermal plume are shown only near the outfall. This is due to both the effect of the southwest monsoon winds and the very weak currents during this season. It can be seen that even during ebbing and flooding, the extent of thermal dispersion is very small and is located mostly within the outfall. The temperature range exceeding 33°C encountered is shown in a narrow zone near the outfall. It is estimated that the mixing zone where strong mixing of effluents and ambient water occur during this season is limited just around the outfall.

As shown by the results, there is a very sharp decrease in the simulated water temperature both during tidal ebbing and flooding, thereby showing a limited area of influence.It should be noted that during this season, the occurrence of storms and other extreme weather conditions further limits the dispersion of the thermal effluents. Cooling of the thermal effluents is expected to be fast during this season and the potential problem of recirculation of the cooling water is avoided since the plume is dispersed away from the intake.

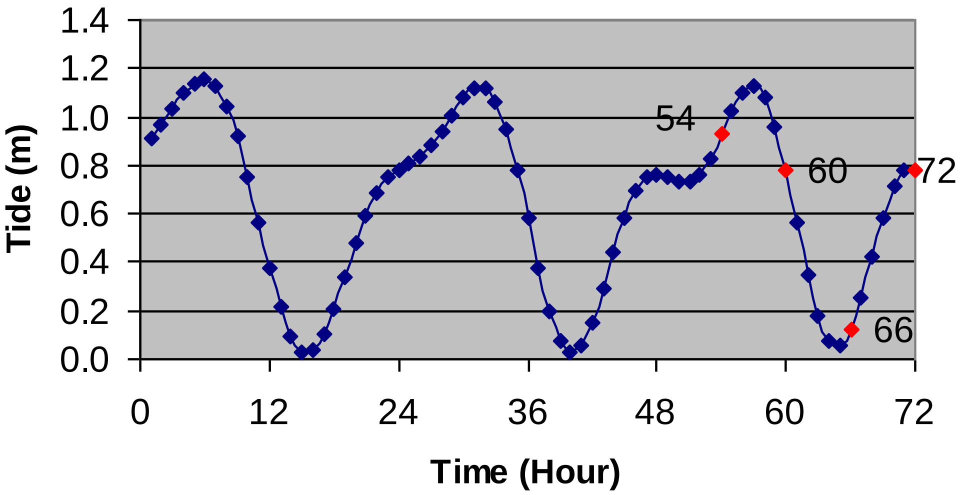


Figure 2-25:Tidal Stage for the Thermal Plume Dispersion Model

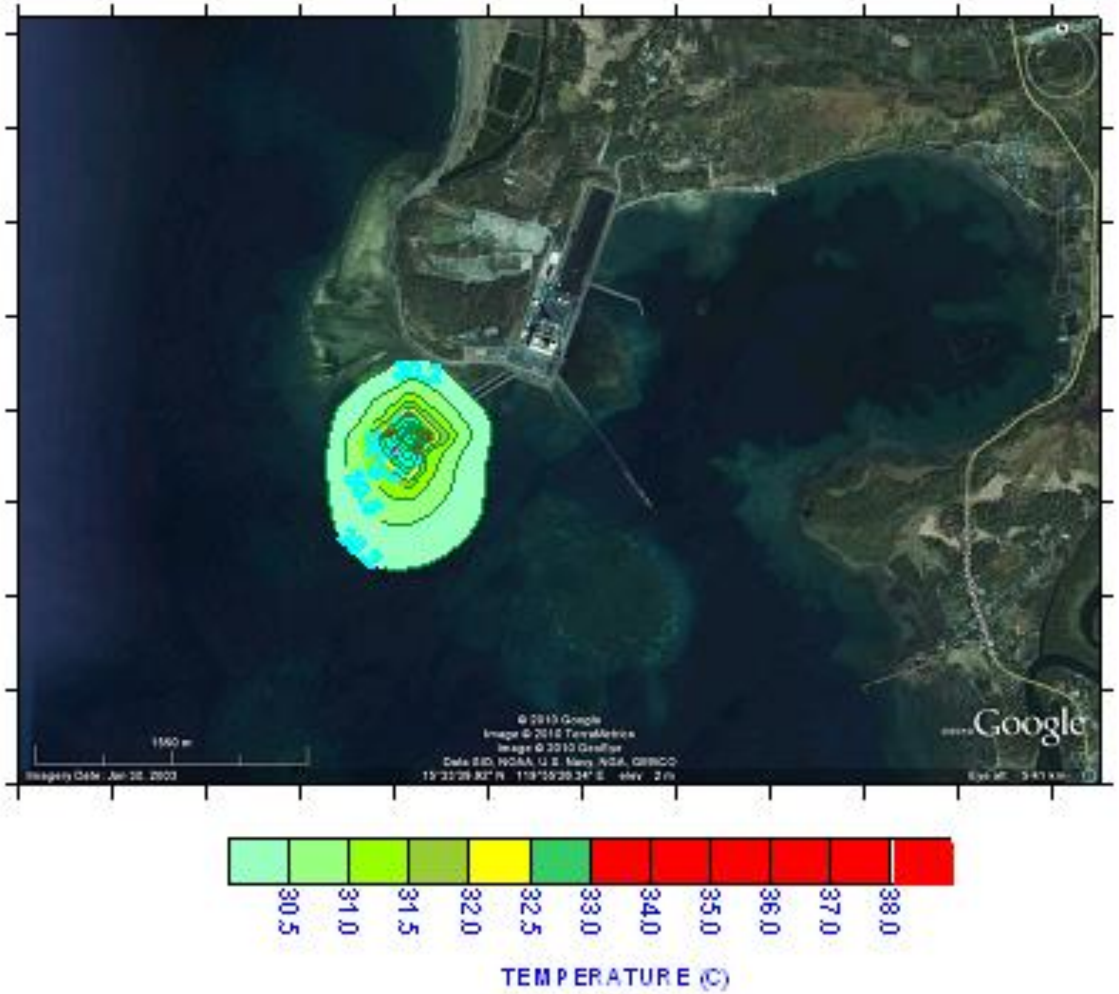


Figure 2-26: Predicted Thermal Plume Dispersion for NE Monsoon at Hour 54

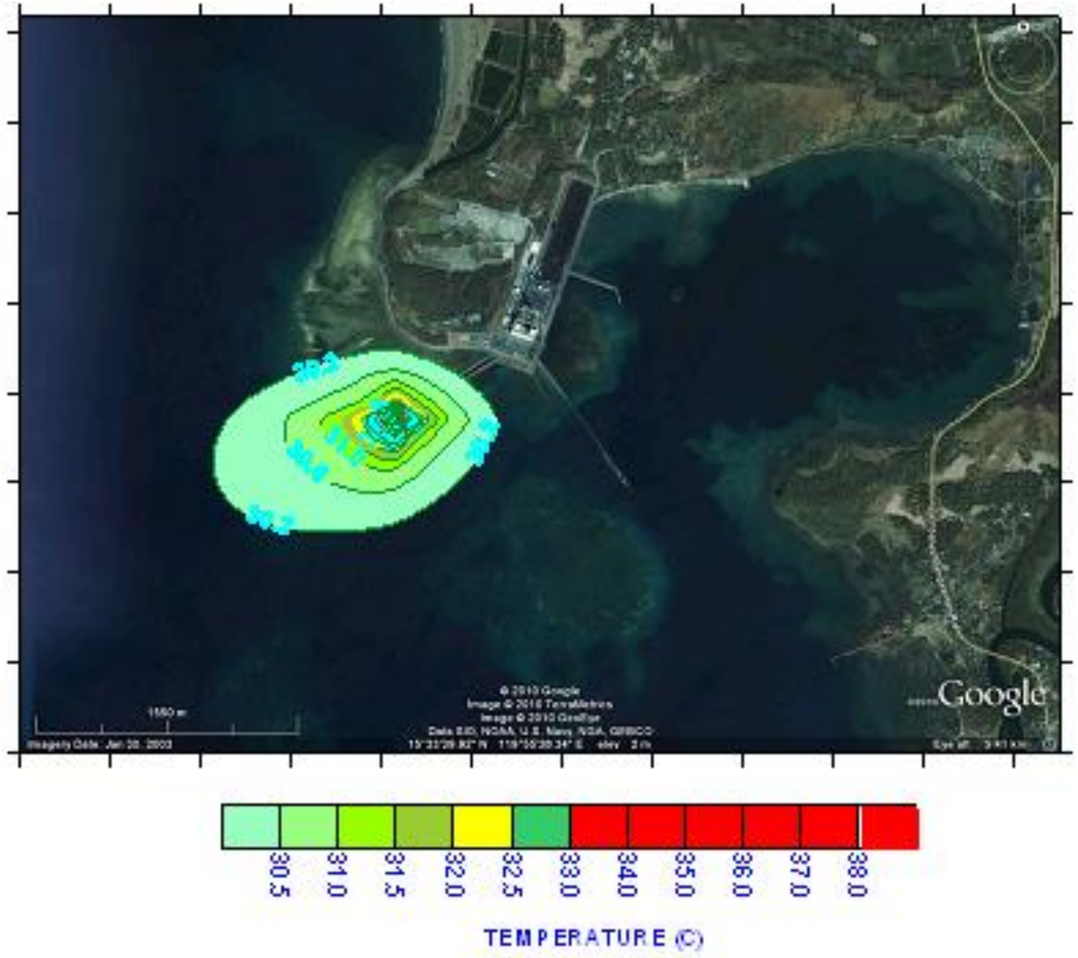


Figure 2-27:Predicted Thermal Plume Dispersion for NE Monsoon at Hour 60

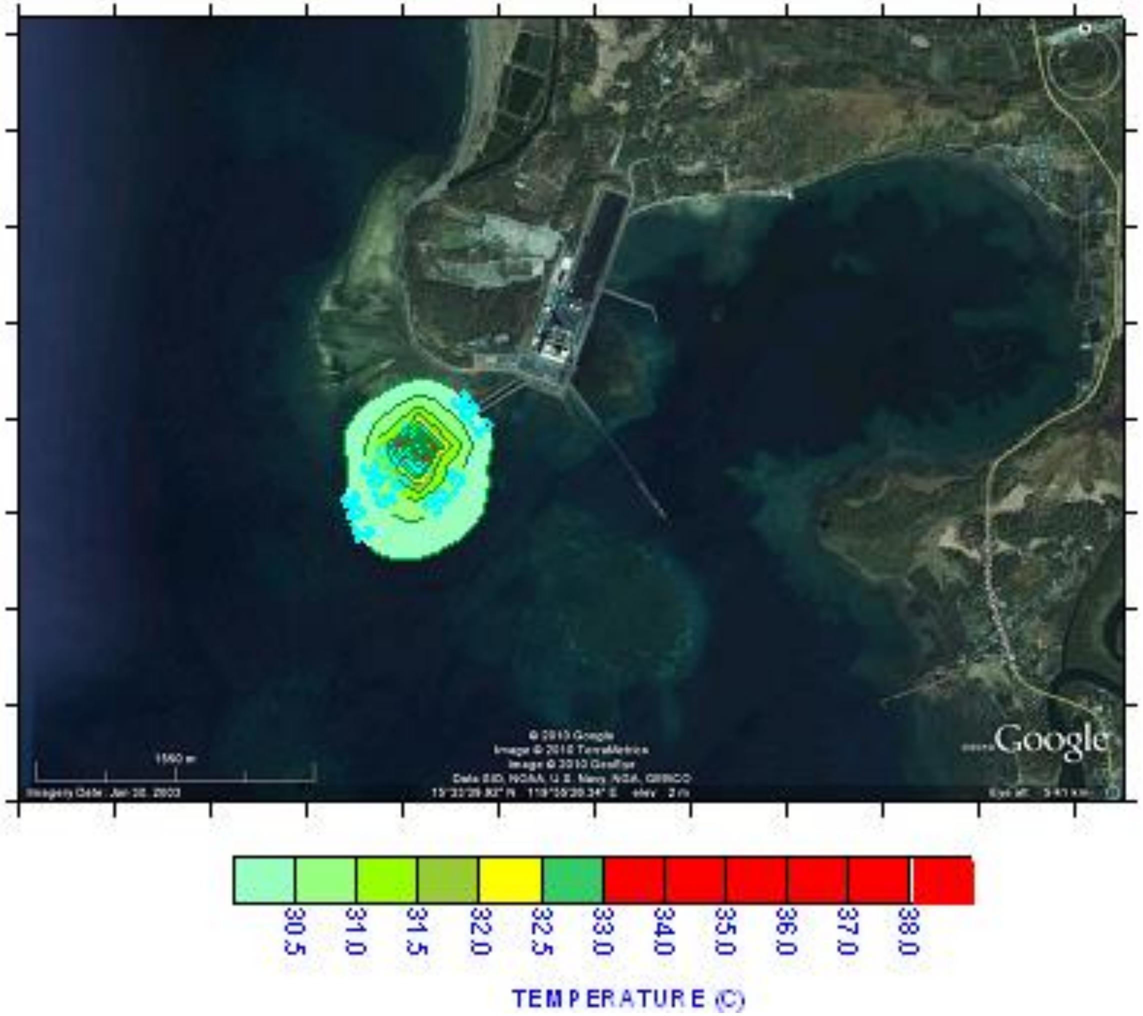


Figure 2-28: Predicted Thermal Plume Dispersion for NE Monsoon at Hour 66

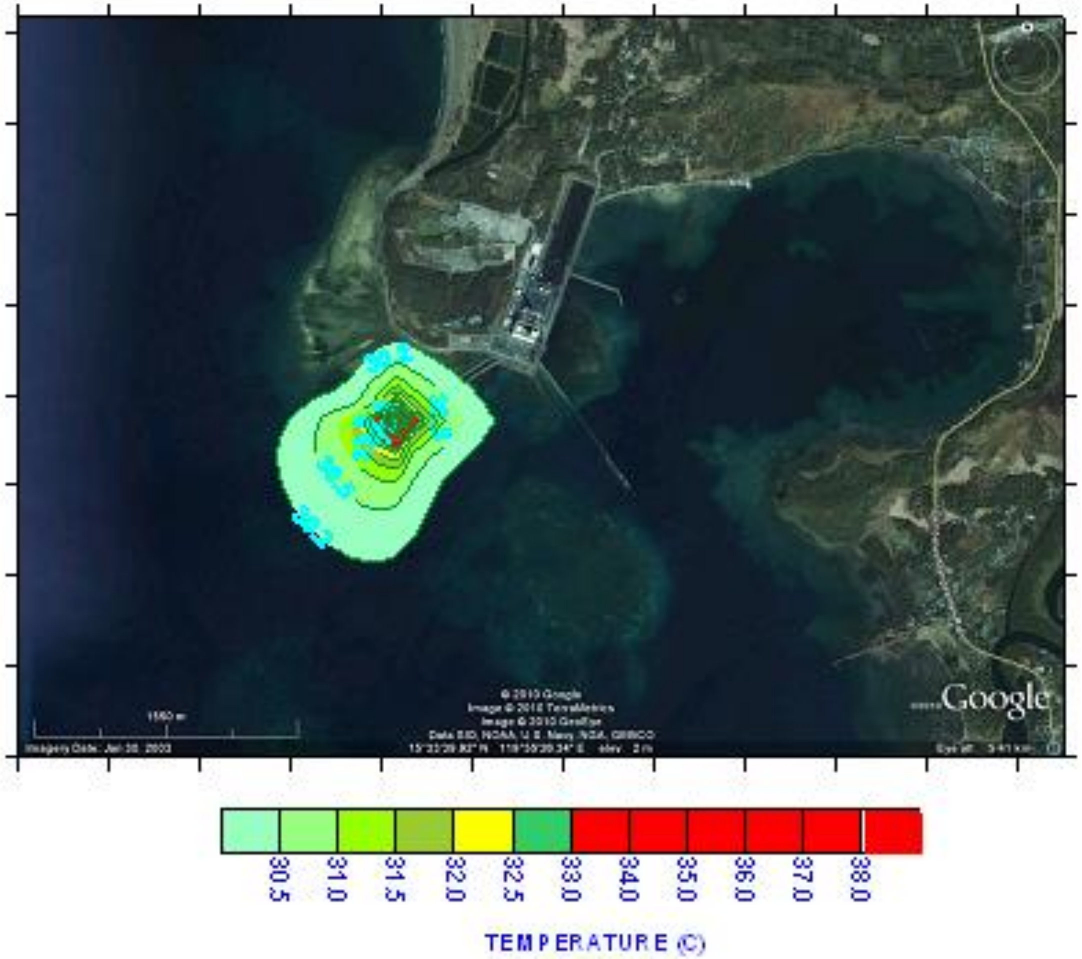


Figure 2-29: Predicted Thermal Plume Dispersion for NE Monsoon at Hour 72

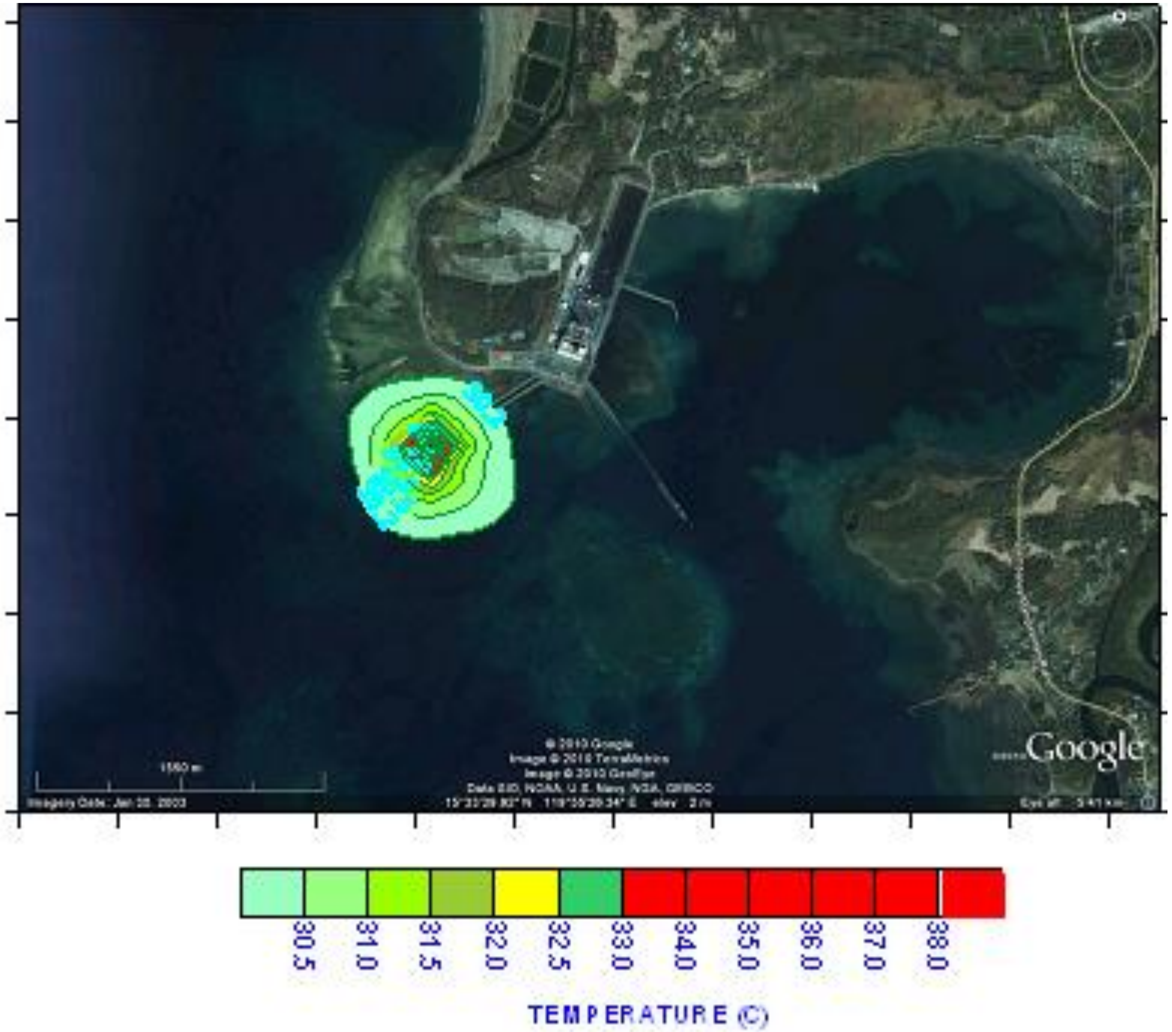


Figure 2-30: Predicted Thermal Plume Dispersion for SW Monsoon at Hour 54

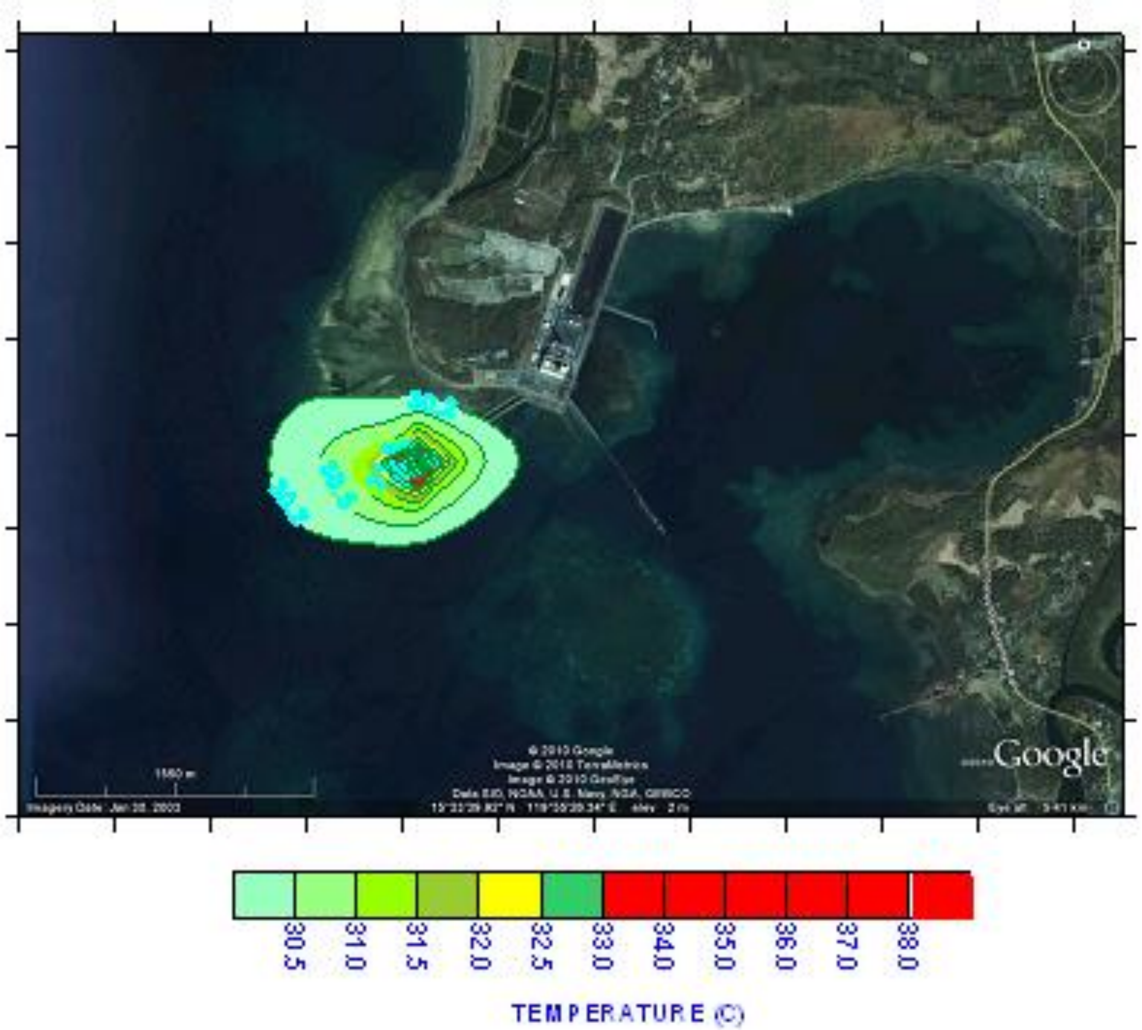


Figure 2-31: Predicted Thermal Plume Dispersion for SW Monsoon at Hour 60

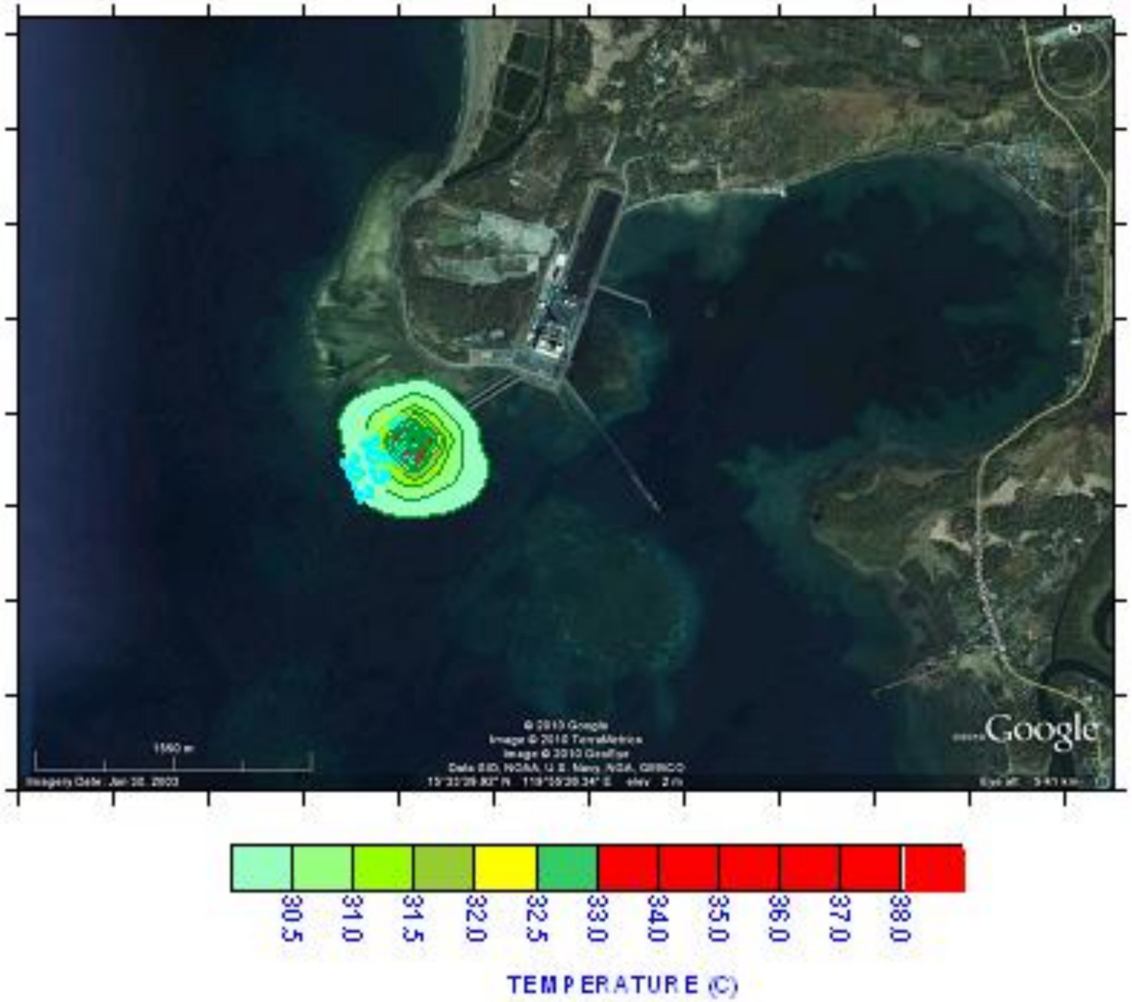


Figure 2-32: Predicted Thermal Plume Dispersion for SW Monsoon at Hour 66

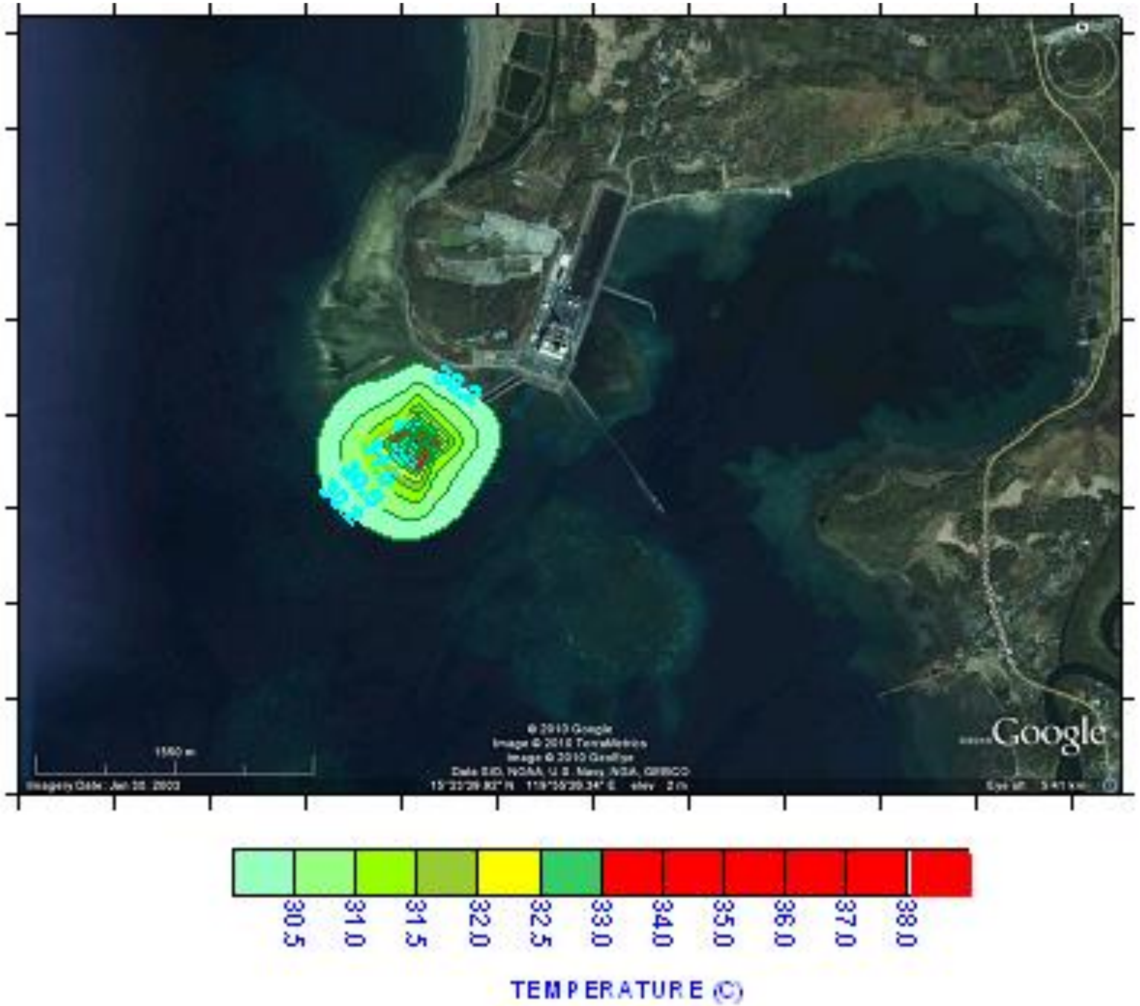


Figure 2-33: Predicted Thermal Plume Dispersion for SW Monsoon at Hour 72

Computed Mixing Zone

The mixing zone is generally defined as an area around the outfall where turbulent mixing of the thermal effluent and the receiving water body occurs and where existing water quality criteria are exceeded as long as no harmful effects on the biota are observed.

For thermal effluents, the Environmental Management Bureau (EMB) has a 3°C rise standard for temperature, which means that the mixing zone is an area around the outfall that exceedsthis standard. For the Masinloc Plant, the mixing zone for the discharge of the thermal effluent in Oyon Bay depends on the strength of the coastal currents that transport the cooling water and the wind speed that affects the rate of atmospheric exchange. These were simulated for the prevailing Amihan (NE Monsoon)and Habagat (SW Monsoon) seasons. The model was run for the projected 1,200 MW capacity assuming that the maximum design temperature of headed effluents to be discharged at the outfall is 40°C. The model results showed that during the NE Monsoon, the thermal plume extends farther offshore, and the predicted mixing zone associated with the 33°C thermal contour (3°C rise) is about 6 hectares (**Figure 2-34**). A relatively smaller area of thermal dispersion is simulated during the SW Monsoon season. However, the predicted thermal mixing zone for the 33°C thermal contour during this season is also about 6 ha (**Figure 2-35**).

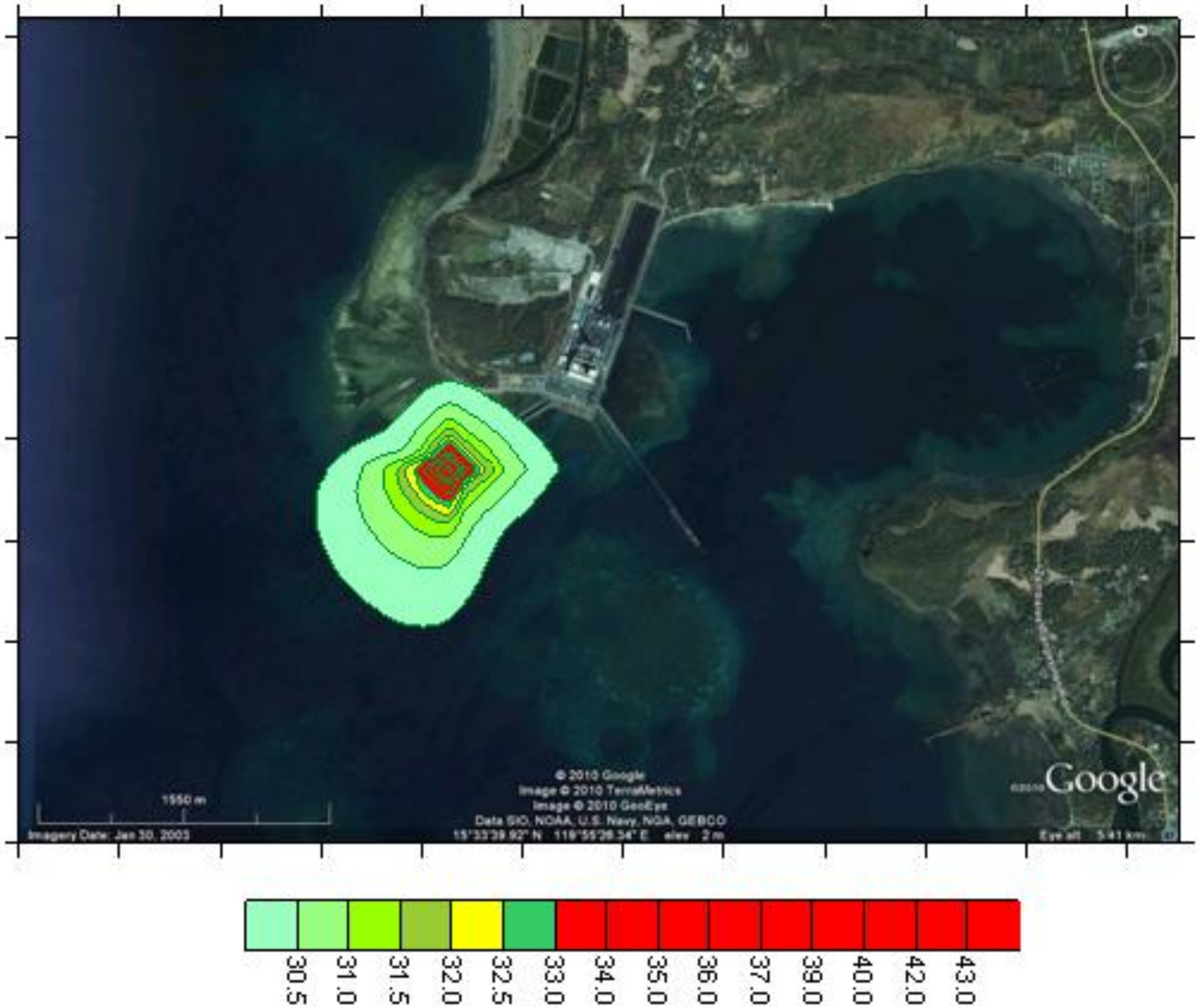


Figure 2-34: Simulated Thermal Plume Dispersion and Mixing Zone (red shade) during NE Monsoon

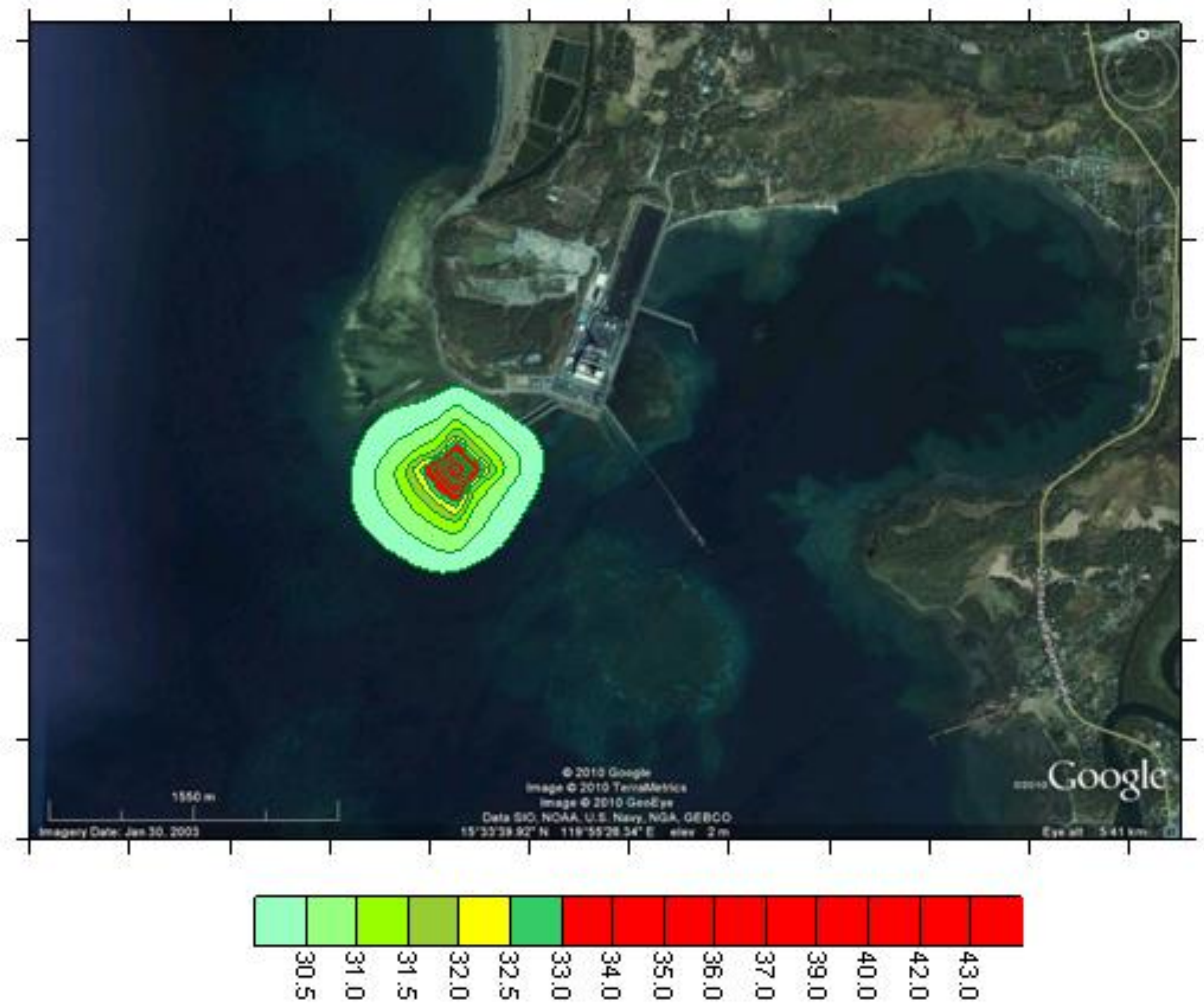


Figure 2-35: Simulated Thermal Plume Dispersion and Mixing Zone (red shade) during SW Monsoon

2.2.2.2 Trend Analysis

The ambient water temperature varies diurnally. Actual temperature measurements in Philippine coastal waters taken in the north-western coast of Luzon reveal a sinusoidal curve such as the one shown in **Figure 2-36**. The diurnal variation of the water temperature can be represented by a time series given by T = 29.7 + 1.25 sin ($2\pi t\Delta t$ / 86400). The observed temperature was taken in the coastal area of Bolinao, which is located north of the project site. Since the study area is relatively small, this can be assumed to represent the whole of Masinloc Bay. The data, with an average value of about 29.5°C, represent sea surface conditions in the study area during the summer.

Actual observations by the MMT in Masinloc (100 m from the Power Plant outfall) showed a fluctuating curve of surface water temperature with irregular occurrence of peaks as shown in **Figure 2-37**. The quarterly record covered the period from June 2003 until the December 2009. During this period, the temperature data taken near the outfall had a mean of about 30.7°C and maximum of about 34.3°C. If the mean water temperature of 29.5°C is used as basis for analysis, the overall mean is 1.2°C higher but is still **well below the prescribed 3°C** limit for coastal waters. The data showed that during the period of observation, only twice did the surface water temperature exceed the 3°C limit (34.3°C in July 2004 and 32.8°C in March 2007). Except for these two, most of the observed temperature did not exceed the ambient water quality criterion (shown by the green line in **Figure 2-37**) and are well below the prescribed limit.

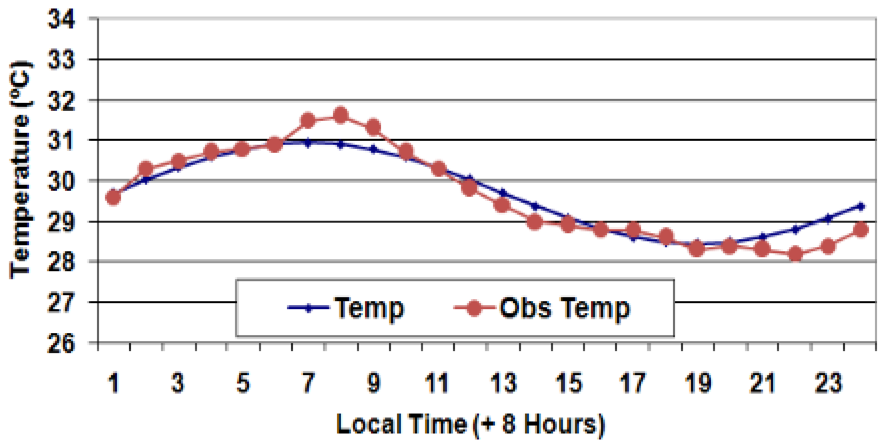


Figure 2-36: Diurnal Variation of Surface Water Temperature in North-western Luzon

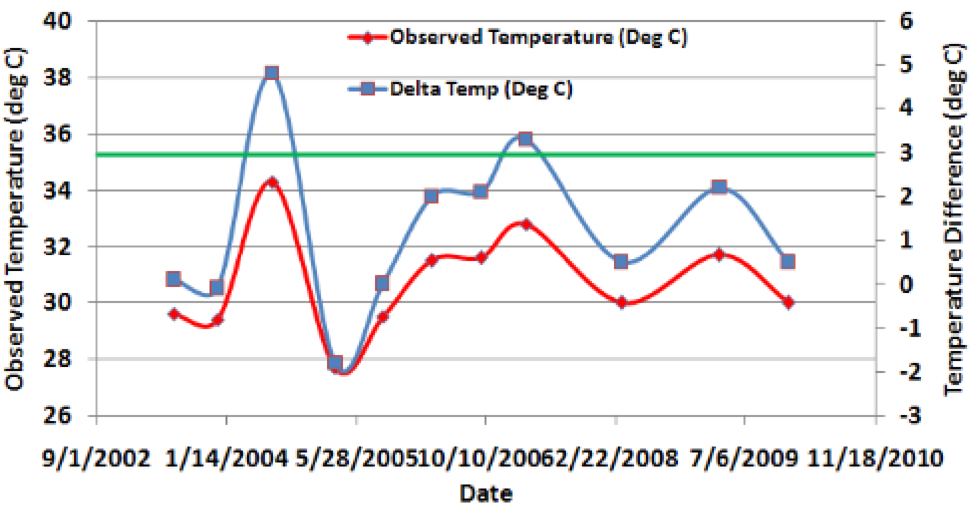


Figure 2-37: Observed Surface Water Temperature at 100 m Away from the Outfall of Masinloc Plant

2.2.3 Water Quality

2.2.3.1 Degradation of Surface Water Quality

The area has two major river systems, Lauis River which drains north of the Masinloc Plant and Masinloc River which drains southeast. The Masinloc Plant does not discharge into any of the nearby river systems.

Masinloc River is approximately two kilometers south of Barangay Bani in the Municipality of Masinloc. Masinloc River drains into Masinloc Bay. NPC's measurement of the discharge flow rate of this river (1978-1987), is 82,944 m^3/day.

Lauis River on the other hand originates from the watershed of Barangay Taltal, Municipality of Candelaria, Province of Zambales. The water quality of Lauis River is influenced by mining activities upstream from Acoje and Coto Nickel mines. The river has two tributaries, the North and the South and converges at about 11 kilometers towards the estuarine. With the surveyed discharge flow rate of Lauis River, it is considered as a source of process water for the Masinloc Plant.

Data for the physico-chemical properties of Lauis and Masinloc Rivers were based on the monitoring of the Masinloc Plant at identified sampling points and established sampling regimes.

Water quality data was also gathered within the Masinloc Plant from effluents (wastewater treatment facility, coal sedimentation basin, ash sedimentation basin, storm drain canal), domestic water, and groundwater.

2.2.3.1.1 Lauis River

The following water quality parameters were measured: ammonia, arsenic, barium, BOD, cadmium, chromium, color, dissolved copper, dissolved oxygen, fluoride, iron, lead, manganese, mercury, nickel nitrate, oil and grease, pH, phosphate, selenium, sulfate, temperature, total suspended solids, and zinc.

Freshwater sampling at Lauis River was conducted as part of the Masinloc Plant monitoring program. Three sampling points where established: LR-1 (Upstream of the freshwater intake) and LR-2 (Near the river mouth/nursery.

2.2.3.1.2 Masinloc River

The same parameters were observed for the Masinloc River. However, only one station was established for the quarterly monitoring, LR-3 (Under Collat Bridge). The following water quality parameters were measured: ammonia, arsenic, barium, BOD, cadmium, chromium, color, dissolved copper, dissolved oxygen, fluoride, iron, lead, manganese, mercury, nickel nitrate, oil and grease, pH, phosphate, selenium, sulfate, temperature, total suspended solids, and zinc.

The river water quality sampling stations are presented in Figure 2-38.

2.2.3.1.3 Results

Table 2-21 shows the results for the quarterly monitoring conducted for the project from the 1st quarter of 2019 u to the 4th quarter of 2019. Results show that the water quality from the freshwater sampling stations is within the DENR Water Quality Guidelines under DAO 2016-08. A slight exceedance, however, was observed in LR-1 for the 3rd 2019 monitoring period for pH. The recorded pH for the said sampling period was measured at 8.6 with the DENR WQG for pH at 8.5.

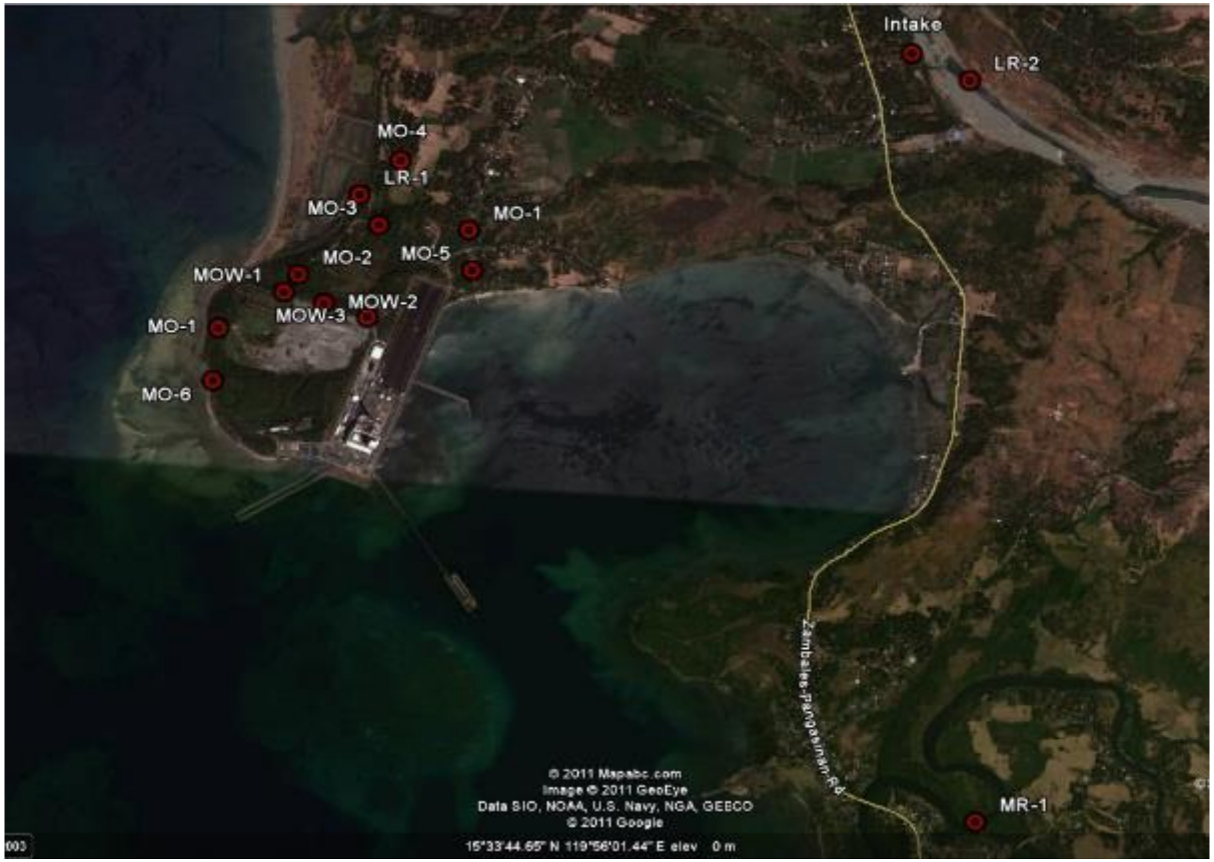


Figure 2-38: Surface Water, Groundwater and Freshwater Ecology Monitoring Stations

Table 2-21: Results of Freshwater Quality Monitoring 1st Quarter 2019-4th Quarter 2019

1 Ammonia (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.05	-	-	<0.003	-
LR 2	0.05	-	-	<0.003	-
LR 3	0.05	-	-	<0.003	-

2 Arsenic (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.01	<0.008	<0.008	<0.008	<0.008
LR 2	0.01	<0.008	<0.008	<0.008	<0.008
LR 3	0.01	<0.008	<0.008	<0.008	<0.008

3 Barium (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.7	<0.005	<0.005	<0.005	<0.005
LR 2	0.7	0.010	0.010	<0.005	<0.005
LR 3	0.7	-	0.010	<0.005	<0.005

4 BOD (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	5	<1	<1	2.00	1.00
LR 2	5	2.00	<1	2.00	1.00
LR 3	5	<1	1.00	2.00	1.00

5 Cd (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.003	<0.001	<0.001	<0.001	<0.001
LR 2	0.003	<0.001	<0.001	<0.001	<0.001
LR 3	0.003	<0.001	<0.001	<0.001	<0.001

6 Cr6+ (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.01	<0.002	<0.002	<0.002	<0.002
LR 2	0.01	<0.002	<0.002	<0.002	<0.002
LR 3	0.01	<0.002	<0.002	<0.002	<0.002

13 Manganese (mg/L)	Standard				

7 Color, TCU	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	50	5.00	5.00	5.00	5.00
LR 2	50	10.00	15.00	10.00	10.00
LR 3	50	5.00	10.00	10.00	8.00

8 Dissolved Copper (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.02	<0.003	-	<0.003	<0.003
LR 2	0.02	<0.003	-	<0.003	<0.003
LR 3	0.02	<0.003	-	<0.003	<0.003

9 Dissolved Oxygen (mg/L)	Standard				
Sampling Station	(min)	Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	5	8	8	8	8
LR 2	5	7	6	8	8
LR 3	5	8	5	8	7

10 Fluoride (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	1	-	-	<0.02	0.10
LR 2	1	-	-	0.40	0.50
LR 3	1	-	-	0.20	0.70

11 Iron (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	1	0.03	-	0.08	0.05
LR 2	1	0.03	-	0.20	0.05
LR 3	1	0.03	-	0.30	0.02

12 Lead (mg/L)	Standard					
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019	Q4 2019
LR 1	0.01	<0.005	<0.005	<0.005	<0.005	7.10
LR 2	0.01	<0.005	<0.005	<0.005	<0.005	7.90
LR 3	0.01	<0.005	<0.005	<0.005	<0.005	7.20

19 Phosphate (mg/L)	Standard				

Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.2	0.004	-	0.005	0.008
LR 2	0.2	0.200	-	0.020	0.010
LR 3	0.2	0.010	-	0.010	0.007

14	Mercury (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	0.001	<0.0002	<0.0002	<0.0002	<0.0002
	LR 2	0.001	<0.0002	<0.0002	<0.0002	<0.0002
	LR 3	0.001	<0.0002	<0.0002	<0.0002	<0.0002

15	Nickel (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	0.04	<0.003	<0.003	<0.003	<0.003
	LR 2	0.04	0.007	<0.003	0.007	0.004
	LR 3	0.04	<0.003	0.004	0.007	0.005

16	Nitrate (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	7	0.06	0.10	0.08	0.50
	LR 2	7	0.50	0.10	0.10	<.02
	LR 3	7	0.08	0.10	0.10	0.10

17	Oil and Grease (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	1	0.84	0.76	0.72	-
	LR 2	1	0.55	0.67	0.85	-
	LR 3	1	0.56	0.66	0.74	-

18	pH	Standard					
	Sampling Station	LL	UL	Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	6.5	8.5	8.50	8.6	8.20	7.10
	LR 2	6.5	8.5	7.90	7.5	7.90	7.90
	LR 3	6.5	8.5	8.10	7.6	7.80	7.20

Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
LR 1	0.5	<0.01	<0.01	0.02	<0.01
LR 2	0.5	<0.01	0.02	0.02	<0.01
LR 3	0.5	<0.01	0.04	0.02	<0.01

20	Selenium (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	0.01	<0.01	<0.01	<0.01	<0.01
	LR 2	0.01	<0.01	<0.01	<0.01	<0.01
	LR 3	0.01	<0.01	<0.01	<0.01	<0.01

21	Sulfate (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	250	-	-	<5.0	-
	LR 2	250	-	-	161	-
	LR 3	250	-	-	113	-

22	Temperature, °C	Standard				
	Sampling Station	LL	Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1		29.00	29.90	27.70	28.60
	LR 2		30.50	30.80	31.20	30.50
	LR 3		30.00	30.40	29.80	32.20

23	TSS (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	65	4.00	<2.5	<2.5	7.00
	LR 2	65	31.00	30.00	5.00	7.00
	LR 3	65	21.00	43.00	9.00	23.00

24	Zinc (mg/L)	Standard				
	Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
	LR 1	2	0.010	-	0.010	0.010
	LR 2	2	0.006	-	0.006	<.0.005
	LR 3	2	<.0.005	-	0.010	<.0.005

2.2.3.2 Degradation of Groundwater Quality

2.2.3.2.1 Groundwater Quality

Nine areas were identified as sampling stations to monitor the following: arsenic, cadmium, lead, mercury, chromium Hexavalent, pH, conductivity, chloride, sulfate, sodium, total hardness. All parameters were compliant with DENR standards (**Table 2-22**).

2.2.3.2.2 Domestic Water

Parameters measured for the domestic water and analyzed in the laboratory were the following: pH, turbidity, total suspended solids, arsenic, cadmium, chromium, lead and mercury. All parameters were compliant with DENR standards. (**Table 2-23**)

Domestic Water sources include:

- Masinloc Water District
- Candelaria Water District
- Palauig Water District
- Resettlement area
- Laboratory building
- Guesthouse

Table 2-22: Results of Ground Water Quality Monitoring 1st Quarter 2019-4th Quarter 2019

1 Arsenic (mg/L)

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	0.010	0.0040	<0.008	0.008
MO 1	<0.008	0.0047	<0.008	<0.008
MO 2	<0.008	0.0031	<0.008	<0.008
MO 3	<0.008	0.0025	<0.008	<0.008
MO 5	<0.008	0.0014	<0.008	<0.008
MO 6	<0.008	0.0067	<0.008	<0.008
MOW 1	<0.008	0.0045	<0.008	<0.008
MOW 2	<0.008	0.0025		<0.008
	<0.008	0.0024	<0.008	<0.008

4 Mercury (mg/L)

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	<0.0002	<0.0002	<0.0002	<0.0002
MO 1	<0.0002	<0.0002	<0.0002	<0.0002
MO 2	<0.0002	<0.0002	<0.0002	<0.0002
MO 3	<0.0002	<0.0002	<0.0002	<0.0002
MO 5	<0.0002	<0.0002	<0.0002	<0.0002
MO 6	<0.0002	<0.0002	<0.0002	<0.0002
MOW 1	<0.0002	<0.0002	<0.0002	<0.0002
MOW 2	<0.0002	<0.0002		<0.0002
MOW 3	<0.0002	<0.0002	<0.0002	<0.0002

2 Cadmium (mg/L)

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	<0.001	-	<0.001	<0.001
MO 1	<0.001	-	<0.001	<0.001
MO 2	<0.001	-	<0.001	<0.001
MO 3	<0.001	-	<0.001	0.003
MO 5	<0.001	-	<0.001	<0.001
MO 6	0.003	-	<0.001	<0.001
MOW 1	<0.001	-	<0.001	<0.001
MOW 2	<0.001	-		<0.001
MOW 3	<0.001	-	<0.001	<0.001

5 Cr6+ (mg/L)

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	<0.005	-	<0.005	<0.005
MO 1	<0.005	-	<0.005	<0.005
MO 2	<0.005	-	<0.005	<0.005
MO 3	<0.005	-	<0.005	<0.005
MO 5	<0.005	-	<0.005	<0.005
MO 6	0.008	-	<0.005	<0.005
MOW 1	<0.005	-	<0.005	<0.005
MOW 2	<0.005	-		<0.005
MOW 3	<0.005	-	<0.005	<0.005

3 Lead (mg/L)

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	0.008	-	<0.005	<0.005
MO 1	<0.005	-	<0.005	<0.005
MO 2	<0.005	-	<0.005	<0.005
MO 3	<0.005	-	<0.005	<0.005
MO 5	<0.005	-	<0.005	<0.005
MO 6	<0.005	-	<0.005	<0.005
MOW 1	<0.005	-	<0.005	<0.005
MOW 2	0.400	-		0.400
MOW 3	0.090	-	<0.005	<0.005

6 pH

Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	7.4	7.3	7.4	7.4
MO 1	6.6	7.6	6.7	6.6
MO 2	8.0	8.0	7.3	8.1
MO 3	7.3	8.0	6.9	7.1
MO 5	6.8	6.7	6.3	6.7
MO 6	6.9	6.2	5.8	6.0
MOW 1	8.0	7.9	8.0	8.0
MOW 2	7.2	7.2		7.5
MOW 3	7.7	7.7	7.5	7.7

7

Conductivity, mSiemens/cm				
Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	0.971	0.931	0.908	0.903
MO 1	0.664	0.736	0.599	0.638
MO 2	1.190	1.170	0.194	1.190
MO 3	0.956	1.640	0.406	0.410
MO 5	0.986	1.260	0.277	0.823
MO 6	5.120	5.850	4.140	3.990
MOW 1	1.340	1.390	1.170	1.130
MOW 2	5.430	5.500		5.580
MOW 3	1.320	1.330	1.270	1.270

8

Chloride (mg/L)				
Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	27	25	21	29
MO 1	19	16	20	21
MO 2	191	191	7	239
MO 3	17	12	11	4
MO 5	37	56	7	22
MO 6	385	675	456	243
MOW 1	21	19	25	34
MOW 2	1,220	1,350		1,360
MOW 3	18	20	22	23

9

Sulfate (mg/L)				
Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	26	19	11	27
MO 1	42	79	16	14
MO 2	71	48	28	56
MO 3	160	557	28	28
MO 5	105	246	14	66
MO 6	2,380	1,970	1,510	865
MOW 1	389	716	269	179
MOW 2	277	500		263
MOW 3	467	464	322	261

10

Sodium Chloride (mg/L)				
Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	44	41	35	48
MO 1	31	26	32	34
MO 2	316	315	12	394
MO 3	28	19	18	6
MO 5	61	93	11	37
MO 6	635	1,110	456	400
MOW 1	35	31	41	56
MOW 2	2,010	2,230		2,250
MOW 3	30	33	32	38

11

Total Hardness (CaCO3)				
Sampling Station	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MD 1	240.00	350.00	350.00	310.00
MO 1	228.00	316.00	244.00	272.00
MO 2	120.00	196.00	52.00	192.00
MO 3	232.00	580.00	128.00	120.00
MO 5	200.00	460.00	106.00	360.00
MO 6	1,470.00	1,240.00	760.00	1,960.00
MOW 1	330.00	160.00	400.00	380.00
MOW 2	212.00	276.00		244.00
MOW 3	280.00	540.00	440.00	560.00

Table 2-23: Results of Domestic Water Quality Monitoring 1st Quarter 2019-4th Quarter 2019

CWD	Standard					
Sampling Station	LL	UL	Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	6.5	8.5	8.30	8.20	7.80	7.50
CWD	6.5	8.5	8.00	8.00	7.90	7.60
PWD	6.5	8.5	7.80	8.10	7.90	7.10
RES	6.5	8.5	7.10	7.20	7.00	6.80
LAB	6.5	8.5	8.20	8.20	7.80	7.30
GH (Housing)	6.5	8.5	8.00	7.80	7.80	7.60

Cd (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	0.003	<0.001	0.0001	<0.001	<0.001
CWD	0.003	<0.001	-	<0.001	<0.001
PWD	0.003	<0.001	-	<0.001	<0.001
RES	0.003	<0.001	-	<0.001	<0.001
LAB	0.003	<0.001	-	<0.001	<0.001
GH (Housing)	0.003	<0.001	-	<0.001	<0.001

Turbidity NTU	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	5	0.85	0.45	0.45	0.45
CWD	5	0.40	0.20	0.55	0.20
PWD	5	0.60	1.80	1.10	1.40
RES	5	2.30	6.10	2.00	2.00
LAB	5	0.30	0.15	0.65	0.20
GH (Housing)	5	0.60	0.20	0.45	0.25

Cr6+ (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	0.05	0.006	0.0047	0.0050	0.0060
CWD	0.05	<0.005	-	<0.005	<0.005
PWD	0.05	<0.005	-	<0.005	<0.005
RES	0.05	<0.005	-	<0.005	<0.005
LAB	0.05	<0.005	-	<0.005	<0.005
GH (Housing)	0.05	<0.005	0.0003	<0.005	<0.005

TSS (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD		<2.5	<2.5	<2.5	<2.5
CWD		<2.5	<2.5	<2.5	<2.5
PWD		2.50	9.00	<2.5	1.00
RES		<2.5	7.00	3.00	<2.5
LAB		<2.5	<2.5	<2.5	<2.5
GH (Housing)		<2.5	<2.5	<2.5	<2.5

Pb (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	0.01	<0.005	-	<0.005	<0.005
CWD	0.01	<0.005	-	<0.005	<0.005
PWD	0.01	<0.005	-	<0.005	<0.005
RES	0.01	<0.005	-	<0.005	<0.005
LAB	0.01	<0.005	-	<0.005	<0.005
GH (Housing)	0.01	<0.005	-	<0.005	<0.005

As (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	0.01	<0.008	0.0065	<0.008	<0.008
CWD	0.01	<0.008	0.0043	<0.008	<0.008
PWD	0.01	<0.008	0.0017	<0.008	<0.008
RES	0.01	<0.008	0.0024	<0.008	<0.008
LAB	0.01	<0.008	0.0039	<0.008	<0.008
GH (Housing)	0.01	<0.008	0.0038	<0.008	<0.008

Hg (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
MWD	0.001	<0.0002	<0.0002	<0.0002	<0.0002
CWD	0.001	<0.0002	<0.0002	<0.0002	<0.0002
PWD	0.001	<0.0002	<0.0002	<0.0002	<0.0002
RES	0.001	<0.0002	<0.0002	<0.0002	<0.0002
LAB	0.001	<0.0002	<0.0002	<0.0002	<0.0002
GH (Housing)	0.001	<0.0002	<0.0002	<0.0002	<0.0002

MD 1	Near Main Gate, Right
MO 1	Bani Point (After Ash Disposal Area)
MO 2	MCFTPP Nursery
MO 3	Between Corafer and Duhok
MO 5	Bani PNP Patrol Base
MO 6	Bani
MOW 1	Bani (near Sedimentation Basin)
MOW 2	Bani (along embankment)
MOW 3	Bani (near warehouse)

2.2.3.3 Degradation of Coastal/Marine Water Quality

The EMB requires the semi-annual water quality monitoring program for the Masinloc Plant (). Monitoring is implemented to ensure the effectiveness of pollution control measures and ensure that the DENR water quality limits are not violated. Twelve (12) monitoring stations (M1 to M12) were covered during all the sampling events (**Table 2-24** and **Figure 2-39**).

Table 2-24: Marine Water Quality Monitoring Stations

Station	Coordinates		Location
	Latitude	Longitude	
M1	15°34'34.26"	119°54'50.91"	Between Lauis River and Bani Point
M2	15°33'29.27"	119°54'59.65"	Outfall (100m from discharge canal)
M3	15°33'29.95"	119°55'33.14"	Cooling Water Intake
M4	15°34'18.53"	119°56'44.60"	Resettlement in Barangay Taltal
M5	15°34'02.19"	119°56'00.11"	C-Square in Barangay Bani; Benguet Loading Area for mining activity
M6	15°33'45.36"	119°57'00.28"	Front of Puerto Asinan Resort in Barangay Baloganon
M7	15°32'46.60"	119°56'26.90"	Benguet Wharf in Barangay Baloganon; with mining activity
M8	15°32'23.85"	119°56'48.99"	Near the mouth of Masinloc River
M9	15°31'11.40"	119°57'33.10"	Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor)
M10	15°30'20.13"	119°57'33.46"	Between fish cages in Barangay Banban; BFAR station
M11	15°30'13.01"	119°54'51.36"	Near San Salvador Island
M12	15°29'48.29"	119°54'12.76"	Near Magalawa Island, Palauig; along Veritas

Table 2-25: DENR Water Quality Criteria for Class SC Coastal and Marine Waters

Parameter	Criteria
Temperature (max. rise in deg. Celsius)	3
pH (range)	6.0-8.5
Dissolved Oxygen (minimum)	5.0 mg/L
Total Suspended Solids (maximum % increase over seasonal average concentration)	10
Oil/Grease (Petroleum Ether Extract)	3 mg/L
Total Coliform	5,000 MPN/100 mL
Fecal Coliform	--
Arsenic	0.05 mg/L
Cadmium	0.01 mg/L
Chromium (Hexavalent)	0.1 mg/L
Copper	0.05 mg/L
Lead	0.05 mg/L
Total Mercury	0.002 mg/L

2.2.3.3.1 Results

Table 2-26 shows the results of the marine water monitoring conducted from 1st quarter 2019 up to 4th quarter 2019. Results show that most samples taken from the monitoring stations are compliant with the DENR WQG. One exceedance was noted for Iron during the 1^{st} quarter 2019 monitoring for station M4. The recorded iron level for that period and station is at 5 mg/L while the DENR standard is at 1.5 mg/L.

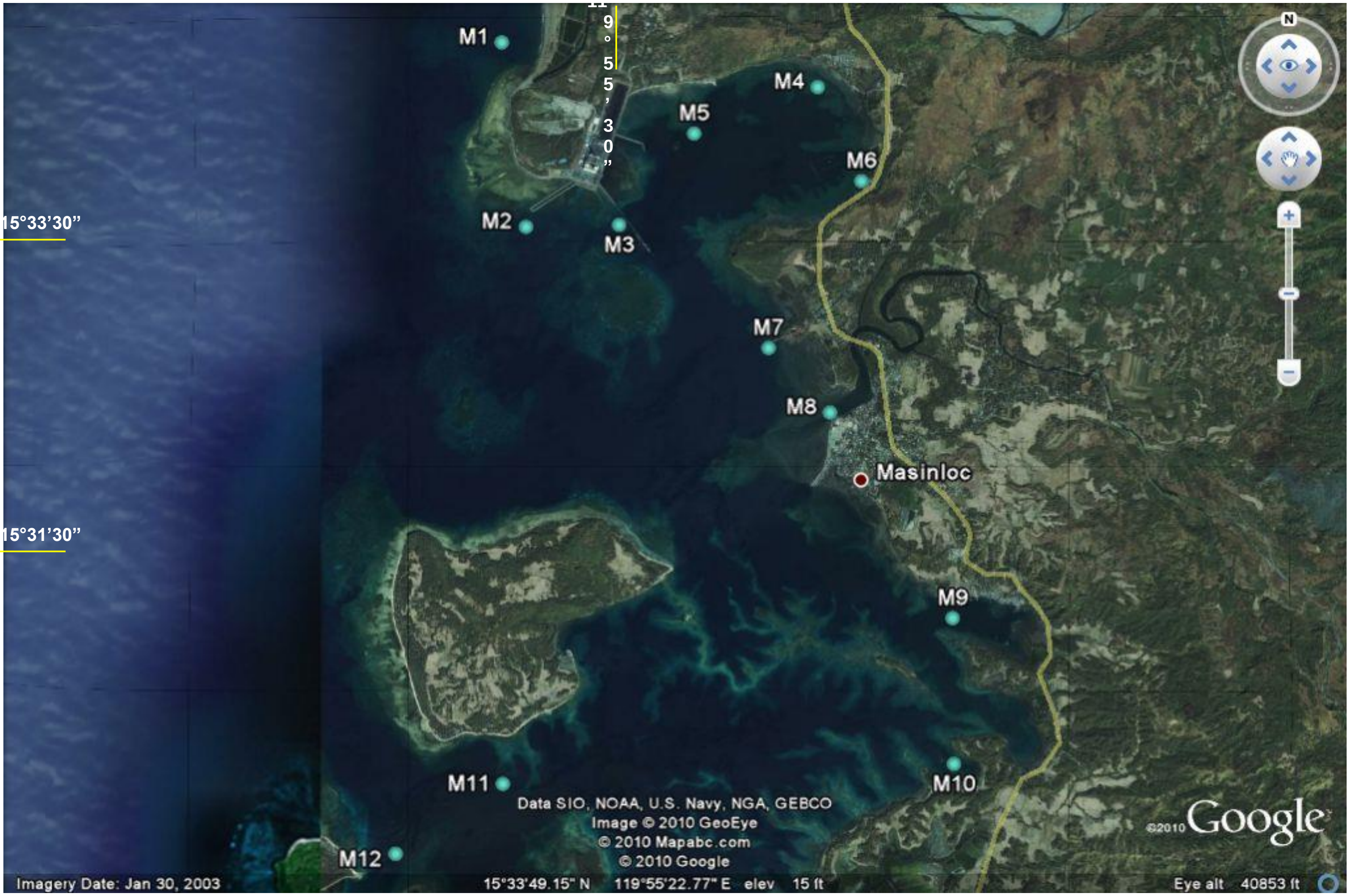


Figure 2-39: Masinloc Plant Marine Water Quality and Ecology Monitoring Stations

Table 2-26: Results of Marine Water Quality Monitoring 1st Quarter 2019-4th Quarter 2019

1

Ammonia (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.05	-	-	0.02	<..003
M2	0.05	-	-	0.03	<..003
M3	0.05	-	-	0.02	<..003
M4	0.05	-	-	<..003	<..003
M5	0.05	-	-	0.01	<..003
M6	0.05	-	-	0.02	<..003
M7	0.05	-	-	0.03	<..003
M8	0.05	-	-		<..003
M9	0.05	-	-	0.01	<..003
M10	0.05	-	-	<..003	<..003
M11	0.05	-	-	<..003	<..003
M12	0.05	-	-	0.02	<..003

2

Arsenic (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.02	<0.008	<0.008	<0.008	<0.008
M2	0.02	<0.008	<0.008	<0.008	<0.008
M3	0.02	<0.008	<0.008	<0.008	<0.008
M4	0.02	<0.008	<0.008	<0.008	<0.008
M5	0.02	<0.008	<0.008	<0.008	<0.008
M6	0.02	<0.008	<0.008	<0.008	<0.008
M7	0.02	<0.008	0.009	<0.008	<0.008
M8	0.02	<0.008	<0.008	-	<0.008
M9	0.02	<0.008	<0.008	<0.008	<0.008
M10	0.02	<0.008	<0.008	<0.008	<0.008
M11	0.02	<0.008	<0.008	<0.008	<0.008
M12	0.02	<0.008	<0.008	<0.008	<0.008

3

Barium (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	1	0.008	0.007	<0.005	<0.005
M2	1	0.008	0.007	<0.005	<0.005
M3	1	0.008	0.006	<0.005	<0.005
M4	1	0.009	0.006	<0.005	<0.005
M5	1	0.009	0.007	<0.005	<0.005
M6	1	0.007	0.007	0.005	<0.005
M7	1	0.007	0.001	0.006	<0.005
M8	1	0.009	0.004		<0.005
M9	1	0.008	-	0.006	<0.005
M10	1	0.008	0.009	0.005	<0.005
M11	1	<0.005	0.007	0.005	<0.005
M12	1	<0.005	0.007	0.006	<0.005

4

Boron (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	5	4.30	3.70	1.70	<0.21
M2	5	4.10	2.80	1.70	<0.21
M3	5	3.70	2.90	1.90	<0.21
M4	5	3.70	2.40	1.80	0.10
M5	5	3.60	2.90	1.70	0.40
M6	5	3.80	3.00	1.90	<0.21
M7	5	3.90	3.00	1.50	0.10
M8	5	3.50	2.90		<0.21
M9	5	3.70	2.60	1.90	0.30
M10	5	3.80	3.00	1.50	<0.21
M11	5	3.50	1.70	2.00	0.20
M12	5	3.40	3.20	1.90	0.20

5

Lead (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.05	<0.005		<0.005	<0.005
M2	0.05	<0.005	<0.005	<0.005	<0.005
M3	0.05	<0.005	<0.005	<0.005	<0.005
M4	0.05	<0.005	<0.005	<0.005	<0.005
M5	0.05	<0.005	<0.005	<0.005	<0.005
M6	0.05	<0.005	<0.005	<0.005	<0.005
M7	0.05	<0.005	<0.005	<0.005	<0.005
M8	0.05	<0.005	<0.005		<0.005
M9	0.05	<0.005	<0.005	<0.005	<0.005
M10	0.05	<0.005	<0.005	<0.005	<0.005
M11	0.05	<0.005	<0.005	<0.005	<0.005
M12	0.05	<0.005	<0.005	<0.005	<0.005

6

Manganese (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.4	0.005	0.003	<0.003	0.003
M2	0.4	0.005	0.001	<0.003	<0.003
M3	0.4	0.003	<0.003	<0.003	<0.004
M4	0.4	0.004	0.004	0.004	0.005
M5	0.4	0.004	0.005	<0.003	<0.003
M6	0.4	<0.003	0.006	0.005	<0.003
M7	0.4	<0.003	0.007	0.010	0.010
M8	0.4	<0.003	0.004		0.003
M9	0.4	<0.003	0.004	0.008	<0.003
M10	0.4	<0.003	0.010	0.007	<0.003
M11	0.4	<0.003	0.006	0.003	<0.003
M12	0.4	<0.003	0.005	0.005	<0.003

7

Mercury (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.002	<0.0002		<0.0002	0.0005
M2	0.002	<0.0002	<0.0002	<0.0002	0.0005
M3	0.002	<0.0002	<0.0002	<0.0002	0.0030
M4	0.002	<0.0002	<0.0002	<0.0002	0.0002
M5	0.002	<0.0002	<0.0002	<0.0002	0.0003
M6	0.002	<0.0002	<0.0002	<0.0002	0.0003
M7	0.002	<0.0002	<0.0002	<0.0002	0.0002
M8	0.002	<0.0002	<0.0002		<0.0002
M9	0.002	<0.0002	<0.0002	<0.0002	0.0005
M10	0.002	<0.0002	<0.0002	<0.0002	0.0004
M11	0.002	<0.0002	<0.0002	<0.0002	0.0009
M12	0.002	<0.0002	<0.0002	<0.0002	0.0004

8

Nickel (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.06	<0.003	<0.003	<0.003	<0.003
M2	0.06	<0.003	<0.003	<0.003	<0.003
M3	0.06	<0.003	<0.003	<0.003	<0.003
M4	0.06	<0.003	<0.003	<0.003	<0.003
M5	0.06	<0.003	<0.003	<0.003	<0.003
M6	0.06	<0.003	<0.003	<0.003	<0.003
M7	0.06	<0.003	<0.003	<0.003	<0.003
M8	0.06	<0.003	<0.003		<0.003
M9	0.06	<0.003	<0.003	<0.003	<0.003
M10	0.06	<0.003	<0.003	<0.003	<0.003
M11	0.06	<0.003	<0.003	<0.003	<0.003
M12	0.06	<0.003	<0.003	<0.003	<0.003

9

Cd (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.005	<0.001	<0.001	<0.001	<0.001
M2	0.005	<0.001	<0.001	<0.001	<0.001
M3	0.005	<0.001	<0.001	<0.001	<0.001
M4	0.005	<0.001	<0.001	<0.001	<0.001
M5	0.005	<0.001	<0.001	<0.001	<0.001
M6	0.005	<0.001	<0.001	<0.001	<0.001
M7	0.005	<0.001	<0.001	<0.001	<0.001
M8	0.005	<0.001	<0.001		<0.001
M9	0.005	<0.001	<0.001	<0.001	<0.001
M10	0.005	<0.001	<0.001	<0.001	<0.001
M11	0.005	<0.001	<0.001	<0.001	<0.001
M12	0.005	<0.001	<0.001	<0.001	<0.001

10

Cr6+ (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.05	<0.002	<0.002	<0.002	<0.002
M2	0.05	<0.002	<0.002	<0.002	<0.002
M3	0.05	<0.002	<0.002	<0.002	<0.002
M4	0.05	<0.002	<0.002	<0.002	<0.002
M5	0.05	<0.002	<0.002	<0.002	<0.002
M6	0.05	<0.002	<0.002	<0.002	<0.002
M7	0.05	<0.002	<0.002	<0.002	<0.002
M8	0.05	<0.002	<0.002	-	<0.002
M9	0.05	<0.002	<0.002	<0.002	<0.002
M10	0.05	<0.002	<0.002	<0.002	<0.002
M11	0.05	<0.002	<0.002	<0.002	<0.002
M12	0.05	<0.002	<0.002	<0.002	<0.002

11

Color, TCU	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	75	5.00		5.00	5.00
M2	75	5.00	5.00	5.00	5.00
M3	75	5.00	5.00	5.00	5.00
M4	75	5.00	5.00	5.00	5.00
M5	75	5.00	5.00	5.00	5.00
M6	75	5.00	5.00	5.00	5.00
M7	75	5.00	5.00	5.00	5.00
M8	75	5.00	5.00	-	5.00
M9	75	5.00	5.00	5.00	5.00
M10	75	5.00	5.00	5.00	5.00
M11	75	5.00	5.00	5.00	5.00
M12	75	5.00	5.00	5.00	5.00

12

Conductivity, mSeimens/cm	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1		53.90	55.00	50.80	52.80
M2		54.60	55.90	48.80	51.60
M3		51.90	54.70	48.30	52.30
M4		56.40	54.70	47.70	52.30
M5		55.30	55.10	47.70	52.40
M6		54.30	55.10	47.30	52.50
M7		54.30	54.70	37.50	51.20
M8		54.50	55.50		52.30
M9		55.00	54.80	44.80	52.10
M10		39.30	55.20	49.50	52.60
M11		54.70	54.50	45.60	52.40
M12		54.30	55.30	45.40	52.40

13

Nitrate (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	10	0.01	0.05	0.06	<0.02
M2	10	0.06	0.02	<0.02	<0.02
M3	10	0.09	<0.02	0.05	<0.02
M4	10	0.10	<0.02	<0.02	0.06
M5	10	0.20	0.05	<0.02	<0.02
M6	10	0.10	<0.02	0.05	<0.02
M7	10	0.04	0.07	0.04	0.08
M8	10	0.10	0.05		<0.02
M9	10	0.07	0.05	0.04	<0.02
M10	10	0.20	0.09	0.03	<0.02
M11	10	0.08	<0.02	0.04	<0.02
M12	10	0.07	0.10	0.04	<0.02

14

Oil and Grease (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	3	0.58	0.56	0.71	0.52
M2	3	0.45	0.68	0.62	0.56
M3	3	0.43	0.53	0.62	0.55
M4	3	0.60	0.41	0.83	0.54
M5	3	0.53	0.52	0.82	0.53
M6	3	0.45	0.67	0.52	0.53
M7	3	0.54	0.65	0.71	0.65
M8	3	0.55	0.42		0.57
M9	3	0.71	0.56	0.71	0.67
M10	3	0.53	0.43	0.71	0.92
M11	3	0.43	0.43	0.95	0.54
M12	3	0.63	0.56	0.63	0.65

15

pH	Standard				
Sampling Station	LL	UL	Q1 2019	Q2 2019	Q3 2019
M1	6.5	8.5	8.20	8.00	7.90
M2	6.5	8.5	8.30	7.90	7.90
M3	6.5	8.5	8.20	7.80	7.90
M4	6.5	8.5	8.20	7.90	7.80
M5	6.5	8.5	8.20	8.00	7.90
M6	6.5	8.5	8.20	7.90	7.80
M7	6.5	8.5	8.30	8.00	7.80
M8	6.5	8.5	8.30	8.00	
M9	6.5	8.5	8.20	7.90	7.90
M10	6.5	8.5	8.10	7.80	7.90
M11	6.5	8.5	8.30	8.00	7.90
M12	6.5	8.5	8.30	8.10	7.90

16

Phosphate (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.5	<0.01	0.02	<0.01	<0.01
M2	0.5	<0.01	0.02	<0.01	<0.01
M3	0.5	0.02	0.02	<0.01	<0.01
M4	0.5	0.03	0.04	<0.01	<0.01
M5	0.5	0.03	0.04	<0.01	<0.01
M6	0.5	0.02	0.04	<0.01	<0.01
M7	0.5	<0.01	0.02	<0.01	<0.01
M8	0.5	<0.01	0.02		<0.01
M9	0.5	<0.01	0.03	<0.01	<0.01
M10	0.5	0.02	0.04	<0.01	<0.01
M11	0.5	<0.01	0.02	<0.01	<0.01
M12	0.5	<0.01	0.02	<0.01	<0.01

17

Dissolved Copper (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.02	<0.003		<0.003	<0.003
M2	0.02	<0.003		<0.003	<0.003
M3	0.02	<0.003		<0.003	<0.003
M4	0.02	<0.003		<0.003	<0.003
M5	0.02	<0.003		<0.003	<0.003
M6	0.02	<0.003		<0.003	<0.003
M7	0.02	<0.003		<0.003	<0.003
M8	0.02	<0.003			<0.003
M9	0.02	<0.003		<0.003	<0.003
M10	0.02	<0.003		<0.003	<0.003
M11	0.02	<0.003		<0.003	<0.003
M12	0.02	<0.003		<0.003	<0.003

18

Dissolved Oxygen (mg/L)	Standard				
Sampling Station	(min)	Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	5	7.00	7.00	7.00	7.00
M2	5	7.00	7.00	7.00	8.00
M3	5	7.00	6.00	6.00	8.00
M4	5	6.00	6.00	7.00	8.00
M5	5	7.00	6.00	7.00	8.00
M6	5	7.00	7.00	8.00	7.00
M7	5	7.00	7.00	8.00	8.00
M8	5	7.00	7.00		7.00
M9	5	7.00	7.00	7.00	8.00
M10	5	7.00	7.00	7.00	8.00
M11	5	7.00	7.00	8.00	7.00
M12	5	8.00	6.00	7.00	8.00

19

Fecal Coliform,MPN/100ml	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	200	2.00	<1.8	<1.8	<1.8
M2	200	<1.8	<1.8	<1.8	4.50
M3	200	<1.8	<1.8	<1.8	<1.8
M4	200	<1.8	<1.8	<1.8	<1.8
M5	200	<1.8	<1.8	<1.8	<1.8
M6	200	<1.8	<1.8	33.00	79.00
M7	200	1.80	<1.8	7.80	2.00
M8	200	33.00	<1.8		<1.8
M9	200	49.00	<1.8	<1.8	2.00
M10	200	<1.8	<1.8	<1.8	2.00
M11	200	<1.8	<1.8	<1.8	<1.8
M12	200	2.00	<1.8	<1.8	<1.8

20

Fluoride (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	1.5	1.20	1.30	1.00	0.70
M2	1.5	1.20	1.10	1.10	0.90
M3	1.5	1.10	1.30	1.20	0.90
M4	1.5	1.10	1.40	1.00	0.80
M5	1.5	1.10	1.20	1.10	0.80
M6	1.5	1.10	1.20	1.10	0.80
M7	1.5	1.10	1.30	1.10	0.90
M8	1.5	1.20	1.20		0.90
M9	1.5	1.20	1.30	1.10	0.90
M10	1.5	1.20	1.20	1.20	0.90
M11	1.5	1.20	1.20	1.10	0.80
M12	1.5	1.20	1.30	0.90	0.70

21

Selenium (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.1	<0.01	<0.01	<0.01	<0.01
M2	0.1	<0.01	<0.01	<0.01	<0.01
M3	0.1	<0.01	<0.01	<0.01	<0.01
M4	0.1	<0.01	<0.01	<0.01	<0.01
M5	0.1	<0.01	<0.01	<0.01	<0.01
M6	0.1	<0.01	<0.01	<0.01	<0.01
M7	0.1	<0.01	<0.01	<0.01	<0.01
M8	0.1	<0.01	<0.01		<0.01
M9	0.1	<0.01	<0.01	<0.01	<0.01
M10	0.1	<0.01	<0.01	<0.01	<0.01
M11	0.1	<0.01	<0.01	<0.01	<0.01
M12	0.1	<0.01	<0.01	<0.01	<0.01

222

Sodium Chloride (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	-	32,600	31,800	30,100	32,500
M2	-	32,600	32,300	32,200	32,100
M3	-	32,500	31,700	30,700	32,100
M4	-	32,000	31,300	30,700	32,500
M5	-	32,300	31,700	31,600	32,600
M6	-	32,500	32,000	30,900	32,100
M7	-	34,600	31,000	24,700	32,100
M8	-	35,300	31,300		32,100
M9	-	27,100	30,800	31,100	32,300
M10	-	23,300	30,800	27,500	32,100
M11	-	34,900	32,000	32,000	32,300
M12	-	35,100	31,700	32,600	33,000

23

Temperature, °C	Standard				
Sampling Station	LL	Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1		28.10	31.00	29.40	29.50
M2		29.60	32.80	30.10	30.20
M3		29.60	32.40	29.80	29.90
M4		29.10	32.00	30.90	30.00
M5		29.60	32.60	30.30	30.00
M6		29.20	32.30	30.70	30.10
M7		29.10	33.00	30.10	30.10
M8		28.60	34.00		30.20
M9		29.10	34.80	31.00	30.70
M10		29.40	34.20	31.40	30.80
M11		28.30	34.40	30.50	30.30
M12		28.50	33.50	30.70	30.10

24

Zinc (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	0.8	<0.005	0.010	0.010	<0.005
M2	0.8	<0.005	0.008	<0.005	<0.005
M3	0.8	<0.005	<0.005	0.020	<0.005
M4	0.8	<0.005	0.010	0.010	<0.005
M5	0.8	<0.005	<0.005	<0.005	<0.005
M6	0.8	<0.005	0.030	0.020	<0.005
M7	0.8	<0.005	0.030	0.020	<0.005
M8	0.8	0.010	<0.005		0.010
M9	0.8	<0.005	0.020	0.005	<0.005
M10	0.8	0.005	0.030	0.005	0.005
M11	0.8	<0.005	0.010	0.200	<0.005
M12	0.8	<0.005	0.009	0.200	<0.005

25

Iron (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
M1	1.5	0.020		0.200	0.020
M2	1.5	0.020		<0.005	0.009
M3	1.5	0.020		0.020	0.200
M4	1.5	5.000		0.070	0.010
M5	1.5	0.030		<0.005	0.007
M6	1.5	0.020		0.040	0.020
M7	1.5	0.020		0.700	0.020
M8	1.5	0.040			0.020
M9	1.5	0.010		0.020	0.020
M10	1.5	0.010		0.030	0.020
M11	1.5	0.010		0.020	0.008
M12	1.5	0.010		0.030	0.007

2.2.3.4 Effluents

The effluents originating from different facilities, such as the Wastewater Treatment Facility (WTF), Coal Sedimentation Basin (CSB), Ash Sedimentation Basin (ASB), and Storm Drain Canal (SDC), were monitored from various significant sampling points. Parameters considered were: arsenic, BOD, boron, cadmium, chemical oxygen demand, chromium Hexavalent, conductivity, dissolved copper, dissolved oxygen, lead, mercury, nickel, oil and grease, pH, sodium chloride, temperature, turbidity and zinc. Most of the parameters are within acceptable limits of the DENR standards for DAO 2016-08.

Table 2-27: Results of Effluent Water Quality Monitoring 1st Quarter 2019-4th Quarter 2019

Arsenic (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.04	<0.008	<0.008	<0.008	<0.008
CSB	0.04	NW	<0.008	<0.008	NW
ASB	0.04	<0.008	<0.008	0.10	<0.008
SDC	0.04	NW	NW	<0.008	NW

BOD (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	100	5	1	4.	1
CSB	100	NW	4	2.	NW
ASB	100	1	2	1.1	3
SDC	100	NW	NW	3	NW

Boron (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	20	0.40	1.30	3.40	0.20
CSB	20	NW	2.30	7.30	NW
ASB	20	5.20	8.30	8.80	5.50
SDC	20	NW	NW	8.50	NW

Cd (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.01	<0.001	<0.001	<0.001	<0.001
CSB	0.01	NW	<0.001	<0.001	NW
ASB	0.01	<0.001	<0.001	<0.001	<0.001
SDC	0.01	NW	NW	<0.001	NW

COD (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	200	44.00	30.00	19.00	23.00
CSB	200	NW	123.00	139.00	NW
ASB	200	17.00	19.00	22.00	26.00
SDC	200	NW	NW	22.00	NW

Cr6+ (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.1	<0.002	<0.002	<0.002	<0.002
CSB	0.1	NW	<0.002	<0.002	NW
ASB	0.1	<0.002	<0.002	<0.002	<0.002
SDC	0.1	NW	NW	<0.002	NW

Conductivity, mSeimens/cm	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF		0.909	0.341	0.319	0.295
CSB		NW	3.370	1.270	NW
ASB		1.750	1.670	1.250	1.380
SDC		NW	NW	1.150	NW

Dissolved Copper (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.04	<0.003	<0.02	<0.003	<0.003
CSB	0.04	NW	<0.02	<0.003	NW
ASB	0.04	0.003	<0.02	<0.003	<0.003
SDC	0.04	NW	NW	<0.003	NW

Dissolved Oxygen (mg/L)	Standard				
Sampling Station	(min)	Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF		7	7	8	8
CSB		NW	5	5	NW
ASB		7	8	7	7
SDC		NW	NW	6	NW

Lead (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.1	<0.005	<0.05	<0.005	<0.005
CSB	0.1	NW	<0.05	<0.005	NW
ASB	0.1	<0.005	<0.05	<0.005	<0.005
SDC	0.1	NW	NW	<0.005	NW

Dissolved Oxygen (mg/L)	Standard				
Sampling Station	(min)	Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF		7	7	8	8
CSB		NW	5	5	NW
ASB		7	8	7	7
SDC		NW	NW	6	NW

Lead (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.1	<0.005	<0.05	<0.005	<0.005
CSB	0.1	NW	<0.05	<0.005	NW
ASB	0.1	<0.005	<0.05	<0.005	<0.005
SDC	0.1	NW	NW	<0.005	NW

Mercury (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.004	<0.0002	<0.0002	<0.0002	<0.0002
CSB	0.004	NW	<0.0002	<0.0002	NW
ASB	0.004	<0.0002	<0.0002	<0.0002	<0.0002
SDC	0.004	NW	NW	<0.0002	NW

Nickel (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	0.3	0.01	<0.03	<0.003	<0.003
CSB	0.3	NW	<0.03	0.004	NW
ASB	0.3	<0.003	<0.03	0.003	<0.003
SDC	0.3	NW	NW	0.006	NW

Oil and Grease (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	10	0.61	0.87	0.83	0.76
CSB	10	NW	0.98	0.99	NW
ASB	10	0.50	0.76	0.75	0.86
SDC	10	NW	0.74	0.73	NW

pH	Standard				
Sampling Station	LL	UL	Q1 2019	Q2 2019	Q3 2019
WTF	6	9	8.40	8.80	8.90
CSB	6	9	NW	8.00	6.70
ASB	6	9	8.80	8.20	7.90
SDC	6	9	NW		7.00

Sodium Chloride (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	-	276	47	39	38
CSB	-	NW	713	33	NW
ASB	-	33,600	63	31	48
SDC	-	NW	NW	-	NW

Temperature, °C	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF		29.80	32.10	29.00	30.10
CSB		NW	35.00	31.70	NW
ASB		32.70	35.20	29.40	30.10
SDC		NW	NW	-	NW

Turbidity, NTU	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	1.5	14.00	6.50		7.50
CSB	1.5	NW	31.00		NW
ASB	1.5	6.40	6.20		4.60
SDC	1.5	NW	NW		NW

Zinc (mg/L)	Standard				
Sampling Station		Q1 2019	Q2 2019	Q3 2019	Q4 2019
WTF	1.5	0.02	<0.01	0.40	0.10
CSB	1.5	NW	<0.01	0.30	NW
ASB	1.5	<0.005	<0.01	0.20	2.00
SDC	1.5	NW	NW	0.60	NW

2.2.4 Freshwater and Marine Ecology

2.2.4.1 Freshwater Ecology

2.2.4.1.1 Threat to Abundance, Frequency and Distribution of Species

Primary Producers (Phytoplankton)

Phytoplankton was collected from the Lauis River during the wet and dry seasons. The wet season was dominated by pinnate diatoms with three species namely: Navicula, Pleurosigma and Pinnularia and corresponding relative abundance are 30%, 17.5 % and 10%, respectively.

This was followed by Chlorophyta with two species namely Chlorococcum and Schroederia with a percentage abundance of 10% and 12.5 %, respectively.

The dry season on the other hand was dominated by Lyngbya which belonged to the Cyanophyta. The Cyanophyta or blue green algae comprised 47.5% of the total phytoplankton assemblage. Chlorophyta was also noted. Chrysophyta namely Navic*ula, was* 15%, Amphora was 12.5% and Pinnilaria was 7.5%. The first station had the most diverse species of Naviculaobserved in both the wet and dry seasons at the Lauis River.
During the first quarterly monitoring of the marine ecology of Masinloc bay, various species of Phytoplanktons have been observed throughout the seven (7) sampling stations. Diatoms are found to be the most abundant group in all sampling stations. Weather changes vary the rates of abundance of these species with some of its number considerably increasing or decreasing its rate. One example is the Rhizosolenia which appears to be the most abundant specie accounting for 23% of the phytoplankton community. In terms of species richness, Station PZB 1 and PZB 2 have the most number of species both with 16 while both Station PZB 4 has again the lowest with 7. The computed diversity index ranges from 1.83 to 2.42 while computed species evenness ranges from 0.70 to 0.93. The measured index of evenness showed relative less variable phytoplankton community among the station while calculated index of diversity showed an absence of a dominant species outcompeting the community. The highest value was found in station 2 while the lowest diversity index was found in station 4 and 5.The domineering amounts of diatoms are observed all throughout the quarterly monitoring procedures of 2015.

Also noted during the third and fourth quarter marine ecology monitoring of Oyon bay were two potentially harmful species found during its sampling period. The *Pseudonitzschia spp*is capable of producing toxins associated with Amnesic Shellfish Poisoning while the *Dinophysis caudate* is capable of producing toxins associated with Diarrhetic Shellfish Poisoning. Sampling of these species appear at about 460 cells/L and 15 cells/L respectively. Since there are no shellfish farming activities, the potential health problem caused by these potentially toxic diatoms can be ruled out. Comparing the present result with the three previous sampling conducted in 4thQuarter to 1st Quarter, there are similarities and minor differences in phytoplankton community observed. During the previous sampling periods, diatoms were consistently dominant. Most of the species collected were indicators of clean water.

Phytoplankton Community (1st-4th Quarterly Monitoring Marine Ecology Report 2015)

TAXA	PZB 01	PZB 02	PZB 03	PZB 04	PZB 05	Grand Total from all Stations
Cyanobacteria						
Trichodesmium			66	58	18	142
Nostoc			55	15	3	73
Diatoms						

Asteromphalus	220	250	233	34		267
Asterumphalus	43	83	40			40
Amphora				23		23
Aulacosiera	25		23			23
Campylodiscus			6			6
Chaetoceros	370	1536	229	187	435	851
Climacosphenia					10	10
Coconeis	10	48				58
Coscinodiscus	2355	3858	2951	2195	1363	6509
Cymbella		45				45
Diploneis	20	27	59	118	15	192
Ditylum	20	53	20			93
Ephemera			19		5	24
Grammatophora			23		13	36
Hemiaulus	8					8
Leptocylindrus	10	10				20
Licmophora					13	13
Melosira	95	180		110		385
Navicula	35	23	65	73	16	212
Odontella	23				30	53
Nitzschia	45	20	44	77	18	204
Pleurosigma	153	210	178	188	41	770
Pseudonitzschia	80	460	38	58	45	681
Pyrophacus	10					10
Rhizosolenia	360	175	31	101	126	793
Skeletonema		178	33			211
Suririella	20		20	33	8	81
Thalassionema	28	211	281	113	38	671
Thalassioria	495	527	483	56	57	1618
Dinoflagellates						
Ceratium furca	60	93	104	0	43	300
Ceratium fusus	13					13
Ceratium lineatum			15			15
Ceratium macroceros	20					20
Cyst		50				50
Diplopsalis	70	40	115	30	43	298
Dinophysis caudata	50					50
Gonyaulax		13	36		25	74
Phalacroma				38		38
Prorocentrum				30		30
Prorocentrum micans	8					8
Protoperidnium	10			23		33
Protoperidnium divergence		50				50

Protoperidinium elegans			50	70		120
Protoperdinium latispinum	35	213				248
Protoperidnium oceanicum	5		15		50	70
Protoperidinium pallidum	20					20
Protoperdinium pentagonum		50	23			73
Pyrophacus	43	90	90	8	25	256
Scrippsiella	10					10
Silicoflagellates						
Dictyocha			19	30	7	56
Favella	30	21		10		61
Tintinids			20			20

Consumers

Zooplankton

The calanoid copepods were the most abundant group of zooplankton during the wet season (76.9%). Of lesser abundance were *Lucifer, Siriella* and *Abyla* with relative abundances of 11.5%, 7.6% and 3.9%, respectively.

The dry season on the other hand was dominated by *Daiphanosoma* (32.48%) and calanoid copepods (28.66%). Other zooplankton was noted such as *Bosmina, Gammarus* and *Microsetela* with corresponding relative abundances of 11.5%, 5.7% and 5.1%, respectively.

During the dry season, Station 2 had the most diverse assemblage with a total of 137 individuals. On the other hand, Station 1 registered a high diversity index during the dry months.

Zooplankton Community (1st-4th Quarterly Monitoring Marine Ecology Report 2016)

Species/Taxa	**Stations**				
Adult Form	PZB1	PZB2	PZB3	PZB4	PZB5
Adult polychaete			100	300	75
Arrow worm	392	457	175	267	13
Calanoid	7225	42149	2663	4522	511
Calanoid copepod	3,600	3,450	8,750	10,350	18,400
Chaetognaths	300		350		225
Cyclopoid	67108	224407	22119	21379	7109
Cyclopoid copepod	9,550	7,950	11,350	7,650	10,625
Flatworm					78
Harpacticoid	1692	32511	539	1617	333
Harpacticoid copepod	100	250	250		700
Larvacean	8550	2175	1525	1025	608
Polychaete		42	25	25	
Rotifer				100	

Salps				113	25
Larva Form	PZB1	PZB2	PZB3	PZB4	PZB5
Barnacle nauplius	3975	14389	18013	2860	719
Bivalve sp1	4,125		208	292	25
Bivalve sp2	2,625	292	58		
Bivalve veliger	27000	13339	1889	3069	519
Bivalve veliger sp1	5,350	50	1,050	750	1,150
Bivalve veliger sp2	1,400	450	1,250	1,050	75
Bivalve veliger sp3					350
Bryozoan larvae		100	100	100	
Cnidarian larvae			17	17	
Crustacean zoae	100			250	500
Decapod larvae		75	33	75	25
Decapod zoeae		400			
Echinoderm larvae		17	25	25	133
Fish larvae					50
Flatworm		25		25	17
Gastropod	1,425	242	117	183	17
Gastropod veliger	4467	23257	2900	2524	688
Large crab larvae		125			
Nauplius	4,950	867	333	442	742
Nauplius and copepodite	31867	30825	24514	13581	9110
Nematode				100	
Ostracod bettles garaopata				117	
Polychaete trochophore	300	300	150	250	275
Pteropod		200	250	50	75
Trochopore	1,575	125	83	83	33
Unidentified decopod			113		
Unidentified egg				200	

Benthic Organisms

Melanoides was noted during the wet and dry seasons, but was more abundant during the latter. In the dry season the relative abundance of *Melanoides* was79.4%. Additional species such as *Thiara, Calcarina, Mitra* and *Narita* were also noted.

Aside from *Melanoides,* which was also dominant during the wet season with an abundance of 23.3%, *Phasianella, Zebina* and *Cerithium* were also collected with a relative abundance of 17.3%, 29.9%. 5.7% and 5.6%, respectively.

The most abundant crustacean species was *Varuna* with some gastropod snails in the form of *Pila* and the spiral snail *Thiara*.

Other Faunal Species

Both freshwater shrimp species, *Macrobrachium* and *Palaemonitis,*were also observed.

Tilapia (*Oreochormis* sp.), an introduced species in the country, has reached the river systems in the area. Other types of fishes recorded are the following: *Aristichthyes* (carp), *Clarias* (catfish), *Trichogaster* (gourami), *Anguilla* (freshwater eel), *Synbranchus* (swamp eel) and *Anabas* (climbing perch). The fishes, including the edible snails and shrimps, are caught from the wild which serve as sustenance food for the community. No form of aquaculture activities has been observed.

The food chain for the aquatic ecosystem in the area of the Masinloc Plant is simple, meaning there are limited species per trophic level. Although the phytoplankton species seemed not very abundant to support the next level consumers, the periphyton and the macrophytes have played major roles to support the consumers.

The above information is consistent with the water quality data, and is indicative of a healthy freshwater ecosystem.

2.2.4.2 Marine Ecology

The proponent conducts quarterly marine environmental monitoring for the project. The results of the 4th Quarter 2019 Marine Environmental Monitoring is provided in this section.

2.2.4.2.1 Site and Study Area Description

The municipality of Masinloc is located in the northern part of Zambales and lies on a coastal plain between the Zambales Mountains to the east and the West Philippine Sea to the west. Masinloc is bounded on the north by the municipality of Candelaria, also of Zambales province; on the east by Mount Masinloc; on the south by the Municipalities of Palauig and Iba; and on the west by Oyon Bay and Masinloc Bay.

It has a total land area of 33,150 hectares with a total coastal length of 42.2 kilometers. Eleven out of 13 barangays comprising Masinloc are located along the coastal areas. These are Barangays San Lorenzo, Sto Rosario, Bamban, Inhobol, North and South Poblacion, Collat, Baloganon, Taltal, Bani, and the island of San Salvador.

Study area is concentrated on a 500-meter radius in the seawaters abutting the Masinloc Power Plant located in Brgy Bani, Masinloc, and Zambales at the northern mouth of Oyon Bay. The coastline of Oyon Bay starting from Bani Point up to Oyon Point measures 8.5 kilometers. The bay has a total area of 5km2, 4km2 of which are found different habitats of seagrasses, corals, mangroves and associated organisms. The coastal areas of Oyon Bay at its northwestern and eastern fringes are bordered by fringing reefs with associated communities such as seagrass meadows and algal flats. The reef sites are characterized by relatively wide reef flats that gently slope to seagrass and algal beds and coral reefs. Small shoals are also scattered inside the bay. Residual mangrove stands are found along the eastern and southeastern shores of the bay.

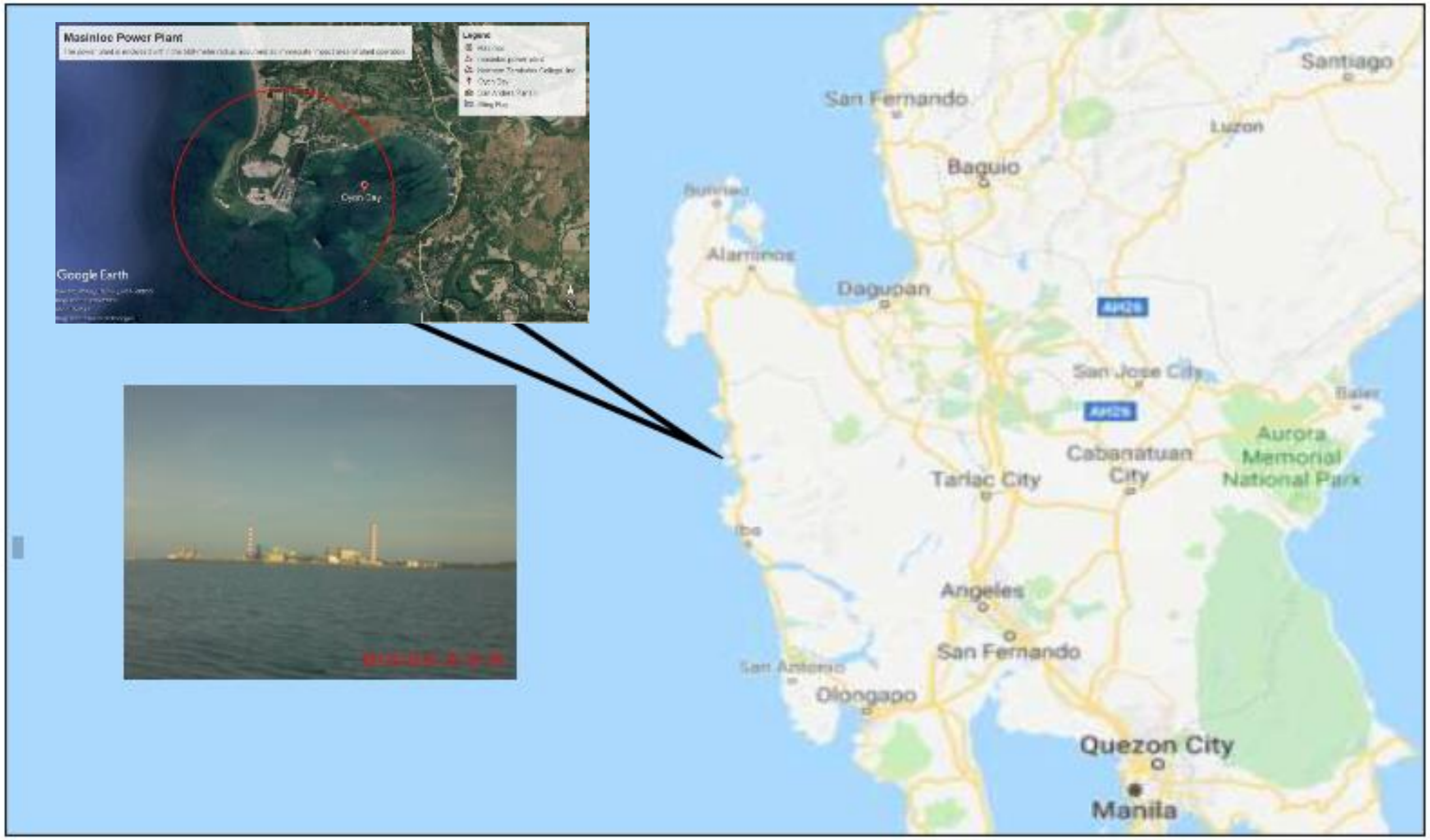


Figure 2-40: Composite of the Study Area Showing Relative Location of Site along the Western Coast of Zambales

2.2.4.2.2 Existing Environmental Condition

Seagrass Meadows

Seagrass ecosystem is one of the most important resources in the coastal areas and of significant importance to fisheries industry. It comprises some of the most heterogeneous landscape structures of shallow-water estuarine/marine ecosystems. Seagrasses are specialized marine flowering plants that have adapted to the nearshore environment of most of the world's continents. These marine flowering plants can produce pollen, fruits and seeds under water that have adapted to the nearshore environment. Most seagrass species are marine, although some species cannot reproduce unless emergent at low tide or subject to freshwater inflow.

Some seagrasses can survive in a range of conditions encompassing freshwater, estuarine, marine, or hypersaline water. Seagrasses support and provide habitats for many coastal organisms. Important fish species such as rabbit fishes (siganids) rely completely upon seagrasses.

Shrimps, sea cucumber, sea urchins, seahorses, crabs, scallops, mussels and snails are economically important and abundant. Many resident and transient species also use the seagrass for refuge, spawning and nursery activities. Moreover, some seagrass species are useful as sewage filters, coastal stabilizers, paper, fertilizer and fodder, food and medicine for man.

Seagrasses are made of less than 0.02% of the angiosperm flora, representing a surprisingly small number of species. There are relatively few species globally (about 60%) and are grouped into just 13 genera and 5 families. In the Philippines, the 16 taxa found is considered the second highest number of seagrass species in the world, next to Australia, which has 19 species. Despite their limited diversity, they have a significant ecological and economical function. These plants support numerous herbivore- and detrivore-based food chains and considered as very productive pasture areas of the sea. They also produce sediments and interact with coral reefs and mangroves in reducing wave energy and regulating water flow. Losses of living organisms in fresh and marine environment including seagrasses from most part of the world were due to natural causes such as cyclones, floods, high-energy storms, or wasting disease or due to human influences such as land reclamation and changes in land use, agriculture runoff, industrial runoff, oil spills. In the Philippines, a significant portion of the coastal habitats is at high risk of being lost in the next decade. Increased human settlements along coastal areas fringed by seagrass beds, mining, coastal aquaculture, deforestation and blast fishing are also causes of seagrass loss.

According to the power plant's initial EIS report, the seagrass beds in the bay are dominated by *Thalassia hemprichii*, *Halophila ovalis* and *Enhalus acoroides*. The average density of seagrasses is 575 shoots/m^2 during the dry season and 1250 shoots/m^2 during the wet season. Other species present are *Cymodocea serrulata*, *Halophila minor*, *Halophila uninervis*, *Cymodocea rotundata*, and *Syringodium isoetifolium*. The seagrass beds in Oyon Bay belong to the disturbed and altered categories. The disturbed seagrass habitats in the bay are found along its western and eastern sections in characteristically high or low diversity areas and occupying small coves. In Oyon Bay, this category of seagrass habitat is associated with the effects of the conversion of mangrove areas into fishponds, cutting of trees for domestic uses, and surface runoff from upland areas around the bay. To some degree, causes of the disturbance were unsound fishing practices such as the haphazard placement of fish enclosures. The altered seagrass habitats are along the northern and southern portions of the bay. These are areas of low cover, density, and species diversity, either permanently or completely changed and converted to other uses like fishponds, or constantly impacted by waves, tidal influences, and other natural elements in such a way that their natural structure no longer supports lush vegetation. Thirty-one species of seaweeds were found along Oyon Bay. In terms of cover, the seaweed community in the bay exhibited poor values with only 0-25% cover.

Methodology

Efforts exerted to relocate approximate locations of the seagrass sampling stations were in order to replicate results of the previous monitoring reports. The seagrass survey was conducted at seven sampling stations (SG1, SG2, SG3, SG4, SG5, SG6 and SG7) using the transect-quadrat method described by English *et al*. (1994;

1997), to determine the species composition, density, percentage cover and biomass of seagrass in the area. All these stations sampled are tabulated in Table 2-28. Also indicated are the coordinates, location and sampling date. The approximate locations of these seagrass study sites are projected on map (Figure 2-41).

Table 2-28: Seagrass Transect- Quadrat Sampling Station Data (December 2019)

Station Code	Location	GPS Coordinates		Sampling Date (2019)
		Latitude North	Longitude East	
SG1	Near C-Square Area	15°34'17.70"	119°56'01.20"	11 December
SG2	Old Gate Area	15°34'15.60"	119°55'41.20"	11 December
SG3	Adjacent to Smokestack	15°33'52.30"	119°55'30.40"	11 December
SG4	Near Intake Area	15°33'41.70"	119°55'23.60"	11 December
SG5	Near Bani Point	15°33'44.30"	119°55'03.90"	10 December
SG6	Oyon Point	15°33'17.30"	119°56'13.20"	10 December
SG7	San Salvador Island	15°31'36.30"	119°54'37.60"	10 December

A transect tape was laid out perpendicular to the shoreline. A 0.25m^2 quadrat made of PVC pipes was laid at intervals of five meters along the transect line beginning from the point where seagrass growth near the shoreline starts and ended at the edge of the seagrass meadow or when no seagrass of significant growth are observed seaward. Estimate in percent cover of the seagrasses was *in* situ, with seagrasses found within the quadrat identified, collected and transported to the team's base of operation for sorting and weighing by species. The samples identified up to species level refer to the work of Meñez *et al.* (1983) and Fortes (1990). Seagrass species was counted for density and weighed for biomass estimation.

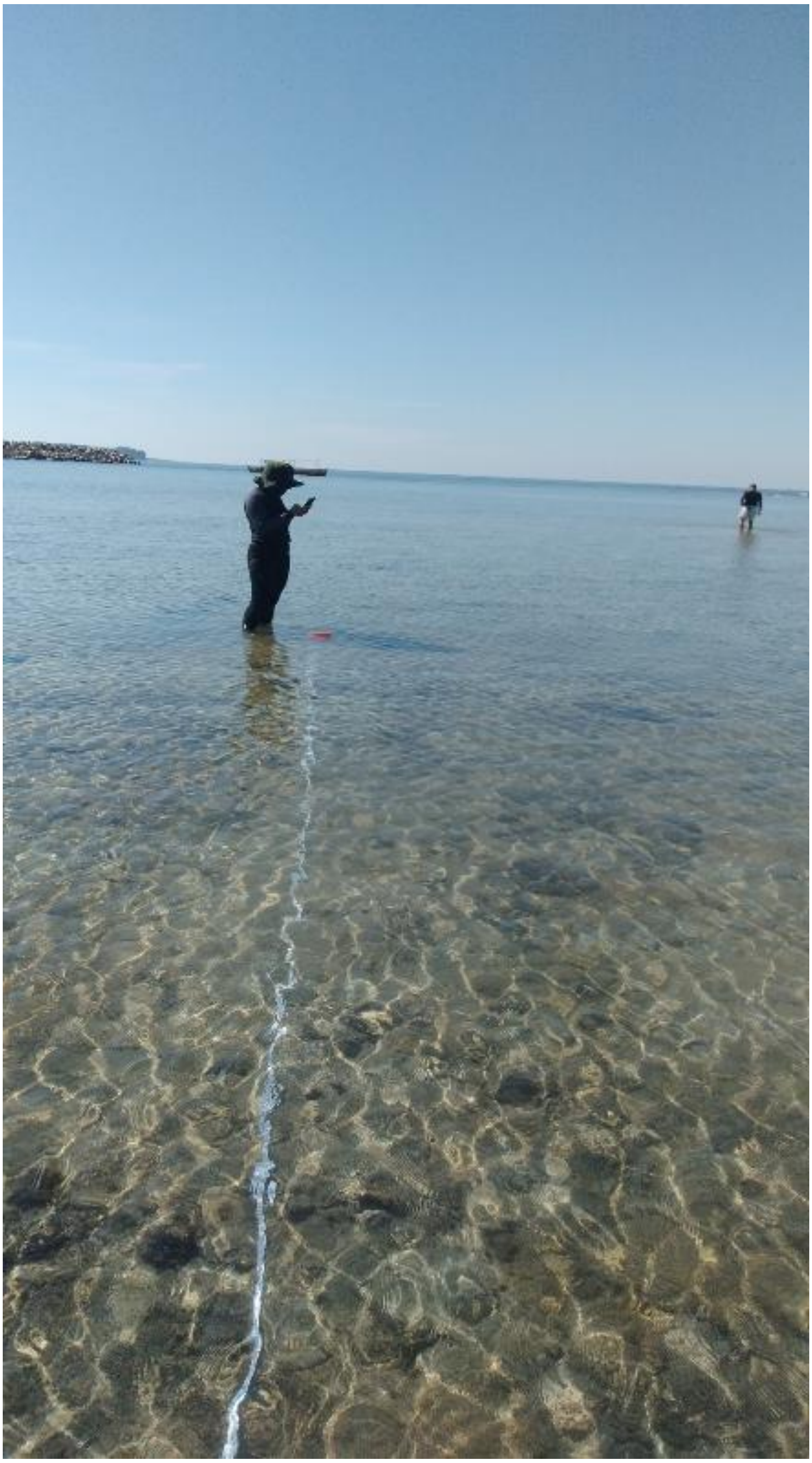


Plate 1: Transect Laying Perpendicular to Shoreline for Seagrass Survey

Figure 2-41: Map Showing the Seagrass Assessment Stations which Approximately Replicates Previous Monitoring Reports

Thalassia hemprichii

Enhalus acoroides

Halodule uninervis

Cymodocea rotundata

Syringodium isoetifolium and H. uninervis

Halodule pinifolia and H. uninervis

Plate 2: Seagrass Species Observed *In-situ* during Seagrass Survey at Different Stations

Cymodocea serrulata and *Halophila minor*

Halophila ovalis

Padina sp.

Sargassum polycystum

Plate 3: More Seagrass and Some Algal Species Observed *In-situ* during Seagrass Survey at Different Stations

Species Composition and Occurrence

The December 2019 seagrass survey yielded the same species composition and occurrence in all the seven (7) stations under observation. The species *Halophila minor* observed in Station SG6 and recorded in the October 2019 survey increasing the number of species accounted to nine (9) compared to the eight (8) recorded in the December 2018 and March 2019 records were still observed and recorded in the latest survey as well as the other species accounted, to wit: *Enhalus acoroides*, *Halophila ovalis, Thalassia hemprichi, Cymodocea rotundata*, *Cymodocea serrulata, Halodule pinifolia, Halodule uninervis* and *Syringodium isoetifolium* (**Table 2-29**). This number represents 47% of the total number of species found in the Philippines (Fortes, 1990). The highest species composition recorded was in Stations SG7 with the presence of eight (8) species. During the October 2019, March 2019, December 2018 and September 2018 surveys, this station also obtained the highest number of species followed in decreasing order by Station SG6 having 6 species, Station SG5 with 5 species, both Stations SG4 and Station SG3 with 4 species each and Stations SG1 and SG2 having one (1) species each.

During the March 2019 and December 2018 surveys, the occurrence of *Cymodocea serrulata* in the collection increased the species composition from seven (7) recorded in the September 2018 survey to eight (8). The other species found are *Enhalus acoroides*, *Halophila ovalis, Thalassia hemprichi, Cymodocea rotundata*, *Halodule pinifolia, Halodule uninervis* and *Syringodium isoetifolium*. (**Table 2-29**). This number represents 42% of the total number of species found in the Philippines (Fortes, 1990). The highest species composition was recorded in Station SG7 with eight (8) species accounted for. Last October 2019, March 2019, December 2018 and September 2018 surveys, this station obtained also the highest number of species. In decreasing order, Station SG6 had 7 species, Station SG5 had 5 species, Station SG3 had 4 species and Station SG4 with 3 species while Stations SG1 and SG2 had one species each.

Percent cover for all stations showed that *Enhalus acoroides* was recorded to have the highest with 25%, followed by *Cymodocea rotundata* at 22%, *Thalassia hemprichii* at 19%, both *Cymodocea serrulata* and *Halodule uninervis* at 11% each, *Syringodium isoetifolium* at 8%, with *Halodule pinifolia* at 3% and *Halophila ovalis* at <1% as the least significant and accountable cover recorded. Observed *Halophila minor* was so few that it was not included in the percent cover projection but accounted as a presence only in Station SG6. (**Table 2-29**). The temporal variations in survey results of these species could possibly be explained as a by chance product of sampling or as effects of natural events like typhoons or of man-made activities.

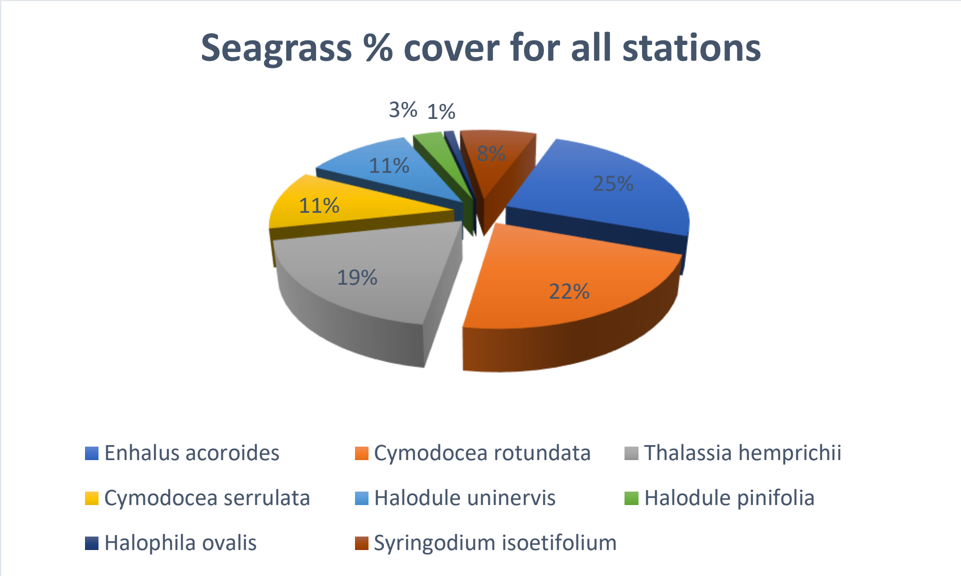


Figure 2-42: Percent (%) Cover of Seagrass Species in all Stations (December 2019)

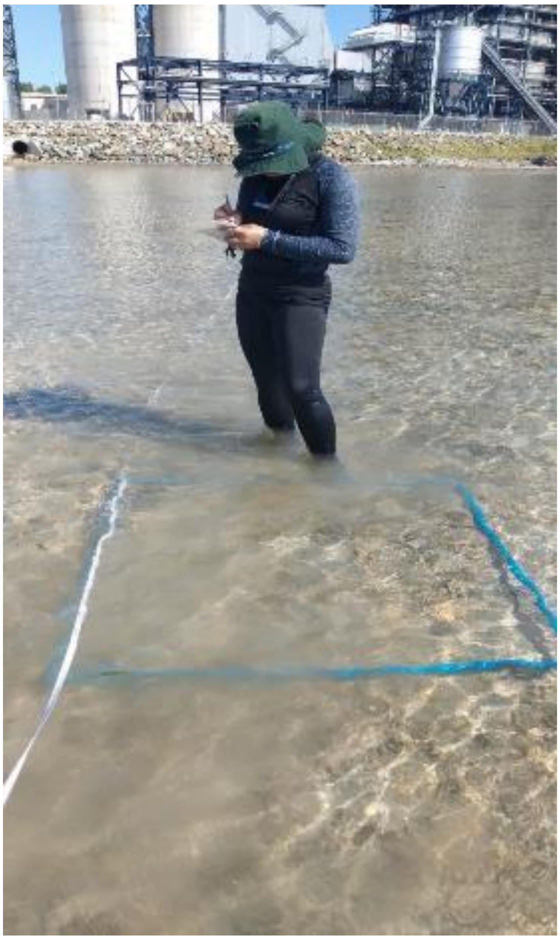


Plate 4 Quadrat Sampling of Seagrass at 5-meter Interval along Transect

Table 2-29: Species Composition of Seagrasses at Seven Sampling Stations in Five (5) Sampling Periods

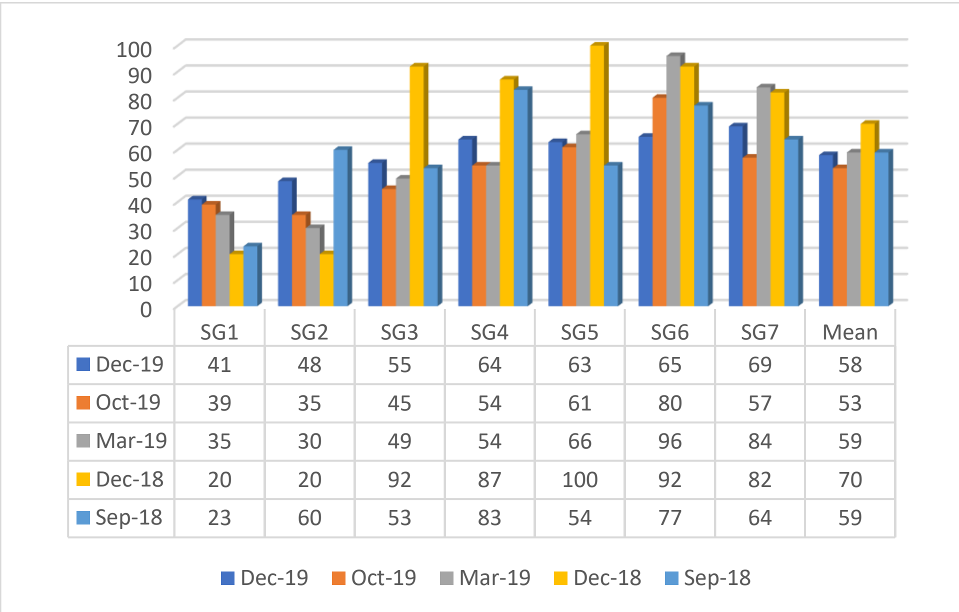
Taxa	Sampling Stations																																		
	SG1					SG2					SG3					SG4					SG5					SG6					SG7				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Family Hydrocharitaceae																																			
Enhalus acoroides	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Halophila ovalis												/					/									/		/				/	/	/	/
Halophila minor																													/	/					
Thalassia hemprichii											/	/		/	/				/	/	/								/	/	/	/	/	/	/
Family Potamogetonaceae																																			
Cymodocea rotundata											/	/	/	/	/		/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/
Cymodocea serrulata													/	/	/								/	/	/		/		/	/	/	/	/	/	/
Halodule pinifolia																			/	/		/												/	/
Halodule uninervis													/	/	/	/	/	/	/	/				/	/	/	/	/	/	/	/	/	/	/	/
Syringodium isoetifolium																										/	/	/	/	/	/	/	/	/	/
No. of Taxa	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**4**	**4**	**5**	**5**	**2**	**4**	**3**	**5**	**5**	**3**	**2**	**3**	**4**	**4**	**5**	**5**	**6**	**7**	**7**	**6**	**7**	**7**	**8**	**8**

Legend: A Sep 2018
B Dec 2018
C Mar 2019
D Oct 2019
E Dec 2019

Seagrass Cover and Density

The seagrass cover at the seven sampling stations for the December 2019 survey ranged from 41% to 69% with a mean average cover of 58%, which is a little higher than the sampling record of October 2019 but slightly lower than the March 2019 survey, much lower than the December 2018 survey with same lower percent cover obtained in the September 2018 survey. Percent cover was highest at Station SG7 with 69% cover, attributable to the proliferation of *Syringodium isoetifolium,* and followed in decreasing order by Stations SG6 with 65%, SG4 with 64%, SG5 with 63%, SG3 with 55%, SG2 with 48% and SG1 with 41%. The eel grass, *Enhalus acoroides,* attained its highest cover at Station SG1 at 41% with some scattered representative of the species *Cymodocea rotundata.* The round-tipped seagrass species, *Cymodocea rotundata,* obtained the highest cover at Stations SG7, SG4 and SG5 comprising more than 80% of the measured percent cover of all quadrats for each station with the remaining 20% composed of scattered representatives of the species *Syringodium isoetifolium*, *Halodule uninervis* and *H. pinifolia*. However, a mixture of *H. uninervis* and *H. pinifolia* occupied the highest cover at 60% out of the total percent cover for all quadrats measured in Station SG2 and SG3 while *Syringodium isoetifolium* had the highest cover at 35% and 25% from the total percentage cover of all quadrats in Station SG6 and SG7 respectively (**Figure 2-44** and **Table 2-30**).

Mean cover last March 2019 was highest in Station SG6 at 96% attributable to the abundant growth of *Syringodium isoetifolium,* followed in decreasing order by Stations SG7 at 84%, Station SG5 at 66%, Station SG4 at 54%, Station SG3 at 49% and the lowest being Station SG1 with 35% and Station SG2 30%, respectively (**Figure 2-43**).



	SG1	SG2	SG3	SG4	SG5	SG6	SG7	Mean
Dec-19	41	48	55	64	63	65	69	58
Oct-19	39	35	45	54	61	80	57	53
Mar-19	35	30	49	54	66	96	84	59
Dec-18	20	20	92	87	100	92	82	70
Sep-18	23	60	53	83	54	77	64	59

Figure 2-43: Comparative Seagrass Cover at Seven Sampling Stations in Five (5) Sampling Periods

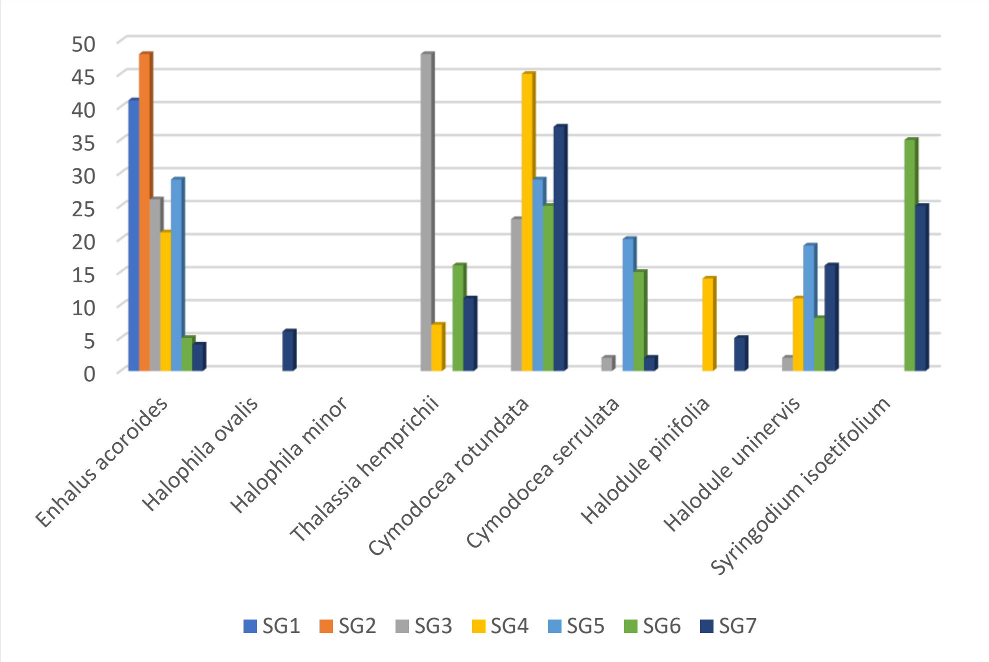


Figure 2-44: Occurrence of Seagrass Species at the Seven Sampling Stations

Table 2-30: Estimated % Cover of Seagrass Species in All Sampling Stations

Seagrass Species	**SG1**	**SG2**	**SG3**	**SG4**	**SG5**	**SG6**	**SG7**
Enhalus acoroides	41	48	26	21	29	5	4
Halophila ovalis							6
Halophila minor							
Thalassia hemprichii			48	7		16	11
Cymodocea rotundata			23	45	29	25	37
Cymodocea serrulata			2		20	15	2
Halodule pinifolia				14			5
Halodule uninervis			2	11	19	8	16
Syringodium isoetifolium						35	25

In the present survey, density of seagrass sampled ranged from a low of 340 shoots/m^2 recorded in Station SG2 to a high of 1,837 shoots/m^2 recorded in Station SG3 with a mean density of 950 shoots/m^2. This was higher compared to the last two (2) sampling periods of October 2019 and March 2019 but much lower than the previous sampling records of December 2018 and September 2018 (**Figure 2-45**). Highest seagrass density was recorded in Station SG3 with 1,837 shoots/m^2 owing to the abundance of *Syringodium isoetifoluim* followed by Stations SG5 with 1,565 shoots/m^2 and SG7 with 1,038 shoots/m^2 attributable to the significant presence of the species *Cymodocea rotundata.* The remaining stations have recorded densities of 800 shoots/m^2 or less with Station SG2 having the lowest density of 340 shoots/m^2 (**Table 2-31**).

As already mentioned, present survey was higher than the previous two surveys of October 2019 and March 2019 with the October 2019 survey ranging from 100 shoots/m^2 to 1,543 shoots/m^2 with mean density of 696 shoots/m^2. Highest seagrass density for the October 2019 survey was recorded in Station SG6 with 1,543 shoots/m^2 owing to the abundance of *Syringodium isoetifoluim*, followed by Station SG7 with 1,487 shoots/m^2 dominated by the species *Cymodocea rotundata.* The remaining stations have recorded less than 650 shoots/m^2 (**Figure 2-45**).

The dominant presence of *Cymodocea rotundata* and *Enhalus acoroides* in almost all stations surveyed is a manifestation of their collective tolerance to environmental variations. However, the low abundance of some seagrass species indicates their low competition capacities (Fortes, 1986).

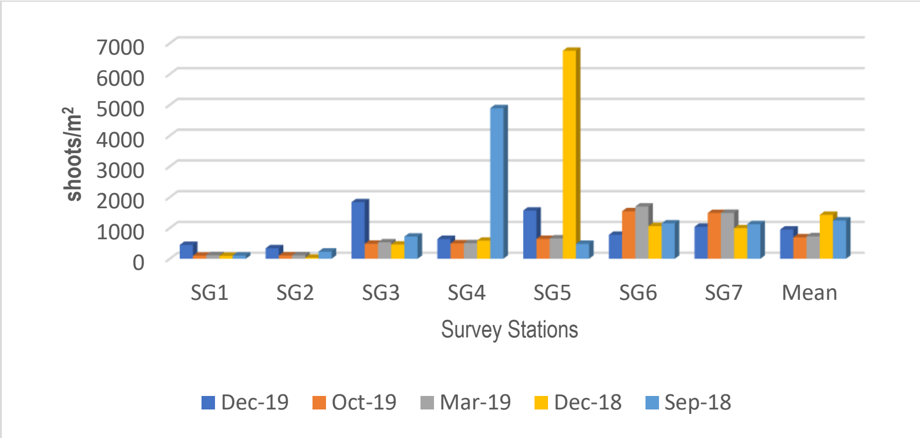


Figure 2-45: Comparative Density in All Sampling Stations in Five (5) Sampling Periods

Table 2-31: Tabulated Density of Seagrasses (shoots/m^2) in All Stations for Five (5) Survey Periods

Survey Periods	SG1	SG2	SG3	SG4	SG5	SG6	SG7	Mean
Dec-19	450	340	1837	643	1565	779	1038	950
Oct-19	100	107	489	500	645	1543	1487	696
Mar-19	114	112	533	505	661	1696	1489	730
Dec-18	96	35	463	587	6757	1061	993	1427
Sep-18	104	232	720	4891	485	1147	1123	1243

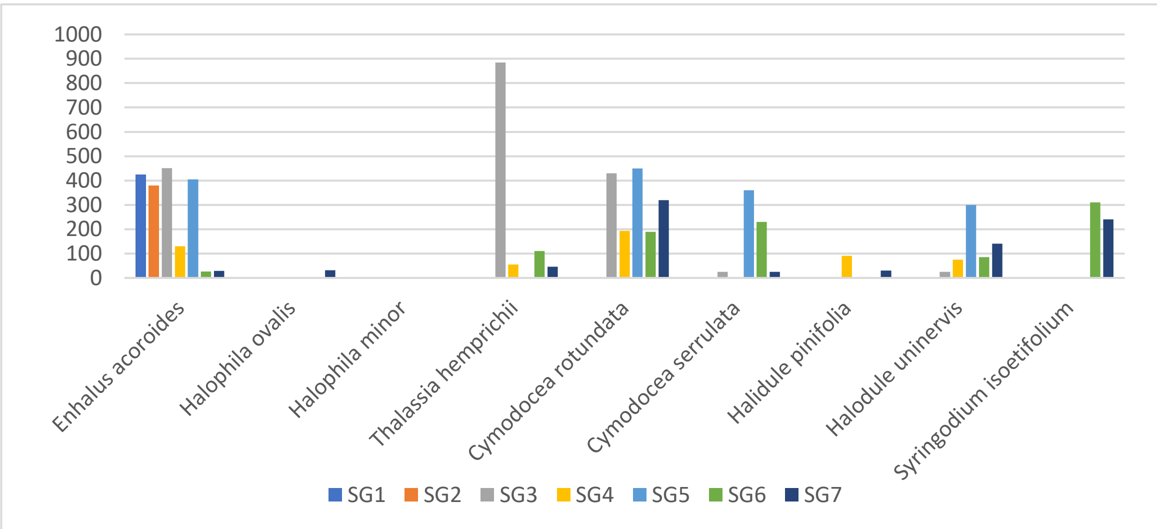
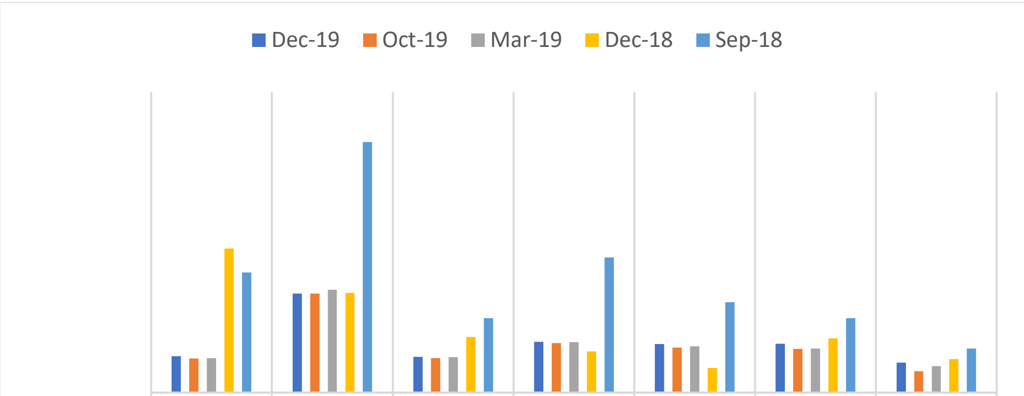


Figure 2-46: Occurrence and Comparative Density of Seagrasses at the Seven Sampling Stations (December 2019)

Biomass Estimates

Measures of biomass are a function of both plant size and shoot density (Fortes, 1990). Large-sized species coupled with high-density values gain higher biomass

In the present survey, biomass of seagrasses sampled ranged from 700 g wwt/m^2 to 2,310 g wwt/m^2 with mean biomass of 1,163 g wwt/m^2. This average was slightly higher compared to the March 2019 and October 2019 surveys with mean yields of 1131 g wwt/m^2 and 1090 g wwt/m^2, respectively. The highest seagrass biomass was recorded in Station SG2 with 2,310 g wwt/m^2 owing to the large sizes of *Enhalus acoroides*, followed by Station SG4 with 1,185 g wwt/m^2 due also to the presence of the large species *Enhalus acoroides*), then in descending order by Station SG6 with standing biomass of 1135 g wwt/m^2 comprised mainly of the specie *Thalassia hemprichii*, Station SG5 with 1,128 g wwt/m^2, Station SG1 with 850 g wwt/m^2, and Station SG3 with 832 g wwt/m^2. The lowest biomass was recorded at Station SG7 with 700 g wwt/m^2.



	SG1	SG2	SG3	SG4	SG5	SG6	SG7
Dec-19	850	2310	832	1185	1128	1135	700
Oct-19	798	2310	800	1150	1050	1019	500
Mar-19	800	2400	827	1173	1076	1028	616
Dec-18	3360	2319	1296	960	573	1267	783
Sep-18	2800	5840	1733	3147	2107	1733	1024

Figure 2-47: Comparative Biomass at the Seven Sampling Stations in Five (5) Sampling Periods

Table 2-32: Tabulated Biomass (g ww/M^2) for Five (5) Survey Periods

Survey Periods	SG1	SG2	SG3	SG4	SG5	SG6	SG7	Mean
Dec-19	850	2310	832	1185	1128	1135	700	1163
Oct-19	798	2310	800	1150	1050	1019	500	1090
Mar-19	800	2400	827	1173	1076	1028	616	1131
Dec-18	3360	2319	1296	960	573	1267	783	1508
Sep-18	2800	5840	1733	3147	2107	1733	1024	2626

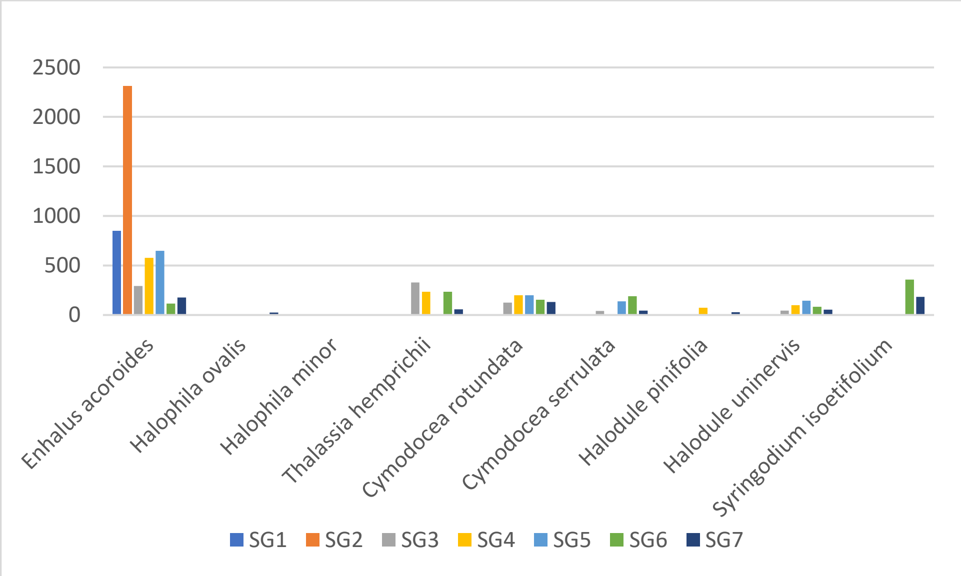


Figure 2-48: Biomass Yield at the Seven Sampling Stations (December 2019)

Table 2-33: Tabulated Biomass Yield (g wwt/m²) at the Seven (7) Survey Stations (December 2019)

Survey Stations	***Enhalus acoroides***	***Halophila ovalis***	***Halophila minor***	***Thalassia hemprichii***	***Cymodocea rotundata***	***Cymodocea serrulata***	***Halodule pinifolia***	***Halodule uninervis***	***Syringodium isoetifolium***
SG1	850								
SG2	2310								
SG3	293			330	124	40		45	
SG4	578			235	198		75	99	
SG5	649				198	138		143	
SG6	117			235	154	189		84	356
SG7	176	25		56	130	45	29	55	184

Species Diversity of Seagrasses

An index of diversity of seagrass species using Shannon-Wiener Index was computed for the communities found in different stations in the study area. Computed species diversity index (H') for the December 2019 survey ranged from 0.00 to 1.68 with a Mean Diversity Index for all stations at H' = 1.04. In general, typical diversity values ranges from H' = 1.5 to H' = 3.5 in most ecological studies and rarely goes beyond that threshold. Taken individually by station, Stations SG7 (H'=1.68), SG6 (H'=1.61), SG4 (H'=1.43) have diversity values within that threshold though SG5 (H'=1.37) and SG 3 (H'= 1.16) have also obtained values of more than one (1) which is generally in the acceptable diversity value level. Station SG1 and SG2 did not reflect any biodiversity index due to poor species representations. It has to be noted that species diversity indices generally increases as species richness and evenness increases

In the October 2019 survey, the same stations showed a species diversity index ranging from Station SG7 with H' = 1.63 followed in descending order by Station SG6 with H' = 1.59, Station SG4 with H' = 1.51, Station SG5 with H' = 1.38 and Station SG3 with H' = 1.16 for a mean diversity index of H' = 1.04, which is of similar value to the December 2019 survey period. Stations SG1 and SG2 also reflected poor diversity value due to poor species representation.

Species Diversity Index of three previous quarterly surveys from September 2018 to March 2019 reflected biodiversity values of less than H' = 1.00 indicating a constantly changing poor diversity indices though there were survey stations where species diversity index approaches the optimal level of H' = 1.5.

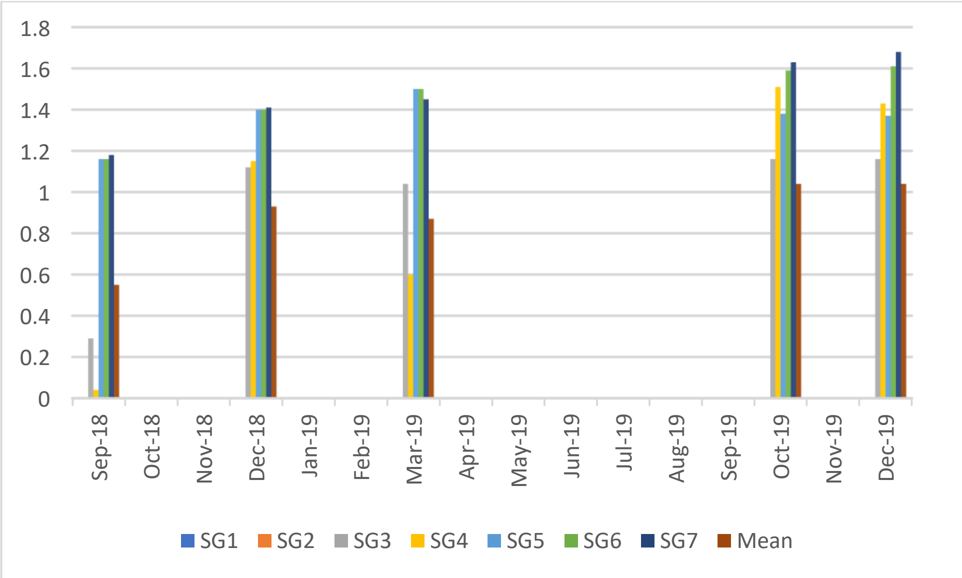


Figure 2-49: Comparative Diversity of Species at each Sampling Station in Five (5) Sampling Periods

Soft Bottom Infaunal Benthos

"Infaunal" refers to aquatic animals that lives in the substrate of a body of water and which are especially common in soft sediments."Benthic" refers to anything occurring at or in the bottom of a body of water. "Infauna" are the organisms that live in the sediments.

They help filter water, recycle organic matter, and are important forage (prey) for fish, reptiles, amphibians, and larger crustaceans (such as blue crabs and horseshoe crabs). Many of the organisms found in the benthos are suspension feeders and deposit feeders. Suspension feeders, also known as "filter feeders", process particles floating in the water column. Deposit feeders consume organic matter lying on or in the sediment.

Seasonal fluctuations of species and their abundances can be driven by recruitment (addition of individuals to a population), predation, poor habitat conditions (such as low dissolved oxygen), impacts like shoreline hardening and meteorological events like hurricanes.

Benthic or bottom dwelling organisms are classified according to their habits. Organisms that burrow into soft sediments are called infauna while those attached to hard substrates or live on the bottom substrate are called epifauna.

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 sources of many benthic or demersal (bottom dwelling) fishes and edible invertebrates on the sea. The soft bottom benthic communities are diverse and play an important role as support systems for the aquatic environment.

This report presents the study on the composition, density, relative abundance, biomass and diversity of the soft bottom infauna. The data described by this study will provide benchmark that will enable detailed comparison with future condition in the area.

Figure 2-50: Map Showing the Relative Location of the PP/ZP/IN Sampling Sites

Collection of sediment samples for the analysis of soft bottom infaunal benthos was by the use of an Ekman bottom grab sampler. Sampled sediments were sieved *in situ* to retain macrobenthos which is then collected in 60ml plastic bottles and preserved with 10% formaldehyde solution. It was labeled and transported to the team's home base for marine laboratory analysis. Small amount of "Rose Bengal" stain was added to the solution to make the macro-organisms visible with the use of a magnifying glass, under a stereoscope or a microscope, whatever is available. Benthic infauna was sorted manually, placed on a tray under sufficient light and classified up to major taxa or down to the genus level if possible. Magnifying glasses were often used for the identification of the organisms in the absence of a stereoscope, which can serve better for its higher magnification level. Abundance of macro-benthic fauna was calculated in the number of individuals per square meter.

Plate 5: Ekman Bottom Grab Sampler used to Collect Sediment Samples for Soft Bottom Subtidal Infaunal Benthos

Plate 6: Process of Collecting Sediment for Infaunal Monitoring

Identified organisms were placed in vials containing 70% alcohol and were 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. Biomass of the benthic infauna for each benthos sample was also measured and expressed in terms of wet weight in grams per square meter (wwt g/m^2).

Species Composition and Relative Abundance

A total of 212 benthic animal organisms were recorded in the samples taken from the five (5) stations for infauna assessment, which was higher than the sampling survey of October 2019 with 175 individual organisms and June 2019 with 201 ind/m^2 but lower than the March 2019 survey that accounted for 239 ind/m^2. The average number of individuals per station based on the total number of individuals counted from the five sampling stations was 42.6 and higher than the October 2019 average of 35 ind/m^2 and 40 ind/m^2 estimate of the monitoring surveys of June 2019 and March 2019, with 19 ind/m^2 in December 2018 and 16 ind/m^2 in September 2018. These organisms represented twenty-three (23) taxa belonging to six (6) major groups, namely: Foraminifera, Nematoda, Nemertea, Annelida, Mollusca and Arthropoda. The survey of October 2019 had recorded 25 taxa, June 2019 recorded 35 taxa and March 2019 have recorded 30 taxa and a higher number of major groups as compared to this survey which recorded only six major groups composed of 23 taxa. Representatives of the Phylum Annelida composed mainly of polychaete worms were the most abundant organisms collected, comprising 53.5% of the total collection, followed by the arthropods with 23%. The percentage composition of the rest of the group only ranged from one to 7.5 with the lowest at 4.2% composed of nemertians. (**Table 2-34**)

Table 2-34: Raw Count of Infauna at the Five Stations along Masinloc Power Plant

Taxa	Sampling Station					Total
	IN1	IN2	IN3	IN4	IN5	
Phylum Foraminifera						
Family: Globerigenidae	5	3		2	1	11
Phylum Nematoda	3	7	2	1	1	14
Phylum Nemertea	5		1		3	9
Phylum Annelida						
Family: Amphinomidae	2	1	5		2	10
Eunicidae		1	1		3	5
Glyceridae	1	1		1	1	4
Neiredidae		3	1	1		5
Pilargidae	1	1			1	3
Syllidae	4	2	2			8
Nephtyidae		2	2	2	3	9
Phyllodocidae	1			3	2	6
Sabellidae	3	3	3			9
Serpulidae	2		1		1	4
Spionidae	2	5	2			9
Cirratulidae			1	1	4	6
Sternaspidae	1	2		1	3	7
Pectinariidae		1				1
Terebellidae		4	2		1	7
Capitellidae	3	4	1	5	2	15
Orbiniidae			1		5	6
Phylum Mollusca						
Family: Tellinidae		2	1		5	8
Mytilidae	2	1	2		3	8
Phylum Arthropoda						
Order: Amphipoda	23	2	7	6	11	49
Total	**58**	**45**	**34**	**23**	**52**	**213**

Based on previous monitoring records, the foraminiferans were the most abundant organisms collected on the surveys made in June 2019 and December 2018 while the annelids were the most abundant recorded on the October 2019 survey at 52% of the total count with the same organism exhibiting a more or less balanced population number in the four (4) previous surveys prior to the October 2019 survey. For the December 2019 survey, infaunal benthic organisms sampled were dominated by the annelids at 53.5% and arthropods at 24% then followed in descending order by the mollusks at 7.3%, nematodes at 6.5%, foramineferans at 5.1% and nemertians at 4.3% (**Table 2-35**).

Species composition by major taxon, average density computed as the number of species divided by the number of stations established and relative density computed as the average density of species divided by the averaged total number of species of the major taxonomic groups of benthic organisms sampled during the present survey are presented in the table below (**Table 2-36**).

Table 2-35: Species Composition, Density, Relative Abundance and Biomass of Subtidal Infauna Sampled (December 2019)

Taxa	Sampling Stations					Ave. Density (No. Ind/m2)	Ave. Relative Density (%)
	IN1	IN2	IN3	IN4	IN5		
Phylum Foraminifera							
Family: Globerigenidae	223	134		89	44.5	98	5.07
Phylum Nematoda	134	312	89	44.5	44.5	125	6.46
Phylum Nemertea	223		44.5		134	80	4.25
Phylum Annelida							
Family: Amphinomidae	89	44.5	223		89	89	4.61
Eunicidae		44.5	44.5		134	44.5	2.3
Glyceridae	44.5	44.5		44.5	44.5	36	1.86
Neirededae		134	44.5	44.5		44.5	2.3
Pilargidae	44.5	44.5			44.5	27	1.67
Syllidae	178	89	89			71	3.67
Nephtyidae		89	89	89	134	80	4.14
Phyllodocidae	44.5			134	89	53	2.74
Sabellidae	134	134	134			80	4.25
Serpulidae	89		44.5		44.5	36	1.86
Spionidae	89	223	89			80	4.25
Cirratulidae			44.5	44.5	178	53	2.74
Sternaspidae	44.5	89		44.5	134	63	3.26
Pectinariidae		44.5				8.9	0.46
Terebellidae		178	89		44.5	62	3.21
Capitellidae	134	178	44.5	223	89	134	6.90
Orbiniidae			44.5		223	53	2.74
Sub-total (Annelida)	891	1337	1114	624	1248	101	
Phylum Mollusca							
Family: Tellinidae		89	44.5		223	71	3.67
Mytilidae	89	44.5	89		134	71	3.67
Phylum Arthropoda							
Order: Amphipoda	1203	89	312	267	489	472	24.43
Total	**2763**	**2005**	**1559**	**1024**	**2319**	**1932**	**100**
No. of Taxa	15	18	17	10	18	23	
Species Richness	14.7	17.7	16.7	9.7	17.7	22.7	
Species Diversity (H')	2.18	2.67	2.7	1.84	2.69	2.8	
Maximum Diversity(Hmax)	2.7	2.9	2.8	2.3	2.9	3.13	
Evenness	0.81	0.92	0.96	0.80	0.92	0.89	
Depth (m)	8	9	10	13	10		

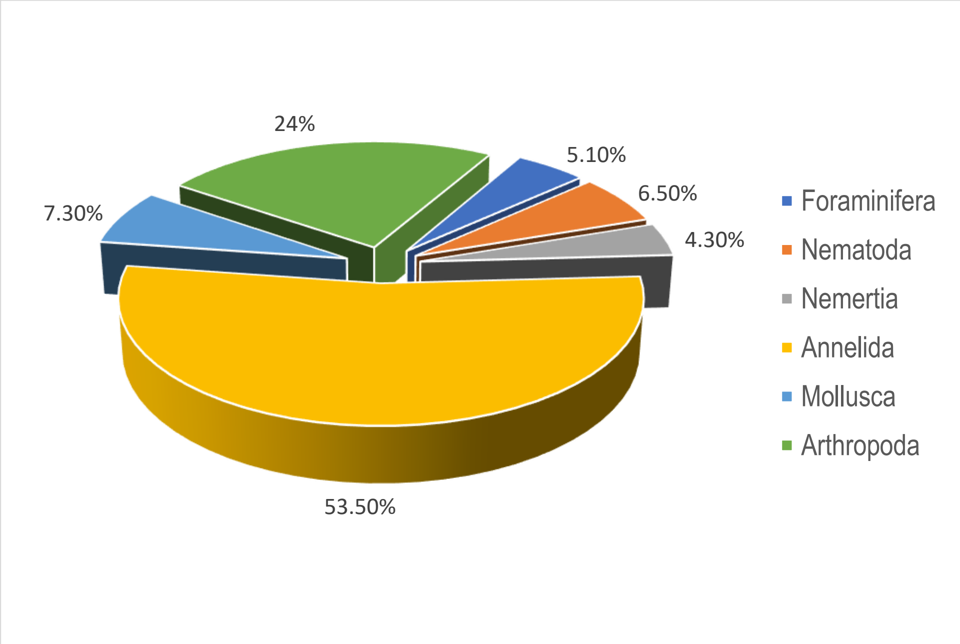


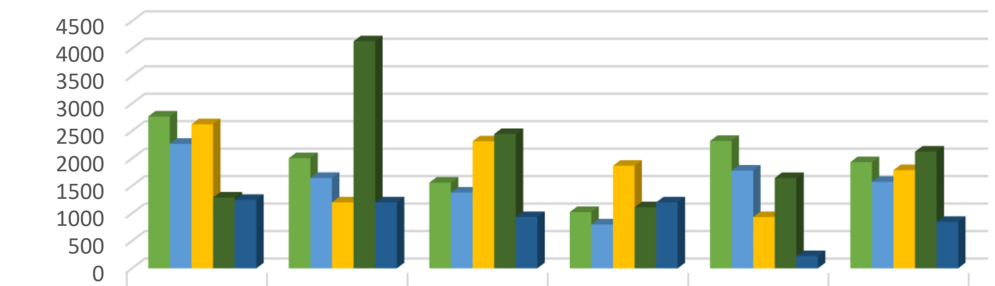
Figure 2-51: Mean Relative Abundance of Infauna Collected from Five Sampling Stations (December 2019)

Table 2-36: Comparative Presentation of Relative Abundance (%) of Infaunal Species in Five (5) Sampling Periods from September 2018 to December 2019

Taxa	Sampling and Survey Period				
	Dec 2019	Oct 2019	June 2019	Mar 2019	Dec 2018
Foraminefera	5.1	2.0	35	7.0	39.0
Nematoda	6.5	8.0	7	0.5	4.0
Sipunculida		0	1	0.5	1.0
Nemertia	4.3	2.0	4	3.0	11.0
Annelida	53.5	52.0	32	39.0	31.0
Mollusca	7.3	6.0	9	4.0	3.0
Arthropoda	24.0	24.0	8	38.0	7.0
Echinodermata		0	3	0	0
Chordata		6.0	2	8.0	4.0
Total		**100**	**100**	**100**	**100**

Benthos Density

The density of benthic organisms was variable among the sampling stations, and ranged from 1,024 to 2,763 ind/m^2. The mean density recorded at 1,932 ind/m^2 was higher than the survey made on October 2019 with a mean density of 1,575 ind/m^2 and on June 2019 with a mean density of 1,787 ind/m^2. The highest density of benthic organisms at 2,763 ind/m^2 sampled at Station IN1 was dominated by the abundance of several species of polychaetes followed by Station IN5 with 2,319 ind/m^2 still due to the numerous presence of polychaetes and arthropods. Ranked third in abundance was Station IN2 with 2,005 ind/m^2 while lower densities with at least 1,500 ind/m^2 or less were recorded at Stations IN4 and IN3 with 1.024 ind/m^2 and 1559 ind/m^2 respectively (**Table 2-35** and **Figure 2-52**).



	IN1	IN2	IN3	IN4	IN5	Mean
Dec-19	2763	2005	1559	1024	2319	1932
Oct-19	2266	1645	1379	799	1779	1575
Jun-19	2622	1200	2311	1867	933	1787
Mar-19	1289	4133	2444	1111	1644	2124
Dec-18	1244	1200	933	1200	222	844

Figure 2-52: Density of Infaunal Benthos for Each Sampling Station on Four Sampling Periods (December 2018, March 2019, June 2019 and Oct 2019)

On the December 2018 survey, Station IN1 recorded with highest density at 1,244 ind/m^2 due to the abundance of polychaetes, particularly the amphinomids and spionids. The sampling period of March 2019 also yielded a slight increase in the population sample at 1,289 ind/m^2 but was recorded as the second lowest in terms of population density for that sampling period with Station IN2 registering the highest density with 4133 ind/m^2. However, the June 2019 and Oct 2019 sampling period again registered Station IN1 as having the highest population density with 2622 ind/m^2 and 2266 ind/m^2 respectively. Apparently, this particular station is showing a constant increase in infaunal population as also recorded in the December 2019 survey and needs closer monitoring to see if the trend continues to determine specific factors affecting such constant increase. Knowing more about this may provide information that could be replicated on some parts of the bay to improve soft bottom productivity which could be beneficial to the biota dependent on these organisms. The other stations are registering a high and low population distribution, which also needs to be studied in relation to the environmental and anthropogenic factors affecting such irregular population flux.

Evidently, abundance and density of infauna is under constant flux as influenced by factors like time and food availability, just among others. Specifically, decline in density of organism in some sites can be a temporal response to the abovementioned factors. Another possible cause of changes in abundance is changes in sedimentary composition, which may not favor habitation by previously observed infaunal organisms. Basic composition of the bottom substrate plays a major role in the occurrence, distribution, and abundance of soft bottom fauna.

Species Richness and Diversity

For the December 2019 survey, the table below shows the various statistical parameters derived from Margalef for species richness, Pielou for species evenness and Shannon-Wienner for species diversity. Stations

IN2, IN3 and IN5 have recorded the highest number of species with 18, 17 and 18 respectively followed by IN1 with 15 and IN4 with 10.

Table 2-37: Tabulated Data on Species Diversity, Richness and Evenness in Five (5) Sampling Stations (December 2019)

Station	No. of Species	No. of Individuals	Species Richness	Species Evenness	Species Diversity
IN1	15	2763	14.7	0.81	2.18
IN2	18	2005	17.7	0.92	2.67
IN3	17	1559	16.7	0.96	2.70
IN4	10	1024	9.7	0.80	1.84
IN5	18	2319	17.7	0.92	2.69

In comparison, the December 2018 survey recorded Station IN1 as having the highest number of species with 13 followed by Station IN2 with 11. Stations IN3 and IN4 have 8 taxa each and Station BN5 had the least with only 3 taxa.

For the March 2019 survey, IN2 and IN3 recorded the highest number of species, with 16 species each and followed by Stations IN1 with 13, IN4 with 11 and IN5 with 10, respectively. On the other hand, the June survey registered Station IN3 as having the highest number of species with 21 followed by Stations IN1, IN4, IN2 and IN5 with 17, 13, 10 and 7, respectively.

In the October 2019 survey, the highest number of species was at Station IN2 and IN3 with 16 species each followed by Station IN5 with 15 species recorded. The least number of species was recorded at Stations IN1 and IN4 with 13 species each.

Margalef's species richness index standardizes the number of species encountered against the total number of individuals. Station IN2 and IN5 showed the highest species richness index with 17.7 each followed by Stations IN3 with 16.7, IN1 with 14.7 and IN4 with 9.7.

During the study period in December 2018, Station IN2 showed the highest species richness index with 2.39 followed by Stations IN1 3.60, IN3 with 2.30 and IN4 with 2.12. Low species richness was recorded at IN5 with 1.24, due to low in numbers of species and individuals (LTI, 2018d).

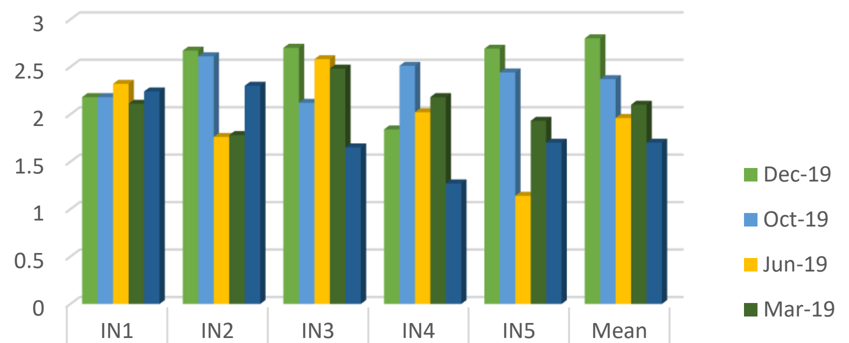
In the March 2019 survey, Station IN3 showed the highest species richness index with 3.74 followed by Stations IN1 with 3.56, IN2 with 3.31 and IN4 with 3.11. Low species richness was recorded at Station IN5 with 2.49 due to the low in numbers of species and individuals.

For the June 2019 survey, Station IN3 showed the highest species richness index with 5.06 followed by IN1 with 3.92, IN4 with 3.21 and IN2 with 2.73. Low species richness was always recorded at Station IN5 with 1.97, due to low numbers of species and individuals.

An index of diversity of benthic organisms using the Shannon-Wiener Index for the communities found in the different stations in the study area showed the following. The index both measures the variety and number of individuals per taxa. Species diversity (H') ranged from 1.84 to 2.70, with mean diversity of H' = 2.8 which is higher than the previous survey periods. Mean diversity index have already taken into account the total number of all the species encountered in the five (5) survey stations. For the individual stations, highest was recorded at Station IN3 with a diversity index of H' = 2.70 followed by Stations IN5 with H'=2.69, IN2 with H'=2.67, Station IN1 with H' = 2.18 and IN4 with H' = 1.84. Less stressful environment promotes high diversity. As stresses in the particular area increased, benthic infauna communities may be dominated only by few kinds of organisms. In this survey period, there appeared a certain balance in species diversity distribution in the five sampling stations with the exception of Station IN4 exhibiting a much lower species diversity as compared to the other stations.

For the October 2019 survey, species diversity ranged from 2.12 recorded at Station IN3 to 2.61 recorded at Station IN2 which is higher than the June survey where species diversity (H') ranged from 1.14 to 2.58, with mean diversity of H'=1.96 which is higher than December 2018 but lower than last March 2019 and the October 2019 survey as well. Highest for the June survey was recorded at Station IN3 with H'=2.58, followed by Station IN1 with H'=2.32 and IN4 with H'=2.02. Stations IN5 and IN2 have species diversity below H'-2.00. Less stressful environment promotes high diversity. As stresses in the particular area increased, benthic infauna communities may be dominated only by few kinds.

Species diversity recorded on the March 2019 survey was highest at IN3 with H' = 2.48 followed by Station IN4 with H' = 2.18 and followed in decreasing order by Stations IN1 with H" = 2.11, IN5 with H' = 1.93 and IN2 with H' = 1.78. The five sampling stations has a mean diversity index of 2.10



	IN1	IN2	IN3	IN4	IN5	Mean
Dec-19	2.18	2.67	2.7	1.84	2.69	2.8
Oct-19	2.18	2.61	2.12	2.51	2.44	2.37
Jun-19	2.32	1.76	2.58	2.02	1.14	1.96
Mar-19	2.11	1.78	2.48	2.18	1.93	2.1
Dec-18	2.24	2.3	1.65	1.27	1.7	1.7

Figure 2-53: Comparative Infaunal Species Diversity Indices from Five Sampling Stations in Four Survey Periods from December 2018 to December 2019

Species diversity (H') of the December 2018 survey ranged from 1.05 to 2.30, with mean diversity of H' = 1.70. Highest was recorded at Station IN2 with H' = 2.30, followed by IN1 with H' = 2.24. All the remaining stations have species diversity below H' = 2.00 and the least was always found at IN5 with H' = 1.05. The low diversity of fauna in other stations indicates highly stressful environment as there is a certain degree of selectivity among the animals with the choice of areas where their population could survive.

An evenness value near one (1) indicates an even distribution of individuals of different species. High evenness suggests that the abundance of individuals is equally proportional to the different species. Lower evenness indicates that the density is being dominated by a single species. Almost all the sampling stations recorded the same proportional evenness with Station IN3 with the highest value of 0.96 followed in decreasing rank by

Stations IN2 and IN5 with 0.92 each, Station IN1 with 0.81 and Station IN4 with 0.80 evenness.

For the October 2019 survey, almost all the sampling stations recorded the same proportional evenness with Station IN4 having the highest value of 0.95 followed in decreasing rank by Stations IN2 with 0.94, IN5 with 0.90, IN1 with 0.85 and Station IN3 with the lowest rank value of 0.78.

For the June 2019 survey, Station IN3 had the highest value with 0.85 followed by Station IN1 with 0.82 and the remaining stations have evenness values below 0.80 and least was Station BN5 with 0.59 due to the low proportion of number of individuals collected against the number of species.

The March 2019 survey had higher evenness values. Station IN4 had the highest value with 0.91 followed in decreasing rank by Stations IN3 with 0.89, IN5 with 0.84, IN1 with 0.82 and least was Station IN2 with 0.64.

During the December 2018 study period, Stations IN2 and IN5 have the highest value of 0.96 each, followed by Station IN1 with 0.87. The remaining stations have evenness values below 0.80. Lowest evenness was recorded at Station IN4 with 0.61.


Polychaete worm (no ID)


Nematode (No ID)


Nemertea (no ID)


***Capitella* sp.**


Tellinid species (no ID)


Amphipod (no ID)


Amphioxus (no ID)

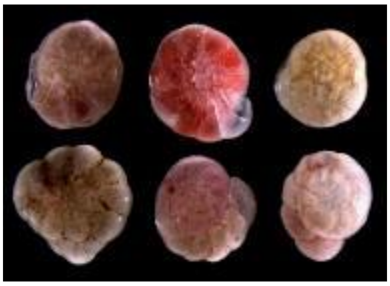

Diatoms (no ID)

Plate 7: Representative Images of Infauna

Plankton

Plankton is a generic term describing a group of organisms that have limited locomotive ability relative to the water bodies in which they inhabit. A variety of organisms lives in the plankton, ranging in size from viruses (femtoplankton) to large jellyfishes (megazooplankton). Individual organisms constituting plankton are called plankters. They provide a crucial source of food to many small and large aquatic organisms, such as bivalves, fish and whales. However, the seasonal occurrence of algal blooms can cause problems in terms of food availability and productivity.

Tropical plankton communities are highly diverse, containing organisms from almost all kingdoms, phyla and families. These organisms use their environment, its resources, and each other, in a wide variety of ways. The most common way to classify planktonic organisms is based on size, which affects sinking, light utilization, mobility and trophic status. Organisms with particular functional roles in the ecosystem (e.g. grazers and nitrogen-fixers) occur in a number of size classes, though in general primary producers tend to be smaller than grazers, which in turn tend to be smaller than predators.

Phytoplanktons account for approximately half the global primary production, and consequently play a major role in cycling of atmospheric carbon dioxide (CO_2). They are also the major primary producers in the ecosystem. Approximately 70 percent of the estimated 2.2 x 105 tons of carbon (C) fixed daily by primary producers in the ecosystem originates from phytoplankton production (58 x107 tons C per year) and, of this, two-thirds is fixed by picoplankton.

Micro- and meso-zooplankton are the basis of food webs supporting oceanic and many coastal fisheries. Plankton and suspended non-living organic particles directly support a wide variety of suspension-feeding organisms and planktivorous fish on coral reefs. In addition, most benthic macroalgae, invertebrates and fish have a planktonic life stage that is dispersed by currents.

Several phytoplankton studies spanning the width of the ecosystem have demonstrated a strong onshore–offshore gradient. Phytoplankton in nearshore waters are more frequently dominated by diatoms because of more consistent nutrient inputs and greater nutrient availability from adjacent terrestrial sources and shallow sediments. Diatom-dominated assemblages are therefore diagnostic of enhanced or persistent nutrient inputs into a region. Diatoms achieve dominance after disturbances, for brief periods at least, because they have faster intrinsic growth rates than picoplanktonic cyanobacteria. The difference in response times between the flagellate grazers of picoplankton (days) and the metazoan grazers of microplankton diatoms (weeks) also contributes to the persistence of diatom blooms. By comparison, communities in oligotrophic (low nutrient) outer-shelf and oceanic waters are dominated by picoplankton-sized unicellular cyanobacteria (Synechococcus) and prochlorophytes (Prochlorococcus), together with nitrogen-fixing cyanobacterial rafts of Trichodesmium and characteristic assemblages of open-ocean dinoflagellates,

In contrast to seasonal ocean-scale cycles in productivity, harmful algal blooms (HABs) occur on a smaller spatial scale and are difficult to predict. Nevertheless, these major biological events lead directly to extensive ecological and socio-economic damage on a global scale. They occur when local algal populations undergo a period of rapid growth, causing toxic or damaging effects to surrounding ecosystems. HABs have been shown to have widespread health impacts on fish and shellfish, marine mammals, birds and humans. HAB events are happening more often and in more places than ever before, and they particularly endanger small communities in the developing world that depend on a healthy catch of seafood to sustain the local population.

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 or "grass of the sea," forming the base of the food web upon which almost all-marine animal life depends (Basson et al., 1977).

In contrast, zooplanktons (or animal plankton) are consumer organisms, which depend upon the phytoplankton, and to some extent on dead organic matter, for their source of food and energy (Basson *et al*., 1977). Since zooplankton is the secondary producer of organic matter living on the phytoplankton in the marine food chain, its importance in fish production is self-evident (Rawson, 1956). It provides the essential food for many of the commercially important fishes such as juveniles and adult tunas (Reintjes and King, 1953), herrings, sardines, small fish, and economically important marine invertebrates like squid and shrimp (King and Hida, 1954; Hida and King, 1955).

The plankton survey intended to evaluate the plankton community in the area with respect to its composition, density, relative abundance and biomass. The study aims to contribute some basic information to the general knowledge of the plankton ecology of nearshore marine waters surrounding the coal power plant facility.

Water column and bottom sediment sampling activities were focused mainly around the power plant facility where a total of five (5) stations were each surveyed and sampled for phytoplankton, zooplankton and soft bottom infaunal benthos. All these stations sampled are listed and their locations, coordinates, wind direction, and sea condition at the time of sampling indicated. The approximate locations of these sampling stations are shown in the table below and projected on the following map.

Table 2-38: Tabulated Data Location and Other Pertinent Information for Plankton Survey

Station	**Location**	**GPS Coordinates**		**Depth (m)**	**Weather/ Sea Condition/ Wind Direction**
PP/ZP1	Front of coal stockyard	15^0 34' 06.46"N	119^0 55' 44.71"E	4	Sunny/calm/SW
PP/ZP2	Between Oyon Point and Powerhouse	15^0 33' 43.70"N	119^0 55'46.56"E	8	Sunny/calm/SW
PP/ZP3	Near Intake	15^0 33' 29.56"N	119^0 55' 19.82"E	10	Sunny/calm/SW
PP/ZP4	Front of discharge canal	15^0 33' 26.76"N	119^0 55' 9.11"E	12	Slightly cloudy/small wavelets/SW
PP/ZP5	Near mouth of Lauis River	15^0 34' 47.11"N	119^0 54' 40.02"E	10	Slightly cloudy/small wavelets/SW

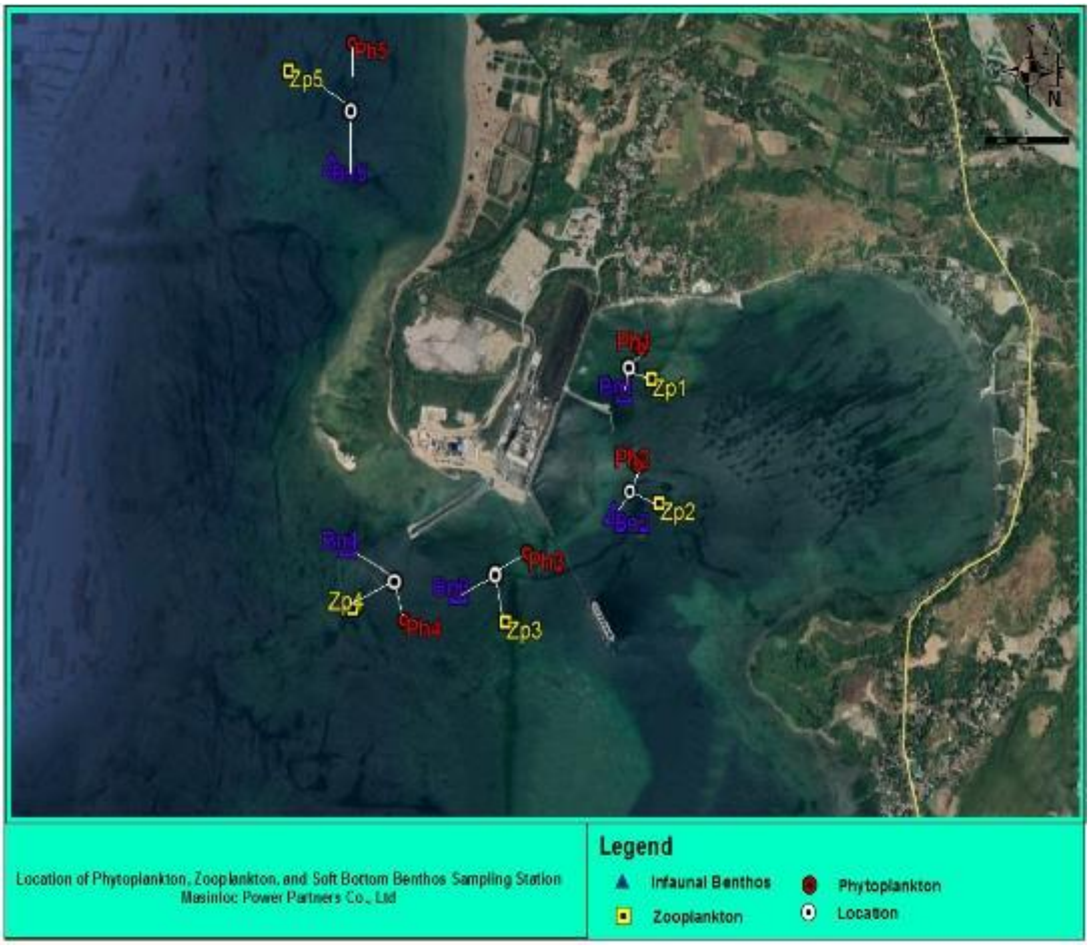


Figure 2-54: Map Showing the Relative Location of the PP/ZP/IN Sampling Sites

Distribution of phytoplankton is not uniform throughout the water column but occurs in patchy distribution in both time and space. They tend to move towards the water surface during daylight as the species tend to avail whatever sunlight is available in order to photosynthesize and sink lower in the water column during nighttime. On the other hand, most of the zooplankton migrates vertically in response to light. They tend to occur lower in the water column during daytime and slowly migrates to the surface as daylight recedes thus the most suitable time to do zooplankton sampling would be during early dawn or morning as the sun rises and late in the afternoon as the sun goes down or during nighttime.

In order to minimize the effect of daylight variations brought about by diurnal migration of plankton, the previous methods used were innovated by making a vertical tow throughout the water column, which is similar to that done during the sampling period of September 2018. This was done by sinking a standard plankton net to the desired depth of the selected sampling station (approximately near the bottom) and hauling it upwards throughout the water column up to the surface where the water collected are decanted into sample bottles for later analysis. This method will enable for the collection of plankton at all levels of the water column thus negating the need to do repetitive horizontal tows dependent on the surface migration of the plankton as mentioned above. Volume of water displaced was obtained by determining the area of the plankton net's mouth times the measured depth of the vertical tow.

Plankton samples were collected at each station by hand-hauling a 25-cm mouth diameter conical plankton net with 20 microns mesh size for phytoplankton and zooplankton collection. All plankton samples were preserved in 10% formalin solution immediately after collection. All of the plankton samples collected was transported to the home base of the monitoring team where it was referred to the USC Marine Laboratory for sorting, identification, counting and recording. At the marine laboratory 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 counting chamber. The estimated densities and values of phytoplankton and zooplankton organisms were extrapolated into number per liter of seawater (no/L).

Phytoplankton

The phytoplankton and zooplankton taxa represented in the samples, their density, and mean percent relative abundance per sampling station are tabulated and shown below. In this survey, the phytoplankton population consists mainly of only two (2) major groups: diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae). The diatoms represented by fourteen (14) genera/taxa, again appeared to be the most dominant phytoplankton group with an average of 1,596 cells/L or 83.0% of the total estimated phytoplankton population. The remaining 17% were composed of the dinoflagellates. Of the diatoms, *Coscinodiscus* has the most number with an average density of 684 ind/L for the five survey stations and constitutes 43% of the total diatoms counted. This was followed by *Chaetoceros* with an average density of 398 ind/L or 25% of the total diatom count.

Table 2-39: Composition, Density and Relative Abundance of Phytoplankton and Zooplankton Collected at Five Sampling Stations

Taxa	**Sampling Stations**					**Ave. Density (no./L)**	**Mean Rel. Density (%)**
	PZ1 (no./L)	**PZ2 (no./L)**	**PZ3 (no./L)**	**PZ4 (no./L)**	**PZ5 (no./L)**		
A. Phytoplankton							
Diatoms							
Cyclotella	21	14	9	20	5	13.8	0.72
Coscinodiscus	1500	900	780	62	180	684	35.6
Chaetocerus	605	220	680	230	257	398	20.7
Thalasiossira	72	57	31	25	19	41	2.13
Prorocentrum	5	22	42	15	9	19	0.98
Biddulphia	310	105	127	81	103	145	7.54
Thalassionema	16	41	36	12	9	22.8	1.19
Nitzchia	32	46	72	19	25	39	2.03
Skeletonema	7		35	16		12	0.62
Rhizosolenia	17	26	53	39	15	30	1.56
Navicula	38		35	17		18	0.93
Fragillaria		15	80	69	17	36	1.87
Melosira	120	42	134	73	35	80	4.16
Licmophora		32	75	92	85	57	2.97
Sub-total	**2,743**	**1,520**	**2,189**	**770**	**759**	**1,596**	**83.03**
Dinoflagellates							
Peridinium	72	90	33	60	51	61	3.17
Ceratium	57	72	48	32	16	45	2.34
Protoperidinium	115	84	53	30	22	60	3.12
Gonyaulax	12		39		47	20	1.04
Noctiluca	108	81	94	125	68	95	4.94
Dinophysis	34	31	47	16	9	27	1.40
Gymnodinium	23	17	31	11	7	18	0.93
Sub-total	**421**	**375**	**345**	**274**	**220**	**326**	**16.96**
Total	**3,164**	**1,895**	**2,534**	**1,044**	**979**	**1,922**	**100**
B. Zooplankton							
Ciliophora	57	120	95	82	64	84	28.9

Taxa	Sampling Stations					Ave. Density (no./L)	Mean Rel. Density (%)
	PZ1 (no./L)	PZ2 (no./L)	PZ3 (no./L)	PZ4 (no./L)	PZ5 (no./L)		
Tintinnid spp.							
Arthropoda							
Acartia nauplii	17	25	7	30	23	20	6.89
Calanus spp.	8	26	18	11	13	15	5.17
Copepad larvae	11	16	23	19	18	17	5.86
Forams	53	31	19	26	16	29	10.0
Chaetognata	8	11	7	5	9	8	2.75
Cnidaria							
Sea anemone larvae	7	3	8	3	9	6	2.07
Planula larvae			9	11	18	8	2.75
Echinodermata							
Brachiolaria larvae	10	15	11	17	13	13	4.48
Echinopluteus larvae	35	23	43	15	25	28	9.65
Gastropoda							
Veliger larvae	5	8	9	17	9	9	3.1
Crustacea							
Shrimp nauplii	25	8	11	42	18	21	7.24
Ichthyoplankton							
Fish larvae	15	22	37	46	33	31	10.68
Total	**251**	**308**	**297**	**324**	**268**	**290**	**100**

The second most abundant phytoplankton group are the dinoflagellates with an average of 326 cells/L or 17% out of the total phytoplankton counted and represented by seven (7) genera/taxa, dominated by representative of the species *Noctiluca* sp. which averaged 95 cells/L constituting 4.9% of the total phytoplankton population. Dinoflagellates are the most common group linked with red tides. They have strong swimming ability, which can attain speeds of one meter per hour or more. Coupled with this is a vertical migration of varying extent, towards the surface during the day and down to the nutricline at night. Approximately, 10% are known to produce resting cysts from which new blooms may be seeded. The organisms producing red tides fall within a predictable spectrum: all are buoyant or motile and nearly all are photosynthetic. Diatoms are not usually involved in these phenomena.

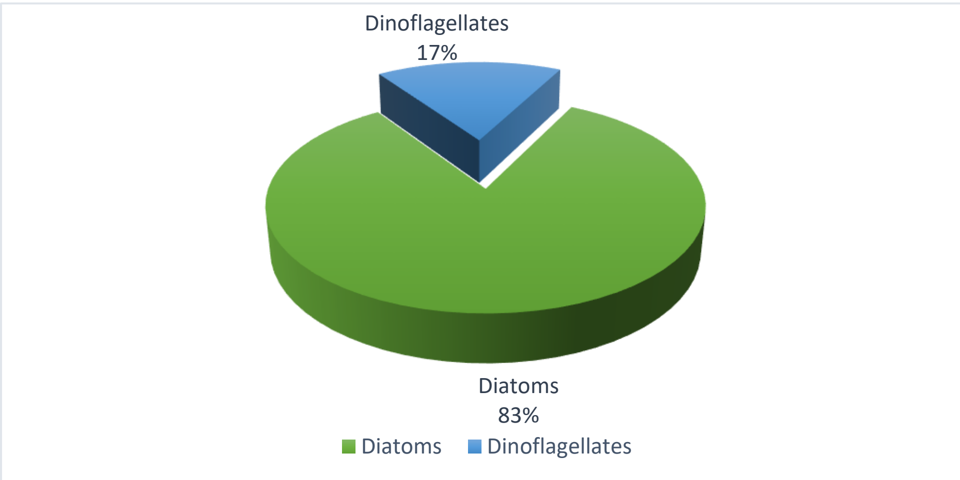


Figure 2-55: Mean Relative Abundance of Major Phytoplankton Groups Collected from Five Sampling Stations (December 2019)

The December 2019 survey yielded an almost predictable result with the diatoms, as a major group, significantly dominant constituting 83% of the phytoplankton community. The remaining 17% was composed of the dinoflagellates. In marine waters, the phytoplankton community is often dominated by diatoms - microscopic representatives of the plant phylum Chrysophyta, which possesses the characteristic silica impregnated cell walls and may be extremely abundant in nearshore or bay ecosystems (Basson *et al.,* 1977). Overall, the phytoplankton organisms in the water column obtained during the present survey was dominated by the diatom *Coscinodiscus* with an average population of 684 cells/L, which is 35.6% of the total phytoplankton population sampled followed by the diatom *Chaetoceros* with an average population of 398 cells/L which constitutes 20.7% of the total phytoplankton population collected (**Table 2-39**). Cells of *Coscinodiscus* are disc-shaped, cylindrical or wedge-shaped, and solitary; usually regarded as one of the largest marine planktonic diatom genera with 400-500 taxa described and identified.

Mean relative densities from previous survey periods since this monitoring program was conducted are presented below for comparative analysis of the phytoplankton group observed at different periods of time.

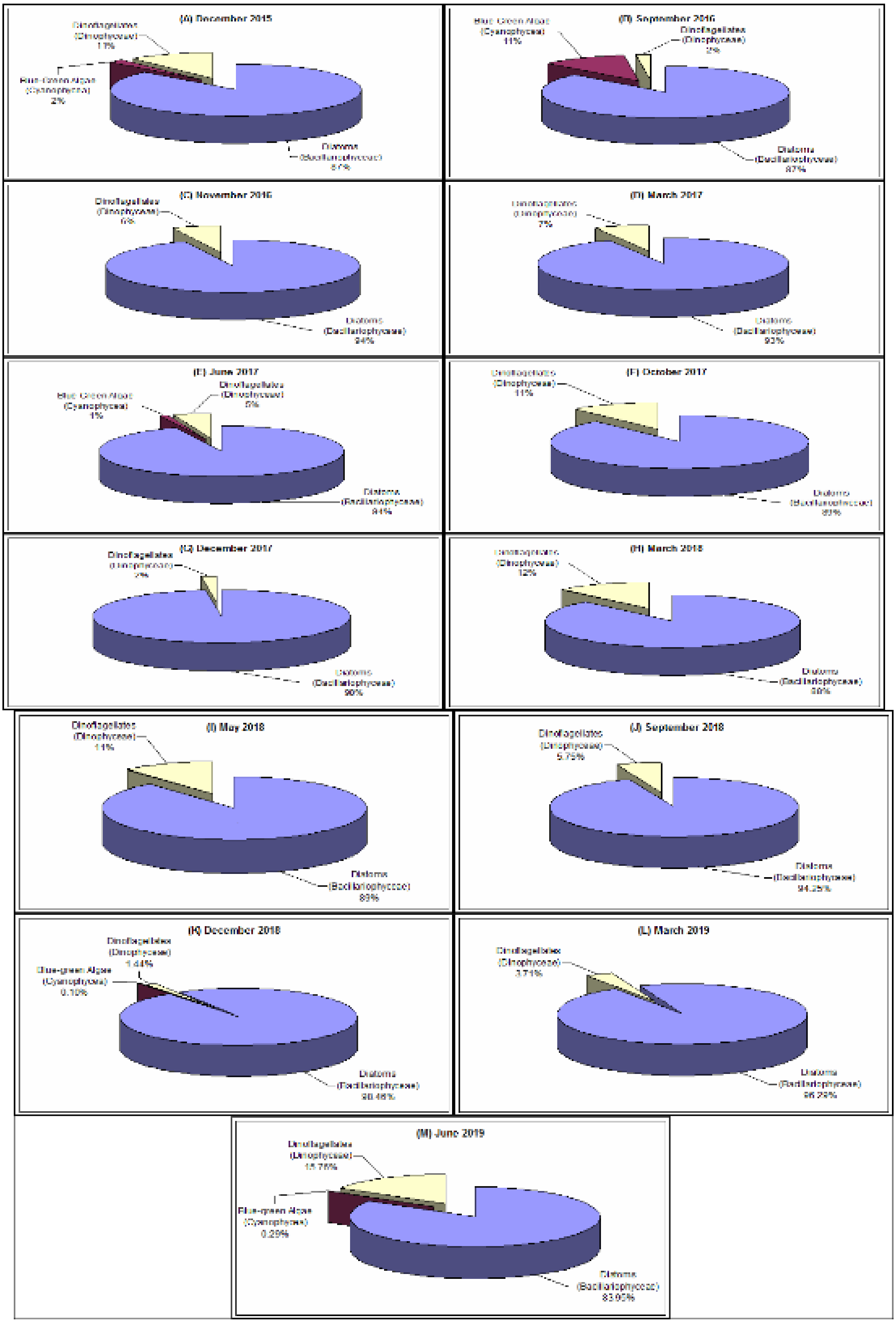
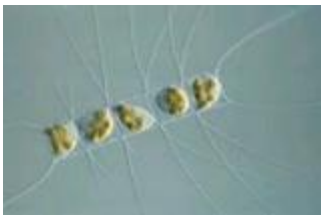
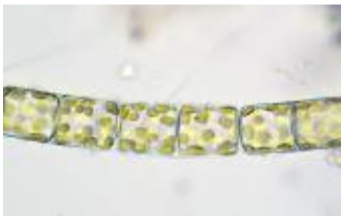


Figure 2-56: Percentage Composition of Major Phytoplankton Groups Observed from Different Sampling Periods from December 2015 to June 2019

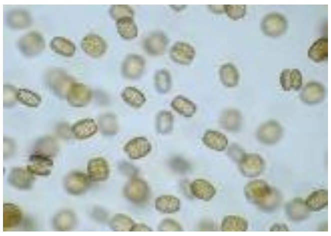

Coscinodiscus

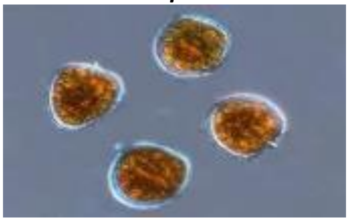

Chaetoceros


Melosira


Biddulphia


Licmophora

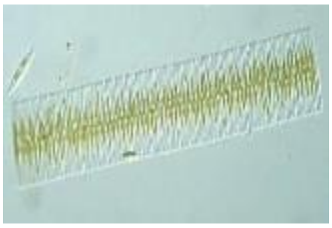

Thalassiosira


Prorocentrum


Nitzchia


Leptocylindrus

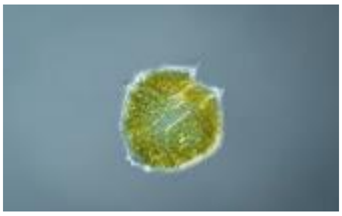

Rhizosolenia

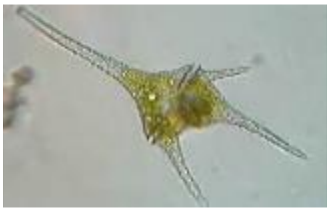

Fragilaria

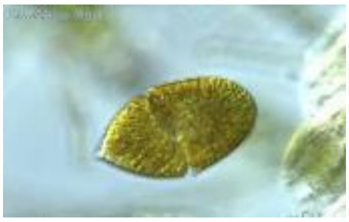

Skeletonema

Plate 8: Diatoms Observed at Five (5) Sampling Stations in the Vicinity of the Masinloc Power Plant, October 2019


Protoperidinium


Peridinium


Ceratium


Gymnodinium


Dynophysis

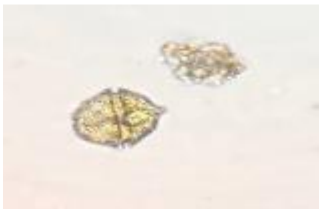
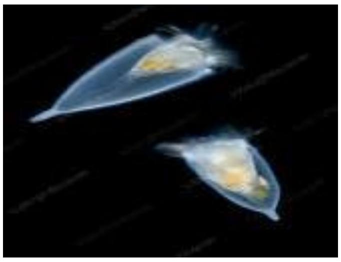

Gonyaulax

Plate 9: Dinoflagellates Observed at 5 Sampling Stations in the Vicinity of the Masinloc Power Plant, October 2019.



Tintinnids
(Ciliophora)

Acartia nauplius
(Arthropoda)

Calanoid copepod
(Arthropoda)

Copepod larvae
(Arthropoda)

Foraminiferans

Sagitta (Arrow worms)
(Chaetognatha)

Sea anemone larvae
(Cnidaria)

Coral planulae
(Cnidaria)

Brachiolaria larva
(Echinoderms)

Echinopluteus larva
(Echinoderms)

Veliger larva
(Mollusca)

Shrimp nauplii
(Crustacea)

Fish larvae
(Ichthyoplankton)

Plate 10: Zooplankton Observed at 5 Sampling Stations in the Vicinity of the Masinloc Power Plant, October 2019 (Source: Internet)

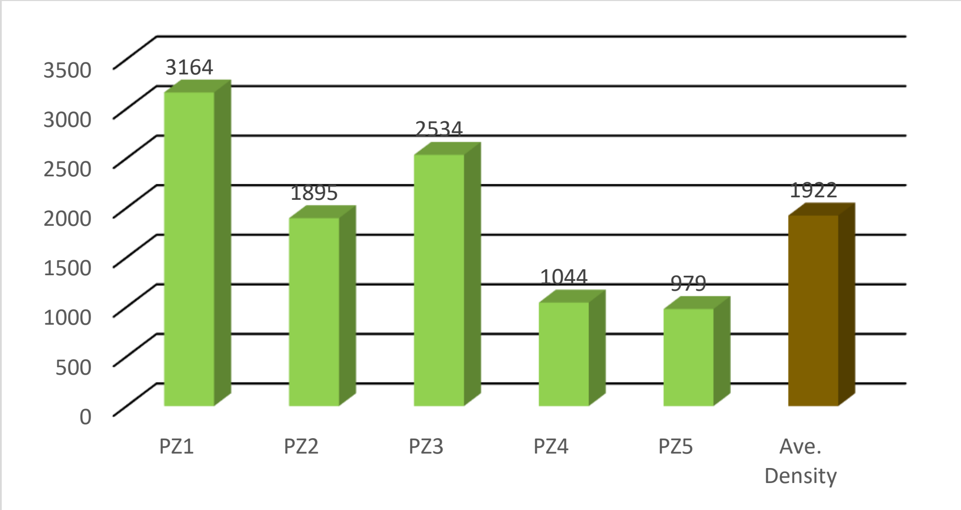


Figure 2-57: Variation of Phytoplankton Population at Five Sampling Stations along the Masinloc Power Plant

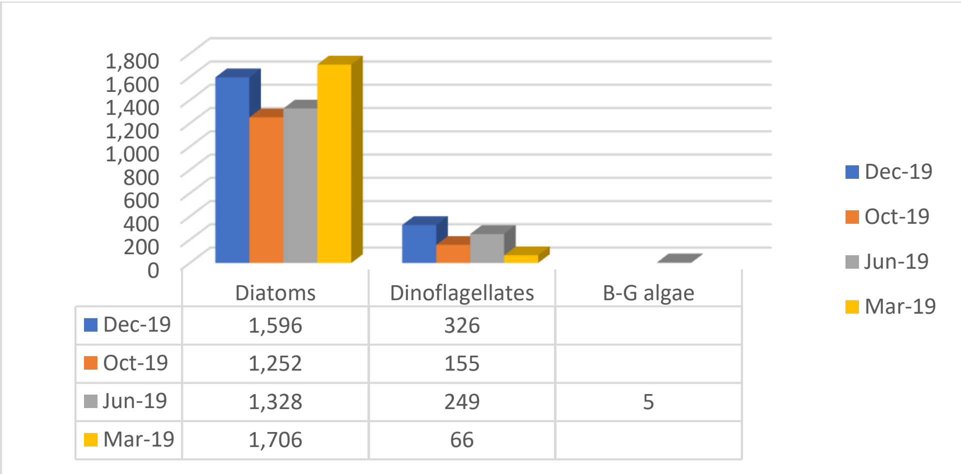


Figure 2-58: Comparative Presentation of Phytoplankton Count between March 2019, June 2019, October 2019 and December 2019

Compared to previous surveys made on Oct 2019, June 2019 and March 2019, the December 2019 survey showed an increase in diatoms counted at 1,596 cells/L as compared to the October 2019 survey with 1,252 cells/L, June 2019 survey with 1,328 cells/L and the March 2019 survey with 1,706 cells/L. On the other hand, there was also an apparent increase in dinoflagellates count on the December 2019 survey which at 326 cells/L is more than double the October 2019 survey of 155 cells/L and much higher than both the June 2019 and March 2019 surveys. This implies that productivity level at the time of the latest survey was high and favors fisheries development that benefits the local communities around Masinloc and Oyon Bays.

<u>Zooplankton</u>

The December 2019 plankton survey showed a change in the population density with the Tintinnids at the top of the count, which with an average projection of 84 individuals/L from five survey stations occupies 28.9% of the population density ratio of the area under study. Second in the population density ratio and still exerting a considerable influence were the arthropods composed of acartian nauplii, copepod larvae and some mature calanoids, which with 52 ind/L comprises 18% of the density count. This was followed by the echinoderms with 41 ind/L (14%), the ichthyoplankton with 31 ind/L (11%), foraminiferans with 29 ind/L (10%), crustaceans with 21 ind/L (7%) and cnidarians with 14 ind/L (5%). The gastropods and chaetognatas occupy the lowest levels of the population hierarchy at 3.1% and 2.75% respectively.

Sharing density concentration as the most abundant zooplankton group for the October 2019 survey were the copepods and the tintinnids. Copepods composed of Acartian nauplii, mature calanoids and copepod larvae registered a total population of 244 individuals recorded in five sampling stations for a mean average of 49 individuals constituting 23.56% of the total zooplankton population counted. On the other hand, Tintinnids registered a total population count of 216 individuals in five sampling stations with a mean average of 43 individuals to constitute 20.7% of the total zooplankton count. The copepods were represented by nauplius larvae and adult forms of the calanoid species. The next numerically abundant zooplankton were the Ichthyoplankton group composed of several unidentified species of fish larvae totaling 161 individuals with a mean average of 32 individuals for the five sampling stations to constitute 15.38% of the total zooplankton population count. Followed in descending order by the following: shrimp nauplii with 10.10%, foraminiferans with 9.62%, echinoderms with 9.13%, gastropod veligers with 4.81%, cnidarian planulae with 3.84% and the lowest represented group of chaetognatas with 2.88%.

The estimates of the total zooplankton at each of the five stations are plotted in Fig. PZ6. Zooplankton density was found to be at its highest in Station Z4 with 324 ind/L followed by Stations Z2 with 308 ind/L, Station Z3 with populations counted at 297 ind/L, Stations Z5 with 268 ind/L and lastly, Station Z1 with 251 ind/L. The flux in total zooplankton population runs proportional with the same general trend to that of the total phytoplankton population. This indicates that the population fluctuation of both groups decrease and increase together, *i.e.*, with high phytoplankton, more zooplankton may be expected and with low phytoplankton, less zooplankton are to be expected. Only in extreme events like algal bloom that imbalances in population ratio may possibly occur where the zooplankton community can be overwhelmed by the vast quantities of phytoplankton in the water column.

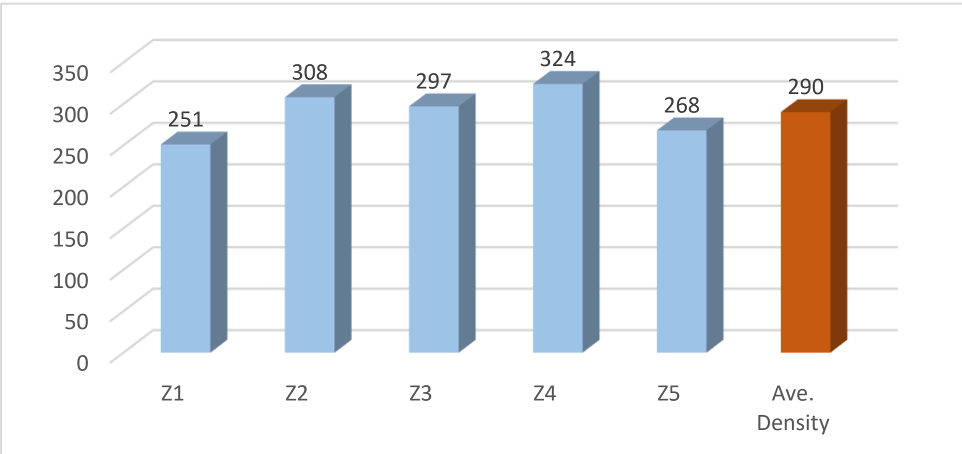


Figure 2-59: Variation of Total Zooplankton Collected from Five Sampling Stations in the Vicinity of the Masinloc Power Plant

This time, the mean density for all the zooplankton stations sampled was estimated at 290 ind/L which is higher compared to the October 2019 with 208 ind/L and all the other previous surveys with the June 2019 survey having an average density of 243 ind/L which is also higher compared to the March 2019 survey at 171 ind/L. This is also much higher compared to the last sampling period December 2018 with an average of 44 ind/L as well as compared to the rest of the monitoring results. This indicates that there was a rise in zooplankton production in the area studied at the time of the latest survey.

Mean Relative Abundance of Major Plankton Groups

Relative average density of the total plankton population to cover both the phytoplankton and the zooplankton for the five survey stations is 2,212 ind/L. Of this, 1,922 ind/L is composed of the phytoplankton which roughly covers at least 87% of the total with the remaining 13% composed of the zooplankton community accounted for in the survey. This is more or less of similar proportion to the October 2019 survey which also exhibits an 87:13 ratio though the population count of both survey periods differs quantifiably.

Basically, the overall marine plankton communities in the October 2019 survey were dominated by phytoplankton comprising also 87% of the total plankton population collected in five sampling stations with 13% comprising the zooplankton population. The December 2018 (4th Quarter 2018) monitoring survey showed the phytoplankton as the most abundant plankton group comprising 98.57% of the collected samples with zooplankton having a very miniscule population density of 1.43%. This is drastically different when compared to the survey of September 2018 (3rd Quarter 2018) where the phytoplankton as the most abundant group have 89.62% with the zooplankton population getting a higher share in density at 10.38%.

The present survey showed a higher ratio in the number of zooplankton which if taken in the context of ecosystem stability is much better as an increase in zooplankton population means a higher degree of phytoplankton consumption and a lesser occurrence of algal blooms.

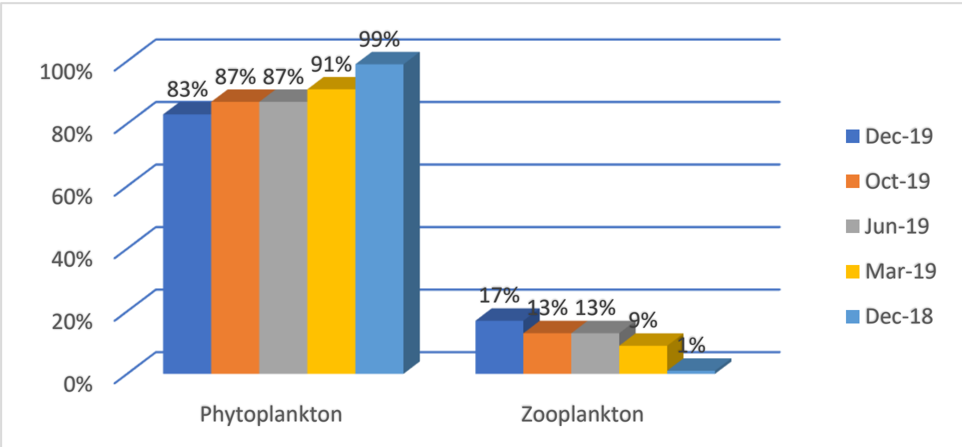
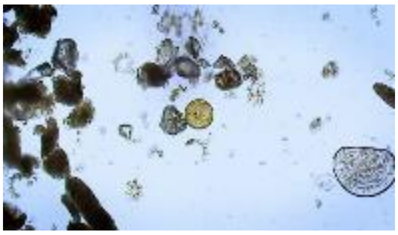


Figure 2-60: Comparison of the Mean Percentage in Relative Abundance of Major Plankton Groups

Diatoms



Dinoflaggelates

Zooplankton

Plate 11: Representative Images of Phytoplankton/Zooplankton (Source: Internet)

Corals

Coral reefs, the “rain forests of the sea,” are among the most biologically rich and productive ecosystems on earth. They also provide valuable ecosystem benefits to millions of coastal communities. They are important sources of food and income, serve as nurseries for commercially valuable marine organisms, attract divers and snorkelers from around the world, generate the sand on tourist beaches, and protect shorelines from the ravages of storms. However, coral reefs face a wide and intensifying array of threats like impacts from overfishing, unregulated coastal development, agricultural runoff, and shipping activities. In addition, the global threat of climate change has begun to compound these local threats to coral reefs in multiple ways. Warming seas have already caused widespread damage to reefs, with high temperatures driving a stress response called coral bleaching, where corals lose their colorful symbiotic algae, exposing their white skeletons and eventual death.

Identified as one of the major factors that determine the structuring of reef communities in the Philippines is the degree of embayment. According to Miyadi, “embayment degree” (see Horikoshi 1988) is the sum of all “location factors”, where ‘location’ defined as the position in a given space exposed to environmental conditions. Since there is a gradient of environmental conditions (e.g. wave energy, temperature, salinity) from the bay mouth to the bay head, a succession of different biotopes and different types of biotic communities can be expected. For example, in a high-energy coast (weak embayment) stunted corals or low-relief table *Acropora* can be seen, unlike in a strongly embayed area where one can find fragile and foliaceous corals (Quibilan and Aliño 2006).

Despite widespread recognition that coral reefs around the world are seriously threatened, information regarding which threats affect which reefs is limited. Thus, efforts to generate information through science-based coral reef surveys are important and vitally useful as a support tool to any conservation efforts of anybody interested to conserve and protect these important resources.

Replicating previous survey stations, the team relocated the position of the seven (7) sampling stations previously established and designated as sampling stations C/F1, C/F2, C/F3, C/F4, C/F5, C/F6 and C/F7 to determine the percentage cover of living corals (both hard and soft), dead corals, algae and bare substrates. All sampling stations tabulated below together with the station coordinates, location and sampling date/time (Table 2-40). The relocation of previously established stations was done with the use of a GPS, projected on map and tabulated below.

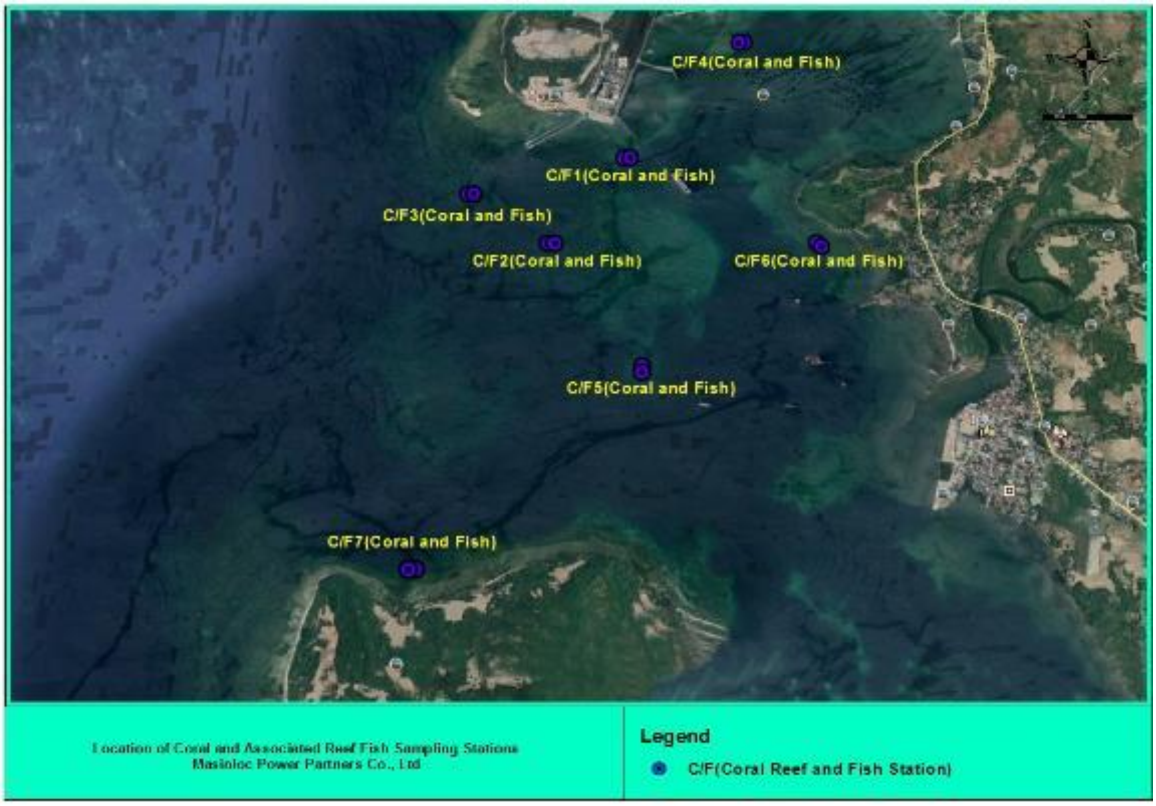


Figure 2-61: Map Showing the Relative Location of the C/F Assessment Stations

Table 2-40: Tabulated Data for Location and Other Relevant Information for the Coral Reef Survey

Station	Site Location	GPS Coordinates		Depth (m)	Weather/Wind Direction/Sea Condition
		North Latitude	East Longitude		
C1	Near Intake Area	15° 33' 30.350" N	119° 55' 27.624" E	5	Fine, Sunny/SW/Calm, small wavelets
C2	Bet. Intake and Outfall	15° 33' 5.248" N	119° 55' 7.933" E	6	Fine, Sunny/SW/Calm, small wavelets
C3	Near Outfall Area	15° 33' 19.436" N	119° 54' 46.251" E	6	Fine, Sunny/SW/Calm, small wavelets
C4	Near C-Square	15° 34' 6.911" N	119° 56' 1.477" E	7	Fine, Sunny/SW/Calm, small wavelets
C5	Near Buoy 7	15° 32' 31.725" N	119° 55' 32.189" E	6	Fine, Sunny/SW/Calm, small wavelets
C6	Oyon Point	15° 33' 5.430" N	119° 56' 17.895" E	5	Fine, Sunny/SW/Calm, small wavelets
C7	San Salvador Island	15° 31' 42.150" N	119° 54' 37.339" E	6	Fine, Sunny/SW/Calm, small wavelets

:

The assessment of the state of coral reefs (i.e., percentage cover, species composition and abundance) was done using the photo transect method. In each of the monitoring station, three 50m transects was laid on the reef following a uniform depth contour. Starting at the zero mark of transect, digital photographs were taken at one-meter interval using a digital still camera equipped with an underwater housing. Photographs were obtained at a camera to substrate distance of 1.2 m. Permanent markers were installed in every station to locate the station during monitoring.

The survey method used was a modified photo-quadrat method somewhat different to what was purportedly applied by the last monitoring team before us. A similar method was utilized in determining coral coverage and changes with time in a number of other reef studies (Bohnsack, 1982; Done, 1981; Dodge *et al*., 1982; KFUMP/RI, 1985, 1988, 1993), and in the previous monitoring surveys carried out in the Philippines such as in Tayabas Bay (RCI-MSEUF, 1996) and in Marinduque Island (WCPI, 1997a, 1997b, 1999b). The advantages of the method are: (1) it provides a good record of events taking place in the area, (2) it can be a good source of information on population estimates for growth rates, partial mortality, mortality and recruitment, and (3) it provides a permanent record of the site (English *et al*., 1997).

Photographs were refined using the ADOBE Photoshop and processed using Coral Point Count with excel extension (CPCe) software. Each picture was overlaid with ten random points and the life forms intercepted in these points are sampled. The life forms and hard coral genus intercepted by each of the points ("+") were recorded and scored. For the life form identification, the standard 28 benthic lifeform categories of *English et al.* (1997) were used. Percent cover was computed using the following equation:

$$\%Cover = \frac{\text{Total Sampled Points/Category}}{\text{Total No. of Points per transect}} \times 100$$

Coral reef status was then categorized based on Live Hard Coral (LHC) as established by *Licuanan et al.* (in press) where;

- Excellent >44%
- Good 34-44%
- Fair 22-33%
- Poor 0-22%

Live Hard Coral Cover

Live hard coral cover was determined per established station. Comparative analysis of the seven (7) stations surveyed as of December 2019 showed that the station designated as C/F3 had the highest LHC cover with 46.37%, which could be rated as **Excellent** based on the category index established by Licuanan et al. It was followed in descending order by C/F5 with 40.08% rated Good, C/F7 with 31.03% rated Good, C/F6 with 29.60% rated Fair, C/F1 with 7.41% rated Poor, C/F2 with 4.79% also rated Poor, and C/F4 rated 0 with no live hard coral cover intercepted during the photoquadrat survey. In general, the average live hard coral cover for all the stations surveyed is 22.75%, placing the coral reef ecosystem of Oyon Bay within the Fair cover category based on the Licuanan et al (2015) suggested index of coral cover in the Philippines.

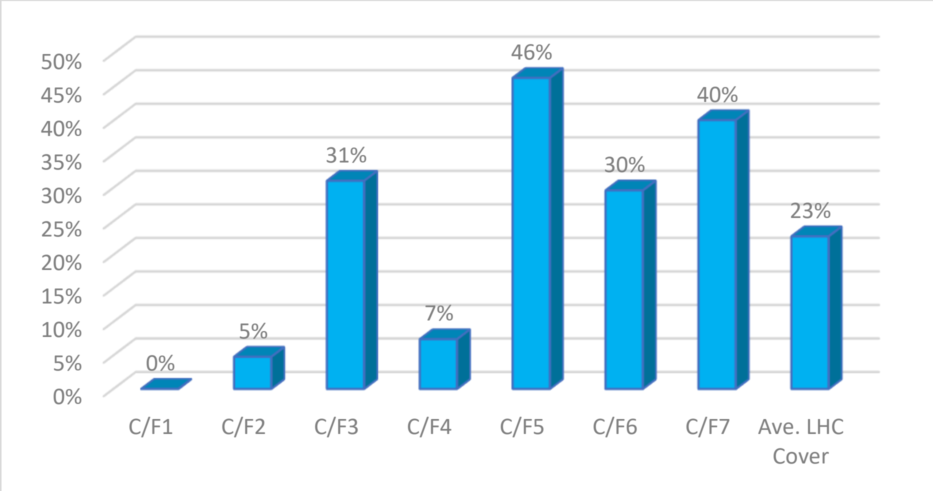


Figure 2-62: Percentage Cover of Live Hard Coral Cover per Survey Station

<u>Percent Cover Description in Seven Survey Stations</u>

1. Station C/F1 (Near intake area)

Station C/F1 showed that the reef area was littered with newly dead corals and dead corals with algae which on measurement comprised 17% of the entire survey transect. This was an indication that the area has been subject to a lot of destructive anthropogenic activities and possibly aggravated by natural events that needs to be addressed by putting in place appropriate mitigation strategies like better protection and coral enhancement program. Live hard coral intercepted along the photoquadrat transect covers a mere 7.5% with several small coral colonies observed at some distance from the transect line and rated Poor based on the category index established by Licuanan et al (2015). The rest of the observed cover composition along the transect consists of the following components: abiotic components had 56.71% cover composed of 33.87% rubbles and 22.65% sand. Turf algae with 20% cover also has a significant environmental influence in the area Other organisms composed of benthic invertebrates like the sea urchins also contributed 2% cover and soft corals which has the lowest cover with only 1%.

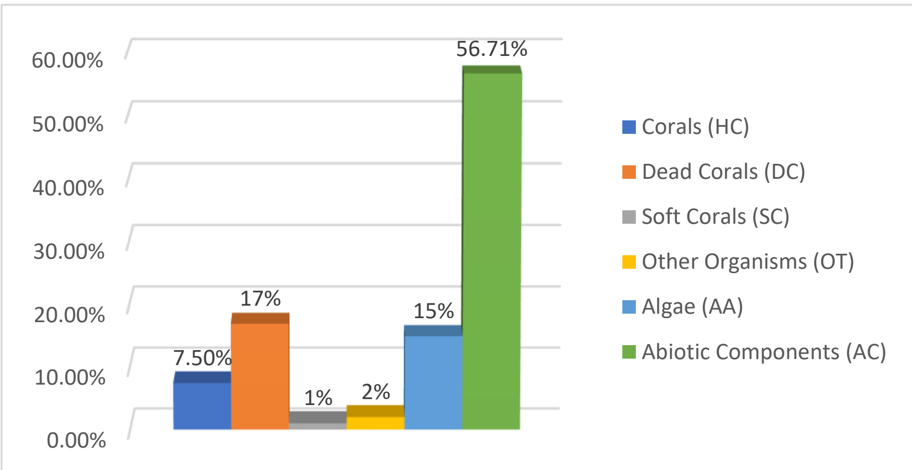


Figure 2-63: Major Substrate Category in C/F1

2. Station C/F2 (Between intake and outfall area)

Assessment on C/F2 station showed that the abiotic component had the highest substrate cover with 74.79%, generally composed of rubble at 21.46%, sand at 2.08% and silt at 51.25%. Dead corals were the next major substrate group observed with 15% cover. Live hard corals in the site cover a mere 4.79% with the rest composed of sessile organisms including soft corals with 5% cover and algae with 1% cover.

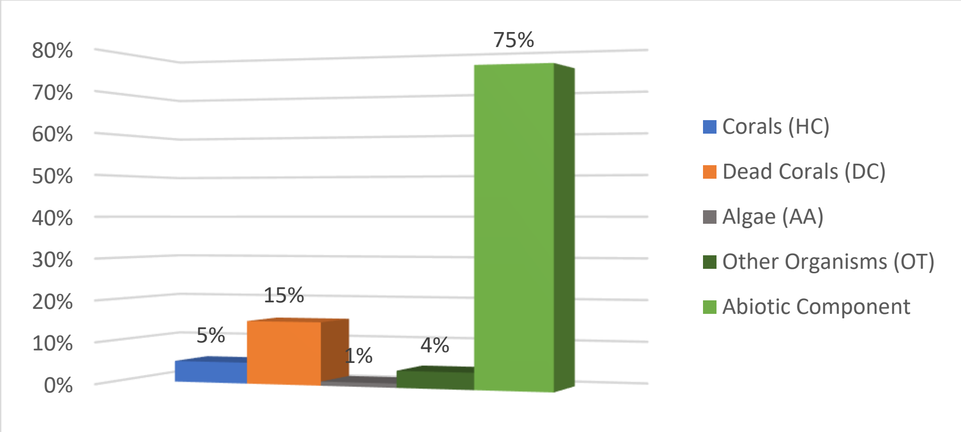


Figure 2-64: Major Substrate Category in Station C/F2

Having a high rate of abiotic components, especially rubbles, silts, and dead corals, indicate that the area is under constant perturbertions which could possibly be by anthropogenic activities like unregulated fishing activities or could have been affected by the cooling water outfall of the power plant that may have caused the non-proliferation of live coral colonies in the area. This condition seriously threatened the loss of the reef ecosystem in the area if not given serious attention. Live hard corals as observed comprised a mere 5% of the reef zone while other organisms to include small colonies of soft corals on the deeper part of the transect comprised another 5% cover and 1% of some turf algae.

There were no *Acropora* species nor do any branching coral colonies of the 5% live hard corals observe in the area. Most of the coral lifeforms observed were non-Acropora species comprised of non-Acropora massive with 2%, non-Acropora encrusting at 1%, *Millepora* at 1% and another 1% of a clustered set of mushroom corals composed of the species *Fungia* and *Herpolitha*. Non-acropora species are more tolerant to disturbances and less sensitive from fluctuating changes in temperature, salinity and turbidity when compared to Acroporans.

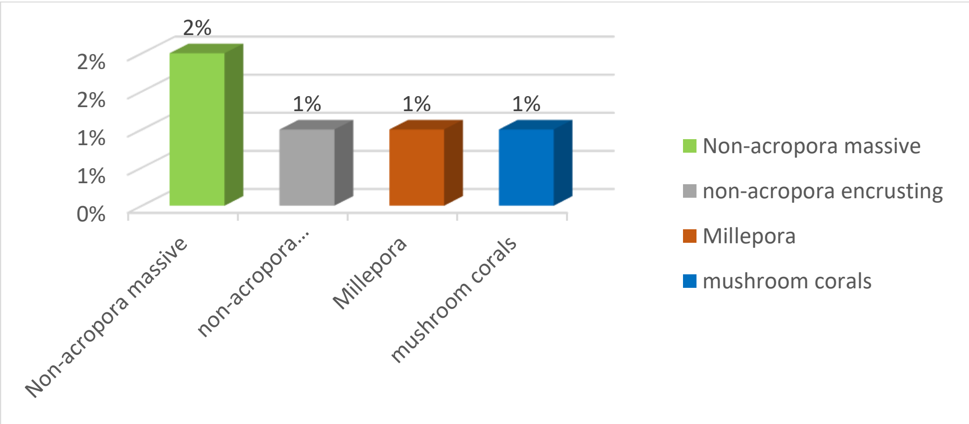


Figure 2-65: Lifeforms Composition of Live Hard Corals (LHC) in Station C/F2

3. Station C/F3: Near Outfall Channel

The major substrate in C/F3 was comprised of live hard corals of 46.37% which falls in Excellent condition based on the category index established by Licuanan et al. (2015). Location of the sampling station is quite strategic for coral development as the area was well inside the bay where efficient water circulation, a major factor in coral growth and establishment, is not constricted. Still it is quite evident that the area is subject to constant perturbations that affect coral development as the abiotic components at 36.74% were also quite high. Dead coral cover at 14.34% should not be taken lightly as it could be caused by two highly destructive factors: unregulated fishing activities and the apparent proliferation of the COT starfish (*Acanthaster planci*). This condition illustrates a serious threat in the viability of a stable coral community. Several sessile filter feeding organisms approximately covering 1.38% of the measured area were also observed.

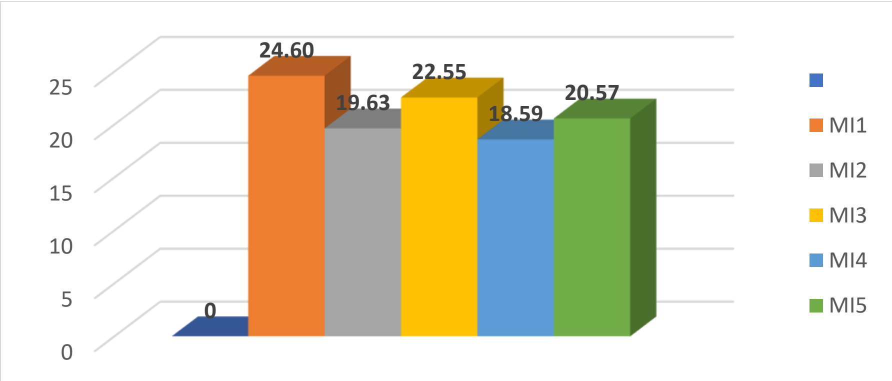


Figure 2-66: Major Substrate Category in Station C/F3

The recorded 46.37% of live hard coral cover were composed of 29.86% non-acropora massive, non-acropora branching of 8.64%, followed by non-acropora submassive 2.55%, next was non-acropora encrusting which calculated as 2.16%, acropora branching of 1.38% and lastly were acropora tabulates (0.98%) and non-acropora millepora (0.79%). Sparsely scattered among these various coral communities are small acropora corals that is yet to attain a certain growth to be considered of significance in the area though their growth and survival were quite limited as could be observed on the stunted dead and dying coral heads.

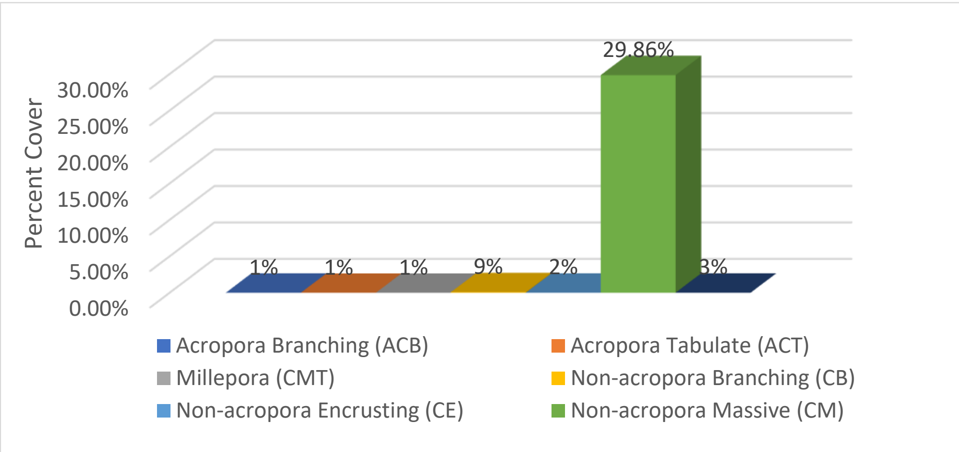


Figure 2-67: Lifeforms Composition of Live Hard Corals (LHC) in Station C/F3

4. Station C/F4: (Near C-square)

Based on the figure shown below, abiotic components which comprised of sand (22.63%), rubbles (25.25%) and silt (4.04%) have the highest percent cover of major substrate category in C/F4 station which indicates that there were a lot of open spaces in the reef which could be developed for coral transplantation but could only be feasible if not for the fishpens that are releasing unconsumed feeds and feed waste into the water column resulting into more than normal amount of suspended particulates. A lot of suspended particulates may result into highly turbid waters that impeded effective light penetration which is one major ecological element for coral growth and development. Presence of dead corals and dead coral heads comprised a percent cover of 42.42% which is basically high but a clear indication that, historically, corals thrives in the area and its eventual loss could only be for lack of mitigations implemented by those who are causing the destruction in the first place. Within the dead coral reef system small soft coral colonies could also be observed and as estimated comprised 1% of the assessed area. These soft tiny organisms were the usual formation that populates the reef together with very small newly colonizing hard corals.

Though small coral colonies were observed around the area these did not fall within the transect zone and the absence of live hard corals in the transect area is a manifestation that the coral colonies are quite sparse which with further area deterioration and lack of mitigation may result to coral depopulation. Turf algae were also observed in the area and the measured cover of 0.50% may look insignificant but can change in a short time as these lifeform can multiply fast especially in nutrient rich water. A rough 5% cover categorized under Other Organisms was estimated for some benthic organisms traversed by the transect tape as they appear in closely clustered groups usually composed of sea urchins, some bivalves and sponges.

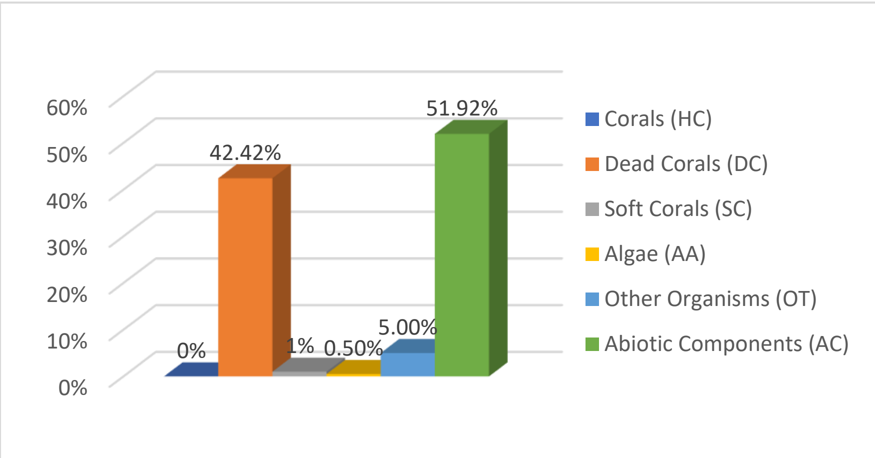


Figure 2-68: Major Substrate Category in Station C/F4

5. Station C/F5: (Near buoy 7)

Live hard coral (LHC) cover is relatively high in this particular station at 40.08% and has the second highest coral cover on all stations surveyed. However, this could have been much higher if not for the destroyed reef zones manifested by a lot of coral rubbles which was incorporated under the abiotic components comprising 49.06% of the survey category. Categorized separately is dead standing coral heads that covers 9.81%, which under observation could have been caused by the proliferation of the starfish *Acanthaster planci* or by the use of toxic chemicals by some local fishermen doing spearfishing in the area. No soft corals and turf algae were intercepted by the transect line. Traversed unidentified orgasnisms like sponges, seastars, sea urchins and starfishes, whether sessile or benthic, traversed by the transect line were categorized under Other Organisms with a total cover of 4.2%. Observed but not traversed by the tranect line were small colonies of soft corals and turf algae which being out of bounds were not included in the cover measurement but cited under observation only.

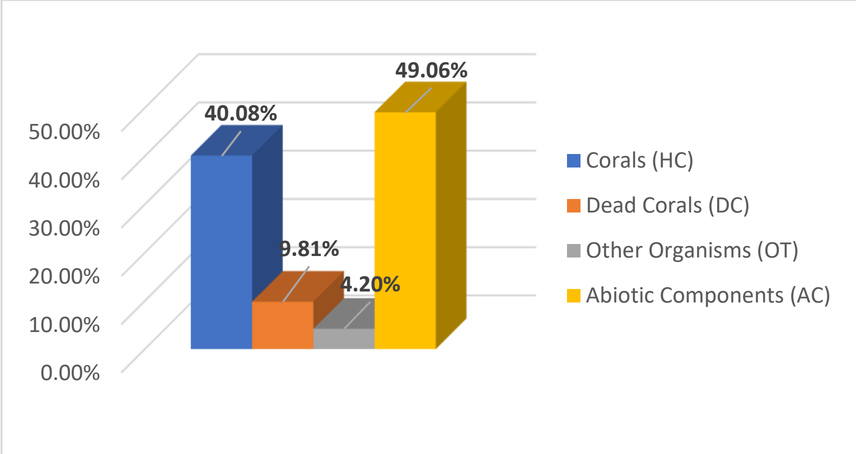


Figure 2-69: Major Substrate Category in Station C/F5

Live hard coral cover was measured at 40.08% in C/F5 station and determined to be diverse with several identified coral lifeforms. Non-acropora massive had the highest percent cover with 19.83%, followed by non-acropora digitate with 8.77% cover, Mushroom corals with 3.13%, Millepora with 2.30%, non-acropora submassive with 2.30%, non-acropora encrusting with 2% and acropora tabulate with 1.8%.

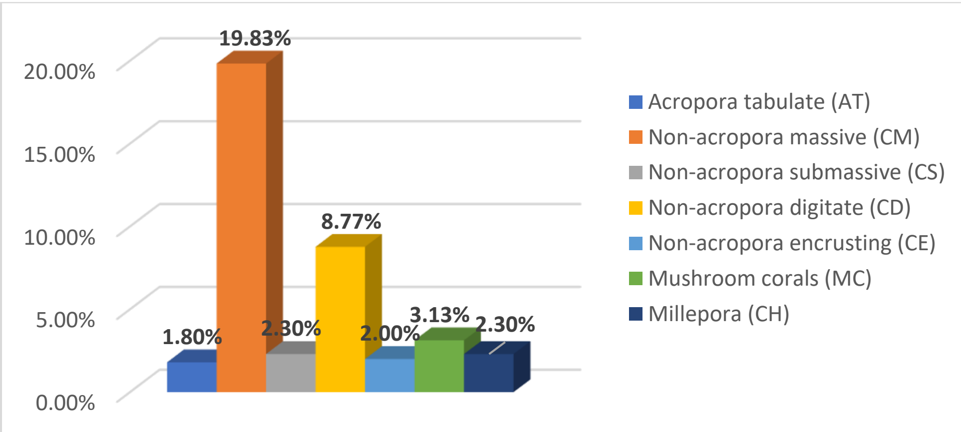


Figure 2-70: Lifeforms Composition of Live Hard Corals (LHC) in Station C/F5

6. Station C/F6 (Tip of Oyon Point)

Station C/F6 is at the innermost part of the bay just at the tip of Oyon Point. As assessed, the area has a live hard coral cover of 29.60% which according to the suggested cover category by Licuanan et al (2015) falls within the Fair bracket. Of particular significance are the observed small pockets of scleractenian coral colonies and some soft corals growing in the open reef areas that if left undisturbed would eventually improve the coral cover in this part of Oyon Bay.

Major concern was the marked increase in the percent cover of dead corals at 7.20% as compared to the October 2019 survey where the observed dead corals barely covers about 1% of the total area surveyed. However, there was also a slight decrease in the area under survey of the abiotic components from 69.68% to 57% probably due to to the observed increase in the area covered by algae at 5% and other attached organisms like sponges at 3%.

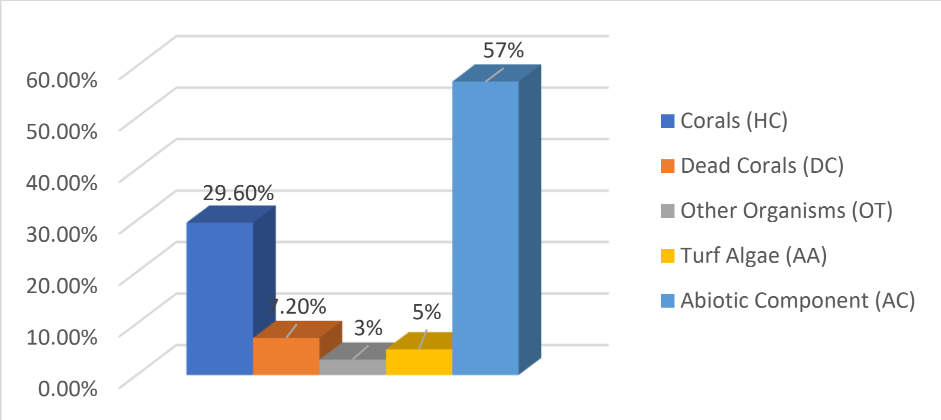


Figure 2-71: Major Substrate Category in Station C/F6

The live hard corals categorized into coral lifeforms showed that of the 29.60% LHC the non-acropora branching corals have the highest percentage composition at 18.2% followed by the non-acropora massive corals at 8.8%. The two main lifeform groups were then followed by six lifeform groups with covers less than 1% each, to wit: acropora branching at 0.8%, mushroom corals at 0.8%, acropora encrusting at 0.4%, non-acropora submassive at 0.23%, non-acropora encrusting at 0.2% and acropora submassive also at 0.2%.

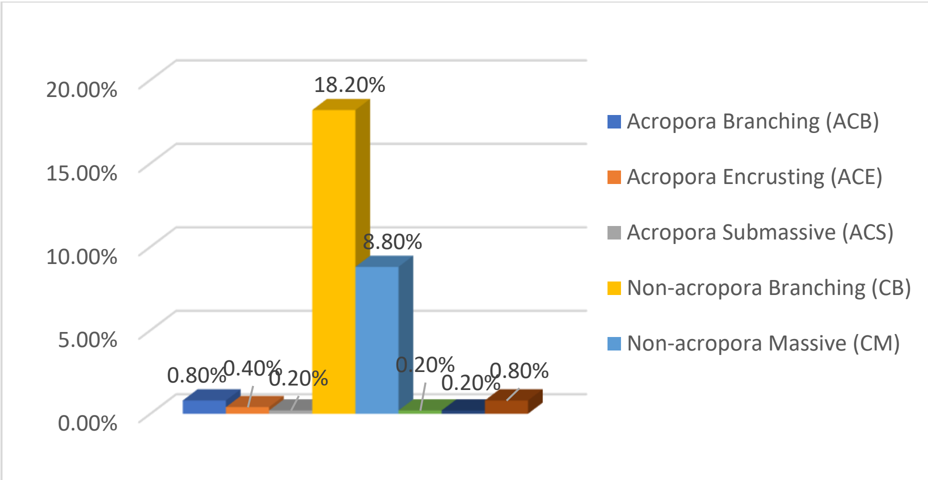


Figure 2-72: Lifeforms Composition of Live Hard Corals in Station C/F6

7. Station C/F7 (Northern shore of San Salvador Island)

Basically, Station C/F7 is the farthest survey station relative to the location of the Masinloc Power Station and could serve as the control station for water quality monitoring assuming that it is well beyond the sphere of environmental influence of the power plant operations. However, this possibility is not applicable to the other parameters like coral reef health or infaunal/benthic organisms as the mode of control is the area monitored itself to determine change in physical state or condition.

Live hard corals recorded in the area under the present survey is 31.03% which was an apparent decrease of almost 25% of the October survey at 40.6% cover that recategorizes it from Good to Fair basing on the Licuanan et al (2015) cover criteria. However, also recorded are dead corals which are almost proportional to the lost live hard coral cover as it increased from the October 2019 survey of 37.2% to 43.61 under the latest survey.

The station is located on the eastern shore of San Salvador Island facing the Masinloc Power Plant. The station was quite distant from the power plant thus any damage or destruction on the area could not easily be attributed to the power plant's operation. Any observed damage to the corals in the area could either be man-made or by natural causes. It has to be noted that survey Station C/F7 was established right in front of the docking area of the island's fishing community and as such, the coral beds were subject to constant trampling in the conduct of their fishing activities by local fishermen especially during low tide.

Aside from the live and dead coral covers, also recorded during the survey are what is categorized as the abiotic component of the criteria, usually are composed of sand, silt,rocks and rubles, which covers a significant 19.27% of the survey transect. This denotes that aside from the dead corals there are part of the reef zones that are open and could possibly accommodate coral development if left undisturbed for quite a time. Sign of coral reef deterioration was manifested by the proliferation of turf algae invading what was a healthy coral reef nearshore and estimated at 4% of the survey area. Also recorded were soft corals at 1.5% and other attached organisms like sponges at another 1.5%.

What is important is that due notice be given to the local governments from the barangay to the municipal level that this part of the Oyon Bay environment needs attention to prevent further coral reef deterioration and degradation. Coastal protection and information dissemination is the best tool to apply in this case. The local governments could will also establish linkages and partnerships with companies exercising due diligence in environmental protection and development, national government agencies, and environmental advocates that could help develop Oyon Bay into an eco-destination area.

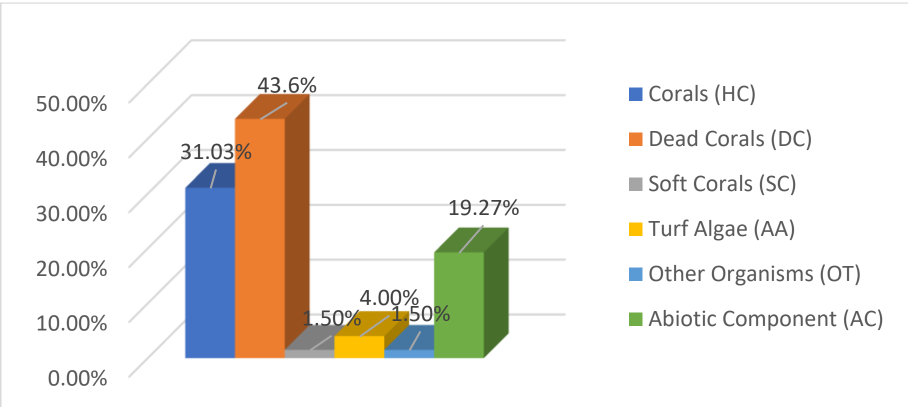


Figure 2-73: Major Substrate Category in Station C/F7

The live hard corals categorized into composite lifeforms showed that of the 31.03% LHC the non-acropora branching corals have the highest percentage composition at 13.79% followed by the non-acropora massive corals at 13.18%. The two main lifeform groups were then followed by five lifeform groups with the following percent covers, to wit: table acropora at 1.62%, non-acropora submassive at 0.81%, mushroom corals at 1.22%, non-acropora encrusting at 0.2% and non-acropora foliose also at 0.2%.

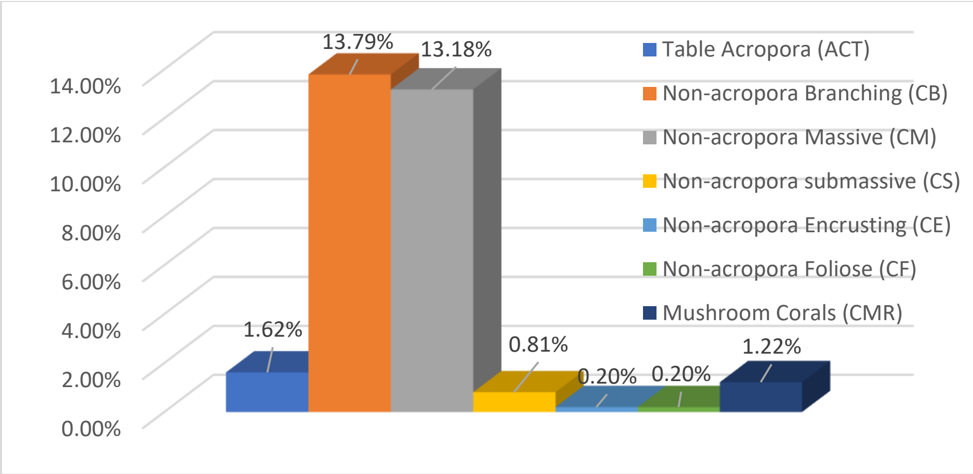


Figure 2-74: Lifeforms Composition of Live Hard Corals in Station C/F7

Reef Condition in the Seven Reef Photo Quadrat Transect Sites

Condition of coral reefs is usually expressed in terms of the percentage cover of live coral (hard and soft-corals combined). In this survey, adapted for categorizing substrate condition to determine status of live hard corals is the category ranking introduced by Licuanan, et al. (in press) which arbitrarily categorize living coral cover as follows: *Excellent* (44% and above), *Good* (34 – 44%), *Fair* (22 – 33%), *Poor* (0 - 22%).

Mean percentage cover of live hard coral and reef condition in the photo transects of the reefs surveyed during the present sampling period are presented in the table below in comparison with previous monitoring results despite the difference in the adapted categorization ranking.

For Station C/F1, there was a marked improvement on the result of the present survey that records a 7.5% cover as compared to the October 2019 survey which records a mere 1% hard coral cover though still lower than the June 2019 and March 2019 surveys. Though we have approximated the survey spot location with the use of a GPS receiver, it is possible that we have not hit the exact spot where the previous monitors have laid transects. However, a thorough swim through over the site provided the visual information that coral colonies are quite few and very small. These were supported with underwater photographs showing that most of the substrate components in and around the survey site are composed of large boulders used to stabilize the constructed fences of the power plant. Most of these large boulders are covered with sediments and epiphytic organisms with no significant coral colonization in place. Where the stacked boulder ends, the substrate is a complex mix of sand, silt and mud easily disturbed by our movements resulting into a murky and turbid water column.

For Station C/F2, result of the present assessment still reflected a poor live hard coral cover of 4.79% though a little higher than the October 2019 survey. This result is still quite low when compared to the June 2019 and March 2019 surveys, which showed a fair 31.5% and 32.0% live hard coral cover respectively. Evidently the area where the transect was laid in approximately the same coordinates as the previous assessments were not in the approximate transect line established by previous assessments. Without properly marking the transect lines established makes the approximation difficult.

In Station C/F3, present survey yielded a live hard coral cover of 46.37% which though considered still Excellent in the percent cover category of Licuanan et al., and was a marked increase on the October 2019 survey still runs contrary to the two previous surveys that yielded an almost 100% live hard coral cover which as far as experienced by the group with its years spent in coral assessment have not encountered before. Total photo coverage of the laid transect line would show that live hard coral cover on that part of the reef area basically conforms with the present percent live hard coral cover measured by the team. Further, the previously observed many small and growing coral colonies in and around the transect site were observed to be healthy and thriving vigorously under the prevailing environmental conditions. Strong water current was still experienced during the dive and assuming that it is a regular occurrence during tidal changes suggests that despite its being near the outfall canal, the flow of warmer water from the outfall has not affected the reef significantly as it was probably dispersed early at the surface level by the strong water current. It is probable that there will be warm water inroads during tidal changes and also during low-low tides when the water level in the area could be as shallow as four meters or less.

For the coral station designated as Station C/F4, no live hard coral cover were intercepted by the laid out transect thus a 0% cover. However, it was observed during a general observation swim-through that there were significant patches of live hard corals attached to rock formations but at a distance from the approximated GPS coordinates as recorded by previous surveys. On the other hand, despite the observation of some coral patches, it is expected that no healthy and vigorous coral colonization will occur in this particular site as it is more or less located in the inner bay where water circulation is poor and very near the established fish pens where nutrient pollutants and turbidity is high due to fish feed wastes coming from the nearby fishpens.

C/F5 station is located in the middle of the bay where water circulation brought about by active water movement during tidal changes regularly occurs. Live hard coral cover assessment showed a healthy coral cover of 40.08% rated as Excellent under the category espoused by Licuanan, et al. However, it is quite below the assessment results of the monitoring done in October 2019, June 2019 and March 2019, which showed Excellent Live hard coral cover of 54.31, 97.8% and 98.9 respectively. This part of the reef system in the bay is worth protecting and enhancing to improve cover that could increase fish catch of the locals as well as to support the efforts of the local governments in promoting ecotourism in the bay area.

C/F6 is near the tip of Oyon Point whose location forms part of an enclosure to the inner part of Oyon Bay and marked the separation of Oyon Bay from Masinloc Bay. Assessment result of the current survey is 29.60% categorized as Fair by Licuanan, et al. and more or less similar to the October 2019 survey result but lower than the two previous surveys with the June 2019 survey at 37.6% coral cover and the March 2019 survey at 37.3%. Seawater along the point is highly turbid at the time of the survey and assumed to be caused by the influence of the nearby large river system with its load of sedimentary runoff especially during heavy flooding.

C/F7 is strategically located on the north shore of San Salvador Island, a small island blocking direct entry into Oyon Bay and may will provide protection against strong winds during the southwest monsoon. The station could serve as a control station in the monitoring program implemented as it is observed that its location and distance from the power plant may negate any significant impact in the process of its operation. Live hard coral assessment on said station showed that the LHC cover in the fringing reef was 30.03% at the time of the survey. It ranked as Fair under the Licuanan et al (2015) category and lower than the October 2019 survey which at 40.6 is ranked as Good under the same categorization. It was markedly much lower than the June 2019 and March 2019 surveys of 64.6 and 64.1% respectively which under the Licuanan et al (2015) criteria would have ranked as Excellent. However, the results of all surveys are actual physical measurements using the same equipments thus the disparity lies not on the criterion used but on the physical difference in actual measurements which could have been caused by the application of the method on different reef zones.

There appeared several conformities in category assignments as far as the compared surveys are concerned.

However, further surveys are required to verify the wide disparities in the result of determining percentage cover. This could be addressed by properly marking underwater the established permanent transect lines so that succeeding surveys can conform to the previous surveys.

Table 2-41: Comparison of Survey Results for Four Monitoring Periods

Station	Site Description	Dec 2019		Oct 2019		June 2019		March 2019	
		%LHC	Reef Condition	%LHC	Reef Condition	%LHC	Reef Condition	%LHC	Reef Condition
C/F1	Near intake area	7.41	Poor	1.2	Poor	11.3	Poor	12.3	Poor
C/F2	Bet. Intake and outfall area	4.79	Poor	2	Poor	31.0	Fair	31.5	Fair
C/F3	Near outfall area	46.37	Excellent	39	Good	97.0	Excellent	97.4	Excellent
C/F4	Near C-Square	0	Poor	2.2	Poor	7.2	Poor	7.5	Poor
C/F5	Near Buoy 7	40.08	Good	54.31	Excellent	94.7	Excellent	97.8	Excellent
C/F6	Oyon Point	29.6	Fair	29.32	Fair	37.6	Fair	37.5	Fair
C/F7	San Salvador Is.	31.03	Fair	40.6	Good	64.6	Good	64.1	Good

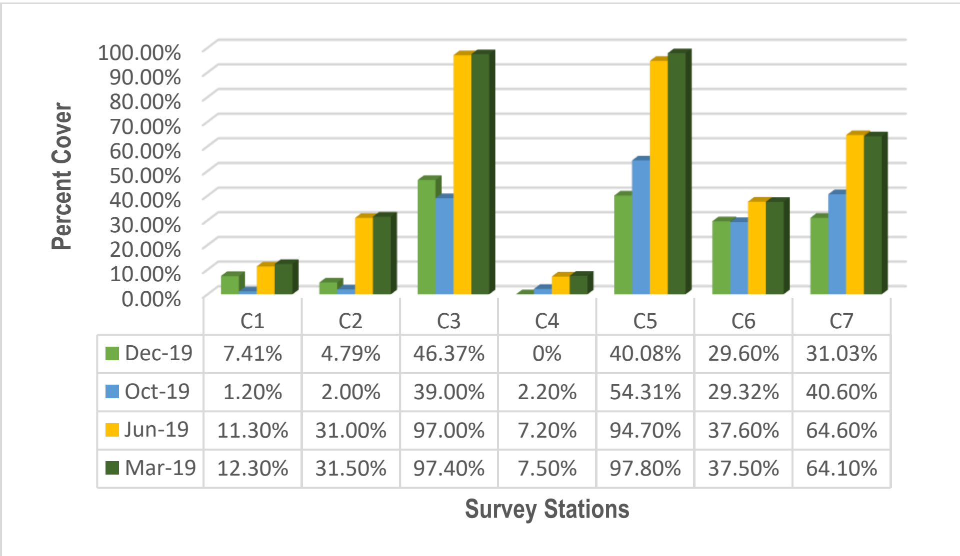
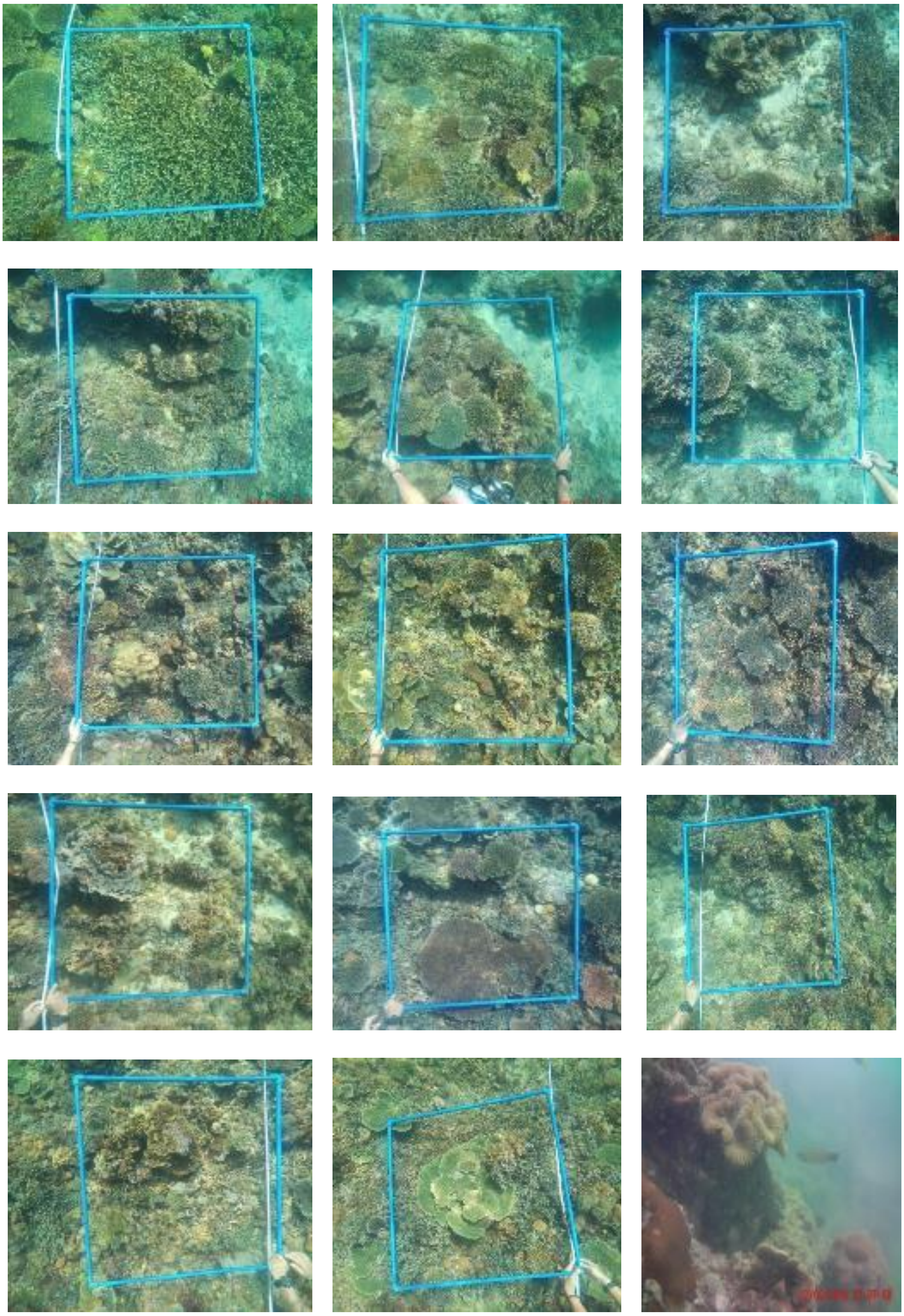


Figure 2-75: Comparison of Percentage Cover (%) of Live Hard Corals at the Seven (7) Survey Stations for the Sampling Periods of December 2019, October 2019, June 2019 and March 2019

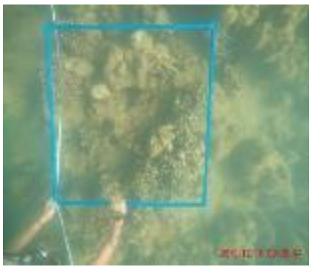
<u>Coral Species Richness</u>

As already reported in the previous monitoring reports (LTI, 2018c,d), there are about 488 coral species found in the Philippines out of the 500 known coral species worldwide (IPAS Report, undated). Eighty-eight (88) of these species have so far been identified during the sampling period of October 2018 at the seven transect sites and immediate vicinity. Station C/F7 has the highest number of coral species with 43 encountered, followed by Stations C/F3 with 35, C/F5 with 31, C/F2 with 23, C/F6 with 19, and C/F4 with 17, respectively. The lowest species richness was recorded at Station C/F1 with 12 species (3rd Qtr 2018 Monitoring Report). This total number of live hard coral species of 88 reported for Masinloc is higher compared to the coral reefs of Semirara Island in Antique having 69 species (LTI, 2018) and Naglatore at Brgy. Cawag in Subic Bay having 38 species (MEAESCF, 2017), but lower compared to the coral reefs in Tayabas Bay waters (Batangas and Quezon) that support 163 coral species (DA/FSP, 1996) and reefs around San Pedro Bay (eastern Visayas) having 181 species (Villoso, 1996).

Plate 12: Photo Montage of Coral Speciation Taken *In Situ* from the Seven (7) Coral Reef Survey Stations

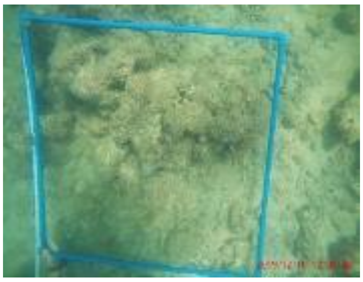
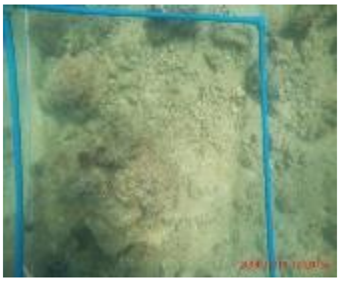
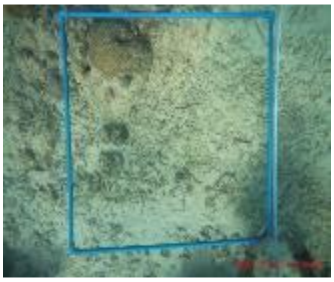
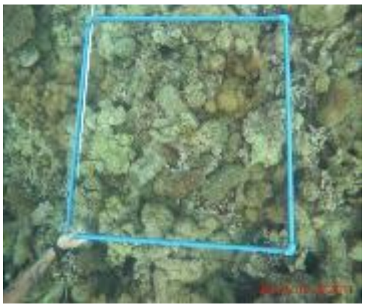


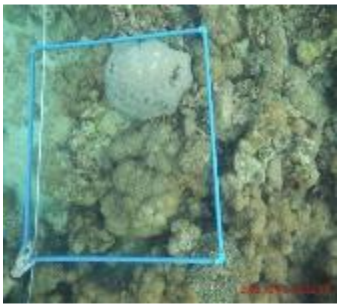










Recent Disturbances on the Coral Reefs Surveyed

The monitoring also includes an assessment of external stresses and disturbances that may pose significant impacts on the coral reef ecosystem and the seawaters of Oyon Bay in general. Power plant operations without observing environmental regulations can pose significant impacts on its surrounding areas hence the need for periodic monitoring. However, exercising due diligence in operational management can greatly reduce probable impacts thus any observed disturbance may not arise from them but from other causes which could either be man-induced or due to natural causes. This part of the report will focus on the coral reef ecosystem.

Disturbance can be defined as “any relatively discrete event in time that disrupts the natural order of things” and may result into changes in the environment, the ecosystems, the community and the resources within.

The nature of the disturbance varies in accordance with the degree of its imposition into the natural order of things. In a reef ecosystem, changes in the reef ecology may result into localized extinction of species, reduction in the number of available resources and damage to the system itself thus the reduction of services it can provide.

Potential sources of external stresses and disturbance can be the following as observed:

1. Unregulated anchorage and fishing practices by small and marginal fishermen

It has been observed that the bay is a favored fishing ground for local small and marginal fishermen who usually drop anchors on top of the reef system as it is where demersal fishes that thrives on the coral reef could be caught by hook and line fishing or by bottom drift nets. Weighted anchors dropped into the reef area can break fragile coral like the branching and table Acropora species. Anchor dragging especially during windy days or sudden current surge can uproot coral colonies from their substrate base thus causing damage and destruction to the coral reef.

There were also several free divers who are spearfishing. Though not observed, it has been the practice of some spear fishers to use mild poison to disorient their target but which may cause damage to the corals less resistant to such poisonous substances.

Discussion with power plant management provided the information that although they have been actively providing interventions like placement of artificial reefs (ARs) and fish attracting devices (FADs) in support to efforts of improving fishery productivity within Oyon Bay as part commitment in environmental compliance, they are not allowed to impose protective measures in the seawaters of Oyon Bay resulting to the destruction of some of their ARs and FADs.

2. Fish farming/Mariculture

Portion of the inner bay has been utilized by several entrepreneurs for fish farming or mariculture. If left unregulated, it can be a potential source of nutrient rich feed waste that can enhance algal bloom or the prolific development of macroalgae. Excessive growth of the algae Sargassum, Padina and a host of filamentous algae can overrun the reef beds that compete and smother coral growth and development.

Settled feed waste can alter sediment structure and enhances the proliferation of bacteria of decay or anaerobic bacteria that may cause foul odor and eutrophication leading to fish kills and coral degradation.

3. Excessive sediment-loaded river runoffs

Upland denudation and development of built-up areas along the riverbanks have caused massive soil erosion inputted into the river system and eventually into the sea. Oyon Bay has been on the receiving end of two river systems that dump tons of sediments into the bay especially during heavy flooding. Excessive sedimentary runoff may settle and smother coral colonies nearshore and offshore result of which is still coral damage and destruction.

4. Crown-of-Thorns (*Acanthaster plancii*) outbreak

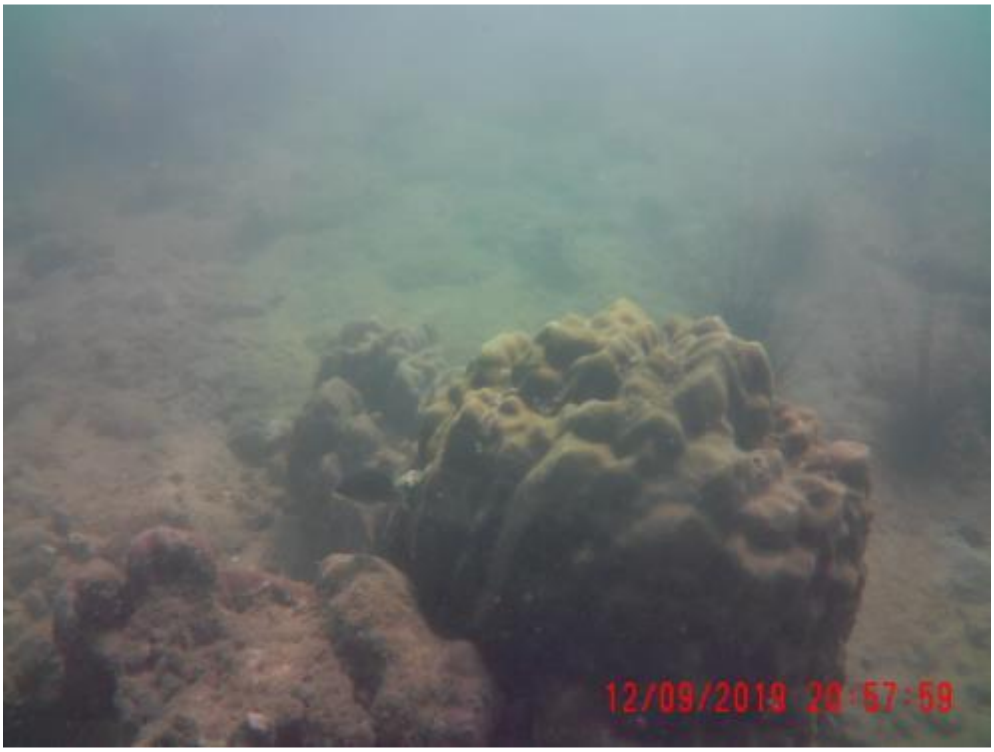
Observed during the conduct of coral assessment were several Crown-of-Thorn starfish predating on some small corals (*Acropora* sp.) in the better reef system designated as C/F5 in the survey for corals and fishes.

Though the number observed is not of alarming proportion, the species as a natural predator of corals needs to be constantly monitored to preempt any possible outbreak that may result to extensive coral damage and destruction.

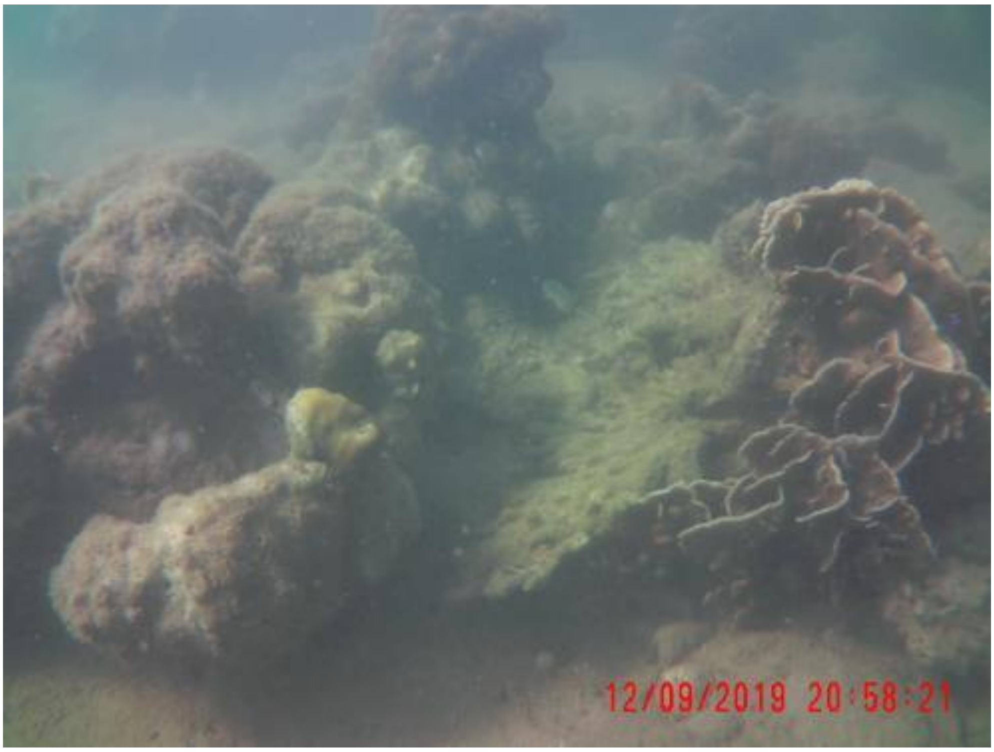
5. Macroalgae and encrusting algal species

Several macroalgae like *Sargassum* and *Padina* and some encrusting algae were observed on the shallower portion of the reef area. This species are prolific in growth especially in nutrient-enriched water and tends to overrun and smother coral colonies. It has been observed to do so in some inshore fringing reefs where seawater has been polluted by wastewater flowing out of local sewerage systems. Awareness of this possibility can provide early corrective action whenever necessary.

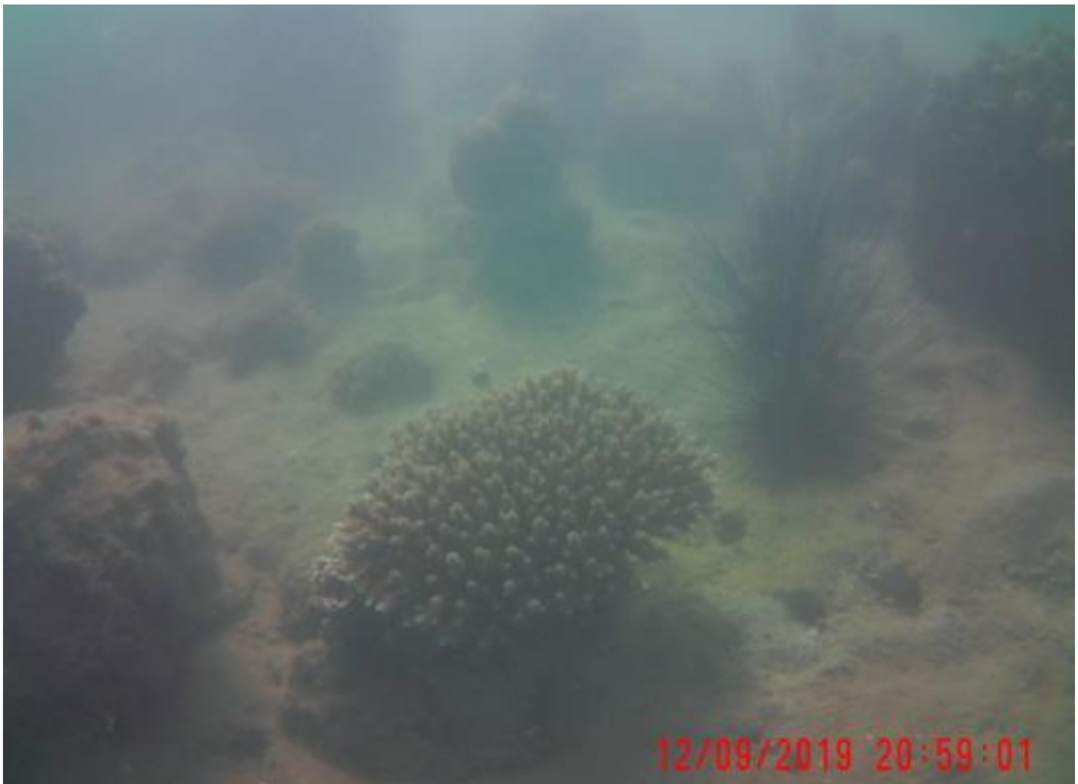
Plate 13: Coral Species Identified *In Situ* during the Coral Survey



***Porites sp.* (submassive)**

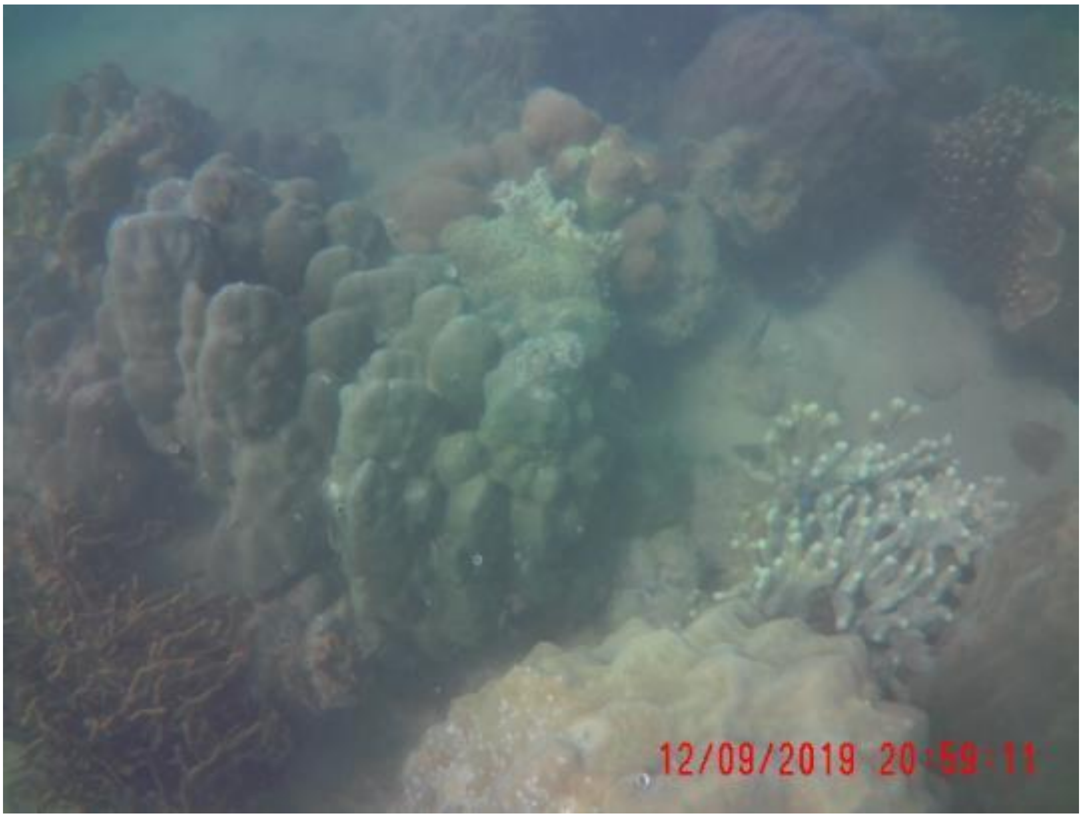


Porites sp.* and *Millepora sp.

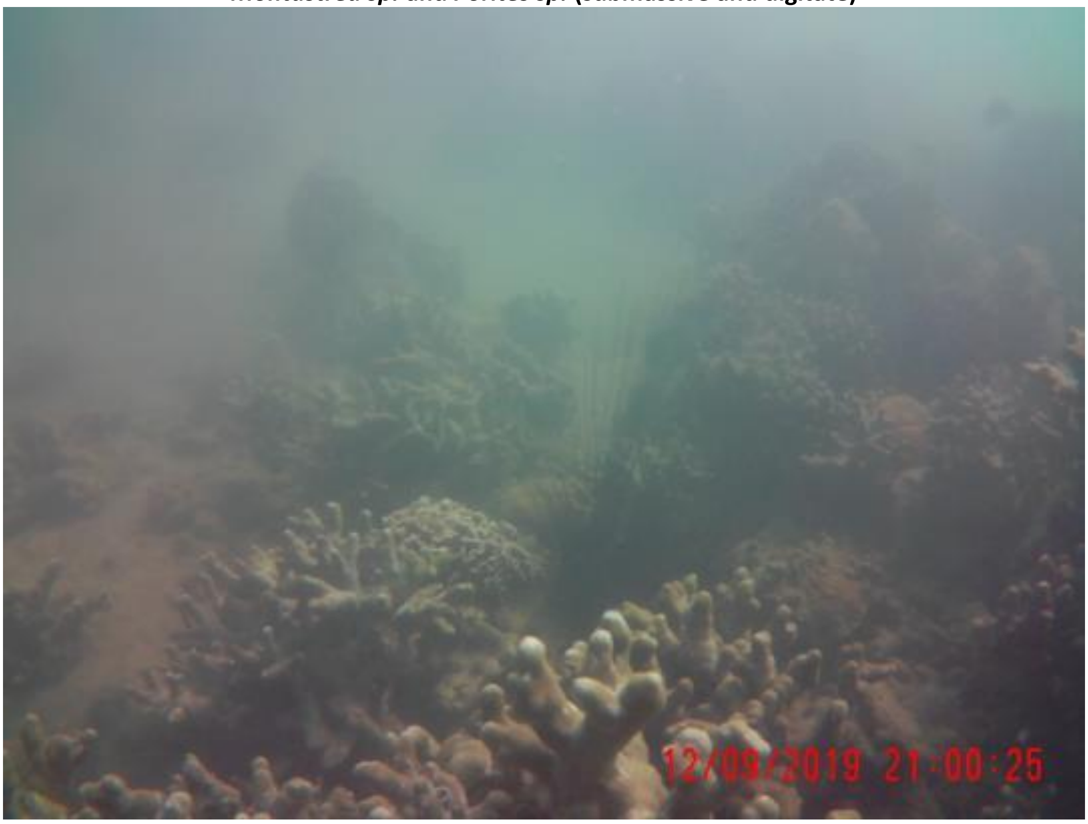


***Acropora sp.* (digitate)**

Porites sp. **(submassive)**



Montastrea sp. **and** ***Porites sp.*** **(submassive and digitate)**



Stylophora sp. **(digitate)**

***Fungia sp*. (solitary coral)**

Fungia* and *Herpolita sp.

Plerogyra sinuosa **(Rounded bubble coral)**

Manicinia areolata

Plerogyra sinuosa **(Rounded bubble coral)**

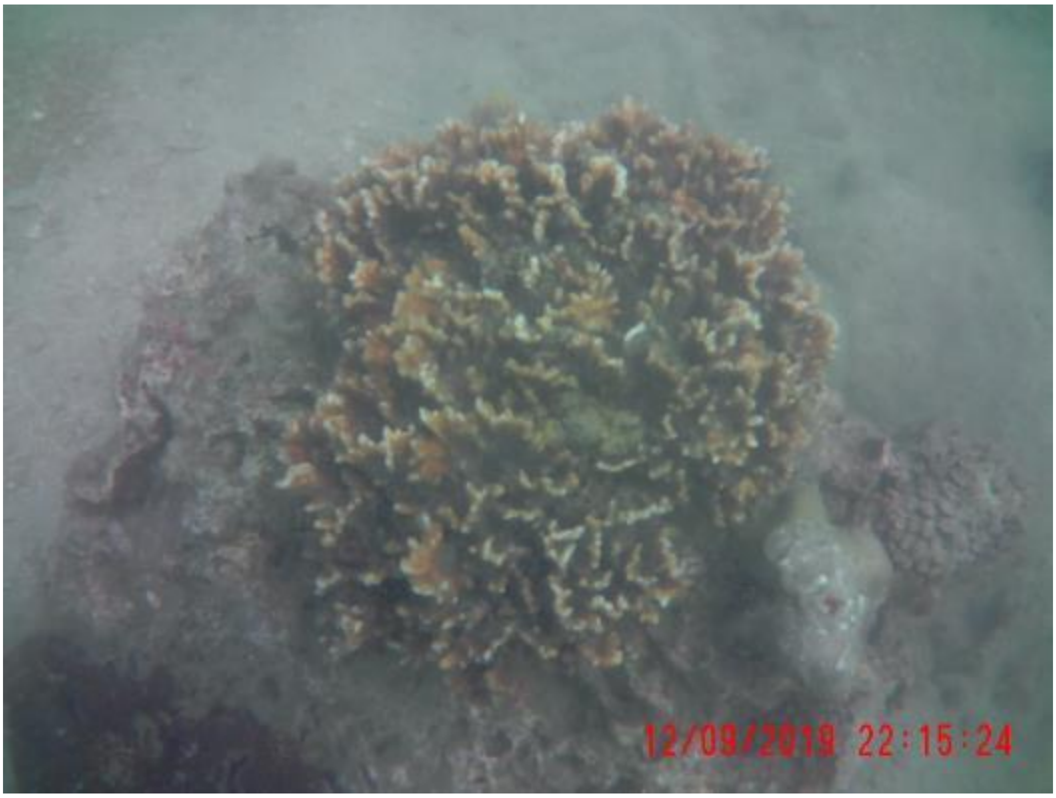
Montastrea cavernosa

Eusmilia sp.

Fungia

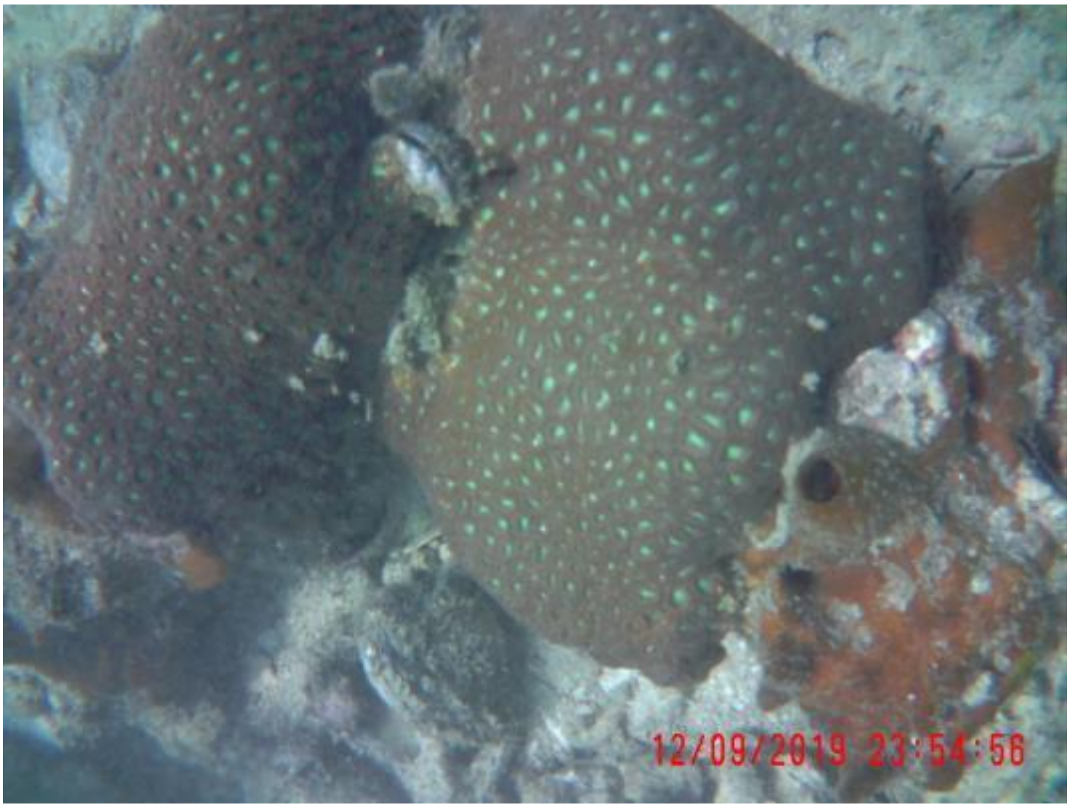
Agaricia fragilis

Isophyllastrea sp.

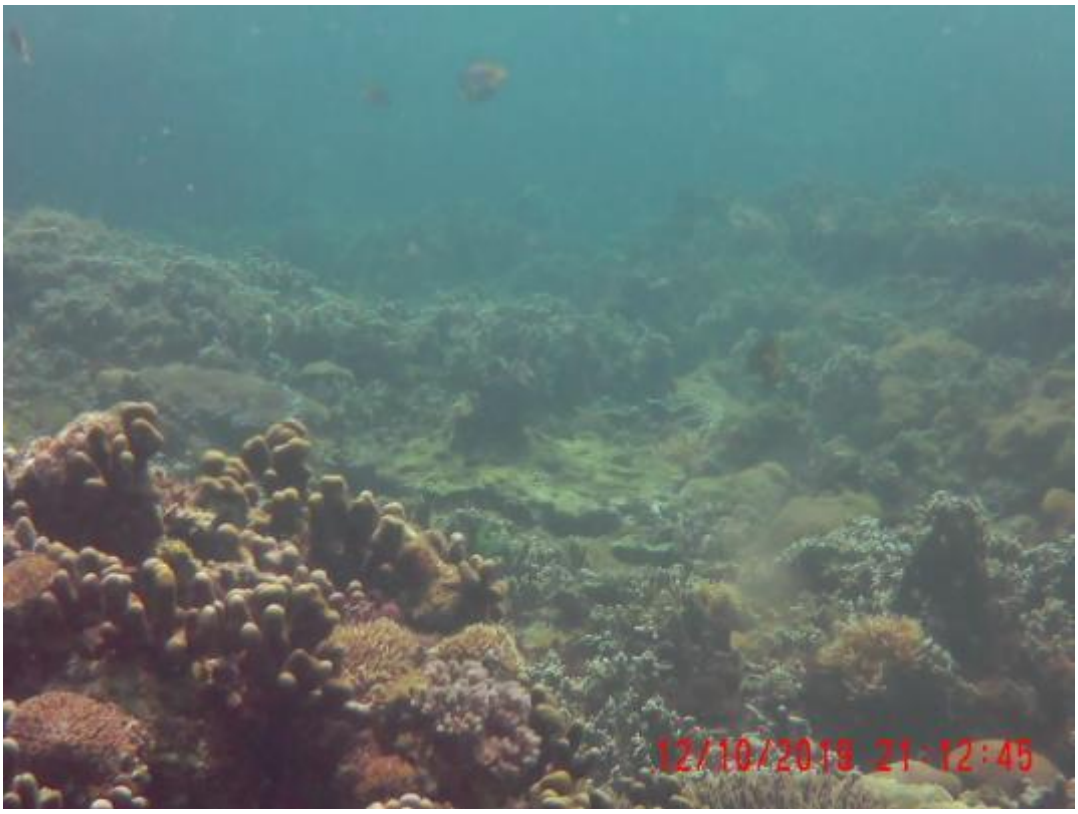


Agaricia tenuifolia

Stylophora pistillata



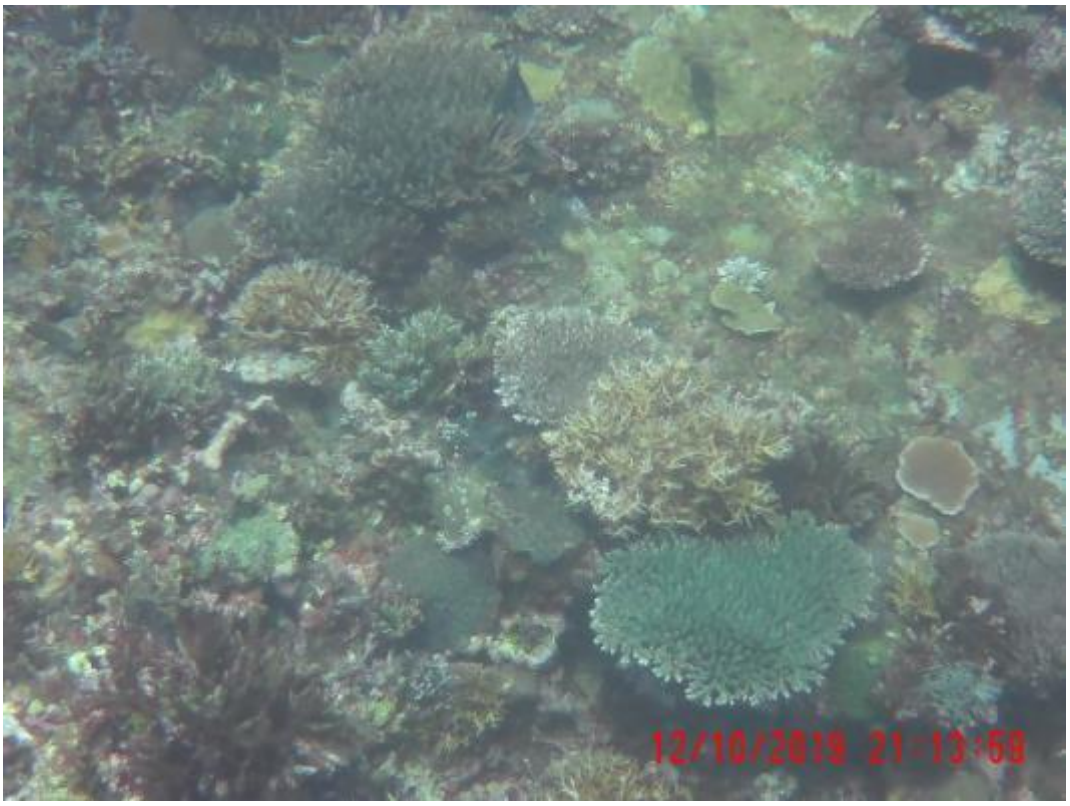
Favia sp. **and sponge**



Madracis sp.

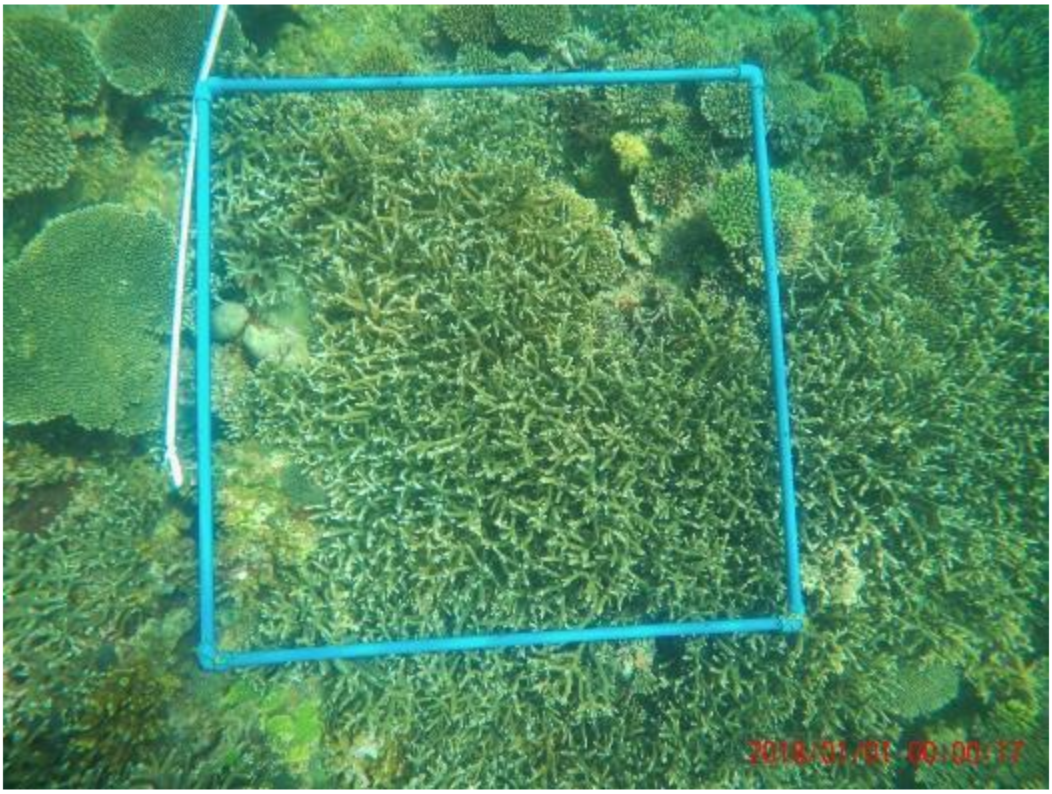
Dichocoenia sp., Madracis and *Seriatopora hystrix*

Acropora sp. **(tabulate)**

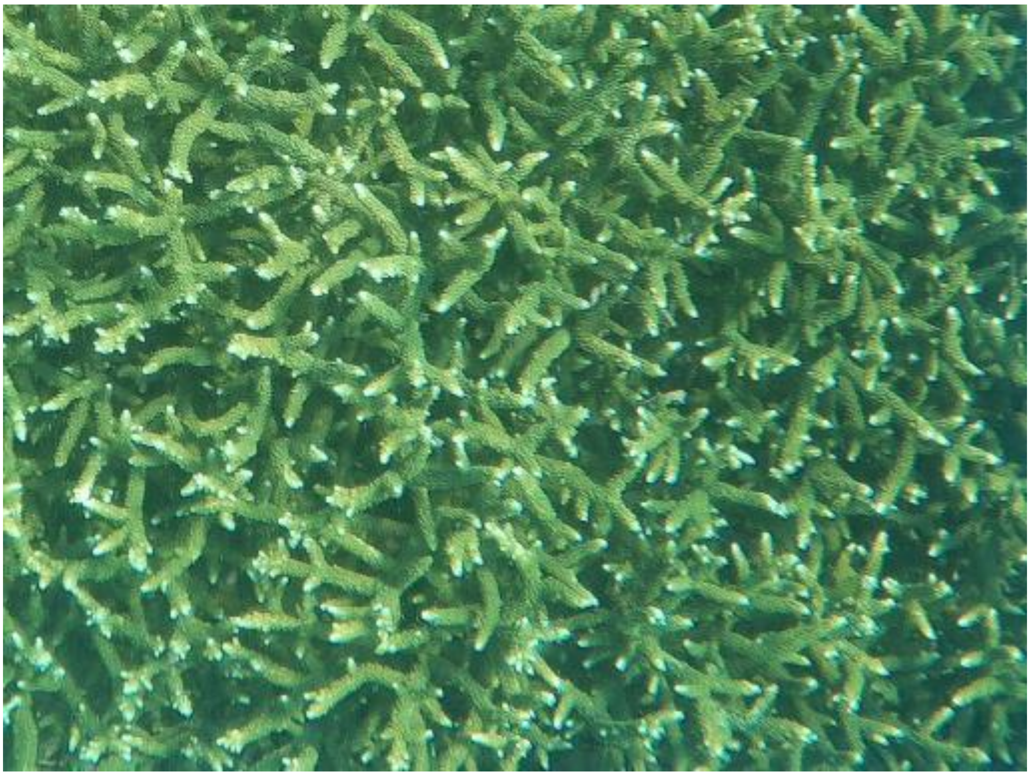


Acropora sp. **(table)*****, Seriatopora sp. Acropora sp.*** **(branching)**

Astreopora sp., Porites sp., Acropora sp. and Seriatopora hystrix



Acropora sp. **(branching)**



Acropora cervicornes

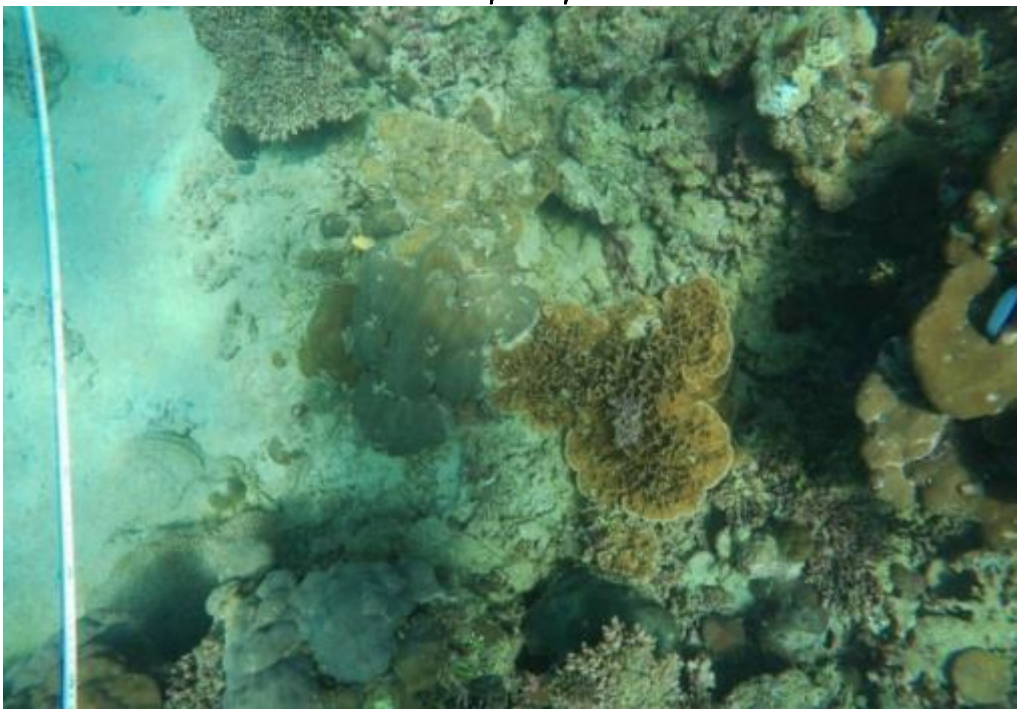
Diploastrea sp. **(encrusting)**

Porites sp. **(submassive)**

Oxypora lacera

Oxypora lacera

Millepora sp.



Montipora striata

Demersal and Coral Reef Fishes

Coral reef fishes are animals that live among or in close relation to coral reefs Hundreds of species can exist in a small area of a healthy reef, many of them hidden or well camouflaged. Reef fish have developed many ingenious specializations adapted to survival on the reefs.

Coral reefs occupy less than one percent of the surface area of the world oceans, but still they provide a home for 25 percent of all marine fish species. Reef habitats are a sharp contrast to the open water habitats that make up the other 99% of the world oceans. Coral reefs contain the most diverse fish assemblages to be found anywhere on earth, with perhaps as many as 6,000–8,000 species that can be found dwelling within coral reef ecosystems of the world's oceans.

The mechanisms that first led to, and continue to maintain, such concentrations of fish species on coral reefs has been widely debated over the last 50 years. While many reasons have been proposed, there is no general scientific consensus on which of these is the most influential, but it seems likely that a number of factors contribute. These include the rich habitat complexity and diversity inherent in coral reef ecosystems, the wide variety and temporal availability of food resources available to coral reef fishes, a host of pre- and post-larval settlement processes, and as yet unresolved interactions between all these factors. The wealth of fishes on reefs is filled by tiny, bottom-dwelling reef fishes.

There are two major regions of coral reef development recognized: the Indo-Pacific (which includes the Pacific and Indian Oceans as well as the Red Sea), and the tropical western Atlantic (also known as the "wider" or "greater" Caribbean). Each of these two regions contains its own unique coral reef fish fauna with no natural overlap in species. Of the two regions, the richest by far in terms of reef fish diversity is the Indo-Pacific where there are an estimated 4,000–5,000 species of fishes associated with coral reef habitats. Another 500–700 species can be found in the greater Caribbean region.

Replicating previous survey stations, the team relocated the position of the seven (7) sampling stations previously established and designated as sampling stations C/F1, C/F2, C/F3, C/F4, C/F5, C/F6 and C/F7 for the conduct of Fish Visual Census to determine the speciation, composition, density, distribution and biomass of the demersal fisheries in the seawaters adjacent to the Masinloc Power Plant. All sampling stations are tabulated below together with the station coordinates, location and sampling date/time. The tracing of previously established stations was done with the use of a GPS and projected on map and tabulated below.

Figure 2-76: Map Showing the Coral and Fish Survey Stations within Oyon Bay

Table 2-42: Tabulated Data on Location and Other Relevant Information for Fish Survey Stations

Station	Site Location	GPS Coordinates		Depth (m)	Weather/Wind Direction/Sea Condition
		North Latitude	East Longitude		
C1	Near Intake Area	15° 33' 30.350" N	119° 55' 27.624" E	5	Fine, Sunny/SW/Calm, small wavelets
C2	Bet. Intake and Outfall	15° 33' 5.248" N	119° 55' 7.933" E	6	Fine, Sunny/SW/Calm, small wavelets
C3	Near Outfall Area	15° 33' 19.436" N	119° 54' 46.251" E	6	Fine, Sunny/SW/Calm, small wavelets
C4	Near C-Square	15° 34' 6.911" N	119° 56' 1.477" E	7	Fine, Sunny/SW/Calm, small wavelets
C5	Near Buoy 7	15° 32' 31.725" N	119° 55' 32.189" E	6	Fine, Sunny/SW/Calm, small wavelets
C6	Oyon Point	15° 33' 5.430" N	119° 56' 17.895" E	5	Fine, Sunny/SW/Calm, small wavelets
C7	San Salvador Island	15° 31' 42.150" N	119° 54' 37.339" E	6	Fine, Sunny/SW/Calm, small wavelets

Reef Associated Fishes

Reef fish assemblages are among the important components in the coral reef community dynamics as a healthy reef essentially provides good habitat and niches that allows dense and diverse fish populations and trophic structures. Fishes react with habitat degradation, changing environmental conditions, and unregulated resource extraction; hence, the state of fish assemblages in terms of density and diversity in a given area may illustrate the biological integrity and quality of the underlying coral reefs. The study aimed to characterize the recent condition of fish assemblages within the study area with emphasis on species richness and diversity, density, relative abundance, and biomass.

This report presents the results of the December 2019 monitoring and assessment of the status of coral reef fishes in the area.

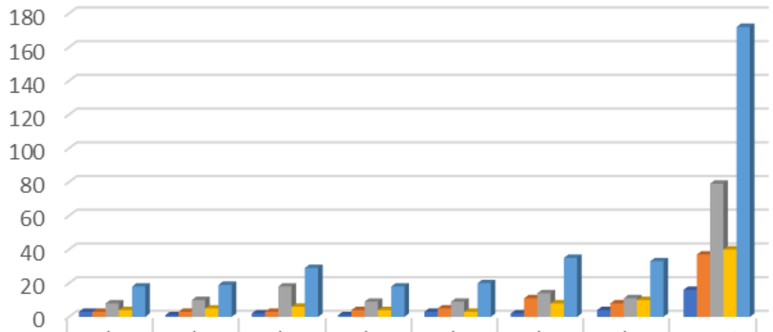
The field survey applied the day-time fish visual census (English *et al.,* 1997) to assess associated fish communities at the seven sampling stations. All fishes observed within 10 meters across the 50-m transect line were identified to species level whenever possible. Fish abundance was determined by actual counts, while fish size (total length) was estimated to the nearest centimeter. Each survey covered a total area of 500 m2.

Fishes were categorized as “target”, “indicator” and “major” species or families during the data processing. Target species are fishes mostly targeted by fishermen for their high market value such as groupers (Serranidae), snappers (Lutjanidae), emperors (Lethrinidae), jacks and trevallies (Carangidae), fusiliers (Caesionidae), goatfishes (Mullidae), parrotfishes (Scaridae), surgeonfishes (Acanthuridae), breams (Nemipteridae), sweetlips (Haemulidae), and some large wrasses (Labridae) among others. Indicator species are regarded to be highly associated with their habitats, which may reflect the relative condition of the reefs where they are present. On the other hand, major families or demersal species are those fishes of ecological importance that occupy various trophic positions in the reef ecosystem.

The estimation of fish biomass was done using the allometric equation $W=aL^b$, where W is the weight in grams, *a* the multiplicative factor, L the total length of the fish (cm), and *b* the exponent. The *a* and *b* values compiled in Kulbicki *et al*. (1993), Letourner *et al.* (1998) and Froese and Pauly (2001) were used in the calculation. In addition, species diversity indices (Shannon Index, Simpson Index and Evenness) and Bray – Curtis similarity cluster analysis were analyzed using PRIMER 5 software.

Species Richness

Species richness and composition of reef associated fish species in terms of group category from the different survey stations are presented in **Figure 2-77** below. Details of these categorical groupings are presented in **Table 2-43** and **Table 2-44**. Station surveys conducted in December 2019 has recorded a total of 101 species belonging to 18 families which is somewhat similar to the October 2019 survey result. This result has a lower number of species but with a higher number of families represented compared to the October 2019 survey but markedly higher than the June survey with only a recorded total of 80 species belonging to 14 families. The same survey result has an almost similar number of species belonging to almost the same number of families when compared to the surveys conducted last March 2019, which recorded 100 species belonging to 17 families. The March 2019 survey results were also relatively higher when compared to the June 2019 survey result.



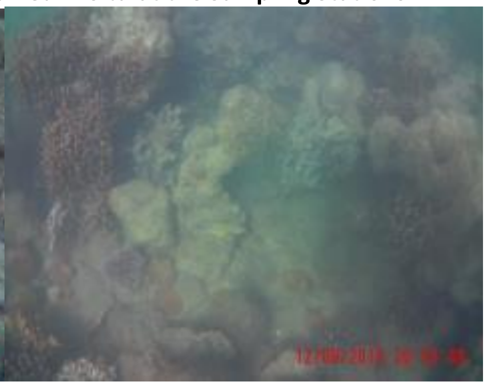
	C/F1	C/F2	C/F3	C/F4	C/F5	C/F6	C/F7	Total
Indicator Species (Coral Cover)	3	1	2	1	3	2	4	16
Indicator Species (Reef Resillience)	3	3	3	4	5	11	8	37
Major Species	8	10	18	9	9	14	11	79
Target Species	4	5	6	4	3	8	10	40
Total	18	19	29	18	20	35	33	172

Figure 2-77: Categorical Presentation of Species Richness in All Survey Stations (December 2019)

Plate 14 and **Plate 15** shows some of the representative fish species recorded during the survey of October 2019 but retained in this report while some were updated as more or less the same species were also observed in the December 2019 survey. High species richness was recorded in Stations C/F6, Station C/F7 and Station C/F3 with 35, 33 and 29 species, respectively. This was followed by Station C/F5 20 species, Station C/F2 with 19 species and both Stations C/F1 and C/F4 registering 18 species each.

Plate 14: Some of the Fish Species Observed *In Situ* at the Sampling Stations

Lionfish (*Dendrochirus* sp.)



Snapper (no ID)

Damselfish (*Pomacentrus tripunctatus*)

Pufferfish (*Arothron* sp.)


False Moorish Idol (*Heniochus* sp.) Sweetlips – juv. (*Plectorhinchus* sp.)


Celebes wrasse (*Oxycheilinus* sp.) Barred soapfish (*Diplorion* sp.)


Cleaner wrasse (*Labroides dimidiatus*) Saw-jawed Monocle Bream (*Scolopsis ciliata*)


Damselfish (*Amblyglyphidodon* sp.) Snapper (*Lutjanus* sp.)

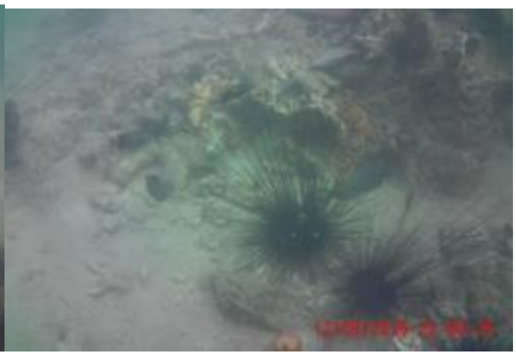
Goatfish (*Parupeneus* sp)

Butterflyfish (*Chaetodon* sp.)

Butterflyfish (*Chaetodon* sp.)

False Moorish Idol (*Heniochus* sp.)

Cardinalfish (*Apogon* sp.)



Damselfish (*Dascyllus* sp.)

Plate 15: Some of the Fish Species Caught by Hook and Line Fishing

Grouper (*Cephalopholis boenak*)

Lizardfish (*Synodus* sp.)

Wrasse (*Anampses* sp.)

Bream (*Scolopsis* sp.)

Triggerfish (*Balistapus undulates*)

Bream (*Nemipterus virgatus*)

Grouper (*Epinephelus* sp.)

Grouper (*Plectropomus leopardus*)

Wrasse (*Coris* sp.)

Snapper (*Lutjanus* sp.)

Emperor (*Lethrinus* sp.)

Cardinal (*Apogon* sp.)

Grouper (*Cephalopholis boenak*)

Snapper (*Lutjanus* sp.)

Trevally (*Carangoides* sp.)

Table 2-43: Summary of Species Diversity, Density and Biomass Recorded in Seven Sampling Stations (October 2019)

Station	C/F1	C/F2	C/F3	C/F4	C/F5	C/F6	C/F7	Mean
Station Name	**Intake Area**	**Between Intake and Outfall Area**	**Outfall Area**	**C-Square**	**Buoy 7**	**Oyon Point**	**San Salvador Island**	
Species Diversity								
Indicator species (coral cover)	3	1	2	1	3	2	4	2
Indicator species (resilience)	12	9	16	8	9	6	21	12
Major species	8	11	18	9	10	13	11	11
Target species	4	5	6	4	3	8	10	6
Number of species	**27**	**26**	**42**	**22**	**25**	**29**	**46**	**31**
Number of families	**8**	**7**	**11**	**6**	**9**	**12**	**12**	**10**
Density (individual/500m2)								
Indicator species (coral cover)	13	2	6	2	4	5	13	6
Indicator species (resilience)	141	41	139	107	98	172	259	136
Major species	31	27	227	69	34	37	103	75
Target species	14	10	17	8	9	19	101	26
Total Density	**199**	**80**	**389**	**186**	**145**	**233**	**476**	**243**
Fish Biomass (grams per 500m2)								
Indicator species (coral cover	180.313	15.661	3621.033	33.370	148.095	110.212	18729.559	3262.606
Indicator species (resilience)	1108.862	236.674	164.948	456.566	2295.25	2373.621	16804.056	3348.57
Major species	1096.716	748.785	2660.348	839.181	947.718	1170.989	548.376	1144.59
Target species	906.319	834.792	1381.299	971.996	2579.15	3779.398	5097.375	2221.48
Total Biomass	**3292.210**	**1835.912**	**7827.628**	**2303.443**	**5970.213**	**7434.22**	**41179.366**	**9977.246**

Table 2-44: Family and Species Density (Individual/500m2) Recorded in Seven Sampling Stations (October 2019)

	Family	Species	Intake area (C/F1)	Bet. Intake and Outfall (C/F2)	Outfall area (C/F3)	C-Square (C/F4)	Near Buoy7 (C/F5)	Oyon Point (C/F6)	San Salvador (C/F7)	Total
Indicator (Coral Cover)	Chaetodontidae	*Chaetodon octofasciatus*	4	2		2	1		2	11
Indicator (Coral Cover)	Chaetodontidae	*Chaetodon unimaculatus*			5					5
Indicator(Coral Cover)	Chaetodontidae	*Chaetodon vagabundus*			4				4	8
Indicator (Coral Cover)	Chaetodontidae	*Heniochus chrysostomus*					2	2	5	9
Indicator (Coral Cover)	Pomacanthidae	*Centropyge vrolikii*					1	3	2	6
Indicator (Coral Cover)	Pomacentridae	*Diproctacanthus xanthurus*	1							1
Indicator (Coral Cover)	Pomacentridae	*Plectroglyphidodon dickii*	8							8
		Total	**13**	**2**	**9**	**2**	**4**	**5**	**13**	**48**
Indicator (Resilience)	Pomacentridae	*Abudefduf vaigiensis*	3		7		58	20		88
Indicator (Resilience)	Acanthuridae	*Acanthurus leucopareius*			2				10	12
Indicator (Resilience)	Acanthuridae	*Acanthurus mata*			6		5		75	86
Indicator (Resilience)	Acanthuridae	*Acanthurus nigrofuscus*			3					3
Indicator (Resilience)	Chaetodontidae	*Chaetodon kleinii*		2		2		2		6
Indicator (Resilience)	Pomacentridae	*Chromis margaritifer*	2	4	16	7			6	35
Indicator (Resilience)	Pomacentridae	*Chromis nitida*			11					11
Indicator (Resilience)	Pomacentridae	*Chromis xanthochira*	4	2	4				4	14
Indicator (Resilience)	Pomacentridae	*Chrysiptera glauca*							8	8
Indicator (Resilience)	Pomacentridae	*Chrysiptera hemicyanea*	6	6						11
Indicator (Resilience)	Pomacentridae	*Chrysiptera oxycephala*			5				2	7
Indicator (Resilience)	Pomacentridae	*Chrysiptera rex*			10		2		28	40
Indicator (Resilience)	Pomacentridae	*Chrysiptera starcki*						15	30	45

	Family	Species	Intake area (C/F1)	Bet. Intake and Outfall (C/F2)	Outfall area (C/F3)	C-Square (C/F4)	Near Buoy7 (C/F5)	Oyon Point (C/F6)	San Salvador (C/F7)	Total
Indicator (Resilience)	Acanthuridae	*Ctenochaetus cyanocheilus*							10	10
Indicator (Resilience)	Pomacentridae	*Dascyllus aruanus*	2							2
Indicator (Resilience)	Pomacentridae	*Dascyllus reticulatus*	25	7	7		3		8	50
Indicator (Resilience)	Pomacentridae	*Dascyllus trimaculatus*	63	10	10				5	88
Indicator (Resilience)	Pomacentridae	*Dischistodus chrysopoecilus*	7							7
Indicator (Resilience)	Pomacentridae	*Dischistodus prosopotaenia*			3	9		10		22
Indicator (Resilience)	Pomacentridae	*Dischistodus pseudochrysopoecilus*	4							4
Indicator (Resilience)	Pomacentridae	*Neoglyphidodon nigroris*						6	5	11
Indicator (Resilience)	Pomacentridae	*Pomacentrus amboinensis*				10			2	12
Indicator (Resilience)	Pomacentridae	*Pomacentrus bankanensis*			10					10
Indicator (Resilience)	Pomacentridae	*Pomacentrus brachialis*	16	4	28	41	15	17	12	133
Indicator (Resilience)	Pomacentridae	*Pomacentrus chrysurus*						7	15	22
Indicator (Resilience)	Pomacentridae	*Pomacentrus coelestis*				7		2	8	17
Indicator (Resilience)	Pomacentridae	*Pomacentrus emarginatus*						8		8
Indicator (Resilience)	Pomacentridae	*Pomacentrus grammorhynchus*	8	4		18	6	5		61
Indicator (Resilience)	Pomacentridae	*Pomacentrus lepidogenys*						5		5
Indicator (Resilience)	Pomacentridae	*Pomacentrus opisthostigma*						7	12	19
Indicator (Resilience)	Pomacentridae	*Pomacentrus simsiang*		3	10	13		14		40
Indicator (Resilience)	Pomacentridae	*Pomacentrus stigma*					4	30	10	44
Indicator (Resilience)	Pomacentridae	*Plectroglyphidodon lacrymatus*			7					7
Indicator (Resilience)	Scaridae	*Scarus dimidiatus*						2	5	7
Indicator (Resilience)	Scaridae	*Scarus flavipectoralis*						2	2	4
Indicator (Resilience)	Scaridae	*Scarus niger*							2	2
Indicator (Resilience)	Scaridae	*Scarus quoyi*					1			1
Indicator (Resilience)	Zanclidae	*Zanclus cornutus*	1							1
Indicator (Resilience)	Acanthuridae	Zebrasoma scopas					4			4
		Total	**141**	**41**	**139**	**107**	**98**	**172**	**259**	**957**
Major	Apogonidae	Apogon griffini			5		4		7	16

	Family	Species	Intake area (C/F1)	Bet. Intake and Outfall (C/F2)	Outfall area (C/F3)	C-Square (C/F4)	Near Buoy7 (C/F5)	Oyon Point (C/F6)	San Salvador (C/F7)	Total
Major	Blenniidae	Aspidontus taeniatus							5	5
Major	Chaetodontidae	Chaetodon auriga			4			2		6
Major	Chaetodontidae	Coradion chrysozonus					2			2
Major	Labridae	Coris picta							5	5
Major	Labridae	*Halichoeres argus*	4							4
Major	Labridae	*Halichoeres chloropterus*					2	2		4
Major	Labridae	*Halichoeres hortulanus*	8	2	4		3	3		20
Major	Labridae	*Halichoeres prosopeion*			7					7
Major	Labridae	*Halichoeres melanurus*	2	1		2				5
Major	Labridae	*Halichoeres richmondi*			14					14
Major	Labridae	*Halichoeres scapularis*	2	1	2			3		8
Major	Labridae	*Labroides dimidiatus*		4	2	3		2		11
Major	Labridae	*Stethojulis interrupta*						2	5	7
Major	Labridae	*Thalassoma hardwicke*			5	5		2	2	14
Major	Labridae	*Thalassoma jansenii*			2					2
Major	Labridae	*Thalassoma lunare*	2	1	9	1	3	2	2	20
Major	Labridae	*Thalassoma lutescens*		6					4	10
Major	Labridae	*Thalassoma purpureum*			3					3
Major	Pomacentridae	*Acanthochromis polyacanthus*							5	5
Major	Pomacentridae	*Amblyglyphidodon curacao*			23		3			26
Major	Pomacentridae	*Amphiprion ocellaris*	4							4
Major	Pomacentridae	*Chromis amboinensis*	3			7				10
Major	Pomacentridae	*Chromis flavomaculata*		2		18				20
Major	Pomacentridae	*Chromis leucura*		4	3					7
Major	Pomacentridae	*Chromis randalli*			13		4	4		21
Major	Pomacentridae	*Chromis ternatensis*			8					8
Major	Pomacentridae	*Chromis xanthura*	6	3	118		10	4	54	195
Major	Pomacentridae	*Chrysiptera parasema*								
Major	Pomacentridae	*Pomacentrus armillatus*				11		2	12	25

	Family	Species	Intake area (C/F1)	Bet. Intake and Outfall (C/F2)	Outfall area (C/F3)	C-Square (C/F4)	Near Buoy7 (C/F5)	Oyon Point (C/F6)	San Salvador (C/F7)	Total
Major	Pomacentridae	*Pomacentrus auriventris*				21		5		26
Major	Ostraciidae	Ostracion meleagris			2			2		4
Major	Platycephalidae	Platycephalus indicus					3			3
Major	Zanclidae	Zanclus cornutus		3	4	1		4	2	6
		Total	**31**	**27**	**228**	**69**	**34**	**39**	**103**	**531**
Target	Acanthuridae	*Acanthurus nigricans*					4		6	10
Target	Acanthuridae	*Acanthurus nigricauda*					2		8	10
Target	Acanthuridae	*Ctenochaetus binotatus*						2	5	7
Target	Acanthuridae	*Ctenochaetus striatus*							65	65
Target	Balistidae	*Balistapus undulatus*	2		2				2	6
Target	Haemulidae	*Plectorhinchus chaetodonoides*						2		2
Target	Holocentridae	*Sargocentron rubrum*	2	1						3
Target	Holocentridae	*Neoniphon argenteus*						5		5
Target	Labridae	*Cheilinus fasciatus*		4	2					6
Target	Labridae	*Hemigymnus melapterus*			5					5
Target	Labridae	*Choerodon anchorago*				1				1
Target	Labridae	*Choerodon jordani*							2	2
Target	Lutjanidae	*Lutjanus lutjanus*			3					3
Target	Nemipteridae	*Pentapodus bifasciatus*							5	5
Target	Nemipteridae	*Scolopsis ciliata*	8	2	4	5		2	3	24
Target	Nemipteridae	*Scolopsis lineata*		1				2	2	5
Target	Nemipteridae	*Scolopsis vosmeri*					3			3
Target	Serranidae	*Epinephelus merra*		2				2		4
Target	Serranidae	*Epinephelus sexfasciatus*				1		2		3
Target	Serranidae	*Diploprion bifasciatum*				1			3	4
Target	Synodontidae	*Synodus binotatus*	2		1			2		5
		Total	**14**	**10**	**17**	**8**	**9**	**19**	**101**	**178**
		Grand Total	**198**	**81**	**397**	**186**	**145**	**235**	**470**	**1,712**

Fish Density

In terms of fish density, highest count of indicator species for coral health was recorded in both Station C/F1 and Station C/F7 with 13 indv/500m2. This was followed by Station C/F3 with 6 indv/500m2, Station C/F6 with 5 indv/500m2, Station C/F5 with 4 indv/500m2. Stations C/F2 and C/F4 have the lowest number at 2 indv/500m2.

On the other hand, fish density of indicator species for reef resiliency showed Station C/F7 with the most number of individuals for every 500 square meters 259 indv/500m2. This was followed by Station C/F6 with 172 indv/500m2, Station C/F1 with 141 indv/500m2, Station C/F3 with 139 indv/500m2, Station C/F4 with 107 indv/500m2, Station C/F5 with 98 indv/500m2 and lastly Station C/F2 with 41 indv/500m2.

In the case of the major species, the highest density was recorded in Station C/F3 with 227 indv/500m2 followed by Station C/F7 with 103 indv/500m2 and in decreasing order by Stations C/F4, C/F6, C/F5, C/F1 and C/F2 with 69 indv/500m2, 37 indv/500m2, 34 indv/500m2, 31 indv/500m2 and 27 indv/500m2 respectively.

Notably, target species, by being regularly fished, registered a lower species density with the highest being recorded at Station C/F7 with 101 indv/500m2. This was followed in decreasing order by Station C/F6 with 19 indv/500m2, Station C/F3 with 17 indv/500m2, Station C/F1 with 14 indv/500m2,, Station C/F2 with 10 indv/500m2, Station C/F5 with 9 indv/500m2 and lastly, Station C/F4 with 8 indv/500m2, respectively.

Collectively, the recorded number of individual fishes for all stations numbers 1,708. Setting aside the qualitative state of each individual station, it would appear that there were 243 indv/500m^2 in the context of the entire area under study. It being a hypothetical assumption, could not exist in the real world considering that living organisms like fishes tends to congregate on areas favorable for survival, thus the apparent diaparity in species density and distribution with more species and individuals favoring the area where food and living conditions ideally support their daily needs for survival.

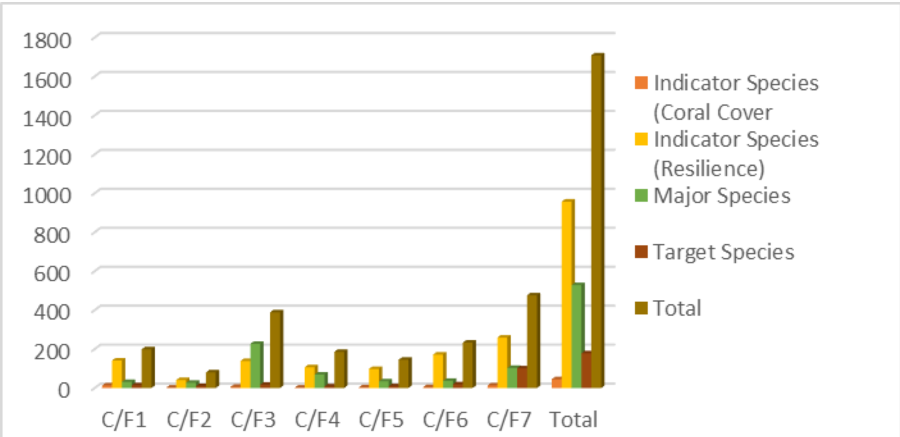


Figure 2-78: Density by Fish Category and Total Density of Fish Assemblages at the Seven (7) Sampling Stations (December 2019)

Density and distribution of species varied from station to station. Taken in context of the total number of survey stations, the ten (10) highest number of individual fish ranked from one to ten was the following species: *Chromis xanthura*, in the Major species group, ranked first with a total number of 195 from the seven stations surveyed with the most number recorded at Station C/F3. The species was followed in decreasing degree of representation by *Pomacentrus brachiales* in the Indicator species for reef resilience with 133, *Abudefduf vaigiensis* in the Indicator species for reef resilience with 88, *Acanthurus mata* also with the Indicator for reef resilience group with 86, *Dacylus trimaculatus* of the Indicator for reef resilience group with 68, *Ctenochaetus striatus* of the Target species group with 65, *Pomacentrus grammorhynchus*, another species of the Indicator for reef resilience group, with 61, *Dacylus reticulatus*, still of the Indicator for reef resilience group, with 50, *Chrysiptera starcki*, another Indicator for reef resilience with 45 and *Pomacentrus stigma*, still a reef resilience indicator with 44.

Looking at the density and abundance of the top ten species relative to the total number of species recorded for all stations with *Chromis xanthura* as having the highest representation at around 11% from the total 1,708 counted and the rest of the top ten species at around 37% with most species belonging to the Indicator species for reef resilience, the area potential for a more productive reef system is achievable provided that better coastal and marine management program is in place.

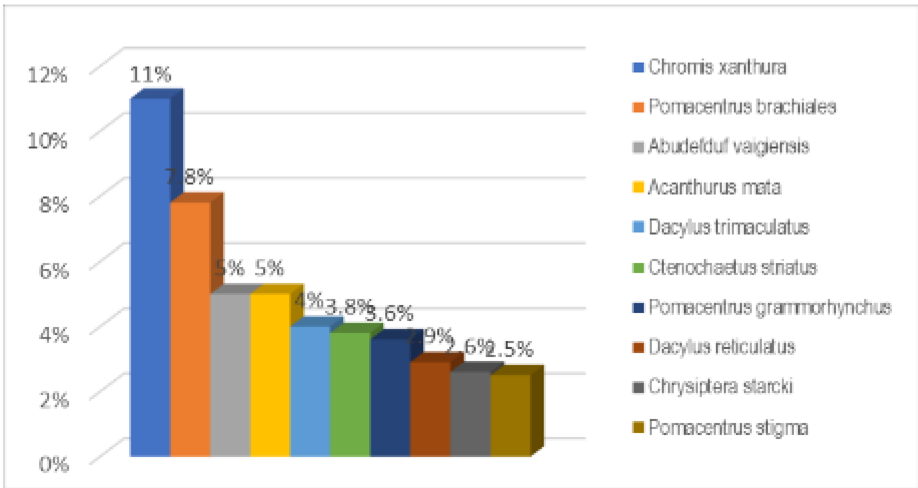


Figure 2-79: Relative Density of Top 10 Fish Species in Seven Sampling Stations (December 2019)

<u>Fish Biomass</u>

Fish biomass is a primary driver of coral reef ecosystem services and has high sensitivity to human disturbances, particularly fishing. Estimates of fish biomass, their spatial distribution, and recovery potential are important for evaluating reef status and crucial for setting management targets. It has been shown to be a key proxy for coral reefs where the state of reef ecosystems and the life history composition of the fish community are well predicted by a simple biomass metric (McClanahan et al 2016).

Biomass as a measure of ocean productivity was derived out of the Fish Visual Census conducted on the same seven survey sites for coral cover assessment. Estimates were made on the categorized species group as Indicator Species (Coral Cover), Indicator Species (Reef Resilience), Major Species and Target Species. As determined, the biomass value of the indicator species for coral cover was relatively high in Stations C/F7 with 18,729.559 gm/500m^2 and C/F3 with 3,621.033 grams/500 m^2. The rest of the stations have registered biomass at less than 200 gm/500 m^2. In the case of the indicator species for reef resilience, Station C/F7 registered the highest biomass with 16,804 gm/500 m^2 which is quite high when compared to the other survey stations though three other stations, namely: C/F6, C/F5 and C/F1 have registered highs of 2,373.621 gm/500 m^2, 2,291 gm/500 m^2 and 1,108 gm/500 m^2, respectively. The rest have biomass values of less than 500 gm/500 m^2 with Station C/F5 having 456.566 gm/500 m^2, Station C/F2 236.674 gm/500 m^2 and Station C/F3 164.948 gm/500 m^2.

For the major species there was no significant disparity in the distribution of major species on all the survey stations with Station C/F3 registering a high of 2,660 gm/500 m^2 and Station C/F7 the lowest at 548 gm/500 m^2. The rest of the station have biomass values between the registered high and low values for major species with very little difference between them. In the case of the Target species, biomass values were relatively high in almost all the survey stations with Station C/F7 having 5,097.375 gm/500 m^2, Station C/F6 with 3,779.398 gm/500 m^2, Station C/F5 with 2,579.151 gm/500 m^2, Station C/F3 with 1,381.299 grams/500 m^2. With lower biomass but still relatively high compared to most of the other groups were Station C/F1 with 906.319 grams/500 m^2, Station C/F2 with 834.792 grams/500 m^2 and C/F4 with 971.996 grams/ 500 m^2, respectively. As a whole, the recorded total biomass in the area ranged from 1, 835.913 to 7,827.68 grams/500 m^2. Higher biomass was recorded in Station C/F7 for all categorical groupings while lowest biomass was observed in Station C/F4 who reflected 0% in the coral cover survey. (**Figure 2-80**).

Comparing the result of fish biomass conducted last December 2019 to the previous survey on October 2019, June 2019 and March 2019 showed a declining biomass.

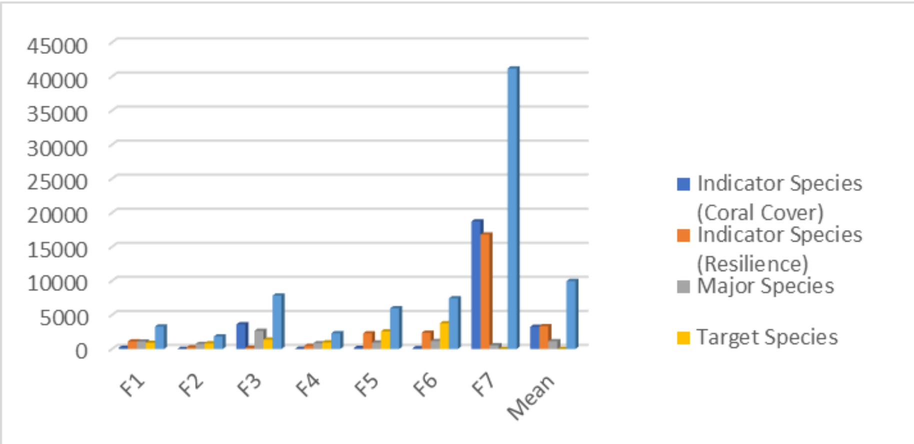


Figure 2-80: Biomass by Fish Category and Total Biomass of Fish Assemblages at the Seven Sampling Stations (December 2019)

Extrapolation of recorded actual biomass values to a set criteria of standard values based at number of individuals per 1000m^2 and biomass at metric tons per km^2 introduced by Hilomen *et al*. (2000), the estimated actual values recorded rated Very Poor to Moderate in fish density and Very Poor to High in fish biomass. It is only in the reef zones of Station C/F7 in San Salvador Island and Station C/F3 that fish population approached an acceptable level of moderate density while the rest of the survey stations reflected very poor fish density per square kilometer.

In the case of biomass recorded, estimated values as a result of the surveys showed that most of the survey stations rated Poor in biomass when compared to the standard values set by Hilomen *et al.* in metric tons per square kilometer. It is only in Station C/F7 that an acceptable level of biomass values was rated High in biomass while Station C/F2 having the lowest biomass value was rated Very Poor. (Table 2-45)

Table 2-45: Comparison of Extrapolated Fish Density and Biomass at the Seven Sampling Stations (October 2019)

Station	Extrapolated Density (Ind. /1000m^2)	Density Category (Hilomen et al., 2000)	Extrapolated Biomass (tons/km^2)	Density Category (Hilomen *et al.*, 2000)

1 - Intake area	398	Poor	6.58	Poor
2 - Between Intake and Outfall	168	Very Poor	3.67	Poor
3 - Outfall area	778	Moderate	15.65	Poor
4 - C - Square	372	Poor	4.60	Poor
5 - Buoy 7	290	Poor	11.94	Poor
6 - Oyon Point	466	Poor	14.86	Poor
7 - San Salvador Island	952	High	83.34	High

The poor density and biomass in the sampling stations could be explained by reduced habitat quality and complexity due to sedimentation and unregulated fishing activities. There could also be several ecological or environmental factors that are influencing the quality of fisheries in the bay.

On the other hand, seasonal recruitment and reproduction are maybe the factors contributing to the abundance and increase in fish density and biomass in Station C/F7 (San Salvador Island). This is because the highest number of fish species and greatest abundance of individuals tend to be associated with reef areas that provide the greatest topographical relief and structural complexity (Rogers, 1990) in combination with exposure, depth, and coral cover (Benfield *et al*., 2008). Sites with better topographic complexity have bigger surface area thus offers greater diversity and availability of niches, shelter and/or foraging zones. A combination of these factors redounds to the positive correlation of topographic complexity with species richness, total abundance, higher biomass and species diversity (Bejarano et al., 2011).

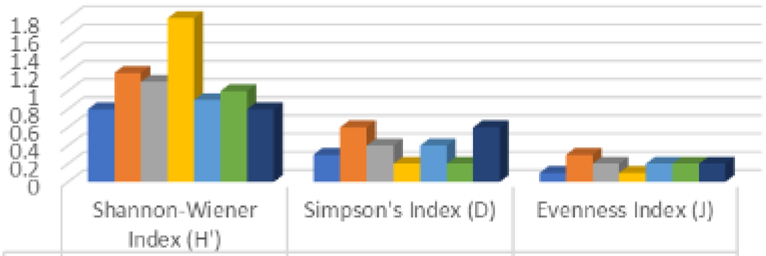
The low density of chaetodontids in the sampling stations may also reflect on the current condition of the underlying coral reefs. Coral-feeding chaetodontids were observed to be less abundant on disturbed reefs with low live coral cover than on reefs with high coral cover (Hourigan *et al.,* 1988 cited by Öhman *et al.,* 1997), which can serve as a measure of the degree of disturbance on coral reefs (Öhman *et al.,* 1997). Significant correlation between the number of individuals of certain species of butterflyfish with certain substrate components and an overall correlation with the percentage of living coral coverage had been detected (Temraza and Abou Zaid, 2005). Several studies have also documented positive relationships between the density of obligate corallivorous butterflyfish and coral cover of their preferred prey species (Rotjan and Lewis, 2008).

Species Diversity and Similarity Indices

Computations of biodiversity indices are included in this report to further describe the fish assemblages at the sampling stations. These indices provide empirical measures to assess change in biotic communities (Buckland *et al*., 2005; Hill *et al.,* 2005). Three commonly used indices such as Shannon index (H'), Simpson's index (D), and Evenness Index (J) were used in the analysis.

Data collected in December 2019 showed that Shannon Index (H') ranged from 0.8 to 1.8, Simpson Index ranged from 0.2 to 0.6 and Evenness Index value ranged from 0.1 to 0.2 88304. Diversity index value was consistently higher in Station C/F6 (Oyon Point), Station C/F7 (San Salvador Island) and Station C/F3 (Between

Intake and Outfall Area) (**Figure 2-81**).



	Shannon-Wiener Index (H')	Simpson's Index (D)	Evenness Index (J)
F1	0.8	0.3	0.1
F2	1.2	0.6	0.3
F3	1.1	0.4	0.2
F4	1.8	0.2	0.1
F5	0.9	0.4	0.2
F6	1.0	0.2	0.2
F7	0.8	0.6	0.2

Figure 2-81: Indices of Diversity for the Fish Assemblages at the Seven Sampling Stations (December 2019)

Bray-Curtis cluster analysis showed four distinct clusters and showed that Stations C/F7 (San Salvador Island) with its better coral reef relief manifests a significant difference when compared to the other stations. Stations C/F5 (Buoy 7) showed similarity to Station C/F3 (Outfall Area), while Station C/F2 (Between Intake and Outfall Area) showed distinct similarity to Station C/F1 (Intake Area). In addition, Station C/F6 (Oyon Point) showed significant similarity to Station C/F4 (C - Square) (Figure 2-82).

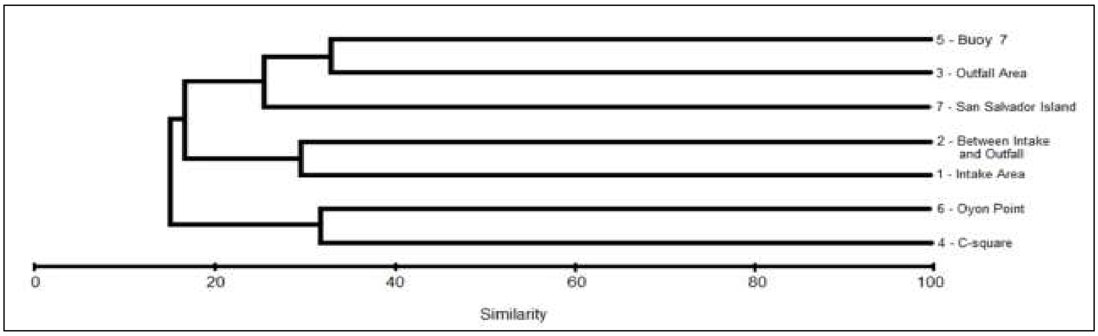


Figure 2-82: Dendogram Based on the Bray-Curtis Cluster Analysis of the Seven Sampling Stations (December 2019)

Reef Associated Macro-Invertebrates

Understanding species distributions and their community structure is increasingly important when taking an ecosystem-based approach to conservation and management. However, knowledge of the distribution and community structure of species in mid-range trophic levels (e.g. macroinvertebrates) is lacking in most marine ecosystems.

As ecologists move towards an ecosystem-based approach to spatial (e.g. Marine Protected Areas) and fisheries management (Lester et al. 2013), understanding species ranges and distributions is increasingly important (Airam et al., 2003; Lourie & Vincent 2004). Understanding the ranges of species at each trophic level within an ecosystem as well as how oceanographic variables influence those spatial distributions is essential information for proper management of marine resources (Smith & Jon 1999; Blanchette et al. 2009).

The inclusion of macroinvertebrates in the characterization of coral reef community structures is a common practice in reef assessment. However, data generated on this component is relegated to rudimentary analysis and poor utilization, as priority is given to the keystone species, the corals, or to the reef fish assemblage. Several macroinvertebrates like corals, zooanthids and sponges, being relatively sessile, are vulnerable to sudden and extreme environmental changes thus the need for a more comprehensive and holistic approach to examine changes in the assemblages of this biota in relation to changes in habitat structure.

Quantitative macroinvertebrate survey was conducted using a standardized comprehensive monitoring protocol using SCUBA. Stations covered were those established for the corals and fish visual census survey. Transects laid for coral and fish survey were also used for the conduct of the macroinvertebrate survey. Transect was modified as a transect belt one meter wide on both sides of the transect line. Macroinvertebrates encountered were identified down to the species level and counted as to the number of occurrences within the belt.

Marine invertebrates are those organisms that thrive in marine habitats. Invertebrate is a generic term applied to organisms without backbones and include all animals apart from animals with backbone, the vertebrates belonging to the phylum Chordata. Invertebrates lack a vertebral column and some have evolved a shell or a hard exoskeleton as protection against predation and other harmful events. As on land and in the air, marine invertebrates have a large variety of body plans, and have been categorized into over 30 phyla. They make up most of the macroscopic life in the oceans. Their value is more than emblematic though, as a wide variety of species is of significant ecological and economic importance. Many marine invertebrates are filter feeders meaning they siphon small food particles from the water column into their digestive systems.

Species Composition, Abundance and Occurrence

Marine invertebrates surveyed for the month of December 2019 in the seven (7) established monitoring stations within Oyon Bay recorded as having a total number of thirty (30) species belonging to twenty-six (26) Families. These macroinvertebrates identified are *Polycarpa aurata* (Styelidae), *Euplectella* sp. (Callyspongidae), *Lopha cristagali* (Ostridae), *Holothuria leucospilota* (Holothuroidae), *Tridacna* sp. (Tridacnidae), *Colobometra perspinosa* (Colobometridae), *Ectyoplasia ferox* (Raspailiidae), *Spirobrancchus giganteus* (Serpulidae), *Lambis truncata* (Strombidae), *Acanthaster planci* (Acanthasteridae), *Bohadschia graeffei* (Holothuroidae), *Choriaster granulatus* (Oreasteridae), *Protoreaster nodosus* (*Oreasteridae*), *Diadema setosum* (Diadematidae), *Heteractis magnifica* (Stichodactylidae), *Archaster typicus* (Asteroidea), *Synapta maculata* and *Opheodesoma* sp. (Synaptidae), *Linckia laevigata* (Ophidiasteridae), *Atrina pectinata* (Pinnidae), *Echinothrix sp* (Diadematidae), *Cerianthus sp.* (Cerianthidae) *Clavilena* sp. (Clavelinidae) and *Theonella swinhoei* (Theonellidae), *Conus nemone* (Conidae), *Trochus niloticus* (Trochidae), *Synaptula* sp. (Synapta), *Zygometra* sp. (Zygometridae), *Strombus* sp. (Strombidae), *Balanus balanoides* (Balanidae) (Table 2-46)

This survey result recorded was at least 30% higher than the October 2019 survey that recorded a total of 20 macroinvertebrates species belonging to 15 families. Except for a reduction in species observed during the June 2019 survey, a constant gradual increase in the number of macroinvertebrate species was recorded from October 2018 up to the last survey period of December 2019.

There was an apparent better distribution of species throughout all the stations surveyed with six (6) species found in all the survey stations. Of these six species, found most numerous is the species *Diadema setosum* with a counted population of 326 individuals in all the stations surveyed followed by the species *Clavelina sp*.

with 245, *Spirobranchus giganteus* with 126, *Colobometra perspinosa*. with 110, *Cerianthus* sp. with 95 and lastly, *linckia laevigata* with 52.

The highest number of species in the December 2019 survey was observed in Station MI1 with 25 species out of the 30 species recorded. This was followed by Stations MI6 and MI7 with 24 species each, Stations MI3 with 23 species, followed by Station MI5, with 21 species, Stations MI2 with 20 species and Station MI4 with 19 species each. Ten additional species was recorded in this particular survey period. These are the species *Polycarpa aurata, Trochus sp.*, *Conus nemone, Lopha cristagilli*, *Euplectella* sp*, Aplysina* sp., *Archaster typicus*, *Synaptula* sp., *Zygometra* sp., *Strombus* sp. and *Balanus balonoides*. In all reported surveys, the long spined black sea urchin (Diadema setosum) was found consistently in Stations C/F2, C/F1 and C/F4 while it is followed by the pen shell (*Atrina pectinata)* where it is abundant in Station C/F2 and C/F4.

A total of 11 macroinvertebrate species classified under four (4) major faunal groups were recorded in the June 2019 survey. The highest number was observed at Station MI5 with 6 species, followed by Station MI1 with 4 species, MI7 with 3 species and MI3, MI4 and MI6 with 2 species each. The least number was recorded at Station MI2 with 1 species only.

This recorded 11 species was much lower compared to the March 2019 survey that recorded a total of 14 species and even lower than the October 2019 survey that recorded a total of 20 species. Reduction in number of macroinvetebrate species observed in the June 2019 survey was attributed to the non-observance of the holothurians *Opheodesoma* sp. and *Holothuria coluber*, an unidentified red sponge and the sea anemone *Heteractis* sp. but recorded a green feather star *Comanthus* sp.2 as an additional new species to the previous listings.

Consistently, among the species of macroinvertebrates found most common on most of the reef transect stations was the long-spined black sea urchin (*Diadema setosum*). The survey of October 2019 was not able to observe this species on two survey stations, namely Stations MI3 and MI7. For the December 2019 survey, all stations recorded a large number of the *Diadema* species implying that there was an apparent high increase in species population in a matter of two months. This could possibly have been caused by massive spawning which usually occurs during full moon under favorable conditions. Kaplan (1982) reported that the long-spined black sea urchin seems to require coral reefs to hide in during the day. They begin to move toward a shadow, which represents the shelter of a crevice in the reef. During the present survey, *D. setosum* was observed spread in large areas in the reef slope and sheltering under corals and near rocky promontories in the deeper portion of the reef zone.

The pen shell *Atrina pectinata* was found most abundant in Station MI2 and in considerable number in Stations MI4 and MI1. This edible species usually occurs in areas of sand and mud in and around reefs, particularly on inshore areas rich in food for this filter feeding bivalve.

Plate 16: Macroinvertebrates Observed *In Situ* within the Seven (7) Reef Transect Stations

Blue sea star (*Linckia laevegata*) **Granulated sea star (*Choreaster granulatus*)**

Black Feather Star (*Colobometra perspinosa*) **Yellow feather star (*Comantheria* sp.)**

Black Sea Cucumber (*Holothuria leucospilota*) **Graeffe's Sea Cucumber (*Bohadschia graeffei*)**

COT starfish (*Acanthaster plancii*) **Octopus sponge (*Ectyoplasia ferox*)**

Christmas tree worms (*Spirobranchus gigantius*)

Giant clam (*Tridacna sp.*)

Spider conch shell (*Lambis truncata*)

Comb penshell (*Atrina pectinata*)

Long-spined sea urchin (*Diadema setosum*)

Horned starfish (*Protoreaster nodosus*)

Medusa sea cucumber (*Synapta maculata*)

Sea squirt (*Clavelina* sp.)

Tube sponge (*Theonella* sp.)

Tube anemone (*Cerianthus* sp.)

Worm sea cucumber (*Opheodesoma* sp.) **Sea anemone (*Heteractis* sp.)**

Sea squirt (*Clavelina* sp.) **Cock's comb oyster (*Lopha cristagalli*)**

Except for a reduction in species observed during the June 2019 survey due to the reason cited previously, a constant gradual increase in the number of macroinvertebrate species was recorded from December 2018 up to the last sampling period of December 2019.

Among the species of macroinvertebrates found most common and with 100% occurrence in all of the reef transect stations was the long-spined black sea urchin (*Diadema setosum*) which was observed and recorded on all survey stations. At the time of the survey the species *Diadema* was found most abundant in Stations MI2, MI1 and MI4. This sea urchin species was found less abundant at Station MI7 (**Table 2-46**). Kaplan (1982) reported that the long-spined black sea urchin seems to require coral reefs to hide in during the day. They begin to move toward a shadow, which represents the shelter of a crevice in the reef. During the present survey, *D. setosum* was commonly seen on reef slope and base sheltering under corals and rocks.

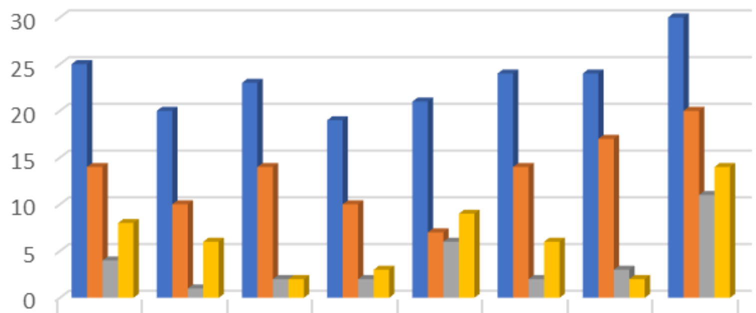
The pen shell *Atrina pectinata* was found most abundant in Stations MI2 and MI4. This edible species is usually found deeply embedded in areas of sand and mud around reefs, particularly on inshore areas rich in food for this filter feeding bivalve.

Other macroinvertebrates observed of with significant presence in all stations were the blue starfish *Linckia laevigata* and the horned starfish *Protoreaster nodosus.* The former was observed to be present in all survey stations but found more numerous at Stations MI2, MI1 and MI5 while the species *P. nodosus* was present in six of the seven station surveyed and more numerous in Station F2.MI

The crown-of thorns (COTs) starfish, *Acanthaster planci* was again observed at Station MI5 and even if found very low in terms of population density needs to be constantly observed considering its persistent presence in the same survey station for several survey periods already.

On the total of fourteen (14) macroinvertebrate species classified under five (5) major faunal groups recorded in the March 2019 survey, the highest was at Station MI5 where nine (9) species were recorded, followed by Station MI1 with eight (8) species, MI2 and MI6 with six (6) species each, and Station MI4 with three (3) species. The least was recorded at Stations MI3 and MI7 with two (2) species each (**Figure 2-83**).

The total visual count of macroinvertebrate species during this December 2019 survey at thirty (30) species was higher than the October 2019 survey which recorded only 20 species and much higher than the survey period of June 2019 with only 11 species listed, March 2019 with fourteen (14) species listed and December 2018 with sixteen (16) species. This increase in the number of macroinvertebrates species accounted may be caused by the prevailing state of the seawater at the time of the survey, maturity of previously spawned species or doing a closer observation in recording the number of species seen.



	MI1	MI2	MI3	MI4	MI5	MI6	MI7	Total
Dec-19	25	20	23	19	21	24	24	30
Oct-19	14	10	14	10	7	14	17	20
Jun-19	4	1	2	2	6	2	3	11
Mar-19	8	6	2	3	9	6	2	14

Figure 2-83: Number of Species per 100m^2 in Seven (7) Sampling Stations

Population Density

The marine macroinvertebrates in all survey stations totaled 1,883 individuals for all stations with a computed density of 269 ind/100m^2. Highest count is in Station MI2 with a total of 477 ind/100m^2 followed by Station MI1 with 324 ind/100m^2 then, in descending order, Stations M4 with 260 ind/100m^2, Station MI7 with 223 ind/100m^2, Station MI5 with 215 ind/100m^2, Station MI6 with 213 ind/100m^2 and Station MI3 with 171 ind/100m^2, respectively.

As observed by previous monitors, as well as, under the current monitoring activity, the long-spined black sea urchin (*Diadema setosum*) was observed to be the most abundant numbering 326 individuals and found in all the stations under monitor. The next found to be most abundant is the pen shell *Atrina pectinata* with 270 individuals counted in just three stations (MI1, MI2 and MI4). This was followed by the species *Clavelina* with a population count of 245 individuals and also found on all the seven stations surveyed. Other species found to be of significant populations were the species *Echinotrix* sp. with 149 individuals counted in five out of the seven stations, *Spirobranchus giganteus* with 126 individuals and *Colobometra perspinosa* with 110 individuals counted. The rest accounts for less than a hundred individuals for each species.

The pen shell *Atrina pectinata* or *Pinna pectinata*, is found to be most abundant in stations MI1, MI2 and MI4 in close association with the sea urchins. The species was not observed in Station MI3, MI5, MI6 and MI7. This edible species usually occurs in areas of sand and mud in and around reefs, particularly in inshore areas rich in food for this filter-feeding bivalve.

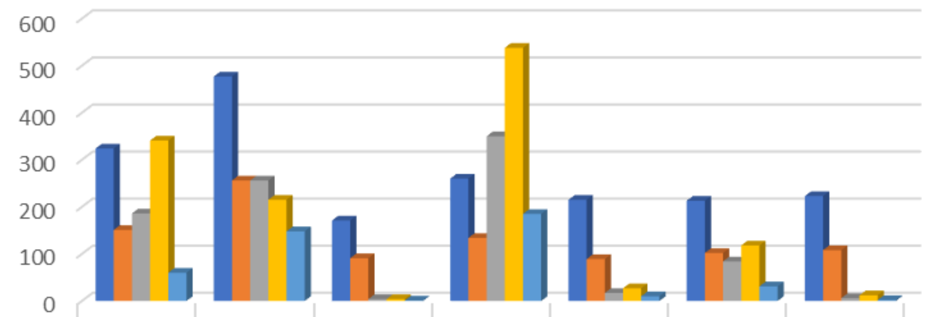
Other common macroinvertebrates observed were the blue starfish *Linckia laevigata* and the black feather star *Colobometra perspinosa* which were also observed in all monitoring stations accounting for a total of 63 and 44 individuals respectively. Others observed in considerable quantity also were the species *Spirobrancchus giganteus* and the sea squirt *Clavelina* sp. though their occurrence was not in all the monitoring stations (**Table 2-46**).

One species accounted in the survey of October 2019, the Banded Boxer Shrimp *Stinopus hispidus* was no longer observed during the December 2019 survey. Though not rare, the species is small, cryptic by nature and usually solitary so very difficult to detect.

Table 2-46: Tabulated List of Species Identified and Number of Individuals Counted/Species on Seven (7) Monitoring Stations (October 2019)

Species	Survey Stations							Total	Mean Density
	M1	M2	M3	M4	M5	M6	M7		
Polycarpa aurata	1		1	5	1	2	3	13	1.857
Euplectella sp.	1	1	1	1	4	2	1	11	1.571
Aplysina sp.	1		1	1	2		3	8	1.143
Trochus sp.		1		1	4	2		8	1.143
Conus nemone					3			3	0.429
Lopha cristagalli	1		2	2	2	1	1	9	1.286
Holothuria leucospilota	1	1	4		8	1	2	17	2.429
Colobometra perspinosa	11	22	18	5	1	22	31	110	15.714
Ectyoplasia ferox	2	10	2	4	2	3		23	3.286
Spirobranchus giganteus	24	21	9	5	8	34	25	126	18.000
Lambis truncata	3	4	4	1	10	2	3	27	3.857
Acanthaster planci	4		5		3	3	2	17	2.429
Bohadschia graeffei			2			1	2	5	0.714
Choriaster granulatus	1		7			3	4	15	2.143
Protoreaster nodosus	1	6	2		1	1	3	14	2.000
Diadema setosum	69	94	32	55	34	22	20	326	46.5714
Echinotrix sp.	84	22	4			23	16	149	21.286
Heteractis magnifica	3	2	1	1	5	8	10	30	4.286
Synapta maculata	2			22	53	12		89	12.714
Linckia laevigata	10	12	8	2	10	5	5	52	7.429
Atrina pectinata	49	143		78				270	38.571
Clavelina sp.	10	35	28	44	51	35	42	245	35.000
Cerianthus sp;.	18	27	10	3	1	9	27	95	13.571
Theonella swinhoei	2	1		6			3	12	1.714
Archaster typicus	5	2		17		3	9	36	5.143
Synaptula sp.	15	11	5	7		3	2	43	6.143
Zygometra sp.	4	3	23		7	13	5	55	7.857
Strombus sp.	2		1		5	3	3	14	2.000
Balanus balanoides		59						59	8.429
Tridacna sp.			1				1	2	0.286
Total	**324**	**477**	**171**	**260**	**215**	**213**	**223**	**1,883**	**269.00**
No. of Species	**25**	**20**	**23**	**19**	**21**	**24**	**24**	**30**	

Comparing the survey results of the three survey periods of March 2019, June 2019 and October 2019 to that of the December 2019 survey, one could observe that the survey of December 2019 showed a more proportional distribution of population in all the survey stations and a relatively high population count as compared to the previous surveys. Exception is Station MI2 whose population density was much higher than the others because of the major presence of the species *Diadema setosum.*

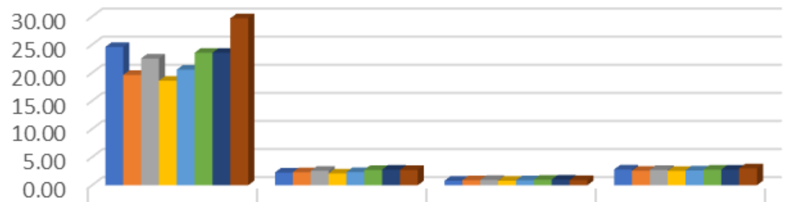


	MI1	MI2	MI3	MI4	MI5	MI6	MI7
Dec-19	324	477	171	260	215	213	223
Oct-19	151	256	91	134	89	102	108
Jun-19	186	256	4	350	17	84	6
Mar-19	341	215	4	538	27	118	12
Dec-18	60	148	1	185	10	31	2

Figure 2-84: Comparative Projection of Species Population Density of Seven Sampling/Survey Stations

<u>Species Richness, Species Diversity and Species Evenness</u>

The simplest variables which could be used in biological and ecological monitoring are the number of species, the species composition and the proportional abundance of the species. Species abundance or species richness is simply the total number of species present. It can be expressed as the number of species in a sample or habitat or could be expressed more usefully as species richness per unit area. Computations of biodiversity indices are included in this report to further describe the dynamics of the macrobenthic population in the survey areas. These indices can provide empirical measures to assess change in biotic communities (Buckland *et al*., 2005; Hill *et al.,* 2005). Applied in this report for the determijnation of species richness is Margalef's Index, for species diversity the Shannon-Wiener Index and for evenness the Shannon's Equitability Index.



	Species Richness	Species Diversity	Species Evenness	Hmax
MI1	24.60	2.275	0.81	2.82
MI2	19.63	2.332	0.90	2.59
MI3	22.55	2.571	0.94	2.73
MI4	18.59	2.087	0.82	2.54
MI5	20.57	2.339	0.89	2.64
MI6	23.57	2.735	0.98	2.78
MI7	23.57	2.788	1.00	2.78
Total	29.69	2.734	0.91	3.00

Figure 2-85: Diversity Indices for the Macrobenthic Assemblages at the Seven Survey Stations (December 2019)

Data collected in December 2019 showed that Species Richness using Margalef's Index was relatively balanced for all stations but slightly lower when compared to the indexed total number of species at 29.69. Lowest in species richness is Station MI4 with 18.59 and highest Station MI1 with 24.60. The rest of the stations were closely clustered in-between extremes.

On the other hand, Shannon-Wiener's Index (H') of diversity ranged from 2.087 to 2.788 for species occurrence in each station. This reflects that diversity among stations were closely similar with no apparent difference in species distribution and abundance. However, this measure is limited to the macrobenthics and does not consider other species in the ecosystem under survey. General diversity index is reflected as 2.734 for all 30 species encountered in all stations and stands slightly off with Stations MI6 and MI7 which showed slightly higher diversity indices with 2.735 and 2.788 respectively.

For the measure of evenness, figures ranged from 0.81 to 1.00 which in effect showed that diversity in all stations are approaching a balanced species distribution though not necessarily the same kind of species are represented in all stations.

2.3 The Air

2.3.1 Meteorology/Climatology

2.3.1.1 Change in the local micro-climate

Discussions on meteorology were lifted from the Air Dispersion Modeling Report (**Annex E**). Meteorological data used in the modeling are wind direction, wind speed, mixing height, and atmospheric temperature. Data from the PAGASA station at Cubi Point, Subic Bay, Olongapo City, Zambales and EMB data from Clark Air Force Base, Pampanga were used. **Table 2-47** and **Table 2-48**show the normals and the summary of wind frequency distribution at the PAGASA Subic station.

The Masinloc Plant facility is located in a Type I climate based on the Modified Coronas Classification of the Philippine Climate (**Figure 2-86**). A Type I climate has two pronounced seasons; dry from December to May and wet from June to September. Areas characterized by this climate type are generally exposed to the southwest monsoon.

The wind frequency data showed that the prevailing wind direction is in the North-East and South-West sectors with a prevailing wind speed range of one to four meters per second as shown in **Figure 2-87**.

The EMB data measured at the Clark Air Force Base (CAFB) showed that the prevailing wind direction is at the North-West sector and near due South (**Figure 2-88**).The data set included 12,048 hourly values of temperature, wind speed, wind direction, stability, and mixing heights from January 1, 2004 to December 8, 2005.

Table 2-47: Meteorological Normals at the Cubi Pt., Subic PAGASA Station (1992-2000)

Month	Rainfall		Temperature (°C)						Vapor Pressure (mbs)	Rel. Hum. (%)	MSLP (MBS)	Wind		Cloud Amount (okta)	No. Days w/	
	Amount (mm)	No. of RD	Max	Min	Mean	Dry Bulb	Wet Bulb	Dew pt.				Dir	SPD		TSTM	LTNG
Jan	4.1	2	31.0	22.4	26.7	26.1	21.7	19.8	22.9	68	1012.9	NNE	4	4	0	0
Feb	0.5	0	31.8	22.5	27.1	26.5	21.8	19.8	22.9	66	1012.9	NE	4	4	0	0
Mar	13.3	3	33.3	23.4	28.4	27.7	22.8	20.8	24.4	66	1011.6	NE	4	4	0	1
Apr	13.1	3	34.2	24.7	29.4	28.9	24.0	22.2	26.5	66	1010.7	NE	3	4	2	3
May	544.1	13	32.8	24.9	28.8	28.5	24.8	23.5	28.7	74	1009.2	SW	3	5	11	7
Jun	308.1	15	31.9	24.8	28.3	28.1	25.1	24.1	29.8	78	1009.5	SW	3	6	10	10
Jul	781.2	22	30.8	24.3	27.5	27.3	24.6	23.6	29.1	80	1008.2	SW	3	7	10	11
Aug	754.6	21	30.7	24.3	27.5	27.2	24.4	23.4	28.6	79	1009.1	SW	3	6	11	10
Sep	801.7	22	30.4	24.1	27.2	26.8	24.5	23.7	29.1	83	1008.9	SW	3	7	10	7
Oct	338.4	15	31.5	24.2	27.8	27.4	24.5	23.5	28.7	79	1009.5	NNE	3	6	6	7
Nov	100.0	9	31.5	24.0	27.8	27.4	23.8	22.5	27.0	74	1010.2	NNE	3	5	2	3
Dec	27.2	6	30.8	23.3	27.0	26.5	22.3	20.6	24.0	69	1011.7	NNE	4	5	0	0
Annual	3686.4	131	31.7	23.9	27.8	27.4	23.7	22.3	26.8	74	1010.4	SW	3	5	62	59

Source: PAGASA

Table 2-48: Summarized Wind Frequency Data Used in the Modeling (1994-2003)

Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
N	0	1.2	3.6	6.7	3.9	3.7	2.8	4.3	5.3	4.2	1.3	0	3.1
NNE	26.9	20.5	18.6	13.3	9.3	13.3	9.7	7.2	4.3	15.8	19.7	26.5	15.4
NE	22.2	22.4	20.7	16.7	7.9	10.4	9.3	8.6	3.6	10.6	17.7	24.8	14.6
ENE	28.7	22.9	26.6	19.3	13.9	13.7	7.9	7.5	11.3	25.5	32	27.1	19.7
E	17.5	24.4	19	23	9.7	7.4	2.5	6.1	10.7	21	24	19.4	15.4
ESE	0.7	0.4	0.4	1.9	1.8	0.4	0	0.7	1	0.3	0.7	1	0.8
SE	0.7	0.7	0	0.7	0.7	1.5	1.1	0.4	2	0.3	0	0	0.7
SSE	0	0.7	1.1	0.3	1.1	0.7	1.4	0.4	2.7	0.3	0.3	0.3	0.8
S	0	0.4	0	0.4	2.5	4.1	6.8	7.2	6.3	2.3	1.3	0	2.6
SSW	0.7	2	2.5	1.5	9.7	9.6	13.3	18.6	12.7	4.2	1	0	6.3
SW	1.8	2	5.7	9.3	26.9	28.9	36.6	22.2	23.1	8.4	1	0.3	13.9
WSW	0.4	0.8	1.4	3.7	8.6	2.2	2.1	11.8	11.3	2.6	0	0	3.7
W	0	0	0	0	1.4	1.1	2.1	1.4	0.3	0.3	0	0	0.6
WNW	0	0	0	0.3	0.8	1.5	0.4	0.7	0.7	0.3	0	0	0.4
NW	0	0.8	0.4	0.3	0.7	0	1.1	0.4	1.7	1.6	0	0	0.6
NNW	0.4	0.8	0	1.9	1.1	1.5	2.9	1.8	3	2.3	1	0.6	1.4
Source: PAGASA													
Calm	1	0.4	0.9	0.2	0.5	1.4	1.1	0.5	0.4	1	1.6	1.6	0.9
1-4	99	99.3	98.9	99.8	99.4	98.6	98.9	99.5	99.4	99	98.3	98.4	99.1
5-8	0	0.2	0.2	0	0.1	0	0	0	0.2	0	0.1	0	0
8-12	0	0.1	0	0	0	0	0	0	0	0	0	0	0
13-16	0	0	0	0	0	0	0	0	0	0	0	0	0
>16	0	0	0	0	0	0	0	0	0	0	0	0	0

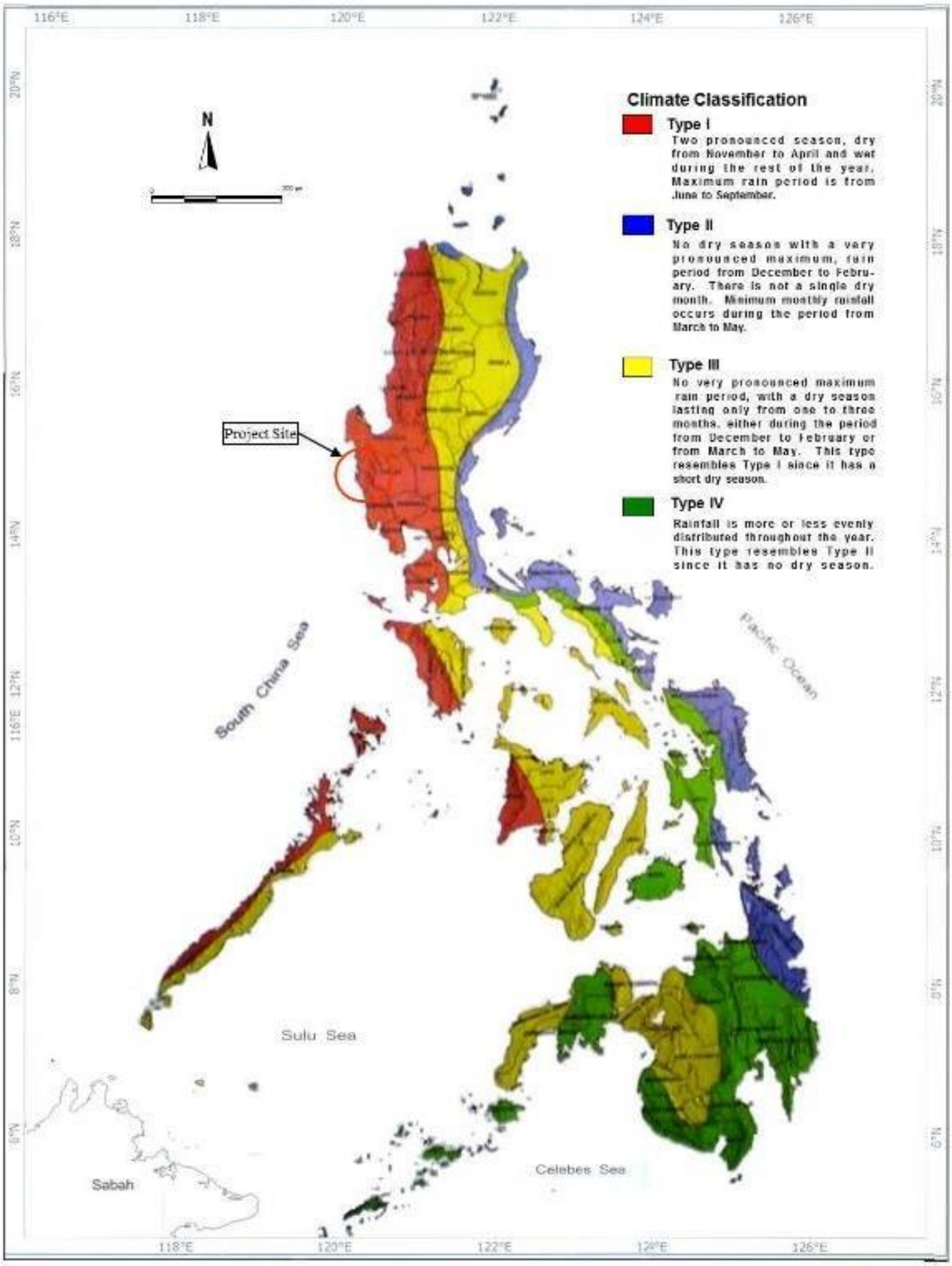
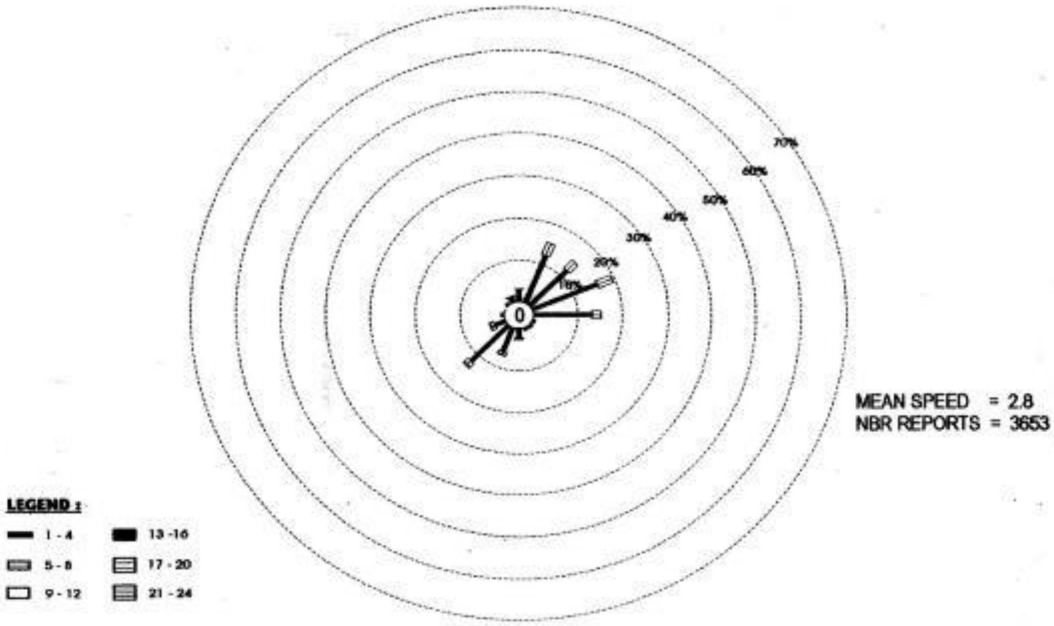


Figure 2-86: Climate Map of the Philippines



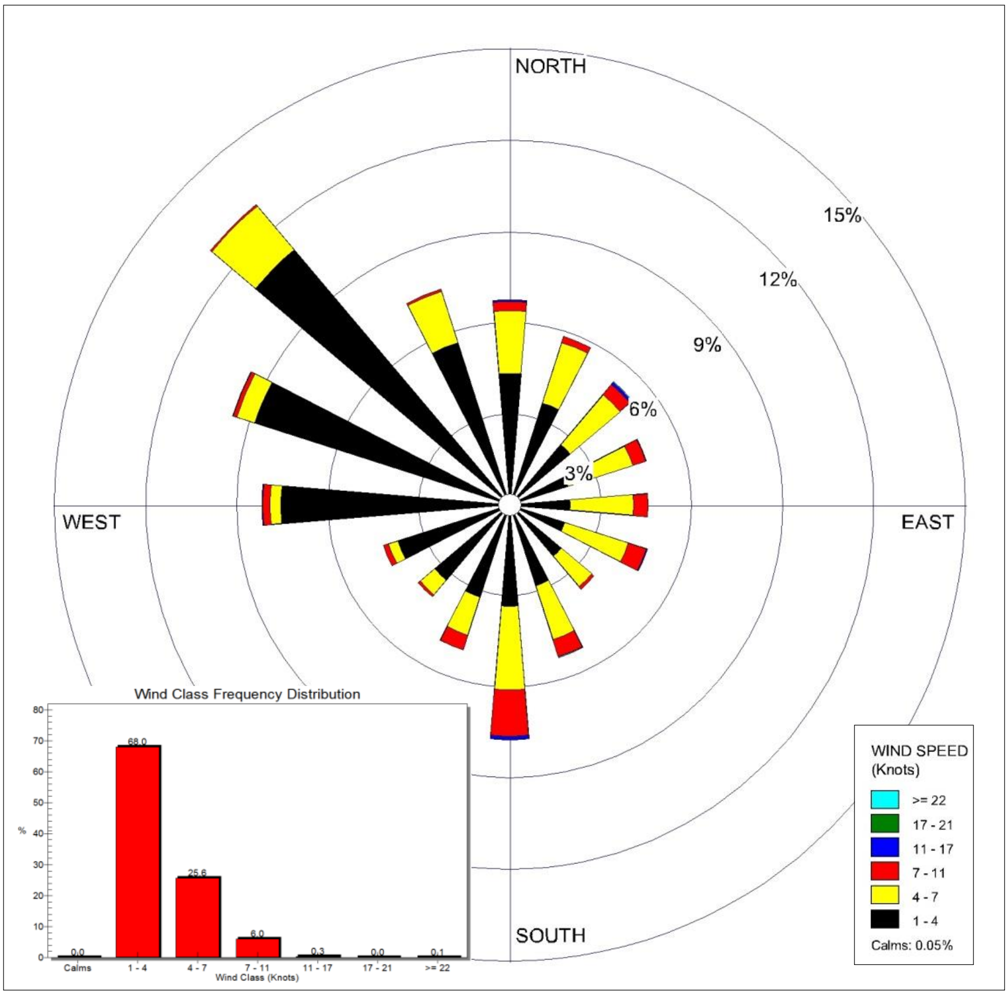
FREQUENCY TABLE

Cubi Point, Subic, Olongapo
Wind Speed and Direction
(1994 - 2003)

SPEED (mps)	DIRECTION																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM																	0.1
1 - 4	3.0	12.4	11.8	16.1	13.2	0.7	0.7	0.8	2.1	6.1	12.1	2.7	0.6	0.4	0.6	1.4	83.7
5 - 8	0.1	3.1	2.7	3.6	2.2	0.0	0.0	0.0	0.4	0.9	1.1	0.9	0.0	0.0	0.0	0.1	15.1
9 - 12	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.5	0.2	0.0	0.0	0.0	0.0	1.1
TOTAL	3.1	15.5	14.5	19.8	15.4	0.7	0.7	0.8	2.6	6.2	13.7	3.8	0.6	0.4	0.6	1.4	100.0

Source: PAGASA

Figure 2-87: Annual Windrose at the Cubi Pt., Subic PAGASA Station (1994-2003)



Source: Generated by WRPlot 5

Figure 2-88: Windrose of CAFB Data (2004-2005)

2.3.2 Air Quality and Noise

2.3.2.1 Degradation of Air Quality

2.3.2.1.1 Ambient Air Quality

Figure 2-89 to Figure 2-91 show the plot of the measured NOX (as NO2) and SOX (as SO2) from January 1, 2015 to September 30, 2020 using CEMS at the stacks of Units 1, 2, and 3. Measured one-hour average stack gas concentrations of SOX and NOX were generally within the emission standards for existing sources set at 1500 mg/Nm3 (797.3 ppm) for NOX (as NO2) and 1500 mg/Nm3 (573.05 ppm) for SOX. (as SO2). As per MPPCL, there were values greater than the said emission standards at Units 1 and 2 due to equipment malfunction or the need for calibration and when the unit is on start up

For Unit 3, which is categorized as a new source, measured stack gas concentrations (one-hour average) were all within the emission standard set at 1000 mg/Nm3 (or 531.52 ppm) for NOX and 700 mg/Nm3 (or 267.42 ppm) for SOX (Figure 2-91).

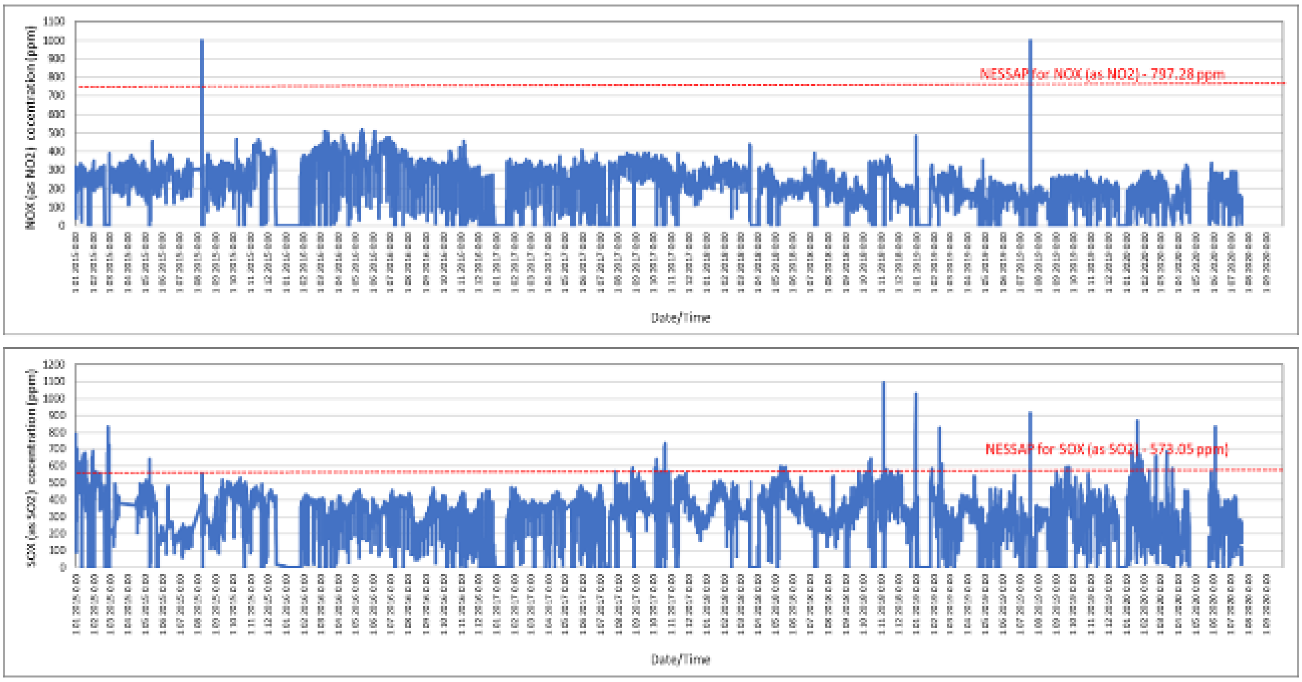


Figure 2-89. Plot of measured NO_X (as NO_2) (above) and SO_X (as NO_2) (below) using CEMS at the stack of Unit 1

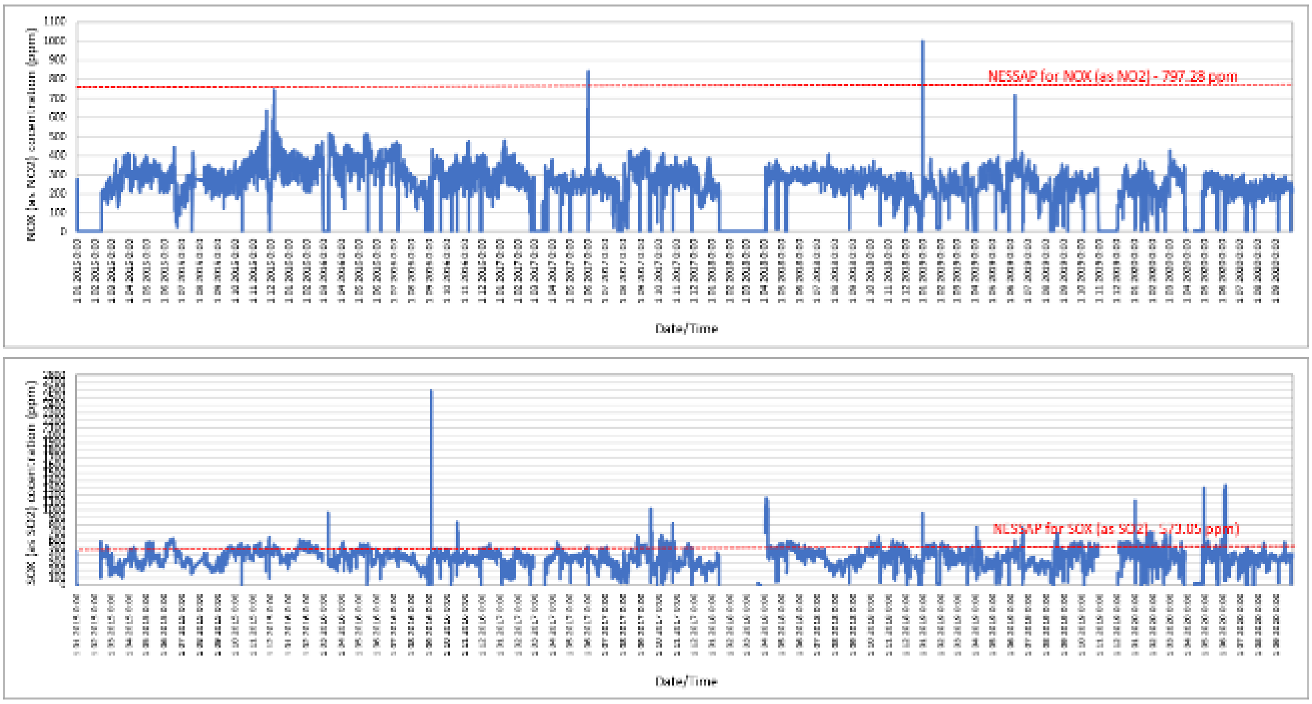


Figure 2-90. Plot of measured NO_X (as NO_2) (above) and SO_X (as NO_2) (below) using CEMS at the stack of Unit 2

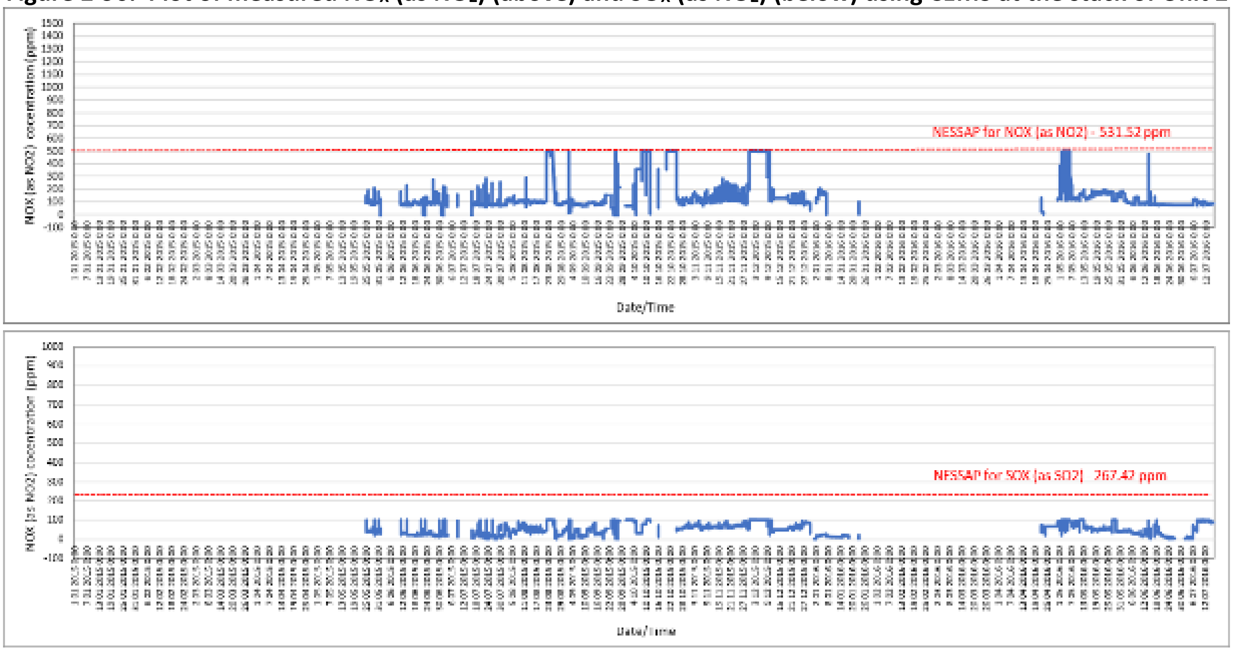


Figure 2-91. Plot of measured NO_X (as NO_2) (above) and SO_X (as NO_2) (below) using CEMS at the stack of Unit 2

2.3.2.1.2 Impact Assessment and Mitigation Measures

The main objective of the air dispersion modelling for this project is to check (or demonstrate) if the dispersed emissions at the breathing zone emanating from the existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) comply with the National Ambient Air Quality Values (NAAQG), pursuant to Section 3, Rule X of DENR AO No. 2000-81 (or DAO 2000-81)(**Plate 2-17)**. DAO 2000-81 is the implementing rules and regulations (IRR) of the Philippine Clean Air Act (PCAA) of 1999. The ambient air quality guideline values (NAAQG) are shown in Table **2-49**.

Section 3. Increment Consumption

No new source may be constructed or existing source modified if emissions from the proposed source or modification will, based on computer dispersion modeling, result in;

Exceedance of the National Ambient Air Quality Guideline Values; or
An increase in existing ambient air levels above the levels shown below

PM-10, annual arithmetic mean	17 micrograms per cubic meter
PM-10, 24-hr maximum	30 micrograms per cubic meter
Sulfur Dioxide, annual arithmetic mean	20 micrograms per cubic meter
Sulfur Dioxide, 24-hr maximum	91 micrograms per cubic meter
Nitrogen Dioxide, annual arithmetic mean	25 micrograms per cubic meter

In the case of multiple point sources at a single facility, the net emissions from all affected sources shall be included in a single increment analysis.

Plate 2-17. Dispersion modelling requirement for proposed sources or existing sources with modification (Source: Section 3, Rule X of DAO 2000-81)

Table 2-49. National Ambient Air Quality Guideline Values (NAAQGV) for TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3, and Pb

Pollutants	Short-term Concentration[a]			Long Term Concentration[f]		
	$\mu g/Nm^3$	ppm	Averaging Time	$\mu g/Nm^3$	ppm	Averaging Time
Total Suspended Particulates (TSP)[b]	230	-	24 hours	90	-	1 year[g]
Suspended particulates 10 microns or lesser (PM_{10})[bc]	150	-	24 hours	60	-	1 year[g]
Sulfur dioxide (SO_2)[b]	180	0.07	24 hours	80	0.03	1 year
Nitrogen dioxide (NO_2)	150	0.08	24 hours	-	-	-
Other air pollutants	Table 1 of DAO 2000-81					

[a] Maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year.

[b] SO_2 and Suspended Particulate matter are sampled once every six days when using the manual methods. A minimum of twelve sampling days per quarter or forty-eight sampling days each year is required for these methods. Daily sampling may be done in the future once continuous analysers are procured and become available.

[c] Provisional limits for PM_{10} until sufficient monitoring data are gathered to base a proper guideline.

[d] As per DAO No. 2013-13: "Establishing the Provisional National Ambient Air Quality Guideline Values for Particulate Matter 2.5 ($PM_{2.5}$)", NAAQGV for $PM_{2.5}$ (24 hours) was upgraded from 75 $\mu g/Nm^3$ to 50 $\mu g/Nm^3$ on January 1, 2016.

[e] Evaluation of this guideline is carried out for 24-hour averaging time and averaged over three moving calendar months. The monitored average value for any three months shall not exceed the guideline value.

Pollutants	Short-term Concentration[a]			Long Term Concentration[f]		
	µg/Nm³	ppm	Averaging Time	µg/Nm³	ppm	Averaging Time

[f] Arithmetic mean.

[g] Annual geometric mean

2.3.3 Air Dispersion Modeling

Figure 2-92 shows the process flow in air dispersion modelling. Dispersion modelling involves use of preprocessors to process the terrain (topography), meteorological data, and building dimensions (heights and widths), which were consequently used as input to the dispersion model.

The source inputs are the information or data related to the locations and heights of the stacks (existing and proposed units) and the emission rates. The other model inputs are the a) building dimensions and heights, b) receptor coordinates, elevation, and hill heights, and c) meteorological data.

A license AERMOD View Air Dispersion Model (Version 9.9.0) with Serial No. AER0006927 was used to predict the dispersion of air emissions emanating from project (existing and proposed sources). AERMOD View is Graphical User Interface (GUI) software for U.S.EPA's AERMOD, which was developed by the American Meteorological(AMS/U.S.EPA Regulatory Model Improvement Committee (AERMIC). It is one of the regulatory models prescribed in the DENR MC 2008-003 (Guidelines for Air Dispersion Modelling)

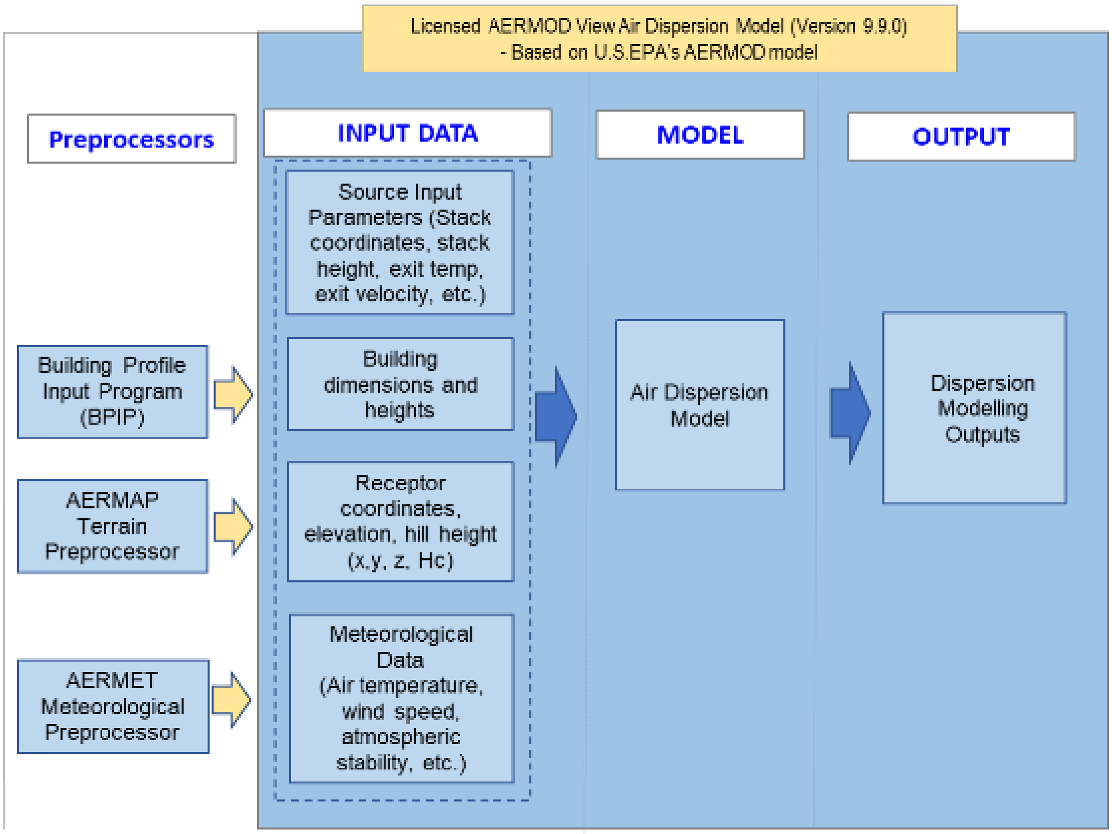


Figure 2-92. Dispersion modelling process

2.3.3.1 Model Input Data

Table 2-50 show the summary of the model input data. The details of the model inputs are discussed in detail in the subsequent sub-sections. .

Table 2-50 . Summary of model input data

	Particular	Details
1	Source input parameters	
	Source Location (x, y, and z coordinates, and stack or release height)	• Stack locations for the existing and proposed stacks were based on data provided MPPCL, i.e., site development plan and coordinates • Base elevations for each stack including the stack heights were provided by MPPCL. **Annex A1** shows the elevation drawing of the stack for Unit 1 and Unit 2 • Plate **2-18** shows the stack coordinates, base elevations and release heights (stack heights)
	Source release parameters (emission rates of SO_2, NO_2, TSP and CO, stack inside diameter, stack gas temperature and stack gas exit velocity)	• Emission rates (in g/sec) for the existing stacks were a) based on stack sampling results from 2015 to 2019, which were conducted by DENR-accredited stack testing firms (Table **2-51**,Table **2-52**, and Table **2-53** and **Annex A3**, **Annex A4**, and **Annex A-5** for Units 1, 2, and 3, respectively, and b) CEMS data for 2020 **(Table 2-54** for SO_X as SO_2, **Table 2-55** for NO_X as NO_2 • Emission rates (in g/sec) for the proposed stacks were a) based on guaranteed emission values of the contractor/supplier and the MPPCL, and b) emission limits (NESSAP) of the air pollutants [NO_X as NO_2, SO_X as SO_2, particulates, and CO]. (**Table 2-56,**Plate 2-19**, and Plate 2-20** for the guaranteed emissions) **and Annex A-4** (computation spreadsheets) • Other source inputs (stack gas temperature and stack exit velocity) for the proposed sources (Unit 4 and Unit 5) were based on Unit 3 stack testing results
2	Building dimensions and heights	Based on data provided by MPCCL. **Annex A** shows the dimensions of the buildings. **Table 2-57** shows the details of the building input parameters .
3	Receptor coordinates, elevation and hill heights (x, y, z, Hc)	Based on Shuttle Radar Topography Mission (SRTM) data, as downloaded using the terrain preprocessor (named AERMAP View) of AERMOD View
	a) Multi-tier	Total of three (3) tiers: • 20 m at 1000 m from centroid of stacks • 100 m from 1000 m to 5000 m from the centroid of stacks • 200 m grid spacing from 5000 to 10000 m from centroid of stacks (Figure **2-98** shows the multi-tier grid)
	b) Discrete Cartesian Receptors	Assigned ten (10) discrete receptors in vicinity of the project site
	c) Plant boundary	Assigned along the property boundaries
	d) Receptor height	2 m above ground level
4	Meteorological Data	Based on prognostic meteorological data covering the period 2007 to 2009 (three years of prognostic meteorological data), which were purchased on-line from Lakes Environmental Software, Inc. based in Canada

2.3.3.1.1 Source Input Parameters

a) Stack locations, stack heights, and stack diameters

Plate **2-18** shows the stack coordinates, base elevations and release heights (stack heights) of the existing sources (Units 1, 2, and 3) and the proposed sources (Units 4 and 5). The locations of the stacks are shown in **Figure 2-93** and **Figure 2-94** for the existing and the existing and proposed sources, respectively. A three-dimensional view of the emission sources and building tiers is shown in **Figure 2-95**.

The plots of the proposed sources were based on the site development plan provided by the MPPCL, which was superimposed or imported in AERMOD View (Figure **2-96**). Nearby receptors or households are generally located the N-E and S-E quadrant of the proposed project site.

#	Source ID	Source Type	X Coord. [m]	Y Coord. [m]	Base Elevation	Release Height [m]	Description
1	STCK1	POINT	813560.00	1722982.00	3.5	150	Unit 1- Existing stack
2	STCK2	POINT	813564.75	1722982.00	3.5	150	Unit 2 - Existing stack
3	STCK3	POINT	812980.00	1722860.00	5	150	Unit 3 - Existing stack
4	STCK4	POINT	812971.76	1722896.68	5	150	Unit 4- Proposed stack
5	STCK5	POINT	812845.13	1723165.22	15	150	Unit 5 - Proposed stack

Plate 2-18. Screenshot of source locations and heights

b) Emission Rates and Other Source Input Parameters

Emission rates for the existing stacks were based from a) stack sampling results from 2015 to 2019 2020 (Table **2-51**, Table **2-52**, and Table **2-53**), which were conducted by DENR-accredited stack testing firms, and b) CEMS data for 2020 (Table **2-54** and Table **2-55**). The data plots and computation worksheets are presented in **Annex A3**, **Annex A4**, and **Annex A-5** for Units 1, 2, and 3, respectively.

The emission rates for the proposed stacks were a) based on guaranteed emission values of the contractor/supplier and the MPPCL, and b) emission limits (NESSAP) of the air pollutants [NO_X as NO_2, SO_X as SO_2, particulates, and CO] (Table **2-56**). The other source inputs, such as the stack gas temperatures and stack exit velocities, for the proposed sources (Unit 4 and Unit 5) were based on Unit 3 stack testing results.

The guaranteed emission values for the proposed sources were based on agreement/contract between the MPPCL and the contractor/supplier. Plate **2-19** and Plate **2-20** show the guaranteed emission limit for the proposed Unit 4 , which are also the guaranteed limits for Unit 5 as per MPPC. Note that the guaranteed emissions concentrations were lower than the emission standards (NESSAP) stipulated in the Philippine Clean Air Act (PCAA) of 1999 and its implementing rules and regulations (DAO 2000-81).

Annex A4 shows the computation spreadsheets for the proposed sources (Units 4 and 5).

Table 2-51. Statistics of source input parameters for Unit 1 (Stack 1) based on results of 3rd party stack testing from 2005 to 2009[1]

Parameters[4]	Unit	Minimum	Maximum	Average	98th percentile
SO_X (as SO_2)	g/s	392.381	606.138	459.015	**589.790**
NO_X (as NO_2)	g/s	25.800	67.738	39.568	**65.050**
Particulate Matter	g/s	2.197	15.000	6.816	**14.740**
CO	g/s	12.382	132.700	58.590	**130.577**
Mercury (Hg)	g/s	Mercury	0.000	0.014	0.002
Gas exit temperature	ºC	132.0	170.9	**158.4**	169.8
Gas exit velocity	m/s	19.4	27.4	**22.7**	26.7
Actual volumetric flow rate[2]	accm	27596.394	39020.000	32339.855	38079.671
Normal volumetric flow rate[3]	dccm	18207.940	29982.097	22205.473	29282.221
Normal volumetric flow rate	Nm^3/s	303.466	499.702	370.091	488.037

Notes:
[1] Conducted by DENR-accredited 3rd party monitoring companies
[2] accm = actual cubic meter per minute
[3] dccm = normal cubic meter per minute
[4] Stack diameter = 5.5 m (provided by MPPCL)
[5] Stack base elevation = 3.5 m (provided by MPPCL)

Table 2-52. Statistics of source input parameters for Unit 2 (Stack 2) based on results of 3rd party stack testing from 2015 to 2019[1]

Parameters[4]	Unit	Minimum	Maximum	Average	98th percentile
SO_X (as SO_2)	g/s	550.421	353.456	564.038	**444.720**
NO_X (as NO_2)	g/s	76.463	1.520	78.739	**43.170**
Particulate Matter	g/s	14.256	0.042	15.361	**4.820**
CO	g/s	354.022	10.059	398.000	**86.425**
Mercury (Hg)	g/s	0.245	0.000	0.249	**0.049**
Gas exit temperature	ºC	168.77	136.0	170.4	**153.2**
Gas exit velocity	m/s	23.32	17.7	23.3	20.5
Actual volumetric flow rate[2]	accm	49088.153	984.5	52578.3	28101.1
Normal volumetric flow rate[3]	dccm	42310.684	877.8	46929.1	19963.0
Normal volumetric flow rate	Nm^3/s	705.178	14.6	782.2	332.7

Notes:
[1] Conducted by DENR-accredited 3rd party monitoring companies
[2] accm = actual cubic meter per minute
[3] dccm = normal cubic meter per minute
[4] Stack diameter = 5.5 m

Table 2-53. Source input parameters for Unit 3 (Stack 3) based on results of 3rd party stack testing in 2019[1]

Parameters[2]	Unit	Value
SO_x (as SO_2)	g/s	23.952
NO_x (as NO_2)	g/s	24.893
Particulate Matter	g/s	5.257
CO	g/s	6.732
Mercury (Hg)	g/s	0.003
Gas exit temperature	ºC	86.8
Gas exit velocity	m/s	14.4
Stack diameter	m	5.7
Actual volumetric flow rate	accm	22117.520
Normal volumetric flow rate	dccm	17262.727
Normal volumetric flow rate	Nm^3/s	287.712
Notes: [1] Conducted by DENR-accredited 3rd party monitoring company		

Table 2-54. SO_x (as SO_2) emission rates for Units 1, 2, and 3 based on CEMS data for 2020

Unit No.	Conc (ppm)	Conc (mg/Nm^3)	Normal Flow Rate (Nm^3/s)	Emission Rate (g/s)
Unit 1	552.331	1445.774	370.09	535.068
Unit 2	569.463	1490.619	332.72	495.953
Unit 3	100.091	261.997	287.71	75.380

Table 2-55. NO_x (as NO_2) emission rates for Units 1, 2, and 3 based on CEMS data for 2020

Unit No.	Conc (ppm)	Conc (mg/Nm^3)	Normal Flow Rate (Nm^3/s)	Emission Rate (g/s)
Unit 1	286.473	538.968	370.09	199.467
Unit 2	343.783	646.790	332.72	215.197
Unit 3	501.007	942.590	287.71	271.195

Table 2-56. Source input parameters for Unit 4 (Stack 4) and Unit 5 (Stack 5)

		Option 1		Option 2	
Parameters[2]	**Unit**	**Value**	**Remarks**	**Value**	**Remarks**
SO_x (as SO_2)	g/s	57.255	Computed based on guaranteed emission values	201.398	Computed based on emission limits or NESSAP values and normal volumetric flow of Unit 3 (Stack 3)
NO_x (as NO_2)	g/s	129.183		287.712	
Particulate Matter	g/s	14.098		43.157	
CO	g/s	143.856		143.856	
Mercury (Hg)	g/s	2.589		2.589	Computed based on guaranteed values and normal volumetric flow of Unit 3 (Stack 3)
Gas exit temperature	ºC	86.8	Based on stack test results from Unit 3	86.8	Based on stack test results from Unit 3
Gas exit velocity	m/s	14.4		14.4	
Stack diameter	m	5.7	Design stack diameter (provided by MPPCL)	5.7	Design stack diameter (provided by MPPCL)

2-5 Emission (100% coal firing based on 6% O_2 in dry exhaust gas at stack inlet)

NOx	≤ 450 mg/Nm³ (219 ppm) (Without SCR, by low NOx burner)
	≤ 144 mg/Nm³ (70 ppm) (If with SCR, as option)
	(Philippines standard :1,000 mg/Nm³)
SOx	≤ 200 mg/Nm³ (70 ppm)
	(Philippines standard : 700 mg/Nm³)
Particulate	≤ 50 mg/Nm³ Expected Value (By ESP)
	(Philippines standard 150 mg/Nm³)
CO	≤ 500 mg/Nm³

Note : Above emission is compliant with Philippines Clean Air Act emission standard.

Plate 2-19. Guaranteed stacks emissions of the proposed Unit 4

Reference File:
Onshore Construction Contract_03102020_Appendices (Memo after meeting on 0703 & 0706 & 0709 2020)_LBA04152020_JBG05252020

MASINLOC POWER PLANT EXPANSION PROJECT

[1 X 315MW (NET) COAL FIRED POWER PROJECT]

AT BARANGAY BANI, MASINLOC, ZAMBALES, THE PHILIPPINES

LUMP SUM CONSTRUCTION CONTRACT

BETWEEN

MASINLOC POWER PARTNERS CO., LTD.

AND

TRUE NORTH MANUFACTURING SERVICES CORPORATION

dated as of ______________

SDC_IMANAGE\23581\373004\90913.v9-11/30/15

2.2. Emissions Guarantees

Contractor shall, at a minimum, meet the requirements for Unit 4's air emissions set forth in Section 2.2.1 and Unit 4's and the Facility's liquid effluent set forth in Section 2.2.2 when firing Coal as specified in Table A-2 of this Appendix A. Compliance with each of the requirements set forth in this Section 2.2 is mandatory; hence, there are no Buydown Amounts or other liquidated damages.

2.2.1. Air Emissions Guarantees

Pollutant	Maximum Permissible Limit (see Note 4)	IFC Limits	Guarantee Values
Flue Gas Temperature after Gas-Gas Heater			>80 °C (See Note 6)
Total Particulate Matter	150 mg/NCM	50 mg/Nm^3 (see notes 1, 2 & 3)	50 mg/Nm^3 (See Notes 1, 2 & 3)
Sulfur Dioxide (SO_2)	700 mg/NCM as SO_2	200 mg/Nm^3 (see notes 1, 2 & 3)	200 mg/Nm^3 (See Notes 1, 2 & 3) as SO_2
Nitrogen Oxides (NOx)	1000 mg/NCM as NO_2	510 mg/Nm^3 as NO_2 (see notes 1, 2 & 3)	450 mg/Nm^3 as NO_2 (See Notes 1, 2 & 6) as NO_2
Opacity	20%		20%
Carbon-monoxide (CO)	500 mg/NCM as CO		500 mg/NCM as CO

Notes for Table:

[1] IFC Environment, Health, and Safety Guidelines for Thermal Power Plants – December 19, 2008 define normal conditions for Nm^3 as 0°C and 1 atmosphere of pressure.

[2] All pollutant concentrations for coal firing are to be corrected to 6% oxygen, dry basis.

SDC_IMANAGE\23581\373004\90913.v9-11/30/15

Plate 2-20. Guaranteed stacks emissions of the proposed Units 4

Figure 2-93. Locations of existing stacks

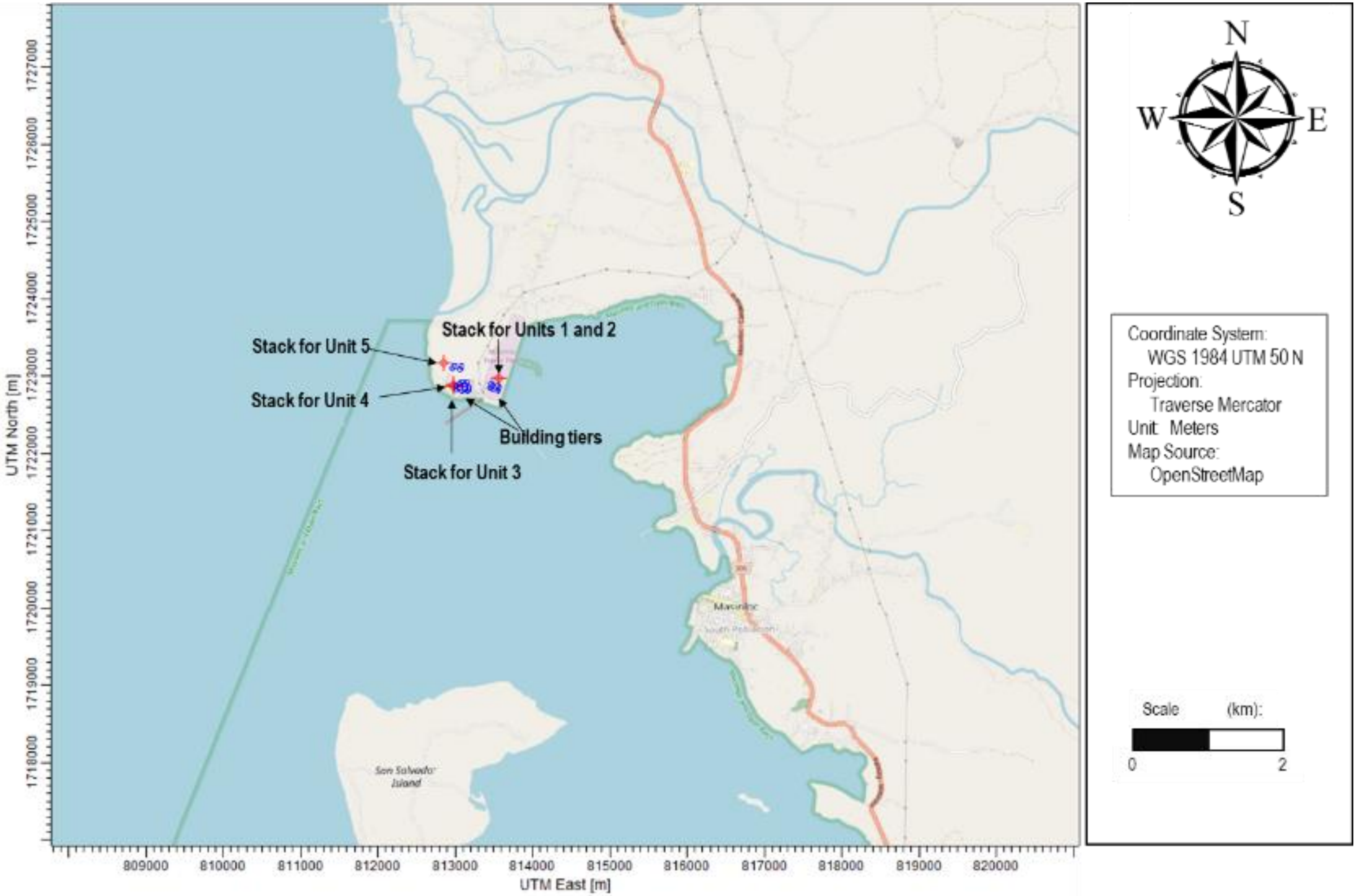


Figure 2-94. Locations of existing and proposed stacks

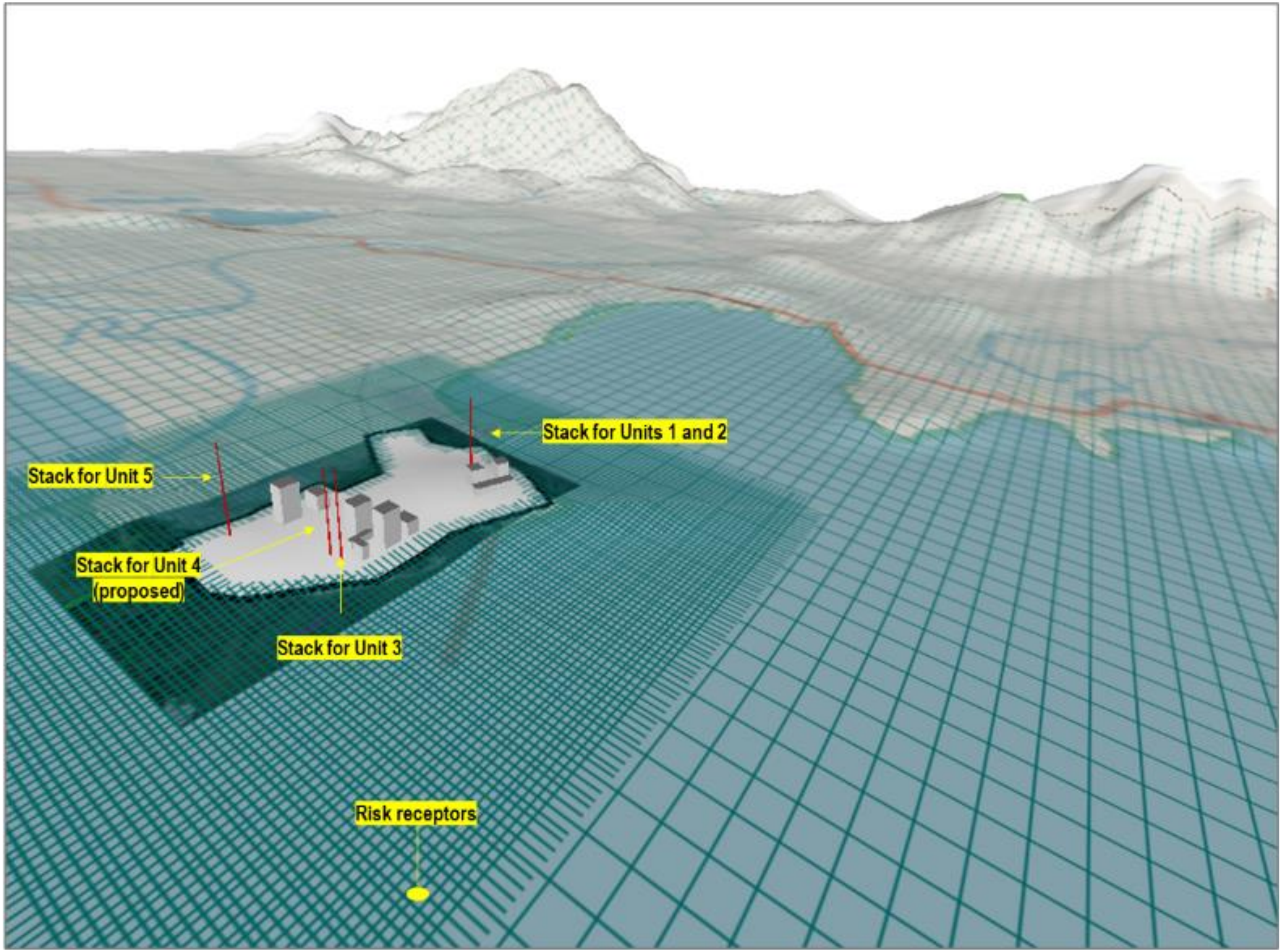


Figure 2-95. Three (3) dimensional view of the existing and proposed sources and the risk receptors

Figure 2-96. Site development plan showing the locations of the proposed stacks for Unit 4 and Unit 5

2.3.3.1.2 Building Profile Input Data

Table 2-57 shows the building parameters (dimensions, base elevations, and heights), which were used to generate the building parameters, i.e., projected building widths, needed for the air dispersion modelling. The building parameters were inputted in the Building Profile Input Program (BPIP), which generated the projected building dimensions and the GEP 5L area of influence. This area of influence (GEP 5L) determines the stacks or emission sources that may be likely affected or influenced by the effect of building wakes, depending on the heights of the stack or emission source (**Figure 2-97**).

DENR MC 2008-003 (Guidelines for Air Dispersion Modelling) provides that building dimensions should be included in the modelling as cavities created at the wake zones of buildings forms low pressure areas, which may form building downwash, a scenario that produces very high ground level concentrations, particularly for shorter stacks.

2.3.3.1.3 Receptor Input Data

Figure 2-98 and **Figure 2-99** show the locations of the receptors (multi-tier and discrete Cartesian receptors). Finely grid spacings (20 m grid) were assigned within 1 km from the centroid of the stacks. This was to ensure that dispersed concentrations near the source were included in the simuations. A receptor is a point or location within the modelling domain or calculation area in which the predicted dispersed concentrations are computed by the model (AERMOD).

The modelling domain or calculation area is large enough so that areas or receptors that may be affected by the dispersed air pollutants are included in the simulations. The modelling domain covers 20 km x 20 km with the centroid of the stacks at the center of the modelling domain.

The elevations at the receptors were derived from the Shuttle Radar Topography Mission (SRTM) data. The terrain data (or elevation) including the hill heights were extracted using AERMAP View – a terrain preprocessor of AERMOD View.

Figure 2-100 and **Figure 2-101** show terrain contours as generated using AERMAP View. Compex terrain or terrain higher than the elevation of the top of the stack (or 15 m base elevation + 150 m stack height = 165 m for Stack 5) from about 8 km to 10 km and greater within the N-E to S-E quadrant of the project site.

Each of the receptor was assigned a height of two (2) meters above ground level.

Onsite receptors or receptors within the project boundaries were disabled or excluded in the simulations because these receptors represent locations within the workplace or project site.

.

AERMOD View - Building Parameters
MS Excel - Lakes Format

Parameters	Units	Description
ID_Building =	-	Name up to 8 characters with no spaces or "-"
Description =	-	Optional (up to 250 characters)
Tier_Number =	integer	Integer
Base_Elevation =	[m]	Building base elevation above mean sea level (If blank, base elevation will be auto-calculated)
Tier_Height =	[m]	Tier height above ground / height of tank
Diameter =	[m]	Diameter of the tank/building (CIRCULAR Buildings only)
X_Length =	[m]	Building length on X-direction (RECTANGULAR Buildings only)
X_Length =	[m]	Building length on Y-direction (RECTANGULAR Buildings only)
Rotation_Angle =	[deg]	Rotation angle (-360 to +360) (If blank, 0 will be assigned) (RECTANGULAR Buildings only)
Num_Coords =	integer	Number of coordinate pairs (X,Y) for the building corners to follow
X1 =	[m]	X coordinate for corner 1 or for center of tank/building
Y1 =	[m]	Y coordinate for corner 1 or for center of tank/building
X2 =	[m]	X coordinate for corner 2
Y2 =	[m]	Y coordinate for corner 2
X3 =	[m]	X coordinate for corner 3
Y3 =	[m]	Y coordinate for corner 3
X4 =	[m]	X coordinate for corner 4
Y4 =	[m]	Y coordinate for corner 4

...

NOTE: You may keep adding additional coordinate pairs for an POLYGONAL building with more than 4 corners (e.g. X5, Y5, etc)

Notes:

1) CIRCULAR Buildings/Tanks: Specify "Diameter", "Num_Coords=1" and "X1, Y1" coordinates for the center

2) RECTANGULAR Buildings: Specify "X_Length", "Y_Length", "Rotation_Angle", "Num_Coords=1" and "X1, Y1" coordinate

3) POLYGONAL Buildings: Specify "Num_Coords>=4" and all the coordinates for the corners (e.g., X1/Y1, X2/Y2, X3/Y3...

ID_Building	Description	Tier_Number	Base_Elevation [m]	Tier_Height [m]	Diameter [m]	X_Length [m]	Y_Length [m]	Rotation_Angle (deg)	Num_Coords	X1 [m]	Y1 [m]
BLD_1	B4-U1 CCR and Turbine B	1	3.5	29.85		37.5	137	252	1	813446.48	1722852.59
BLD_2	B5-U2 Boiler Structure	1	3.5	52.7		45.98	42.5	250	1	813555.38	1722872.52
BLD_3	B6-U1 Boiler Structure	1	3.5	52.7		45.98	42.5	253	1	813465.08	1722900.4
BLD_4	B1-U3 Boiler structure	1	5	66.06		56.3	50	0	1	813083.51	1722814.1
BLD_5	B2-U3 Steam turbine bldg	1	5	32.7		39.51	62.15	0	1	813159.84	1722812.02
BLD_6	B3-U3 Central Contro Bldg	1	5	22.5		72	20	5	1	813021.71	1722872.35
BLD_7	B7- U3 ESP	1	5	28.39		21.14	43.7	0	1	813016.63	1722818.17
BLD_8	Unit 4 - Boiler building	1	5	66.06		56.3	50	0	1	813055.36	1722900.85
BLD_9	Unit 4 - Turbine bldg	1	5	32.7		39.51	62.15	0	1	813137.93	1722888.03
BLD_10	Unit 5 - Boiler bldg	1	15	66.06		56.3	50	0	1	812961.35	1723102.03
BLD_11	Unit 5 - Turbine building	1	15	32.7		39.51	62.15	0	1	813060.54	1723091.98

Table 2-57. Building parameters as extracted in AERMOD View)

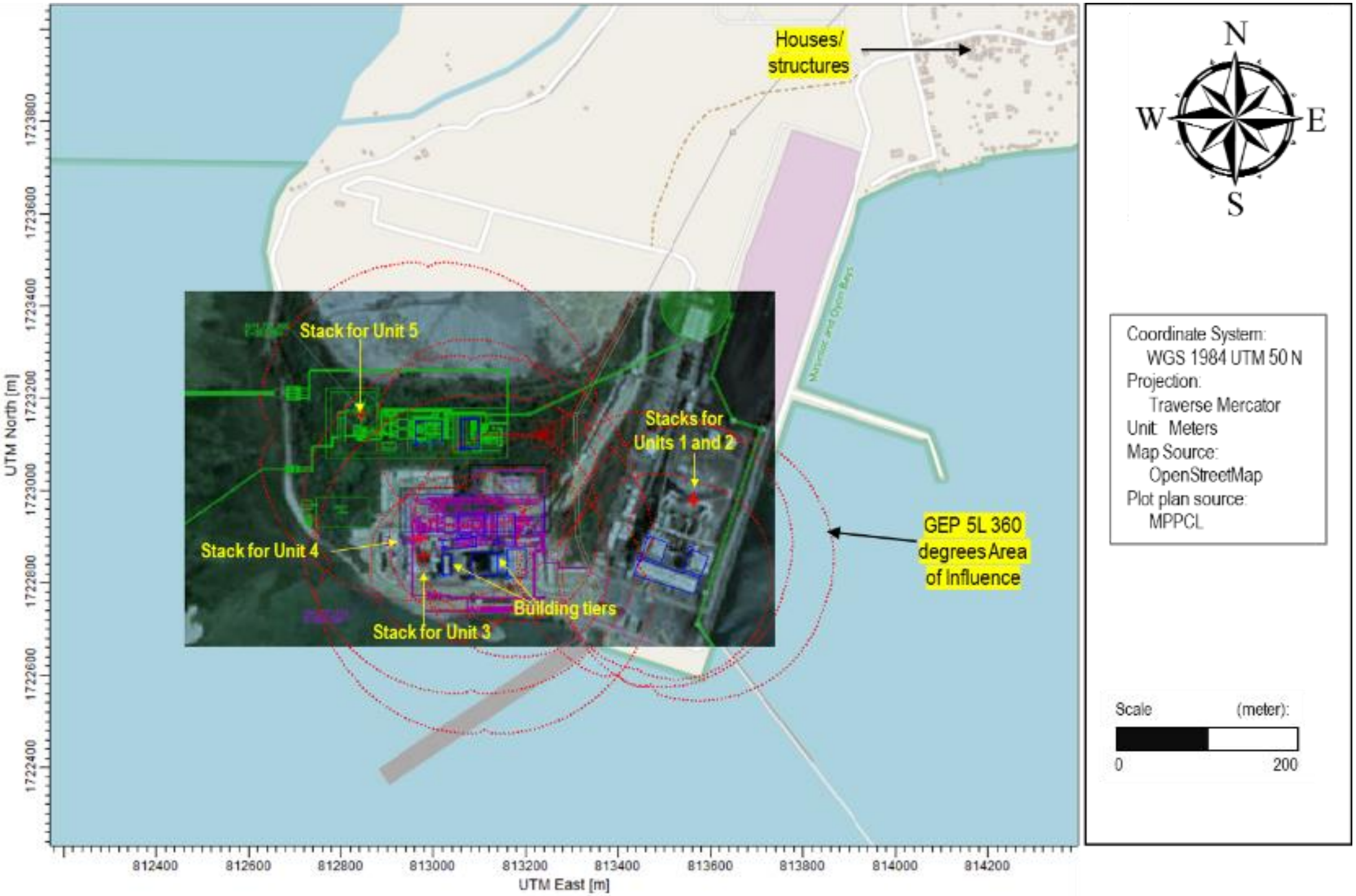


Figure 2-97. Good Engineering Practice (GEP) 5L area of influence

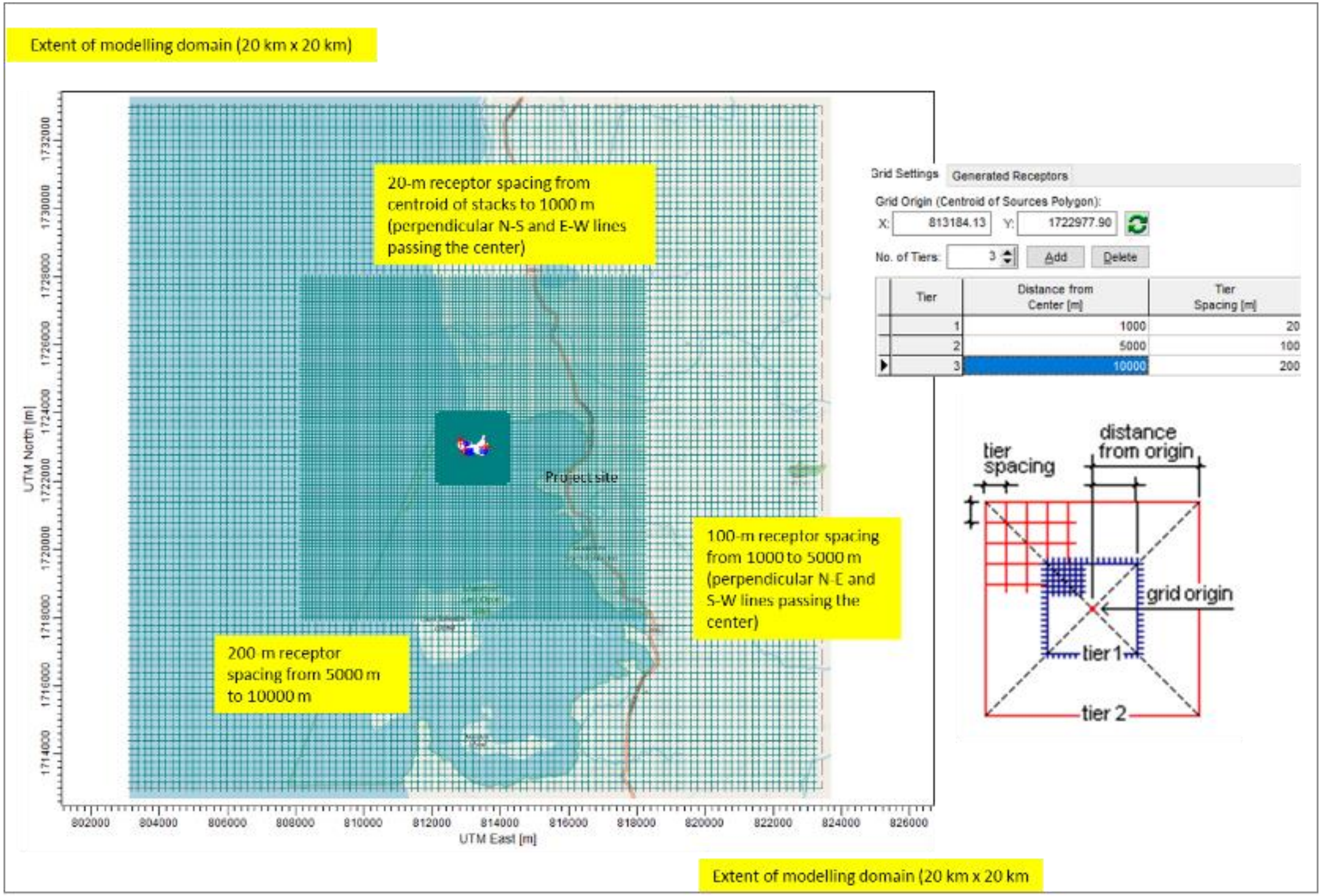


Figure 2-98. Details of the risk receptors

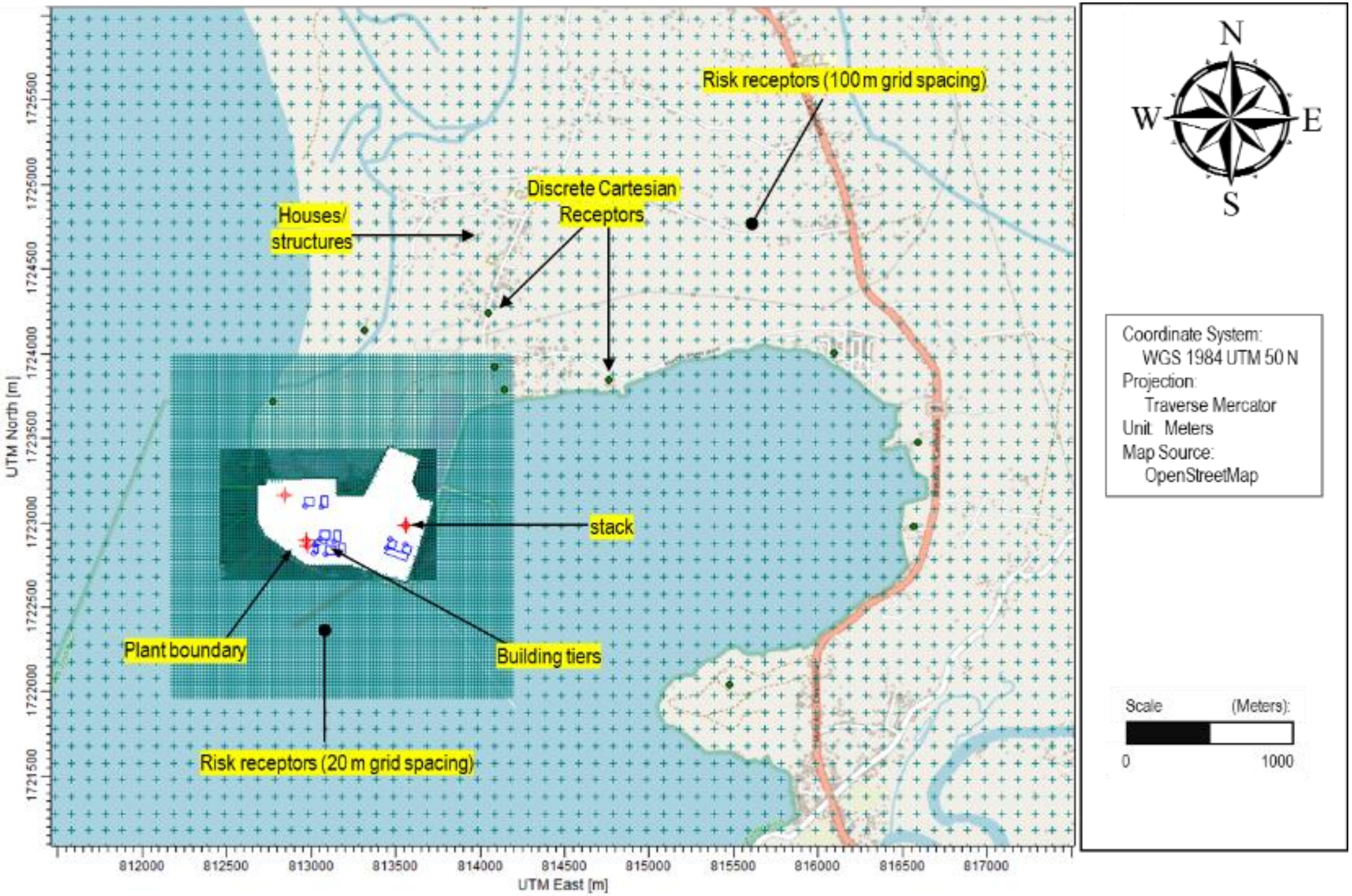


Figure 2-99. Closer view of the risk receptors, discrete receptors, stacks, and houses/structures

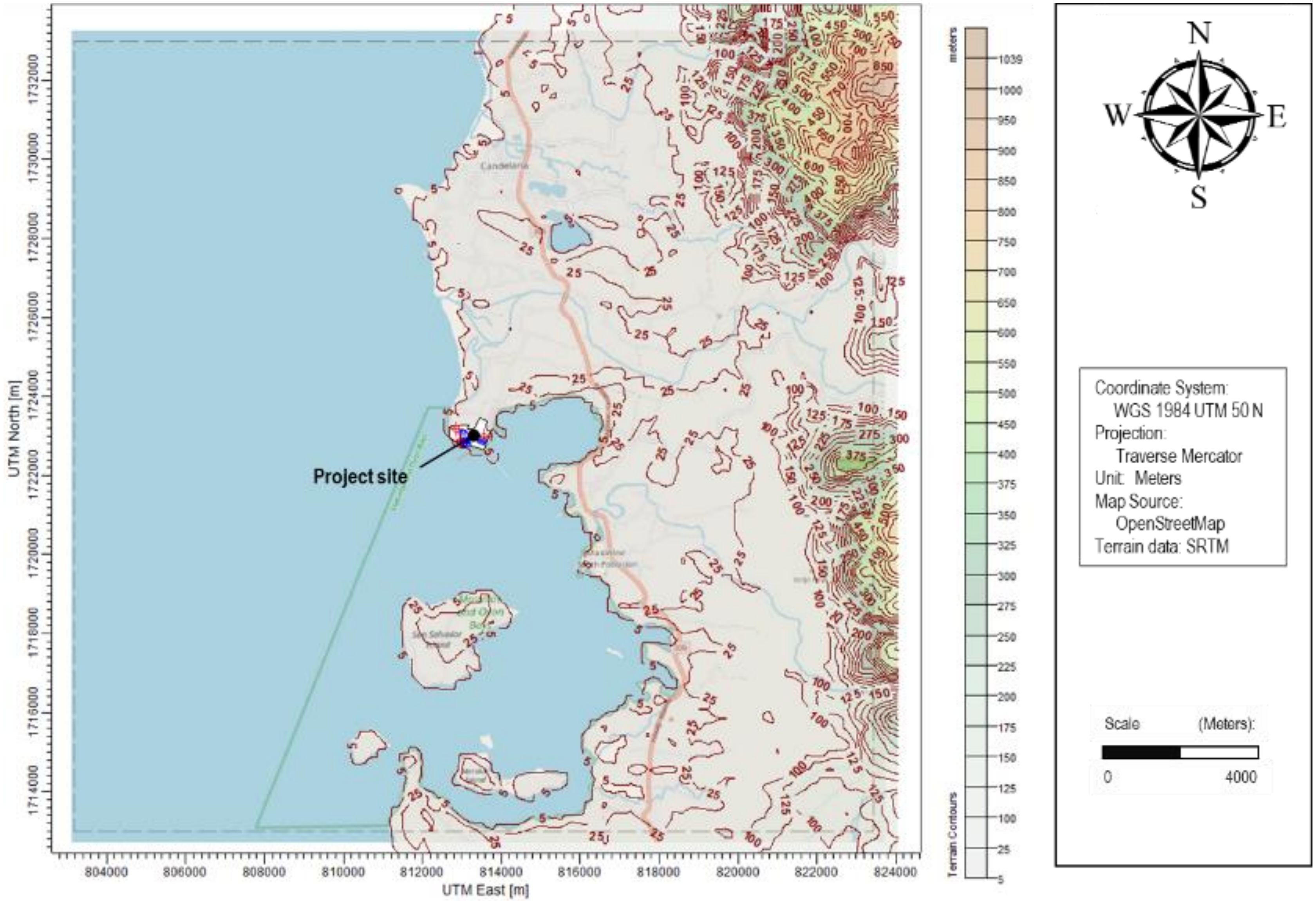


Figure 2-100. Terrain contours within the modelling domain of 20 km x 20 km

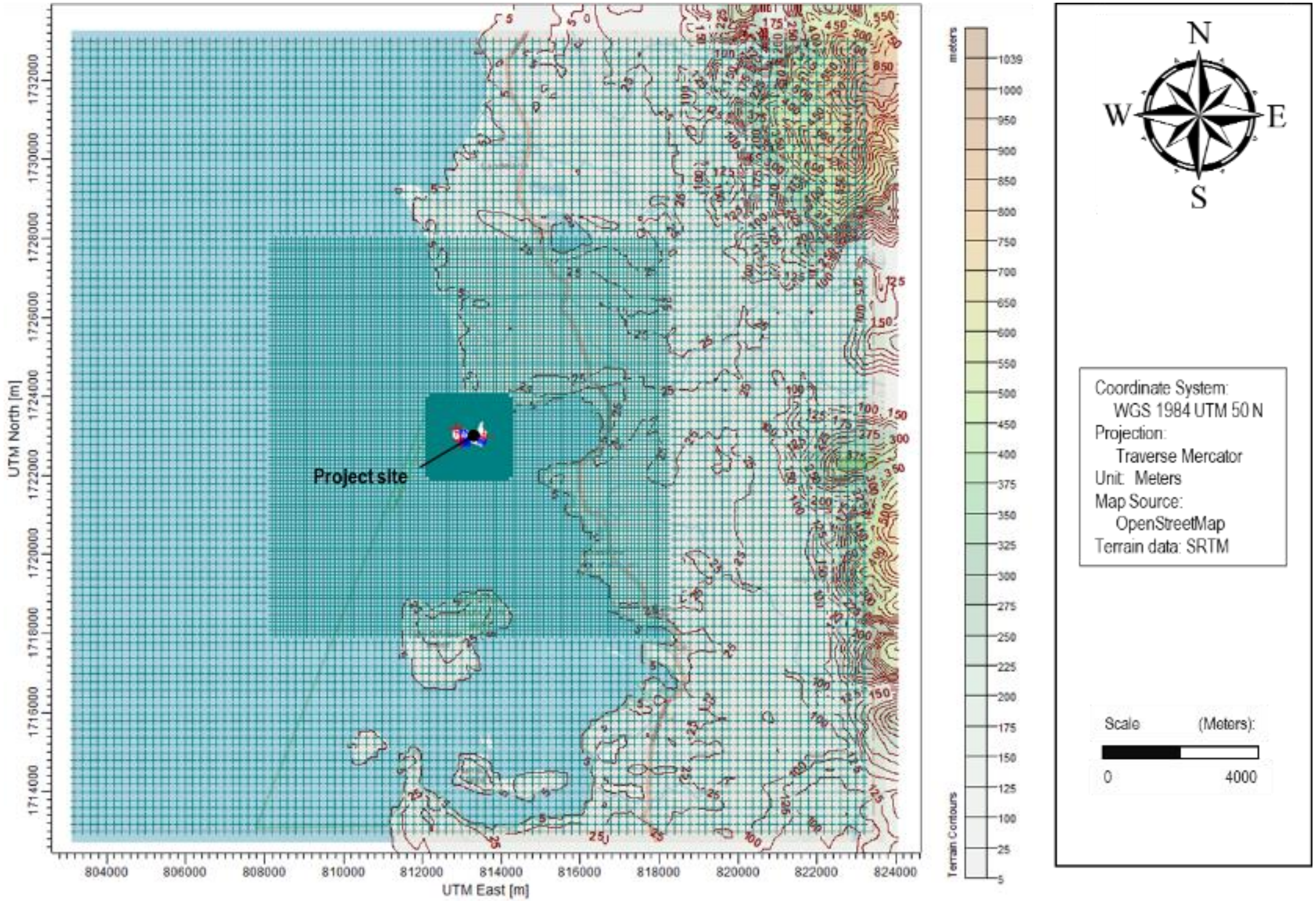


Figure 2-101. Terrain contours and the risk receptors within the modelling domain of 20 km x 20 km

2.3.3.1.4 Meteorological Input Data

Meteorological data used in the dispersion modelling were generated from the MM5 or the Fifth-Generation Penn State/NCAR Mesoscale Model – a regional mesoscale model used for weather forecasting (Plate **2-21**). The data were acquired or purchased online from Lakes Environmental Software based in Canada and processed using AERMET View – a preprocessor of AERMOD View.

The input data to AERMOD View consisted of the surface input data file (Plate **2-22** and Plate **2-23**) and the profile or upper air data (Plate **2-24**). The surface and profile input data files consisted of sequential hourly meteorological data from January 1, 2017 to December 31, 2019 or three (3) years of meteorological data. DENR MC 2008-003 (Guidelines for Air Dispersion Modelling) requires at least three (3) years of meteorological data when prognostic meteorological data are used in the dispersion modelling.

Lakes Environmental Software — Met Data Services

Surface & Upper Air Met Data
AERMET/AERMOD
Preprocessed from MM5 Data

Dec 11, 2020

Met Data Order Information:

Order #:	MET2017687
Ordered by:	Ronald Pahunang
Company:	RHR Consult Services Inc
Met Data Type:	AERMET-Ready (Surface & Upper Air Data)
Start-End Date:	Jan 01, 2017 - Dec 31, 2019
Latitude:	15.564589 N
Longitude:	119.920374 E
Datum:	WGS 84
UTM Zone:	50
Site Time Zone:	UTC+0800
Closest City & Country:	Masinloc - Philippines

Calculated Pseudo Met Station Parameters:

Anemometer Height:	15 m
Station Base Elevation:	99 m
Upper Air Adjustment:	-8 hour(s)

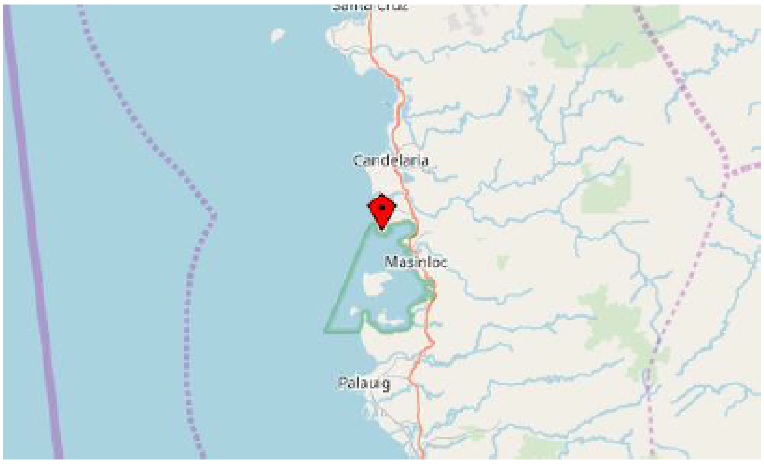
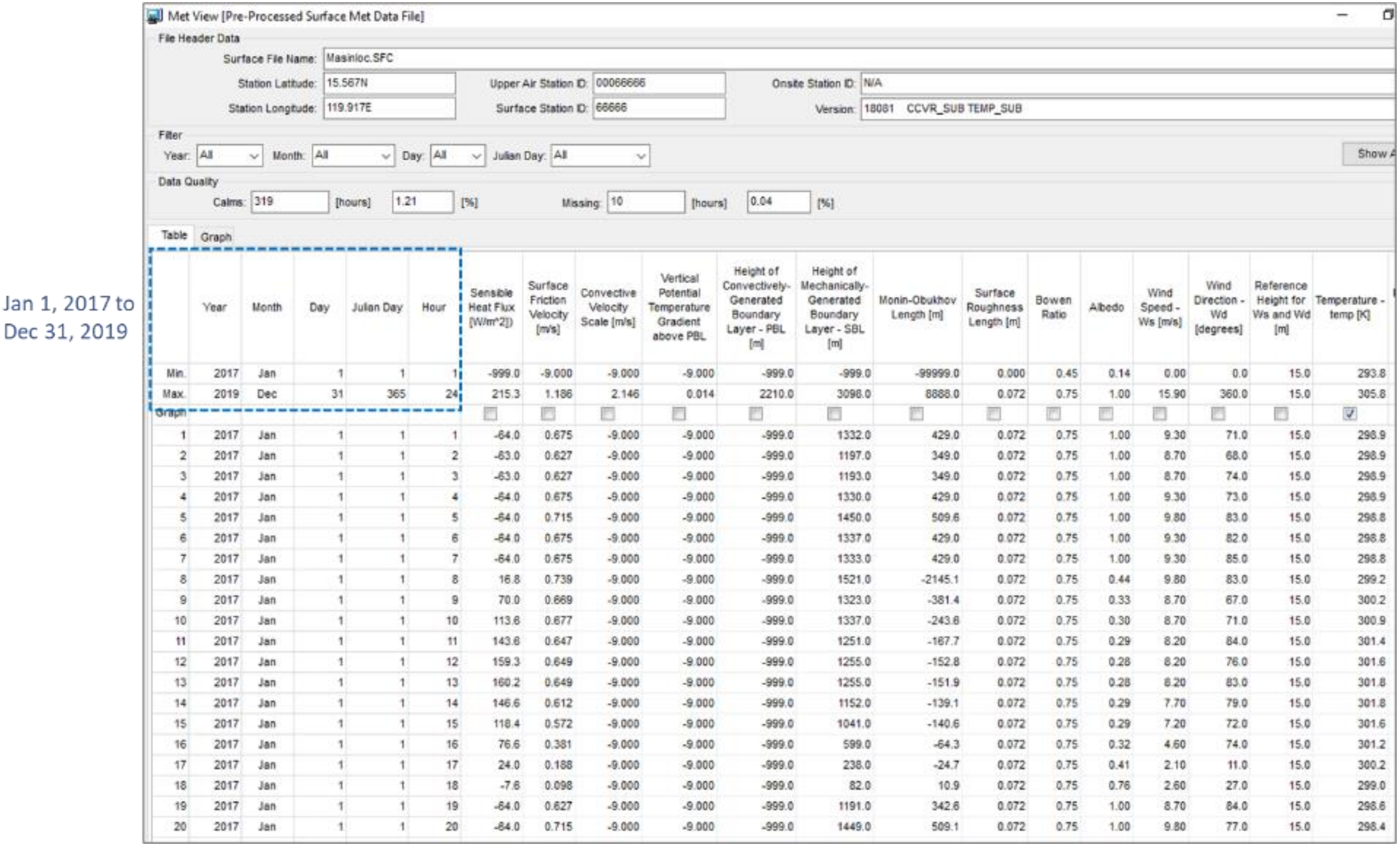
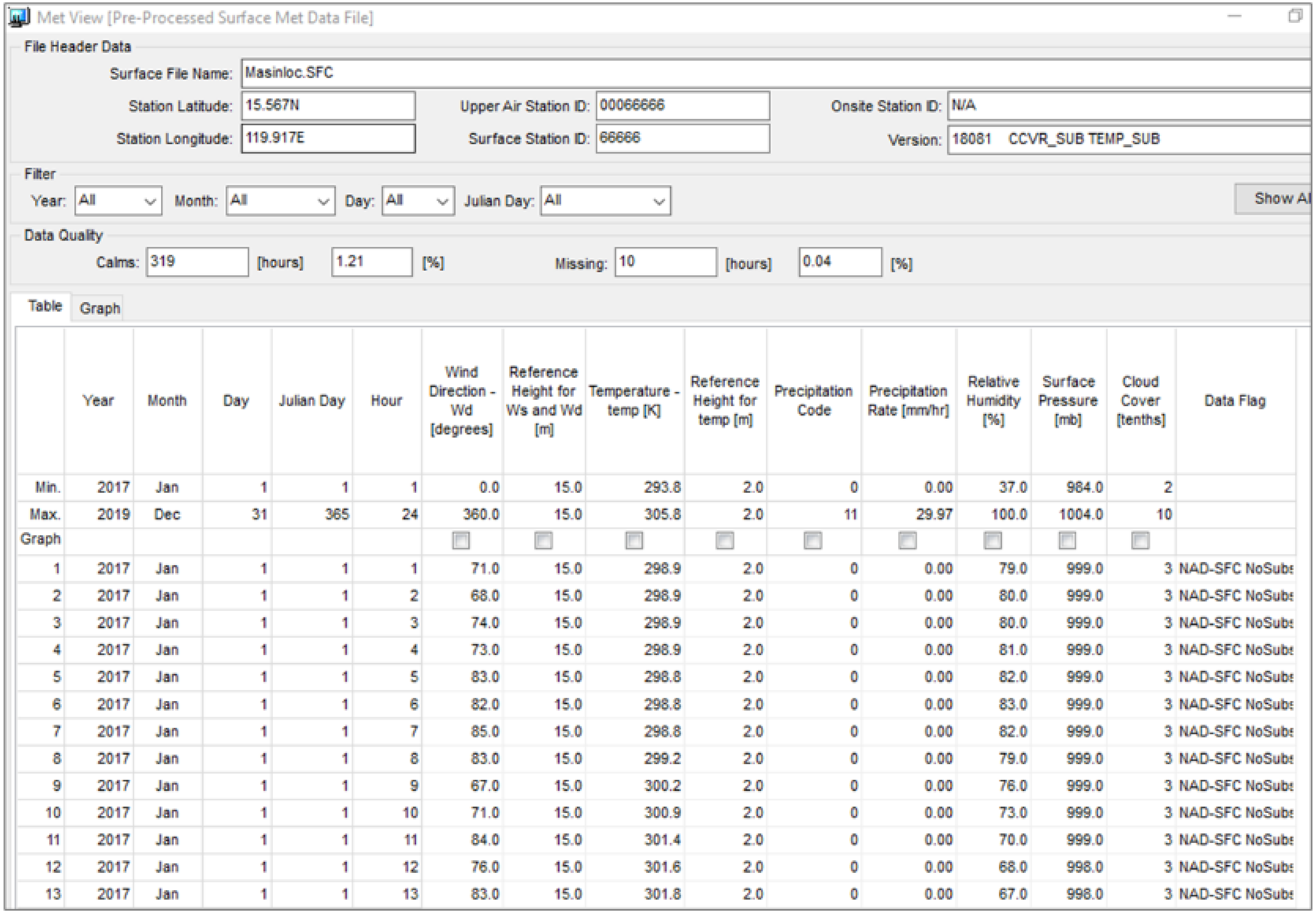


Plate 2-21. Information on the prognostic surface and upper air data used in the dispersion modelling



	Year	Month	Day	Julian Day	Hour	Sensible Heat Flux [W/m^2])	Surface Friction Velocity [m/s]	Convective Velocity Scale [m/s]	Vertical Potential Temperature Gradient above PBL	Height of Convectively-Generated Boundary Layer - PBL [m]	Height of Mechanically-Generated Boundary Layer - SBL [m]	Monin-Obukhov Length [m]	Surface Roughness Length [m]	Bowen Ratio	Albedo	Wind Speed - Ws [m/s]	Wind Direction - Wd [degrees]	Reference Height for Ws and Wd [m]	Temperature - temp [K]
Min.	2017	Jan	1	1	1	-999.0	-9.000	-9.000	-9.000	-999.0	-999.0	-99999.0	0.000	0.45	0.14	0.00	0.0	15.0	293.8
Max.	2019	Dec	31	365	24	215.3	1.186	2.146	0.014	2210.0	3098.0	8888.0	0.072	0.75	1.00	15.90	360.0	15.0	305.8
Graph						☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
1	2017	Jan	1	1	1	-64.0	0.675	-9.000	-9.000	-999.0	1332.0	429.0	0.072	0.75	1.00	9.30	71.0	15.0	298.9
2	2017	Jan	1	1	2	-63.0	0.627	-9.000	-9.000	-999.0	1197.0	349.0	0.072	0.75	1.00	8.70	68.0	15.0	298.9
3	2017	Jan	1	1	3	-63.0	0.627	-9.000	-9.000	-999.0	1193.0	349.0	0.072	0.75	1.00	8.70	74.0	15.0	298.9
4	2017	Jan	1	1	4	-64.0	0.675	-9.000	-9.000	-999.0	1330.0	429.0	0.072	0.75	1.00	9.30	73.0	15.0	298.9
5	2017	Jan	1	1	5	-64.0	0.715	-9.000	-9.000	-999.0	1450.0	509.6	0.072	0.75	1.00	9.80	83.0	15.0	298.8
6	2017	Jan	1	1	6	-64.0	0.675	-9.000	-9.000	-999.0	1337.0	429.0	0.072	0.75	1.00	9.30	82.0	15.0	298.8
7	2017	Jan	1	1	7	-64.0	0.675	-9.000	-9.000	-999.0	1333.0	429.0	0.072	0.75	1.00	9.30	85.0	15.0	298.8
8	2017	Jan	1	1	8	16.8	0.739	-9.000	-9.000	-999.0	1521.0	-2145.1	0.072	0.75	0.44	9.80	83.0	15.0	299.2
9	2017	Jan	1	1	9	70.0	0.669	-9.000	-9.000	-999.0	1323.0	-381.4	0.072	0.75	0.33	8.70	67.0	15.0	300.2
10	2017	Jan	1	1	10	113.6	0.677	-9.000	-9.000	-999.0	1337.0	-243.6	0.072	0.75	0.30	8.70	71.0	15.0	300.9
11	2017	Jan	1	1	11	143.6	0.647	-9.000	-9.000	-999.0	1251.0	-167.7	0.072	0.75	0.29	8.20	84.0	15.0	301.4
12	2017	Jan	1	1	12	159.3	0.649	-9.000	-9.000	-999.0	1255.0	-152.8	0.072	0.75	0.28	8.20	76.0	15.0	301.6
13	2017	Jan	1	1	13	160.2	0.649	-9.000	-9.000	-999.0	1255.0	-151.9	0.072	0.75	0.28	8.20	83.0	15.0	301.8
14	2017	Jan	1	1	14	146.6	0.612	-9.000	-9.000	-999.0	1152.0	-139.1	0.072	0.75	0.29	7.70	79.0	15.0	301.8
15	2017	Jan	1	1	15	118.4	0.572	-9.000	-9.000	-999.0	1041.0	-140.6	0.072	0.75	0.29	7.20	72.0	15.0	301.6
16	2017	Jan	1	1	16	76.6	0.381	-9.000	-9.000	-999.0	599.0	-64.3	0.072	0.75	0.32	4.60	74.0	15.0	301.2
17	2017	Jan	1	1	17	24.0	0.188	-9.000	-9.000	-999.0	238.0	-24.7	0.072	0.75	0.41	2.10	11.0	15.0	300.2
18	2017	Jan	1	1	18	-7.6	0.098	-9.000	-9.000	-999.0	82.0	10.9	0.072	0.75	0.76	2.60	27.0	15.0	299.0
19	2017	Jan	1	1	19	-64.0	0.627	-9.000	-9.000	-999.0	1191.0	342.6	0.072	0.75	1.00	8.70	84.0	15.0	298.6
20	2017	Jan	1	1	20	-64.0	0.715	-9.000	-9.000	-999.0	1449.0	509.1	0.072	0.75	1.00	9.80	77.0	15.0	298.4

Plate 2-22. Screenshot of the surface data input file showing data in columns 1 to 20 (blue rectangle and notes indicate the data coverage)



Met View [Pre-Processed Surface Met Data File]

File Header Data

Surface File Name: Masinloc.SFC

Station Latitude: 15.567N — Upper Air Station ID: 00066666 — Onsite Station ID: N/A

Station Longitude: 119.917E — Surface Station ID: 66666 — Version: 18081 CCVR_SUB TEMP_SUB

Filter

Year: All — Month: All — Day: All — Julian Day: All — Show Al

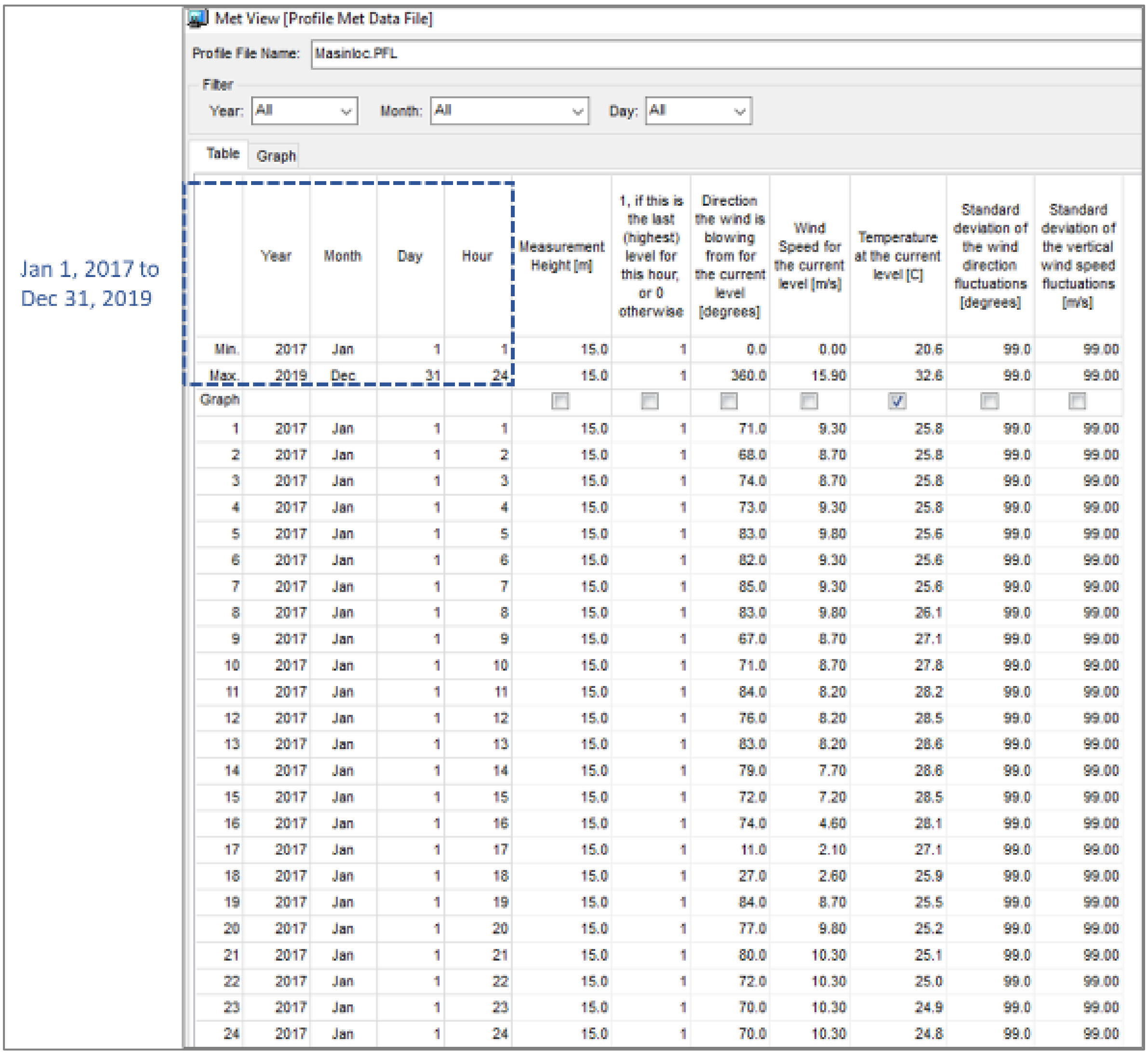
Data Quality

Calms: 319 [hours] 1.21 [%] — Missing: 10 [hours] 0.04 [%]

Table | Graph

	Year	Month	Day	Julian Day	Hour	Wind Direction - Wd [degrees]	Reference Height for Ws and Wd [m]	Temperature - temp [K]	Reference Height for temp [m]	Precipitation Code	Precipitation Rate [mm/hr]	Relative Humidity [%]	Surface Pressure [mb]	Cloud Cover [tenths]	Data Flag
Min.	2017	Jan	1	1	1	0.0	15.0	293.8	2.0	0	0.00	37.0	984.0	2	
Max.	2019	Dec	31	365	24	360.0	15.0	305.8	2.0	11	29.97	100.0	1004.0	10	
Graph						☐	☐	☐	☐	☐	☐	☐	☐	☐	
1	2017	Jan	1	1	1	71.0	15.0	298.9	2.0	0	0.00	79.0	999.0	3	NAD-SFC NoSubs
2	2017	Jan	1	1	2	68.0	15.0	298.9	2.0	0	0.00	80.0	999.0	3	NAD-SFC NoSubs
3	2017	Jan	1	1	3	74.0	15.0	298.9	2.0	0	0.00	80.0	999.0	3	NAD-SFC NoSubs
4	2017	Jan	1	1	4	73.0	15.0	298.9	2.0	0	0.00	81.0	999.0	3	NAD-SFC NoSubs
5	2017	Jan	1	1	5	83.0	15.0	298.8	2.0	0	0.00	82.0	999.0	3	NAD-SFC NoSubs
6	2017	Jan	1	1	6	82.0	15.0	298.8	2.0	0	0.00	83.0	999.0	3	NAD-SFC NoSubs
7	2017	Jan	1	1	7	85.0	15.0	298.8	2.0	0	0.00	82.0	999.0	3	NAD-SFC NoSubs
8	2017	Jan	1	1	8	83.0	15.0	299.2	2.0	0	0.00	79.0	999.0	3	NAD-SFC NoSubs
9	2017	Jan	1	1	9	67.0	15.0	300.2	2.0	0	0.00	76.0	999.0	3	NAD-SFC NoSubs
10	2017	Jan	1	1	10	71.0	15.0	300.9	2.0	0	0.00	73.0	999.0	3	NAD-SFC NoSubs
11	2017	Jan	1	1	11	84.0	15.0	301.4	2.0	0	0.00	70.0	999.0	3	NAD-SFC NoSubs
12	2017	Jan	1	1	12	76.0	15.0	301.6	2.0	0	0.00	68.0	998.0	3	NAD-SFC NoSubs
13	2017	Jan	1	1	13	83.0	15.0	301.8	2.0	0	0.00	67.0	998.0	3	NAD-SFC NoSubs

Plate 2-23. Screenshot of the surface data input file showing data in columns 1 to 6 and columns 17 to 26



	Year	Month	Day	Hour	Measurement Height [m]	1, if this is the last (highest) level for this hour, or 0 otherwise	Direction the wind is blowing from for the current level [degrees]	Wind Speed for the current level [m/s]	Temperature at the current level [C]	Standard deviation of the wind direction fluctuations [degrees]	Standard deviation of the vertical wind speed fluctuations [m/s]
Min.	2017	Jan	1	1	15.0	1	0.0	0.00	20.6	99.0	99.00
Max.	2019	Dec	31	24	15.0	1	360.0	15.90	32.6	99.0	99.00
Graph											
1	2017	Jan	1	1	15.0	1	71.0	9.30	25.8	99.0	99.00
2	2017	Jan	1	2	15.0	1	68.0	8.70	25.8	99.0	99.00
3	2017	Jan	1	3	15.0	1	74.0	8.70	25.8	99.0	99.00
4	2017	Jan	1	4	15.0	1	73.0	9.30	25.8	99.0	99.00
5	2017	Jan	1	5	15.0	1	83.0	9.80	25.6	99.0	99.00
6	2017	Jan	1	6	15.0	1	82.0	9.30	25.6	99.0	99.00
7	2017	Jan	1	7	15.0	1	85.0	9.30	25.6	99.0	99.00
8	2017	Jan	1	8	15.0	1	83.0	9.80	26.1	99.0	99.00
9	2017	Jan	1	9	15.0	1	67.0	8.70	27.1	99.0	99.00
10	2017	Jan	1	10	15.0	1	71.0	8.70	27.8	99.0	99.00
11	2017	Jan	1	11	15.0	1	84.0	8.20	28.2	99.0	99.00
12	2017	Jan	1	12	15.0	1	76.0	8.20	28.5	99.0	99.00
13	2017	Jan	1	13	15.0	1	83.0	8.20	28.6	99.0	99.00
14	2017	Jan	1	14	15.0	1	79.0	7.70	28.6	99.0	99.00
15	2017	Jan	1	15	15.0	1	72.0	7.20	28.5	99.0	99.00
16	2017	Jan	1	16	15.0	1	74.0	4.60	28.1	99.0	99.00
17	2017	Jan	1	17	15.0	1	11.0	2.10	27.1	99.0	99.00
18	2017	Jan	1	18	15.0	1	27.0	2.60	25.9	99.0	99.00
19	2017	Jan	1	19	15.0	1	84.0	8.70	25.5	99.0	99.00
20	2017	Jan	1	20	15.0	1	77.0	9.80	25.2	99.0	99.00
21	2017	Jan	1	21	15.0	1	80.0	10.30	25.1	99.0	99.00
22	2017	Jan	1	22	15.0	1	72.0	10.30	25.0	99.0	99.00
23	2017	Jan	1	23	15.0	1	70.0	10.30	24.9	99.0	99.00
24	2017	Jan	1	24	15.0	1	70.0	10.30	24.8	99.0	99.00

Plate 2-24. Screenshot of the profile data input file (blue rectangle and notes indicate the data coverage)

2.3.3.2 Modeling Results

a) Compliance with Ambient Guideline Values (NAAQG)

Concentrations of dispersed air pollutants at ground level or at other heights from the ground, i.e., 2 m, from an emission source (stack) are proportional to the rate of air pollutant emitted from the source. The larger the emission rate of the air pollutant emitted from the stack, the greater will be the dispersed air pollutants. This can be deduced from the Gaussian plume equation in which emission rate is proportional to the dispersed air pollutants.

Based on stack sampling data from 2015 to 2019, which was conducted by DENR-accredited stack testing companies (Table **2-51** to Table **2-53**), and emissions data from CEMS, it appears that the highest emission rate was that of SO_X (as SO_2), particularly for the existing units (Unit 1 and Unit 2). Thus, initial simulations focused on SO_2 because if predicted SO_2 concentrations will be within ambient guideline value (NAAQG), then predicted dispersed concentrations of other primary air pollutants (NO_2, TSP and CO) may also likely be within the corresponding guideline values.

Figure 2-102 to **Figure 2-113** show the isopleths or contours of predicted dispersed concentrations at two (2) meters above ground level and at various averaging periods and source inputs. The highest predicted concentrations (at 98th percentile, except on annual average) were compared with the applicable ambient guideline values (NAAQG), as shown in Table **2-58** to Table **2-62**.

Results show that the predicted concentrations of SO_2, NO_2, TSP, and CO emanating from the existing sources (Units 1, 2 and 3) and from the existing and proposed sources (Unit 4 and 5) were within the corresponding ambient air quality guideline values, as depicted in in Table **2-58** to Table **2-62**. Note that for Units 4 and 5, simulations were based on emission rates derived from emission standards, i.e., 700 mg/Nm^3 for SO_2,, thus, it follows that emission rates that are within the guaranteed values, i.e., 200 mg/Nm^3 for SO_2, will be lower in predicted concentrations as compared to those derived from emission limits or standards.

The highest predicted dispersed concentrations (24-hour average at 98th percentile) were located about 1.1 and 2.2 km about east and west of Stack 1. Higher predicted concentrations were also noted over complex terrain located about 8 to 10 km S-E and N-E of the project site as dispersed air pollutants are greater at higher elevation due to its proximity to the plume centreline. The coordinates of the highest predicted concentrations are shown in the right portions of the figures (**Figure 2-102** to **Figure 2-113**).

Table 2-58. Predicted highest 98th percentile concentrations of SO_2 (in µg/m^3) emanating from the existing sources (Units 1, 2, and)

Particular	SO_2	SO_2
Averaging Time	24 hours	1 year
Predicted concentration from existing units (Units 1, 2 and 3)	55.9	14.9
NAAQG	**180**	**80**
Remarks	Within NAAQG	Within NAAQG
Reference figure	Figure **2-102**	-
Note: 1) Emission rates for SO_2 were based on results of stack sampling from 2015 to 2019 by 3rd party stack testing companies; 2) Source inputs included the computed 98th percentile of SO_2 emission rate and the average stack gas temperature and stack gas exit velocity		

Table 2-59. Predicted highest 98th percentile concentrations of SO_2 (in µg/m^3) emanating from the existing sources (Units 1, 2, and) and proposed sources (Units 4 and 5)

Particular	SO_2	SO_2
Averaging Time	24 hours	1 year
Predicted concentrations from existing (Units 1, 2, and 3) and proposed units (Unit 4 and 5)	95.0	25.1
NAAQG	**180**	**80**
Remarks	Within NAAQG	Within NAAQG
Reference figure	Figure **2-103**	Figure **2-110**
Notes: 1) Emission rates for SO_2 were based on results of stack sampling from 2015 to 2019 (except Unit 3) by third party stack testing companies; 2) Source inputs included the computed 98th percentile of SO_2 emission rate and the average stack gas temperature and stack gas exit velocity; 3) For Units 3, 4 and 5, emission rates were derived based on emission limit of 700 mg/Nm^3 (this was for conservatives); 4) Stack gas temperature and stack gas exit velocity for Units 3, 4, and 5 were based from actual test results at Unit 3 in 2019.		

Table 2-60. Predicted highest 98th percentile concentrations of SO_2 and NO_2 (in µg/m^3) emanating from the existing sources (Units 1, 2, and) and proposed sources (Units 4 and 5)

Particular	SO_2	NO_2

Particular	SO_2		NO_2	
Averaging Time	24 hours	1 year	24 hours	1 year
Predicted concentration from existing (Units 1, 2, and 3) and proposed units (Unit 4 and 5)	78.9	21.4	92.1	22.7
NAAQG	**180**	**80**	**150**	**Not Specified**
Remarks	Within NAAQG	Within NAAQG	Within NAAQG	-
Reference figure	Figure **2-104**		Figure **2-105**	Figure **2-111**
Note: 1) Emission rates for SO_2 were based on CEMS data for 2020; 2) Source inputs included the computed 98th percentile of SO_2 emission rate; 3) Average stack gas temperature and stack gas exit velocity were from stack testing results from 2015 to 2019; 4) For Unit 3, emission rates were derived based on emission limits of 700 mg/Nm^3 for SO_2 and 1000 mg/Nm^3 for NO_2 (this was for conservative estimates); 4) Stack gas temperature and stack gas exit velocity for Units 3, 4, and 5 were based from actual test results at Unit 3 in 2019.				

Table 2-61. Predicted highest 98th percentile concentrations of NO_2 (in µg/m^3) emanating from the existing sources (Units 1, 2, and) and proposed sources (Units 4 and 5)

Particular	NO_2	NO_2
Averaging Time	24 hours	1 year
Predicted concentration from existing (Units 1, 2, and 3) and proposed units (Unit 4 and 5)	52.2	13.6
NAAQG	**150**	**Not specified**
Remarks	Within NAAQG	
Reference figure	Figure **2-106**	
Notes: 1) Emission rates of NO_2 were from results of stack sampling from 2015 to 2019 (except Unit 3) by third party stack testing companies; 2) Stack gas temperature and stack gas exit velocity for the existing sources were average values from 2015 to 2019; 3) For Units 3, 4 and 5, emission rates were derived from emission limit of 1000 mg/Nm^3 for NO_2 (this was for conservative estimates); 4) Stack gas temperature and stack gas exit velocity for Units 3, 4, and 5 were based from actual test results at Unit 3 in 2019.		

Table 2-62. Predicted highest 98th percentile concentrations of TSP and CO (in µg/m^3) emanating from the existing sources (Units 1, 2, and) and proposed sources (Units 4 and 5)

Particular	TSP		CO		Mercury
Averaging Time	24 hours	1 year	1 hour	8 hours	1 year
Predicted concentrations from existing (Units 1, 2, and 3) and	12.6	3.0	144.1	119.7	0.0036

Particular	TSP		CO		Mercury
proposed units (Unit 4 and 5)					
NAAQG (µg/Nm^3)	**230**	**90**	**35,000**	**10,000**	**1** (based on WHO Europe)
Remarks	Within NAAQG	Within NAAQG	Within NAAQG	Within NAAQG	Within specified values
Reference figure	Figure **2-107**	Figure **2-112**	Figure **2-108**	Figure **2-109**	Figure **2-113**
Note: 1) Emission rates for TSP and CO were from results of stack sampling from 2015 to 2020 by DENR-accredited third-party monitoring companies; 2) Source inputs included the computed 98th percentile of TSP and CO emission rates; 3) Average stack gas temperature and stack gas exit velocity for the existing units were from stack testing results from 2015 to 2019; 4) For Units 3, 4 and 5, emission rates were derived from emission limits of 500 mg/Nm^3 for CO and 150 mg/Nm^3 for particulates (this was for conservative estimates); 4) Stack gas temperature and stack gas exit velocity for Units 3, 4, and 5 were based from actual test results at Unit 3 in 2019.					

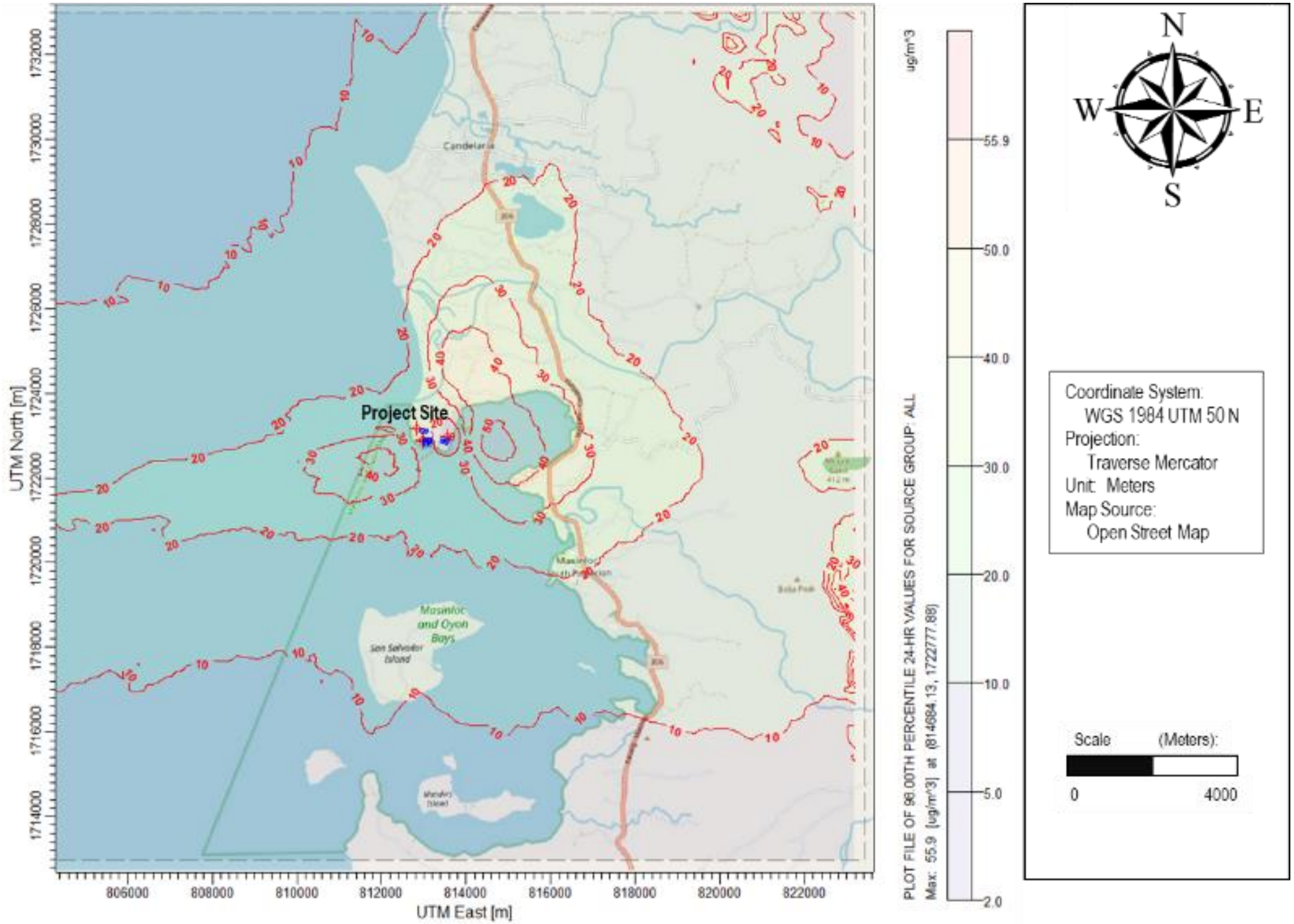


Figure 2-102. Predicted 24-hr average conc. of SO_2 (98th percentile) arising from existing sources (Units 1, 2 and 3) with emissions from stack sampling (3rd party)

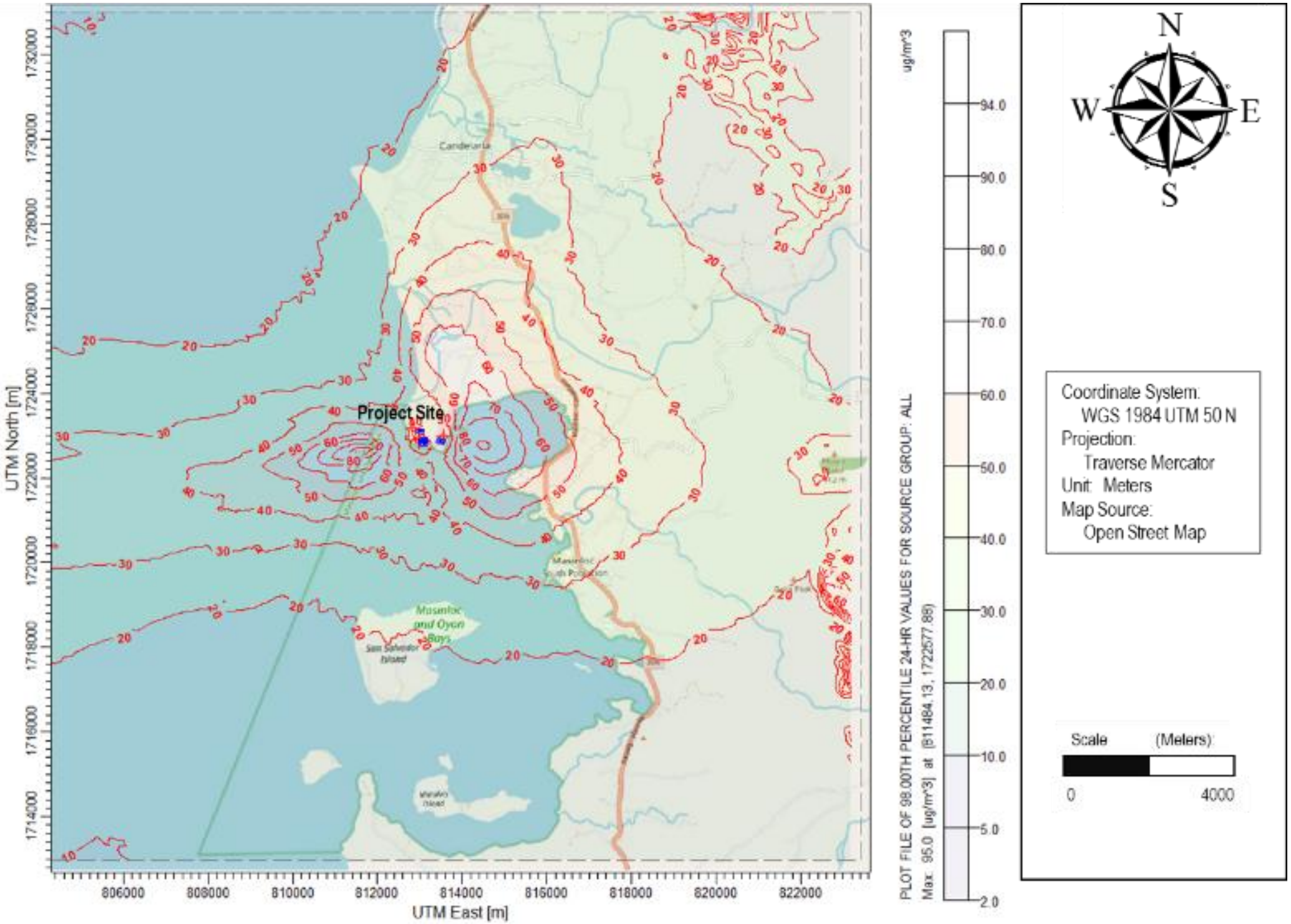


Figure 2-103. Predicted 24-hr average conc. of SO_2 (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) (except Unit 3) for existing and the emission limit for the proposed sources (Note: Unit 3 based on emission limit)

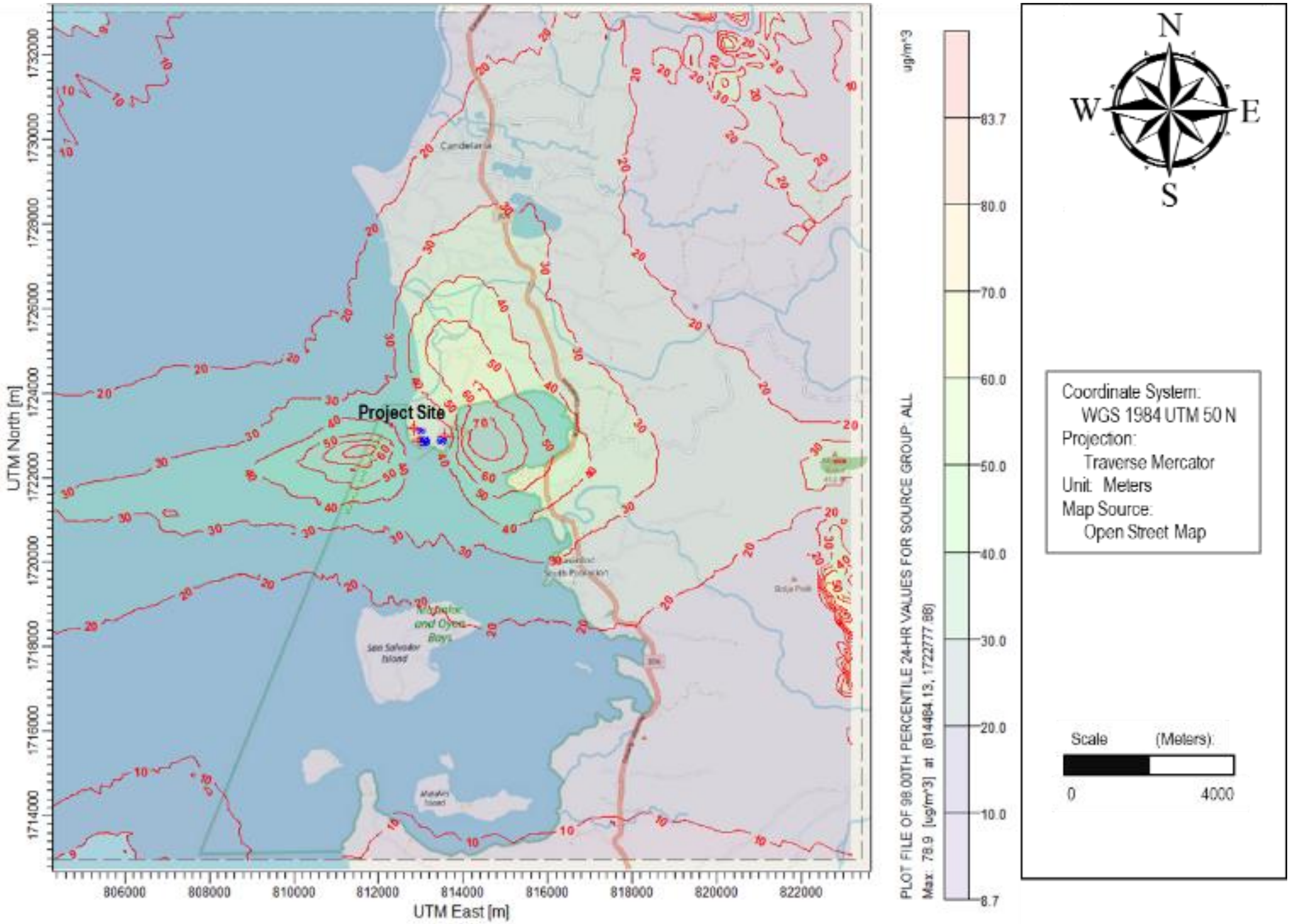


Figure 2-104. Predicted 24-hr average conc. of SO_2 (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from CEMS 2020 data for the existing sources and the emission limit for the proposed sources

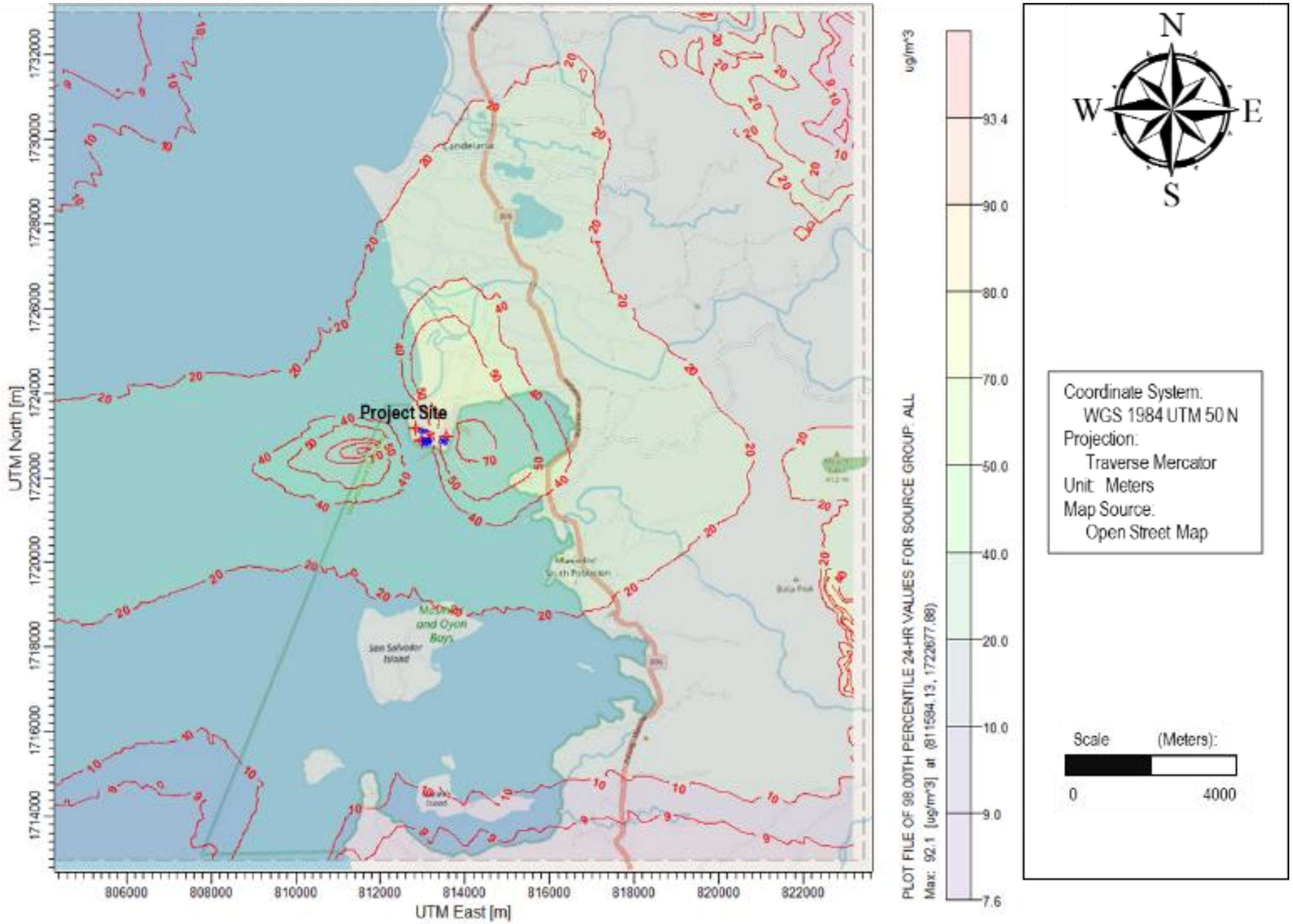


Figure 2-105. Predicted 24-hr average conc. of NO_2 (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from CEMS 2020 data for the existing sources and the emission limit for the proposed sources

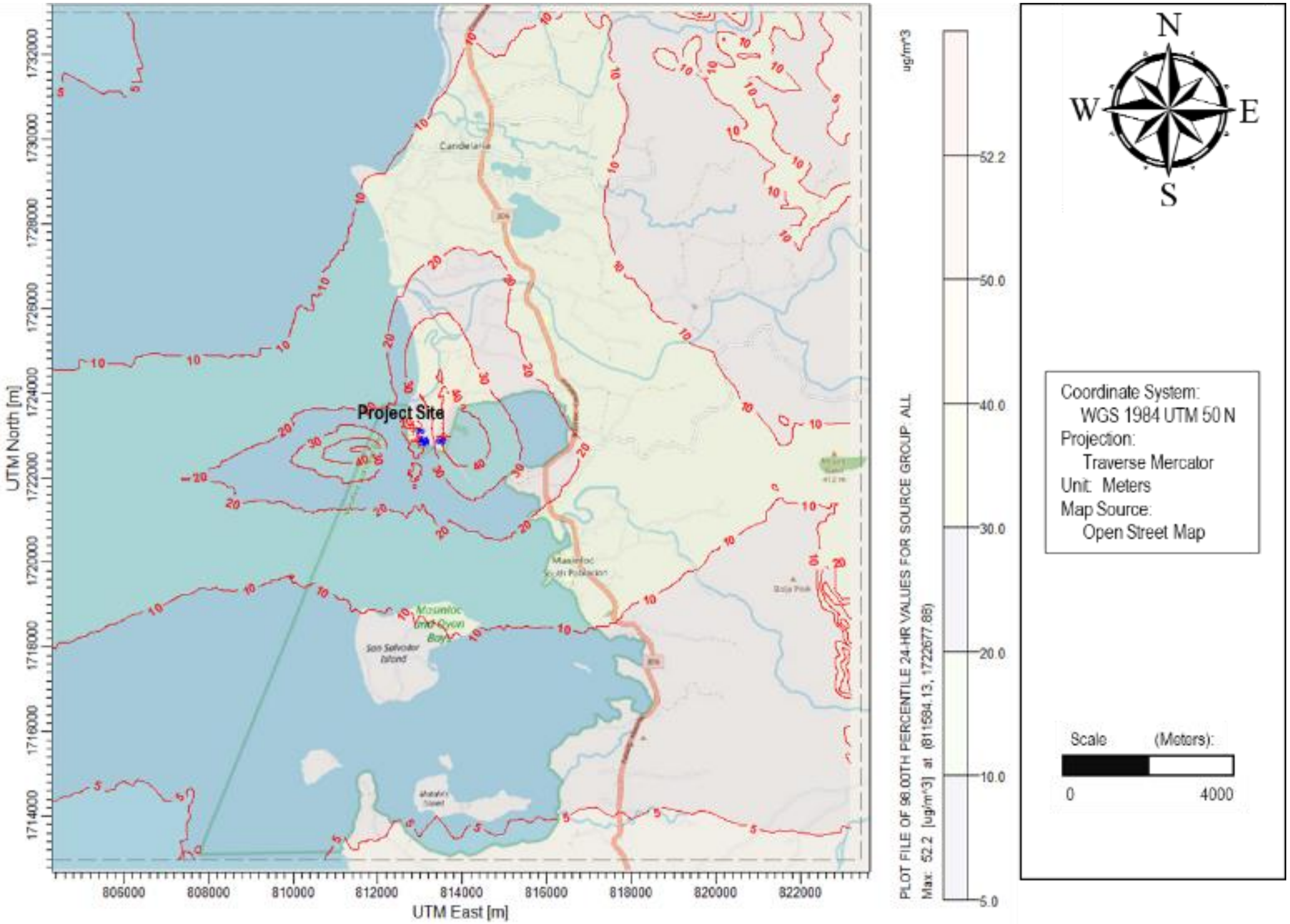


Figure 2-106. Predicted 24-hr average conc. of NO_2 (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

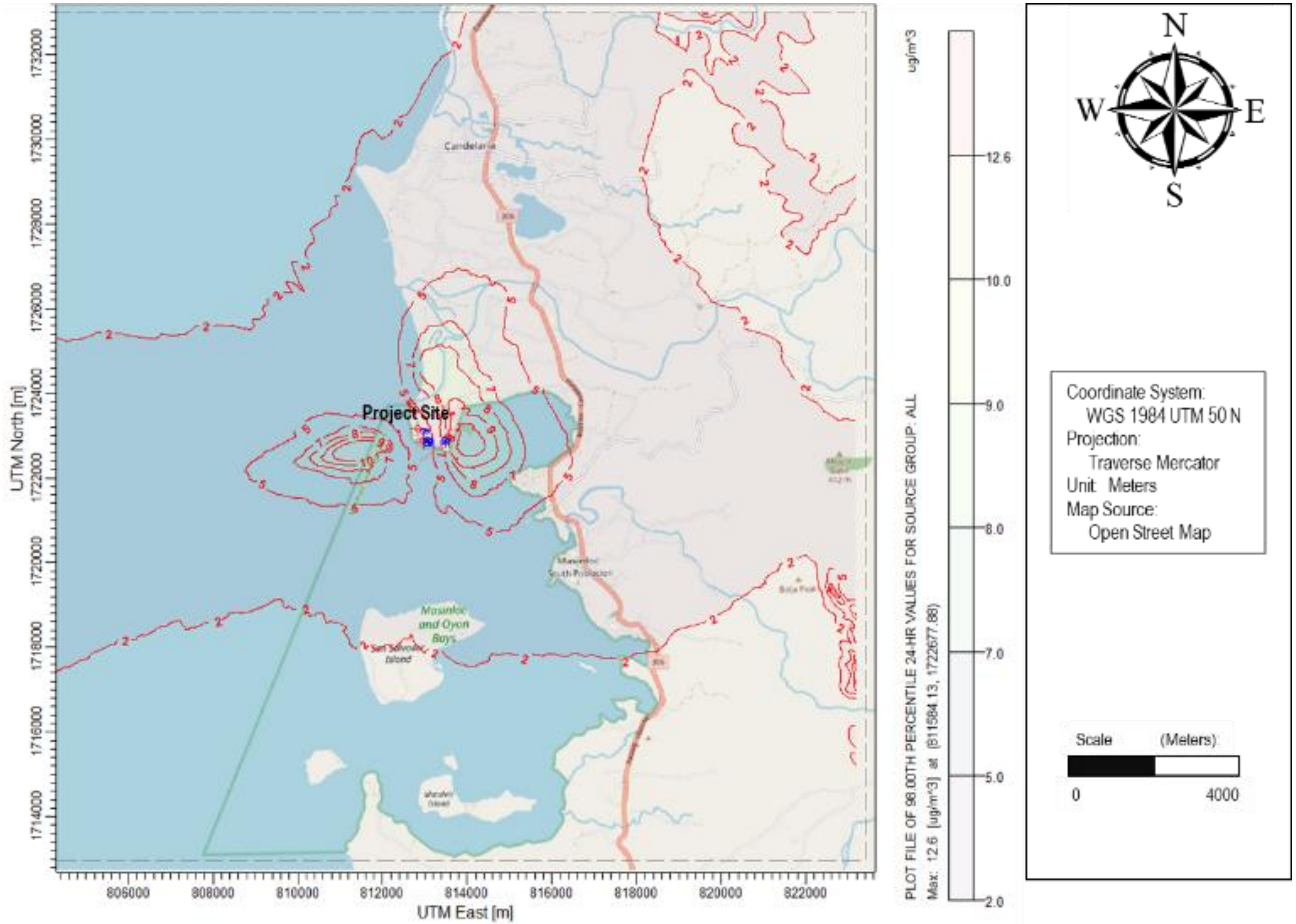


Figure 2-107. Predicted 24-hr average conc. of TSP (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

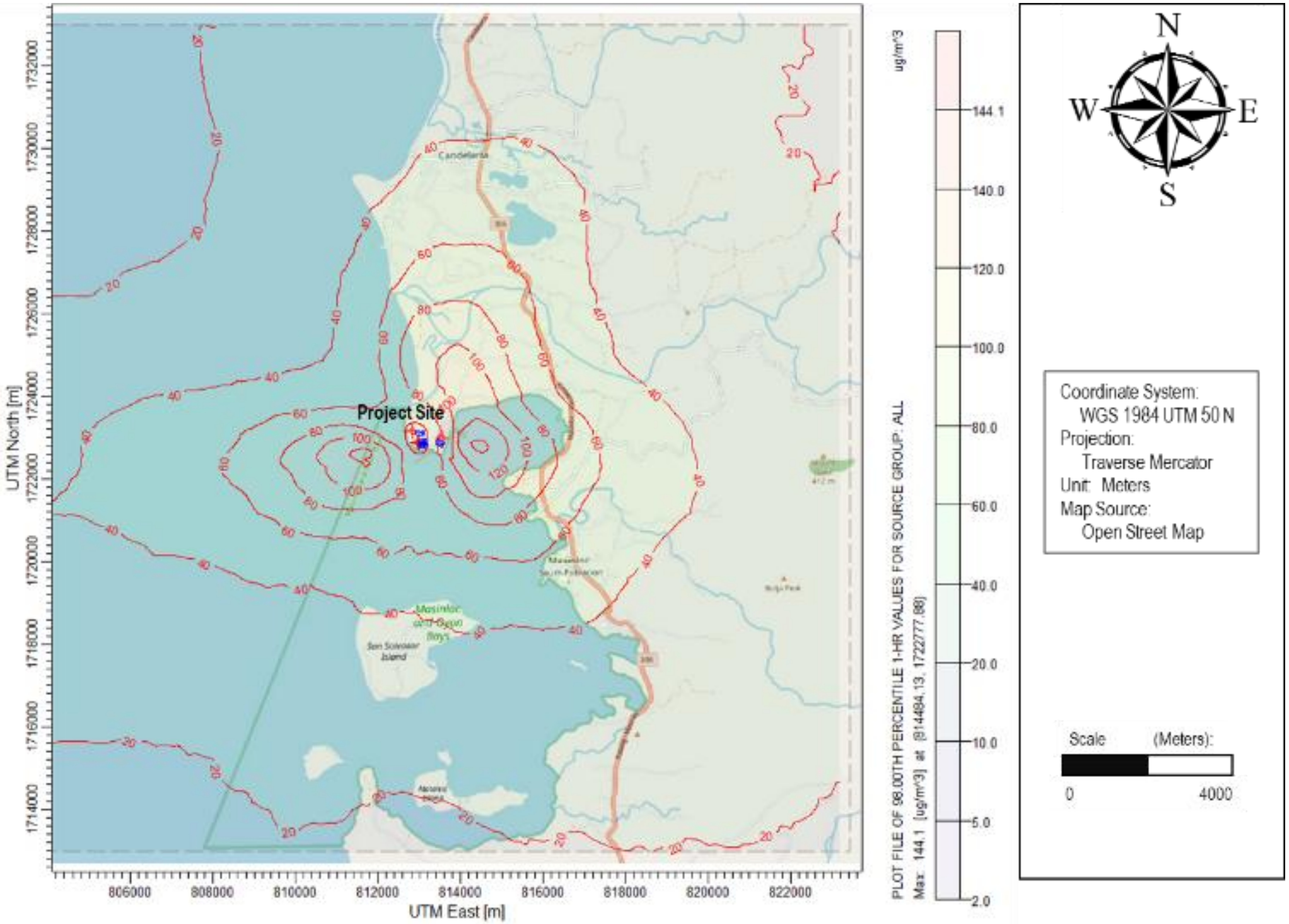


Figure 2-108. Predicted 1-hr average conc. of CO (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

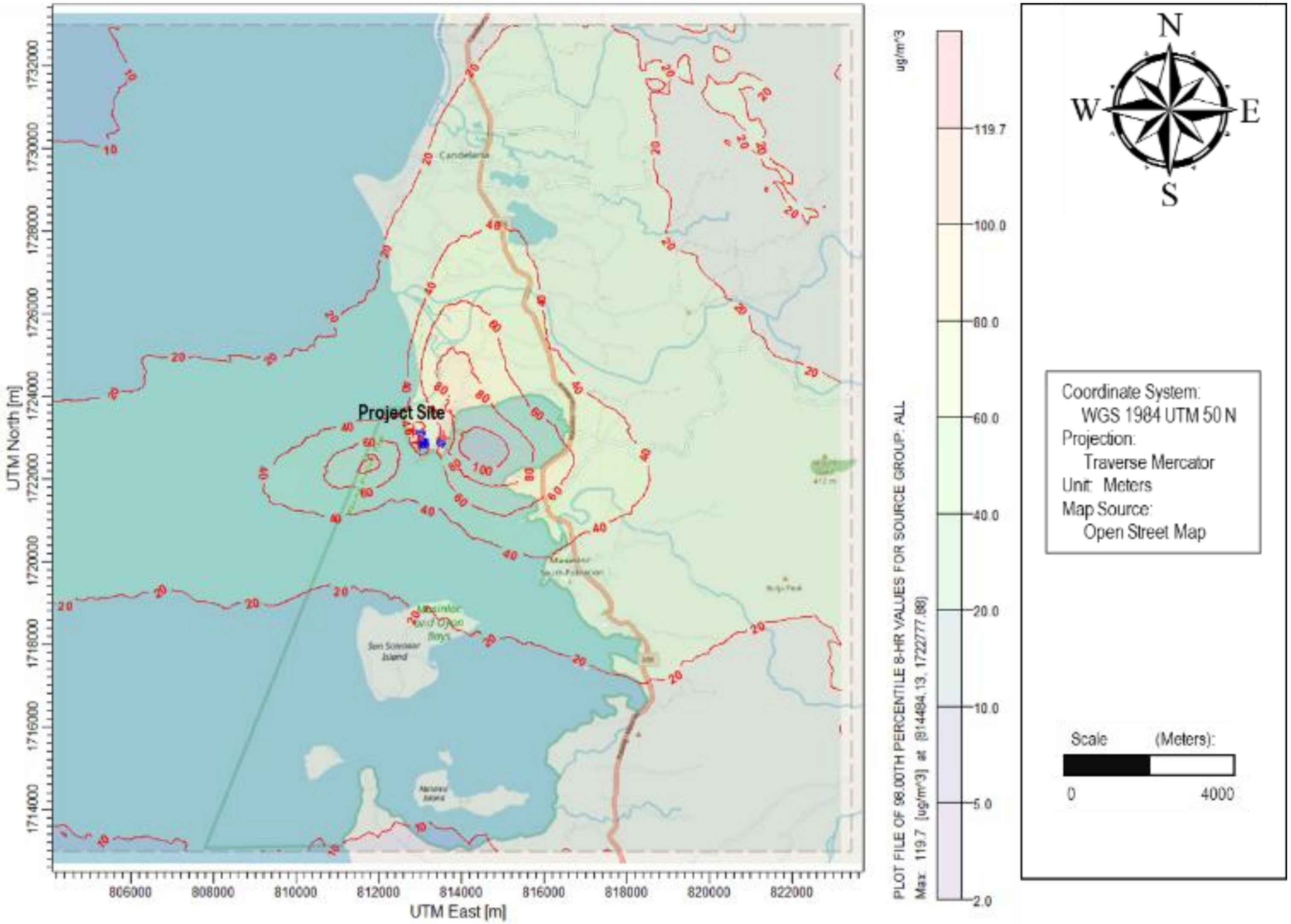


Figure 2-109. Predicted 8-hr average conc. of CO (98th percentile) arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

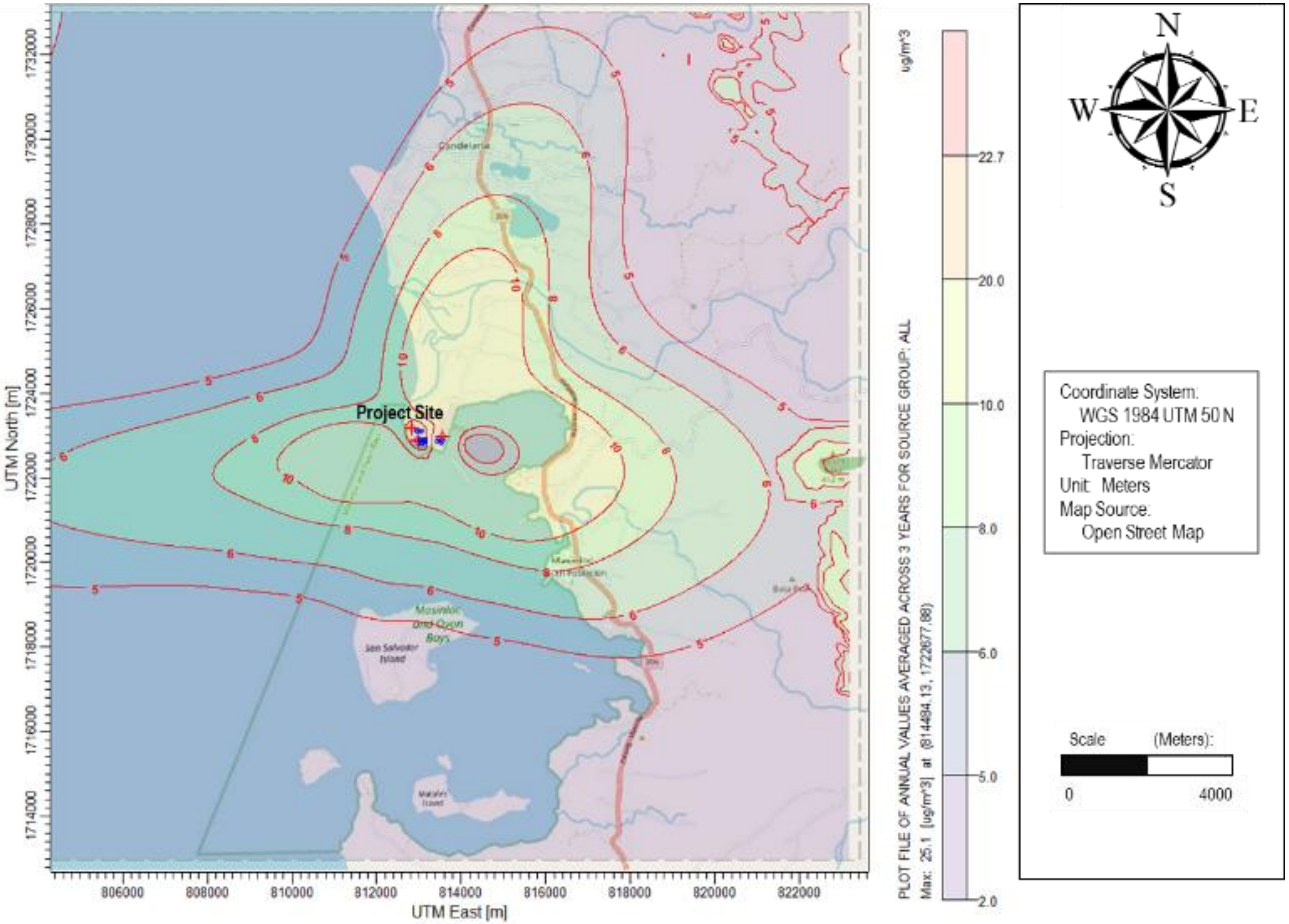


Figure 2-110. Predicted annual average conc. of SO_2 arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources (except Unit 3) and the emission limit for the proposed sources (Note: Unit 3 from emission limit)

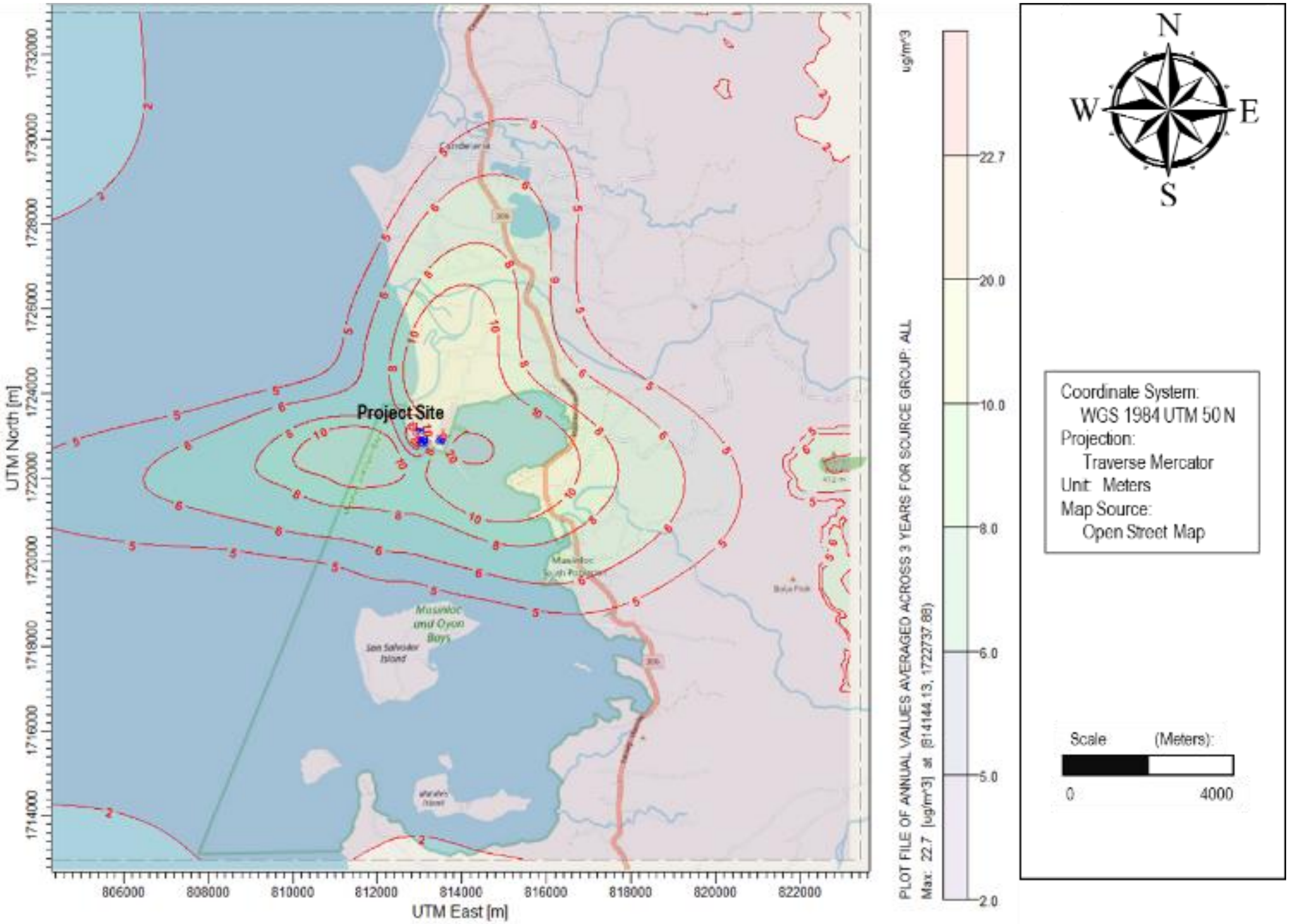


Figure 2-111. Predicted annual average conc. of NO_2 arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

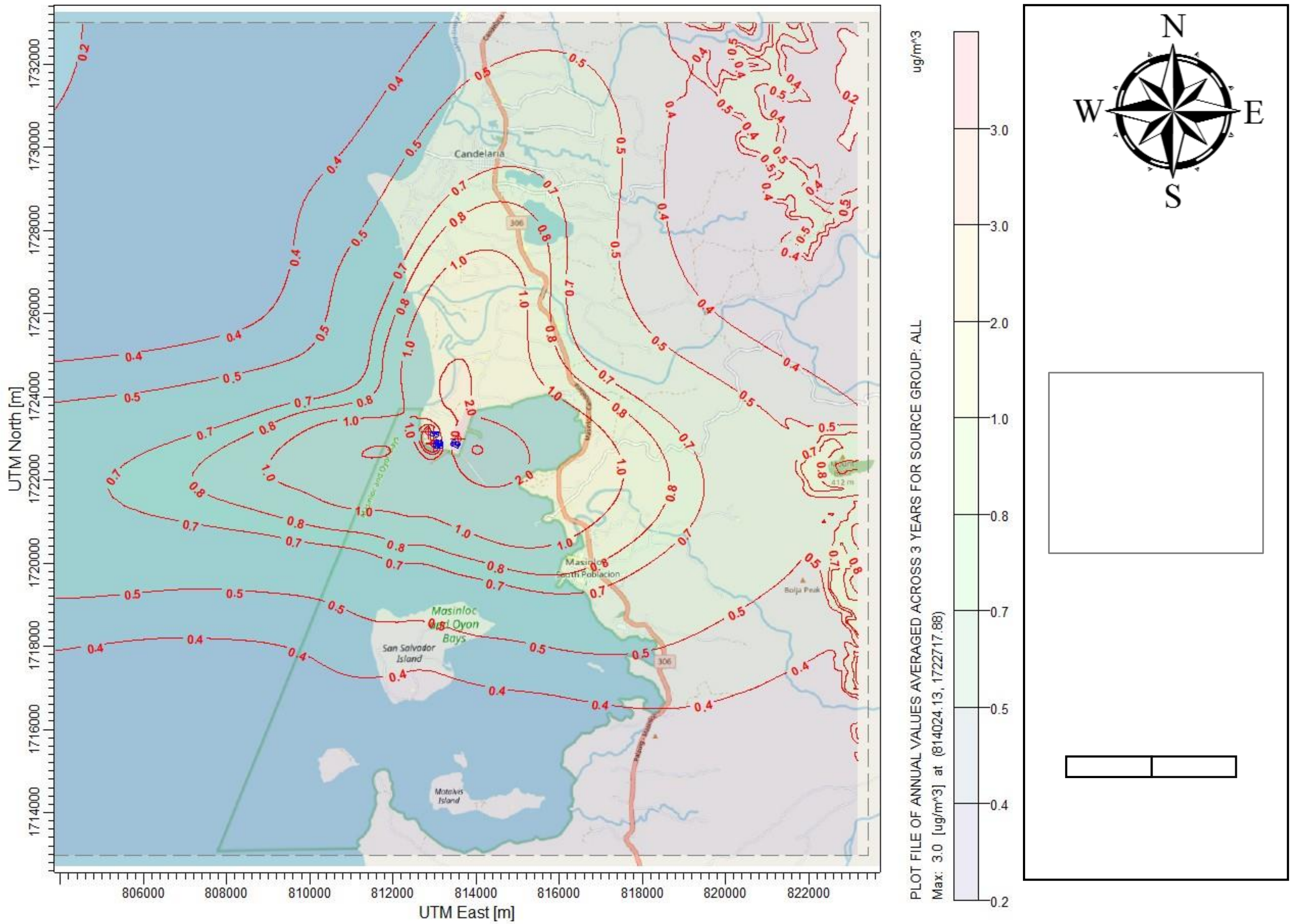


Figure 2-112. Predicted annual average conc. of TSP arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

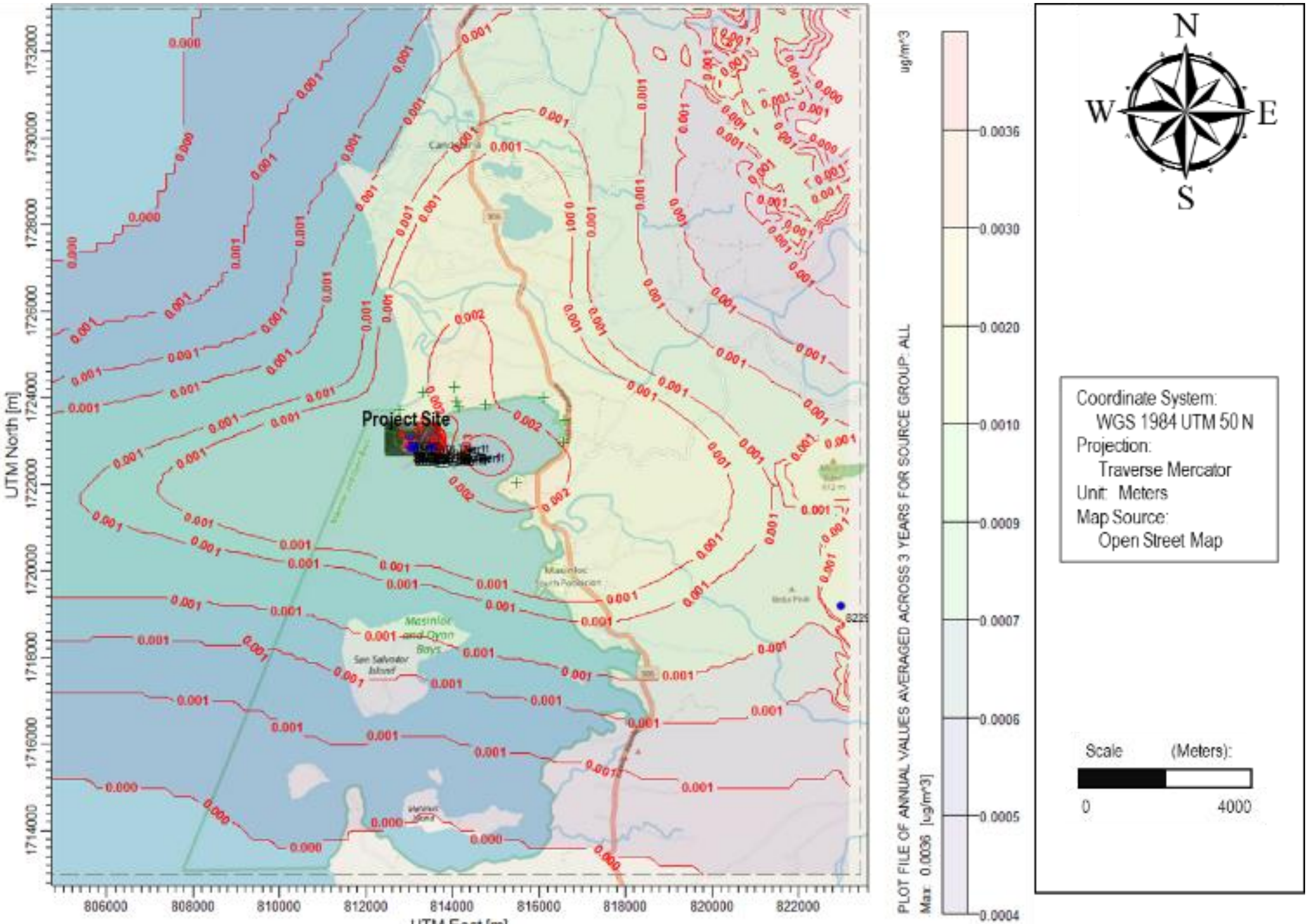


Figure 2-113. Predicted annual average conc. of mercury arising from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit for the proposed sources

b) Comparing Dispersed Emissions with the Ambient Air Quality Standards (NAAQS)

Although demonstration of compliance with the ambient air quality standards is not required for proposed sources or emission sources with modification pursant to Section 3, Rule X of DAO 2000-81 (**Plate 2-17**), additional simulations were performed to determine the 4st highest maximum 1-hour values of SO_2, in accordance with the U.S.EPA's 1-hour SO_2 NAAQS (an option in the Control Pathway of AERMOD View).

The following were the modelling scenarios in modelling dispersed SO_2 concentrations based on the U.S.EPA's NAAQS:

- Scenario 1 (Existing and proposed sources – Units 1, 2, 3, 4 and 5) – SO_2 emission rates from 3rd party stack sampling in 2015 to 2020 for the existing sources and derived from the emission limit (700 mg/Nm3) for the proposed sources (Units 4 and 5); and
- Scenario 2 (Existing and proposed sources – Units 1, 2, 3, 4 and 5) – SO_2 emission rates from 3rd party stack sampling in 2015 to 2020 for the existing sources (except Unit 3) and from the guaranteed emission value of 200 mg/Nm^3 for the proposed sources (Units 4 and 5, including Unit 3)

Results for Scenario 1 show that dispersed ambient concentrations emanating from existing (Units 1, 2, and 3) and proposed sources (Units 4 and 5) were greater than the ambient air quality standard set at 340 µg/Nm^3, particulary in the vicinity of the emission sources (power plant) and on complex terrain located N-E to S-E quadrant from the project site (**Figure 2-114**). This shows that although emissions from the said sources (existing and proposed) were within the emission standards, the dispersed air pollutants at breathing zone may likely exceed the ambient standards set for SO_2 (1 hour average) at 340 µg/Nm^3.

Decreasing the emissions to within the guaranteed emission value for SO_2 set at < 200 µg/Nm^3 shows that dispersed emissions at breathing zones appear to be within or closer to the ambient air quality standard set at 340 µg/Nm^3 (**Figure 2-115** to **Figure 2-117**). This suggests that emission of SO_X (as SO_2) greater than the guaranteed emission concentration set for SO_2 may likely show exceedances with the ambient air quality standard set for SO_2. It should be noted, however, that the implementing rules of the PCAA of 1999 requires that the proposed sources or sources with modification should demonstrate compliance with the NAAQG values through dispersion modelling. Ironically, during operation, DAO 2000-81 requires that emission sources shall comply with the ambient air quality standards. The NAAQS and the NAAQG for a given pollutant differ on the averaging periods and the concentration. The above additional scenarios, however, could provide an insight on the possible limits of the regulated air pollutants, i.e., SO_2, as exceedance with the ambient air quality standards may occur when there will be further increase in stack emissions (SO2) from the project site.

Limitations

The modelling conducted for the project is limited only to emissions from the existing and proposed stacks. Fugitive emissions, such as those from other sources, i.e., stock piles and other area, line, or volume sources, were not included in the simulations. Section 13 (Prohibited Acts), Rulex XXV (Stationary Sources-General) stipulates the restrictions of emitting particulate matter (or fugitive particulates) from any source, including but not limited, to vehicular movement and other related sources.

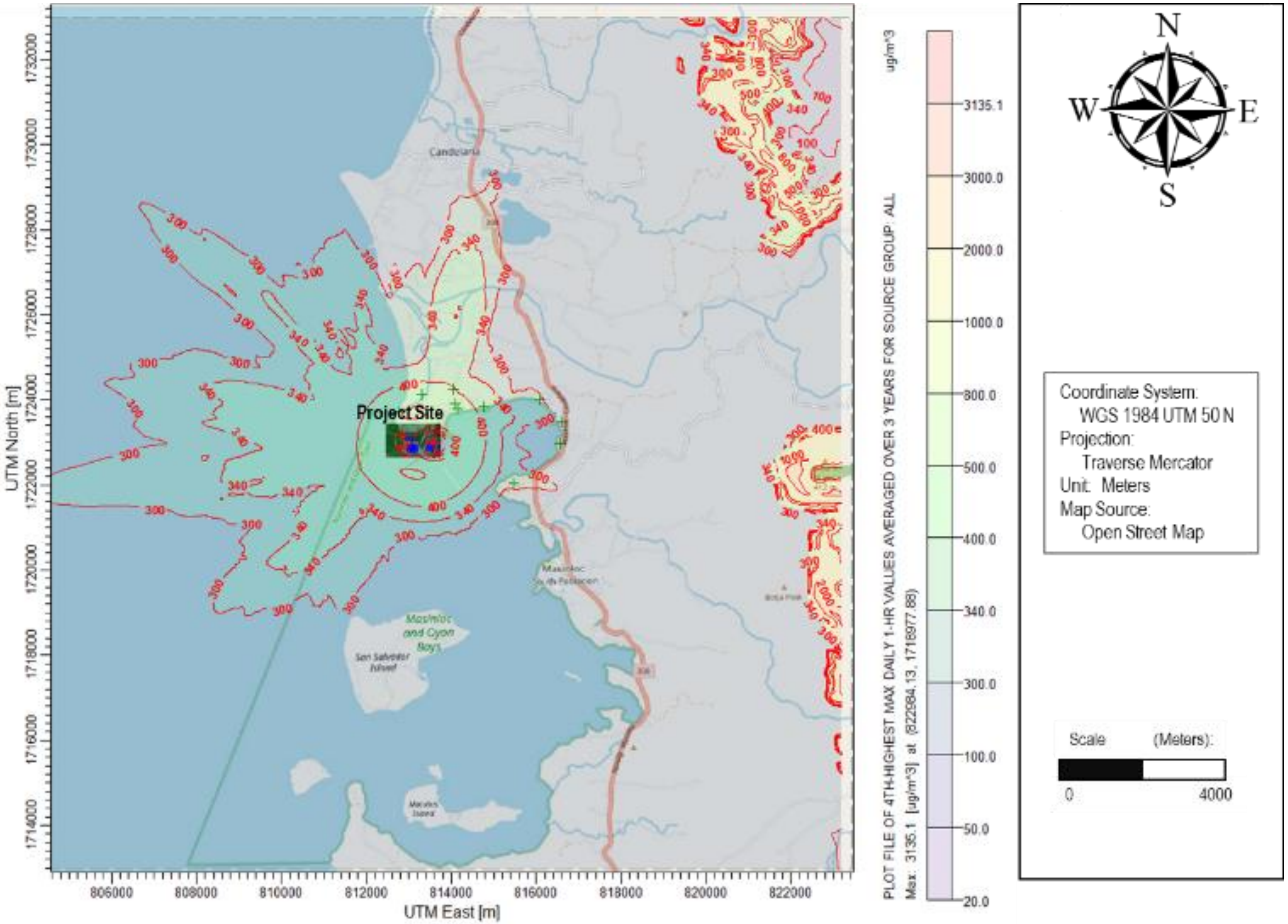


Figure 2-114. Predicted 4th highest maximum daily 1-hour values of SO_2 averaged over three (3) years emanating from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the emission limit of 700 mg/Nm^3 for the proposed sources

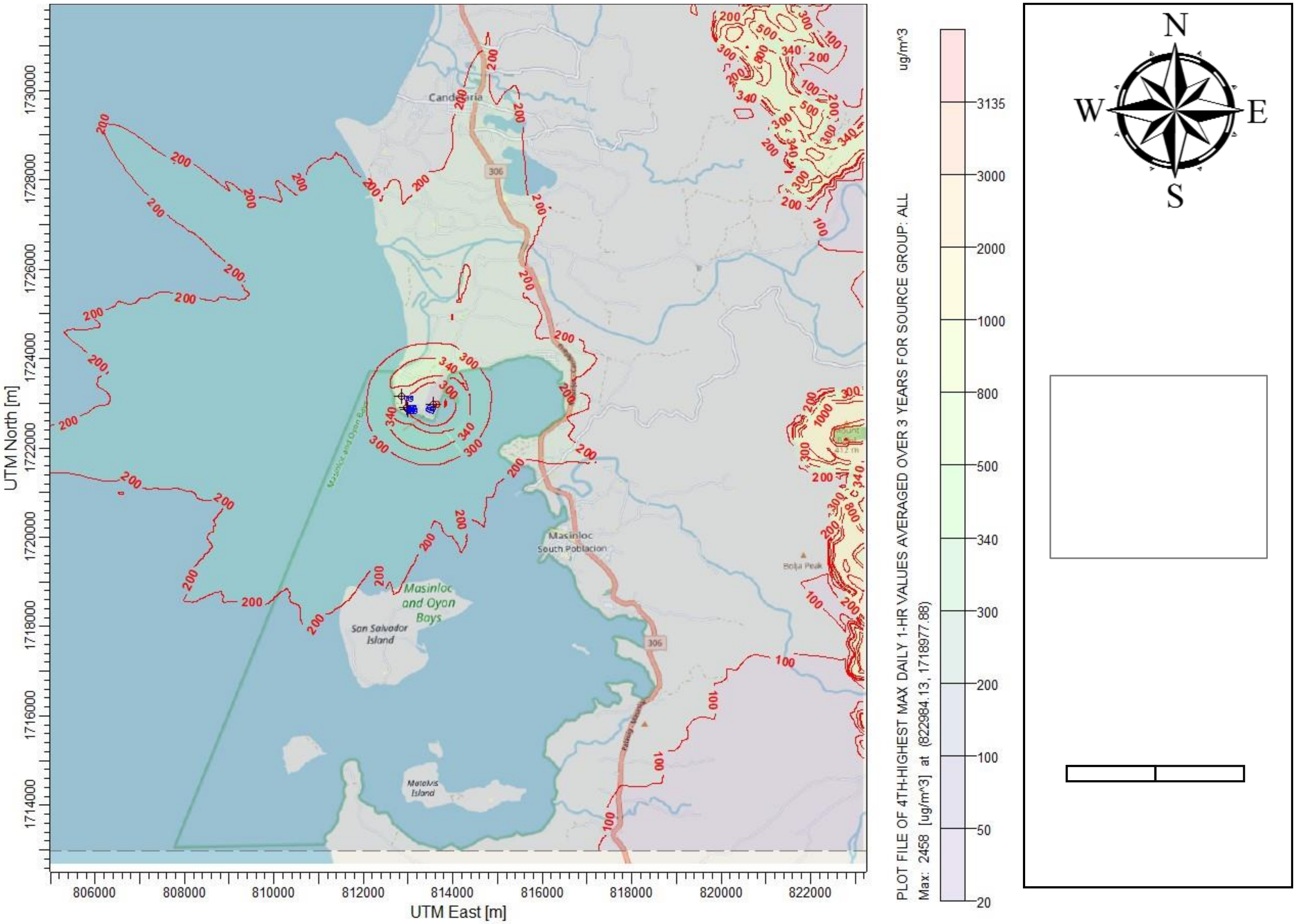


Figure 2-115. Predicted 4th highest maximum daily 1-hour values of SO_2 averaged over three (3) years emanating from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the guaranteed emission limit for SO2 of < 200 mg/Nm^3

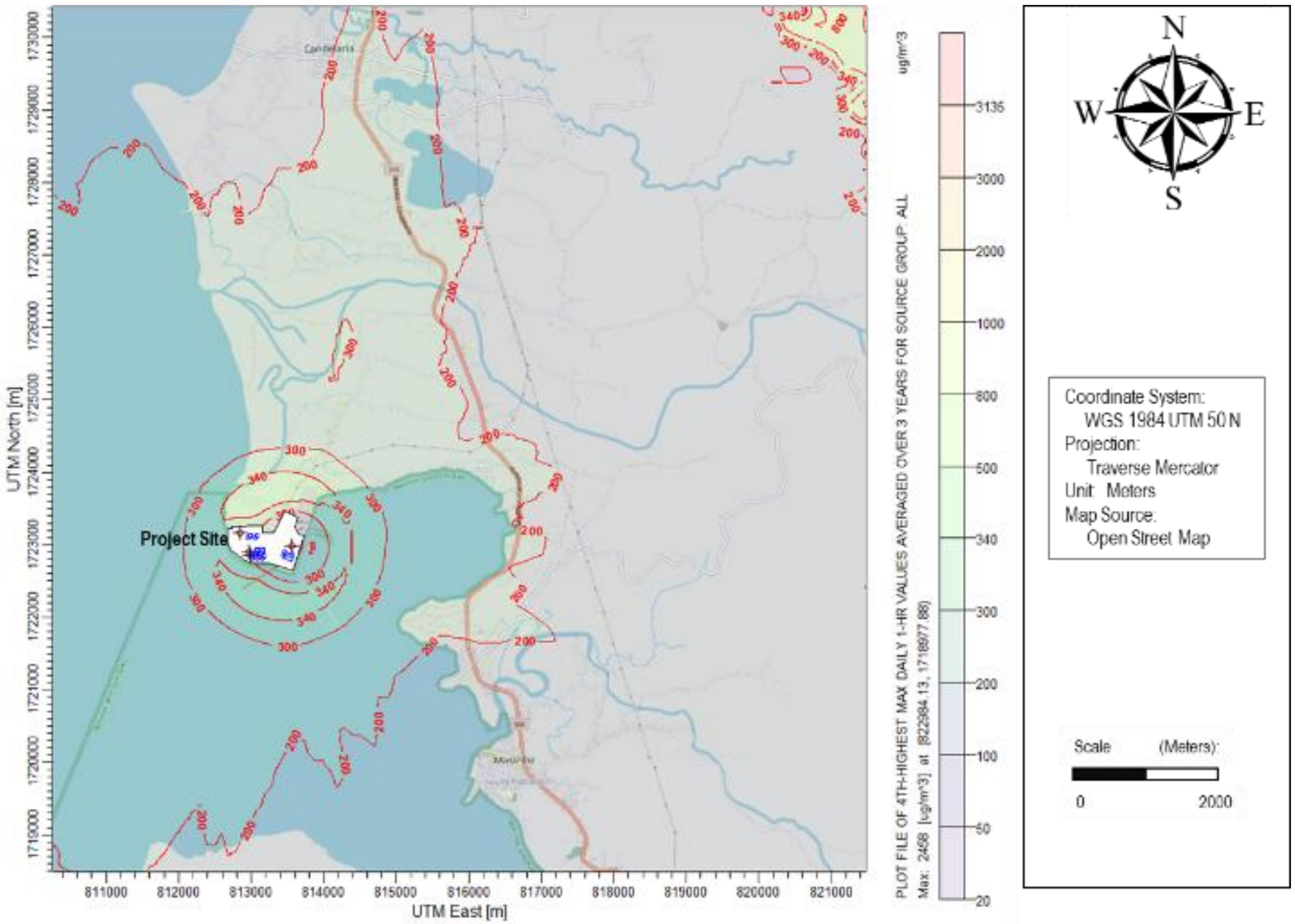


Figure 2-116. Closer view of the predicted 4th highest maximum daily 1-hour values of SO_2 averaged over three (3) years emanating from existing sources (Units 1, 2 and 3) and proposed sources (Units 4 and 5) with emissions from stack sampling (3rd party) for the existing sources and the guaranteed emission limit for SO2 of <= 200 mg/Nm^3

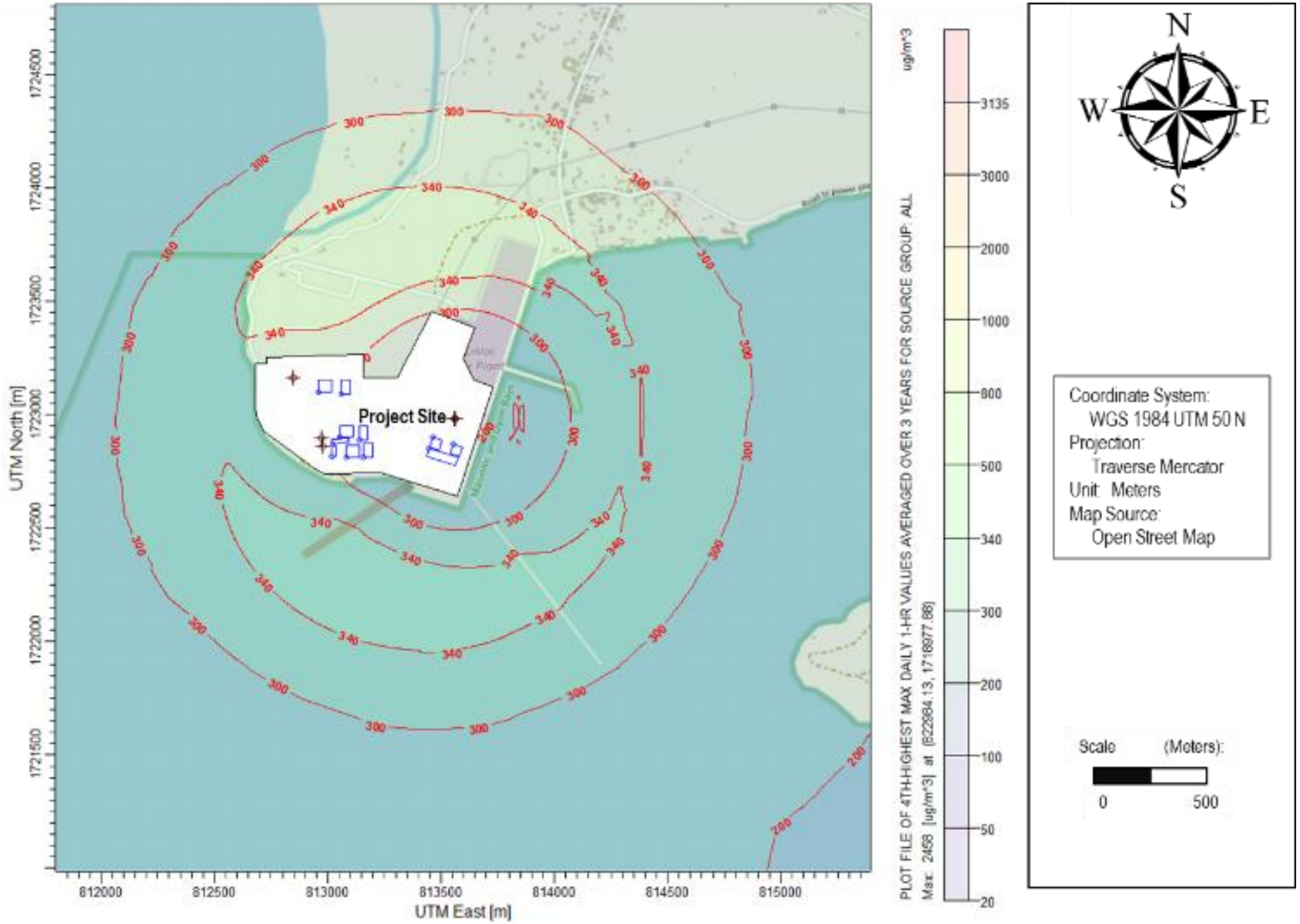


Figure 2-117. Predicted 4th highest maximum daily 1-hour values of SO_2 averaged over three (3) years in the vicinity of the sources (same as previous figures – Figure 1-25)

2.4 The People

2.4.1 Summary of Demographic Data

2.4.1.1 Demography, Population Growth Rate and Population Density

The Municipality of Masinloc is a First Class Municipality in the Second District of the Province of Zambales. It has a total population of 47,719 as of August 1, 2015, which reflects a 1.41% increase from its 2010 population of 44,342. According to the 2015 Census, the age group with the higest population in Masinloc is 5 to 9, with 5,422 individuals.

The barangays included in the DIA are Barangays Bani, Baloganon, and Taltal of the Municipality of Masinloc. The IIA include Barangay Binabalian and Lauis of the Municipality of Candelaria. All barangays are classified as rural barangays. **Table 2-63** shows the summary of population growth in the DIA.

Table 2-63: Population Growth Rate

	2007 Population	2010 Population	2015 Population	% Increase (Decrease)	Average Annual Growth Rate
Philippines	88,548,366	92,337,852	100,981,437	15.77	1.72
Zambales	493,085	534,443	590,848	13.73	1.79
Masinloc	40,603	44,342	47,719	2.21	1.41
Barangay Bani	2,811	3,529	3,972	3.88	2.28
Barangay Baloganon	6,180	6,346	6,783	3.21	1.28
Barangay Taltal	4,796	4,502	4,541	1.20	0.16

Source: Phillipine Statistics Authority, Census of Population 2007, 2010, 2015

It can be observed that there is a minimal increase in population for the three barangays. The population of Barangay Bani increased by 12.55% from 2010 to 2015, or 2.28% annually.For Barangay Baloganon, the increase is 6.89% for the period and 1.28% annually. Barangay Taltal registered an increase of 0.87% for 2010-2015 and an annual growth rate of 0.16% for the five year period. The increase in population and annual growth rate for Barangays Bani and Baloganon surpassed the Municipal average of 2.28% increase in population and 0.30% average annual growth. However, they are both below the provincial and national levels average rate of growth. The increases for Barangay Taltal are well below the municipal, provincial and national levels rate of growth. **Table 2-64**shows the population density per barangay.

Table 2-64: Population Density per Barangay

Barangay	2010			2015		
	Population (2010)	Area (km^2)	Population Density (per km^2)	Population (2015)	Area (km^2)	Population Density (per km^2)
Bani	3,529	5.30	666	3,972	5.30	749
Baloganon	6,346	7.49	847	6,783	7.49	906
Taltal	4,502	6.34	710	4,541	6.34	716

Source: PSA National Census of Population 2010, 2015; Masinloc Municipal Profile

2.4.1.2 Number and Size of Households by Barangay

Table 2-65 shows the estimated number of households and household size per barangay. Barangay Baloganon has the most number of households (1507) followed by Barangay Taltal (1193). Barangay Bani (682) has the least number of households among the DIA. All of them, however, registered an average household size of five members per household.

Table 2-65: Number and Household Size per Barangay

Barangay	Population (2015)	Number of Households (2015)	Average Household Size
Bani	3,972	794	5
Baloganon	6,783	1,357	5

Barangay	Population (2015)	Number of Households (2015)	Average Household Size
Taltal	4,541	908	5

Source: PSA National Census of Population 2010, 2015; Masinloc Municipal Profile

2.4.1.3 Gender and Age Distribution

Table 2-66, **Table 2-67** and **Table 2-68** show the age and gender distribution for each barangay. In all barangays, there are more males than females. The economically active group (15-64) comprises the majority of the population at 53.91%. Dependency ratio (i.e., the ratio of economically active group to non-economically active group, ages 0 to 14 and 65 above) is at 11.32.

Table 2-66: Age and Gender Distribution in Barangay Bani

Age Group	Male		Female		Total	
	Frequency	%	Frequency	%	Frequency	%
Under 1 year	46	1.36	44	1.28	90	2.27
1-4	206	6.03	195	5.73	337	8.48
5-9	259	7.61	242	7.11	404	10.17
10-14	235	6.89	226	6.62	423	10.65
15-44	735	21.58	731	21.46	1841	46.35
45-64	191	5.59	180	5.28	662	16.67
65 Above	61	1.78	57	1.68	215	5.41
Total	**1733**	**50.84**	**1675**	**49.16**	**3972**	**100**

Source: PSA National Census of Population 2015; Masinloc Municipal Profile

Table 2-67: Age and Gender Distribution in Barangay Baloganon

Age Group	Male		Female		Total	
	Frequency	%	Frequency	%	Frequency	%
Under 1 year	102	1.36	96	1.28	159	2.34
`1-4	454	6.03	432	5.73	574	8.46
`5-9	573	7.61	536	7.11	817	12.04
`10-14	519	6.89	499	6.62	746	11.00
15-44	1626	21.58	1617	21.46	2932	43.23
45-64	421	5.59	398	5.28	1170	17.25
65 Above	134	1.78	127	1.68	385	5.68
Total	**3831**	**50.84**	**3705**	**49.16**	**6,783**	**100**

Source: PSA National Census of Population 2010, 2015; Masinloc Municipal Profile

Table 2-68: Age and Sex Distribution in Barangay Taltal

Age Group	Male		Female		Total	
	Frequency	%	Frequency	%	Frequency	%
Under 1 year	81	1.36	76	1.28	93	2.05
`1-4	360	6.03	342	5.73	440	9.69
`5-9	454	7.61	424	7.11	518	11.41
`10-14	411	6.89	395	6.62	500	11.01
15-44	1287	21.58	1280	21.46	1881	41.42
45-64	333	5.59	315	5.28	824	18.15
65 Above	106	1.78	100	1.68	285	6.28
Total	**3033**	**50.84**	**2933**	**49.16**	**4541**	**100**

Source: Masinloc RHU, 2009

2.4.1.4 Municipal Income

Below is a chart that compares the Masinloc Municipality share of National Government Revenue with the Real Property Tax generated from the Masinloc Plant and fees generated from the operating permits of the Masinloc Plant (**Table 2-69**). It should be noted that prior to AES taking over of the Masinloc Plant in 2008, there was minimal tax generated from the Masinloc Plant to the local municipality due to NPC being a government owned entity and therefore was not liable for Real Property Tax.

Table 2-69: Municipal Income in terms of Internal Revenue Allotment

Calendar Year	Masinloc Share of National Government Revenue	Real Property Tax from Masinloc Plant	Operating Permits from Masinloc Plant
2008	PhP 52MM	PhP 10k	PhP 1MM
2009	PhP 68MM	PhP 155MM	PhP 9MM
2010	PhP 68MM	PhP 155MM	PhP 9MM
2011	PhP 74MM	PhP 311MM	PhP 9MM
2015		PhP 466MM	PhP 12MM
2018 (Est.)		PhP 621MM	PhP 15MM

Source: Masinloc LGU

From 1993 to 2008, the National Power Corporation (NPC) provided various socio-economic programs to the surrounding communities of Masinloc Power Plant, totalling PhP 282,000,000. The said program covered infrastructure projects such as asphalting of roads and bridges, construction of public elementary and high schools, installation of water system and improvements of barangay plaza.

Loan assistance was also provided to the Municipality of Masinloc under the same program to finance the construction of the Masinloc Public Market and concreting of economic zone roads.

Direct beneficiaries of NPC's said socio-economic program were the Province of Zambales; Municipalities of Masinloc, Palauig and Candelaria; Barangays Taltal and Bani. Meanwhile, the PhP 70,700,000 ER 1-94 projects funded under NPC time covered installation of streetlights in the Province of Zambales, construction of elementary schools, day care centers and multi-purpose hall; irrigation; livelihood projects; upgrading of health facilities and medical equipment; and procurement of ambulance.

From the time of acquisition of AES Philippines in 2008, the company has invested PhP 56,300,000 for National and Local CSR Programs. The company has also facilitated access to ER 1-94 funds so far amounting to PhP 7,400,000 for purchase of garbage trucks (Masinloc) and renovation and extension of the Bani covered court.

These socio-economic programs and ER 1-94-funded projects helped the Province of Zambales and Municipalities of Masinloc, Candelaria and Palauig in providing the needed support to the education system, improving the road infrastructure and irrigation system, and broadening livelihood opportunities for the community.

In terms of barangay electrification, the Province of Zambales is 100% energized and is currently implementing a street lighting program through the electrification projects funded under ER 1-94.

In conclusion, the presence of the Masinloc Power Facility and its socio-economic program over the years has been instrumental in helping to elevate Masinloc to become a first class municipality. In terms of revenue collections, Masinloc placed 3rd in the Province of Zambales and 42nd in the Regional level.

2.4.2 Household Socio-economic Profile and Perception Survey Results

Aside from the above general demographic profile, the study included a socio-economic/perception survey which was undertaken to establish a more detailed demographic, socio-economic, health and environmental profile of the communities in the DIA. The study was also conducted to determine the awareness level and the perception of the Project.

For the actual sampling of respondents, 10% of the households for each of the barangays in the DIA were selected using a ten page questionnaire. The survey covered 292 households broken down as follows: (i) 70 in Barangay Bani, (ii) 126 in Barangay Baloganon and (iii) 96 in Barangay Taltal.

2.4.2.1 Barangay Bani

2.4.2.1.1 Respondents' Profile

In Barangay Bani, 45 of the 70 respondents are male, while the rest are female. The respondents are between the ages of 18 to 73 years old. Half of the respondents are between the ages of 29 to 50 years old while 17.14% are in the 18 to 29 year old age group and the remaining 31.43% are 51 years old and above. Majority of the respondents are married (81.43%), while the single and widowed comprises of 2.86% of the respondents.

In terms of highest level of education reached, most of the respondents are High School graduates (47.14%). Only six (8.57%) finished College while 12 (17.14%) reached the College Level. Majority of the respondents are Roman Catholics (70%) followed by Iglesia Ni Cristo (14.29%). There are also Protestants (8.57%) and Baptists (2.86%) among the respondents.

Half of the respondents have not lived in other places and were born in the barangay. The rest have lived in other barangays within Masinloc (24.24%), other municipalities within Zambales (18.18%), other provinces within Region 3 (21.21%) or other places outside of Region 3(18.18%).

2.4.2.1.2 Household Characteristics

The average household size for the barangay is five members per household. **Table 2-70** shows the household size distribution for the barangay.

Table 2-70: Household Size in Barangay Bani

Household Size	Frequency	%
1	0	0.00
2	4	5.71
3	9	12.86
4	16	22.86
5	15	21.43
6	8	11.43
7	11	15.71
8	1	1.43
9	1	1.43
10	4	5.71
11	1	1.43
Average Household Size	**5**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-71 shows the age distribution in the barangay. It can be observed that those between the agesof 0 to 4 year old make up 35.42% of the surveyed population, while those above the age of 65 comprise6.54% of the surveyed population. With the economically active part of the population between the ages of15 to 64 years old, which are pegged at 58.04%, this would result in a dependency ratio of0.72.

Table 2-71: Age Distribution in Barangay Bani

Age Distribution	Frequency	%
Age 0-4	47	12.81
Age 5-9	39	10.63
Age 10-14	44	11.99
Age 15-19	32	8.72
Age 20-24	34	9.26
Age 25-29	28	7.63
Age 30-34	22	5.99
Age 35-39	23	6.27
Age 40-44	28	7.63
Age 45-49	16	4.36
Age 50-54	10	2.72
Age 55-59	15	4.09

Age Distribution	Frequency	%
Age 60-64	5	1.36
Age 65-69	11	3.00
Age 70-74	4	1.09
Age 75 up	9	2.45

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

In terms of level of education completed, 19 (13.29%) of the members of the household between ages6 to 24 years old have not received any formal education. Within the same age group, 54 (37.76%) are in elementary, 47 (32.87%) are in High School, and 14 (9.79%) are in college. Six (4.20%) finished college, while three finished vocational studies. Of those belonging to the 6 to 24 age group, 101 (75.37%) are studying, while 17 (12.69%) are not. Among the reasons cited by the respondents for not studying, are financial difficulties and lack of interest.

2.4.2.1.3 Household Income and Expenditure

In terms of employment, there are 47 respondents (22.60%) that are not employed, while 38 (18.27%) are employed and 23 (11.06%) are self-employed. Seven (3.37%) of the households are involved withfarming, while 34 (16.35%) of the households are involved withfishing. Other sources of income include running their own businesses (7 or 3.37%), pension/retirement funds (5 or2.43%) and land rental (1 or 0.49%). It is observed that fishing ranks next to employment as the source of income among the households.**Table 2-72** shows the summary of employment status in the barangay.

Table 2-72: Sources of Income in Barangay Bani

Employment Status	Frequency	%
Not Employed	47	22.60
Housewife	27	12.98
Student	19	9.13
Employed	38	18.27
Self Employed	23	11.06
Farming	7	3.37
Fishing	34	16.35
Business	7	3.37
Rental	1	0.48
Pension	5	2.40
Average Income	**PhP 9,303.72**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Farm sizes range from 0.50 to 8 ha. Four (57.14%) of the farmlands are irrigated while three are rain-fed. Four of the farmers harvest twice a year, while three of the farmers harvest only once a year.

The average income for the households is PhP 9,304.The annual per capita poverty threshold in 2007 for the Province is PhP 15,295 (NSCB, 2007). With this figure, then, a family of five in the Province of Zambales should have at least a monthly income of PhP 6,372 to meet their basic needs.**Table 2-73** shows more than half (56.89%) of the households having a monthly income of PhP 7,000 and below. This group now represents those living below the poverty line.

Table 2-73shows the income distribution in the barangay. It can be observed that a large number (31%) of the respondents earn less than PhP 4,000 a month, followed by 26% of the respondents earning between PhP 4,001-PhP 7,000.

Table 2-73: Income Distribution in Barangay Bani

Income Distribution	Frequency	%
4,000 below	18	31.03
4,001-7,000	15	25.86
7,001-10,000	6	10.34
10,001-13,000	6	10.34
13,001-16,000	5	8.62

Income Distribution	Frequency	%
16,001-20,000	2	3.45
20,001-23,000	0	0.00
23,001-26,000	1	1.72
26,001-29,000	2	3.45
29,001-40,000	3	5.17
40,001 and above	0	0.00
Total	58	100.00
Average Monthly Income = PhP 9,304		

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-74shows the monthly household expenditure. The largest expense allocated is for food, followed by non-food groceries and expenses for education. The monthly average expenditure is PhP 7,059.

Table 2-74: Monthly Household Expenditure in Barangay Bani

Expenses	PhP	%
Food	3,127.42	44.30
Education	1,374.95	19.48
Groceries (excluding food)	1,452.42	20.58
Electricity	758.23	10.74
Water	58.87	0.83
Clothes	148.39	2.10
Rent	24.19	0.34
Tax	24.40	0.35
Loan Amortization	60.97	0.86
Rest and Recreation	20.97	0.30
Other Expenses	8.06	0.11
Average Monthly Expense	**PhP 7,059**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.1.4 Health and Sanitation

In terms of health, the most commonly experienced illnesses over the last five years include cough (52.08%), headache/migraine (37.05%), influenza (30.21%), common colds (14.58%) and hypertension (14.58%). In terms of causes of deaths, the most prominent is heart problems (25%), followed by hypertension (18.75%), diabetes (12.5%), cancer (12.5%) and pneumonia (6.25%). **Table 2-75** shows the summary of the causes of illness and death in the barangay.

Table 2-75: Top Causes of Illnesses and Deaths in Barangay Bani

Causes of Illnesses	Frequency	%
Cough	50	52.08
Headache / Migraine	36	37.50
Influenza (Flu)	29	30.21
Common cold	14	14.58
Hypertension	14	14.58
Asthma	7	7.29
Diarrhea	5	5.21
Skin rashes/Allergy	4	4.17
Urinary Tract Infection	4	4.17
Sinusitis, Loss of Smell	3	3.13
Causes of Death	**Frequency**	**%**
Heart Problem	4	25.00
Hypertension	3	18.75
Diabetes	2	12.50
Cancer	2	12.50
Pneumonia	1	6.25
Old Age	1	6.25
Hydrocephalus	1	6.25

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Most of the respondents avail of the services of the Rural Health Unit in the town center for their regular consultation and medical needs. For serious cases, they are referred to either the District Hospital in Candelaria, which is approximately 15 minutes away, or the Provincial Hospital in Iba, approximately 1 hour from the town proper. The most common medicines taken by respondents are: paracetamol (44.29%), Biogesic (28.57%) and Bioflu (21.43%). These medicines are available in drugstores (72.86%) or sari-sari stores (18.57%).

When it comes to drinking water, majority (77.14%) get their drinking water from pumped wells while 11 or 8.43% get theirs from artesian wells. Only a few, 8.57%, access water from bottled sources. For domestic purposes (cooking, bathing, and cleaning) 92.86% of households use pumped wells. **Table 2-76** shows the summary of water sources for the barangay.

Table 2-76: Water Source for Drinking and Domestic Use in Barangay Bani

Source of Drinking Water	Frequency	%
Pumped wells	54	77.14
Artesian Well	8	11.43
Bottled water	6	8.57
Spring	1	1.43
Water Vendor	1	1.43
Water for household chores		
Pumped wells	65	92.86
Public Artesian Well	3	4.29
Pressure tank	1	1.43
Other sources	1	1.43

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

For sanitation facilities, most of the respondents have water sealed toilets (70%), while 16 or 22.86% use open pit type of toilets (**Table 2-77**).

Table 2-77: Toilet Facilities in Barangay Bani

Toilet Type	Frequency	%
Water Sealed	49	70.00
Open Pit	16	22.86
Others	1	1.43

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Burning is the most prevalent method of waste disposal in the Barangay (47.14%) followed by open pit dumping (45.71%). Only four mentioned that waste is collected by the Local Government Unit (LGU), while one of the respondents disposes their garbage by throwing it in a river.

Table 2-78: Waste Disposal Method in Barangay Bani

Waste Disposal	Frequency	%
Burned	33	47.14
Collected by LGU	4	5.71
Open Pit	32	45.71
Thrown in river	1	1.43

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Based on the observation of the enumerators, pigpens significantly contribute to the foul smell in the surveyed households (24.29%). This is followed by chicken pens and stock piles of garbage (both at 8.57%). The Masinloc Plant is perceived as a source of air pollution in the community by a few respondents (5.71%).

Tricycles are cited as one of the primary contributors tonoise pollution in the barangay (38.57%). This is followed by jeepneys and trucks (14.29%). Meanwhile, the Masinloc Plant is also perceived as a source of noise pollution by a few respondents (10%). **Table 2-79** shows the summary of the sources of noise and air pollution.

Table 2-79: Perceived Sources of Air and Noise Pollution in Barangay Bani

Source of Air Pollution	Frequency	%

Source of Air Pollution	Frequency	%
None	8	11.43
Pigpen	17	24.29
Chicken coop	6	8.57
Stock of Garbage	6	8.57
Masinloc Plant	4	5.71
Stagnant water	3	4.29
Fishpond	3	4.29
Public toilet	1	1.43
Ulingan	1	1.43
Source of Noise	**Frequency**	**%**
None	0	0.00
Tricycles	27	38.57
Jeepney/Trucks	10	14.29
Masinloc Plant	7	10.00

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.1.5 Housing Characteristics/Other Social Amenities

The average size of a housing unit in the barangay is 116.76 m^2 with 56% of the housing units measuring less than $100m^2$. The average number of rooms and bedrooms is two per housing unit.

The most common type of flooring material is concrete (75.71%), followed by soil (11.43%) and tiles (4.29%). On the other hand, most of the walls of the houses are concrete (71.43%). Some households, however, use wood (24.29%), nipa and bamboo (1.43% each) depending on their budget.

A large majority of the households are powered by electricity (94.29%). Only a few households currently use gas lamps (4.29%). Firewood is mostly used by households for their cooking requirements (67.14%), followed by kerosene (28.57%) and electricity (1.43%).

TV is the most commonly owned appliance (74.29%), followed by electric fans (70%) and VCD/DVD players (61.43%). With such amenities, households enjoy recreational activities comfortably inside their homes without extra costs.

2.4.2.1.6 Knowledge and Perception of the Project

Majority of the respondents have heard or have knowledge of the Project (57%), while the rest (40%) have no idea about the Project. Those who know about the Project cited (i) expansion (47.50%), (ii) additional 300MW (30%), and (iii) additional capacity (12.5%) as the components of the Project.

Majority source their Project information from local officials (75%). Only three mentioned that the Proponent as their source of information. **Table 2-80**shows the respondents' knowledge of the Project and their sources of information.

Table 2-80: Knowledge of the Project and Sources of Information in Barangay Bani

Knowledge of the Project	Frequency	Percentage
Knows about the Project	40	57.14
Does not know about the Project	28	40.00
Did not answer	2	2.86
What they know about the Project		
Expansion	19	47.50
Additional 300MW	12	30.00
Additional Capacity	5	12.50
Additional Electricity Power	2	5.00
Additional Plant	1	2.50
Construction of Additional 600MW	1	2.50
Source of Information		
Radio/TV	2	4.55
Local Officials	33	75.00

Proponent	3	6.82
NGO/PO	2	4.55

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

When asked if the Project is beneficial to them, majority answered positively (74.29%), while 11 (15.71%) responded otherwise. Among the perceived benefit of the Project are additional employment (75.71%), income and livelihood (5.71% each). Only two mentioned that there is no Project benefit that they can think of.

Of the 70 respondents, 54.29% mentioned that the Project may have negative impacts, while 38 (40%) answered otherwise. The negative impacts cited include air pollution (81.58%), environmental destruction (13.16%) and water pollution (7.89%).

When asked if these negative impacts can be avoided or prevented, 70.83% of those perceiving negative impacts said it can be avoided. Further asked how the negative impacts can be avoided, some of the answers given are the following: (i) monitor waste properly/not to dump it out to the sea (ii) ensure safety/build properly, (iii) follow proper procedures, (iv) not to proceed with the Project. **Table 2-81**shows responses to prevention of negative impacts.

Table 2-81: Perceived Ways to Avoid Negative Impacts

Are these negative impacts preventable?	Frequency	%
Yes	34	70.83
No	14	29.17

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

When asked if they still favor the implementation of the Project after considering both perceived positive and negative impacts, majority of the respondents (44 or 62.86%) are in favor. Only 15 or 21.43% seemed not to favor the implementation. There are 11 (15.71%) who did not answer.

According to the respondents, employment and increase in income are the primary reasons why they are in favor of the Project.
On the other hand, perceived negative effects on the environment and diminishing fish catch are some of the reasons cited of why the Project should not push through. **Table 2-82** shows the reasons given by those in favor and thoseagainst the Project.

Table 2-82: Summary of Reason for Favoring/Opposing the Project in Barangay Bani

Are you in favor of implementing the project	Frequency	%
No	15	21.43
Yes	44	62.86
No answer	11	15.71
If No, Why?		
It will destroy the environment	5	33.33
It will diminish fish catch	2	13.33
It will further pollute the environment	1	6.67
Because there will be relocation	1	6.67
Environmental destruction	1	6.67
If Yes, why?		
Employment	34	77.27
Additional income and employment	5	11.36
Assistance to the barangay	1	2.27
Development of our community	1	2.27

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

When asked for other comments, some of the respondents mentioned that there should be a fair basis for employment. If the Project will not harm nor destroy the environment, some respondents mentioned that they would favor the Project. Others mentioned that the Project should use pollution-free technology. There were also some who suggested that the Proponent provide free electricity if the Project proceeds. On the other hand, there are those who said that more studies on the effect of the Project on the people and the environment should be conducted before continuing with the Project.

2.4.2.2 Barangay Taltal

2.4.2.2.1 Respondent's Profile

In Barangay Taltal, there are a total of 96 respondents. Of the 96 respondents, 69.79% are male while the rest are females.

The age of the respondents ranges from 25-74 years old. The age group, 45 to 54 years old, accounts for the largest proportion among the respondents at 32.29%, followed by those in the 34 to 44 years old age group, at 27.08%. The 25 to 34 years old age group comprises about 30.83% while the 55 to 64 years old age group makes up 12.5%. The smallest proportion (7.29%) represents the 65 to 74 years old age group.

Majority of the respondents (88.54%) are married while six are widowed (6.25%) and two are single (2.08%).

In terms of education, most of the respondents are High School graduates (43.75%). There are 14 (14.58%) who reached College level and 11 (11.46%) who actually finished College. The rest reached only High school level (7.29%), Elementary graduate (15.63%) or elementary levels (5.21%).

An overwhelming majority of respondents are Roman Catholic (87.5%). Other religion in the present in the barangay includes Baptists (8.33%) and Protestants (1.04%).

Majority (62.5%) of the respondents have not lived in any other place while 35 of the respondents have lived in other barangays in Masinloc (50%), other municipalities in Zambales (9%), other provinces in Region 3 (5.56%) or other places outside Region 3 (19.44%).

2.4.2.2.2 Household Characteristics

Table 2-83 shows the household size for Barangay Taltal. The average household size for the barangay is 5 members per household.

Table 2-83: Household Size in Barangay Taltal

Household Size	Frequency	%
1	1	1.04
2	7	7.29
3	16	16.67
4	17	17.71
5	24	25.00
6	16	16.67
7	7	7.29
8	4	4.17
9	1	1.04
10	1	1.04
11	1	1.04
12	1	1.04
Average Household Size	**5**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-84 below shows the age distribution of respondents' household in Barangay Taltal. It can be observed that the economically active group of the household population (between the ages of 15 to 64 years old) makes up around 64% while the young dependents(between the ages of 0 to 14 years old) comprise 31.56%. The old dependents (above the age of 65) comprise only 6% of the respondents' household members. With these figures, the over-all dependency ratio is 0.58.

Table 2-84: Age Distribution in Barangay Taltal

Age Distribution	Frequency	%
Age 0-4	46	9.81
Age 5-9	53	11.30
Age 10-14	49	10.45

Age Distribution	Frequency	%
Age 15-19	58	12.37
Age 20-24	42	8.96
Age 25-29	37	7.89
Age 30-34	27	5.76
Age 35-39	33	7.04
Age 40-44	35	7.46
Age 45-49	25	5.33
Age 50-54	20	4.26
Age 55-59	11	2.35
Age 60-64	14	2.99
Age 65-69	8	1.71
Age 70-74	5	1.07
Age 75 up	6	1.28

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

In terms of educational attainment of household members, for those 6-24 years of age, 7.92 % are college graduates while 30 or 14.85% are in the college level. A total of 123 (60.89%) individuals from the same age group are still studying while 13.37% do not go to school. Financial reason is cited as a significant cause for non-schooling among the respondents.

2.4.2.2.3 Household Income and Expenditure

Of the economically productive age group 15 to 64 years old, 57 or 35.19% are employed while 29 or 17.90% are not employed. About 21.6%consider themselves as self-employed while 4.32% are engaged in professional work. There are 22 (13.58%) households engaged in farming and another 12 (7.41%) households are engaged in fishing. **Table 2-85** shows the summary of employment status in the barangay.

Table 2-85: Employment Status in Barangay Taltal

Employment Status	Frequency	%
Not Employed	29	17.90
Employed	57	35.19
Self Employed	35	21.60
Professional	7	4.32
Farming	22	13.58
Fishing	12	7.41
Average Income	**PhP 8,394.03**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Land allocated for farming ranges from 0.02 ha to 1.50 ha. Of this, 12 or 54.55% are irrigated while the remaining eight or 36.36% are rain-fed. Also, 63.64% (14) of those engaged in farming harvests twice a year while the remaining six (27.27%) harvests only once a year.

The average monthly income for the households is PhP 8,394. Considering the minimum monthly requirement of PhP 6,372 for a family of 5 members or poverty threshold for the province to meet household's food and non-food items(NSCB, 2007), there are about 55% of the households who are below the poverty line.

In Barangay Taltal, 37% of the respondents earns below PhP 4,000 while 21% earns somewhere between PhP 7,001 to PhP 10,001. This is followed by those who earn between PhP 4,001 to PhP 7,000 (18%). The rest is summarized in **Table 2-86**.

Table 2-86: Income Distribution in Barangay Taltal

Income Distribution	Frequency	%
4,000 below	29	37.17
4,001-7,000	14	17.95
7,001-10,000	16	20.51
10,001-13,000	5	6.41
13,001-16,000	4	5.13
16,001-20,000	4	5.13

Income Distribution	Frequency	%
20,001-23,000	3	3.85
23,001-26,000	-	0
26,001-29,000	1	1.28
29,001-40,000	2	2.56
40,001 and above		0
Total	78	100
Average Monthly Income = PhP 8.394		

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-87 below shows the distribution of household expenditure for the barangay. The largest household expenditure is allocated to food (38.8)4% followed by education (25.70%) and non-food groceries (13.10%). The average household expenditure for the barangay is at PhP 7,473.

Table 2-87: Monthly Household Expenditure in Barangay Taltal

Expenses	PhP	%
Food	2,902.44	38.84
Education	1,920.43	25.70
Groceries (excluding food)	978.66	13.10
Electricity	592.93	7.93
Water	25.18	0.34
Clothes	287.80	3.85
Rent	80.30	1.07
Tax	81.10	1.09
Loan Amortization	459.17	6.14
Rest and Recreation	80.49	1.08
Other Expenses	64.63	0.86
Average Monthly Expense	**PhP 7,473**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.2.4 Health and Sanitation

Table 2-88 below shows the top causes of morbidity and death for the last five years in Barangay Taltal. In terms of morbidity, top causes include cough (76.04%), sneezing/blocked nose (38.54%), headache (22.93%), diarrhea (20.83%) and Influenza (17.71%).

In terms of causes of deaths, the leading causes are heart disease (40%) followed by pneumonia (20%). One case each for cardiac arrest, asthma liver disease and stroke had been recorded.

Table 2-88: Top Causes of Morbidity and Deaths in Barangay Taltal

Causes of Morbidity	Frequency	%
Cough	73	76.04
Sneezing, running or blocked nose	37	38.54
Headache / Migraine	22	22.92
Diarrhea	20	20.83
Influenza (Flu)	17	17.71
Asthma	15	15.63
Skin rashes/allergy	13	13.54
Itching or watering of the eyes	12	12.50
Sinusitis, loss of smell	8	8.33
Allergic rhinitis	7	7.29
Causes of Death		
Heart Disease	4	40.00
Pneumonia	2	20.00
Cardiac Arrest	1	10.00
Asthma	1	10.00
Liver Disease	1	10.00
Stroke	1	10.00

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

A third (33.33%) of the respondents avails of the services of the Rural Health Unit in the town proper. The Candelaria District Hospital is also accessed by the residents since it is near their residence (30.21%). The rest utilizes the services of the Barangay Health Station (14.58%) and the Provincial Hospital in Iba (15.63%) for the more serious cases.

The most frequent medicine taken is paracetamol, used by 68.75% of the respondents. This is followed by amoxicillin (27.08%) and other antibiotics (21.88%). carbocisteine (15.63%) and biogesic (13.54%). Medicines are acquired mostly in drugstores (76.04%) and sari-sari stores (8.33%). There are also those who get them from barangay health centers (5.21%) and the municipal health center (7.29%).

In terms of water sources for drinking, the most common is deep well/jetmatic source (71.88%). Only a few use spring water for drinking purposes (18.75%). For domestic use, the respondents widely depend on deep wells (90.63%) while some on public artesian wells (8.3%). **Table 2-89** shows the summary of water sources used in the barangay.

Table 2-89: Water Source for Drinking and Domestic Use in Barangay Taltal

Source of Drinking Water	Frequency	%
River	2	2.08
Spring	18	18.75
Deep well/jetmatic	69	71.88
Faucet	1	1.04
Water Tank	1	1.04
Water for household chores		
Deep well/Jetmatic	87	90.63
Public Artesian Well	8	8.33

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

In terms of toilet facilities, majority (88.54%) of the respondents use water sealed toilets while there are only 6.25% that still use the open pit type (**Table 2-90**).

Table 2-90: Toilet Facilities in Barangay Taltal

Toilet Type	Frequency	%
Water Sealed	85	88.54
Open Pit	6	6.25

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-91 shows that burning is the most prominent type waste disposal in the barangay (50%). This is followed by garbage collection undertaken by the LGU (31.25%). Open pit dumping is practiced 14 of the respondents.

Table 2-91: Method of Waste Disposal in Barangay Taltal

Waste Disposal	Frequency	%
Burned	48	50.00
Collected by LGU	30	31.25
Open Pit	14	14.58
Thrown in river	1	1.04

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

The most common perceived sources of air pollution in the barangay are pigpens (21.88%), followed closely by fishponds (20%) and domestic waste/stock garbage (11.46%)

In terms of noise pollution, the most prominent seen sources are jeepneys/trucks (41.67%), followed by tricycles (27%).**Table 2-92** shows the summary of the sources of noise and air pollution in the Barangay.

Table 2-92: Perceived Sources of Air and Noise Pollution in Barangay Taltal

Source of Air Pollution	Frequency	%
None	32	33.33
Pigpen	21	21.88

Fishpond	20	20.83
Stock of Garbage	11	11.46
Stagnant Water	4	4.17
Chicken pen	2	2.08
Public Toilet	1	1.04
Source of Noise	**Frequency**	**%**
None	21	21.88
Jeepney/Trucks	40	41.67
Tricycles	26	27.08
Pub/Restaurant/Disco	3	3.13
Machine Shop	2	2.08

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.2.5 Housing Characteristics

The average number of rooms per housing unit in the barangay is two. The average house area is 245.71 m^2, 52% of which is below 100m^2.

The most common flooring material is plain cement (76%). Others are made of wood (7%) and bamboo (6.25%) while a few use plain soil for flooring (5.21%). The walls are mostly concrete (63.54%), followed by wood (15.63%) and nipa (7.29%).

In terms of lighting source, most of the households have electrical connections (90%) while 8.33% use gas lamp. For cooking, firewood is commonly used (65.63%) while some use kerosene (29%). Only two use electrical stoves for cooking.

2.4.2.2.6 Knowledge and Perception of the Project

Of the 96 respondents, 46% have mentioned that they have heard about the Project while a relatively bigger proportion (50%)said that they have no idea about the Project.

Those who knew about the Project mentioned that it is the Phase 2 or expansion of the power plant (48%).

The primary sources of information about the Project are the local officials (45%). On the other hand, some 34% got their information from the Project Proponent. **Table 2-93**shows the summary of respondents' knowledge and source of information about the Project.

Table 2-93: Knowledge of the Project and Sources of Information in Barangay Taltal

Knowledge of the Project	**Frequency**	**%**
Knows about the Project	44	45.83
Does not know about the Project	48	50.00
Did not answer	4	4.17
Phase 2 Expansion	21	47.73
Bad Effects on the Environment	1	2.27
No Answer	22	50.00
Source of Information		
Radio/TV	1	2.27
Newspaper	1	2.27
Local Officials	20	45.45
Project Proponent	15	34.09
Private persons	0	0.00
NGO/PO	3	6.82

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

When asked if the project is beneficial for the households, 44% answered in the affirmative while 40% think otherwise. Majority (58%) cited employment as the most important benefit from the Project.

When asked if the project has negative impacts, majority (62.5%) were positive about it. Further asked if the negative impacts can be avoided, 45% said that negative impacts can be avoided. Various measures were cited including (i) following safety procedures, (ii) proper use of chemicals, (iii) proper waste disposal and (iv) employing best practices. Some however, implored not to proceed with the project. **Table 2-94** shows the summary of perceived ways to avoid negative impacts.

Table 2-94: Perceived Ways to Avoid Negative Impacts

Are these negative impacts preventable?	Frequency	%
Yes	45	62.50
No	27	37.50

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Almost half of the respondents (47.92%) are in favor of implementing the Project while 32.39% are against it. There are 19, respondents who did not provide any answer.

Adverse health effects (62%); negative impacts on the environment (26%) and benefitting only a few (10%) were among the reasons cited by those who believe the Project should not push through.

On the other hand, employment is the primary reason for those who think the Project should be continued. Prioritized for hiring should be the local residents, according to some respondents. A summary of the reasons of those in favor and against the Project is shown below (**Table 2-95**).

Table 2-95: Summary of Reasons for Favoring/Opposing the Project in Barangay Taltal

Are you in favor of implementing the Project	Frequency	%
No	31	32.29
Yes	46	47.92
No answer	19	19.79
If No, Why?		
Adverse health effect	19	61.29
Bad effect on the environment	8	25.81
Only others will benefit the Project	3	9.68
If Yes, why?		
Employment	43	93.48
Additional tax collection	1	2.17
It's good for everyone	1	2.17
It cannot be stopped anyway	1	2.17

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Asked for other comments for the Project, respondents in Barangay Taltal mentioned that there should be fair basis for employment and residents should be prioritized during hiring. Others mentioned that the Proponent, in general, must provide assistance to the barangay, specifically free water system and electricity for the resident. Others settled for lowered/ subsidized electricity rates if the Project proceeds. There are also some who mentioned that negative effects on health and environment should be avoided/ minimized if the Project is to proceed. Other stressed that safety procedures and applicable laws should be followed by the Proponent.

2.4.2.3 Barangay Baloganon

2.4.2.3.1 Respondents' Profile

In Barangay Baloganon, a total of 126 respondents were interviewed. Of this, 81 or 64.29% are female while the remaining 45 are males.

Those in the 44 to 55 years old age bracket represent the largest group among the respondents, accounting for 27.78%. This is followed by the 32 to 43 years old age group, comprising about 24.60% and the 56 to 67 years old age group, consisting of 18.25%. A relatively smaller proportion is observed among the 19 to 31 years old age group, represented by only 11%; while the smallest percentage (6%) is represented by the 68 to 79 years old age group.

Majority of the respondents are married (101 or 80.16%) while 13 (10.32%) are widowed. Only a few (4.76%) are single and one (0.79%) is separated.

Most of the respondents are high school graduates (46.88%), while 15 (11.90%) reached college level but did not finish. About 23.96% of the respondents finished college education. Some are elementary graduates (12 or 12.5%), while others only reached elementary level (10 or 10.42%). There were three respondents who did not receive any formal education.

In terms of religious affiliation, majority of the respondents are Roman Catholic (107 or 84.29%). Other denominations include Baptist (11 or 8.73%), Iglesia Ni Cristo and Protestant (1 or 0.79% each).

Only 36 (28.57%) of the respondent have lived outside the barangay, while majority (53.97%) have not lived in other places. Of those who have lived elsewhere(22.22%) have lived in other barangays in the municipality, nine (25%) have lived in other towns in Zambales, seven (19.44%) have lived in other provinces in Region 3 and nine (25%) have lived in other places outside Region 3.

2.4.2.3.2 Household Characteristics

Table 2-96shows the household size in Barangay Baloganon. The average household size in the barangay is 5 members per household.

Table 2-96: Household Size in Barangay Baloganon

Household Size	Frequency	%
1	3	2.38
2	12	9.52
3	15	11.90
4	26	20.63
5	30	23.81
6	21	16.67
7	9	7.14
8	3	2.38
9	3	2.38
10	2	1.59
17	1	0.79
Average Household Size	**5**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-97shows the age distribution in the barangay. The young dependent age group (0 to14 years old) in the barangay comprises about 30.54% of the population while the old dependents (65 years old and above) account for only 5.6%. The biggest group, economically active population (15 to64 years old)), comprises about 63.76%. Based on this age structure, the dependency ratio is pegged at 0.57.

Table 2-97: Age Distribution in Barangay Baloganon

Age Distribution	Frequency	%
Age 0-4	58	9.73
Age 5-9	62	10.40
Age 10-14	62	10.40
Age 15-19	55	9.23
Age 20-24	60	10.07
Age 25-29	43	7.21
Age 30-34	44	7.38
Age 35-39	41	6.88
Age 40-44	39	6.54
Age 45-49	33	5.54
Age 50-54	27	4.53
Age 55-59	23	3.86
Age 60-64	15	2.52
Age 65-69	16	2.68
Age 70-74	11	1.85

Age Distribution	Frequency	%
Age 75 up	7	1.17

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.3.3 Household Income and Expenditure

About one third (94 or 31.76%) of household members are not employed. For those with occupation, 58 or 19.59% are employed while 74 or 25% are self-employed. Ten are engaged in professional work. Nine households are engaged in farming while 51 or 17.23% are engaged in fishing.

Self-employment makes up for the bigger source of income compared to regular employment. On the other hand, fishing is a more prevalent economic activity among the households compared to farming.
Table 2-98 shows the summary of employment for the barangay.

Table 2-98: Summary of Employment Status in Barangay Baloganon

Employment Status	Frequency	%
Not Employed	94	31.76
Employed	58	19.59
Self Employed	74	25.00
Professional	10	3.38
Farming	9	3.04
Fishing	51	17.23

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-99shows the income distribution in the barangay. Almost 37% of the respondents earns below PhP 4,000 per month. This is followed by those who earn PhP 4,001 to PhP 7,000 per month (26%) and those who earn PhP 7,001 to PhP 10,000 (16%).

Table 2-99: Income Distribution in Barangay Baloganon

Income Distribution	Frequency	%
4,000 below	41	36.94
4,001-7,000	29	26.13
7,001-10,000	18	16.22
10,001-13,000	6	5.41
13,001-16,000	9	8.11
16,001-20,000	3	2.70
20,001-23,000	1	0.90
23,001-26,000	0	0.00
26,001-29,000	0	0.00
29,001-40,000	1	0.90
40,001 and above	3	2.70
Total	111	100
Average Monthly Income = PhP 7,701		

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-100shows the monthly household expenditures. The biggest household expenditure goes to food (49.25%) followed by education (19.10%) and non-food items (groceries) (14.63%). The average monthly household expenditure is pegged at PhP 6,550.

Table 2-100: Monthly Household Expenditure in Barangay Baloganon

Expenses	PhP	%
Food	3,226.25	49.26
Education	1,251.14	19.10
Groceries (excluding food)	957.95	14.63
Electricity	475.25	7.26
Water	53.18	0.81
Clothes	256.82	3.92
Rent	39.77	0.61
Tax	22.73	0.35

Expenses	PhP	%
Loan Amortization	142.05	2.17
Rest and Recreation	96.59	1.47
Other Expenses	27.84	0.43
Average Monthly Expense	**PhP6,550**	

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.3.4 Health and Sanitation

The causes of illness among the households are (i) cough (74.6%), (ii) influenza (33.33%), (iii) Diarrhea (24.6%), (iv) headache (22.22%) and (v) hypertension (18.25%). On the other hand, heart disease (28.57%) is the leading cause of death in the barangay. This is followed by stroke (2 cases or 28.57%) respiratory disease, emphysema, and paralysis (1 case or 14.29% each).**Table 2-101** shows the summary of the causes of deaths illness and death in the barangay.

Table 2-101: Top Causes of Morbidity and Deaths in the Barangay

Causes of Morbidity	Frequency	%
Cough	94	74.60
Influenza (Flu)	42	33.33
Diarrhea	31	24.60
Headache / Migraine	28	22.22
Hypertension	23	18.25
Sneezing, running or blockade nose	22	17.46
Asthmatic	18	14.29
Itching or watering of the eyes	14	11.11
Skin rashes/allergy	10	7.94
Urinary Tract infection	8	6.35
Cause of Death	**Frequency**	**%**
Heart Disease	2	28.57
Stroke	2	28.57
Respiratory Disease	1	14.29
Emphysema	1	14.29
Paralysis	1	14.29

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Majority of the respondents (63.49%) avail themselves to the services of the Rural Health Unit in Masinloc town proper for consultation and regular check-up. Some go to the Barangay Health Center in Baloganon (36.51%) and the Provincial Hospital in Iba (23.19%) for other medical reasons.

Various drugs are taken by the household members to treat some of the common illnesses such as fever, colds or cough and diarrhea. These include paracetamol (44.44%), amoxicillin (23.81%), salbutamol (10.32%), other antibiotics (7.94%) and Loperamide (6.35%).

Most of the residents buy their supply of medicines from drugstores (90.48%). Only a small proportion of the respondents accesses medicines from the Barangay Health Center (2.38%).

Table 2-102below shows the sources of water for drinking and domestic use. For drinking purposes, the most commonly used in the barangay is deep well/ jetmatic (46.24%). Some rely on bottled water for drinking (28.57%). There are a few who are connected to the local water district (9.52%). Others have access to public artesian wells (7.14%).

For household chores or domestic use, the most commonly used are deep wells and jetmatic pumps (76.98%). A few respondents source water from the local water district (6.36%) and from public artesian wells (7.94%).

Table 2-102: Water Source for Drinking and Domestic Use

Source of Drinking Water	Frequency	%
Bottled or Mineral Water	36	28.57
Water district	12	9.52

Private Deep well/Jetmatic	57	45.24
Public Artesian Well	9	7.14
Water for household chores		
Water District	8	6.35
Private deep well/Jetmatic	97	76.98
Public artesian well	10	7.94

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

In terms of toilet facility, 95 of the respondent s have water sealed toilet facility while seven uses open pit type (**Table 2-103**).

Table 2-103: Toilet Facility in Barangay Baloganon

Toilet Type	Frequency	%
Water Sealed	95	75.40
Open Pit	7	5.56

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Table 2-104shows the method of solid waste disposal practiced by the respondents. Majority of the respondents (93 or 73.02%) expressed the LGU collects their garbage. Burning is also practiced by 17.46% of the respondents. Only three respondents use the open pit type for disposing their wastes.

Table 2-104: Waste Disposal Method in Barangay Baloganon

Waste Disposal	Frequency	%
Collected by LGU	92	73.02
Open Pit	3	2.38
Burned	22	17.46

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Based on the observation of the interviewers, foul smell from pigpens cause air pollution in the barangay (11.11%). This is followed by stagnant water (8.73%) and fishponds (3.97%).

On the other hand, tricycles (41.27%), and jeepneys (41.27%) are perceived as significant contributors to the noise pollution in the environment. **Table 2-105**shows the perceived sources of air and noise pollution.

Table 2-105: Source of Air and Noise Pollution in Barangay Baloganon

Source of Air Pollution	Frequency	%
None	54	42.86
Pigpen	14	11.11
Stagnant Water	11	8.73
Fishpond	5	3.97
Stock of Garbage	2	1.59
Chicken Pen	2	1.59
Source of Noise		
None	38	30.16
Tricycles	52	41.27
Jeepney/Trucks	9	7.14
Others	5	3.97
Pub/Restaurant	1	0.79

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

2.4.2.3.5 Housing Characteristics

The average size of a housing unit in the barangay is 99.24 m^2. The households have an average of two rooms. Majority of the respondents use cement for flooring (75.4%). Only some use wood (7.14%) and tiles/marble (4.76%). Most houses are made of concrete materials (61.11%). However, some still use wood for walling (15.87%).

For lighting purposes, majority have electrical connections (86.51%), while only a few (6.35%) use gas lamps. On the other hand, majority of the households still use firewood (66.67%) for cooking. Some, however, use gas (LPG) (22.22%).

2.4.2.3.6 Knowledge and Perception of the Project

Table 2-106 shows the respondents awareness and their sources of information about the Project. Majority (89 or 70.63%) of the respondents know about the project or have an idea what the Project is all about. Most of them expressed that it is supposed to be a proposed expansion of the Masinloc Plant. Among their major sources of information are local officials (40.45%), NGOs/POs (12.36%) and the Proponent (12.36%).

Table 2-106: Knowledge of Project and Sources of Information in Barangay Baloganon

Knowledge of the Project	Frequency	%
Knows about the Project	89	70.63
Does not know about the Project	28	22.22
Did not answer	9	7.14
Expansion	44	49.44
Phase 2 Expansion	2	2.25
Power plant	2	2.25
Increase in power supply	1	1.12
No Answer	41	46.07
Source of Information		
Radio/TV	3	3.37
Newspaper	7	7.87
Local officials	36	40.45
Proponent	11	12.36
Private persons	4	4.49
NGO/PO	11	12.36
Other sources	1	1.12

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

Less than half of the respondents (61 or 48.41%) believed that there would be benefits from the Project while 36.51% expressed otherwise. Among the possible benefits cited are additional employment (57.14%), additional income (4.76%) and additional livelihood (1.59%).

Further asked if there would be negative project impacts, majority (67 or 53.17%) of the respondents answered positively. Among the most cited negative impacts are air pollution (76.32%) and water pollution (7.89%). Meanwhile, 86.84% of those who think that the project has negative impacts believed the situation can be prevented.

While some think the Project should not continue (25%), about 34.88% proposed measures for the proponent to mitigate or avoid negative impacts such as the following: (i) observing safety procedures, (ii) implementing proper waste disposal, (iii) maintaining cleanliness and (iv) using new technology to protect the environment. **Table 2-107** shows the summary of how the negative impacts can be avoided.

Table 2-107: Perceived Ways to Avoid Negative Impacts

Are these negative impacts preventable?	Frequency	%
Yes	58	86.84
No	9	13.16
Management is knowledgeable	1	1.52

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

There are almost an equal proportion of respondents favoring Project implementation (56 or 46.03%) to those who are against it, 56 or 44.44%.

Those favouring the project cited as their primary reasons the benefit of employment (93.48%) and additional tax collection (2.17%). Additional comments from respondents include fair basis for employment/priority for local hires, provision of water service and reduction of power rates, among others.

On the other hand, adverse health effects (61.29%); negative impacts on the environment (25.81%) and question on who will benefit from the Project (9.68%) are the top reasons for those who think the Project should not push through. **Table 2-108** presents the reasons for favoring or opposing the Project.

Table 2-108: Summary of Reasons for Favoring/Opposing the Project

Are you in favor of implementing the Project?	Frequency	%
No	56	44.44
Yes	58	46.03
No answer	12	9.52
If No, Why?		
Adverse health effect	19	61.29
Bad effect on the environment	8	25.81
Only others will benefit the project	3	9.68
If Yes, why?		
Employment	43	93.48
Additional tax collection	1	2.17
It's good for everyone	1	2.17
It cannot be stopped anyway	1	2.17

Source: Perception Survey for Masinloc Power Plant Expansion, LTI 2010

When sought for other comments about the Project, the respondents mentioned that a fair basis for employment should be established. According to the respondents, locals should be the priority in hiring. Others mentioned that the Project should not worsen the health environmental condition in the barangay while others proposed continuing studies to be conducted to minimize health and environmental effects. Others lobbied for free/subsidized water and electricity from the Proponent. Some commented that the Proponent follow safety procedures and observe applicable laws.

Based on the results of the survey, it does not necessarily follow that the expenditures always exceeds the income to be able to conclude that they are below the poverty threshold level. Factors that may be considered are as follows:

i. Household heads or most of the respondents say they limit expenses or totally will not spend on other items except for food and necessities (*nagtitipid sa ibang pagkakagastusan*) but this will have an impact on children's schooling, which is the first expense to be cut together with other food items, clothing, and social/recreation expenses. Other basic needs such as those for health and access to other social services are not prioritized by the household to the extent that they resort to self-medication and go to see the doctor only when the illness is already serious.

ii. Other households seek help from other relatives if they don't have enough money to buy food. Overall, in-kind support from these sources is neither considered as a form of income nor as an expense and are therefore not accounted for.

iii. Documentation of expenses, particularly in-kind sources, is not given attention to by households and is also not mentioned during interviews, which will have a significant bearing on the estimation of household income and expenses. Either way, this leads to the under estimation of income and expenses.

iv. The estimated savings of poor households is not that big and may not be sustainable due to the seasonality of work.

2.4.2.4 Settlement Map and Population Distribution per Barangay

Figure 2-118 to **Figure 2-120** show the spot maps of each barangay.

Figure 2-118: Spot Map of Barangay Bani

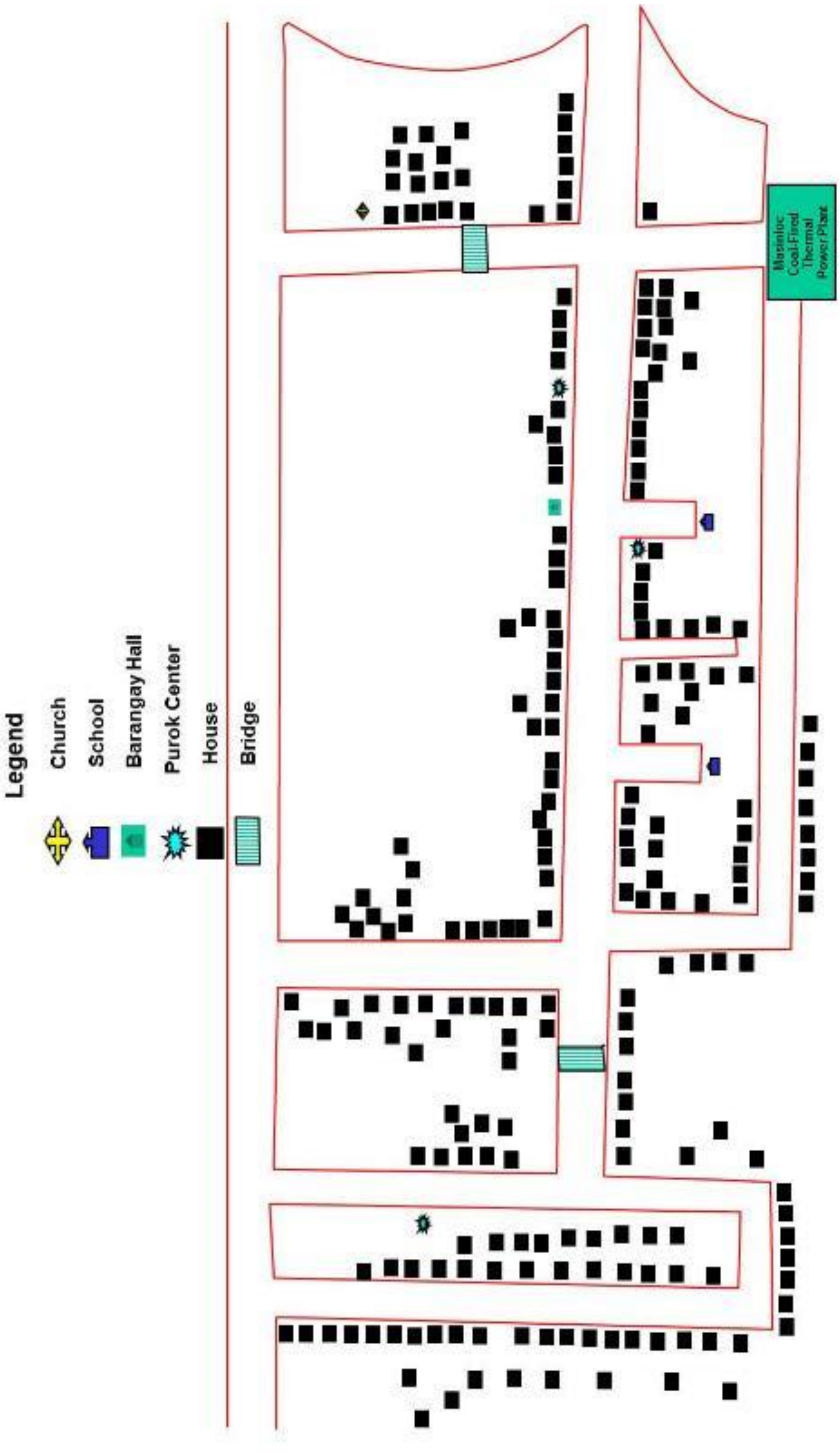


Figure 2-119: Spot Map of Barangay Baloganon

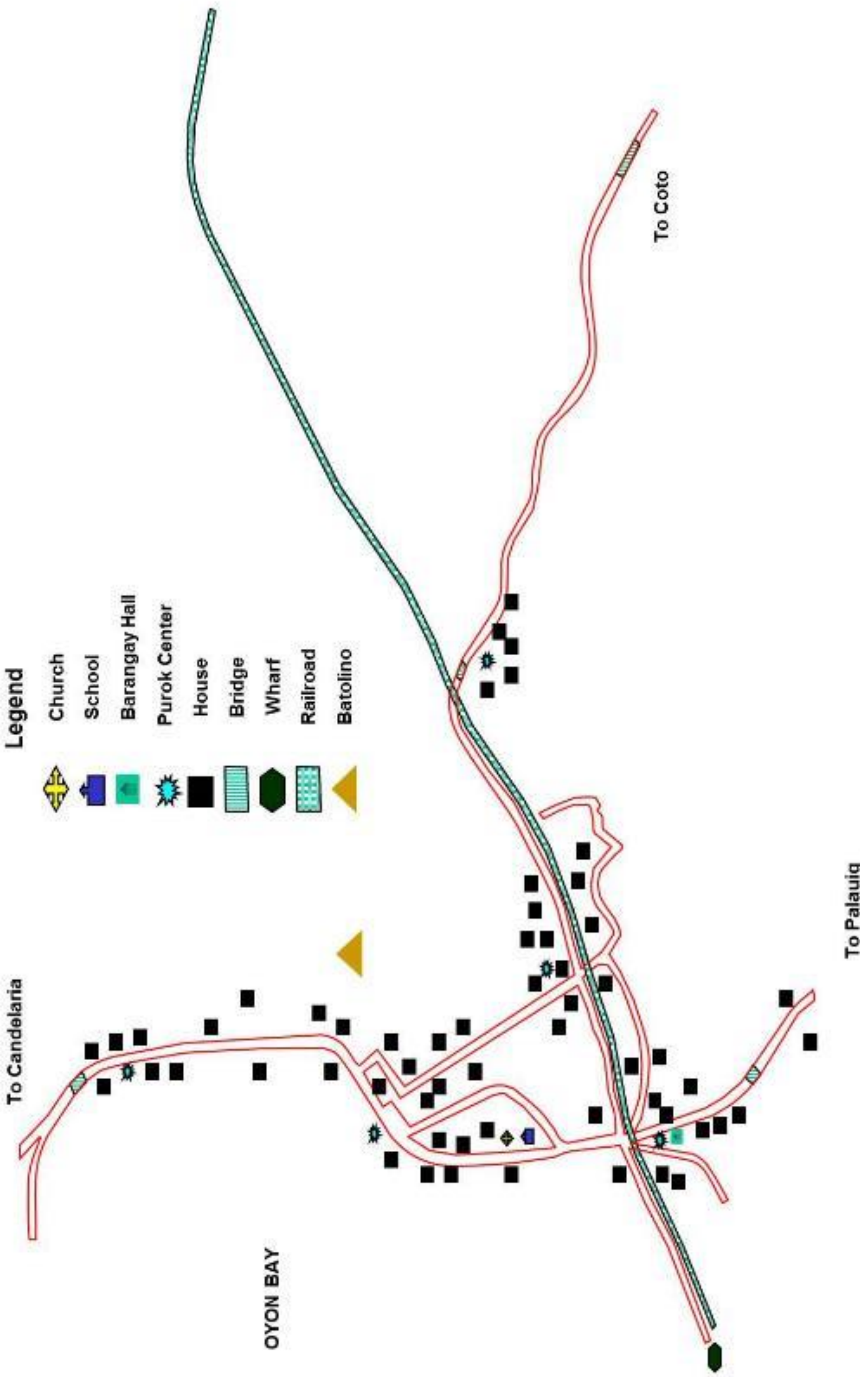
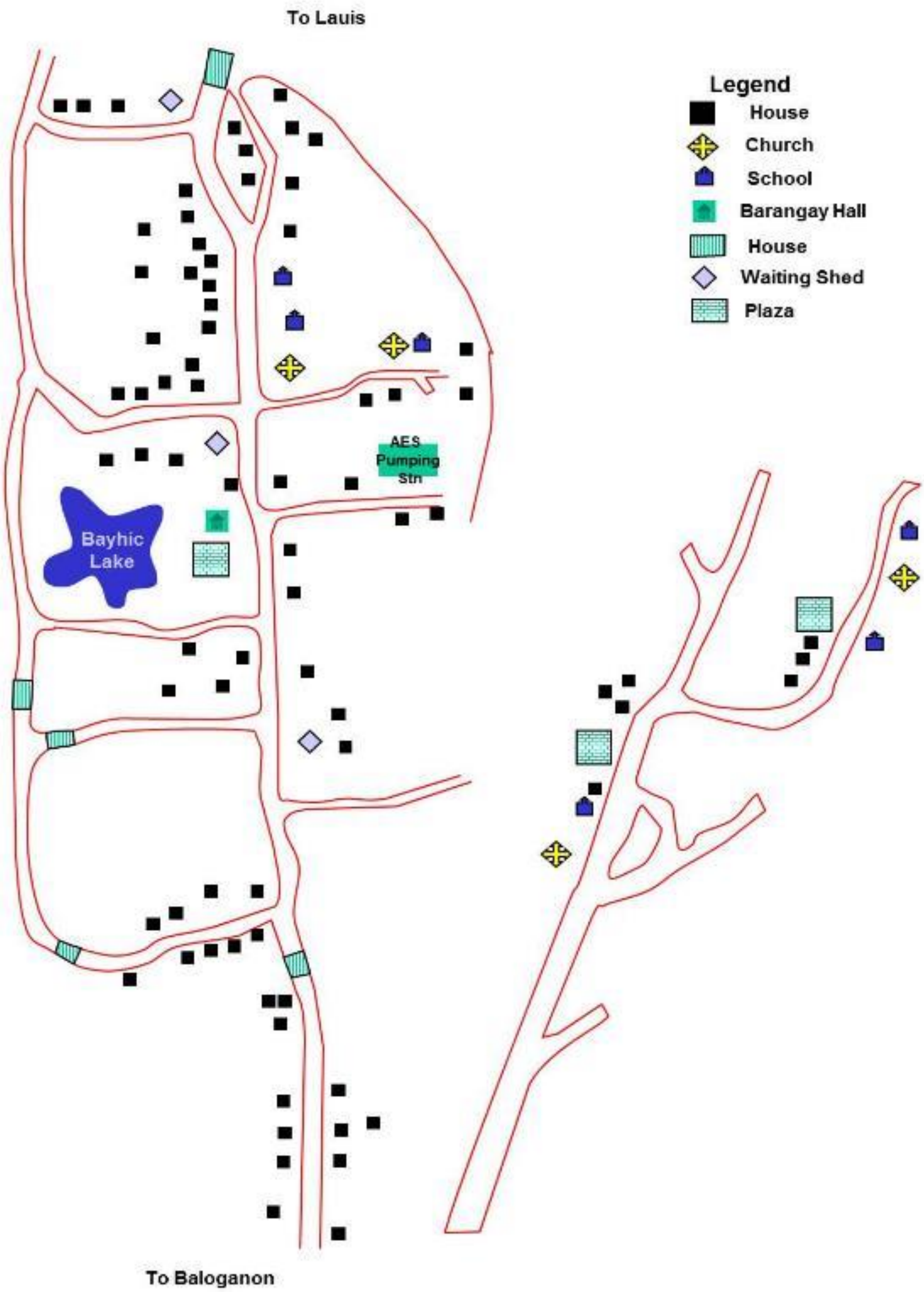


Figure 2-120: Spot Map of Barangay Taltal



2.4.2.5 Candelaria

The Municipality of Candelaria, a 3rd Class Municipality in the 2ndDistrict of the Province of Zambales, is considered as an IIA. It is approximately 42 km from the Provincial Capital,Iba, and approximately 250 km from Manila. The municipality has a total land area of 33,359.1896 ha of which 1,675.35 ha are allocated for rice lands, 534.96 ha for fruit trees cultivation and 3,833.91 ha for residential area. **Table 2-109** shows the summary of land use in the municipality.

Table 2-109: Existing Land Use in Candelaria

Land Use	Area (ha)	%
Riceland	1,675.35	5.02
Irrigated	1,044.00	
Rain-fed	629	
Root crops	2.345	0.01
Fruit trees cultivation	534.96	1.60
Residential Lands	3,833.91	11.49
Forested and Rolling Hills	27,318.00	81.88

Source: Municipal Profile of Candelaria

2.4.2.5.1 Population

Candelaria had a total population of 27,174 as of August 2015. This is a 8.61% increase from its population of 25,020 in May 2010. For the year 2010, the projected population of the municipality is 24,722 based on the average annual population growth rate of 0.49 for the period of 2000 to 2007. **Table 2-110** shows the summary of population growth in the municipality compared to the provincial and national trends.

Table 2-110: Population Growth Rate Candelaria, Zambales

	2010 Population	2015 Population	% Increase (Decrease)	Average Annual Growth Rate
Philippines	92,337,852	100,981,437	15.77	1.72
Zambales	534,443	590,848	13.73	1.79
Candelaria	25,020	27,174	8.61	1.58

Source: National Statistics Office, Census of Population 2000, 2007

The annual growth rate of the municipality is lower than the provincial and national averages. In terms of actual increase in population, the municipality registered an increase in population that is lower than the increase in provincial and national levels.

With a population of 27,174 as of 2015 and a land area of 33,359.1986 ha, population density is low with less than 1 person/hectare.

The municipality is divided into 16 barangays, only one of which is classified as urban. This places the urban population at 955 or 3.93% of the total population, while the rural population is 23,288 or 96.06% of the total population.

2.4.2.5.2 Employment

Of those belonging to the economically active age group (15 to 64 years old), 3,410 or 37.66% of the 9,054 in the said age group are employed in various sectors. **Table 2-111** shows the summary of employment status in the municipality. Based on municipal records, 10% of the working population is engaged in farming, while 2.42% are engaged in fishing. Those involved in industry, manufacturing and mining comprise the bulk of the work force, which is 17% of the employed population.

Table 2-111: Employment Status

Occupation	Employed	%
Farming	923	10.19
Unskilled Labor	365	4.03
Fishing	219	2.42
Industry, Manufacturing, Mining	1,563	17.26
Professionals	340	3.76
Total	**3,410**	**37.66**

Source: Municipal Profile of Candelaria

2.4.2.5.3 Health

Table 2-112shows the available health resources in the municipality. The municipality has one RHU serviced by one doctor, two nurses, six midwives, one dentist, one dental aide and one sanitary inspector. The municipality also hosts a district hospital where serious cases are referred, which also caters to the needs of nearby municipalities. There are also 13 Barangay Health Centers distributed among the barangays of the municipality.

Table 2-112: Local Health Resources

Health Personnel	Number
Doctor	1
Nurses	2
Midwife	6
Dentist	1
Dentist Aide	1
Sanitary Inspector	1
Health Facilities	**Number**
District Hospital	1
Rural Health Unit	1
Barangay Health Center	13

Source: Comprehensive Land Use Plan of Candelaria

The RHU offers various services, which include: immunization, control of communicable diseases, maternal and child health, environmental sanitation, health education, medical care, family planning, malnutrition monitoring and herbal gardening.

In terms of malnutrition monitoring, of the 2,990 individuals belonging to the 0 to 6 year age group, 0.03% suffers from 3rd degree malnutrition, 2.41% experience 2nd degree malnutrition, while 564 individuals or 18.86% in the said age group suffer from 1st degree malnutrition. There are 50 individuals or 1.67% from the same age group that are considered to be overweight. **Table 2-113**shows the summary of malnutrition incidence in the municipality.

Table 2-113: Cases of Malnutrition

	Number of Cases	%
Third Degree Malnourished	1	0.03
Second Degree Malnourished	72	2.41
First Degree Malnourished	564	18.86
Overweight	50	1.67

Source: Comprehensive Land Use Plan of Candelaria

In terms of mortality, the leading causes in the municipality are hypostatic pneumonia (18 cases), cancer (all forms, 15 cases), Chronic Obstructive Pulmonary Disease (11 cases) and vascular disease (11 cases). **Table 2-114** shows the summary of the causes of mortality in the municipality.

Table 2-114: Causes of Mortality

Cause	Number of Cases	Incidence per 1000 Individuals
Hypostatic Pneumonia	18	7.4
Cancer (all forms)	15	6.2
COPD	11	4.5
Vascular Diseases	11	4.5
Coronary Artery Disease	5	2
PTB	5	2
Renal Failure	5	2
Diabetes Milletus Type II	4	1.6
Multiple Gunshot Wound	2	0.83
Bleeding Peptic Ulcer	2	0.83

Source: Comprehensive Land Use Plan of Candelaria

Table 2-115shows the summary of the causes of morbidity in the municipality. Acute Respiratory Infection (ARI) (4,235 cases), skin disease (391 cases) and diarrhea (281 cases) were among the top causes of morbidity in the municipality.

Table 2-115: Causes of Morbidity

Cause	Number of Cases	Incidence per 100000 Individuals
Acute Respiratory Infection	4,235	1,757.55
Skin Disease	391	162.26
Diarrhea	281	116.61
Dental Abscess	179	74.28
UTI	126	52.29
Parasitism	99	41.08
HPN	81	33.61
PTB	51	21.13
Dengue Fever	44	18.26
Diabetes Milletus	12	4.98

Source: Comprehensive Land Use Plan of Candelaria

2.4.2.5.4 Transportation and Communication

Tricycles are the main mode of transportation in the municipality, while multicabs and buses are the other means of transportation to neighboring towns and provinces. The municipality has a total of 94.81 km of road networks. Of this network, 16.07 km are made of concrete, 22.83 km are made of asphalt, 41.78 km are made of gravel and 21.20 km are made of earth-fills.

Globe, Smart and Sun Cellular provide communication services within the municipality. The Integrated National Police Radio Communication System also maintains communication facilities in the municipality.

2.4.3 Displacement of Settlers

In the implementation of the Masinloc Plant, a total of 198 families were relocated and duly compensated. Relocation and compensation was initiated by the NPC.

For the Project, there is no displacement or relocation of settlers expected since the facilities will be constructed within the property of the Masinloc Plant.

2.4.4 Impact on In-migration Patterns as a Result of Project Implementation

Based on the population growth rate, the population of the municipality did not grow significantly (still below the National Levels) even with the presence of the Masinloc Plant and a mining company in a neighboring barangay.

A temporary influx of workers is expected during the construction phase of the Project. However, since host communities will be prioritized during hiring, it is expected that the in-migration related to the Project will be minimal.

2.4.5 Impacts on IPs and Culture/Lifestyle

There is no known presence of Indigenous Cultural Communities in the immediate area of the Masinloc Plant. Since the Project is within the Masinloc Plant property, there are no IP communities that will be affected.

2.4.6 Local Benefits from the Project

Benefits for the community will be in direct and indirect forms. The indirect benefits will come from increase in taxes that the Proponent pays to Government Agencies (i.e., Real Property Taxes, Income Taxes, and Permit fees). As the Proponent's generation sales increase due to the Project, their contribution to ER 1-94 will also increase. At present, the total ER 1-94 fund available to the host communities is PhP 37 million. With the Project, this fund may increase to PhP 74 million.

Employment is the direct benefit the community is expected to receive. The estimated employment to be generated for the construction phase is between 300 to 600 skilled and unskilled positions over span of 4 years. To ensure that there will be qualified local residents that can be hired; the Proponent is currently constructing a trade school in coordination with the Masinloc Public Employment Service Office (PESO) and the Technical Education and Skills Development Authority (TESDA). It is also expected that for every one employee that will be hired during the construction phase, it will create two employment opportunities outside the Project in ancillary related services such as food catering, lodging, transportation and laundry services.

Also, with the increase in generation sales, the Proponent expects to expand its Corporate Social Responsibility (CSR) program to include not only the host barangays, but also the host Municipality and Province. Their CSR program at present includes medical missions, supplemental feeding, scholarships and tree planting. A complete list of the Proponent's CSR program, awards and recognitions is presented in

Annex G.

2.4.7 Public Participation

Focus Group Discussions (FGD) and Key Informant Interviews (KII) were conducted to supplement the results of the survey and identify issues and concerns of key sectors. Local government officials, particularly barangay officials, were interviewed as well as leaders of the local people's organizations, being the most significant sector most likely to be affected by the Project.

Public Consultation meetings were conducted onOctober 13,November 9 and December 22, 2010, and March 30, 2011 to gather issues and concerns that the stakeholder communities may have towards the Project. A cross-section of the stakeholders, including LGU representatives, religious groups, educational institutions and other socio-civic organizations, was consulted.

Table 2-116to **Table 2-119**are summaries of the issues and concerns that were raised during the consultation meetings.

Table 2-116: Summary of the Issues and Concerns Raised during the Consultation Meetings

Project Benefits - Guarantee the employment of local residents - Priority for local residents training - Unpaid benefit/compensation from NPC - Reduced electricity costs - Status of rehabilitation of schools - Real Property Tax. - Improve water supply and street lighting - Assistance to vulnerable population - Access to medical services and medications - Livelihood projects - Eligibility for MPPCL trade school - Use of ER 1-94 funds - Local water usage fees - Access to fly ash
Environmental/Health Issues - Increase in vibration, noise, and odor - Worsening agricultural crop yields (mangoes and rice), and declining fish catch - Plant emissions and relationship to respiratory illnesses - Use of Semirara coal
Public Participation -Possible NGOpartnership - Participation of NGOs during consultations - Regular dialogue between community and Masinloc Plant - Access to Project details

Table 2-117: Issues and Concerns Raised during the Consultation Meetings with the DIA

Name	Issue/Concern Raised	Proponent's Response
Barangay Baloganon, Masinloc, Zambales **October 14, 2010, 9:30AM**		
Armando San Jose Resident Community-Based Rehabilitation	Assistance to Persons With Disabilities	• MPPCL is active in providing monthly medical assistance to the organization by reimbursing expenses for medicine through its coordinator, Ms Lolita San Jose.
Anilita Lagayos Resident BHW	What assistance can the company provide to BHWs? The barangay have insufficient supply of medicine.	• Medical missions are regularly conducted. • Community can avail of ER 1-94 fund to establish a Barangay Clinic. • MPPCL may initially provide medicines
	Can residents expect employment?	• MPPCL is still trying to formulate a

Name	Issue/Concern Raised	Proponent's Response
	There should be fair basis for employment based on skills.	fool proof fair hiring process. • MPPCL will establish a welding school to facilitate hiring for local workers.
Bea Macasa Resident	Is the emission from the plant safe? There are many incidence of respiratory illness in the barangay. Are they related?	• Studies conducted showed there are no health effects of the emissions of coal-fired power plant. Please refer to the health effects of the emissions of coal-fired power plants • Based on MMT monitoring, the plant is compliant to ECC conditions and DENR standards. • Copies of MMT report are available and may be requested by stakeholders.
Rosita Montero BHW	What benefits can AES give to the Barangay Health Center?	• Letter of request for assistance should be submitted. • Initially, MPPCL can provide medicine.
Corazon Ilago BHW	Livelihood projects for women.	• A rag-making project is on the works and coordination is on-going.
Kagawad Mantolino	According to a MOA with NPC, the coal to be used should be Australian coal. There are rumors that you are using Semirara coal which, according to some groups, is harmful to the health. Is the coal used in the plant from Australia?	• Our MOA stated that we can use a broad range of imported coal as long as it is compliant with our ECC requirement that it should contain less than 1.0% sulfur. Semirara coal does not fit this requirement; hence, we don't use Semirara coal. • Since MPPCL took over, emission of sulfur is less than 1.0% or coal with high calorific value. • Our coal does not always come from Australia. Sometimes it is from Indonesia or China since it costs less to transport.
Hebalyn Sacaleneo Resident	Last year, a short course on welding was conducted in the barangay. Will you hire welding graduates even without experience? Even if they are not graduate of the AES School?	• A welding school will be established by MPPCL. • Contractors will be asked to teach in the school. • Local hiring will be prioritized. • All hiring notices are posted in the PESO/Barangay Halls.
Mylene Canoneo Resident	Will AES shoulder all the expenses for the welding school?	• All facilities and equipment will be provided. • Set-up for the manpower of the school is still under discussion.
Hansel Tolentino Resident	Will AES provide allowance for the students?	• This will be considered in the planning of the welding school. • MPPCL accepts OJT students. A letter should be submitted to facilitate OJT training in the plant.
Lolita San Jose Resident	Where will the additional plant be constructed? Will there be families to be affected and will they be relocated?	• All facilities will be constructed within the property of MPPCL
Barangay Taltal, Masinloc, Zambales October 14, 2010, 2:30PM		
Kagawad Rogelio Ridao LGU, Barangay Taltal	The pumping station of AES is located in Barangay Taltal and not in Lauis. Real Property Tax (RPT) should be paid to Barangay Taltal	• If the pumping station is located in Barangay Taltal, then the RPT should be paid to Barangay Taltal. • A separate meeting on the matter will be scheduled. • A survey will be conducted to determine the location of the

Name	Issue/Concern Raised	Proponent's Response
		pumping station. • MPPCL facilitated a meeting between Barangay Taltal and Masinloc Municipal Assessor's Office. Decision and purview of tax assessment is with the Municipal Assessor's Office.
Kagawad Dante	They said that the plant will have negative effects on the people and the environment. What is your proposed solution? For example, mangoes are badly affected by ashes from the plant. They turn black and rot. What is your proposed solution for this?	• These effects mentioned were reduced, if not prevented, since MPPCL took over. • The Multi-Partite Monitoring Team (MMT) has investigated the issue on mango productivity and hired consultants from UP to do the study. Results of the study showed that the type and amount of chemicals used, and other factors caused the problems. Same studies were done on rice productivity. • The MMT prepares quarterly monitoring reports on environmental conditions as well as on people. If there are negative or adverse impacts identified, corresponding mitigation measures are being instituted as provided for in the Environmental Management and Monitoring Plan to be prepared. These reports are available to the public.
Barangay Resident	How can you guarantee that locals will be prioritized in employment? Is there no qualified resident in Masinloc?	• One of the conditions in any amended ECC usually states that the Proponent shall prioritize the locals in hiring opportunities. • MPPCL is still trying to formulate a fool proof fair hiring process. • MPPCL is constructing a welding school.
	The pumping station is within Barangay Taltal. Taxes should go to the barangay.	• If the pumping station is located in Barangay Taltal, then the RPT should be paid to Barangay Taltal
	We are requesting for installation of water supply and street lighting	• The barangay is within the franchise area of Masinloc Water District. • The street lighting was funded through ER1-94. The Barangay LGU pays for the electricity cost. • MPPCL cannot provide electricity within the franchise of ZAMECO.
Kagawad Gonzalo	During NPC times, a water system project was initiated through ER1-94. However, it was not finished because of lack of fund. How can AES assist in this?	• The water system project can utilize ER1-94 funds so it could be completed.
Barangay Resident	Can the electricity cost be reduced further?	• The power generated by Masinloc goes to Sual and returns via the transmission lines of NGC. ZAMECO 1 and ZAMECO 2 should agree to buy the transmission lines so that it does not have to travel to Sual. However, they have not agreed on the proposal.
Barangay Resident	Will the expansion use the water from Taltal?	• The Technical Feasibility is on-going and options are being studied whether the water will be from the river or the sea.

Name	Issue/Concern Raised	Proponent's Response
Kagawad Gonzalo	Streetlights for Barangay Taltal	• The electricity generated by the plant goes straight to the transmission line. • MPPCL can place lights in the perimeter fence of the Company. • MPPCL cannot directly provide electricity since it is within the franchise of ZAMECO 1
Barangay Resident	Before the construction of the power plants, NAPOCOR promised to provide free streetlight	• NAPOCOR is a government agency and can freely give subsidy. • The community can request the local government to provide free streetlight as a result of the increase in its revenue coming from these kinds of projects.
Aida Lang Barangay Resident	Regarding the pumping station, there should be streetlights on the road leading to the pumping station	• The community can utilize ER1-94 to provide streetlights for the area.
Bugnoy Lang Barangay Resident	Could AES construct a Riprap of the river to prevent flooding?	• If MPPCL is causing the erosion of the riverbanks, measures will be taken
Barangay Resident	Assistance to senior citizens	• The community's best option is to utilize ER1-94 funds and MPPCL will assist in the preparation of documents and follow-ups to be made.
Barangay Resident	Water System for Purok 1 and 2	
Barangay Bani, Masinloc, Zambales November 8, 2010, 9:30 AM		
Ramil Soviebeja	Is it possible to directly route electricity to Bani without going through NGCP?	• The Company is not allowed to directly sell to consumers since the barangay is under the franchise of Zambales Electric Cooperative.
Isabelo Ines	What is the difference between NPC and AES?	• NPC is a government agency and former owner of the plant while MPPCL is a private Company
	What is the total benefit for the barangay so far?	• The company paid about PhP21M in terms of taxes. The company has also been conducting various Corporate Social Responsibility (CSR) activities.
	There should be community meetings every 2 months	• Comment is noted. It is important that meeting with the communities be continuous.
Rowena Elayba School Teacher	What is the status of the school rehabilitation that AES promised?	• The funds for it are being prepared.
Nila Ebido	Is it possible that the electricity cost for the barangay residents be reduced?	• The electricity price is not solely determined by MPPCL but the Company will try to look at what it can do.
Alfonso Sequinia	What is the participation of NGOs during Scoping?	• NGOs can raise environmental issues that they deem relevant in conducting the EIA for the Project.
	Can our NGO partner with AES projects?	• We coordinate our projects through our CSR personnel.
Barangay Resident	Guarantee on local employment Training priority for residents Provision of service/transportation to those who will be employed	• The company is already sensitive to the issues when it comes to the definition of "local hiring". To prioritize local communities in the hiring, the company will conduct training and try to come up with a hiring scheme that is acceptable to all. The provision of service vehicles and transportation to those who will be employed is already included in the

Name	Issue/Concern Raised	Proponent's Response
		package of benefits given to the employees.
Sophia Castro Barangay Resident/Lot Owner	Who should we go to for the unpaid benefit/compensation from NPC for the transmission tower built on our property?	• This is within the concerns of NGCP which is a separate entity. However, the Company can assist in communicating with NGCP.
Oscar dela Cruz	The Project should not continue since the vibration, noise and odor from the plant could worsen. If the Project continues, there should be relocation for those living very near the plant.	• Vibration, noise and odor shall be considered and addressed in the EPRMP being prepared. • The company is compliant to all monitoring parameters as shown in MMT reports so there is no need for relocating the nearby residents.

Table 2-118: Issues and Concerns Raised during the Consultation Meetings with the Masinloc LGU

Name	Issue/Concern Raised	Proponent's Response
Coun. Daniel Yamilao Sangguniang Bayan Member	Why is it that Public Hearings were conducted in the barangays already?	• The plan was to consult the barangays first then present in the municipality • Upon talking with the Mayor and Vice Mayor, we were told to present to the barangays first.
Mr. Dennis Leyco Sangguniang Bayan Secretary	Environmental Issues: • Who comprises the MMT? • Who conducts the monitoring and sampling? • Who brings the samples? • If AES also brings the samples to the laboratory, the results might be questionable. And independent body should conduct sampling. • The participation of the LGU is limited to the taking sample. During the transport and analysis of the samples, the LGU has no participation	• MMT is based on a 1995 MOA and composed of LGU, DENR and the Proponent and signed by DENR, Mayor and the Proponent. • The content of the MOA were agreed by the signatories as well as the job descriptions of each members. • Analysis by third party laboratory is upon the discretion of the PENRO • A third party lab, CRL Laboratory in Pampanga, analyses some of the sample. • Next time the samples are taken to Clark, LGUs will be invited. The samples are handled based on DENR-approved method. • Third party consultants will be invited next time for the monitoring activities.
	Employment: The 300-500 employees you will hire are these from Masinloc? If it is 300-500 only it is too few	• The 300-500 is based on the premise that there will only be additional units to be constructed unlike during the first units where they started from scratch. • A Trade School will be constructed in partnership with TESDA. Certifications will be issued to qualified residents so they can work in the plant. • Consultation will continue on the hiring process.
	Taxes: How are taxes to be paid?	• We will be paying the maximum allowed taxes • The taxes for next year are prepaid. • The necessary funds are being prepared for paying the prepaid taxes.

Name	Issue/Concern Raised	Proponent's Response
Mr. Richard Lacerona Municipal Civil Registrar	• Participation of LGU on monitoring /processing /transfer of samples • Re-organization of MMT so that LGU representatives can be trained on sampling activities • Representative on ECC studies • Is there provision on ECC on expansion? • Is the current area fit to host another 600MW?	• It is standard in all ECC conditions that if a project plans to undergo expansion, they will have to conduct another EIA • The Project is currently in the planning stage; the EIA can help in planning the design of the Project. • There will still be further studies about the final design of the Project. • Reorganization of the MMT will be taken up with DENR • A workshop with DENR on the activities of the MMT can be conducted
	Wouldn't the project worsen health conditions?	• Part of the studies being conducted is the modeling study where scenario for maximum ground level concentration is forecasted. Once the results are out it will be presented. • Proper management measures will be recommended
	Why another coal plant? Coal plants are being shunned by other countries. Why not wind, or hydro power or other source?	• Different technologies were looked into. However, at present the Luzon Island is in demand for more energy and coal is the cheapest that can be introduced and the facilities are already present.
Mr. Nelson Mayola SB Member	Can there be a PowerStation dedicated to Zambales? So that charges and taxes can be avoided.	• The law does not allow us to sell power to individuals. It is handled by WESM who distributes the power. • We can enter contracts into cooperatives like ZAMECO I.
Mr. Xavier Edora SB Member	Is there any plan to purchase/acquire land for the expansion?	• There is no immediate need to purchase additional land.
Hon. Jeffrey Bautista Vice-Mayor	Execution/implementation of MOA between PSALM-LGU Masinloc should be revisited.	• We already have a copy of the MOA and have given the Governor a copy
Mr. Mac Aranas II MCDO/MTIPO	ECC-How much did you pay to get the ECC? It took you less than a week to get the ECC.	• The Proponent will not pay any fee to expedite or get things done faster than normal. • As a US company, we are being monitored by a Corrupt Policy Act. Every payment we made is studied by legal people so that we cannot be accused of bribery or corrupt practices
	Members of MMT should be trained in analyzing data. The representatives that the LGU send are not trained.	• Qualification standards for the representatives to the MMT will be established.
	Comparison of Original EIA and Present EIA result.	• Data of the past EIA is available. With the EPRMP a new set of data is gathered and compared to the possible effects of the Project. • The instructions are to project the model based on the stringent standards and determine if it will affect the environment and health of the people.
Dr. Sylvia Yamilao Municipal Health Officer	There is an increase in Upper Respiratory Tract Infection in the Municipality	• We are currently reviewing our Medical Mission activity

Name	Issue/Concern Raised	Proponent's Response
	The Medical Missions that AES conducts are not effective since it is a one day event. You might be able to help improve medical facilities We also lack medicines	• We are planning on setting-up a AES Foundation • There is also a P37M fund available for the community in the DOE. The community just needs to write a proposal and the Proponent will help to make sure the funds are released.
Municipal Councilor	Will you provide financial assistance to the Municipality before the expansion	• No. For the same reasons (corrupt practices act). If the LGU have project, there is ER 1-94 that is sitting in a bank in Manila.
Municipal Councilor	If you spend Php10M for CSR Projects, why not build a hospital instead? It is better than availing of the ER 1-94.	• We already plan to build a clinic but some commented that accessibility of the clinic might be an issue. • The Proponent can buy a van and hire a doctor and a nurse and can make rounds in the barangays.
	There was one instance where we tried to avail of the ER 1-94. Up to now, it is still stuck in PSALM.	• We've already talked to DOE about the matter. They said that NPC still owes them money. We told them that since the Proponent is already paying, they should let the people avail of the fund.
Dr. Sylvia Yamilao Municipal Health Officer	The idea of a van is good but we already have health centers. It would better if we just improve the health facilities in the town proper. In cases of emergencies, the van might not be available.	•
Municipal Councilor	We tried to avail of ER 1-94 funds. It has already been a few years and the costing there is no longer applicable. During NPC times, road construction was fast tracked because the financial assistance was given directly. In Barangay Bani, there were street lights but they need to turn it off because they can no longer pay the electricity bills. Maybe you can provide electricity for some parts. In terms of employment, most of the employees are not from Masinloc since locals lack the expertise.Can you do something about this?	• Please understand that we are not NPC. About the streetlights, we can't provide electricity for it. • The best approach would be to utilize ER1-94 and we will help in getting • We can't fulfill promises that NPC made. We can only honor commitments that we made. • The Proponent will construct a Trade School
Ms. Josie Barcena PESO	• What is the meaning of AES? • When will the Trade School open? • Employment-Why do you still post on the internet? Can you provide the PESO office job orders?	• AES used to mean Applied Energy Solutions. But overtime, just the acronym AES is used • Coordination is on-going for the trade school • Postings on the internet were made for transparency since the job expertise is not available locally. • We post job openings on Barangay halls. Next time we will coordinate with PESO for job openings.
Mr. Dennis Leyco Sangguniang Bayan Secretary	Who monitors production capacity?	• Production is monitored in two ways. NGCP has their own sealed meter to monitor those that goes to their system. Masinloc Plant has its own monitoring system in place.
Mr. Elmar Rulido	• Weak harvest maybe due to	• The Masinloc Plant meets the

Name	Issue/Concern Raised	Proponent's Response
Municipal Agriculturist	operations of AES • Finance projects for Fishery and Agriculture Sector	standards set by DENR. • Possible are for assistance can be explored

Table 2-119: Issues and Concerns Raised during the Consultation Meetings with the Sangguniang Panlalawigan

Name	Issue/Concern Raised	Proponent's Response
Gov. Hermogenes Ebdane Jr. (Governor of Zambales)	Specific Data should have been presented, i.e. before the construction of the existing and for the expansion for comparison purposes	• The data will be included in the EPRMP submitted to DENR and copies will be circulated to the Governor's office.
Gov. Hermogenes Ebdane Jr. (Governor of Zambales)	On the medical missions—Concentrate on the supposed illness that is suspected to be caused by the plant. (i.e., asthma, TB). Even if it is not caused by the plant, if we can improve the health conditions of those within the vicinity of the plant that will be a very positive for the operation of plant.	• This will be taken into consideration as part of the Proponent's overall CSR Program. • Evaluating the possibility of sponsoring mobile medical clinic to regularly visit barangays.
Gov. Hermogenes Ebdane Jr. (Governor of Zambales)	On the water extraction—First you mentioned that you might double your extraction of water from Lauis River, and then you said that you might consider desalination. You might want to consider that since future projects in the upstream of the river might affect your supply.	• It is unlikely that the Project will need to use additional water from the Lauis River.
Gov. Hermogenes Ebdane Jr. (Governor of Zambales)	On discharge of the water to the sea—There is a temperature of water that you have to maintain so as not to affect the fish. Either you have a cooling chamber or a longer canal before discharge. I think a cooling chamber before discharge is more appropriate.	• Seawater discharge would be monitored and comply with DENR standards.
Jessu Edora (Ex-Mayor of Masinloc) 66:15	On hiring locals for the Project—When AES took over from NPC, local security guards were removed because someone from AES said that people from Zambales could not be trusted. People are now afraid that they would be left out.	• Local hires are used for securities at most monitoring stations. Corporate policy dictates that security should come from non-local employees. A preference will be given for local, qualified persons for other job opportunities. The Proponent is also looking to a fund welding school to train locals in anticipation of future expansion needs.
Jean Morana (Mayor of Candelaria) 77:10	On respiratory complications—According to the presentation, there were no significant increase in the number of respiratory diseases, but the data was only in Masinloc. There was a significant increase in Candelaria of respiratory diseases, therefore barangays from the area should be considered in the report.	• Health data and health profile of Candelaria will be retrieved for inclusion to the EPRMP.
Gov. Hermogenes Ebdane Jr. (Governor of Zambales) 78:20	LGUs should be given copies of the technical data so they could have their own technicians analyze it.	• Copies of the EPRMP will be given once it is submitted to the DENR. The EPRMP will contain data on current Plant's operation and potential impact from the planned Expansion.
Vice Gov. Ramon G. Lacbain 85:51	The benefits of the community should be properly identified for the affected LGUs. The major document readily available to us is the original MOA signed by NPC, but there are violations in the MOA before. You should give us a copy of the benefits in writing to be monitored by the Multipartite Monitoring Team.	• The original MOA that was referred to was signed on May 2, 1992 and amended January 20, 1998. This MOA was superseded by a MOA signed in 2005. To the Proponent's knowledge, no terms of the applicable MOA was violated by the Proponent. Proponent would

Name	Issue/Concern Raised	Proponent's Response
		welcome discussions on the concerns in this regard. • MMT reports are regularly provided to LGU offices (Barangay. Bani, ENROZ - Capitol, Masinloc, Candelaria, Palauig, CENRO, PENRO, EMB-DENR Region 3, Protected Area Management Board) on a quarterly basis (every 3 months). Transmittal letters are receipt acknowledged by these respective offices. • Written communication of the benefits to the host communities will be regularly communicated by the Proponents IEC plan.
Vice Gov. Ramon G. Lacbain	There should be a regular reporting of the MMT to the LGUs.	• See above.
Unnamed participant -1 108:00	You should allow us to authorize any entity, even the provincial government, to get the fly ash from the silo, subject to regulation.	• The release of fly ash is governed by agreement dated March 31, 2005 among the DOE, NPC, PSALM, Zambales, Masinloc, Candelaria and Bani, which allocated the fly ash from the plant to Zambales subject to 40-40-10-10 sharing for Zambales, Masinloc, Candelaria and Bani, respectively. Zambales in turn signed an agreement in 2007 granting fly ash rights to Pozzolanic Philippines, Incorporated. There is a court case on who has the right to receive fly ash since the province has rejected the agreement with Pozzolanic. As the party obligated to release the fly ash, the Proponent has the right to know who has the legal right to the fly ash in that court case before it can release the fly ash.
Unnamed participant -1	People are now discouraging the expansion because they haven't seen any improvement over the years of the plant's operation.	• The Proponent contends that there has been improvement on the Plant's operations since the Proponent has taken over it, namely in efficiency, emissions levels, and adherence to environmental regulation.
Unnamed participant -1	Ever since the plant started its operations, the community still did not experience any decrease in the electric bills.	• The electricity produced from the Plant is sold to the Luzon Grid. The electricity rates in which the community pays is dependent on the rate that the local electric utilities purchase the power.
Atty. Sancho A. Abasta Jr. (Provincial Board Member) 111:54	Going back on the issue of fly ash, is it not a fact that the fly ash is owned by the provincial government, under the old MOA? You do not have to wait for the court proceedings to terminate, because the AES has no bearing on the contract of the Pozzolanic and the provincial government.	• There is a court case on who has the right to receive fly ash since the province has rejected the agreement with Pozzolanic. As the party obligated to release the fly ash, the Proponent has the right to know who has the legal right to the fly ash in that court case before it can release the fly ash.
Atty. Sancho A. Abasta Jr. (Provincial Board Member) 111:54	There should be a study or negotiations done to decide whether the company should continue its operation, instead of the topic of expansion.	• The Proponent believes that continuing operations of the Plant and the development of the

Name	Issue/Concern Raised	Proponent's Response
		Expansion is for the benefit of the Philippines.
Vice Gov. Ramon G. Lacbain (Vice Governor of Zambales) 120:22	Regarding Mr. Pierce's position between Pozzolanic and Zambales, I think he shouldn't be dealing with the issue of the fly ash. AES should side with Zambales since they have no liability with Pozzolanic.	• There is a court case on who has the right to receive fly ash since the province has rejected the agreement with Pozzolanic. As the party obligated to release the fly ash, the Proponent has the right to know who has the legal right to the fly ash in that court case before it can release the fly ash.
Unnamed participant -2 (Concerned citizen of Candelaria) 125:43	Death toll in Candelaria is now estimated at around 20 per month, which could be attributed to the plant's operation. Farm production (Mung beans) is also adversely affected. Water shortage is a major problem in Candelaria now.	• The Proponent complies with all Philippine laws and regulations. The Proponent believes that the death toll at Candelaria and the adverse productions of mung beans are not related to the Plant's operations.
Rodel Eclarinal (Punong Barangay of Taltal) 127:50	Regarding the pumping station assigned to the barangay, we asked the real property tax from the treasury office of Masinloc. The treasurer said that it would only amount to PhP 600 for 2 years. Since the plant is using water from the barangay, the people are asking how come they are not benefitting from the tax.	• The Proponent complies with all Philippine's tax related laws. The amount of RPT is 1% of the assessed value and apportioned between the province, municipality and barangay.
Jean Morana (Mayor of Candelaria) 130:30	Actually, the freshwater being used is from Lauis River, which is a part of Candelaria. Why then must the negotiations regarding the payment for the use of water go through the National Water Regulatory Board?	• Philippines law dictates that the National Water Regulatory Board (NWRB) is the authorizing agency for freshwater use including that from the Lauis River.
Jean Morana (Mayor of Candelaria) 135:17	The agenda for today is supposed to be for the Phase 2, or expansion. However, there are still issues with the Initial phase of the plant's operation. I think it's only appropriate to give us a copy of the technical report so we could consult our own sources to have a better discussion/negotiation with AES.	• Copies of the EPRMP will be given once it is submitted to the DENR. The EPRMP will contain data on current Plant's operation and potential impacts from the Project.
Brgy. Kagawad Bactadan(Kawani ng Taltal) 137:22	The water may come from Lauis River, but the siphoning tube from the plant is on Taltal. So, we are wondering if Taltal has a part of the money intended for the payment of the use of river water. I acknowledge mayor's statement that the ash is drifting towards Candelaria. We are currently experiencing power problems. I'm just requesting that the operation should be improved.	• The price paid for use of freshwater from the Lauis River is made to NWRB and any real property taxes that the Proponent is levied. The Proponent has paid in full these amounts. The Proponent had sent a tax person to accompany the Barangay Chairman of Taltal and some of its officials to the Municipal Treasurer to discuss its share of RPT. It was agreed that Barangay Taltal should meet with the Municipal Assessor so that the tax declaration of the pumping station located in Barangay Taltal be revised accordingly. Share of RPT due to the pumping station should go to Barangay Taltal and it is the responsibility of the municipality to apportion the barangay's share of RPT appropriately. • The Proponent has an extensive fly-ash management system and complies with DENR regulation. • Any power problems are most likely

Name	Issue/Concern Raised	Proponent's Response
		due to the distribution lines issues in which the Proponent has no involvement with.

2.4.8 Project Implementation's Threat to Public Health vis-à-vis the Baseline Health Conditions in the Area

2.4.8.1 Introduction

The general perception is that a coal-fired thermal power as a source of energy is potentially related to several environmental hazards including chemical, physical and biological agents. One of the concerns of the residents living near a power plant is exposure to contaminants that could cause health problems. The by-products and contaminants of a coal-fired thermal power plant operation include air emissions of carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM), coal ash, soil and water chemical contamination. Hazardous agents may spread through pathways (air, soil and water) that may directly or indirectly affect residents (receptors) through inhalation, ingestion and skin contact. Inhalation of air-borne dust and chemicals, drinking of contaminated water from public and private wells and other sources, direct contact with contaminated soil are some of the possible areas of contacts with residents in the area.

The concern of this study is to determine the environmental health hazards associated with the Masinloc Plant and how it can affect the communities in the surrounding areas. A baseline study of the health profile of the community was investigated and serves as a reference for future studies during the pre-operation, operation and decommissioning of the power plant.

2.4.8.2 Objectives

1. To establish baseline health status of the DIA.
2. To determine the vital health statistics of the DIA.
3. To enumerate the leading causes of mortality and morbidity of the DIA.
4. To identify the environmental health and sanitation profile of the DIA.
5. To identify the health facilities and human resources available.
6. To enumerate the health hazards associated with coal-fired thermal power plants on the health of workers and the residents in the DIA.
7. To identify the health consequence/s of the identified hazards.
8. To cite the population group at risk.
9. To estimate the risk index of the hazards identified.
10. To prioritize the risks identified and to be able to recommend mitigation plan.
11. To recommend a health monitoring plan.

2.4.8.3 Methodology

The Masinloc Plant was visited including the Project area. The outlying impact communities in Barangays Bani, Taltal and Baloganon were also visited. The Municipal Health Officer and nurse, barangay midwives in the Rural Health Unit (RHU) and residents were interviewed on the health status of the residents and the health services available in the area. Secondary health data were also collected from the RHU and Barangay Health Stations (BHS).

The nurse and safety officer of Masinloc Plant werealso interviewed on the health status of the workers. Information on the health services, safety training and health monitoring provided by the Proponent was also collected. The secondary health data and records on occupational safety and injury were also gathered from the nurse and safety officer.

To determine the environmental health impact assessment (EHIA) of the Project, a qualitative health risk assessment was executed using the following steps:

1. Comprehensive identification of environmental health hazards to workers and the DIA.

2. Estimation of the probability of occurrence of the exposure incident. The incident potential technique is based on information of past occurrences of the exposure situation being assessed.
3. Identification of adverse health consequences on the human receptors and rating them based on the severity of ill-health (health consequence rating).
4. Integration of the adverse health consequence rating with the incident potential rating to come up with a health risk prioritization matrix that will be the basis for planning and prioritization of control and preventive measures.

Literature review was done on the adverse health effects of the chemicals, physical and biological agents recently published in the medical journals.

2.4.8.4 Municipal Health Profile

The only RHU in South Poblacion, Masinloc was established in 1985. It is certified by "Sentrong Sigla" and has received an award in year 2000.

The primary services offered by the RHU include medical consultations, delivery of first aid treatments, preventive medicine dispensing including immunization, and health education. The RHU implements the health programs of the Department of Health shown in **Table 2-120**.

Table 2-120:MunicipalHealth Programs, 2009

Program/Activities
1. Maternal and Child Care
a. Pre-natal Care
1. Pregnant woman with 4 or more visits
2. Pregnant women given TT2+
3. Pregnant women given:
TFAP/OFS
Iron
Iodine
b. Post-Partum
1. Total post-partum home visits
2. Women receiving at least 1 PP visit
II. Expanded program for immunization (EPI)
Immunization: BCG
DPT1
DPT2
DPT3
OPV1
OPV2
OPV3
Measles
FIC fully immunized child
Hepa B1
Hepa B2
Hepa B3
Children given Vitamin A during measles Immunization
III. Control of Diarrheal Diseases (CDD)
Diarrheal Cases seen: <1 year
1 – 4 years old
Treated with Oresol: <1 year
1 – 4 years old
IV. Nutrition
Identification of 0 – 72 mos. children
OPT – Operation Timbang
Children 0 – 72 mos. Given: TFAP
Vitamin A

Program/Activities
Iron
VI. Family Planning Program
New acceptors: pills, condom, DMPA, NFP/LAM, IUD
Continuing User
VII. Diseases Control Tuberculosis, Malaria, Leprosy, Schistosomiasis, Rabies, STD, Parasitism

The program “Garantisadong Pang Bata” offers Vitamin A, deworming, iodized salt testing and measles vaccination to children in the community. The Family Birth-Control Program includes quarterly injections of Depot provera, pills and natural family planning lectures. Deworming of children is also supported by the Local Government Unit. The health personnel also conduct minor surgery including “Operation Tuli” in summers.

Birth attendances are primarily conducted by the midwives in the RHU and also in the homes of the patients. They are assisted by the “trained hilot”.

Dental services are limited to teeth extraction and dental prophylaxis for the day care students.

The RHU also offers laboratory examinations including CBC, fecalysis, urinalysis and sputum AFB smears for the diagnosis of PTB.

Education on Life Style Diseases and its modification like Hypertension, Cardio-vascular diseases, Tuberculosis and Diabetes Mellitus are regularly conducted by the RHU.

The list of health personnel in the RHU who implement all the health programs of the DOH are shown in **Table 2-121**.

Table 2-121:RHU Health Personnel

Health Services	Number
Doctor – General Practitioner	2
Nurse	4
Midwife	8
Medical Specialist	1 Family medicine
Med tech/lab tech	2
Dentist	2
Dental aide	1
Dietitian/Nutritionist	1
Barangay Health Worker	126
Rural Sanitary Inspector	1

Source: Masinloc RHU, 2009

There is no hospital located in Masinloc, Zambales. Patients who need immediate diagnosis and management are referred to the hospitals outside of Masinloc.**Table 2-122** shows the hospitals where patients are referred to, the method of travel used, time of travel from the RHU and cost of travel. A referral form is used to facilitate communication between the health facilities.

Table 2-122: Referral Health Facilities

Type of Health Facility	No.	Method of Travel	Travel Time	Cost
District Hospital Candelaria district	1	Jeep, tricycle	15 mins.	PhP 10.00
Provincial Hospital Iba	1	Jeep Bus	45 mins.	PhP 36.00 PhP 40.00
Private Clinic	6	Jeep, tricycle	5 mins.	PhP 10.00
Sta. Cecilia Hosp. in Iba	1	Jeep Bus	45 mins.	PhP 36.00 PhP 40.00
Traditional Medicine	>10	Jeep, tricycle	5 min – 15 mins.	PhP 10.00

Source: Masinloc RHU, 2009

Some of the residents are members of the PhilHealth Insurance Program. The LGU isresponsible for paying the monthly membership fee.There are 300 members who avail of the health insurance benefit. The RHU is presently applying for accreditation so it can receivethe capitation fund benefits given by the PhilHealth to LGU and health units.

All patients seen at the RHU get all their medicines for free during the first three days of treatment. Drugs are usually available to these patients; however, there would be days that all medicines are consumed due to the bulk of patients seen (100) per day.Continuation of treatment and unavailable medicines are acquired from drug stores and "sari-sari" stores. **Table 2-123** enumerates the facilities where drugs are acquired. Hospitals outside of Masinloc do not give free medicines to patients.

Table 2-123: Sources of Medicines

Sources	Number
RHU	1
BHU	13
Hospitals	0
Pharmacy/Botica	7
Botica sa barangay (medicines from DOH)	5
Botica natin	1
Generic drugs	1
Mayor's office supply	-
DOTS from DOH	-

Source: Masinloc RHU, 2009

Table 2-124 shows the donations and health activities contributed by organizations to the communities of Masinloc.

Table 2-124:Health-related People's Organization/NGO/Private Organization

Name	Contributions
NAPOCOR	Instruments and equipment
Proponent	Medical missions and free medicines
Rotary	Deworming program
Church	Allowance and medical assistance to the disabled

Source: Masinloc RHU, 2009

Table 2-125 shows the vital health statistics of Masinloc.

Table 2-125: Vital Health Statistics of Masinloc Municipality

	2007	2008	2009
Total Population	47510	48741	50003
Number of Barangays	13	13	13
Number of BHS			
Total Number of Live births	1123	1163	1140
Birth Rate	27.71	23.86	22.80
Total Number of Deaths Male Female	154	260	296
Mortality Rate	3.80	5.33	5.97
Number of Infant Mortality	5	6	5
Infant Mortality Rate	27.71	23.86	5.92
Number of Neonatal Deaths	3	6	12
Neonatal Death Rate	2.67	5.15	10.53
Number of Maternal Deaths	0	1	0
Maternal Death Rate	0	0.85	0

Source: Masinloc RHU, 2009

The population in Masinloc Municipality hasincreased from 2007 to 2009 as shown in **Figure 2-121**.

.

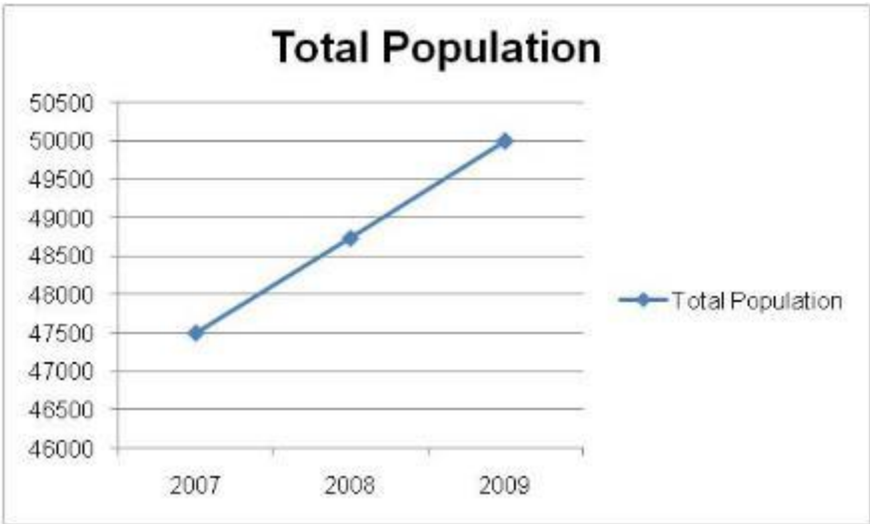


Figure 2-121: Total Population of Masinloc

There is a slight increase in the number of live births in the same period of time. **Figure 2-122** shows the increase in mortality and neonatal death rates from 2007 to 2009. There is a significant decline in the infant mortality rate in the same years. There areno maternal deaths in 2007 and 2009.

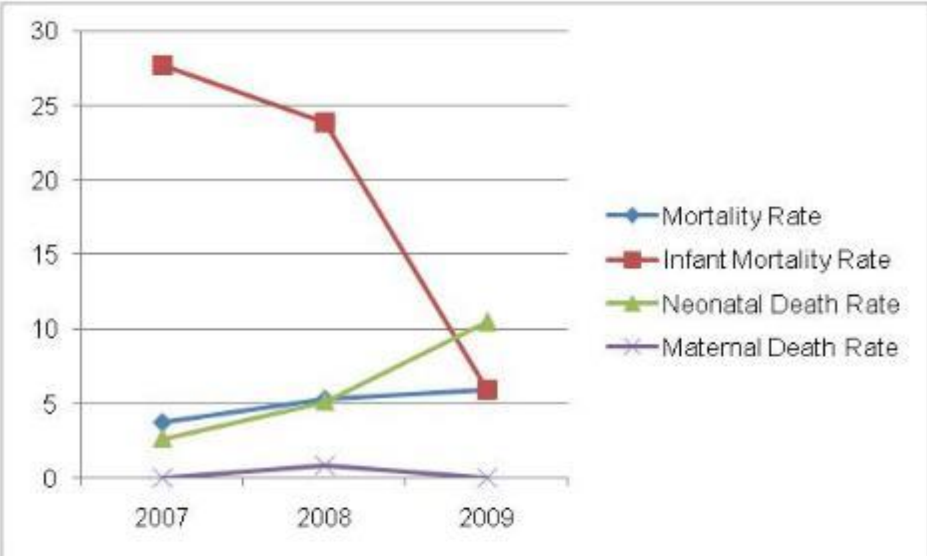


Figure 2-122: Death Rates

The causes of diseases are usually due to acute respiratory infections (ARI), diarrheal diseases, urinary tract infections (UTI), hypertension and bronchial asthma. The less common diseases but still included in the top ten morbidities are pulmonary tuberculosis (PTB), dog bite, chicken pox and anemia (**Table 2-126** and **Figure 2-123**).

Table 2-126: Top Ten Leading Causes of Disease

Disease	Rank	Rate (per 1000 population)
Acute Respiratory Infection	1	152.67
Diarrheal diseases	2	11.48
Urinary tract infection	3	8.99
Hypertension	4	5.46
Bronchial asthma	5	4.52
Medico-legal reports	6	2.86
Pulmonary tuberculosis	7	2.56
Dog bite	8	1.24

Disease	Rank	Rate (per 1000 population)
Chicken pox	9	0.88
Anemia	10	0.58

Source: Masinloc RHU, 2009

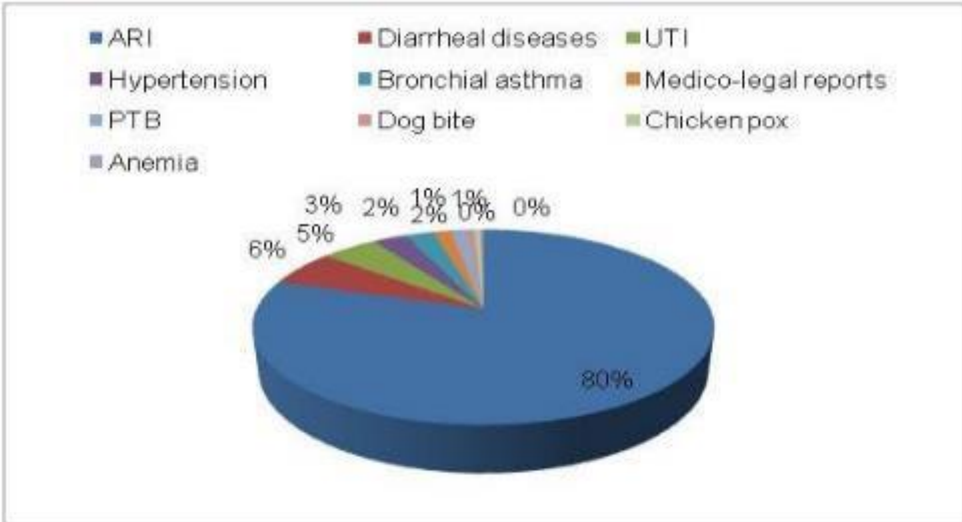


Figure 2-123: Top Ten Leading Causes of Diseases

Table 2-127 and **Figure** 2-124 show the rates of diseases in Masinloc. The rates of diarrheal diseases, hypertension, bronchial asthma, dog bites and chicken pox increased over a three year span. The diseases that decreased include urinary tract infections, pulmonary tuberculosis and pneumonia.

Table 2-127: Leading Causes of Diseases

Cause	2007	2008	2009
Acute Respiratory Infection	158.03	195.24	152.67
Diarrheal diseases	7.22	10.67	11.48
Urinary tract infection	13.30	9.95	8.99
Hypertension	2.69	2.52	5.46
Bronchial asthma	3.49	9.56	4.52
Medico-legal reports	-	-	2.86
Pulmonary tuberculosis	2.78	2.97	2.56
Dog bite	0.78	0.57	1.24
Chicken pox	0.34	-	0.88
Anemia	-	-	0.58
Pneumonia	0.53	0.47	-
Mumps	-	0.41	-

Source: Masinloc RHU, 2009

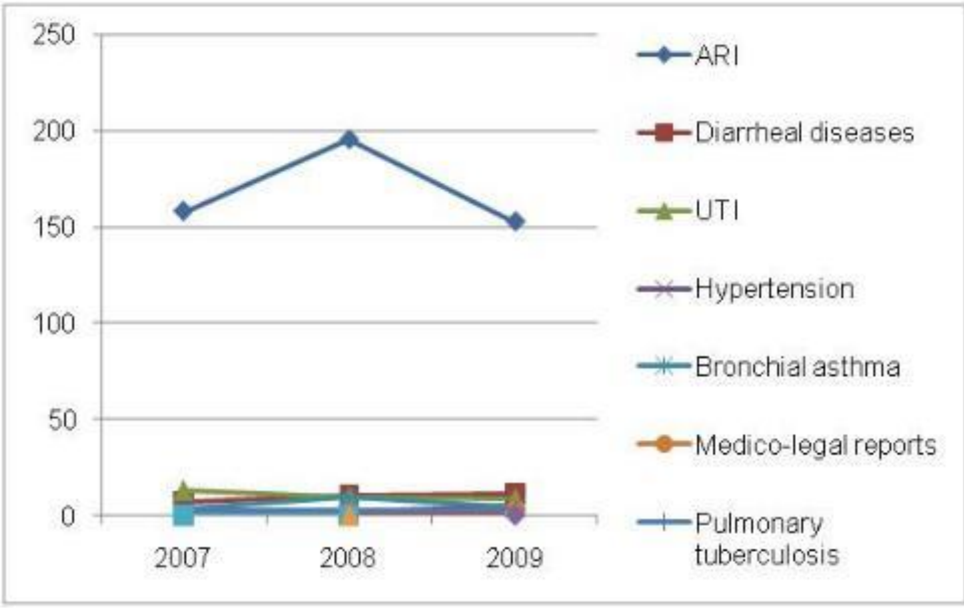


Figure 2-124: Leading Causes of Diseases

In 2009, the leading causes of deaths in Masinloc include multiorgan failure, pneumonia, myocardial infarction, cancer, cerebro-vascular accident (CVA), PTB, diabetes mellitus, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF) and vehicular accident (**Table 2-128** and **Figure 2-125**).

Table 2-128: Causes of Mortality

Cause	**Rate (per 1000 population)**
Multiorgan Failure	1.20
Pneumonia	0.74
Myocardial infarction	0.68
Cancer	0.52
Cerebro-vascular accident	0.44
Pulmonary tuberculosis	0.28
Diabetes mellitus	0.28
COPD	0.18
Congestive heart failure	0.14
Vehicular accident	0.12

Source: Masinloc RHU, 2009

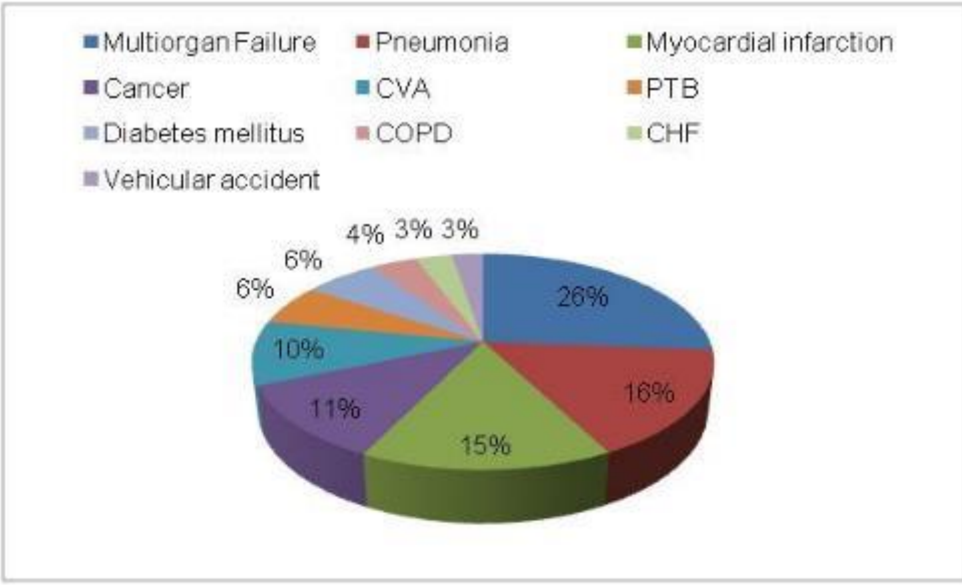


Figure 2-125: Causes of Mortality

Over a span of three years, multiorgan failure, pneumonia, cancer, CVA, PTB, diabetes mellitus and COPD incidents increased, while the case of myocardial infarction, congestive heart failure and vehicular accidents decreased (**Table 2-129** and **Figure 2-126**). Hypertension and septicemia were recorded as leading causes of disease once only in 2007 and 2008, respectively.

Table 2-129: Leading Causes of Mortality

Causes	2007	2008	2009
Multiorgan Failure	-	0.68	1.20
Pneumonia	0.23	0.16	0.74
Myocardial infarction	0.69	0.98	0.68
Cancer	0.38	0.41	0.52
Cerebro-vascular accident	0.19	0.29	0.44
Pulmonary tuberculosis	0.25	0.18	0.28
Diabetes mellitus	0.11	-	0.28
COPD	0.15	0.16	0.18
Congestive heart failure	0.02	0.21	0.14
Vehicular accident	0.08	0.12	0.12
Septicemia	-	0.16	-
Hypertension	0.17	-	-

Source: Masinloc RHU, 2009

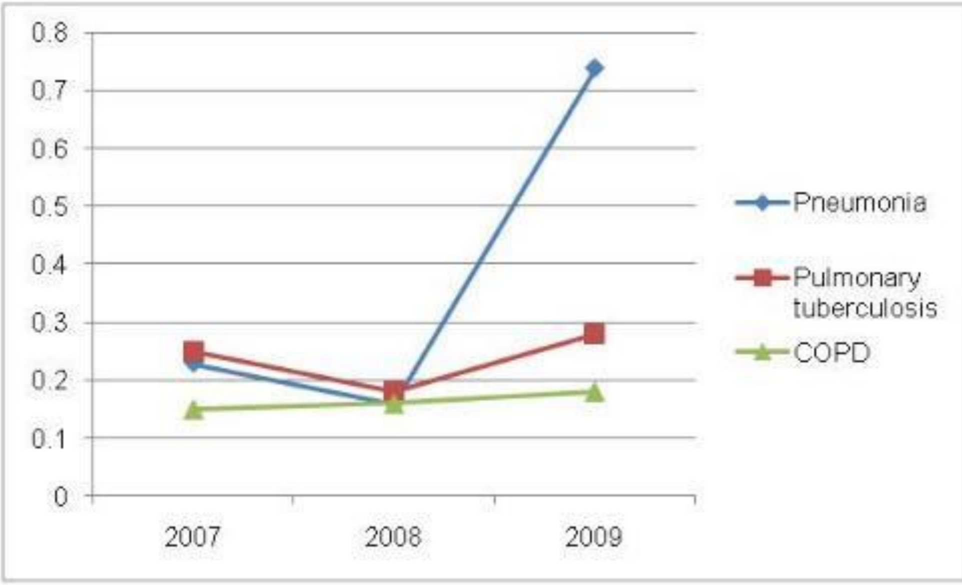


Figure 2-126: Leading Causes of Mortality due to Pulmonary Diseases

Table 2-130 enumerates the causes of infant deaths in Masinloc. In 2007, the recorded causes were multiorgan failure, respiratory failure, anemia, hypoxia and sepsis. In 2008, infant deaths weredue to aspiration, multiple congenital anomaly, bronchitis/bronchiolitis and pneumonia.In 2009, the infant deaths weredue to acute respiratory distress syndrome (ARDS), PTB and sudden infant death syndrome. Deaths due to sepsis occurred in all three years.

Table 2-130: Causes of Infant Mortality

Causes	2007	2008	2009
Multi-organ failure	0.89	-	-
Respiratory failure	0.89	-	-
Anemia	0.89	-	-
Severe hypoxemia	0.89	-	-
Sepsis	0.89	0.85	0.88
Aspiration pneumonia	-	1.71	-
Multiple congenital anomaly	-	0.85	-
Bronchitis/bronchiolitis	-	0.85	-
Pneumonia	-	0.85	0.88
ARDS	-	-	0.88
Sudden infant death syndrome	-	-	0.88
PTB	-	-	0.88

Source: Masinloc RHU, 2009

Table 2-131 shows the decreasing number of underweight and overweight children in Masinloc. Children of normal bodyweight haveincreasedover a span of three years.

Table 2-131: Nutritional Status

Status	2007	2008	2009
Very low	76	82	63
Low	790	834	775
Normal	5075	4986	6256
Above normal	63	86	57
Total	**6004**	**5988**	**7151**

Source: Masinloc RHU, 2009

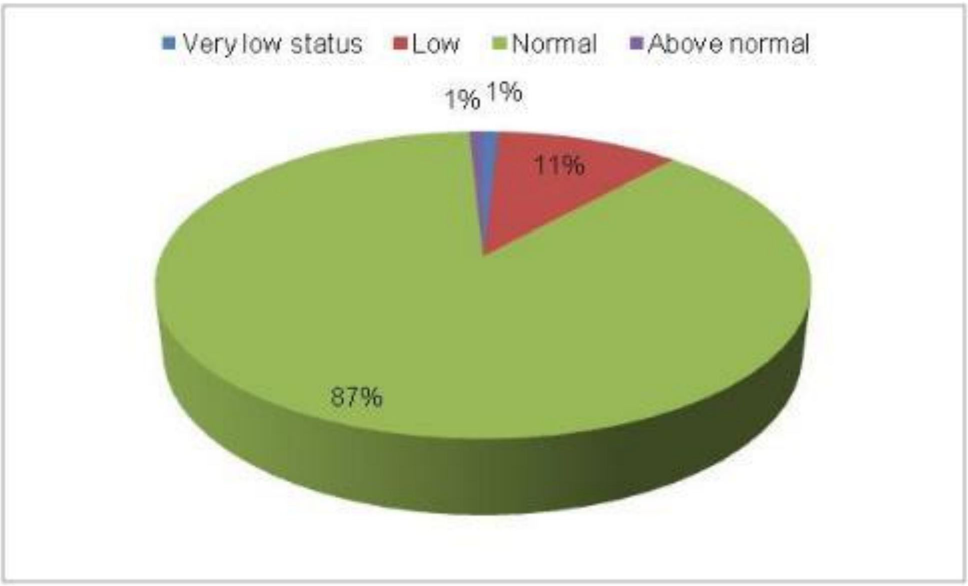


Figure 2-127: Nutritional Status

Majority of children in Masinloc have good and normal nutritional status (87%). Eleven percent of them are slightly underweight, while one percent has very low weight. However, one percent is overweight (**Figure 2-127**).

Table 2-132 shows the Environmental Indices by year in Masinloc. Approximately 91% of households have access to safe water supply, while 96% of households make use of sanitary toilets.

Table 2-132: Environmental Indices

Activities	2007	2008	2009
No. of Households (HH)	7918	8123	8519
HH with access to safe water supply	5900	5950	7746
HH without access to safe water supply	1895	1845	909
HH with Sanitary Toilet Facilities	5033	5088	8220
HH with Unsanitary Toilet Facilities	1936	0	683
HH with without Toilet Facilities	0	1881	1156

Source: Masinloc RHU, 2009

Figure 2-128 shows the significant increase in the number of households with access to safe water supply and sanitary toilets fromthe years2007 to 2009.

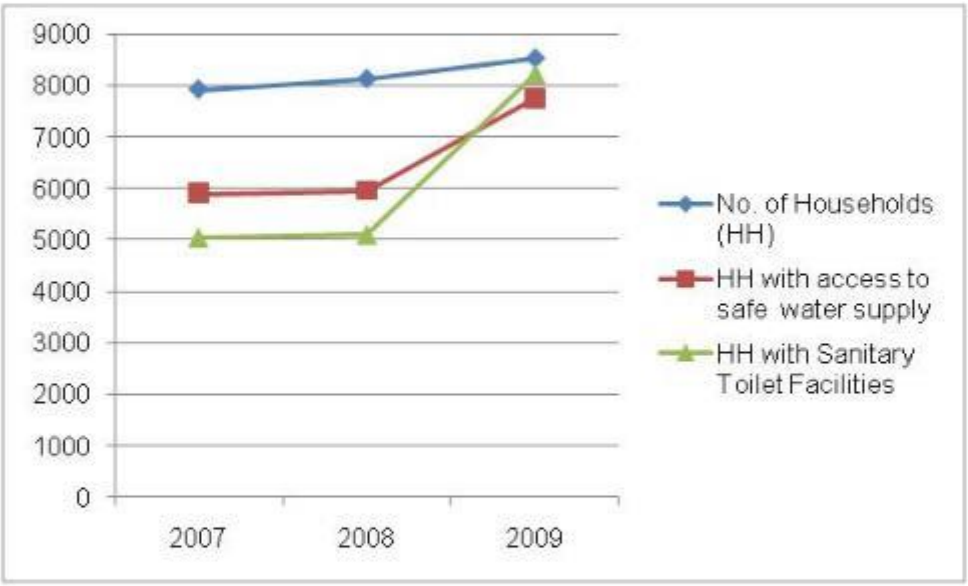


Figure 2-128: Environmental Indices

2.4.8.5 Impact Barangays Health Profile

Table 2-133: Health Profile of the DIA

	Baloganon	Bani	Taltal
Estimated Population	7536	3408	5966
No. of Households	1507	682	1193
No. of Government Hospitals	0	0	1
No. of Rural Health Units	0	0	1
No. of Barangay Health Station	1	1	1
No. of Live Births	205	84	101
Crude Birth Rate	27.20	24.64	16.92
Total Deaths	41	14	31
Crude Death Rate	54.40	41.07	5.19
Infant Deaths	2	1	1
Infant Death Rate	9.75	11.9	9.90
Neonatal Deaths	2	1	2
Neonatal Death Rate	9.75	11.9	19.80
Maternal Deaths	0	0	0
Maternal Death Rate	0	0	0
Fetal Deaths	0	0	0
Fetal Death Rate	0	0	0

Source: Masinloc RHU, 2009

Barangay Baloganon has the highest Crude Birth and Death Rates while Barangay Taltal has the lowest rates for both.

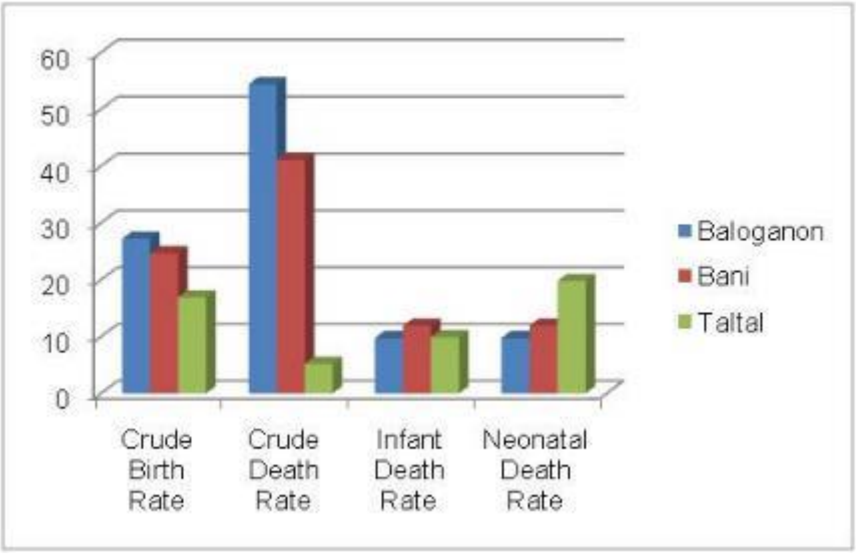


Figure 2-129: Crude Birth and Death Rates by DIA

The Infant Death Rate is highest in Barangay Bani, while Barangays Baloganon and Taltal have the almost the same rate (**Figure 2-129**). Neonatal death rate is highest in Barangay Taltal.

Table 2-134: Leading Causes of Diseases by DIA

Cause	Baloganon	Bani	Taltal
Acute Respiratory Infection	163.61	82.74	66.04
Diarrheal diseases	11.68	0.06	3.86
Urinary tract infection	9.82	0.04	6.03
Hypertension	4.78	0.03	4.36
Bronchial asthma	6.37	0.03	1.17
Pulmonary tuberculosis	1.59	0.01	1.34
Dog bite	1.46	0.01	0.84
Chicken pox	0.66	-	-
Hepatitis	-	0.01	-
Pneumonia	0.53	-	0.50
Mumps	0.40	-	-
Leprosy	-	0.003	-
Anemia	-	-	1.68

Source: Masinloc RHU, 2009

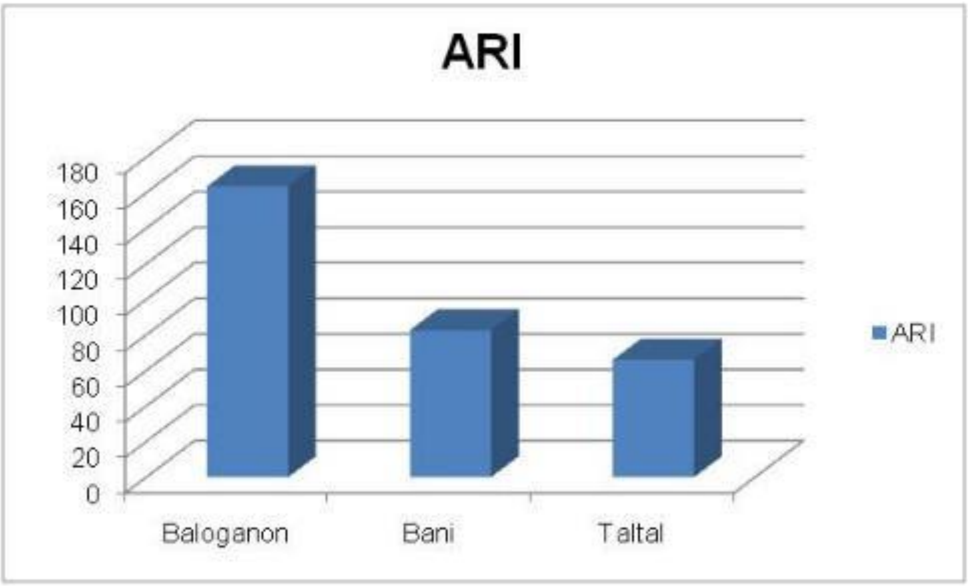


Figure 2-130: Acute Respiratory Infection by DIA

Acute respiratory infection is highest in Barangay Baloganon, followed by Barangay Bani and the least is Barangay Taltal (**Figure 2-130**). Diarrheal Diseases, UTI, hypertension, bronchial asthma, PTB and dog bite are highest (in rates) in Barangay Baloganon, while Barangay Bani has the lowest rates for the diseases (**Figure 2-131**).

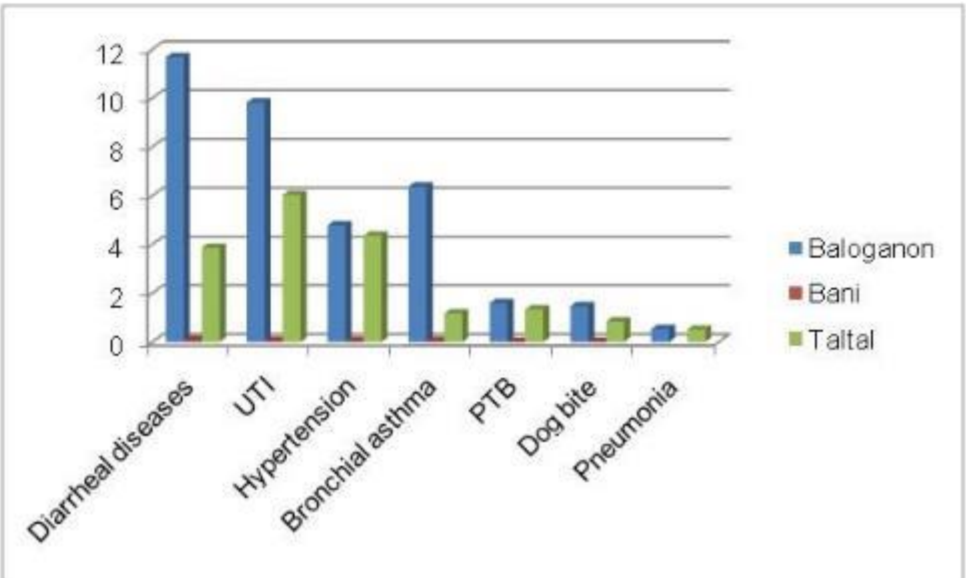


Figure 2-131: Other Leading Causes of Diseases by DIA

Table 2-135: Causes of Mortality by DIA

Causes	Baloganon	Bani	Taltal
Multiorgan Failure	0.53	0.88	1.01
Pneumonia	0.93	0.59	0.34
Myocardial infarction	0.40	0.29	0.67
Cancer	0.80	0.29	0.50
Cerebro-vascular accident	0.40	-	0.34
Pulmonary tuberculosis	0.27	-	0.50
Diabetes mellitus	-	0.29	0.17
Congestive heart failure	-	0.29	-
Septicemia	0.27	-	-

Causes	Baloganon	Bani	Taltal
Cardio-vascular disorder	0.40	0.59	-
Prematurity	0.13	-	-
Liver cirrhosis	-	0.29	-
Meconium aspiration	-	0.29	0.34
Acute gastro-enteritis	-	0.29	-

Source: Masinloc RHU, 2009

Barangay Taltal has the highest mortality rates for multi-organ failure, myocardial infarction, PTB and meconium aspiration. Barangay Baloganon has the highest rates for pneumonia, cancer and CVA. Barangay Bani has the highest rates ofdiabetes mellitus and CVD (**Figure 2-132**).

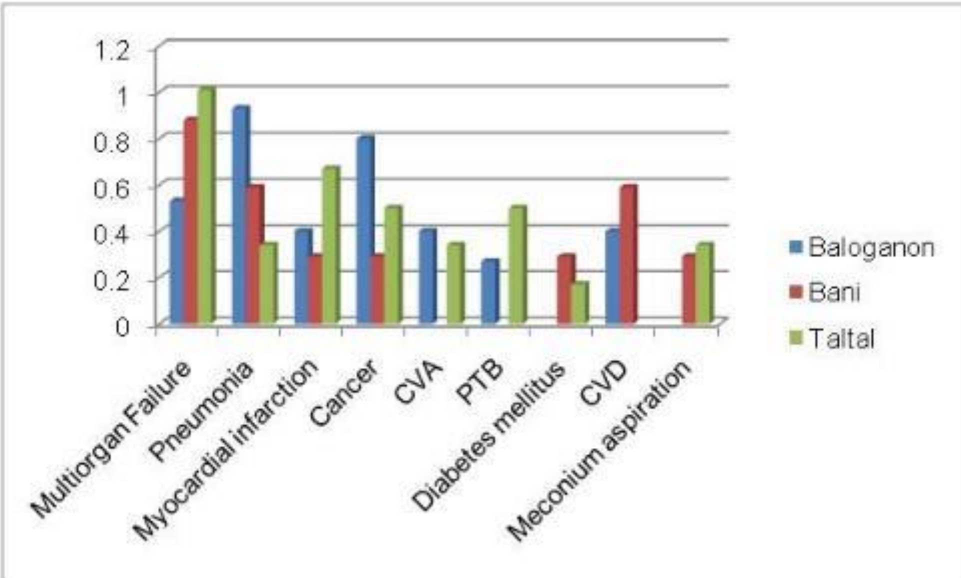


Figure 2-132: Causes of Mortality by DIA

Acute respiratory infection is also the leading cause of disease among the infants in all impact barangays. Diarrhea is next among the most common diseases. Barangay Taltal reported cases of anemia and PTB. Pneumonia/bronchitis was seen in Barangays Baloganon and Taltal. Infants die of bronchial asthma in Barangay Baloganon.

Table 2-136: Leading Causes of Infant Diseases by DIA

Cause	Baloganon	Bani	Taltal
Acute Respiratory Infection	6.83	4.05	3.17
Diarrhea	0.93	0.71	0.89
Anemia	-	-	0.10
Pulmonary Tuberculosis	-	-	0.10
Pneumonia/Bronchitis	0.05	-	0.10
Bronchial Asthma	0.15	-	-

Source: Masinloc RHU, 2009

The reported causes of infant deaths are sepsis, pneumonia and wilms tumor in Barangays Baloganon, Bani and Taltal, respectively (**Table 2-137**).

Table 2-137: Causes of Infant Mortality by DIA

Causes	Baloganon	Bani	Taltal
Sepsis	9.75	-	-
Pneumonia	-	11.9	-
Wilms tumor	-	-	9.90

Rate per 1,000 Population

Table 2-138 shows the causes of neonatal mortality. Pre-maturity was reported in Barangay Baloganon. Congenital anomalieswere seen in Barangay Baloganon.

Table 2-138: Causes of Neonatal Mortality by DIA

Causes	Baloganon	Bani	Taltal
Prematurity	4.87	-	-
Congenital Anomaly	4.87	-	-
Meconium aspiration	-	11.9	19.80

Source: Masinloc RHU, 2009

2.4.8.6 Related Studies on the Health Impacts of Coal-Fired Power Plants

An independent study was jointly conducted by the Centre of Excellence for Sustainable Energy in Southeast Asia (CESE) and Lichel Technologies, Inc. to identify the main environmental and socio-economic and health effects related to the generation of electric power using coal as fuel using primary and secondary information. The study covered three coal fired power plants: Mirant Pagbilao Corporation located in Pagbilao, Quezon, Mirant Sual Corporation located in Sual, Pangasinan and Salcon Power Corporation located in Naga, Cebu.

Based on the information obtained during the study, it showed that there was no direct correlation between the operation of the power plants and the occurrence of some respiratory diseases. Causes of such illnesses could be attributed to exposure to indoor pollution through the emissions from burning of cooking fuel used by the households, cigarette smoking and road dust.

Other potential sources of local air pollution were from uncontrolled burning of solid wastes, types of cooking fuel, cigarette smoking and vehicular emissions. Majority of residents in Sual and Pagbilao dispose of their domestic solid wastes through open burning, within their compound or in open areas. Furthermore, the majority of the households used wood and kerosene as fuel for cooking.Thus, residents were possibly exposed to indoor pollutants coming from cooking fuel, cigarette smoking and transport dust and particulates.

Health records for Pagbilao and Sual showed the pattern of diseases prior to and during operation of the power plant projects. Respiratory diseases, particularly Acute Respiratory Infection (ARI), Bronchitis, and Pneumonia were the leading diseases in the area even before the power plant facilities were established. These diseases were also being observed and reported in other barangays of the municipality and in other parts of the province. Reviews/studies done by other independent consultants in 2002 and 2005 revealed that the risk of developing diseases is higher in the control barangay than in the impact barangays. It was also reported that people might also be exposed to other environmental pollutants.

Therefore, based on this it was concluded that the causes of diseases and deaths were not associated with the operation of the power plants. Though association of respiratory diseases was not established, it was still strongly recommended that the power plants be operated efficiently through the use of coal with low sulfur content and the use of efficient pollution controls and devices. The plants shall ensure compliance with all local, national and international environmental laws.

The local government/health units through taxes from the power plants shall allocate funds for the provision or delivery of basic health services.

Advocacy on the health effects of indoor pollution and poor sanitation condition, to increase the community's level of awareness. Residents were encouraged to shift to using clean fuel in cooking food, i.e., LPG, avoid smoking, and provide proper housing ventilation. Open burning of solid wastes was also prohibited.

2.4.8.7 Conclusion and Recommendations

1. The RHU of Masinloc, Zambales is certified to be compliant with DOH standards,and is capable to implement health care to the community.
2. The RHU implements the health programs of Department of Health and it follows the inter-referral health system within the local government unit (LGU) of Masinloc.
3. The causes of diseases and deaths in Masinloc are similar to those experienced on a national level.

4. There is a need to enhance the implementation of the health programs like Control of ARI, National PTB Program and Health education and prevention of life-style diseases.

2.4.8.8 Occupational Health and Safety Program of the Proponent

A copy of the Proponent's Occupational Health and Safety Guidelines is included as

Annex H.

2.4.9 Local Benefits Expected from Project Implementation

From 1993 to 2008, the National Power Corporation (NPC) provided various socio-economic programs to the surrounding communities of Masinloc Power Plant, totaling PhP 282,000,000. The said program covered infrastructure projects such as asphalting of roads and bridges, construction of public elementary and high schools, installation of water system and improvements of barangay plaza.

Loan assistance was also provided to the Municipality of Masinloc under the same program to finance the construction of the Masinloc Public Market and concreting of economic zone roads.

Direct beneficiaries of NPC's said socio-economic program were the Province of Zambales; Municipalities of Masinloc, Palauig and Candelaria; Barangays Taltal and Bani. Meanwhile, the PhP 70,700,000 ER 1-94 projects funded under NPC time covered installation of streetlights in the Province of Zambales, construction of elementary schools, day care centers and multi-purpose hall; irrigation; livelihood projects; upgrading of health facilities and medical equipment; and procurement of ambulance.

From the time of acquisition of AES Philippines in 2008, the company has invested PhP 56,300,000 for National and Local CSR Programs. The company has also facilitated access to ER 1-94 funds so far amounting to PhP 7,400,000 ER 1-94 for purchase of garbage trucks (Masinloc) and renovation and extension of the Bani covered court.

These socio-economic programs and ER 1-94-funded projects helped the Province of Zambales and Municipalities of Masinloc, Candelaria and Palauig in providing the needed support to the education system, improving the road infrastructure and irrigation system, and broadening livelihood opportunities for the community.

In terms of barangay electrification, the Province of Zambales is 100% energized and is currently implementing a street lighting program through the electrification projects funded under ER 1-94.

In conclusion, the presence of the Masinloc Power Facility and its socio-economic program over the years has been instrumental in helping to elevate Masinloc to become a first class municipality. In terms of revenue collections, Masinloc placed 3rd in the Province of Zambales and 42nd in the Regional level.

Going forward, benefits for the community will be in direct and indirect forms. The indirect benefits will come from increase in taxes that the Proponent pays to Government Agencies (i.e., Real Property Taxes, Income Taxes, and Permit fees). As the Proponent's generation sales increase due to the Project, their contribution to ER 1-94 will also increase. At present, the total ER 1-94 fund available to the host communities is PhP 37 million. With the Project, this fund may increase to PhP 74 million.

Masinloc Power Facility Operating Capacity	ER 1-94 Benefit (Projected)
2 X 300 MW	PhP 37 million
3 X 300 MW	PhP 56 million
4 X 300 MW	PhP 74 million

In addition, the Proponent has recently completed a baseline study "Community Resource Inventory & Mapping of Strategic Indicators for Masinloc Coal Power Station", to identify specific local community needs and develop a comprehensive plan to help support LGUs, NGOs and GOs in addressing the issues identified by the study. The main areas of focus that the Proponent will look to support are health, education, livelihood and environment. A corporate foundation to manage these initiatives is being set up by the Proponent in order to effectively implement and monitor the socio-economic programs. Specific programs and its plans for implementation are expected to start by mid-2012.

Employment is the direct benefit the community is expected to receive. The estimated employment to be generated for the construction phase is between 300 to 600 skilled and unskilled positions over span of 4 years. To ensure that there will be qualified local residents that can be hired; the Proponent is currently constructing a trade school in coordination with the Masinloc Public Employment Service Office (PESO) and the Technical Education and Skills Development Authority (TESDA). It is also expected that for every one employee that will be hired during the construction phase, it will create two employment opportunities outside the Project in ancillary related services such as food catering, lodging, transportation and laundry services.

Also, with the increase in generation sales, the Proponent expects to expand its Corporate Social Responsibility (CSR) program to include not only the host barangays, but also the host Municipality and Province. Their CSR program at present includes medical missions, supplemental feeding, scholarships and tree planting. A complete list of the Proponent's CSR program, awards and recognitions is presented in

Annex G.

2.4.10 Effect on the Delivery of Basic Services and Resource Competition in the Area

2.4.10.1 Water Supply and Demand

The Municipality of Masinloc is covered by the local water district, although there are still areas not yet serviced by the water distribution system. The Masinloc Plant draws its water supply from the Lauis River. The intake structure at the Lauis River is located downstream of the river's potential users to avoid competing with their requirements. A treatment facility is operated in the Masinloc Plant compound for the domestic water and boiler make up water requirements.

2.4.10.2 Power Supply and Demand

The Project is not expected to compete with local needs in terms of power supply. The Proponent utilizes power from their plant for their electricity needs.

2.4.11 Effect on Traffic Situation in the Area

The Project is expected to generate a moderate increase in traffic volume during the construction phase due to delivery of materials and increase of workers going to and from the plant. However, after construction, it is expected that traffic volume would return to pre-construction levels.

2.4.12 Entity to be Accountable for Environmental Management in the Area

The Proponent has an environmental section that oversees the environment-related aspects of the Masinloc Plant operations. This section is headed by the Pollution Control Officer (PCO), who directly reports to the plant manager. Periodic monitoring is also undertaken with the assistance of the Multi-Partite Monitoring Team (MMT).

2.4.13 Effect on Existing Properties in the Area in terms of Relocation and Devaluation

There is no expected change in land ownership since the Project is within the property of the Masinloc Plant. No Right-of-Way conflict is expected since the Project will be done within the property of the Masinloc Plant.

2.4.14 Other Affected Properties

The Project is within the property of the Masinloc Plant. There are no foreseen effects on properties in the immediate vicinity of the Project.

3 ENVIRONMENTAL/ECOLOGICAL RISK ASSESSMENT

3.1 Rationale

Risk Screening (RS) is conducted as a component of the EPRMP report of Masinloc Power Partners Co., Ltd. (MPPCL) proposed expansion project to expand the output of its existing 600-MW power plant to 1,200 MW. The proposed expansion involves the construction and installation of two additional 300-MW units within the existing premises of the power plant.

The RS in the context of the Philippine EIS System is primarily concerned with safety risks associated with the usage of substances and/or materials in terms of their reactive, flammability, and toxic properties as compared to geologic risks covered by the Engineering Geological and Geo-hazards Assessment Report (EGGAR) requirement of the Mines and Geosciences Bureau (MGB) and health risks assessed in the Environmental Health Impact Assessment (EHIA) of the Department of Health (DOH) mandate.

The RS provides an initial assessment of the physical and chemical risks posed by the substances and materials in the existing power plant and the proposed expansion which can be used as basis for the Quantitative Risk Assessment (QRA) during the operation phase.

The RS Report will follow the prescribed format in Annex 2-7e of the Revised Procedural Manual
(RPM) of DAO 2003-30.

3.2 Information Relating to the Operator and the Establishment

Since this Environmental Risk Assessment (ERA) is part of the Environmental Performance Report and Management Plan (EPRMP), this Section will discuss both the details of the information relating to the operation of the existing or present power plant consisting of Units 1, 2, and 3, and the proposed plant consisting of Units 4 and 5. Details of the Operator (Masinloc Power Partners Co., Ltd.) and the proposed project are discussed in the previous sections of the EPRMP Report.

Details of the Proponent and the proposed Project are discussed in Section 1of the EPRMP. There are 91 substances and materials used at the Masinloc Plant (**Table 3-1** and **Table 3-2**). The substances listed in **Table 3-2** are used in the a) Power House (dosing and fuel), b) Demineralization Plant, c) Freshwater Plant, and d) Wastewater Treatment Plant.

Data provided by the Proponent showed that except for the fuel system, i.e., Industrial Diesel Oil (yellow-shaded cell in **Table 3-3**) substances listed in **Table 3-2** will increase because of the proposed expansion.

Table 3-1: Substances and Materials Used at the Masinloc Plant

No.	Substance	Chemical Formula	Total Quantity	CAS NO.
1	1,5 Diphenylcarbazide	$C_{13}H_{14}N_4O$	50 grams	140-22-7
2	1,10 Phenanthroline Monohydrate	$C_{12}H_8N_2.H_2O$	2 grams	66-71-7
3	Acetic Acid, Glacial	C_3H_3COOH	72 liters	758-12-3
4	Ammonia Solution	NH_4OH	1700 liters	8013-59-0
5	Ammonium Chloride	NH_4Cl	500 grams	12125-02-9
6	Ammonium Dichromate	$(NH_4)_2Cr_2O_7$	500 grams	7789-09-5
7	Ammonium Nitrate	NH_4NO_2	250 grams	6484-52-0
8	Barium Chloride Dihydrate	$BaCl_2{\cdot}H_2O$	1.3 kilograms	10326-27-9
9	Boiling Stones	-	50 grams	-
10	Boric Acid	H_3BO_3	500 grams	10043-35-3
11	Butanol	$C_4H_{10}O$	44 liters	75-65-0
12	Calcium Chloride	$CaCl_2$	1 kilogram	10043-52-4
13	Calcium Chloride Dihydrate	$CaCl_2{\cdot}2H_2O$	1 kilogram	10035-04-8
14	Calcium Hydroxide	$Ca(OH)_2$	500 grams	1305-62-0
15	Carminic Acid	$C_{22}H_{20}O_{13}$	19 grams	1260-17-9
16	Citric Acid Monohydrate	$C_6H_8O_7{\cdot}H_2O$	1.5 kilograms	5949-29-1
17	Cobaltous Chloride Hexahydrate	$CoCl_2{\cdot}6H_2O$	500 grams	7791-13-1

No.	Substance	Chemical Formula	Total Quantity	CAS NO.
18	EDTA Disodium Salt Dihydrate	$C_{10}H_{14}Na_2O_8{\cdot}2H_2O$	14 kilograms	139-33-3
19	Ethyl Alcohol	C_2H_5OH	3.5 liters	64-17-5
20	Ethylenediamine Tetra Acetic Acid	$C_{10}H_{16}N_2O_8$	1 kilogram	60-00-4
21	Ferrous Ammonium Sulfate	$Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O$	25 grams	7783-85-9
22	Formaldehyde	CH_2O	5 liters	50-00-0
23	Formic Acid	CH_2O_2	25 liters	64-18-6
24	Hydrochloric Acid	HCl	36 liters	7647-01-0
25	Hydrogen Peroxide	H_2O_2	5.5 liters	7722-84-1
26	Hydroxyl Ammonium Chloride	NH2OH·HCl	250 grams	5470-11-1
27	Hydroxylamine Sulfate	$NH_2OH_2{\cdot}H_2SO_4$	500 grams	10039-54-0
28	Iodine	I_2	600 grams	7553-56-2
29	L(+) Ascorbic Acid	$C_6H_8O_6$	700 grams	50-81-7
30	Lanthanum (II) Oxide	La_2O_3	100 grams	1312-81-8
31	Lanthanum (III) Nitrate Hexahydrate	$LaNO_3{\cdot}6H_2O$	100 grams	10277-43-7
32	Lithium Hydroxide	LiOH	40 grams	1310-65-2
33	Magnesium Nitrate Hexahydrate	$Mg(NO_3)_2{\cdot}6H_2O$	500 grams	13446-18-9
34	Mercuric Chloride	$HgCl_2$	600 grams	7487-94-7
35	Mercuric Iodide	HgI_2	350 grams	7774-29-0
36	Mercury (II) Sulfate	$HgSO_4$	25 grams	7783-35-9
37	N-(1-Naphthyl)-Ethylenediamine Dihydrochloride	$C_{10}H_7NHCH_2CH_2NH_2{\cdot}2HCl$	190 grams	1465-25-4
38	Nickel Nitrate Hexahydrate	$Ni(NO_3)_2$	900 grams	13478-00-7
39	Nitric Acid	HNO_3	12.5 liters	7697-37-2
40	Pararosaniline Hydrochloride	$(NH_2C_6H_4)_2C{:}C_6H_4{:}NH.HCl$	35 grams	569-61-9
41	Perchloric Acid	$HClO_4$	2.5 liters	7601-90-3
42	Phosphoric Acid	H_3PO_4	6 liters	7664-38-2
43	Potassium Chloride	KCl	800 grams	7447-40-7
44	Potassium Chromate	K_2CrO_4	500 grams	7789-00-6
45	Potassium Dichromate	$K_2Cr_2O_7$	500 grams	7778-50-9
46	Potassium Fluoride	KF	250 grams	7789-23-3
47	Potassium Hydrogen Diiodate	$KH(IO_3)_2$	100 grams	13455-24-8
48	Potassium Iodate	KIO_3	225 grams	7758-05-6
49	Potassium Iodide	KI	500 grams	7681-11-0
50	Potassium Permanganate	$KMnO_4$	1.5 kilograms	7722-64-7
51	Potassium Sulfate	K_2SO_4	1 kilogram	7778-80-5
52	Potassium Tartrate	$(CHOH{\cdot}COOK)_2{\cdot}1/2H_2O$	500 grams	921-53-9
53	Propanol	C_3H_7OH	4 liters	71-23-8
54	Pyrogallol	$C_6H_3(OH)_3$	100 grams	87-66-1
55	Silver Nitrate	$AgNO_2$	500 grams	7761-88-8
56	Silver Sulfate	$AgSO_4$	25 grams	10294-26-5
57	Sodium Acetate Trihydrate	$C_2H_3NaO_2{\cdot}3H_2O$	3 kilograms	6131-90-4
58	Sodium Bicarbonate	$NaHCO_2$	1 kilogram	144-55-8
59	Sodium Carbonate	Na_2CO_3	2 kilograms	497-19-8
60	Sodium Chloride	NaCl	750 grams	7647-14-5
61	Sodium DiSulfate	$Na_2S_2O_5$	900 grams	13870-29-6
62	Sodium Hexameta Phosphate	$(NaPO_3)_{12\text{-}13}{\cdot}Na_2O$	200 grams	10124-56-8
63	Sodium Hydroxide	NaOH	900 grams	1310-73-2
64	Sodium Metabisulfite	$Na_2S_2O_5$	400 grams	7681-57-4
65	Sodium Nitrate	$NaNO_2$	100 grams	7631-99-4
66	Sodium Sulfate	Na_2SO_4	900 grams	7757-82-6
67	Sodium Sulfite	Na_2SO_3	5.5 kilograms	7757-83-7
68	Sodium ThioSulfate Pentahydrate	$Na_2S_2O_3{\cdot}5H_2O$	1.4 kilograms	10102-17-7
69	Stannous Chloride Dihydrate	$SnCl_2{\cdot}H_2O$	1.7 kilograms	10025-69-1
70	Stannous Sulfate	$SnSO_4$	500 grams	7488-55-3
71	Starch Soluble	$(C_6H_{10}O_5)_n$	750 grams	9005-84-9
72	Starch Soluble, Potato	$(C_6H_{10}O_5)_n$	500 grams	9005-84-9
73	Sucrose	$C_{12}H_{22}O_{11}$	400 grams	57-50-1
74	Sulfamic Acid	NH_2SO_3H	900 grams	5329-14-6
75	Sulfanilamide	$C_6H_8N_2O_2S$	90 grams	63-74-1

No.	Substance	Chemical Formula	Total Quantity	CAS NO.
76	Sulfanilic Acid	$C_6H_7NO_3S$	950 grams	121-57-3
77	Sulfuric Acid	H_2SO_4	62.5 liters	7664-93-9
78	Zinc Chloride Dihydrate	$ZnCl{\cdot}2H_2O$	500 grams	4468-02-4

Source: MPPCL

Table 3-2: Substances Stored in Tanks at the Masinloc Plant

No.	Substance	Chemical Formula	Total Stored, m^3	CAS NO.
79	Sodium Phosphate	Na_3PO_4	0.80	7601-54-9100
80	Ammonia Solution, 1%	NH_3	0.50	1336-21-6
81	Elimin-ox(Carbohydrazide), 3%	CH_6N_4O	1.50	497-18-7
82	Hydrochloric Acid, 35%	HCl	42.88	7647-01-0
83	Liquid Caustic Soda, 50%	NaOH	81.33	1310-73-2
84	Strong Acid Cation Resin	-	3.35	-
85	Strong Base Anion Resin	-	2.55	-
86	Mixed Bed Polisher Resin	-	1.42	-
87	Coagulant (Polyaluminum Chloride)	$[Al_2(OH)nCl_{6-n}]m$	4.38	1327-41-9
88	Coagulant Aid (10% Polymer)	-	0.40	-
89	Anionic Polymer, 0.5%	-	3.34	-
90	Sludge Coagulation Polymer, 0.5%	-	1.08	-
91	Industrial Diesel Oil	-	10,261.00	68476-30-2

Source: MPPCL

Table 3-3: Description of the Masinloc Expansion Relative to the Existing Configuration

Components	Existing	Modification/Addition	Final Project Scope
Rated Capacity	2 x 324 MW (Units 1 and 2)	No change	2 x 324 MW
	1 x 300 MW (Unit 3)	No change	1 x 300 MW
	1 x 300 MW (Unit 4: For Development)	Increase capacity to 315 MW	1 x 315 MW
		1 x 315 MW (Unit 5: For Expansion)	1x 315 MW
Project Area	138.5 ha	138.5 ha	138.5 ha
Annual Production	8,746 GWh/year (in operation)	105 GWh/year by 2024 2,207 GWh/year by 2025	8.851 GWh/year by 2024 11,059 GWh/year by 2025

Source: MPPCL

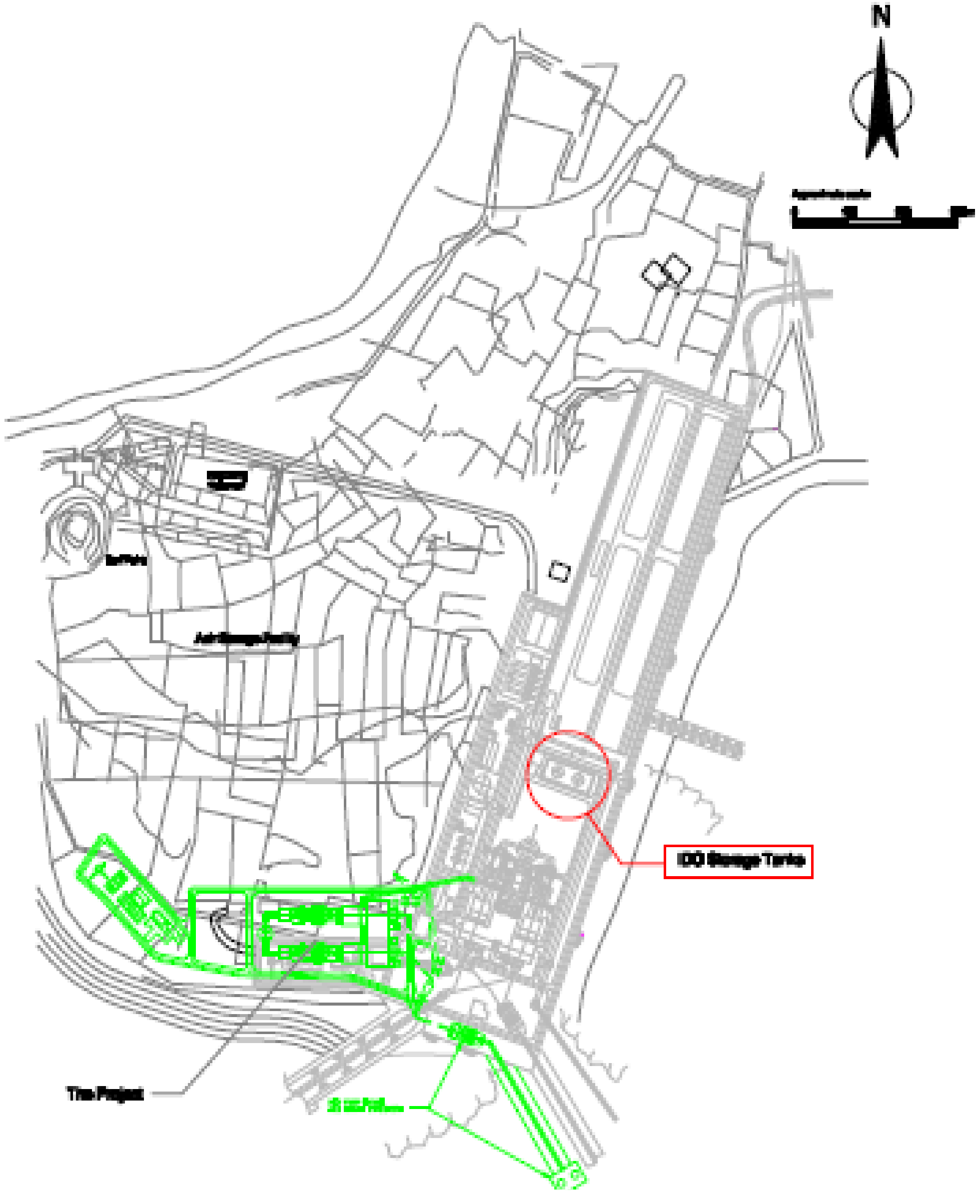


Figure 3-1: Location of Storage Tanks at the Masinloc Plant

3.3 Scope of Analysis Employed

3.3.1 General Risk Assessment Process

Environmental impacts described in the EIA are thought of as risks with a high probability of occurrence which needs mitigation (ADB, 1991). While the EIS may identify these impacts qualitatively, risk assessment attempts to quantify the consequence and probabilistic element of these impacts.

Generally, risk assessment identifies and assesses the potential risks to human health and safety. It is also intended to assess the proposed safety management schemes that would minimize if not eliminate such hazards and risks.**Figure 3-2** shows the general ERA process.

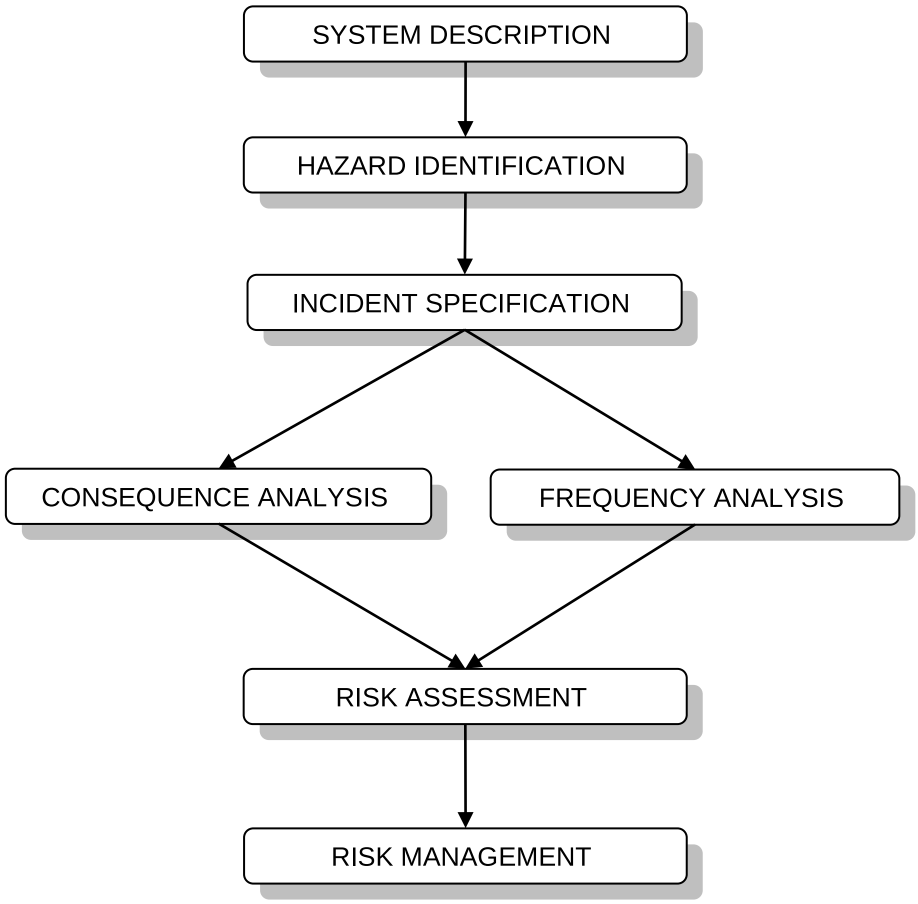


Figure 3-2: Flow Diagram of the Risk Assessment Process

Hazard identification is the first step in the risk assessment process. It involves the identification of all possible events or processes that could lead to disastrous or fatal incidents. It also entails defining the inherent and potential hazards of the substances or materials used, as well as process hazards with potential to adversely affect project personnel, the public, and the environment.

Consequence analysis is the second step, involving the estimation and/or assessment of the effects or results of an incident. It uses models beginning with release rates calculations, dispersion and physical effects.

Frequency analysis is the third step and may be defined as the estimation of the likelihood of occurrence of the identified hazard.

Risk is the product function of the frequency and consequence analyses.

Risk assessment is defined as the examination, analysis, evaluation, and estimation of an adverse or undesirable event occurring in a given project area which could cause unacceptable impacts or results, expressed as fatalities per million per year.

Risk management encompasses the risk assessment process. It is the term applied to a logical and systematic method of identifying, analyzing, assessing, treating, monitoring and communicating risks associated with any activity, function or process in a manner that would enable one to minimize losses and maximize opportunities.

3.3.2 ERA in the Context of the Philippine EIS System

As defined in the Revised Procedural Manual (RPM) of DAO 2003-30 ERA is "*a process of analyzing and describing the risks associated with a project or activity to ecosystems, human health and welfare*". Risk is a measure of potential human injury/death, economic loss, or environmental damage in terms of the probability of the loss, injury/death or damage occurring and the magnitude of the loss, injury/death or damage if it occurs. It is the product of the calculated consequence of a postulated accident scenario and the probability or frequency of occurrence of such event. Other terms are summarized in **Table 3-4** .

Table 3-4: Definition of ERA Terminologies

Term	Definition
Accident	Specific unplanned event or sequence of events that has a specific undesirable consequence. Most accidents are caused by the failure of people, equipment, supplies or surroundings to behave or react as expected.
Consequence	The result of an accident. In this document it is the ultimate outcome of an accident. It is expressed in terms of fatality, health effects, and economic loss.
Event	Refers to an accident either as the cause or a contributing cause to an accident.
Hazard	Characteristic of the system/ plant/ process/ substance that represents a potential for an accident or an adverse effect on the public or the environment. It is the combination of a material and an operating environment such that certain unplanned events could result in an accident.
Hazardous	Capable of posing an unreasonable risk to health and safety or capable of doing harm.
Major Hazard	Any hazard which can result in accidents affecting persons outside the facility fence (off-site).
Probability	An expression for the likelihood of occurrence of an event or an event sequence during an interval of time.
Toxicity	The ability of a substance to produce injury by non-mechanical means once it reaches a susceptible site in or on the body.
"Worst Case" Consequence	Conservative (high) estimate of the consequences of the most severe accident identified.

3.3.3 General RS Methodology for the Proposed Project

The RS focuses on consequence assessment using worst-case accident scenarios. Frequency analysis is not considered due to lack of historical data for similar facilities in the country.

There will be two kinds of consequences: (a) chemical consequence, and (b) physical consequence. The former is defined as the result from exposure to the toxic nature of materials. While the latter is defined as the result from extreme conditions of the flammable and explosive nature of a substance.

Procedures for the RS include the identification of the hazardous substances/materials/preparations that will be used by the proposed Project; presentation of the physical and chemical properties of the hazardous substances; discussion of the hazards associated with the use and storage of these substances; conduct consequence analysis for the accident scenarios for the substances; and update the emergency response measures.

3.3.3.1 Identification of Hazardous Substances

To identify the hazardous substances, the National Fire Protection Association (NFPA) 704 hazard rating was used and shown in **Table 3-1** and **Table 3-2**. The NFPA is a U.S. organization charged with creating and maintaining minimum standards and requirements for fire prevention and suppression activities, training, and equipment, as well as other life-safety codes and standards.

The NFPA 704 employs four color coded divisions which include the following:

- BLUE indicating level of health hazard,
- RED indicating flammability,
- YELLOW (chemical) reactivity, and
- WHITE containing special codes for unique hazards

Each of health, flammability and reactivity is rated on a scale from 0 (no hazard; normal substance) to 4 (severe risk). The description of the NFPA hazard rating scheme is shown in **Table 3-5**.

Table 3-5: NFPA 704 Hazard Rating Scheme

Hazard Rating Number	Details
HEALTH (Blue)	
0	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material, e.g., *lanolin*.
1	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given, including those which require use of an approved canister type gas mask, e.g., *acetone*. Includes materials a) which under fire conditions would give off irritating combustion products, and b) which on the skin could cause irritation without destruction of tissue.
2	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given, including those requiring use of respiratory protective equipment with independent air supply. Includes materials a) giving off toxic combustion products, b) giving off highly irritating combustion products, and c) which either under normal or fire conditions gives off toxic vapors lacking warning properties, e.g., *ethyl ether*.
3	Materials which upon short-term exposure could cause serious temporary or residual injury even with prompt medical treatment, including those requiring protection from all bodily contact. Includes materials a) giving off highly toxic combustion products, and b) corrosive to living tissue or toxic by skin absorption, e.g., *chlorine gas*.
4	Materials which upon very limited exposure could cause death or major residual injury even with prompt medical treatment, including those which are too dangerous to be approached without specialized protective equipment.

Hazard Rating Number	Details
	Includes materials a) which can penetrate ordinary rubber protective clothing, and b) which under normal conditions or fire conditions give off gases which are extremely hazardous (i.e., toxic or corrosive) through inhalation or through contact with or absorption through the skin, e.g., *hydrogen cyanide, phosphine*.
FLAMMABILITY (Red)	
0	Any material that will not burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes, e.g., water.
1	Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature condition, before ignition and combustion can occur. Includes materials a) which will burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes or less, and b) liquids, solids, and semisolids having a flash point above 200°F (93.4°C), e.g., *soybean oil*.
2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres. Includes a) liquids having a flash point above 100°F (37.8°C), but not exceeding 200°F (93.4°F), and b) solids and semisolids which readily give off flammable vapors, e.g., *diesel fuel*.
3	Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this rating produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions, e.g., *gasoline*. This rating includes: • Liquids with a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C) • Liquids with a flash point at or above 73°F (22.8°C) and below 100°F (37.8°C) • Solid materials in the form of coarse dusts which may burn rapidly but which generally do not form explosive atmospheres with air • Solid materials in a fibrous or shredded form which may burn rapidly and create flash fire hazards, such as cotton, sisal and hemp • Materials which burn with extreme rapidity, usually by reason of self-contained oxygen (e.g., *dry nitrocellulose* and *many organic peroxides*) • Materials which ignite spontaneously when exposed to air
4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or which are readily dispersed in air, and will burn readily, e.g., *propane*. This rating includes: • Gases; • Cryogenic materials; • Any liquid or gaseous material which is a liquid while under pressure and have a flash point below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C). • Materials which on account of their physical form or environmental conditions can form explosive mixtures with air and which are readily dispersed in air, such as dusts of combustible solids and mists of flammable or combustible liquid droplets.
REACTIVITY (Yellow)	
0	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water, e.g. helium.
1	Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently, e.g. *propene*.
2	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This rating includes materials which can undergo chemical change with rapid release of energy at normal temperatures and pressures or which can undergo violent chemical change at elevated temperatures and pressures. It also includes materials which react violently with water or form potentially explosive mixtures with water, e.g., *phosphorus, Potassium, Sodium*.
3	Materials which in themselves are capable of detonation or of explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This rating includes materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures or which react explosively with water without requiring heat or confinement, e.g. *Ammonium Nitrate*.

Hazard Rating Number	Details
4	Materials which in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This degree should include materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures, e.g., *nitro glycerine, RDX*.
SPECIAL KEY (White)	
Ox	Denotes materials that are oxidizing agents. These compounds give up oxygen easily, remove hydrogen from other compounds, or attract negative electrons, e.g., *Potassium perchlorate, Ammonium Nitrate, hydrogen peroxide*.
W	Denotes materials that are water-reactive. These compounds undergo rapid energy releases on contact with water, e.g., *cesium, Sodium*.
G	Compressed gas
SA	Simple asphyxiant gas, e.g. *nitrogen, helium, neon, argon, krypton, and xenon*.
LN2	Liquid nitrogen
LHE	Liquid helium

The ratings for the listed substances and materials are shown in **Table 3-6** and **Table 3-7**. Only those with a NFPA rating of 3 or 4 in any category (Health, Reactivity, Flammability) will be considered hazardous for chemicals listed. For substances that are stored in large amounts (in tanks), an NFPA rating of 2 or more will be considered as hazardous and will be subjected to consequence analysis.

Table 3-6: NFPA Ratings of listed Substances and Materials used at the Masinloc Plant

No.	Substance	Chemical Formula	Total Quantity	CAS NO.	NFPA Rating			
					H	F	R	SK
1	1,5 Diphenylcarbazide	$C_{13}H_{14}N_4O$	50 grams	140-22-7	1	1	0	
2	1,10 Phenanthroline Monohydrate	$C_{12}H_8N_2.H_2O$	2 grams	66-71-7	2	1	0	
3	Acetic Acid, Glacial	C_3H_3COOH	72 liters	758-12-3	3	2	0	
4	Ammonia Solution	NH_4OH	-	8013-59-0				
5	Ammonium Chloride	NH_4Cl	500 grams	12125-02-9	2	0	0	
6	Ammonium Dichromate	$(NH_4)_2Cr_2O_7$	500 grams	7789-09-5	2	1	1	Ox
7	Ammonium Nitrate	NH_4NO_2	250 grams	6484-52-0	0	0	3	Ox
8	Barium Chloride Dihydrate	$BaCl_2{\cdot}H_2O$	1.3 kilograms	10326-27-9	3	0	0	
9	Boiling Stones	-	50 grams	-	-	-	-	
10	Boric Acid	H_3BO_3	500 grams	10043-35-3	1	0	0	
11	Butanol	$C_4H_{10}O$	44 liters	75-65-0	2	3	0	
12	Calcium Chloride	$CaCl_2$	1 kilogram	10043-52-4	1	0	1	
13	Calcium Chloride Dihydrate	$CaCl_2{\cdot}2H_2O$	1 kilogram	10035-04-8	1	0	1	
14	Calcium Hydroxide	$Ca(OH)_2$	500 grams	1305-62-0	3	0	0	
15	Carminic Acid	$C_{22}H_{20}O_{13}$	19 grams	1260-17-9	0	1	0	
16	Citric Acid Monohydrate	$C_6H_8O_7{\cdot}H_2O$	1.5 kilograms	5949-29-1	2	1	0	
17	Cobaltous Chloride Hexahydrate	$CoCl_2{\cdot}6H_2O$	500 grams	7791-13-1	2	0	0	
18	EDTA Disodium Salt Dihydrate	$C_{10}H_{14}Na_2O_8{\cdot}2H_2O$	14 kilograms	139-33-3	1	0	0	
19	Ethyl Alcohol	C_2H_5OH	3.5 liters	64-17-5	0	3	0	
20	Ethylenediamine Tetra Acetic Acid	$C_{10}H_{16}N_2O_8$	1 kilogram	60-00-4	1	0	0	
21	Ferrous Ammonium Sulfate	$Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O$	25 grams	7783-85-9	2	0	0	
22	Formaldehyde	CH_2O	5 liters	50-00-0	3	4	0	
23	Formic Acid	CH_2O_2	25 liters	64-18-6	3	2	0	
24	Hydrochloric Acid	HCl	36 liters	7647-01-0	3	0	1	
25	Hydrogen Peroxide	H_2O_2	5.5 liters	7722-84-1	2	0	3	Ox
26	Hydroxyl Ammonium Chloride	NH2OH·HCl	250 grams	5470-11-1	3	1	1	
27	Hydroxylamine Sulfate	$NH_2OH_2{\cdot}H_2SO_4$	500 grams	10039-54-0	3	1	1	
28	Iodine	I_2	600 grams	7553-56-2	3	0	1	Ox
29	L(+) Ascorbic Acid	$C_6H_8O_6$	700 grams	50-81-7	1	0	0	
30	Lanthanum (II) Oxide	La_2O_3	100 grams	1312-81-8	1	0	1	W
31	Lanthanum (III) Nitrate Hexahydrate	$LaNO_3{\cdot}6H_2O$	100 grams	10277-43-7	2	0	1	Ox
32	Lithium Hydroxide	$LiOH$	40 grams	1310-65-2	3	0	0	
33	Magnesium Nitrate Hexahydrate	$Mg(NO_3)_2{\cdot}6H_2O$	500 grams	13446-18-9	1	0	0	Ox
34	Mercuric Chloride	$HgCl_2$	600 grams	7487-94-7	3	0	0	
35	Mercuric Iodide	HgI_2	350 grams	7774-29-0	3	0	0	
36	Mercury (II) Sulfate	$HgSO_4$	25 grams	7783-35-9	3	0	1	
37	N-(1-Naphthyl)-Ethylenediamine	$C_{10}H_7NHCH_2CH_2NH_2{\cdot}2HCl$	190 grams	1465-25-4	2	1	0	

No.	Substance	Chemical Formula	Total Quantity	CAS NO.	NFPA Rating			
					H	F	R	SK
	Dihydrochloride							
38	Nickel Nitrate Hexahydrate	$Ni(NO_3)_2$	900 grams	13478-00-7	1	0	0	Ox
39	Nitric Acid	HNO_3	12.5 liters	7697-37-2	4	0	0	Ox
40	Pararosaniline Hydrochloride	$(NH_2C_6H_4)_2C{:}C_6H_4{:}NH.HCl$	35 grams	569-61-9	3	1	0	
41	Perchloric Acid	$HClO_4$	2.5 liters	7601-90-3	3	0	3	Ox
42	Phosphoric Acid	H_3PO_4	6 liters	7664-38-2	2	0	0	
43	Potassium Chloride	KCl	800 grams	7447-40-7	1	0	0	
44	Potassium Chromate	K_2CrO_4	500 grams	7789-00-6	3	0	1	Ox
45	Potassium Dichromate	$K_2Cr_2O_7$	500 grams	7778-50-9	3	0	0	
46	Potassium Fluoride	KF	250 grams	7789-23-3	3	0	0	
47	Potassium Hydrogen Diiodate	$KH(IO_3)_2$	100 grams	13455-24-8	3	0	3	Ox
48	Potassium Iodate	KIO_3	225 grams	7758-05-6	1	0	1	Ox
49	Potassium Iodide	KI	500 grams	7681-11-0	1	0	0	
50	Potassium Permanganate	$KMnO_4$	1.5 kilograms	7722-64-7	1	0	0	Ox
51	Potassium Sulfate	K_2SO_4	1 kilogram	7778-80-5	1	0	0	
52	Potassium Tartrate	$(CHOH{\cdot}COOK)_2{\cdot}1/2H_2O$	500 grams	921-53-9	0	0	0	
53	Propanol	C_3H_7OH	4 liters	71-23-8	1	3	0	
54	Pyrogallol	$C_6H_3(OH)_3$	100 grams	87-66-1	3	1	0	
55	Silver Nitrate	$AgNO_2$	500 grams	7761-88-8	1	0	0	
56	Silver Sulfate	$AgSO_4$	25 grams	10294-26-5	1	0	1	
57	Sodium Acetate Trihydrate	$C_2H_3NaO_2{\cdot}3H_2O$	3 kilograms	6131-90-4	1	1	0	
58	Sodium Bicarbonate	$NaHCO_2$	1 kilogram	144-55-8	1	0	0	
59	Sodium Carbonate	Na_2CO_3	2 kilograms	497-19-8	2	0	0	
60	Sodium Chloride	NaCl	750 grams	7647-14-5	1	0	0	
61	Sodium DiSulfate	$Na_2S_2O_5$	900 grams	13870-29-6	-	-	-	
62	Sodium HexametaPhosphate	$(NaPO_3)_{12\text{-}13}{\cdot}Na_2O$	200 grams	10124-56-8	1	0	0	
63	Sodium Hydroxide	NaOH	900 grams	1310-73-2	3	0	1	
64	Sodium Metabisulfite	$Na_2S_2O_5$	400 grams	7681-57-4	3	0	1	
65	Sodium Nitrate	$NaNO_2$	100 grams	7631-99-4	1	0	0	Ox
66	Sodium Sulfate	Na_2SO_4	900 grams	7757-82-6	1	0	0	
67	Sodium Sulfite	Na_2SO_3	5.5 kilograms	7757-83-7	1	0	0	
68	Sodium ThioSulfate Pentahydrate	$Na_2S_2O_3{\cdot}5H_2O$	1.4 kilograms	10102-17-7	1	0	0	
69	Stannous Chloride Dihydrate	$SnCl_2{\cdot}H_2O$	1.7 kilograms	10025-69-1	1	0	0	
70	Stannous Sulfate	$SnSO_4$	500 grams	7488-55-3	2	0	0	
71	Starch Soluble	$(C_6H_{10}O_5)_n$	750 grams	9005-84-9	0	2	0	
72	Starch Soluble, Potato	$(C_6H_{10}O_5)_n$	500 grams	9005-84-9	0	2	0	
73	Sucrose	$C_{12}H_{22}O_{11}$	400 grams	57-50-1	0	1	0	
74	Sulfamic Acid	NH_2SO_3H	900 grams	5329-14-6	3	0	0	

No.	Substance	Chemical Formula	Total Quantity	CAS NO.	NFPA Rating			
					H	F	R	SK
75	Sulfanilamide	$C_6H_8N_2O_2S$	90 grams	63-74-1	1	1	0	
76	Sulfanilic Acid	$C_6H_7NO_3S$	950 grams	121-57-3	1	1	0	
77	Sulfuric Acid	H_2SO_4	62.5 liters	7664-93-9	3	0	2	W
78	Zinc Chloride Dihydrate	$ZnCl{\cdot}2H_2O$	500 grams	4468-02-4	-	-	-	

NOTE: H – Health, F – Flammability; R – Reactivity; SK – Special Key

Table 3-7: NFPA Ratings of Substances and Materials Stored in Tanks at the Masinloc Plant

No.	Substance	Chemical Formula	Total Stored, m^3	CAS No.	H	F	R
79	Sodium Phosphate	Na_3PO_4	0.80	7601-54-9100	2	0	1
80	Ammonia Solution, 1%	NH_3	0.50	1336-21-6	3	1	0
81	Elimin-ox(Carbohydrazide), 3%	CH_6N_4O	1.50	497-18-7	2	0	0
82	Hydrochloric Acid, 35%	HCl	42.88	7647-01-0	3	0	1
83	Liquid Caustic Soda, 50%	NaOH	81.33	1310-73-2	3	0	1
84	Strong Acid Cation Resin	-	3.35	-	-	-	-
85	Strong Base Anion Resin	-	2.55	-	-	-	-
86	Mixed Bed Polisher Resin	-	1.42	-			
87	Coagulant (Polyaluminum Chloride)	$[Al_2(OH)nCl_{6-n}]m$	4.38	1327-41-9	1	0	0
88	Coagulant Aid (10% Polymer)	-	0.40	-	-	-	-
89	Anionic Polymer, 0.5%	-	3.34	-	-	-	-
90	Sludge Coagulation Polymer, 0.5%	-	1.08	-	-	-	-
91	Industrial Diesel Oil	-	10,261.00	68476-30-2	2	2	0

NOTE: H – Health, F – Flammability; R – Reactivity

3.3.3.2 Methodology on Consequence Analysis

The identified hazardous substances will determine the consequence analysis. The methods to be used include the off-site consequence analysis methods of USEPA and US Federal Emergency Management Agency (US FEMA). Based on the NFPA ratings, consequence analysis will be on Toxic Vapor Dispersion (TVD), Pool Fires (PF), and Unconfined Vapor Cloud Fires (UVCF). The TVD will be applied to the substances that will emit vapors or gases during decomposition (reaction with another substance). The general description of the methods for TVD, PF, and UVCF calculations are discussed in the following paragraphs.

3.3.3.2.1 Release of Toxic Substances

In general, dispersion of toxic gases or vapors is influenced by a) release rate, b) prevailing atmospheric conditions, c) limiting concentration, d) duration of release, e) elevation of the source, f) surrounding terrain, g) source geometry, and h) initial density of the release. The maximum vapor concentration due to an accidental release is given by:

$$C_m = \frac{C_c}{2}\left[erf\left(\frac{x}{\sqrt{2\sigma_x}}\right) - erf\left(\frac{x-U_w t_R}{\sqrt{2\sigma_x}}\right)\right] \quad x \le \frac{U_w t_R}{2}$$

$$C_m = \frac{C_c}{2}\left[erf\left(\frac{x-U_w t_R}{2\sqrt{2\sigma_x}}\right)\right] \quad x \ge \frac{U_w t_R}{2}$$

$$C_c = \frac{Q}{2\pi\sigma_y\sigma_z U_w} e^{\frac{y^2}{2\sigma_y^2}} \times \left\{\exp\left[-\frac{(z-H)^2}{2\sigma_z^2}\right] + \exp\left[-\frac{(z+H)^2}{2\sigma_z^2}\right]\right\}$$

where:

C_m	Maximum centerline concentration, kg/m^3
Q	Continuous source release, kg/sec
U_w	Wind speed, m/sec
z	Vertical distance, m
y	Crosswind distance, m
x	Downwind distance, m
H	Source height, m
σ_x	Pasquill-Gifford longitudinal standard deviation, m
σ_y	Pasquill-Gifford lateral standard deviation, m
σ_z	Pasquill-Gifford vertical standard deviation, m

The end point for the model run is the Toxic Hazard Distance (THD), i.e., distance from the evaporating pool where the concentration of the substance is equal to its toxic threshold limits.

3.3.3.2.2 Fire

A pool fire results from a combination of incidents which include fuel leaks or spills and presence of ignition sources. It is a turbulent diffusion fire burning above a horizontal pool of vaporizing liquid of zero or low initial momentum which may either be static or running.

The measure for the endpoint of a pool fire is known as the distance to heat radiation.An incident flux level of 10,000 W/m^2 quickly causes third-degree burns that are likely to lead to fatality. These two levels are typically used in determining injury and fatality hazard zones (US FEMA).

The endpoint for pool fires as specified by the US EPA is a radiant heat dose of 5 kilowatts per square meter (kW/m^2) for 40 seconds; a 40 second exposure to this heat level could cause second degree burns (**Table 3-8**).

Table 3-8: Thermal Radiation Burn Injury Criteria

kW/m³	Btu/hr-ft³	Time for Sever Pain (sec)	Time for 2nd Degree Burn (sec)
1	300	115	663
2	600	45	187
3	1000	27	92
4	1300	18	57
5	1600	13	40
6	1900	11	30
8	2500	7	20
10	3200	5	14
12	3800	4	11

The pool is assumed as a point source where a selected fraction of the heat of combustion is emitted as radiation in every direction. Calculating the incident flux to an observer involves four steps: Geometric characterization of the flame; Estimation of flame radiation properties; Estimation of attenuation coefficients; and Computation of the geometric view factors between the observer and flame.

Spill surface and thermo-chemical properties of the spilled substance will determine the size of the flame. In particular, the diameter of the fire (if not confined by a dike), the visible height of the flame, and the tilt and drag of the flame due to wind can be correlated with the burning velocity of the liquid. The radiative output of the flame will depend on the fire size, the extent of mixing with air and the flame temperature. Some fraction of the thermal radiation is absorbed by carbon dioxide and water vapor in the intervening atmosphere. In addition, large hydrocarbon pool fires produce thick smoke which can significantly obscure flame radiation. Finally, the incident flux at an observer location will depend on the radiation view factor which is a function of the distance from the flame surface, the observer's orientation, and the flame geometry.

Experimental data on thermal radiation hazards suggest that an incident flux level of 5 kW/m^2 (1,600 Btu/hr-ft^2) will cause second-degree burn injuries on bare skin, if the duration of exposure is about 45 seconds. An incident flux level of 10 kW/m^2 (3,200 Btu/hr-ft^2) quickly causes third-degree burns that will likely lead to fatality. These two levels are typically used in determining injury and fatality hazard zones. Estimating the thermal radiation hazards from pool fires involves three main steps:

a) Characterization of the flame geometry;
b) Approximation of the radiative properties of the fire; and
c) Calculation of the safe separation distance to specified levels of thermal radiation.

The following parameters will be calculated:

a) Fuel burning velocity;
b) Effective emissive power; and
c) Fatality and injury hazard zones.

The following assumptions have been made to simplify the computation:

1. Pool area is circular and the observer is at ground level;
2. Atmospheric absorption of thermal radiation is negligible; and
3. Negligible wind in the vicinity of the flame, thus, uniform thermal radiation field radially and no flame tilt.

The equation to estimate the burning velocity is:

$$y = \frac{92.6 e^{-0.0043 T_B} Mw}{\rho} \frac{10^{-7}}{6}$$

where

y	Burning velocity, m/s
Mw	Molecular weight, kg/kg-mole
ρ	Liquid specific gravity
T_B	Normal boiling point, °F

The estimation of the mean visible flame height is based on the correlation of experimental data for laboratory-scale wooden crib fires which agrees well with observations of actual liquid pool fires. Based on these experimental data, Thomas developed a correlation for the mean visible flame height, H_{flame}:

$$H_{flame} = 42D_p\left[\frac{BV\rho}{\rho_a\sqrt{gD_p}}\right]^{0.61}$$

where:

H_{flame}	Flame height, m
D^p	Pool diameter, m
ρ	Liquid density, kg/m^3
ρ_a	Air density at ambient temperature, kg/m^3
g	Gravitational acceleration, 9.8 m/s^2
V	Liquid spill rate, m^3/sec

The emissive power of a large turbulent fire is a function of the black body emissive power and the flame emissivity. Based on observed values of emissive powers reported in the literature and other available data, the effective emissive power was correlated to the normal boiling point for selected fuels by the expression:

$$E_P = -0313T_B + 117$$

where:

E_p	Effective emissive power, kW/m^2
TB	Normal boiling point, °F

Materials with a boiling point above 30°F typically burn with sooty flames. The emissive power from the sooty portion, based on limited data, is in the order of 20 kW. An effective sooty flame average emissive power can therefore be estimated by assigning relative areas of sooty and unshielded flame and calculating an area based average emissive power. Finally, the incident flux at any given location is given by the equations:

$$Q_{incident} = EP \times \tau \times VF$$

$$VF = 1.143\left[\frac{R_p}{X}\right]^{1.757}$$

where:

$Q_{incident}$	Incident flux, kW/m^2
τ	Transmissivity
VF	Geometric view factor
R_p	Pool radius, m
X	Distance from the flame center, m

The view factor defines the fraction of flame that is seen by a given observer. This geometric term has been calculated as a function of distance from the flame center for an upright flame approximated by a cylinder. It has also been assumed that the optimum orientation between observer and flame that yields a maximum view factor prevails.

3.3.3.2.3 Explosion

Accidental releases of flammable liquids or gases often result in the formation of a vapor cloud that is dense relative to ambient conditions. If the cloud encounters an ignition source then a VCF may result (VCF is synonymous to either flash fire or fireball). Such a fire could flash back and could produce severe heat radiation to anyone in the area of the cloud. Vapor cloud fires may be modeled using air dispersion modeling techniques to estimate distances to a concentration equal to the Lower Flammability Limit (LFL). This represents the maximum distance where the effects of the radiant heat of a vapor cloud fire results in serious consequences.

The vapor cloud fire method is similar to estimating toxic vapor hazards endpoints except that the LFL is calculated instead of the toxic threshold. This is done because a cloud or plume of a flammable vapor released to the atmosphere can create fire hazard if it encounters an ignition source as it drifts downwind. A flame burns and propagates through the space occupied by the cloud. The hazard zone is defined by the length and width dimensions of where the concentration of the hazardous vapor is equal to or greater than its lower flammability limit.

Dispersion of toxic gases or vapors in general is influenced by a) release rate, b) prevailing atmospheric conditions, c) limiting concentration, d) duration of release, e) elevation of the source, f) surrounding terrain, g) source geometry, and h) initial density of the release. The maximum vapor concentration due to an accidental release is given by:

$$C_m = \frac{C_c}{2}\left[erf\left(\frac{x}{\sqrt{2\sigma_x}}\right) - erf\left(\frac{x-U_w t_R}{\sqrt{2\sigma_x}}\right)\right] \quad x \le \frac{U_w t_R}{2}$$

$$C_m = \frac{C_c}{2}\left[erf\left(\frac{x-U_w t_R}{2\sqrt{2\sigma_x}}\right)\right] \quad x \ge \frac{U_w t_R}{2}$$

$$C_c = \frac{Q}{2\pi\sigma_y\sigma_z U_w} e^{\frac{y^2}{2\sigma_y^2}} \times \left\{\exp\left[-\frac{(z-H)^2}{2\sigma_z^2}\right] + \exp\left[-\frac{(z+H)^2}{2\sigma_z^2}\right]\right\}$$

where:

C_m	Maximum centerline concentration, kg/m^3
Q	Continuous source release, kg/sec
U_w	Wind speed, m/sec
z	Vertical distance, m
y	Crosswind distance, m
x	Downwind distance, m
H	Source height, m
σ_x	Pasquill-Gifford longitudinal standard deviation, m
σ_y	Pasquill-Gifford lateral standard deviation, m
σ_z	Pasquill-Gifford vertical standard deviation, m

3.3.3.2.4 Assumptions and Data Used in Model Runs

Leakage as a hazard *per se* can be considered insignificant because safety mechanisms will be in place and part of the design, installation, and operation of the storage facilities. However, leakage can be a precursor to the physical hazards involved. Hence, the consequences associated with these will be related to the individual physical hazards.

Storage tank spillage can be caused by a number of reasons, among them are (a) faulty operational procedures, (b) pipe deterioration, (c) tank failure, (d) sabotage, and (e) *force majeur*. Spillage will not be analyzed as a separate event but a precursor to the consequence analysis. The worse-case scenario of instantaneous release of the hazardous substance will be considered. **Table 3-9**summarizes the assumptions prescribed by the USEPA and US FEMA for worse-case scenarios and **Table 3-10** shows the tank data and consequence event and endpoints. **Figure 3-3**shows a general event tree in determining the consequence events for a chemical release for the worse-case scenario.

Table 3-9: Worse-case Release Scenario Assumptions

Parameter	Definition
Quantity	The release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to a specified endpoint.
Wind speed/stability	Wind speed of 1.5 m/s and F stability class.
Ambient temperature and humidity	25°C; 50% relative humidity
Height of release	Ground-level release
Dense or neutrally buoyant gases	Models used for dispersion of toxic substances must account for gas density (Gaussian or dense-gas).
Temperature of released substance	For liquids (other than gases liquefied by refrigeration), the highest daily maximum temperature was used (PAGASA).

Parameter	Definition
Release duration	Continuous release of chemicals into the atmosphere (10 minutes)
Other assumptions	• Tank contents at total capacity will be spilled within one-minute into the bund (instantaneous release). • The pool spreads to its full size prior to ignition. This will result to the largest fire (worst-case)

Table 3-10: Hazardous Substances for Consequence Analysis

Substance	Largest Tank Volume, m^3	Tank Dimensions, m		Consequence Event
		Diameter	Height	
Hydrochloric Acid	21.25	2.972	3.125	Toxic vapor dispersion
Caustic Soda	72.5	3.656	7.010	Toxic vapor dispersion
Industrial Diesel Oil	10,261.00	18.9	18.288	• Pool fire • Vapor cloud fire

3.3.3.3 Emergency Response Measures (ERM)

Recommendations for the ERM were adapted from the the Transport Canada (TC), the U.S. Department of Transportation (US DOT), the Secretariat of Transport and Communications of Mexico (SCT) and CIQUIME (Centro de InformaciónQuímica para Emergencias) of Argentina (**Annex J**).

3.4 Information Relating Every Hazardous Substance or Situation Present in the Establishment

3.4.1 Identification of the Hazardous Substances

Of the 91 substances that are used at the existing power plant, 33 were considered in this RS as being hazardous (**Table 3-11**).

Table 3-11: Identified Hazardous Substances Used at the Masinloc Plant

No.	Substance	Chemical Formula	CAS NO.	H	F	R	SN
1	Acetic Acid, Glacial	C_3H_3COOH	758-12-3	3	2	0	
2	Ammonium Nitrate	NH_4NO_2	6484-52-0	0	0	3	Ox
3	Barium Chloride Dihydrate	$BaCl_2 \cdot H_2O$	10326-27-9	3	0	0	
4	Butanol	$C_4H_{10}O$	75-65-0	2	3	0	
5	Calcium Hydroxide	$Ca(OH)_2$	1305-62-0	3	0	0	
6	Ethyl Alcohol	C_2H_5OH	64-17-5	0	3	0	
7	Formaldehyde	CH_2O	50-00-0	3	4	0	
8	Formic Acid	CH_2O_2	64-18-6	3	2	0	
9	Hydrochloric Acid	HCl	7647-01-0	3	0	1	
10	Hydrogen Peroxide	H_2O_2	7722-84-1	2	0	3	Ox
11	Hydroxyl Ammonium Chloride	NH2OH·HCl	5470-11-1	3	1	1	
12	Hydroxylamine Sulfate	$NH_2OH_2 \cdot H_2SO_4$	10039-54-0	3	1	1	
13	Iodine	I_2	7553-56-2	3	0	1	Ox
14	Lithium Hydroxide	LiOH	1310-65-2	3	0	0	
15	Mercuric Chloride	$HgCl_2$	7487-94-7	3	0	0	
16	Mercuric Iodide	HgI_2	7774-29-0	3	0	0	
17	Mercury (II) Sulfate	$HgSO_4$	7783-35-9	3	0	1	
18	Nitric Acid	HNO_3	7697-37-2	4	0	0	Ox
19	Pararosaniline Hydrochloride	$(NH_2C_6H_4)_2C{:}C_6H_4{:}NH.HCl$	569-61-9	3	1	0	
20	Perchloric Acid	$HClO_4$	7601-90-3	3	0	3	Ox
21	Potassium Chromate	K_2CrO_4	7789-00-6	3	0	1	Ox
22	Potassium Dichromate	$K_2Cr_2O_7$	7778-50-9	3	0	0	
23	Potassium Flouride	KF	7789-23-3	3	0	0	
24	Potassium Hydrogen Diiodate	$KH(IO_3)_2$	13455-24-8	3	0	3	Ox
25	Propanol	C_3H_7OH	71-23-8	1	3	0	
26	Pyrogallol	$C_6H_3(OH)_3$	87-66-1	3	1	0	
27	Sodium Hydroxide	NaOH	1310-73-2	3	0	1	
28	Sodium Metabisulfite	$Na_2S_2O_5$	7681-57-4	3	0	1	
29	Sulfamic Acid	NH_2SO_3H	5329-14-6	3	0	0	
30	Sulfuric Acid	H_2SO_4	7664-93-9	3	0	2	W
31	Hydrochloric Acid, 35% (T)	HCl	7647-01-0	3	0	1	

No.	Substance	Chemical Formula	CAS NO.	H	F	R	SN
32	Liquid Caustic Soda, 50% (T)	NaOH	1310-73-2	3	0	1	
33	Industrial Diesel Oil (T)	-	68476-30-2	2	2	0	

3.4.2 Physical and Chemical Properties of the Identified Hazardous Substances

Table 3-12 shows the physical and chemical properties of the hazardous substances listed in **Table 3-11**. The following are the description of the properties of the substances relevant to the physical consequence analysis:

a) Auto-ignition temperature. A material's auto-ignition or ignition temperature is the temperature at which a material self-ignites without any obvious sources of ignition, such as a spark or flame.
b) Flammability limits or range. This is the distance from the leanest (LFL - Lower FlammabilityLimit) to the richest (UFL - Upper Flammability Limit) mixture of fuel and air that will burn. Fuels with narrower ranges are safer to work with but are less versatile because they offer less choice of air to fuel ratios.
c) Flashpoint. The flashpoint is the lowest temperature at which a liquid gives off enough vapor to be ignited (start burning) at the surface of the liquid with the presence of an ignition source. Sometimes more than one flashpoint is reported for a chemical. Since testing methods and purity of the liquid tested may vary, flashpoints are intended to be used as guides only, not as fine lines between safe and unsafe.
d) Flammable or explosive limits. A material's flammable or explosive limits also relate to its fire and explosion hazards. These limits give the range between the lowest and highest concentrations of vapor in air that will burn or explode.

3.4.3 Stability and Reactivity Information

The stability and reactivity description will be limited to the hazardous substances with an NFPA “R” rating of 1 or greater (**Table 3-13**). Of the 33 hazardous substance identified, 13 were considered reactive.

3.4.4 Description of the Hazards Imposed by the Substances

The description of the hazards imposed by the substances will be discussed by its chemical and physical effects. The substances IDO, HCl, and NaOH will be discussed as these are the one subjected for the consequence analysis.

3.4.4.1 Emission of Potentially Hazardous Substance (Chemical Effects)

The description of chemical hazards will be limited to the hazardous substances with an NFPA “H” rating of 2 or greater (**Table 3-14**). Of the 33 hazardous substance identified, 31 were considered having potential for chemical effects (NFPA H=>2). The chemical hazard data will be described using occupational exposure thresholds from different institutions in the United States and the European Union OSHA.
Table 3-15 summarizes the routes and health effects due to chemical exposure for the HCl, NaOH and IDO.

Table 3-12: Physical and Chemical Properties of the Identified Hazardous Substances in Table 3-11

No.	Substance	Physical state	Molecular Weight	Flash Point	Auto-ignition Temp.	Flammable* Limits (%)		Boiling Point	Melting Point	Specific Gravity	Solubility (in water)	Vapor Pressure
				°C	°C	Lower	Upper	°C	°C		g/100 mL	mm Hg
1	Acetic Acid, Glacial	Colorless liquid with pungent odor	60.1	39	485	6.0	17	118	16.7	1.05	Miscible	11.25@20°C
2	Ammonium Nitrate	White solid/colorless crystals	80.052	51.67	-	-	-	210	169.6	1.73@23°C	190	<5@ 23.89°C
3	Barium Chloride Dihydrate	White solid	244.3	-	-	-	-	1,560	113	3.86@24°C	38@26°C	-
4	Butanol	Colorless liquid or crystals , with characteristic odor	74.1	11	470	1.7	8.0	83	25	0.8	Miscible	30.8@20°C
5	Calcium Hydroxide	White power or colorless crystals	74.1	-	-	-	-	-	580	2.2	0.185	-
6	Ethyl Alcohol	Colorless liquid , with characteristic odor	46.1	13	363	3.3	19	79	-117	0.8	Miscible	43.5@20°C
7	Formaldehyde	Gas with characteristic odor	30	FG	430	7	73	-20	-92	0.8	Very good	-
8	Formic Acid	Colorless fuming liquid with pungent odor	46	69	520	18	51	101	8	1.2	Miscible	34.5@20°C
9	Hydrochloric Acid	Colorless fuming liquid with pungent odor of hydrogen Chloride	36.5	-	-	-	-	53	-74	1.18	Infinite	190@25°C
10	Hydrogen Peroxide	Colorless liquid	34	-	-	-	-	141	-11	1.4	Miscible	1.5@20°C
11	Hydroxyl Ammonium Chloride	Colorless hygroscopic crystals	69.5	-	-	-	-	-	151-152	1.7	83@17°C	-
12	Hydroxylamine Sulfate	White crystals or powder	164.1	-	-	-	-	-	120	1.88	58.7@20°C	-
13	Iodine	Bluish black or dark purple crystals with pungent odor	253.8	-	-	-	-	184	114	4.9	0.03@20°C	0.3@25°C
14	Lithium Hydroxide	Colorless hygroscopic crystals	23.95	-	-	-	-	924	450-471	1.46	12.8@20°C	
15	Mercuric Chloride	White crystals or powder	271.5	-	-	-	-	302	276	6.5	7.4@20°C	7.5×10^{-4}@20°C
16	Mercuric Iodide	Odorless scarlet red powder	454.4	-	-	-	-	350	259	6.36@25°C	0.006@25°C	100@261.8°C
17	Mercury (II) Sulfate	White crystalline powder	296.7	-	>450	-	-	D	450	6.5	Reaction	
18	Nitric Acid	Colorless to yellow liquid with pungent odor	63	-	-	-	-	121	-41.6	1.4	Miscible	16.5@20°C
19	Pararosaniline Hydrochloride	Green crystalline solid	323.85	-	-	-	-	-	268-270 (D)	-	SS	-
20	Perchloric Acid	Colorless liquid with pungent odor	100.46	-	-	-	-	19(D)	-112	1.76@22°C	Miscible	-
21	Potassium Chromate	Odorless yellow crystals	194.19	-	-	-	-	-	975	2.73	69.9@20°C	0
22	Potassium Dichromate	Orange to red crystals	294.2	-	-	-	-	500 (D)	398	2.7	12@20°C	-
23	Potassium Fluoride	Odorless white powder	58.1	-	-	-	-	1,505	860	2.48	-	1@885°C

No.	Substance	Physical state	Molecular Weight	Flash Point	Auto-ignition Temp.	Flammable* Limits (%)		Boiling Point	Melting Point	Specific Gravity	Solubility (in water)	Vapor Pressure
				°C	°C	Lower	Upper	°C	°C		g/100 mL	mm Hg
24	Potassium Hydrogen Diiodate	Odorless white solid	389.9	-	-	-	-	-	-	-	-	-
25	Propanol	Clear colorless liquid, with characteristic odor.	60.1	15	371	2.1	13.5	97	-127	0.8	Miscible	15@20°C
26	Pyrogallol	Whit solid in various forms. Turns grey to exposure in light and air	126.1	-	-	-	-	309	131-134	1.45	60@20°C	10@168°C
27	Sodium Hydroxide	White hygroscopic solid; Clear colorless solution	40	-	-	-	-	1388 (S) 105 (10%) 115 (30%) 140 (50%)	318 (S) -10 (10%) 1 (30%) 12 (50%)	2.1 (S) 1.11 (10%) 1.33 (30%) 1.53 (50%)	109@20°C (S) Completely miscible	13@60°C (50%)
28	Sodium Metabisulfite	White powder	190.1	-	-	-	-	-	150(D)	1.4	54	-
29	Sulfamic Acid	Odorless and colorless crystals or powder	97.1	-	-	-	-	-	205(D)	2.15	moderate	-
30	Sulfuric Acid	Colorless, oily, hygroscopic liquid with no odor	91.8	-	-	-	-	340(D)	10	1.8	Miscible	0.98@146°C
31	Industrial Diesel Oil (T)	Amber-color liquid with hydrocarbon odour	-	75	220	1	6	282-338	-	0.92@20°C	Negligible	2.17 @ 21°C <3.8@40°C

*synonymous with explosive limits; D – decomposes; SS – slightly soluble; S - solid

Table 3-13: Reactivity and Stability Information of the Identified Hazardous Substances

No.	Substance	Stability	Conditions to Avoid	Incompatible Materials	Hazardous Decomposition/Reactivity	Hazardous Polymerization/Corrosivity
1	Ammonium Nitrate	Stable under ordinary conditions of use and storage. Substance is hygroscopic.	Heat, flame, ignition sources, dusting and incompatibles. Moisture and combustible materials. Shock sensitive.	Aluminum, Antimony, Chromium, Copper, Iron, lead, Magnesium, Manganese, Nickel, Zinc, brass, oil, charcoal, organic material, acetic acid, AmmoniumChloride, bismuth, Cadmium, chlorides, cobalt, phosphorus, Potassium and AmmoniumSulfate, Sodium, Sodium hypochlorite, Sodium perchlorate, Sodium-Potassium alloy, and sulfur.	Emits nitrous oxides when heated to decomposition. Liberates ammonia in reaction with strong alkalis.	Hazardous polymerization will not occur.
2	Hydrochloric Acid	Stable under ordinary conditions of use and storage. Containers may burst when heated.	Heat and direct sunlight.	Incompatible with many substances such as cyanides, sulfides, sulfites, and formaldehyde and highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials.	• Emits toxic hydrogen Chloride fumes when heated to decomposition. • Reacts with water or steam to produce heat and toxic and corrosive fumes. • Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas. • Reacts with water especially when water is added to the acid. • Very energetic reaction with phosphides. • Generation of chlorine gas upon reaction with oxidizers. • Reacts with most metals to produce flammable hydrogen gas. • Emits hydrogen Chloride gas when in contact with sulfuric acid	• Hazardous polymerization will not occur. • Extremely corrosive in presence of Aluminum, Copper, and stainless steel. Non-corrosive in presence of glass. • Attacks nearly all metals except Mercury, Gold, platinum, tantalum, Silver, and certain alloys
3	Hydrogen Peroxide	• Normally stable if uncontaminated, but slowly decomposes to release oxygen.	Avoid excess heat and contact with combustible or organic materials. Light and incompatibles.	• Heat, reducing agents, organic materials, dirt, alkalis, rust, and many metals. • Spontaneous combustion may	• Decomposes to water and oxygen with rapid heat release. • The solution can decompose	Hazardous polymerization will not occur.

No.	Substance	Stability	Conditions to Avoid	Incompatible Materials	Hazardous Decomposition/Reactivity	Hazardous Polymerization/Corrosivity
		• Unstable with heat, may result in dangerous pressures. • Reacts violently upon contact with many organic substances, particularly textile and paper. • Avoid light and keep in a closed but vented container to prevent evaporation and contamination.		occur on standing in contact with readily flammable materials.	violently upon heating.	
4	Hydroxyl Ammonium Chloride	• Stable under ordinary conditions of use and storage. Slowly decomposes when moist.	Heat, flame, moisture, dusting, sources of ignition and shock, and incompatibles.	Strong oxidizing agents, heat plus Sodium acetate or ether, carbonyl compounds, CopperSulfate, Zinc and phosphorus chlorides.	Emits toxic fumes of nitrogen oxides and hydrogen Chloride when heated to decomposition.	Hazardous polymerization Will not occur.
5	Hydroxylamine Sulfate	• Stable under ordinary conditions of use and storage. • Can decompose violently at elevated temperatures.	Heat and incompatibles.	Oxidizers and bases.	Burning may produce sulfur oxides and nitrogen oxides.	Hazardous polymerization will not occur.
6	Iodine	Stable under ordinary conditions of use and storage.	Heat, sunlight, and poor ventilation.	• Incompatible with ammonia, powdered metals, alkali metals, or strong reducing agents. • Reaction can be violent or explosive with acetaldehyde and acetylene. • Reacts with Ammonium hydroxide to form shock-sensitive iodides on drying.	Toxic gases and vapors may be released if involved in a fire.	Hazardous polymerization will not occur.
7	Mercury (II) Sulfate	• Stable under ordinary conditions of use and storage.	Light, heat, incompatibles.	• Acetylene, ammonia, strong acids. • Corrosive to Iron, Magnesium, Aluminum, Zinc, lead and Copper.	• Oxides of sulfur, oxides of Mercury. • Decomposed by water into a	Hazardous polymerization will not occur.

No.	Substance	Stability	Conditions to Avoid	Incompatible Materials	Hazardous Decomposition/Reactivity	Hazardous Polymerization/Corrosivity
		• Decomposes on exposure to light.			yellow insoluble basic Sulfate and sulfuric acid.	
8	Perchloric Acid	Unstable at ordinary temperature and pressure and can undergo explosive decomposition, especially at elevated temperatures or if allowed to dehydrate.	Heat and incompatibles.	• Incompatible with numerous materials, including combustible materials, organic chemicals, strong dehydrating agents, reducing and oxidizing agents. • Reacts violently with benzene, Calcium hydride, wood, acetic acid, charcoal, olefins, ethanol, sulfur and sulfuric acid. • Do not use perchloric acid in a hood designed for other purposes.	May emit toxic Chloride fumes when heated to decomposition.	Hazardous polymerization will not occur.
9	Potassium Chromate	Stable under ordinary conditions of use and storage.	Heat and incompatibles.	• Reducing agents, hydrazine, and flammable materials. • Any combustible, organic or other readily oxidizable material (paper, wood, sulfur, Aluminum or plastics).	Burning may produce chrome oxides.	Hazardous polymerization will not occur.
10	Potassium Hydrogen Diiodate	• Stable under normal temperatures and pressures • Light sensitive.	Incompatible materials, ignition sources, dust generation, combustible materials, reducing agents.	Reducing agents, finely powdered metals, finely divided Aluminum, Arsenic, Copper, carbon, phosphorus, sulfur, hydrides of alkali and alkaline earth metals, metal sulfides, metal cyanides, thiocyanates, Manganese dioxide, sulfides of Antimony and Arsenic, and direct light.	Hydrogen iodide, oxides of Potassium.	Hazardous polymerization will not occur.
11	Sodium Hydroxide	• Stable under ordinary conditions of use and storage. • Very hygroscopic. • Can slowly pick up moisture from air and react with carbon dioxide from air to form Sodium carbonate.	Moisture, dusting and incompatibles.	• May causes violent reactions when in contact with acids and organic halogen compounds, especially trichloroethylene. • Contact with nitromethane and other similar nitro compounds cause formation of shock-sensitive salts. • Contact with metals such as Aluminum, Magnesium, tin, and	• Decomposition by reaction with certain metals releases flammable and explosive hydrogen gas. • Generates large amounts of heat when solid NaOH is dissolved in water. • Generates considerable heat when the solution is mixed with an acid	• Hazardous polymerization will not occur. • Extremely corrosive in presence of aluminium and brass, Copper, and stainless steel in the presence of moisture. • Non-corrosive in presence of glass.

No.	Substance	Stability	Conditions to Avoid	Incompatible Materials	Hazardous Decomposition/Reactivity	Hazardous Polymerization/Corrosivity
				Zinc cause formation of flammable hydrogen gas. • Even in fairly dilute solutions, reacts readily with various sugars to produce carbon monoxide. • Precautions should be taken including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.	• Reactive with water, acids, aldehydes, carbamates, esters, halogenated organics, isocyanates, ketones, acid chlorides, strong bases, strong oxidizing agents, strong reducing agents, flammable liquids, powdered metals and metals metal compounds, mitrides, nitriles, nitro compounds, acetic anhydride, hydroquinone, chlorohydrin, hlorosulfonic acid, ethylene cyanohydrin, glyoxal, hydrosulfuric acid, oleum, propiolactone, acylonitrile, phorosous pentoxide, chloroethanol, chloroform-methanol, tetrahydroborate, cyanogen azide, 1,2,4,5 tetrachlorobenzene, cinnamaldehyde.	
12	Sodium Metabisulfite	• Stable under normal temperatures and pressures. • Slowly oxidized to the Sulfate on exposure to air and moisture.	• Dust generation, moisture, exposure to air, excess heat. • Corrosive to Aluminum in aqueous solution.	Strong oxidizing agents and acids.	Oxides of sulfur and toxic fumes of Sodium oxide.	Hazardous polymerization has not been reported to occur.
13	Sulfuric Acid	• Stable under ordinary conditions of use and storage. • Concentrated solutions react violently with water, spattering and liberating heat.	Heat, moisture, and incompatibles.	Water, Potassium chlorate, Potassium perchlorate, Potassium permanganate, Sodium, Lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals (yields hydrogen gas), strong oxidizing and reducing agents and many other reactive substances.	• Fumes of sulfur oxides when heated to decomposition. • Will react with water or steam to produce toxic and corrosive fumes. • Reacts with carbonates to generate carbon dioxide gas, and with cyanides and sulfides to form poisonous hydrogen	Hazardous polymerization will not occur.

No.	Substance	Stability	Conditions to Avoid	Incompatible Materials	Hazardous Decomposition/Reactivity	Hazardous Polymerization/Corrosivity
					cyanide and hydrogen sulfide respectively.	

Source: International Chemical Safety Cards (NIOSH)

Table 3-14: Occupational Exposure Limits of the Identified Hazardous Substances

No.	Substance	OSHA PEL	NIOSH REL	ACGIH TLV	EU OEL	IDLH
1	Acetic Acid, Glacial	TWA 10 ppm (25 mg/m^3)	TWA 10 ppm (25 mg/m^3) ST 15 ppm (37 mg/m^3)	10 ppm as TWA 15 ppm as STEL	10 ppm; 25 mg/m³ as TWA	50 ppm
3	Barium Chloride Dihydrate	NE	NE	TWA (as Ba) 0.5 mg/m³; A4	(as Ba) 0.5 mg/m³ as TWA	NE
4	Butanol	TWA 100 ppm (300 mg/m^3)	TWA 100 ppm (300 mg/m^3) ST 150 ppm (450 mg/m^3)	100 ppm as TWA; A4	NE	1600 ppm
5	Calcium Hydroxide	TWA 15 mg/m^3 (total) 5 mg/m^3 (respiratory)	TWA 5 mg/m^3	5 mg/m³	NE	ND
7	Formaldehyde	TWA 0.75 ppm ST 2 ppm	Ca TWA 0.016 ppm C 0.1 ppm 15-minute http://www.cdc.gov/niosh /npg/nengapdx.html - a	0.3 ppm (Ceiling value); A2; SEN	NE	Ca 20 ppm
8	Formic Acid	TWA 5 ppm (9 mg/m^3)	TWA 5 ppm (9 mg/m^3)	5 ppm (9.4 mg/m³) as TWA; 10 ppm (19 mg/m³) as STEL	5 ppm, 9 mg/m³ as TWA	30 ppm
9	Hydrochloric Acid	C 5 ppm (7 mg/m^3)	C 5 ppm (7 mg/m^3)	2 ppm (Ceiling value); A4	NE	50 ppm
10	Hydrogen Peroxide	TWA 1 ppm (1.4 mg/m^3)	TWA 1 ppm (1.4 mg/m^3)	1 ppm as TWA; A3	NE	75 ppm
11	Hydroxyl Ammonium Chloride	NE	NE	NE	NE	NE
12	Hydroxylamine Sulfate	NE	NE	NE	NE	NE
13	Iodine	C 0.1 ppm (1 mg/m^3)	C 0.1 ppm (1 mg/m^3)	0.1 ppm (Ceiling value)	NE	2 ppm
14	Lithium Hydroxide	NE	NE	NE	NE	NE
15	Mercuric Chloride	NE	NE	(as Hg) 0.025 mg/m³ as TWA; (skin); A4	NE	NE
16	Mercuric Iodide	Mercury and Mercury compounds: 0.1 mg/m^3 (TWA), skin	NE	inorganic and metallic Mercury, as Hg: 0.025 mg/m^3 (TWA) skin, A4; (TWA) for Iodides: 0.01 ppm for inhalable fraction and vapor.	NE	NE
17	Mercury (II) Sulfate	NE	NE	(as Mercury) 0.025 mg/m³; (skin); A4	NE	NE
18	Nitric Acid	TWA 2 ppm (5 mg/m^3)	TWA 2 ppm (5 mg/m^3) ST 4 ppm (10 mg/m^3)	2 ppm as TWA 4 ppm as STEL;	NE	25 ppm
19	Pararosaniline Hydrochloride	NE	NE	NE	NE	NE
20	Perchloric Acid	NE	NE	NE	NE	NE
21	Potassium Chromate	For chromic acid and chromates, as CrO_3: 0.1 mg/m^3 (ceiling)	NE	For water-soluble Cr(VI) compounds, as Cr = 0.05 mg/m^3 (TWA), A1.	NE	NE
22	Potassium Dichromate		NE	: (as Cr) 0.05 mg/m³ as TWA; A1	NE	NE
23	Potassium Flouride	TWA 2.5 mg/m^3	NE	TWA 2.5 mg/m^3; A4	NE	NE
24	Potassium Hydrogen	NE	NE	NE	NE	NE

No.	Substance	OSHA PEL	NIOSH REL	ACGIH TLV	EU OEL	IDLH
	Diiodate					
26	Pyrogallol	NE	NE	NE	NE	NE
27	Sodium Hydroxide	TWA 2 mg/m³	C 2 mg/m³	2 mg/m³ (Ceiling value)		10 mg/m³
28	Sodium Metabisulfite	NE	TWA 5 mg/m³	5 mg/m³ as TWA; A4	NE	ND
29	Sulfamic Acid	NE	NE	NE	NE	NE
30	Sulfuric Acid	TWA 1 mg/m³	TWA 1 mg/m³	0.2 mg/m³ Thoracic fractionA2 (sulfuric acid contained in strong inorganic acid mists)	NE	15 mg/m³
31	Industrial Diesel Oil	TWA: 5 mg/m³, as mineral oil mist	NE	TWA 100 mg/m³, skin, A3	NE	NE

Source NIOSH, OSHA, AGCIH, EU OSHA

Notations:

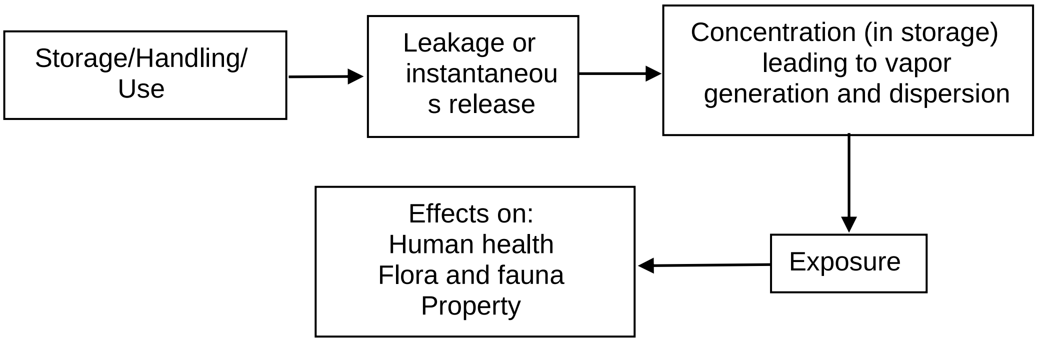
ACGIH - American Conference of Governmental Industrial Hygienists
NIOSH - National Institute of Occupational Safety and Health
OSHA - U.S. Occupational Safety & Health Administration
PEL - Permissible Exposure Limit (OSHA)
REL - Recommended Exposure Limit (NIOSH)
STEL - Short-Term Exposure Limit (generally 15 minutes)
OEL – Occupational Exposure Limits (EU)
EU – European Union
ST – Short term
TLV - Threshold Limit Value (ACGIH)
TWA - Time Weighted Average (8 hr)
IDLH – Immediately Dangerous to Life or Health (NIOSH)
NE – not established
Ca – potential occupational carcinogen
C – Ceiling value
A1 - confirmed human carcinogen
A2 - suspected human carcinogen
A3 - confirmed animal carcinogen with unknown relevance to humans
A4 - not classifiable as a human carcinogen

Table 3-15: Chemical Routes of Exposure and Effects of HCl, NaOH, and IDO

Substance	Route	Effect
Hydrochloric Acid	Inhalation	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.
	Dermal Contact	Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.
	Eye Contact	Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
	Ingestion	Swallowing can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea. Swallowing may be fatal.
	Chronic Exposure	Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.
Sodium Hydroxide	Inhalation	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may occur.
	Ingestion	Swallowing may cause severe burns of mouth, throat, and stomach. Severe scarring of tissue and death may result. Symptoms may include bleeding, vomiting, diarrhea, fall in blood pressure. Damage may appear days after exposure.
	Dermal contact	Contact with skin can cause irritation or severe burns and scarring with greater exposures.
	Eye contact	Causes irritation of eyes, and with greater exposures, it can cause burns that may result in permanent impairment of vision, even blindness.
	Chronic exposure	Prolonged contact with dilute solutions or dust has a destructive effect upon tissue.
Diesel	Inhalation	Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.
	Ingestion	The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.
	Dermal contact	May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed following acute (single) exposure. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.
	Eye contact	Contact with liquid or vapor may cause mild irritation.

3.4.4.2 Chemical Consequence: Pathways

Pathway evaluation considers various routes by which a person could be exposed to the hazard identified. Associated with this is the degree to which the hazards can be directly related to human safety. The following diagram represents the exposure pathway for the listed hazardous chemicals:



3.4.5 Physical Risks

The hazards associated with storage, handling, and use of the HCl, NaOH, and IDOare summarized in **Table 3-16**.

Table 3-16: Physical Effects of the Hazardous Substances

Substance	Physical Hazard
IDO	• Thermal radiation from pool and vapor cloud fires and generation of combustion gases. • Tank fire resulting to thermal radiation and generation of gases.
Hydrochloric Acid	Toxic vapor clouds from evaporating pools from accidental release.
Sodium hydroxide	

Light hydrocarbon vapors can build up in the headspace of tanks posing flammability/explosion hazards even at temperatures below the normal flash point of the fuel (flash point must not be regarded as a reliable indicator of the potential flammability of vapor in fuel oil tank headspaces). Tank headspaces should always be regarded as potentially flammable and care should be taken to avoid static electrical discharge and all ignition sources during filling, ullaging and sampling from storage tanks. Fuel oil will present a flammability hazard if heated above flash point but bulk liquids at normal storage temperatures will present virtually no fire hazard. If the fuel gets into contact with hot surfaces, or leaks from high pressure fuel pipes, the vapor and/or mists generated will create a flammability or explosion hazard.

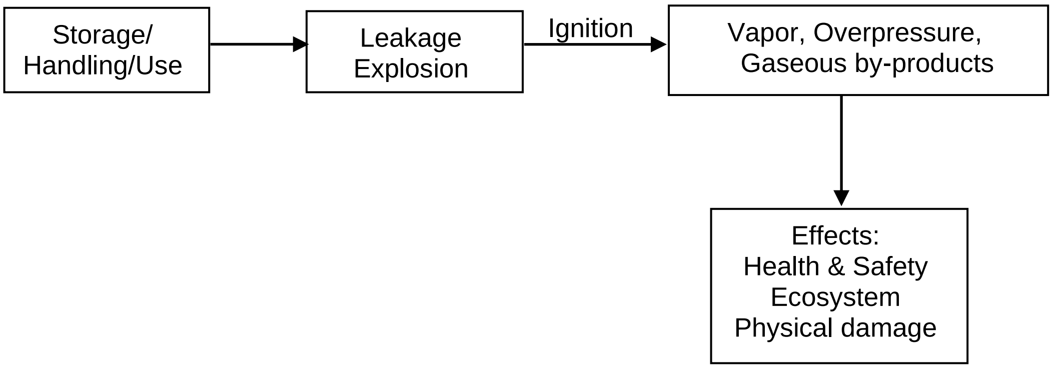
Large spills may form a film on water surfaces impairing oxygen transfer and may result in anaerobic conditions. This material may be harmful to aquatic organisms. The fuel may be biodegraded by micro-organisms, but degradation is selective and can result in sediments becoming enriched with aromatic hydrocarbons.

IDO C vapors may form flammable mixtures when combined with air within their flammability limits. The vaporization of the fuel, however, is dependent on atmospheric conditions since these are liquids at normal temperature and pressure. Hence, vaporization may be slower compared to fuels stored at high pressures or low temperatures such as LPG or LNG.

An empty IDO storage tank may still contain the fuel in vapor form and thus is potentially dangerous. In this state, the internal pressure is approximately atmospheric.If a valve is leaking or is left open, air can diffuse into the container forming a flammable mixture and creating a risk of explosion: alternatively, the vapor can diffuse to the atmosphere. The following are the hazards associated with IDO storage and handling: (a) toxic vapor dispersion and (b) pool fire. Toxic vapor dispersion and fire hazard in this case will be in terms of H_2S generation.

3.4.5.1 Physical Consequence: Pathways

Pathway evaluation will consider various routes by which persons could be exposed to the hazards identified. Associated with this is the degree to which the hazards can be directly related to human safety. The following scheme represents the pathway:



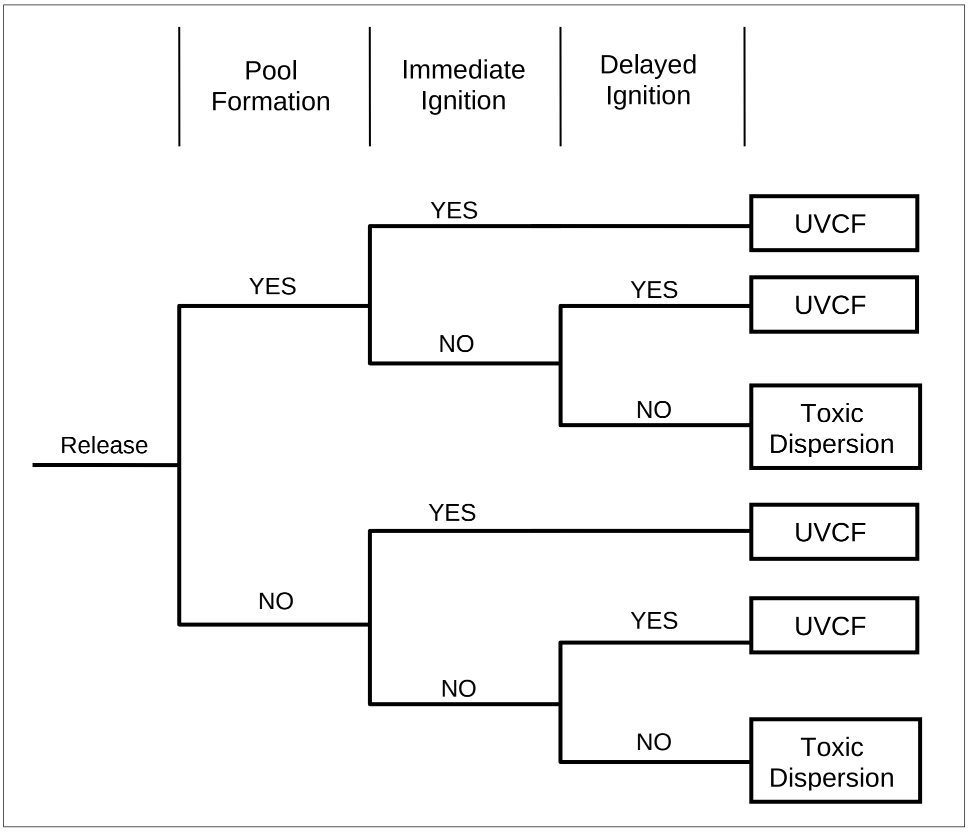


Figure 3-3: Event Tree for the Worse Case Scenario

3.4.6 Description of the Potential Sources of Major Accidents

There are three main types of hazards that are expected to occur at the coal-fired power plant: fires, explosions, and release of toxic materials into the ground or atmosphere. These hazards can arise from the handling, storage and processing of large quantities of flammable and/or acutely toxic materials. Such accidents can occur while the materials are being transferred from vessels into the storage facility, while the power plant is in operation as it produces electricity, and while the waste materials are being disposed. Fires can expose people and resources to heat radiation, explosions cause blast overpressure and projectiles that can cause harm and the accidental release of toxic materials can affect the surrounding communities.

- **Fires** are caused when flammable materials are ignited. The resulting flames can expose people and materials to heat. The intensity of heat is known to decrease rapidly proportional to distance from the open flame. Since the power plant is relatively isolated from the public, fires from the coal-fired power plant generally pose little risk to the public. All fires experienced in the coal-fired power plants are expected to be confined to the vicinity of the equipment where the flammable materials are released.

- **Explosions** occur when flammable vapors and gases are ignited or when flammable substances are released at high temperatures and elevated pressures. The effects of explosions include the shock wave which is the sudden increase of high pressure into the surroundings.
- **Release of toxic materials** occurs when hazardous substances such as hydrogen sulfide, sulfur dioxide, or any other harmful power plant by-products are accidentally released into the atmosphere or surroundings. Such releases occur usually during fire or other catastrophic accidents in the power plant. Such a release can pose threat if the gas or materials reach populated areas outside of the power plant.

3.5 Consequences of Major Accidents, the Probablity of its Occurrence, and an Estimation of the Risk

3.5.1 Discussion of the Probability of Occurrence of the Potential Accident Scenarios

The frequency and/or probability of the hazards mentioned were not considered in this reportbecause the project is still in the planning stage. It is recommended that this parameter be determined during the QRA.

3.5.2 Discussion of the Consequence Results

3.5.2.1 Hydrochloric Acid TVD

The largest storage tank for the 35% HCl solution is found at the existing Wastewater Treatment Plant with a volume of 21.25 m^3. The *Content* column indicates the amount of HCl at the time of the one-minute instantaneous release, e.g., all the contents are released within one minute when the tank is 25% full of HCl. The results of model runs showed possible off-site effects for unbunded scenarios (**Table 3-17**) based on the NIOSH IDLH limit of 50 ppm. The results also showed that the TVD is significantly reduced in the presence of bunds.

Table 3-17: Toxic Vapor Distances (TVD) for HCl

Content	Downwind TVD, m		
	1 cm	1 m	CE
25% Full	2,858	167	2,434
50% Full	4,661	247	3,079
75% Full	6,269	312	3,540
100%Full	7,773	369	3,913

NOTE: Pool depths: 1 cm – USEPA screening assumption (unbunded);
1 m – assumed average bund height;
CE – crude estimate based on previous spill data (unbunded)

3.5.2.2 Sodium Hydroxide TVD

The largest storage tank for the 50% NaOH solution is also found at the existing Wastewater Treatment Plant with a volume of 72.5 m^3. The *Content* column indicates the amount of NaOH at the time of the one-minute instantaneous release, e.g., all the contents are released within one minute when the tank is 25% full of NAOH. The results of model runs showed possible off-site effects for unbunded scenarios (**Table 3-18**) based on the NIOSH IDLH limit of 10 mg/m^3. The results also showed that the TVD is significantly reduced in the presence of bunds.

Table 3-18: Toxic Vapor Distances (TVD) for NaOH

Content	Downwind THD, m		
	1 cm	1 m	CE
25% Full	922	66	588
50% Full	1,437	96	724
75% Full	1,880	119	820
100%Full	2,280	139	895

NOTE: Pool depths: 1 cm – USEPA screening assumption (unbunded); 1 m – assumed average bund height;
CE – crude estimate based on previous spill data (unbunded)

3.5.2.3 IDO Pool and UVC Fires

The largest single storage tank for the IDO has a volume of about 5,131 m^3. There were two additional scenarios for each assumed pool depths: 1) the pool area expands to its full size prior to ignition and 2) the pool immediately ignites. The fatality zone is the area where death occurs due to heat exposure. The results of model runs showed possible off-site effects for unbunded scenarios (**Table 3-19**). Similar to the HCl and NaOH runs, the *Content* column indicates the amount of IDO at the time of the one-minute instantaneous release.

Table 3-19: Pool Fire Effects for IDO

Tank content	Pool Depth	Ignition	Hazard Zone	Radius, m	Tank Content	Pool Depth	Ignition	Hazard Zone	Radius, m
25% Full	1 cm	FSI	Injury	479	75% Full	1 cm	FSI	Injury	830
			Fatality	334				Fatality	579
		II	Injury	176			II	Injury	263
			Fatality	123				Fatality	183
	1 m	FSI	Injury	48		1 m	FSI	Injury	83
			Fatality	34				Fatality	58
		II	Injury	48			II	Injury	83
			Fatality	34				Fatality	58
	CE	FSI	Injury	100		CE	FSI	Injury	131
			Fatality	69				Fatality	91
		II	Injury	100			II	Injury	131
			Fatality	69				Fatality	91
50% Full	1 cm	FSI	Injury	678	95%Full	1 cm	FSI	Injury	934
			Fatality	473				Fatality	652
		II	Injury	227			II	Injury	287
			Fatality	158				Fatality	200
	1 m	FSI	Injury	68		1 m	FSI	Injury	94
			Fatality	48				Fatality	65
		II	Injury	68			II	Injury	94
			Fatality	48				Fatality	65
	CE	FSI	Injury	118		CE	FSI	Injury	138
			Fatality	83				Fatality	97
		II	Injury	118			II	Injury	138
			Fatality	83				Fatality	97

NOTES: FSI - Full pool size before ignition; II - Immediate ignition

The model runs showed minimal hazards for UVC fire under the worse-case scenario.

3.6 Information Relating to the Safety Management System for the Establishment

The Masinloc Plant has an Emergency Response and Contingency Plan (ERCP) implemented on February 28, 2008 (

Annex I). The main purpose of the ERCP is to define the protocols and identify the elements to be used during On-site and Off-site emergencies.

The ERCP covers the following potential incidents:

- Personnel injury/fatality
- Process upsets
- Fire or explosion
- Structural failures
- Chemical leak and spill incidents
- Oil leak and spill incident
- Natural events (Earthquake, Tsunami, Typhoon, Storm, etc.)
- Security threats

The ERCP also contains the following elements:

- Levels of Emergency
- Incident Command Structure
- Incident Command System
- Quick-View Emergency Response Action Plan
- Emergency Actions
- Discovering and Reporting Emergencies
- Emergency Alarm System
- Evacuation Alarm Testing
- Emergency Response Evacuation
- Emergency All-Clear
- Emergency Assigned Tasks

3.7 Description of Hydrogen Cooling of Turbine Generators

In Japan, the turbine generators manufactured up to 1945 had been using air at atmospheric pressure for cooling. In 1923, when Max Scholar's patent of a sealing method using pressurized liquid was approved in the United States, the hydrogen-cooled generator were successfully manufactured by General Electrics and Westinghouse in 1926 and 1928 respectively. The following are the some characteristics of a hydrogen-cooled turbine generator:

- Reduction of maintenance expenses because the closed re-circulating gas system prevents entry of dirt and moisture;
- Increased operational life of the insulation on the stator winding because the absence of oxygen and moisture prevent decay;
- Windage noise is reduced due to the low density of hydrogen gas and the closed ventilating system.

Table 3-20 shows the main characteristics of hydrogen gas that makes it better than air as a cooling medium.

Table 3-20: Characteristics of Hydrogen Gas and Air as a Cooling Medium

Parameter	**ir**	**ydrogen**
Density	.00	.07
Thermal conductivity	.00	.00
Heat transfer coefficient from		
Surface to gas	.00	.35
Specific heat	.00	.98
Support of combustion	es	o
Oxidizing agent	es	o

3.7.1 Safety Features of a Hydrogen-cooled Turbine

Hydrogen has a wide range of explosive limits with air (about 5 to 70 per cent hydrogen by volume). Hence, the system and the operating procedures should be designed to prevent these mixtures from occurring under normal operating conditions. Designing the system as "explosion-proof" means the stator frame of the generator will withstand an explosion even though other materials of the system are destroyed.

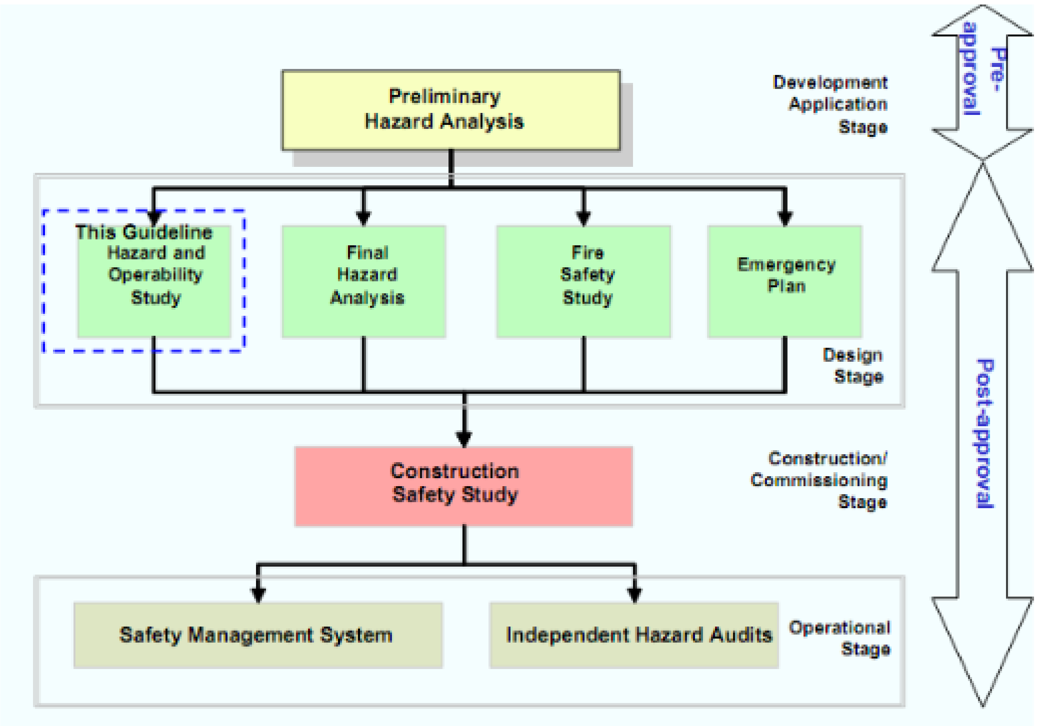
The intensity of explosion of a mixture of air and hydrogen will vary according to the ratio of the volume and pressure of the two gases. The explosion hazard is only possible during gas replacement with an intensity of less than 7 kg/cm^2, hence, the stator frame of a hydrogen-cooled generator is designed to withstand this overpressure. The three critical measures to be observed when replacing the gas are:

- No mixing of hydrogen and air;
- Using carbon dioxide as intermediate gas during replacement; and
- Provision of an exhaust vent to the atmosphere within the generator so avoid pressures in the range of 0.1 - 0.2 kg/cm^2.

3.7.2 The HAZOP Study

A Hazard and Operability (HAZOP) study is defined as a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate potential hazards and operability problems. The HAZOP process is used to identify potential hazards and operational problems in terms of plant design and human error. The technique should be applied to a plant during final design before construction commences. The use of HAZOP is also beneficial when upgrading the safety standards or modifying a plant already in operation.

The HAZOP study is done during the detailed design stage because inputs like the detailed piping and instrumentation diagrams (P&Ids) are already available (**Figure 3-4**). As a compromise, the HAZOP is usually carried out as a final check when the detailed design has been completed. Hence, doing a HAZOP at the EIA stage where everything is at best is at the FS stage is not recommended.



Source: Hazardous Industry Planning Advisory Paper No. 8, Department of Planning, NSW Government, July 2008

Figure 3-4: HAZOP Framework

3.7.2.1 Risk Screening of Hydrogen Gas

3.7.2.1.1 Physical and Chemical Properties

The NFPA rating of hydrogen gas is shown in Table 3-21.

Table 3-21: NFPA Rating of Hydrogen Gas

No.	Substance	Chemical Formula	CAS NO.	NFPA Rating			
				H	F	R	SK
1	Hydrogen Gas	H_2	1333-74-0	0	4	0	SA

NOTE: H – Health, F – Flammability; R – Reactivity; SA – simple asphyxiant

The physical properties of hydrogen gas are listed below:

Appearance and physical state: colorless gas at normal temperature and pressure
Odor: odorless
Molecular weight: 2.016
Boiling Point: (1 atm): -252.8°C
Freezing Point: -259.2°C
Specific gravity(Air =1): 0.06960
Solubility(in water(Vol/Vol at 15.6°C): 0.019
Gas density at 21.1°C and 1 atm: 0.08342 kg/m^3
Specific volume at 21.1°Cand 1 atm: 11.99 m^3/kg
Vapor Pressure: Not applicable
Flash Point: n/a (gas)
Auto-ignition Temperature: 570°C
Flammable or explosive limits (%): Lower: 4%; Upper: 74.5%

3.7.2.1.2 Stability and Reactivity Information

Stability: stable
Conditions to avoid: oxidizers
Incompatible materials: None
Hazardous decomposition products: None
Hazardous polymerization: will not occur

3.7.2.1.3 Chemical and Physical Hazards

Chemical Hazards

Symptoms of Exposure:

INHALATION: High concentrations of hydrogen so as to exclude an adequate supply of oxygen to the lungs causes dizziness, deeper breathing due to air hunger, possible nausea and eventual unconsciousness.
EYE CONTACT: None
SKIN CONTACT: None
CHRONIC EFFECTS: None
OTHER EFFECTS OF OVEREXPOSURE: None

Toxicological Properties:

- Hydrogen gas is inactive biologically and essentially nontoxic; therefore, the major property is the exclusion of an adequate supply of oxygen to the lungs.
- Hydrogen gas is not listed by OSHA as a carcinogen or potential carcinogen.
- Persons in ill health where such illness would be aggravated by exposure to hydrogen should not be allowed to work with or handle this product.

Table 3-22: Occupational Exposure Limits of Hydrogen Gas

Substance	**OSHA PEL**	**NIOSH REL**	**ACGIH TLV**	**EU OEL**	**IDLH**
Hydrogen gas	None	none	Simple asphyxiant	None	none

Source: NIOSH, OSHA, AGCIH, EU OSHA

Notations:

ACGIH - American Conference of Governmental Industrial Hygienists
NIOSH - National Institute of Occupational Safety and Health
OSHA - U.S. Occupational Safety & Health Administration
PEL - Permissible Exposure Limit (OSHA)
REL - Recommended Exposure Limit (NIOSH)
STEL - Short-Term Exposure Limit (generally 15 minutes)
OEL – Occupational Exposure Limits (EU)
EU – European Union
ST – Short term
TLV - Threshold Limit Value (ACGIH)

TWA - Time Weighted Average (8 hr)
IDLH – Immediately Dangerous to Life or Health (NIOSH)
A3 - confirmed animal carcinogen with unknown relevance to humans
A4 - not classifiable as a human carcinogen

Physical Hazards

Hydrogen gas is extremely flammable.It is easily ignited by heat, sparks or flames and will form explosive mixtures with air. Hydrogen is lighter than air and will rise and causing fires that are difficult to detect because it burns with an invisible flame. The following are the physical hazards involved with the handling, storage, and use of hydrogen gas:

- Confined Explosions (leakage of H_2 into buildings, contamination of high pressure H_2 storage facilities by air; and
- Unconfined Explosions(major rapid release into the atmosphere)

3.7.2.2 Generic Emergency Response

The general emergency response protocols are shown in **Table 3-23**.

Table 3-23: Emergency Response to Hydrogen Gas Hazards

Potential Hazards	Public Safety	Emergency Response
HEALTH. Gas may cause dizziness or asphyxiation without warning. FIRE OR EXPLOSION. Hydrogen gas is extremely flammable. It is easily ignited by heat, sparks or flames and form explosive mixtures with air.	As an immediate precautionary measure, isolate spill or leak area for at least 100 meters in all directions. Keep unauthorized personnel away, stay upwind, keep out of low areas, and ventilate closed spaces before entering. PROTECTIVE CLOTHING. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection. EVACUATION Large Spill.Consider initial downwind evacuation for at least 800 meters. Fire**.** If tank, rail car or tank truck is involved in a fire, isolate for 1600 meters in all directions	FIRE Do not extinguish a leaking gas fire unless leak can be stopped. Small Fires → CO_2, dry chemical. Large Fires → Water spray or fog. Move containers from fire area if possible without risk. Fire involving tanks → Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. SPILL OR LEAK Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area).All equipment used when handling the product must be grounded. Stop leak if you can do it without risk. Isolate area until gas has dispersed. FIRST AID • Move victim to fresh air and call the appropriate emergency medical service. • Give artificial respiration if victim is not breathing. • Administer oxygen if breathing is difficult. • Remove and isolate contaminated clothing and shoes. • Ensure that medical personnel are aware of the hazards of H_2 and take precautions to protect themselves.

3.8 Summary and Recommendations

3.8.1 Summary

The major findings of the RS are:

- Possible toxic vapor off-site effects of unbunded scenarios for HCl and NaOH largest storage tanks based on the NIOSH IDLH limits. The results also showed that the off-site effects are significantly reduced by containing the pool, i.e., providing bunds for the tanks.
- Minimal hazard from Unconfined Vapor Cloud Fire resulting from worse-case release of the IDO.
- Possible radiant heat off-site effects of unbunded scenarios for IDO but providing bunds will significantly reduce the hazard zones by containing the burning pool.

3.8.2 Recommendations

Three strategies for risk management are recommended by the World Bank (1988):

- Reduction of the consequences or effect distances – may be achieved through reduction of inventories of the hazardous material, modification of process or storage conditions, outright elimination of the hazardous material from the process, or improvement of shut-down mechanism or secondary containment;
- Reduction of the probability of release of the hazardous materials;
- Reduction of impacts – measures are undertaken to lessen the impacts in case the accident happens.

Annex Jwill provide useful inputs in fine-tuning the ERCP of the Masinloc Plant for the identified hazardous substances. These were adopted from the emergency response guidelines by the Transport Canada (TC), the U.S. Department of Transportation (DOT), the Secretariat of Transport and Communications of Mexico (SCT) and CIQUIME (*Centro de Información Química para Emergencias*) of Argentina.

4 IMPACTS MANAGEMENT PLAN (IMP)

The activities presented for the Project is similar to the ones conducted for the Masinloc Plant and changes or enhancements thereafter, hence, the EPRMP considered the projected impacts stated in the 1994 EIS and subsequent reports. Conditions present at monitoring events and corresponding impact identification and mitigation are presented in **Table 4-1**.

4.1.1 Potential Erosion

The excavation phase (construction phase), which is estimated to be completed from five to six months after project onset, is expected to entail minimal erosion events. The to be generated spoils will also be kept to a minimum since these will be primarily used as fill materials for lower areas within the Plant premises.

Various erosion control measures, such as slope stabilization, vegetative measures, and green areas maintenance, will be conducted during plant operation to further minimize soil erosion and its probable impacts.

4.1.2 Ash Storage Facility

An embankment (5.5 m high, 5.0 m wide and 600 m long) was established to enhance the ash containment capability in the northern portion of the ASF. Both engineering (e.g. slope stabilization, gabions, concrete walls along embankment slope) and vegetative measures (e.g. establishment of ipil-ipil tree rows along slope contour) were and will be implemented to further improve the facility and prevent erosion or shallow slumping. Furthermore, it is still recommended to plant other tree species (e.g. mahogany) along the base of the slope to aid in improving slope stability. Lastly, cover crops (e.g. *Colopogonium sp.*) may be planted for additional soil surface protection.

4.1.3 Increase in Unit 4 Capacity and Expansion with Unit 5

Both the Unit 4 enhancement and establishment of Unit 5 will be within the existing premises of the Masinloc Plant. Appropriate slope protection, including gabions, retaining walls and concrete plastering, will be established along cut slopes as a result of construction. In addition, a buffer area around will be retained, including the natural surroundings to preserve the natural aesthetics and serve as alternative habitat for wildlife.

4.1.4 Foundation and Seismicity

In general, the Masinloc plant facilities are regarded to be protected from seismic disturbances which can be brought by earthquakes. The main foundations of the Plant are securely located on firm ground composed of sandstone and siltstone. In addition, an N value of > 50 was for the rock formations. Furthermore, the structures were built for sufficient rigidity, consistency and strength against disturbances.

In the design of the Project structures, the following seismic parameters are recommended to be adopted:

- Soil profile type - S_C
- Zone Factor, Z - 0.40
- Seismic Source Type - A
- Near Source Factor, N_a - 1.0
- Near Source Factor, N_v - 1.0
- Seismic coefficient, C_a - 0.40
- Seismic coefficient, C_v - 0.56
- Ground acceleration - 0.22g

4.1.5 Terrestrial Ecology

Two endangered flora species, *Cycas revoluta* and *Cananga odorata*, which are considered mainly as ornamentals and are of high demand commercially for specific uses (e.g. *C. odorata* essential oils are used as ingredient for perfumes), were found in the plant complex. Semi-annual monitoring of the presence or absence of both species will be conducted. In addition, both species are hereby recommended to be planted for revegetating the degraded areas within company's premises.

Established buffer zones (approximately 23.4 Ha) within and around the Masinloc plant complex will be protected in a form of biodiversity corridor to serve as alternative habitat for wildlife. Revegetation and enrichment planting were also done in the plant to enhance its ecological functions and aesthetic conditions. In addition, stress-/pollution-resistant flora species were also planted, primarily to serve as windbreakers and protection against coal dust. Tree planting activities of suitable species which can invite wildlife were also conduction outside of the plant's complex to also serve as alternative habitat. The Proponent will also conduct timely monitoring and maintenance of established buffer zones and planting sites to aid the continuous development of vegetation therein

Minimum disturbance is expected when construction activities are done in the plant complex. Clearing of vegetation can likewise be kept at minimum in the upgrading of Unit 4 and in the establishment of Unit 5. Activities, such as hammering, materials transport, piling, drilling, among others, are expected to be temporary, only until the establishment of the structures. Use of heavy equipment will also be monitored and controlled to essential construction activities only. Furthermore, knowledge on best industry practices on minimizing noise and dust pollution will be observed during construction.

The probable effects of sulfur emissions during plant operations on flora species will be monitored by conducting timely tissue analysis. Sulfur dioxide emissions can possibly to cause harmful effects on plant species, some of the symptoms that can be observed are dwarfing and chlorosis. In addition, fauna species monitoring will also be implemented to monitor probable effects of sulfur emissions on wildlife and consequently devise mitigation measures to avert negative impacts of sulfur emissions

4.2 The Water

4.2.1 Freshwater Withdrawal from Lauis River

The Masinloc Plant primarily derives the freshwater it utilizes for its operation (demineralized and filtered) from Lauis River, where the intake structure downstream of an irrigation system and other river water consumers. Small concrete weir was also constructed along the intake area. Hence, the withdrawal of freshwater by the Plant does not mainly affect the availability of freshwater supply for other users. Furthermore, the minimum discharge rate of the river is at 0.124 m^3/s during the dry season, which is significantly higher than the maximum withdrawal rate by the intake facility at 0.029 m^3/s. There have been changes in the rainfall condition during the current year and it is predicted to further increase during the wet season and decrease during the dry season based on 2050 predictions. Hence, it is recommended that the Plant investigate and study other alternative sources of freshwater due to the foreseen changes in water discharge rate and volume in Lauis River.

4.2.2 Wastewater

Wastewater or effluent generated by the operation of the Masinloc Plant is classified into constant wastewater (daily effluent) and occasional wastewater (effluent at annual inspection).

Sewage water, primarily from office, powerhouse, port water and treatment facilities, is treated before discharged; together with oil and effluent in the event of boiler blowdowns, are classified as constant wastewater. On the other hand, wastewater generated by commissioning tests and annual inspections fall under occasional wastewater classification, which primarily come from the condenser, boiler, tube water flushing, deaerator water flushing, electrostatic precipitator water cleaning, air heater water cleaning, chemical cleaning of boiler and cleaning of oil and ash in the general plant area. An approximate of ~2100 t effluent is generated from cleaning and washing activities. All effluents are treated prior to discharge to have the following quality parameters before disposal to the bay:

pH	5.5 to 9.0
COD	Below 50 mg/L
SS	Below 10 mg/L
Fe	Below 1 mg/L
Ni	Below 1 mg/L
Mn	Below 1 mg/L
Oil	Below 10 mg/L

The Plant plans to construct an additional wastewater treatment facility with similar specifications of the currently installed system as the need arises from expansion.

4.2.2.1 Special Features

a) Dry Ash Type Disposal System – enables lower freshwater requirement of the Plant
b) Wastewater Treatment Facility – enables the treatment of effluents before discharge
c) Discharge of thermal effluents at 650m from the shore to minimize impacts to marine ecology, in general
d) Ash Storage Facility – limits the possibility of ash leaching and infiltration

4.2.2.2 Thermal Effluents

Thermal effluents (cooling water) come with the open cycle (once through) condenser cooling system during plant operations, impacts of which mainly depend on the subsequent excess temperature brought to the environment and sensitivity of marine species to changes in temperature. Hence, monitoring of thermal effluents discharge temperature is conducted regularly, the results of which are submitted to EMB.

Information gather presented that the release of thermal effluents did not have significant impacts to the marine sanctuary located in San Salvador Island, as well as the fish collection ground proximate to the mouth of Lauis River.

Implementation of thermal effluent surface discharge minimizes, if not eliminate, impacts on projected impact zones. In addition, temperature reduction of thermal effluents will also be implemented for the same purpose.

At current Plant capacity, simulation shows around 6 Ha mixing zone size, where the associated mixing distance where the zone is located is around 138.2 m. Hence, the cooling system complementing a winding cooling canal was designed to minimize thermal effluent effects on marine ecology. The canal is seen to be a few hundred meters long. Discharge with the use of the cooling system and canal will enable thermal effluent temperatures < 40°C.

4.2.3 Marine Water Quality/Oceanography

4.2.3.1 Thermal Mixing Zone Monitoring

It was found that ≥ 3.0°C predominates the area of about 0.05 km^2 (5 ha) proximate to the outfall (based on the table below sourced from the previous EIS). However, verification cannot be done since the number and location of sampling points, established by the MMT, were not sufficient. Nonetheless, the estimated area is similar to what was observed in thermal modeling conducted for EPRMP.

Areas of Average and Maximum Excess Temperature

Excess Temperature (°C)	Average (km^2)	Maximum (km^2)
≥ 3.0	< 0.05	0.05
≥2.0	0.2	0.4
≥1.0	0.9	1.9

Source: EIS Report (1994)

Recommendations to enhance future monitoring practices:

- Include additional stations to represent the 0.05km2, 0.9km2, and 1.9km2 areas around the outfall.
- Frequency should consider the seasonality of conditions and be done for the two monsoon seasons

Dispersion of any oil spill from coal ships that services the Plant and quality of wastewater effluents are also identified to potentially affect the bay water quality. However, both effluents and possible oil spills may be limited to the reef flat, west of Bani Point since the predominant water current was determined to be northward.

Drifter observations were done for eight stations. Overall, during the time of observations, stations within the bay had a northwestward drift with speeds ranging from 3 to 9 cm/sec. At the intake, the drift was southwestward with a speed of 8 cm/sec. Outside the bay, the drift was mostly westward between 8 to 16 cm/sec. These rates are similar to those measured during 1993 to 1994 field expeditions. Dominant direction was northward and going outside of the bay.

A total of eight stations were established for drifter observations, where drift speeds were observed to be ranging from 3 to 9 cm/s northwestward. On the other hand, drift near the intake was southwestward at 8cm/s while it was 8 to 16 cm/s westward outside the bay. These were similar to the observations from 1993 to 1994. Drift direction was dominantly northward. Tidal conditions should also be considered when measuring drift and correlated in the analysis.

4.2.4 Marine Ecology

The intake facility is coupled with a cooling water intake structure. Both of these are almost similar in terms of echosound readings and distance from coral reef edge

4.2.4.1 Impacts of New Structures

Continued precautionary measures will be implemented in these facilities, including maintenance of impermeable turbidity barriers or silt curtains while laying pipes to protect reed surfaces. These structures mainly prevent resettling of silt over large areas of the reef. There is also be a controlled containment area which will allow silt and other suspended solid particles within the immediate area of the disrupted portion of the reef.

4.3 The Air

4.3.1 Air Quality

4.3.1.1 Construction

Dust (air particulates) and noise levels may increase due to construction activities, mainly caused by equipment operation, excavation, and transport of materials on unpaved roads. Ambient concentrations of Sox and NOx may also increase but are expected to be still within the standard limits, near the construction site as emitted by heavy equipment and transport vehicles. For noise levels, variations will be present from day to night, with some temporary high levels due to construction activities, vehicle traffic and heavy equipment operations, and is deemed to be temporary. It is anticipated that Barangay Bani may experience nuisance from the increased noise levels, but in general, noise reaching the barangay may significantly be reduced by vegetation foliage in between. In addition, a traffic management plan may also be implemented to reduce the noise coming from vehicles.

4.3.1.2 Operations

Emission regulations are strictly being followed by the Masinloc Plant. Various practices, such as use of coal with < 1% sulfur and coal blending of differently sourced coals. The Plant also uses efficient combustors and efficient ESPs (for minimizing dust particulates), as well as in the Project. This results in lower Sox and NOx air particulates as products of combustion. Furthermore, BACT will be acquired and utilized for the Project to ensure regulatory requirements are met.

4.3.2 Pollution Control Devices

The Project intends to install pollution control devices, similar to Unit 4, for Unit 5 with the following specifications:

SOx	BACT
NOx	BACT
Particulate Matter	BACT

4.3.3 Special Features

Minimization of adverse impacts of the Project and moving towards meeting regulatory standards will entail the use of the following practices and facilities:

a) Use of low-sulfur coal for combustion to be within the allowable700 mg/NCM for SOx.
b) SFGD system will be installed to ensure SOx emissions are compliant.
c) Low-NOx burners and efficient combustion systems will be utilized to keep NOx emissions to no more than 1,000mg/NCM
d) A continuous stack monitoring system will be utilized which will measure smoke density, SOx and NOx, where the detectors will be placed in the economizer outlet for CO and NOx and at the induced draft fan for SOx and at the ESP outlet for smoke density.
e) ESPs with dust emission of less than 200 mg/NCM will be utilized
f) Flue gases will be diffused by a 220 m stack to achieve low ground level pollutant concentrations that is within ambient standards.
g) Sprinklers will be maintained at the coal storage yard and the coal unloading facility to prevent/minimize dust generation. Dust cover will be provided in the conveyor and an effective physical windbreak around the coal yard will be installed/enhanced.
h) Dust-free continuous unloader will be used to unload coal from ships
i) Noise abatement systems will be used to minimize noise levels

4.3.4 Noise

The design, construction and operation activities of the Project will be devised in such a way to minimize noise levels, similar to the design of the Plant. In addition, noise abatement systems will be operational to enhance noise level minimization meeting standards in the Noise Rating Curve ISO 85, although some facilities may still exceed levels depending on the situation (i.e. boiler start-up and other pressure reducing devices that operate in cases of emergency)

4.4 The People

4.4.1 Social Development Plan Framework

4.4.1.1 Background

The Social Development Plan (SDP) of the Project was not realized until the issuance of DAO 96-37 since the former EIS of the Project was written under National Environmental Protection Council (NEPC) Guidelines. A Memorandum of Agreement (MoA) was entered into by NPC management with DENR, Zambales Provincial Government, Masinloc Municipal Government and Barangay Bani on May 2, 1993. This MoA generally outlined the interventions and projects that NPC will finance, assistance provisions though the institutions' Environmental Management and Social Engineering Departments. Some of the general provisions were:

- An amount of PhP 97.56M will be given as Financial Assistance and fund Infrastructure Projects for the Provincial Government of Zambales;
- Formation of MMT thru ECC provisions;
- Land acquisition and resettlement package for the affected households;

- Provision of scholarships, skills and on-the-job training for residents of Barangay Bani and Masinloc;
- Mango Processing Plant feasibility study;
- Barangay Bani clinic construction;
- Municipal Reforestation Projects;
- Upgrading of the Masinloc Water District;
- Aid in coordinating with the National Irrigation Administration (NIA) for municipal irrigation projects;
- Direct tapping of Masinloc's power requirement in accordance with Department of Energy's (DOE) implementing guidelines;
- Establishment of a fish sanctuary in Barangay Bani;
- Arrange for a loan to construct a municipal fish port and reclamation in South Poblacion;
- An Economic Package for the LGUs;
- Establishment of the Masinloc Industrial Estate;
- Employment opportunities for the local residents;
- Establishment of a Public Employees Service Office (PESO);
- NPC's commitment to seek public approval for future expansion plans.

ER1-94 Approved Projects

Date of Approval	*Name of Project*	Source of Funds	Project Cost
CY 2015	*Slope Protection Project (Brgy. Collat, Masinloc, Zambales)*		8,398,045.33
	Construction of Bridge (Brgy. North Poblacion, Masinloc, Zambales)		9,598,880.70
	Improvement of Bani-Taltal (Togue) Road (Brgy. Bani, Masinloc, Zambales)		25,220,322
	Construction of Irrigation Canal (Sitio Pulangi, Brgy. Bani, Masinloc, Zambales)		9,799,999.22
	Construction of Slope Protection (Sitio Bangal, Brgy. Bani, Masinloc, Zambales)		4,599,999.61
	Procurement of various medical equipment (Sitio Bangal, Brgy. Bani, Masinloc, Zambales)		1,857,792.00
	Slope Protection Project (Brgy. Bani, Masinloc, Zambales)		4,600,000.00
	Construction of Irrigation Canal (Brgy. Bani, Masinloc, Zambales)		9,800,000.00
	Purchase of medical equipment for the Barangay Health Clinic of Bani (Brgy. Bani, Masinloc, Zambales)		1,709,140.00
	Improvement of Bani-Taltal (Togue) Road (Brgy. Bani, Masinloc, Zambales)		23,464,584.06
Total (CY 2015)			**99,048,762.92**
CY 2016	*Concreting of Resettlement Road (Brgy. Taltal, Masinloc, Zambales)*		4,199,901.14
	Rehabilitation/Construction of Storm Drainage		1,298,584.02

Date of Approval	*Name of Project*	Source of Funds	Project Cost
	Canal (Brgy. Taltal, Masinloc, Zambales)		
Total (CY 2016)			**5,498,485.16**
CY 2017	*Purchase of Medical Equipment (Sitio Tugue, Brgy. Taltal, Masinloc, Zambales)*		699,220.03
	Rehabilitation/Construction of Storm Drainage Canal (Sitio Tugue, Brgy. Taltal, Masinloc, Zambales)		1,298,584.02
	Construction/Rehabilitation of Resettlement Health Center (Sitio Tugue, Brgy. Taltal, Masinloc, Zambales)		1,899,951.54
Total (CY 2017)			**3,897,755.59**
GRAND TOTAL			**108,445,003.67**

Note: ER 1-94 approved projects were only from 2015-2017

4.4.1.2 Rationale

The Social Development Plan Framework (SDPF) was formulated to address the issues, concerns and impacts identified during the consultations and discussions with the affected barangays/community stakeholders. Thus, the Project will include the needs of the various stakeholders in the formulation of proposed interventions. Basic social services and community empowerment interventions are to be provided for by the Proponent as part of its social responsibility, especially to the resident of the impact area which are considered partners for sustainable development. The SDPF also aims to plan approaches which will help to improve the overall standard of living of the affected communities. Thus, being able to enhance the affected residents' productivity, and help them improve self-esteem and self-reliance towards seeing themselves as important partners in the society through socio-economic programs and projects that will be implemented.

4.4.1.3 Legal Framework

Appropriate interventions to concerned stakeholders will be established through the SDPF. The ER1-94 funds will be utilized to aid in the implementation of projects and interventions as identified and prioritized by the affected stakeholders.

4.4.1.4 Basic Features of the SDP: Development Strategies/Approach

The main goal of the SDPF is to empower communities and stakeholders in undertaking sustainable development activities even after the project has been decommissioned with the use of approaches pointing to sustainable development and self-reliance/sustainability.

The most disadvantaged and vulnerable sectors of affected communities should be able to receive the totality of the Project benefits. Planning, implementation and evaluation of projects under the SDPF are to include these vulnerable sectors (e.g. youth, women, elderly, persons with disability, fishermen, farmers, small traders and enterprise owners, etc.) as partners as they participate in all aspects of the project. Furthermore, the SDPF will consider the existing local government Development plans, as well as its identified priorities, to develop a complementary approach in project planning, implementation and evaluation.

4.4.1.5 Proponent's Current Efforts and Initiatives

The Proponent shall continue to integrate its initiatives into the Social Development Plan (SDP). The MPPCL has received a Plaque of Appreciation from DENR-Region 3 for its projects, such as medical mission, river cleaning, solid waste and environmental management, among others.

Residents of Barangay Taltal and Baloganon have initially identified issues and the following proposed programs were devised to address specific concerns which are considered in the SDP preparation:

Socio-economic Conditions/Concerns and Issues	Proposed Mitigation Measures
a. Assistance to Persons with Disabilities/Senior citizens (Barangay Baloganon/Barangay Taltal)	• Provision of assistance, specifically in for medicines and other requirements, if sickly. • To be more holistic and comprehensive prioritization in addressing the needs and problems for the PAD may be explored in consultation with MWSD and PWD/Senior Citizens' Association at the barangay/municipal levels.
b. Insufficient supply of medicines/Establishment of a Barangay Clinic (Barangay Baloganon)	• Medical missions and provisions of medicines are currently being undertaken by the Proponent. • Establishment of a barangay clinic. • Further enhancement of the skills of BHWs to be able to provide more effective service is necessary.
c. Benefits of Employment (How to ensure fair distribution of available work/jobs and prioritization of local residents.	• A multi-sectoral committee shall be organized in coordination with the Proponent and local contractors to review equitable distribution of local employment opportunities during construction and power plant operations. This committee will develop the policy and mechanisms for application, screening and hiring, distribution of quota among the affected barangays, monitor compliance of the system and make necessary improvements to meet equitable work/job distribution, if needed. • The establishment of the multi-sectoral committee composed of representatives of various sectors from affected barangays is important to avoid bias in selection, minimize political intervention, and ensure hiring competent workers.
d. Enhancing competency and competitiveness of local residents to improve access to Proponent's job and manpower requirements.	• The Proponent is in the process of establishing a welding school which will train interested residents who may be hired after graduation. • The Proponent is coordinating with TESDA for appropriate curriculum design, the LGU for the site of the training center and contractors as trainers with TESDA. The Proponent will supply the facilities and equipment. • Provision of scholarship and allowance to

Socio-economic Conditions/Concerns and Issues	Proposed Mitigation Measures
	trainees
e. Livelihood Opportunities for Women	• Proponent will implement possible livelihood projects. • The Proponent assesses and identifies possible company requirements can be sub-contracted to women and other groups, some of which are: (i) supply of food requirements (i.e., vegetables, fruits, meat, eggs, chicken, etc.) which can be possibly grown in the barangays, (ii) uniforms, (iii) lawn maintenance, (iv) food vending for workers during construction, among others.
f. Water supply system (Purok 1 and 2, Barangay Taltal	• Provision of water supply explored using ER 1-94. Appropriate request and operational plan will be made on how to operate and operate the water system.

4.4.1.6 SDP Preparation and Planning and Implementation Process

Use of CO and OD approaches will be considered in the preparation of SDP, ensuring various stakeholders' participation, including affected residents who will be involved in the empowerment process, which will include:

- The various stakeholders will be involved from planning to evaluation of implemented projects throughout the cycle of then Project
- Capacity enhancement of partner organizations and cooperatives and their members will be undertaken to ensure the viability and sustainability of projects and business undertakings. Capital build-up and savings formation will be an important element ensuring their financial stability and to be able to serve more members even after project decommissioning.

4.4.1.6.1 Institutional/Project Proponent Responsibility

1. The creation of a Community Relations Office (COMREL) by the Proponent is prioritized. The office assumes the function of addressing the issues and concerns as presented by various stakeholders and the affected communities. The main functions of the COMREL are:
   - Assessing the communities' capability to undertake and implement projects by conducting IEC activities and acquiring participative feedback from participants
   - Planning of projects to be implemented which considers the conduct of community needs assessment
   - Organization of core groups, associations and/or cooperatives which can conduct various community projects even after the decommissioning of the Project
   - Organize and facilitate capacity-building activities for empowerment of community organizations, especially to identified officers for decision-making conflict management
   - Monitoring of on-going projects and evaluating progress status of each, while also identifying concerns issues to be addressed in Project implementation
   - Determine learnings and possible sustainability mechanisms by evaluating completed projects

2. COMREL staff are tasked to spearhead, implement, facilitate, enhance, monitor and evaluate SDP milestones in its implementation
3. Capacity building activities are also provided for the COMREL staff to empower them in carrying-out tasks assigned to the office
4. Key stakeholders in all sectors comprise a core SDP committee aimed to strengthen the partnership to the Proponent in terms of project planning, implementation and evaluation

4.4.1.6.2 Proposed Tasks and Responsibilities of the SDP Committee

i. Key persons from the various stakeholders will be involved in the whole project cycle activities
ii. Host barangays' key persons are also to participate as part of the committee and be given the opportunity to identify needs and propose activities to address issues
iii. The committee also comprise of key persons from various NGO connected to the community
iv. Representatives from the LGUs are also to participate, primarily in supporting the SDP that will be produced from inputs of the various sectors by helping in the project planning, implementation and evaluation through decision-making skills and technical knowledge

Appropriate budget shall be allotted for the SDP to ensure and facilitate its smooth implementation. The budget should be able to cover various programs and projects that will be prioritized or identified by affected communities and various stakeholders.

The projects identified for the SDP will be appropriated with budget to facilitate its implementation. The committee may also decide on the prioritizing of projects/programs to be implemented based on factors that the committee deem considerable. Partners from the various stakeholders are to participate in the actual project planning, prioritization and proposal preparation. The design of these projects/programs are based on the needs/issues assessment from the stakeholders.

Establishing Network and Linkages

The SDP also aims to link other local, regional and national agencies and NGOs to the various stakeholders of the Project. This can enable the expansion of network and linkages to further strengthen the conduct of implemented and proposed projects. Furthermore, this will also widen the scope of interventions and support to the residents of the affected locality.

Monitoring and Evaluation of the Social Development Program

Representatives of the various sectors, NGOs and LGUs are organized as a local development council which aims to monitor the projects undertaken and its milestones. The council is also to periodically assess project outcomes and impacts on the socio-economic status of target beneficiaries. Appropriate recommendations for project enhancement will also be identified and documented, together with feedback.

Ensuring that the aforementioned benefits gained from the Project reaches out to all affected stakeholders and that these benefits continue to be realized even after Project completion is the general purpose of the SDP. It is also targeted that empowered organizations and cooperatives through the SDP will be less dependent on the government and will be able to operate sustainably in providing the services to its members.
.

Table 4-1: Summary Matrix of Environmental Management Plan

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Construction/Pre-Operations Phase						
People	Health	• Adverse health impacts during construction • Workplace Safety	• Strict implementation of Occupational Health and Safety Policy • Proponent to conduct continuing Information, Education and Communication (IEC) efforts on Project developments	MPPCL	Part of the construction cost	EMP, EMoP
	Employment	Construction of the Project will need skilled and unskilled workers • Access to employment opportunity • Access to MPPCL tradeschool	• Qualified residents in the Direct Impact Area (DIA) and Indirect Impact Area (IIA) shall be given priority during hiring of the workers • Conduct manpower trainings in order to develop residents in the DIA and IIA for better employment opportunities Ensure equitable access to trade school	MPPCL	Part of the construction cost	EMP, EMoP
	Population	The influx migrant construction workers will induce the proliferation of service establishments. (food eateries, lodging houses)	• Positive impact; no mitigation needed	MPPCL	Part of the construction cost	EMP, EMoP
	Commerce and Industry	There will be high demand for construction materials which will intensify production and increase employment in cement, metal, wood, and chemical industry	• Positive impact; no mitigation needed	MPPCL	Part of the construction cost	EMP, EMoP
	Social Acceptability	Only 50% of the residents in the area in favour of the project implementation	• Creation or Strengthening of the Community Relations Office (COMREL) to address the concerns and issues of various stakeholders of affected communities • Conduct more Project acceptance campaigns • Implement Information and Education	MPPCL	Part of the construction cost	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			Campaign(IEC) activities			
Operations Phase						
People		The operation of Masinloc Plant and Project will add a total of 1200 MW to the Luzon grid	• Positive impact, no mitigation required	MPPCL	Part of the Operation cost	EMP, EMoP
	Vulnerable Groups	Assistance to Persons with Disabilities/Senior Citizens	• Provision of assistance specifically in meeting their needs such as medicines and other requirements	MPPCL	Part of the Operation cost	EMP, EMoP
	Basic Services	Insufficient supply of medicines/ Access to health facilities	• Medical missions and provision of medicines are currently undertaken by the Proponent • Provide better access to health care	MPPCL	Part of the Operation cost	EMP, EMoP
		Water supply system	• Proponent to facilitate assistance in the use and access to ER1-94	MPPCL	Part of the Operation cost	EMP, EMoP
	Employment and Livelihood	Benefits of Employment (How to ensure fair distribution of available work/jobs and prioritization of local residents • Equitable access to employment • Access to livelihood opportunities • Access to other development programs	• Proponent will include in its procurement and contracting procedures to prioritize qualified local hiring. • Advertise job opportunities to all affected communities. • In coordination with contractors, open job fairs would be conducted.	MPPCL	Part of the Operation cost	EMP, EMoP
		Enhancing competency and competitiveness of local residents to improve access to Proponent's job and manpower requirements	• The Proponent is in the process of establishing a welding school which will train interested residents who may be hired after graduation.	MPPCL	Part of the Operation cost	EMP, EMoP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			• The Proponent is currently coordinating with Technical Education and Skills Development Authority (TESDA) for appropriate curriculum design, the LGU for the site of the training center and contractors as trainers with TESDA. The Proponent will supply the facilities and equipment. • Provision of scholarship and allowance to trainees shall be studied and implemented			
		Livelihood Opportunities for Women	• Proponent shall implement livelihood projects such as "rag making" for women • The Proponent shall assess and identify what possible company requirements can be sub-contracted to women and other groups such as (i) supply of food requirements (i.e., vegetables, fruits, meat, eggs, chicken, etc.) which can be possibly grown in the barangays, (ii) uniforms, (iii) lawn maintenance, (iv) food vending for workers during construction, among others	MPPCL	Part of the Operation cost	EMP, EMoP
Abandonment/Decommissioning Phase						
People	Community Assistance	Continuity /sustainability of development interventions	• Evaluation of effectiveness of intervention activities • MPPCL to conduct continuing IEC efforts on Project developments	MMT/SDP committee	Part of Operation Cost	EMP, EMoP

5 SOCIAL DEVELOPMENT PROGRAM (SDP)FRAMEWORK AND INFORMATION, EDUCATION, AND COMMUNICATION (IEC) IMPLEMENTATION

5.1 Background/Rationale

The Social Development Program(SDP) will address the issues and concerns and impacts identified during the consultations and discussions with the affectedcommunities. It will incorporate the proposed intervention programs based on needs of various stakeholders of the Project.

As part of its corporate social responsibility (CSR), the Proponent will aim to provide support in the delivery of basic social services and develop the capacity of the stakeholders, especially the affected residents as partners for sustainable development.

It will also strive to develop strategies that will alleviate poverty and improve the standard of living of communities through socio-economic programs with a goal to develop self-reliant communities.

5.2 Legal Framework

The Proponent has an annual budget allocation for community relations programs which will form part of the SDP. The Proponent will provide assistance to affected communities in developing projects and facilitate the submission to the DOE for those projects that can be funded through ER 1-94.

The SDP will establish parameters for intervention for the direct and indirectly affected communities, the LGU and other stakeholders that may be affected as a result of the Project.

5.3 Basic Features of the SDP: Development Strategies/Approach

The SDP will be based on the sustainable development and self-reliance approaches. Its goal is to develop the capacity of the communities and stakeholders to undertake sustainable development projects, even after the decommissioning of the Project.

The full benefits of the Project should be able to trickle down to the most disadvantaged and vulnerable sectors of affected communities. Identification of projects will be based on the results of the EPRMP in consultation with the concerned sectors (youth, women, elderly, persons withdisability, fishermen, farmers, small traders and enterprise owners). Different sectors can participate in project implementation, monitoring and evaluation as “program/project partners”.

The SDP should be able to complement the existing Municipal/Provincial Development Plans and consider their basic priorities identified by the LGUs, and more importantly, the project impact and stakeholders’ concerns and issues.

5.4 Proponent’s Current Efforts and Initiatives

The Proponent is currently doing a baseline study that will generate community resource inventory and mapping of strategic indicators towards a sustainable CSR framework. Focused group discussion and consultation with stakeholders will be done.

Upon acquisition of the Masinloc Plant, the Proponent has been initiating community relations programs such as medical missions, scholarship programs, feeding programs, environment protection programs, coastal and river clean-up, various community donations and sponsorships among others. These current initiatives of the Proponent shall be integrated into the final SDP.

The SDP will take into consideration the following issues raised by the residents fromaffected communities (Direct Impact Areas: Barangay Bani, Baloganon, Taltal; Indirect Impact Areas: Barangay Binabalian and Lauis; Municipalities of Masinloc and Candelaria; Province of Zambales) (**Table 5-1**). Proposed mitigation measures are hereby identified as basis for further planning and discussions with specific stakeholder groups in the preparation of the SDP.

Table 5-1: Socio-economic Issues and Proposed Mitigation Measures

Socio-economic Conditions, Concerns, and Issues	Proposed Mitigation Measures
a. Assistance to Persons with Disabilities (PWD)/Senior citizens	a. Provision of assistance specifically in meeting their needs such as medicines and other requirements. b. To have more holistic and comprehensive prioritization of needs and problems for the PWD may be explored in consultation with Municipal Welfare and Social Development Office (MWSDO) and PWD/Senior Citizens' association at the barangay/municipal levels.
b. Insufficient supply of medicines/Establishment of a Barangay Clinic	a. Medical missions and provisions of medicines are currently undertaken by the Proponent. b. Establishment of a mobile health clinic is being considered. c. Continuous dialogue with BHWs and RHUs to understand health issues and needs. d. Facilitate skills enhancement opportunities for BHWs.
c. Benefits of Employment (Fairness and prioritization in hiring)	a. Proponent will include in its procurement and contracting procedures to prioritize qualified local hiring. b. Advertise job opportunities to all affected communities. c. In coordination with contractors, open job fairs would be conducted.
d. Skills Development and Training	a. The Proponent is in the process of establishing a Community-based Livelihood and Skills Training Center. b. Skills training center will be open and accessible to local residents.
e. Livelihood Opportunities	a. Proponent is assessing multiple livelihood opportunities to be made available to local residents such as: (i) supply of food requirements (i.e., vegetables, fruits, meat, eggs, and chicken) which can be possibly grown in the barangays, (ii) rag-making, (iii) food vending for workers during construction. b. Proponent will consider sub-contracting opportunities for short and medium term durations.
f. Infrastructure Projects	a. Proponent to facilitate assistance in accessing ER 1-94 funds for various local projects such as water system, street lighting, school improvement, and roads.

5.5 SDP Preparation and Planning and Implementation Process

The SDP will be developed on education, health, livelihood and environmental stewardship projects. Project partners will be involved in the planning and implementation on a per project basis. Capacity building for partner organization will be provided to ensure sustainability of the project.

In order to have a meaningful preparation of the Social Development Plan (SDP), the Proponent intends to prepare the SDP in the schedule shown below (**Table 5-2**). Initial consultation with the concerned communities will be done to identify specific issues/activities from different stakeholder segments (i.e., health, education, women, and fisher folks). The Proponent should ensure that various stakeholders groups will be consulted or represented during the initial consultation. The Proponent will then categorize identified issues/activities and identify cost and possible source of funding for the said activities. The prepared plan will then be validated with the identified stakeholder group. After comments and inputs from the concerned stakeholders have been integrated, the Final SDP will be presented and submitted to the concerned agencies. **Table 5-3** below is a sample of the Social Development Plan Matrix. Once approved, the Proponent intends to implement the SDP as scheduled. The entire preparation and finalization of the SDP is expected to last for six weeks.

Table 5-2: Social Development Plan Formulation Timeline

Activities	Schedule (weeks)					
	1	2	3	4	5	6
Initial consultation with concerned stakeholder						
Preparation of activities, cost and funding						
Validation of SDP with stakeholders						
Finalization of SDP						
Presentation of finalized SDP						

Table 5-3: Social Development Plan Matrix

oncerns	Responsible Community Member/Beneficiary	Government Agency/ Non-government Agency and Services	Proponent	Indicative Timeline	Source of Fund
1. Health / Education Concerns Program Intervention – Health **<u>Current/Continuing Projects:</u>** - Medical and Dental Mission **<u>Future Projects:</u>** - Establishment of Mobile Health Clinic - Maternal and Child Care Program Program Intervention – Education **<u>Current/Continuing Projects:</u>** - ICT Infrastructure Enhancement Program - In-school Feeding Program - Literacy Program (Bright Minds Read Program) - Distribution of School supplies/Musical Instruments and Sports Equipment to DepEd - Sight Saving Program - Participation to DepEd's National Maintenance Week (Brigada Eskwela) - Annual Book/Reference Materials Donation **<u>Future Projects:</u>** - Reading Program - Teachers Training	Provincial/ Municipal and Barangay government Units	MPDC MHO DOH DSWD DEPED Corporate Foundations	Community Relations /EHS Group/ AES Philippines Power Foundation – APPF (soon to be establsihed)	Pre-Construction	MPPCL/ APPF
2. Employment Concerns Program Intervention **<u>Current/Continuing Projects:</u>** - Job openings coordination with PESO and Barangay Halls - Tertiary Scholarship Program **<u>Future Projects:</u>** - Establishment of Welding Center and Donation of	Provincial/ Municipal and Barangay government Units/	PESO TESDA MSWD DSWD	Community Relations/APPF	Pre-Construction	MPPCL/ APPF

oncerns	Responsible Community Member/Beneficiary	Government Agency/ Non-government Agency and Services	Proponent	Indicative Timeline	Source of Fund
Welding Equipment					
3. Livelihood Opportunities (esp. for women) Program Intervention **<u>Future Projects:</u>** - Establishment of Women's Club - Development of relevant livelihood program for Women	Provincial/ Municipal and Barangay government Units/	PESO TESDA MSWD DSWD	Community Relations/APPF	Pre-Construction	MPPCL/ APPF
4. Partnership with NGOs Program Intervention **<u>Current/Continuing Projects:</u>** - Partnership with NGO for implementation of the following project o Relief operations in times of typhoon o Annual Gift-giving program for indigent families **<u>Future Projects:</u>** - Communication Program will cover regular coordination with relevant NGOs, POs, sectoral groups	Provincial/ Municipal and Barangay government Units/ Concerned local NGOs	MSWD	Community Relations/APPF	Pre-Construction	MPPCL/ APPF
5. Environment Program Intervention **<u>Current/Continuing Projects:</u>** - Spearhead regular coastal and river clean-up - Maintenance of seedling nursery - Provide technical expertise in water sampling analysis to LGU **<u>Future Projects:</u>** - Partnership with Academe and Environment Advocacy groups in monitoring of biodiversity (e.g. Wild Bird Club of the Philippines) - Environment Protection/ Conservation	Provincial/ Municipal and Barangay government Units/	MENRO CENRO DENR	Community Relations/ Environmental Group/APPF	Pre-Construction	MPPCL/ APPF

oncerns	Responsible Community Member/Beneficiary	Government Agency/ Non-government Agency and Services	Proponent	Indicative Timeline	Source of Fund
○ Partnership with Bantay-Dagat (Masinloc Marine Sanctuary Association) to prevent illegal fishing (Donation of motorboat for patrolling and participation in policy formulation and implementation) ○ Provide support to LGU's Integrated Coastal Resource Management Program - Resource regeneration ○ Continued support in the government's National Greening Program -					

5.5.1 Institutional/Project Proponent Responsibility

The Proponent is set to establish a Site Communications Unit at the Masinloc Plant. The team will be composed of communications and community relations personnel, who will be the focal persons to address the concerns and issues of various stakeholders of affected communities. The said unit will perform the following functions:

- Undertake IEC activities, receive feedback from affected communities, and assess readiness of community to plan, undertake and implement projects
- Undertake community assessments as basis for short and long term planning of community projects
- Organize core groups and associations/cooperatives to undertake community projects even after project completion
- Coordinate and conduct training to enhance knowledge and skills of members and officers of community organizations, particularly in decision-making and conflict management
- Monitor, assess, and document project progress
- Facilitate access to ER 1-94 funds
- Evaluate completed projects and document/report effectiveness

5.5.2 Stakeholder Engagement

The LGUs, NGOs, POs, Cooperatives, and other stakeholdersare encouraged to provide support to the SDP. As a program partner, they can contribute their technical expertise, know-how, and co-funding.

5.5.3 Establishing Network and Linkages

Network and linkages will be expanded to further mobilize support and assistance reaching out to other agencies, NGOs, and other institutions at the regional and national levels. The objective is to strengthen established linkages to obtain external funding and support. This will provide an opportunity to expand the existing development intervention and assistance to residents of affected communities.

5.5.4 Monitoring and Evaluation of the Social Development Program

Program partners can jointly do the monitoring of programs and milestones of project activities as well as assess their outcomes and effects on the socio-economic status of beneficiaries on a periodic basis.
Recommendations and suggestions will be documented and evaluated for possible program changes. Feedback will be regularly reported to the Municipal and Provincial Offices to inform them of the development efforts.

5.5.5 Sustainability Plan

A network of program partners, including other critical stakeholders, may be organized to monitor and evaluate the implementation of the SDP. The Proponent will consult this network in the development of programs and projects.
The Proponent will provide capacity enhancement of partner organizations, cooperatives, NGOs, POs, and their members to ensure the viability and sustainability of programs and projects. Capital build-up and savings formation will be an important element in ensuring their financial stability and to be able to serve more members in the neighboring communities even after the decommissioning.

5.6 Information, Education and Communication (IEC) Plan Framework

5.6.1 Background/Rationale

The IEC Plan is an important tool in establishing a harmonious relationship between the Proponent and stakeholders. It opens the line of interaction and communication that will identify issues, concerns, and possible mitigation measures for both the stakeholders and the Proponent.The IEC plan goes beyond the objective of providing information or conducting dissemination activities. It focuses on providing on-going interaction between the proponent and stakeholders during the construction, operation and decommissioning phases. More meaningfully, an IEC program will inculcate value formation by making the communities aware of their roles as stakeholders. When the IEC program is conducted effectively, it is a significant confidence and trust-building tool for both the stakeholders and the Proponent.

5.6.2 Goals and Objectives

The IEC plan will seek to reach a broad-based population of various stakeholders that will be affected by the Project. It promotes a better understanding of the issues, concerns, and resolution between the stakeholders and Proponent.

- To provide better understanding of the Project, possible impacts, corresponding concerns, issues, mitigation measures, and Project benefits
- To provide accurate and timely information.
- To establish trust and confidence between stakeholders and the Proponent.
- To ensure transparency between stakeholders and the Proponent.

5.6.3 Identification of Project Stakeholders

5.6.3.1 Stakeholders Identification and Analysis

Various stakeholders will be identified according to their interest in the Project and how it affects their lives, business or group. The stakeholders may be represented by the government institutions, NGOs, sectoral groups (farmers, fisher folks, youth, elderly, etc.). They compose those who will be directly or indirectly affected by the Project.

5.6.3.2 Assessment of Extent of Stakeholder Interest in the Project

Assessment will be made to evaluate the extent of interest or the seriousness of impact to various stakeholders. Since there will be no displacement that will take place as the construction site is within the Masinloc Plant compound, emerging concerns are more on the environmental and health impact of the Project.

5.6.3.3 Define Specific Issues and Concerns

Specific issues and concerns expressed in public orientation meetingswill be defined. Based on the interest of the Project stakeholders, their issues and concerns could be identified and analyzed as basis for the type of content and methodology that would be appropriately used. Refer to **Table 5-4**.

5.6.3.4 Selection of Appropriate IEC Methodology

A working committee composed of both stakeholders and Proponent will be created. This provides the proper venue to build trust and relationship with stakeholders, communicate and clarify issues and how to address them, and ultimately, win champions in the communities. The formation of such committee will be led by the Site Communications Team, in close coordination with both the Masinloc Plant Management team and the Project team.

5.6.3.5 Implement Planned IEC Approaches and Strategies

The proponent will implement planned IEC activities through its proposed Site Communications and Community Relations unit targeting various stakeholders all throughout the project cycle. The EIA social study team will conduct the IEC during the study period.

5.6.3.6 Evaluation of IEC Plan Implementation

IEC effects and results will be periodically assessed to determine its impact and to define improvements on IEC methodology.

An assessment of the interest or stake, project concerns and issues of Project stakeholders including proposed IEC content is shown below:

Table 5-4: Assessment of Stakeholders Concerns and Focal Areas for IEC

Project Stakeholders	Level of Stake or Interest/Project Impact	Project Concerns/Issues	Proposed/IEC Approaches/ Content
A. Pre Construction Phase			
(1) Direct Impact Area			
(i) Barangay Bani, Taltal and Baloganon residents	High –may experience environmental/health impacts.	• Proponent to ensure safety and prevent negative environmental impacts • Ensure locals priority for hiring and for employment and access to Proponent's training school • Project benefits to reach various sectors, women, BHWs, senior citizens • Improve access to water supply and reduced electricity costs	• Clarify the vague information on the Project, present comprehensive picture of project benefits and how potential impacts can be mitigated • Information meetings to discuss project objectives, activities, technology to be used, benefits and advantages, potential threats and mitigation measures • Present Proponent's overall Community Relations Program, among them the Welders' Training Center. The CSR Porgrams being implemented cover health, education, livelihood and the environment.
i. Barangay officials and representatives	High - The project site is under their political jurisdiction, represent the interest and welfare of their constituents to be affected. Expects their constituents to benefit from the project.	• Concern on possible environmental impact(air and noise pollution) which are perceived to have negative impact to health of constituents and trees(mangoes)	• Clarify the vague information on the project, project phases and mitigation measures for potential threats and risks • Information meetings to discuss project objectives, activities, technology to be used, benefits and advantages, potential threats and mitigation measures
ii. Sectoral groups (fishermen, farmers, senior citizens, women, youth etc.,	High - They may be directly affected through decrease in their agricultural productivity in the long run.	• Potential negative impact of the Project on environment and health • Concerns on improving livelihood and employment and other types of assistance • Equitable access to the Proponent's training school	• Present mitigation measures including benefits that will be gained from the project (employment and enterprise development assistance) as well as community projects • Clarify procedures and requirements on the enrolment to the Welders' Training Center • Communicate CSR programs that cover livelihood, health and environment • Clarify procedures on requesting community project support from Proponent through the Community Relations personnel
iii. Provincial and Municipal	High -The project site is under their political jurisdiction,	• Concerns on possible impact to environment	• Clarify the vague information on the project as well as

Project Stakeholders	Level of Stake or Interest/Project Impact	Project Concerns/Issues	Proposed/IEC Approaches/ Content
Government	represent the interest and welfare of their constituents to be affected. Expect their constituents to benefit from the project. Have limited funds to pursue their development plans due to lack of financial resources caused by limited revenues from taxes and other sources.	and heath of constituents. • Corresponding taxes and project benefits for constituents	benefits to the community of Proponent's continued business presence in Masinloc • Information meetings to discuss project objectives, activities, technology to be used, benefits and advantages, potential threats and mitigation measures
B. Project Implementation/ Project Construction			
a. Barangay Officials b. Sectoral groups (fishermen, farmers, traders, businessmen, sari-sari store owners, etc.)	High High	• Concerns of inability of the proponent to implement planned mitigation measures such as benefits, compensation, employment, environmental protection and rehabilitation • Equitable distribution of benefits and taxes and how each one will benefit from the Project	• Mobilize monitoring committee to oversee the implementation of construction, through coordination with the Proponent through the Community Relations Personnel • Participation of stakeholders in projects and programs activities and the implementation of the provision of benefits, compensation, employment and livelihood activities • Inform the public of on-going social development activities,training employment available to residents as well as other opportunities • Solicit suggestions and feedback in project implementation mechanism status and issues. • Regular reporting of Proponent's Community Relations Program status to the Working Committee
C. Decommissioning Phase			
(I) Primary Stakeholders	• High	• Sustainability of development interventions conducted and continuing community assistance	• Inform stakeholders of the plan for decommissioning and corresponding responsibilities of stakeholders • Sustained communications with the communities through the Working Committee on relevant CSR and environment programs to be implemented • Conduct/sustain interest of community-based MMT to undertake monitoring even after decommissioning phase and activate gate keepers from

Project Stakeholders	Level of Stake or Interest/Project Impact	Project Concerns/Issues	Proposed/IEC Approaches/ Content
			affected communities to provide continuing information and get feedback.

Table 5-5: Information, Education and Communication (IEC) Plan/Framework

Target Sector Identified as Needing Project IEC	Major Topics of Concern in Relation to Project	IEC Scheme/Strategy/ Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
A. Preliminary Stakeholder					
a. Residents of affected Barangays: Bani, Baloganon and Taltal	1. Project description and status 2. Objective of EIA study/EIA Findings 3. Issues and concerns about the project 4. Building Trust and confidence 5. Rights and responsibilities of stakeholders/pro-active response to project operations: Monitoring/creation of MMTs	• Community assemblies • Group discussions • Interpersonal/CO approach • Deployment of COMREL Staff for continuing dissemination of information/organization of information/gatekeepers and peer facilitators • Communication of the SDP through the COMREL unit	• Invitation letters • Primer about the Project • Site visits to other power plants • Distribution of information flyers	• Pre-construction • Project Feasibility Phase • During the Conduct of EIA Study • After EIA Study	• Project expected number of attendees • Cost of meals • Cost of Transportation • Cost of Venue • Cost IEC materials
b. LGU: Provincial, Municipal and Barangay Units	1. Project description and status 2. Project Impact 3. Objective of EIA Study/EIA Findings 4. Issues and concerns about the Project 5. Mitigation measures 6. Building trust and	• Group methods • Group workshops • Group discussion • Group discussion • Interpersonal/ CO	• Invitation Letters • One-on-one meetings • Primer about the Project and EIA study • Site visits to other power plants	• Pre-construction • During and after EIA Study	• Project expected number of attendees • Cost of meals • Cost of Transportation • Cost of Venue • Cost IEC materials

Target Sector Identified as Needing Project IEC	Major Topics of Concern in Relation to Project	IEC Scheme/Strategy/ Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
	confidence that mitigation measures will be undertaken	approach • One-on-one meetings • Group workshop/ discussion • Communication of SDP through the COMREL unit	• Distribution of information flyers	• After EIA study	
c. Sectoral Groups (NGOs, POs)	1. Project description and status 2. Project impact 3. Objective of EIA Study 4. EIA findings 5. Concerns about the Project'spotential impact 6. Project benefits (community assistance, training, enterprise development, livelihood and employment, etc. 7. Rights and responsibilities of stakeholders/pro-active response to project operations: Monitoring/creation of MMTs	• Group methods • Community Consultations assemblies • Group discussion • Communication of SDP through the COMREL unit	• Invitation letters • One-on-one meetings • Primer about the Project and EIA study • Site visits to other power plants • Distribution of information flyers	• Pre-construction • During and after EIA study • After conduct of EIA study	• Project expected number of attendees • Cost of meals • Cost of Transportation • Cost of Venue • Cost IEC materials
d. Concerned agencies	1. Project description and	• Community assembly	• One-on-one meetings	• Before	• Project expected

Target Sector Identified as Needing Project IEC	Major Topics of Concern in Relation to Project	IEC Scheme/Strategy/ Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
(DENR, DAR, DA, DSWD, DepEd)	status 2. Project impact 3. Issues and concerns about the Project 4. Mitigation measures 5. Rights and responsibilities of stakeholders/pro-active response to project operations: Monitoring/creation of MMTs	• Group workshop/ discussion • Group workshop/ discussion • Group workshop/ discussion	• Primer about the project and objectives of EIA • Group discussion • SDP presentation • Site visits to other power plants • Distribution of information flyers	construction • During and after conduct of EIA study • After conduct of EIA study	number of attendees • Cost of meals • Cost of Transportation • Cost of Venue • Cost IEC materials

6 ENVIRONMENTAL COMPLIANCE MONITORING

6.1 The Land

6.1.1 Soil Quality

6.1.1.1 Agricultural Areas

Soil pH, organic matter content, Phosphorus and Potassium levels will be monitored annually in the agricultural areas primarily planted with rice and mango.

6.1.1.2 Ash Pond

Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc levels will be monitored for heavy metals.

Monitoring stations were designated as A2 to A4 where sediment collection for the ash pond area was implemented on September 16, 2015. Station A1 is located adjacent to the discharge channel of the cooling water facility while A2 to A4 were proximate to the ash pond facility. In addition, strong wave actions were present while gathering the samples from the stations.

Coal Impact Stations	Date	Time			Sediment	
		Start	End	Duration	Size/Consistency	Color
A1	16-Sep-15	8:27	8:35	0:08	clay; mud	dark gray to black
A2	16-Sep-15	7:47	7:55	0:08	no sediment; coral rubble	
A3	16-Sep-15	7:39	7:45	0:06	fine sand, soft sand	light brown to light gray
A4	16-Sep-15	7:18	7:29	0:11	fine sand, soft sand	light brown to light gray

6.1.1.3 Coal Jetty and Coal Yard Area

Eight sampling stations (from C1 to C2) were designated for sediment sample collection. Observed parameters were differences in size, consistency and color. Light-colored samples were observed from C2 to C8 stations while dark-colored samples were recorded for C1.

Coal Impact Stations	Date	Time			Sediment	
		Start	End	Duration	Size/Consistency	Color
C1	15-Sep-15	6:04	6:12	0:08	fine sediment; mud	dark gray
C2	15-Sep-15	6:16	6:22	0:06	clay; mud	gray to brown
C3	15-Sep-15	6:25	6:32	0:07	fine sand; soft sand	light brown to light gray
C4	15-Sep-15	6:34	6:39	0:05	fine sediment; mud	light brown to light gray
C5	15-Sep-15	6:46	6:50	0:04	fine sediment; mud	light brown to light gray
C6	15-Sep-15	6:54	7:18	0:24	fine sand; soft sand	light brown to light gray
C7	16-Sep-15	10:10	10:17	0:07	fine sand; soft sand	light brown to light gray
C8	16-Sep-15	10:21	10:29	0:08	fine sand; soft sand	light brown to light gray

6.1.2 Agricultural Productivity

Assay plots located in Masinloc and Candelaria will be monitored at harvest season for rice and mango yield.

6.1.3 Terrestrial Flora and Fauna

The pre-established flora and fauna monitoring plots for the baseline survey will be continuously monitored. Frequency of monitoring activities is recommended to be done at least once every three years, where significant developments may be observed. Buffer zones for protection and aesthetic retention purposes will also be monitored for development and possible species recruitment. The information gathered will also be used, possibly, to correlate sulfur emissions during plant operations to any change in species population.

6.2 The Water

6.2.1 Water Quality

6.2.1.1 Freshwater

The two established monitoring stations in Lauis River for freshwater quality, LR-1 (Upstream of the freshwater intake) and LR-2 (Near the river mouth/nursery) will still be utilized for freshwater quality monitoring, where the following parameters will be observed:

General Parameter	Specific Parameters
Physico-chemical	temperature, pH, conductivity, turbidity, dissolved oxygen (DO), oxidation-reduction potential, total dissolved solids (TDS), total suspended solids (TSS) and salinity
Biological	fecal and total coliform
Nutrient level	nitrate, fluoride and sulfate
Heavy Metal Content	Aluminum, Antimony, Arsenic, Cadmium, Calcium, Chromium (6+), total Chromium, Copper, Gold, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Vanadium and Zinc

6.2.1.2 Groundwater

Monitoring of groundwater quality will be continued on the 11 pre-determined sampling stations. Parameters to be observed include pH, conductivity, turbidity, DO, salinity, temperature and TSS, Aluminum,

6.2.1.3 Effluents

Effluent quality monitoring will be done by collecting samples from pre-determined monitoring stations within the Wastewater Treatment Facility (WTF), Coal Sedimentation Basin (CSB), Ash Sedimentation Basin (ASB), Cooling Water Discharge Canal (CWDC), and Storm Drain Canal (SDC). Analysis of various water quality parameters, such as pH, temperature, conductivity, salinity, DO, BOD, oil and grease, TSS, turbidity, TDS, Aluminum, Antimony, Arsenic, Cadmium, Calcium, total Chromium, Chromium (6+), Copper, Gold, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Nickel, phenols, Potassium, Selenium, Silver, Sodium, Sulfate, Vanadium and Zinc, will consequently be conducted to quantify effluent quality.

6.2.2 Oceanography

The primary site for monitoring is within the Oyon Bay. Pre-established monitoring stations in the area will be used for collecting samples which will be analyzed for physical, chemical and biological oceanographic monitoring with consideration to sediment and thermal plume.

6.2.2.1 Thermal Plume Tracking

PEERSCOM Software will be used for tracking thermal plume in the Oyon Bay. To be more accurate in terms of thermal effluent evolution, trajectory and transport following discharge, dispersion models will be production with consideration to hydrodynamic models that exist in the area. Furthermore, various tidal stages present during a 3-day period and extreme weather events, such as typhoons or other tropical weather disturbances, will also be considered in producing monsoon season models. All the aforementioned will be included in simulating thermal plume dispersion.

6.2.2.2 Surface Current Drift Measurements

A GPS with an echosounder capability coupled with a transducer unit, which is capable of measuring water current speed and path, will be used to monitor water depth, current speed and track in pre-established sampling stations in the area. In addition, the GPS unit that will be used is capable of an Acoustic Doppler Current Profiler (ADCP) sonar to be able to measure the velocity of water current.

A handheld anemometer (pre-calibrate to local conditions) will be used for the purposes of monitoring windspeed and trajectory in each station. Present surface dispersions during each monitoring activity will be correlated with consideration to motion data as influenced by both wind and water. In addition, prevalent tidal conditions during each monitoring activity will be recorded and used in conjunction with information gathered for a more meaningful analysis.

6.2.2.3 Water Column CTD-DO/ TSS/ TDS Profiling

A CTD-Fluorometer-Water Quality unit will be used for vertical stratification to produce vertical profiles of water column within pre-established stations for thermal plume models in Oyon Bay. Water samples will also be collected along various spatial (depth) ranges, which will be gauged by using a digital echosounder. Monitoring activities will be conducted on a monthly basis with consideration of April-May, interim season, for tidal phase and monsoon season monitoring.

6.2.2.4 Sampling Design and Monitoring Stations

Monitoring for current drift measurements, water column profiling and the thermal plume tracking are included in the sampling design that considers monsoon seasons. Likewise, hydrodynamic characteristics and coastal hydraulics proximate to the plant complex are considered in devising the dispersion models. All samples will be collected from the pre-determined monitoring stations (**Table 6-1**) which considers three zones, considering the thermal plume area as found in the model output: a) a0.05 km2 area proximate to the outfall pipe; b) a .9km^2 area that covers the reef area proximate to the outfall area, together with the reef crest and slope areas therein; and c) a 1.9km^2 located outside the reef edge, adjacent the narrow canal between the main barrier reef and the fringing reef southwest of the jetty area (**Figure 6-1**).

Table 6-1: Summary Matrix of Thermal Plume Monitoring Stations

Station Code	N	E
0.05km^2 radius_a	15° 33.577'	119° 55.010'
0.05km^2 radius_b	15° 33.606'	119° 54.957'
0.05km^2 radius_c	15° 33.516'	119° 55.021'
0.05km^2 radius_d	15° 33.561'	119° 54.899'
0.05km^2 radius_e	15° 33.477'	119° 54.972'
0.9km^2 radius_a	15° 33.650'	119° 54.906'
0.9km^2 radius_b	15° 33.465'	119° 55.083'
0.9km^2 radius_c	15° 33.362'	119° 55.006'
0.9km^2 radius_d	15° 33.550'	119° 54.820'
1.9km^2 radius_a	15° 33.664'	119° 54.767'
1.9km^2 radius_b	15° 33.332'	119° 55.125'
1.9km^2 radius_c	15° 33.213'	119° 54.930'
1.9km^2 radius_d	15° 33.347'	119° 54.681'
1.9km^2 radius_e	15° 33.533'	119° 54.584'

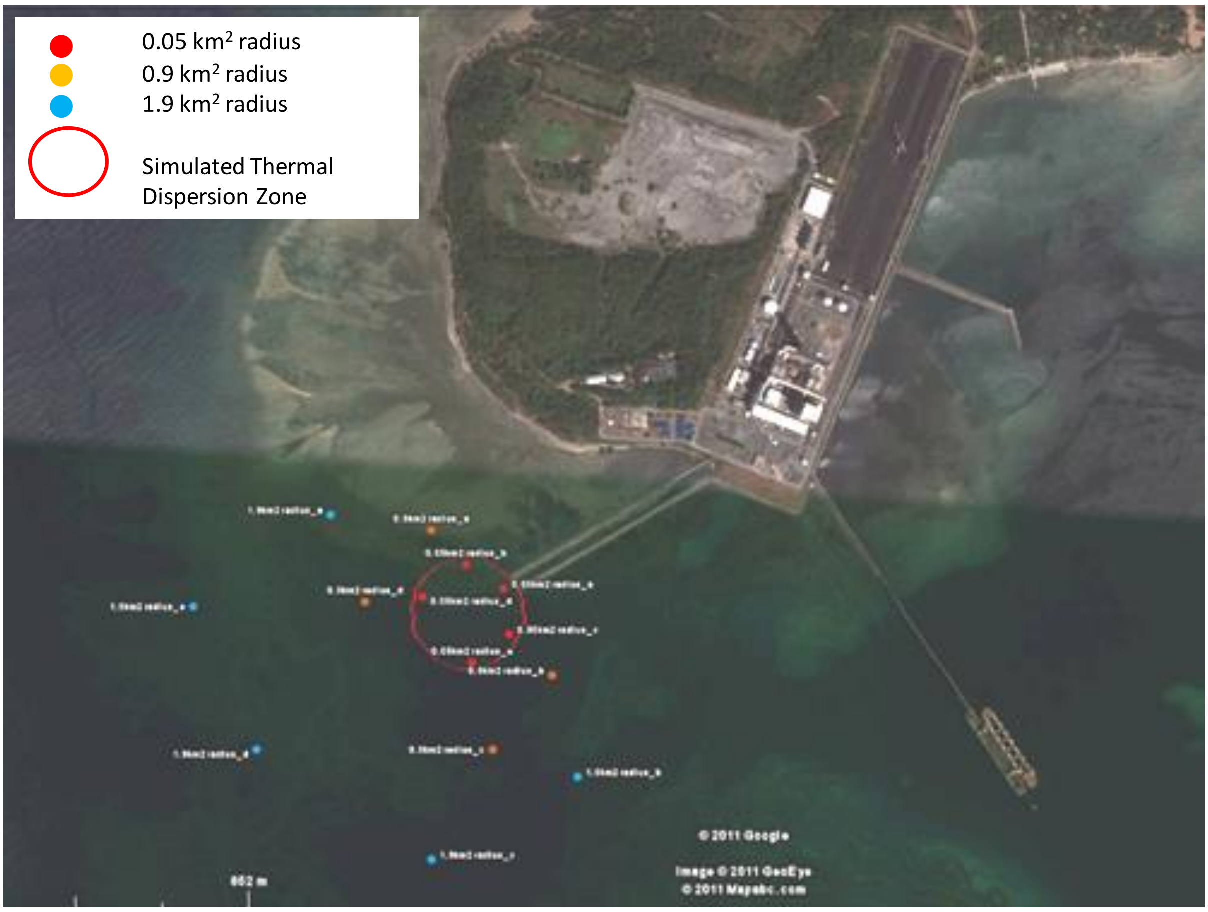


Figure 6-1: Map of Thermal Plume Monitoring Stations

i. Freshwater Ecology

Biannual monitoring (to consider both wet and dry seasons) will be conducted for phytoplankton, zooplankton, benthic organisms, and other aquatic organisms observed within the Lauis River for freshwater ecology. This should also be conducted as part of the water quality monitoring program and its monitoring stations.

6.2.3 Marine Ecology

The suggested sampling design and monitoring activities will reflect the same design in the baseline assessment of the Project. This design will also consider innovations during the conduct of subsequent monitoring activities to enhance the accuracy and realistic presentation of its findings with consideration to Project activities.

The aspects for marine ecology monitoring as stipulated in the Project's Environmental Monitoring Plan is taken into the suggested sampling design (**Table 6-2**and **Figure 6-2**). Monitoring activities is to be conducted quarterly thereafter. General parameters to be monitored will include sediment chemical/nutrient quality, biological parameters, especially dinocysts (**Matsuoka & Fukuyo et. al., 2000**[2]) with reference to determining the species which can cause harmful algal blooms.

Table 6-2: Marine Ecological Monitoring Stations

Station	Coordinates		Location
	Latitude	Longitude	
PZB 01	15°34'6.00"	119°55'45.00"	Adjacent to Coal yard area

[2]Kazumi Matsuoka and Yasuwo Fukuyo. Technical Guide for Modern Dinoflagellate Cyst Study. WESTPAC-HAB/ WESTPAC/IOC. 2000

Station	Coordinates		Location
PZB 02	15°33'43.70"	119°55'45.00"	Between Oyon Point and Powerhouse area
PZB 03	15°33'28.70"	119°55'31.40"	Near Intake area
PZB 04	15°33'30.00"	119°55'0.50"	Discharge or Outfall area
PZB 05	15°34'34.26"	119°54'50.91"	Near Lauis River
SG/SW 01	15°34'17.70"	119°56'1.20"	Near C-Square area
SG/SW 02	15°34'15.60"	119°55'41.20"	Old Gate area
SG/SW 03	15°33'52.30"	119°55'30.40"	Adjacent to Smokestack area
SG/SW 04	15°33'41.70"	119°55'23.60"	Near Intake area
SG/SW 05	15°33'44.30"	119°55'3.90"	Near Bani point
SG/SW 06	15°33'17.30"	119°56'13.20"	Oyon point area
SG/SW 07	15°31'36.30"	119°54'37.60"	San Salvador island area
F&C 01	15°33'30.10"	119°55'27.00"	Near Intake area
F&C 02	15°33'26.60"	119°55'09.40"	Between Intake and Outfall area
F&C 03	15°33'19.20"	119°54'48.00"	Outfall area
F&C 04	15°34'7.30"	119°56'1.70"	Near C-Square area
F&C 05	15°32'30.40"	119°55'31.70"	Near Buoy 7 area
F&C 06	15°33'3.20"	119°56'19.90"	Oyon point area
F&C 07	15°31'40.70"	119°54'37.60"	San Salvador Island area

Figure 6-2: Marine Ecological Monitoring Survey Stations

6.3 The Air

The Masinloc Plant's air quality monitoring program will be adopted for monitoring both ambient and stack emissions of SO_2, NOx, and air particulates (AP). Semi-annual monitoring will be continued for SO_2 and NOx while AP will be monitored quarterly during construction activities and biannually during plant operations. In addition, sampling for noise conditions in five to seven stations around the Project area, with consideration to the locations mentioned in the ambient air quality monitoring section of the report will be conducted quarterly, during the day and during the evening. This will be essential in analyzing the changes brought in the establishment of additional Unit 5 and improvement in Unit 4. Furthermore, this will also enable the verification of calculated emissions and projected ambient ground level concentrations.

For air quality and weather monitoring activities, additional units of the previously installed monitoring devices are recommended to be situated adjacent to the site of Unit 5.

6.4 The People

Continued monitoring of the Proponent's commitments to the communities affected will be done as part of the Proponent's SDP implementation. Concerns of all the stakeholders in the impact communities will be gathered thru the Proponent's IEC and will be handled by the Site Communications Unit of the Plant.

6.5 Status of ECC Compliance

The ECC conditions are being complied based on the MMT and Self-Monitoring Reports (Annex D).

Table 6-6 shows the status of the Proponent's compliance to ECC conditions.

Table 6-3 and **Table 6-4** presents the ambient air quality monitoring and the water quality monitoring programs, respectively, adopted in the Masinloc Plant as stipulated in its 1994 EIS. Furthermore, in consideration to amendments stated in DAO 2003-30, **Table 6-5** presents the Plant's monitoring plan

Table 6-3: Ambient Air Quality Monitoring Program for the Masinloc Plant

Parameters	Method	Frequency	Stations	Remarks
Air Quality				
Air Particulates	High-Volume Sampling (hourly sampling)	Quarterly (during construction) Semi-Annual (during operation)	Barangay Bani, Taltal, Papalyason, Masinloc Town Proper	No monitoring records/documents for construction period Quarterly ambient air quality monitoring conducted at established stations in Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north of the site) Palauig (south of the site), Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020
SO_2 and NO_2	Gas Sampling SO_2 – PRA Method NO_2Griess Saltzman Method	Semi-Annual	Barangay Bani, Taltal, Papalyason, Masinloc Town Proper	Quarterly ambient air quality monitoring conducted at established stations in Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north of the site) Palauig (south of the site), Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020
Stack Sampling SO_2, NO_2 and AP	Continuous Monitoring at the exit			Stack emission monitoring was conducted, Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020
Noise Sampling	Noise Meter	Quarterly (morning and evening)	Five to seven stations around the project site	Quarterly ambient noise monitoring conducted at established stations in Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Barangay Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Barangay Bani, Bani National High School, Barangay Bani, Barangay Bani Multi-purpose Complex and Plant Site (Coal Yard), Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020

Table 6-4:Water Quality Monitoring Program for the Masinloc Plant

Stations	Parameters	Frequency	Remarks
Marine Water Quality			

Stations	Parameters	Frequency	Remarks
Plant Intake Cooling Water Outlet Oyon Bay (1.5 km W of outfall) Oyon Point San Salvador (2 km S of Masinloc Plant)	DO, pH, temperature, turbidity, As, Pb, Hg, Cr, Cd, Cu, Fe salinity, conductivity, temperature, chlorine, As, Pb, Hg, Cr, Cd, Cu, Fe DO, oil and grease, residual chlorine, TSS, TDS, conductivity, As, Pb, Hg, Cr, Cd, Cu, Fe DO, oil and grease, residual chlorine, TSS, TDS, conductivity, As, Pb, Hg, Cr, Cd, Cu, Fe	Semi-Annual Semi-Annual Semi-Annual Semi-Annual	Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020, 12 stations were monitored: M1-Between Lauis River and Bani Point M2-Outfall (100 m from discharge canal) M3-Cooling Water Intake M4-Resettlement in Barangay Taltal M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity M6-Front of Puerto Asinan Resort in Barangay Baloganon M7-Benguet Wharf in Barangay Baloganon; with mining activity M8-Near the mouth of Masinloc River M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor) M10-Between fish cages in Barangay Banban; BFAR station M11-Near San Salvador Island M12-Near Magalawa Island, Palauig; along Veritas
Groundwater Monitoring	As, Pb, Hg, Cr, Cd, Cu, SO_4, oil and grease, total hardness, pH, salinity, conductivity	Semi-Annual	Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020, Eleven areas were identified as sampling stations to monitor the following: pH, conductivity, turbidity, dissolved oxygen, salinity, temperature and total suspended solids, aluminum, antimony, arsenic, calcium, cadmium, chromium, hexavalent chromium, copper, iron, lead, lithium, magnesium, manganese, nickel, potassium, selenium, silver, sodium, vanadium and zinc. All parameters were compliant with DENR standards
Rainwater	As, Pb, Hg, Cr, Cd, Cu, SO_4, pH, carbonates, nitrates	Semi-Annual	No reports on rainwater monitoring
Plant Effluents Condenser Outlet Wastewater Treatment Plant Ash Pond (ASF) Outlet of Oil and Water Separator	 temperature, pH, residual chlorine, conductivity temperature, pH, conductivity temperature, pH, TSS, TDS oil and grease	 Semi-Annual Semi-Annual Semi-Annual Semi-Annual	Quarterly MMT Reports from 2016 to 2020 and SMRs from 2016 to 2020, The effluents originating from different facilities, such as the Wastewater Treatment Facility (WTF), Coal Sedimentation Basin (CSB), Ash Sedimentation Basin (ASB), Cooling Water Discharge Canal (CWDC), and Storm Drain Canal (SDC) were monitored from the period 2003 to 2009. Parameters considered were: pH, temperature, conductivity, salinity, DO, BOD, oil and grease, TSS, turbidity, TDS, aluminum, antimony, arsenic, cadmium, calcium, chromium (total), chromium (hexavalent), copper, gold, iron, lead, lithium, magnesium, manganese, mercury, nickel, phenols,

Stations	Parameters	Frequency	Remarks
			potassium, selenium, silver, sodium, sulfate, vanadium and zinc

Table 6-5: Summary Matrix of Environmental Monitoring Plan and Environmental Quality Performance Level

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
Construction/Pre -Operations Phase													
Land													
Terrestrial Flora and Fauna	Clearing of vegetation in planned areas of construction Removal of vegetation would decrease habitat of small fauna and decrease food source (for seed-eaters, insectivores)		Visual observation only	Semi-annual for every year of construction		MPPCL/3 rd party	300,000			-			
Water													
	Freshwater (River)	DO	Water quality checker (ion probe), AAS method	Quarterly	LR-1 (Upstream of the freshwater intake) and LR-2 (Near the river mouth/nursery), MR-1 (Under Collat Bridge)	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	
		BOD						75%	90%	5.0 mg/L		IEC	
		Temperature						75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Copper						75%	90%	0.05 mg/L		IEC	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater	pH	Water quality checker (ion probe), AAS method		Established groundwater monitoring wells					-			
		SO_4								-			
		Conductivity								-			
		Salinity								-			
		Hardness								-			
		Metals								-			
	Plant Effluents												
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH						75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	
		Cr^{+6}						75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature		Weekly	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling water discharge canal/condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e. low tide, high tide)	Construction sites within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water	Deterioration of	DO	Gravimetric	Monthly	M1-Between Lauis	MPPCL/		75%	90%	5.0 mg/L		3*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Quality	water quality due to construction activities Oil spill	TSS	method; *in-situ*		River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas	MMT		75%	90%	Not more than 30 mg/L increase		1*	
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	
		Cadmium						75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to construction activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Fluorometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)		MPPCL/ MMT/ 3rd party	2,000,000						
Air													
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement),	MPPCL/	400,000	75%	90%	340 μg/NCM		4*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Ambient NO_2	Griess Saltzman for NO_2		Barangay Inhobol, Candelaria (north of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation	MMT		75%	90%	260 µg/NCM		5*	
		Ambient TSP	High Volume sampling for particulates B and K instruments					75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square. (Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)			75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
Operations Phase													
Land													
Ash Storage Facility	Soil contamination	Arsenic	Heavy metal analysis	Quarterly	Ash Storage Facility	MPPCL/ MMT	50,000	75%	90%	5 ppm***		7*	
		Cadmium						75%	90%	5 ppm***		7*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Chromium						75%	90%	5 ppm***		7*	
		Lead						75%	90%	5 ppm***		7*	
		Mercury						75%	90%	0.2 ppm***		7*	
Terrestrial Flora and Fauna	SOx gas emission on plants would catalyze growth of plants since sulfur is a macronutrient that is a component of amino acids and proteins which would increase the tolerance of plants to drought. High concentration of SOx when absorbed by the plant would damage the plant tissues / disrupt plant growth Noise and emissions would disrupt daily routines of fauna especially during feeding time	Visual observation of sulfur – related symptoms of diseases in plants such as Dwarfing; Stunted growth; General chlorosis for young and mature leaves Presence / absence of endangered species	Tissue analysis of selected plants located around the power plant Pay particular attention to populations of endangered species (flora and fauna) Sampling of permanent plots for both flora and fauna	Twice a year until project completion or termination	Established Sampling Points	MPPCL/ 3rd party	750,000			-			
	Agricultural productivity (Rice and Mango)	Yield, soil pH, organic matter, Phosphorus, and Potassium	Yield measurement, soil sampling and analysis	Yearly for the 1st 2 yrs then every five years	Masinloc and Candelaria	MPPCL/ MMT/ Municipal Agriculture Office	150,000						
Water													
	Freshwater (River)	DO	Water quality checker (ion probe),	Quarterly	LR-1 (Upstream of the freshwater	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		BOD	AAS method		intake) and LR-2 (Near the river mouth/nursery), MR-1 (Under Collat Bridge)			75%	90%	5.0 mg/L		IEC	
		Temperature						75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater contamination	pH	Water quality checker (ion probe), AAS method		Established groundwater monitoring wells					-		7*	
		SO_4								-		7*	
		Conductivity								-		7*	
		Salinity								-		7*	
		Hardness								-		7*	
		Arsenic						75%	90%	0.1 ppm****		7*	
		Cadmium						75%	90%	0.003 ppm****		7*	
		Chromium						75%	90%	0.05 ppm****		7*	
		Lead						75%	90%	0.01 ppm****		7*	
		Mercury						75%	90%	0.001 ppm****		7*	
	Plant Effluents												

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH		Quarterly Weekly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal Sedimentation, Oil-water separator			75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	
		Cr+6						75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling Water Discharge Canal/Condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e., low tide, high tide)	Facilities within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Monthly	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-	MPPCL/ MMT		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		Salinity								-			

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Conductivity			Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas					-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		1*	
		Arsenic						75%	90%	0.5 mg/L		1*	
		Cadmium						75%	90%	0.1 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.2 mg/L		1*	
		Lead						75%	90%	0.5mg/L		1*	
		Total Mercury						75%	90%	0.005 mg/L		1*	
		Oil and grease						75%	90%	10.0 mg/L		1*	
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to operation activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Fluorometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)		MPPCL/ MMT/ 3rd party	2,000,000			-			
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north	MPPCL/ MMT	400,000	75%	90%	340 μg/NCM		4*	
		Ambient NO_2	Griess Saltzman for NO_2					75%	90%	260 μg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Ambient TSP	High Volume sampling for particulates B and K instruments		of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation			75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)	MPPCL/ MMT		75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
	Stack Emissions	SO_2 Emission	Pararosaniline for SO_2	Continuous stack emission monitoring/	Boiler	MPPCL/ 3rd party	1,000,000	75%	90%	700 mg/NCM		4*	
		NO_2 Emission	Griess Saltzman for NO_2					75%	90%	1,000 mg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan: Method	Frequency	Location	Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme: EQPL Range: Alert	Action	Limit	Management Measure: Alert	Action	Limit
		TSP Emission	High Volume sampling for particulates B and K instruments	Quarterly reporting				75%	90%	200 mg/NCM		1*	
People													
	Health and Socio-economic	As stated in the Memorandum of Agreement (MOA)	Monitor existing socio-economic projects and identify strengths and weaknesses	Quarterly	Affected barangays and on-going projects	MPPCL	500,000			-			
			Evaluation of accomplishment/ performance	Annually									
Abandonment Phase													
Land													
Terrestrial Flora and Fauna	Establishing vegetative cover in the area	Number of planted seedlings % survival % mortality No. of seedlings produced	Sampling technique could be used for monitoring of plant survival and presence / absence of fauna species	One year until complete conversion		MPPCL	250,000			-			
Water													
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Quarterly for one-year duration	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front	MPPCL		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		TDS								-			
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmental Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Cadmium			of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas			75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Copper						75%	90%	0.05 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Nutrients										1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
People	Sustainability of socio-economic projects	Number of socio-economic projects that are still operating either sustained by community organizations/cooperatives or supported by LGUs and others	Monitor and evaluate outcome of projects and programs annually	One year	Barangays affected	MPPCL	500,000						
		Network and linkages established internally and externally/decreased dependency from proponent	Review operations /capacity of existing network organized	Semi-annually for one year	Barangays affected								

Legend:

IEC – Information Education Campaign

1* - Maintenance of pollution control equipment and increase frequency of monitoring

2* - Derate the plant

3* - Provide LGU with the test results

4* - Coal blending/Derate the plant/Procurement of low Sulfur content
5* - Operation/Calibration of over fire control dampers
6* - Maintenance of plant buildings/equipment
7* - Install lining
***For Soil Contamination: Heavy metals to be monitored:

Arsenic	= 5ppm
Cadmium	= 5ppm
Chromium	= 5ppm
Lead	= 5ppm
Mercury	= 0.2ppm

Note: Limits as per RA6969

****For Groundwater Contamination: Heavy metals to be monitored:

Arsenic	= 0.1ppm
Cadmium	= 0.003ppm
Chromium	= 0.05ppm
Lead	= 0.01ppm
Mercury	= 0.001ppm

Note: there is no DENR limit for groundwater, above limits were as per PNSDW for comparison purposes and test results are also compared to the baseline data

Table 6-6: Status of ECC Compliance

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
I. Environmental Management All commitments, mitigating measures and monitoring requirements, contained in the Environmental Performance Report and Management Plan (EPRMP) for the proposed Masinloc Power Plant Expansion Project, particularly in the Environmental Management and Monitoring Plan (EMMoP), including the modifications and additional information as approved by the EMB, shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:			
1. Conduct an effective Information, Education and Communication (IEC) Program to inform and educate all stakeholders, especially its contractors, workers, and local residents about the mitigating measures embodied in its EPRMP, the conditions stipulated in this Certificate and the environmental	Complied		Continuous and routine activities by the plant. Below were the IEC/Consultation/Meetings that were conducted by the plant: 1. Meeting re: Implementation of MPPCL's Reading Enhancement Program 2. Values Formation and Starting-up Sustainable Mango Production Training 3. Principal Orientation's re-equip in Reading Literacy Program

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
and human safety features of the project for greater awareness, understanding and sustained acceptance of the project;			4. Courtesy Call and Coordination Meeting re: Site Development of Masinloc Plant's Unit 4 5. Canopy Development Training (Mango Production) 6. Coordination re: Donation of alcohol and canned goods to Masinloc LGU 7. Barangay Coordination Meeting re: COVID-19 Prevention 8. Coordination re: DOE advisory - Rationalizing the Utilization of the ER 1-94 Funds by the Host LGUs in Response to Covid-19 Public Health Emergency 9. Coordination re: Donation of dressed chicken for the relief operations of Masinloc LGU 10.Coordination re: Donation of PPEs 11.CER1-94 Discussion with SMCGP Foundation 12. Coordination re: Request for Relief Goods 13. Coordination re: 1st Qtr ER1-94 Funds Remittance 14. Coordination re: Requested chicken for relief operations 15. Online Meeting re EQUIP in Reading Program 16. Coordination Meeting re Reading Proficiency Program in Masinloc
2. Implement a Comprehensive	Complied		Continuous and routine activities by the plant. Below were the SDPs implemented

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
Social Development Program (SDP) and submit a report on a regular basis immediately upon the implementation of the SDP;			by the plant: 1. Educational Programs Scholarship Program for SY 2019 - 2020 Tulong Dunong Program Educational Assistance for IPs Reading Proficiency Program Teacher's Assessment Principal Orientation 2. Livelihood Program a.) Capacity building of mango growers and rehabilitation of less productive carabao mango trees in Masinloc, Zambales (year 1) b.) Values formation and start up of sustainable mango production training in Masinloc, Zambales c.) Establishments of demonstration farms e.) Canopy Development Training 3. Environment Program R. I. S. E. for waste (Inter School Recycling Competition) Establishment of mangrove plantation Giant Clams Restocking 4. Malasakit Program Relief Packs Distribution Donation of Alcohol Donation of Relief Goods Donation of PPE Other Charitable Donations 5. Community Development Access to Energy Regulation (ER) 1-94
3. Establish appropriate measures and buffer and thermal buffer zones along the entire periphery of the project site with appropriate the condition of the	Complied		The plant has established buffer zones planted with the following tree species: 1. Bagras 2. Mahogany 3. Rain Tree 4. Maalibangbang 5. Eucalyptus

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
ecosystems and to serve as noise, vibration and dust buffers;			6. Aure 7. Mangium 8. Gmelina 9. Fire Tree 10. Fruit Trees. 11. Enhancement planting at mangrove plantation, by planting additional 1,000 propagules 12. Planted 3,000 forest and ornamental trees at the Ash Storage Facility.
4. Conduct validation of air dispersion and thermal plume modeling within one year from the start of project operation and submit result of the same to EMB central office	Complied		
5. Establishment of groundwater monitoring wells between the water body and the ash pond.	Complied		
6. Establishment of a reforestation and carbon sink program using endemic/indigenous species to mitigate greenhouse gases (GHG) emissions of the project in line with the DENR's thrust for GHG emission reduction programs to control and maintain emissions within the allowable standards. The program shall be submitted to EMB within six months prior to the project	Complied		MPPCL Ridge to Reef Conservation Program The 117-hectare established upland plantation in Lauis, Candelaria is continuously being maintained by 60 members of working group of Pinagkaisang Samahang Magsasaka/Mangingisda Multi-Purpose Coop. and Pinagrealan/ Lauis Upland Farmers Association. As of December 15, 2017, the upland plantation achieved 92% percent survival. The 8 percent mortality was due to pest and diseases. On the other hand, the

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
operation.			maintenance of existing 150-hectare upland plantation in Sta. Rita, Masinloc under ICRMP project achieved 95 % survival rate. Material Recovery Facility and Plastic Waste Recycling Plant SMCGP Power Foundation initiated the project entitled Community–Based Material Recovery Facility and Plastic Waste Recycling Plant to help address the continuing dilemma on plastic wastes in the province of Zambales, in partnership with Envirotech Waste Recycling Inc. (EWRI).
7. Establishment of measures to control and maintain emissions within the allowable standards	Complied		Use of low sulfur fuel oil and coal. Two stage combustion method. Use of efficient electrostatic precipitators. Adoption of 150 meters high stack. Use of flue gas desulfurization plant.
8. Conduct of detailed studies on the extent of impact of coal and ash deposition in the coral reefs and associated fauna brought about by the operation of the Power Plant prior to project implementatio	Complied		
9. Rehabilitation of nearby coral reefs to replace the marine habitats destroyed due to the operation of the Power Plant prior to project implementation	Complied		

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
10. Regular monitoring to establish reliable trending of the parameters monitored both temporal and spatial, the results of which should be presented to the MOBMR Management Board	Complied		Monitoring by third party with representatives from the local LGU. Monitored species: 1.Temporal 2. spatial – 7 stations for corals, 7 stations for seaweeds & seagras7 stations for /fish, 5 stations for benthos/zooplankton & phytoplankton
General Conditions			
11. The plant operations shall conform with the provisions of RA 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990), RA 8749 (Philippine Clear Air Act of 1999), RA 9003 (Ecological Solid Waste Management Act of 2000), and RA 9275 (Philippine Clean Water Act of 2004) and other relevant policies, rules and regulations	Complied		The plant has valid permits for the ff: 1.Permit to Operate Air Pollution Source and Control Facilities. 2. Discharge Permits. 3. MPPCL was issued with the Waste Generator Registration Certificate ID: No. GR-R3-71-00039, on 03 January 2017, issued by DENR EMB Region 3 Office.
12. The existing Memorandum of Agreement (MOA) on the Environmental Guarantee Fund (EGF), Environmental Monitoring Fund (EMF), and Multipartite Monitoring Team (MMT) shall be amended to include the expansion and inclusion of other relevant stakeholders such as the Department of Energy (DOE). The amended MOA shall be submitted to EMB for approval within sixty (60) days upon	Complied		MPPCL MMT is working and is to continue functioning with the following applicable & required />Funds: 1.Established EGF – Php 8M trust fund and Php 2M cash fund. 2.Approved EMF = Php 881,000.0

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
receipt of this Certificate			
13. Creation of an Environmental Unit (EU) to completely handle all the environment related aspects of the existing project and its expansion in addition to the monitoring requirements as specified in the Environmental Monitoring and Management Plan (EMMoP). The EU shall: a. Monitor actual project impacts vis-à-vis the predicted impacts and management measures in the EPRMP; b. Formulate suggestions on the revision of the EMMoP, whenever necessary, subject to the approval of EMB Central Office and EMB Region III; and c. Ensure that data gathered during monitoring activities are properly documented, assessed, evaluated, and reported in accordance with the standard formats	Complied		Environment Health and Safety is composed of two Environmental Management Specialist/PCO, two Safety Officers and a Team Leader personnel with relevant trainings as required by Environmental laws and other requirements. Monitoring of plant impacts/predicted impacts are monitored on a daily/quarterly bases by Environmental personnel/MMT, respectively. Results of monitoring activities are documented, assessed and evaluated in accordance with the CMVR formats.
14. The proponent shall submit a revised ERA considering the combined risks and hazards arising from the existing and proposed project including the overall management approach to mitigate and/or control those risk	Complied		

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
within 30 days upon issuance of this certificate.			
15. The proponent shall submit HAZOP study for the hydrogen cooling systems for its generator considering the existing and proposed project within thirty (30) days upon the issuance of this certificate	Complied		
16. The proponent shall plant 100 indigenous seedlings as a replacement for every naturally grown tree cut, and shall be maintained for up to three (3) years, with a survival rate of at least 80 %	Complied		The plant, through its Foundation, has entered into a MOA re Ridge to reef Project between DENR and four (4) non-stock, non-profit organizations from Masinloc and Candelaria whose objectives are to establish environmental awareness and community support for environmental protection initiatives through reforestation and riverbanks rehabilitation. MOA has three year term commencing from the signing date
17. The proponent shall ensure that its contractors and subcontractors properly comply with the relevant conditions of this Certificate.	Complied		All contractors/subcontractors/ visitors undergo safety &environmental orientation before they can be allowed to perform work/visit to the plant. Each contractors after completion of their contracted services are evaluated as to its performance based on technical, safety and environmental aspects. Good performers are rewarded.
Restrictions			
18. No cutting of trees whether naturally grown or plantation	Complied		Cutting permits were and will be secured from relevant government entities prior to cutting of trees.

ECC Conditions	Status		
	Complied	To be Complied	For Continuing Compliance
species unless a cutting permit has been secured from the DENR			
19. In case of transfer of ownership of this project, these same conditions and restrictions shall apply, and the transferee shall be required to notify the EMB within fifteen (15) days.	Complied		To be complied once there will be new owner of the of the project

7 EMERGENCY RESPONSE POLICY AND GENERIC GUIDELINES

The Emergency Response and Contingency Plan (ERCP) was reviewed and revised as part of the company's Integrated Management System. The objectives of the plan are as follows:

- Identify potential emergency situations and potential accidents in Masinloc Power Partners Company Ltd. (MPPCL) that can have an impact to the health and safety of personnel and/or to the environment
- Ensure that MPPCL could effectively respond to actual emergency situations and accidents and prevent or associated adverse occupational health and safety (OH&S) consequences and environmental impacts
- Define the method to be followed and to identify the elements to be used in the event of on-site and/or off-site emergencies involving any MPPCL facilities
- Address all aspects of both real and potential situations, which may occur on-site and/or off-site
- Provide the information for safe and successful participation in the required action to prepare for, and effectively manage, all incidents that constitute an emergency under this plan
- Effectively minimize the effects and consequences from emergency incidents by ensuring the associated risks and impacts are suitably identified, managed, controlled, and kept to a minimum in as professional manner as possible

The following systems and procedures are currently being implemented by the Proponent:

- AES Masinloc Safety Management System
- B2 Incident Reporting and Investigation Program
- C3 PPE
- C7 Risk Assessment Procedure
- C11 Safety Committee Procedure
- C14 Emergency Response & Contingency Plan
- C25 Medical Surveillance Guideline for MPPCL
- Emergency Response Procedure for Tsunami

The Occupational Health and Safety Guidelines and updated ERCP are appended as **Annex I**.

8 ABANDONMENT/DECOMMISSIONING / REHABILITATION POLICIES AND GENERIC GUIDELINES

Project abandonment is an unlikely option at this point since there is a pressing need for the Project and that sufficient supply of electricity is needed in the Philippines. Nevertheless, the following is an abandonment framework that will be implemented by the Proponent.

After the expected service life of the Project, parts that are determined to be serviceable will be salvaged for use as replacement parts at the other units of the Proponent. The generating units may be replaced with new units to continue power generation. Otherwise, the major structures will be dismantled and the area may be re-developed according to alternative land uses for the site. The major activities will include removal of all buildings, structures, plant fixtures, equipment and any other works (including roads, foundations and other made up surfaces). The Proponent will ensure minimal damage that may be caused by removal of the facilities. An audit of hazardous wastes and environmental site assessment (ESA) will be conducted to account for proper disposal and site treatment, if such will be required. The Proponent will leave the site in a secure, clean and tidy condition and will ensure that the site is enclosed by a secure boundary structure.

It is estimated that total abandonment costs would be approximately PhP 440 MM for concrete removal and civil works. These costs can be funded by the selling of scrap metal from the Project. Annual environmental monitoring would cost PhP 4.0 MM per year which is based on the costs of current monitoring activities.

As required by the DENR (DAO 2003-30), a detailed decommissioning or abandonment plan will be developed one year prior to the end of the Project operating life.

8.1 The People

The commitments of the Proponent to the impact communities shall be monitored through the implementation of their SDP. The IEC shall serve as the feedback mechanism with the Site Communications Unit at the Masinloc Plant, who will be the focal persons to address the concerns and issues of various stakeholders of affected communities.

8.2 Status of ECC Compliance

The ECC conditions are being complied based on the MMT and Self-Monitoring Reports (Annex D).

The status of MPPCL's compliance with the ECC conditions is presented in .

The ambient air quality monitoring program and the water quality monitoring program of the Masinloc Plant included in the 1994 EIS are shown in **Annex D** and **Annex G**, respectively. The "Remarks" column was added to indicate how the monitoring programs were implemented. The monitoring plan was also updated following the protocols of DAO 2003-30 and presented as **Table 6-5** in the submitted Draft EPRMP.

Table 8-1: Summary Matrix of Environmental Monitoring Plan and Environmental Quality Performance Level

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Construction/Pre -Operations Phase													
Land													
Terrestrial Flora and Fauna	Clearing of vegetation in planned areas of construction Removal of vegetation would decrease habitat of small fauna and decrease food source (for seed-eaters, insectivores)		Visual observation only	Semi-annual for every year of construction		MPPCL/3[rd] party	300,000			-			
Water													
	Freshwater (River)	DO	Water quality checker (ion probe), AAS method	Quarterly	LR-1 (Upstream of the freshwater intake) and LR-2 (Near the river mouth/nursery), MR-1 (Under Collat Bridge)	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	
		BOD						75%	90%	5.0 mg/L		IEC	
		Temperature						75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Copper						75%	90%	0.05 mg/L		IEC	
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater	pH	Water quality		Established					-			

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan: Method	Frequency	Location	Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme: EQPL Range: Alert	Action	Limit	Management Measure: Alert	Action	Limit
		SO_4	checker (ion probe), AAS method		groundwater monitoring wells					-			
		Conductivity								-			
		Salinity								-			
		Hardness								-			
		Metals								-			
	Plant Effluents												
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH						75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	
		Cr^{+6}						75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature		Weekly	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling water discharge canal/condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e. low tide, high tide)	Construction sites within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water Quality	Deterioration of water quality due to construction activities	DO	Gravimetric method; *in-situ*	Monthly	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal),	MPPCL/ MMT		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
	Oil spill	Salinity			M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas					-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	
		Cadmium						75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to construction activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Flourometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)		MPPCL/ MMT/ 3rd party	2,000,000						
Air													
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north	MPPCL/ MMT	400,000	75%	90%	340 µg/NCM		4*	
		Ambient NO_2	Griess Saltzman for NO_2					75%	90%	260 µg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
		Ambient TSP	High Volume sampling for particulates B and K instruments		of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation			75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)			75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
Operations Phase													
Land													
Ash Storage Facility	Soil contamination	Arsenic	Heavy metal analysis	Quarterly	Ash Storage Facility	MPPCL/ MMT	50,000	75%	90%	5 ppm***		7*	
		Cadmium						75%	90%	5 ppm***		7*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Chromium						75%	90%	5 ppm***		7*	
		Lead						75%	90%	5 ppm***		7*	
		Mercury						75%	90%	0.2 ppm***		7*	
Terrestrial Flora and Fauna	SOx gas emission on plants would catalyze growth of plants since sulfur is a macronutrient that is a component of amino acids and proteins which would increase the tolerance of plants to drought. High concentration of SOx when absorbed by the plant would damage the plant tissues / disrupt plant growth Noise and emissions would disrupt daily routines of fauna especially during feeding time	Visual observation of sulfur – related symptoms of diseases in plants such as Dwarfing; Stunted growth; General chlorosis for young and mature leaves Presence / absence of endangered species	Tissue analysis of selected plants located around the power plant Pay particular attention to populations of endangered species (flora and fauna) Sampling of permanent plots for both flora and fauna	Twice a year until project completion or termination	Established Sampling Points	MPPCL/ 3rd party	750,000			-			
	Agricultural productivity (Rice and Mango)	Yield, soil pH, organic matter, Phosphorus, and Potassium	Yield measurement, soil sampling and analysis	Yearly for the 1st 2 yrs then every five years	Masinloc and Candelaria	MPPCL/ MMT/ Municipal Agriculture Office	150,000						
Water													
	Freshwater (River)	DO	Water quality checker (ion probe),	Quarterly	LR-1 (Upstream of the freshwater	MPPCL/ MMT	600,000	75%	90%	5.0 mg/L (min)		IEC	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		BOD	AAS method		intake) and LR-2 (Near the river mouth/nursery), MR-1 (Under Collat Bridge)			75%	90%	5.0 mg/L		IEC	
		Temperature						75%	90%	3°C (max. rise)		IEC	
		Solids						75%	90%	Not more than 30 mg/L increase		IEC	
		Arsenic						75%	90%	0.05 mg/L		IEC	
		Cadmium						75%	90%	0.01 mg/L		IEC	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		IEC	
		Lead						75%	90%	0.05 mg/L		IEC	
		Total Mercury						75%	90%	0.002 mg/L		IEC	
	Sediments	Metals	Gravimetric Method							-			
	Groundwater contamination	pH	Water quality checker (ion probe), AAS method		Established groundwater monitoring wells					-		7*	
		SO_4								-		7*	
		Conductivity								-		7*	
		Salinity								-		7*	
		Hardness								-		7*	
		Arsenic						75%	90%	0.1 ppm****		7*	
		Cadmium						75%	90%	0.003 ppm****		7*	
		Chromium						75%	90%	0.05 ppm****		7*	
		Lead						75%	90%	0.01 ppm****		7*	
		Mercury						75%	90%	0.001 ppm****		7*	
	Plant Effluents												

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan: Method	Sampling and Measurement Plan: Frequency	Sampling and Measurement Plan: Location	Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme: EQPL Range: Alert	EQPL Range: Action	EQPL Range: Limit	Management Measure: Alert	Management Measure: Action	Management Measure: Limit
		Oil and grease		Quarterly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal sed. Basin			75%	90%	10.0 mg/L		1*	
		pH		Quarterly Weekly	Ash Neutralization Basin, WWT Facility, Discharge Canal, Coal Sedimentatiion Oil-water separator			75%	90%	6.0-9.0		1*	
		Ar						75%	90%	0.5mg/L		1*	
		Cd						75%	90%	0.1 mg/L		1*	
		Cr+6						75%	90%	0.2 mg/L		1*	
		Hg						75%	90%	0.005 mg/L		1*	
		Pb						75%	90%	0.5 mg/L		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Mixing zone			75%	90%	3°C (max. rise)		2*	
		Temperature		Daily	Cooling Water Discharge Canal/Condenser Outlet			75%	90%	3°C (max. rise)		2*	
Oceanography	Circulation of water due to physical barriers/ barges/ dikes and floating sediment curtains	Water current speed and direction	Drift measurements, Water column profiling Dispersion and Thermal Plume modeling	Monthly (tidal phases; i.e., low tide, high tide)	Facilities within marine environment Thermal Plume Monitoring Stations (Outfall pipe area-refer to **Table 6-1**)	MPPCL/ 3rd party				-			
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Monthly	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-	MPPCL/ MMT		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		Salinity								-			

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Conductivity			Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas					-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		1*	
		Arsenic						75%	90%	0.5 mg/L		1*	
		Cadmium						75%	90%	0.1 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.2 mg/L		1*	
		Lead						75%	90%	0.5mg/L		1*	
		Total Mercury						75%	90%	0.005 mg/L		1*	
		Oil and grease						75%	90%	10.0 mg/L		1*	
Marine Ecology	Sedimentation and habitat destruction, tensile physical stress due to operation activities Risk of oil spill and deterioration of water quality	Corals, Reef Fish, Phytoplankton, Zooplankton, Ichthyoplankton, Soft bottom fauna, Seagrass, Seaweeds, Mangroves, Fisheries assessment and productivity, Marine mammals, birds and invertebrates	LIT, FVC, Biological Oceanography (net sampling, CTD profiling, Flourometer), Core sampling, Saito-Atobe, Strip sampling, Catch and market survey, Ocular surveys	Quarterly (with preference to monsoon season and tidal phases)		MPPCL/ MMT/ 3rd party	2,000,000			-			
Ambient Air Quality	Air pollution	Ambient SO_2	Pararosaniline for SO_2	Quarterly	Barangay Bani (Resettlement), Barangay Inhobol, Candelaria (north	MPPCL/ MMT	400,000	75%	90%	340 µg/NCM		4*	
		Ambient NO_2	Griess Saltzman for NO_2					75%	90%	260 µg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Ambient TSP	High Volume sampling for particulates B and K instruments		of the site) Palauig (south of the site) and additional site/s (if necessary) upon model validation			75%	90%	300 µg/NCM		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	Ambient Noise	Sound pressure level		Quarterly	Purok Little Baguio (Junction), Purok Percaloha (Junction), Edillor's Residence (150 m from Gate), EPDC Building, C-Square.(Benguet Loading Area), Resettlement Site, Highway, waiting shed of Resettlement, Puerto Asinan, Sitio Atob, Purok Tanguile, Masinloc Town Plaza, Bani National High School (Annex), Taltal, Brgy. Lauis (Junction to Binabalian), Lauis Elementary School, Purok Bangal-Duhok (Junction), Bani Elementary School, Brgy. Bani, Bani National High School, Brgy. Bani, Brgy. Bani Multi-purpose Complex and Plant Site (Coal Yard)	MPPCL/ MMT		75%	90%	50-65 dbA - Class C (Light Industrial Areas)		6*	
	Stack Emissions	SO_2 Emission	Pararosaniline for SO_2	Continuous stack emission monitoring/	Boiler	MPPCL/ 3rd party	1,000,000	75%	90%	700 mg/NCM		4*	
		NO_2 Emission	Griess Saltzman for NO_2					75%	90%	1,000 mg/NCM		5*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
		TSP Emission	High Volume sampling for particulates B and K instruments	Quarterly reporting				75%	90%	200 mg/NCM		1*	
People													
	Health and Socio-economic	As stated in the Memorandum of Agreement (MOA)	Monitor existing socio-economic projects and identify strengths and weaknesses	Quarterly	Affected barangays and on-going projects	MPPCL	500,000			-			
			Evaluation of accomplishment/ performance	Annually									
Abandonment Phase													
Land													
Terrestrial Flora and Fauna	Establishing vegetative cover in the area	Number of planted seedlings % survival % mortality No. of seedlings produced	Sampling technique could be used for monitoring of plant survival and presence / absence of fauna species	One year until complete conversion		MPPCL	250,000			-			
Water													
Marine Water Quality	Deterioration of water quality due to operation activities Oil spill	DO	Gravimetric method; *in-situ*	Quarterly for one year duration	M1-Between Lauis River and Bani Point, M2-Outfall (100 m from discharge canal), M3-Cooling Water Intake, M4-Resettlement in Barangay Taltal, M5-C-Square in Barangay Bani; Benguet Loading Area for mining activity, M6-Front	MPPCL		75%	90%	5.0 mg/L		3*	
		TSS						75%	90%	Not more than 30 mg/L increase		1*	
		TDS								-			
		Salinity								-			
		Conductivity								-			
		pH						75%	90%	6.0-8.5		1*	
		Temperature						75%	90%	3°C (max. rise)		2*	
		Arsenic						75%	90%	0.05 mg/L		1*	

Key Environmental Aspects per Project Phase	Potential Impacts per Environmen-tal Sector	Parameter to be Monitored	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost (PhP)	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
		Cadmium			of Puerto Asinan Resort in Barangay Baloganon, M7-Benguet Wharf in Barangay Baloganon, M8-Near the mouth of Masinloc River, M9-Near the fish port in Purok Matalbis, Barangay Inhobol; Petron (harbor), M10-Between fish cages in Barangay Banban; BFAR station, M11-Near San Salvador Island, and M12-Near Magalawa Island, Palauig; along Veritas			75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Copper						75%	90%	0.05 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Nutrients										1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
People	Sustainability of socio-economic projects	Number of socio-economic projects that are still operating either sustained by community organizations/cooperatives or supported by LGUs and others	Monitor and evaluate outcome of projects and programs annually	One year	Barangays affected	MPPCL	500,000						
		Network and linkages established internally and externally/decreased dependency from proponent	Review operations /capacity of existing network organized	Semi-annually for one year	Barangays affected								
Key Environmental	Potential Impacts	Parameter to be Monitored	Sampling and Measurement Plan			Lead	Annual	EQPL Management Scheme					

			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
Operations Phase													
People													
	Health and Socio-economic	As stated in the Memorandum of Agreement (MOA)	Monitor existing socio-economic projects and identify strengths and weaknesses	Quarterly	Affected barangays and on-going projects	MPPCL	500,000			-			
			Evaluation of accomplishment/ performance	Annually									
		Cadmium						75%	90%	0.01 mg/L		1*	
		Chromium (hexavalent)						75%	90%	0.1 mg/L		1*	
		Copper						75%	90%	0.05 mg/L		1*	
		Lead						75%	90%	0.05 mg/L		1*	
		Total Mercury						75%	90%	0.002 mg/L		1*	
		Nutrients										1*	
		Oil and grease						75%	90%	3.0 mg/L		1*	
People	Sustainability of socio-economic projects	Number of socio-economic projects that are still operating either sustained by community organizations/cooperatives or supported by LGUs and others	Monitor and evaluate outcome of projects and programs annually	One year	Barangays affected	MPPCL	500,000						
		Network and linkages established internally and externally/decreased dependency from proponent	Review operations /capacity of existing network organized	Semi-annually for one year	Barangays affected								

Legend:

IEC – Information Education Campaign

1* - Maintenance of pollution control equipment and increase frequency of monitoring

2* - Derate the plant

3* - Provide LGU with the test results

4* - Coal blending/Derate the plant/Procurement of low Sulfur content

5* - Operation/Calibration of over fire control dampers

6* - Maintenance of plant buildings/equipment

7* - Install lining

***For Soil Contamination: Heavy metals to be monitored:

Arsenic	= 5ppm
Cadmium	= 5ppm
Chromium	= 5ppm
Lead	= 5ppm
Mercury	= 0.2ppm

Note: Limits as per RA6969

****For Groundwater Contamination: Heavy metals to be monitored:

Arsenic	= 0.1ppm
Cadmium	= 0.003ppm
Chromium	= 0.05ppm
Lead	= 0.01ppm
Mercury	= 0.001ppm

Note: there is no DENR limit for groundwater, above limits were as per PNSDW for comparison purposes and test results are also compared to the baseline data

9 INSTITUTIONALPLAN FOR EMP IMPLEMENTATION

The environmental monitoring programs and organization for the Masinloc Plant (Unit 1 and Unit 2) will be adequate to cover the Project. Even prior to the construction of the Masinloc Plant, a Multi-Partite Monitoring Committee was formed in coordination with EMB-DENR and composed of representatives from NPC, LGUs and local communities, NGOs and EMB-DENR.The “1993 MOA between NPC, Zambales and Masinloc”, is the MOA establishing the MMT for the Masinloc Coal-Fired Thermal Power Plant. MPPCL assumed all responsibilities in the MOA when it acquired the Plant in 2008. .

The Committee met with NPC’s environmental and project management staff and worked out an environmental monitoring plan for the Project. The environmental quality parameters to be monitored, the frequency of monitoring, and the procedures to be used for monitoring are shown in **Annex D** and **Annex G**. The proposed modifications and improvements in the EMP and EMoP are presented in the previous sections of this EPRMP. The Masinloc Plant Multi-partite Monitoring Committee, which is chaired by the Municipal Mayor of Masinloc, reports to the Multi-Partite Management Group headed by the Regional Director of EMB Region III. The composition of the Masinloc Plant Environmental Management Group and Committee is shown in **Table 9-1**.

Table 9-1: MMT Organization

MPPCL MULTIPARTITE MANAGEMENT GROUP		
CHAIRMAN	**:**	**REGIONAL TECHNICAL DIRECTOR** **DENR-REGION III**
VICE CHAIRMAN	**:**	**VICE GOVERNOR** **PROVINCE OF ZAMBALES**
MEMBERS	**:**	**DENR-ONE (1) REPRESENTATIVE** **LGU-MAYORS OF MASINLOC, CANDELARIA AND PALAUIG** **BARANGAY CAPTAIN OF BANI** **NON GOVERNMENT ORGANIZATION** **MPPCL-PLANT MANAGER MASINLOC POWER PARTNERS COMPANY LIMITED**
MPPCL MULTIPARTITE MONITORING TEAM		
CHAIRMAN	**:**	**MAYOR, MASINLOC**
VICE CHAIRMAN	**:**	**VICE-MAYOR MASINLOC**
SECRETARY	**:**	**DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES**
1 - REPRESENTATIVE FROM THE OFFICE OF THE GOVERNOR, ZAMBALES		
1 - REPRESENTATIVE FROM THE OFFICE OF THE PROVINCIAL BOARD, ZAMBALES		
1 - REPRESENTATIVE FROM THE OFFICE OF CONGESSMAN		
1 - REPRESENTATIVE FROM THE SANGGUNIANG BAYAN, MASINLOC		
1 - REPRESENTATIVE FROM THE OFFICE OF THE MAYOR, MASINLOC		
1 - REPRESENTATIVE FROM THE OFFICE OF THE MAYOR, PALAUIG		
1 - REPRESENTATIVE FROM THE OFFICE OF THE MAYOR, CANDELARIA		
1 - REPRESENTATIVE FROM THE MASINLOC POWER PARTNERS COMPANY LIMITED		
1 - REPRESENTATIVE FROM THE NON GOVERNMENT ORGANIZATION, BASED IN MASINLOC		
1 - REPRESENTATIVE FROM THE BARANGAY COUNCIL, BANI		
1 - DEPARTMENT OF ENVIRONMNET AND NATURAL RESOURCES		
1 - DEAPRTMENT OF AGRICULTURE (SFAR)		

AIR QUALITY TEAM	WATER QUALITY TEAM	MARINE ECOLOGY TEAM
DENR LGU NGO MPPCL	DENR LGU NGO MPPCL	DENR LGU NGO MPPCL

Annex A: Land Lease Agreement

Annex B: Flora and Fauna Monitoring Reports

Annex C: Water Quality Monitoring Data

Annex D: Self Monitoring Reports

Annex E: Air Dispersion Modeling Results

Annex F: Stack Emission Monitoring Data

Annex G: CMRs

Annex H: HAZOP

Description of Hydrogen Cooling of Turbine Generators

In Japan, the turbine generators manufactured up to 1945 had been using air at atmospheric pressure for cooling. In 1923, when Max Scholar's patent of a sealing method using pressurized liquid was approved in the United States, the hydrogen-cooled generator were successfully manufactured by General Electrics and Westinghouse in 1926 and 1928 respectively. The following are the some characteristics of a hydrogen-cooled turbine generator:

- Reduction of maintenance expenses because the closed re-circulating gas system prevents entry of dirt and moisture;
- Increased operational life of the insulation on the stator winding because the absence of oxygen and moisture prevent decay;
- Windage noise is reduced due to the low density of hydrogen gas and the closed ventilating system.

Table 1 shows the main characteristics of hydrogen gas that makes it better than air as a cooling medium.

Table 1: Characteristics of Hydrogen Gas and Air as a Cooling Medium

Parameter	Air	Hydrogen
Density	1.00	0.07
Thermal conductivity	1.00	7.00
Heat transfer coefficient from		
Surface to gas	1.00	1.35
Specific heat	1.00	0.98
Support of combustion	Yes	No
Oxidizing agent	Yes	No

Safety Features of a Hydrogen-cooled Turbine

Hydrogen has a wide range of explosive limits with air (about 5 to 70 per cent hydrogen by volume). Hence, the system and the operating procedures should be designed to prevent these mixtures from occurring under normal operating conditions. Designing the system as "explosion-proof" means the stator frame of the generator will withstand an explosion even though other materials of the system are destroyed.

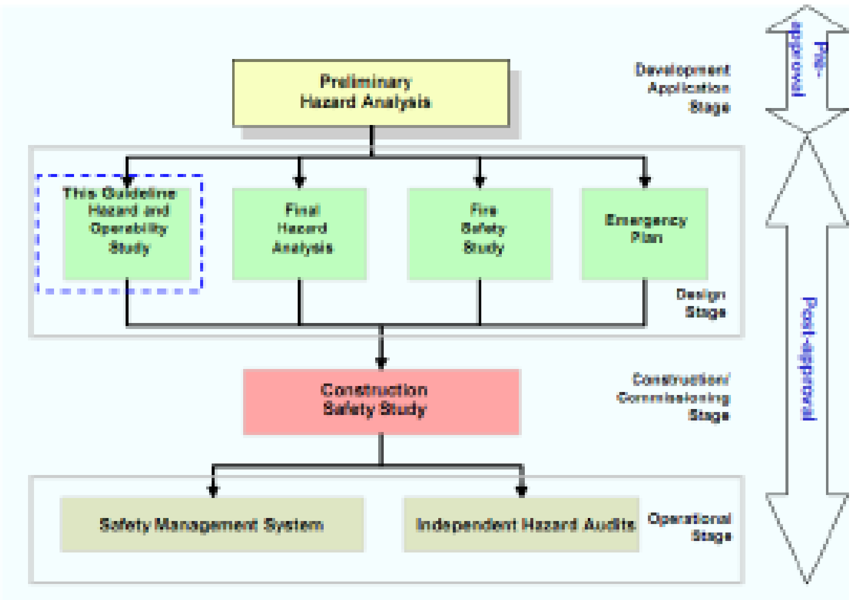
The intensity of explosion of a mixture of air and hydrogen will vary according to the ratio of the volume and pressure of the two gases. The explosion hazard is only possible during gas replacement with an intensity of less than 7 kg/cm^2, hence, the stator frame of a hydrogen-cooled generator is designed to withstand this overpressure. The three critical measures to be observed when replacing the gas are:

- No mixing of hydrogen and air;
- Using carbon dioxide as intermediate gas during replacement; and
- Provision of an exhaust vent to the atmosphere within the generator so avoid pressures in the range of 0.1 - 0.2 kg/cm^2.

The HAZOP Study

A Hazard and Operability (HAZOP) study is defined as a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate potential hazards and operability problems. The HAZOP process is used to identify potential hazards and operational problems in terms of plant design and human error. The technique should be applied to a plant during final design before construction commences. The use of HAZOP is also beneficial when upgrading the safety standards or modifying a plant already in operation.

The HAZOP study is done during the detailed design stage because inputs like the detailed piping and instrumentation diagrams (P&Ids) are already available (**Figure 1**). As a compromise, the HAZOP is usually carried out as a final check when the detailed design has been completed. Hence, doing a HAZOP at the EIA stage where everything is at best is at the FS stage is not recommended.



Source: Hazardous Industry Planning Advisory Paper No. 8, Department of Planning, NSW Government, July 2008

Figure 1: HAZOP Framework

Risk screening of Hydrogen Gas

1. Physical and Chemical Properties

The NFPA rating of hydrogen gas is shown in **Table 2**.

Table 2: NFPA Rating of Hydrogen Gas

No.	Substance	Chemical Formula	CAS NO.	NFPA Rating			
				H	F	R	SK
1	Hydrogen Gas	H_2	1333-74-0	0	4	0	SA

NOTE: H – Health, F – Flammability; R – Reactivity; SA – simple asphyxiant

The physical properties of hydrogen gas are listed below:

Appearance and physical state: colorless gas at normal temperature and pressure
Odor: odorless
Molecular weight: 2.016
Boiling Point: (1 atm): -252.8°C
Freezing Point: -259.2°C
Specific gravity (Air =1): 0.06960
Solubility(in water (Vol/Vol at 15.6°C): 0.019
Gas density at 21.1°C and 1 atm: 0.08342 kg/m^3
Specific volume at 21.1°C and 1 atm: 11.99 m^3/kg

Vapor Pressure: Not applicable
Flash Point: n/a (gas)
Auto-ignition Temperature: 570°C
Flammable or explosive limits (%): Lower: 4%; Upper: 74.5%

2. Stability and Reactivity Information

Stability: stable
Conditions to avoid: oxidizers
Incompatible materials: None
Hazardous decomposition products: None
Hazardous polymerization: will not occur

3. Chemical and Physical Hazards

Chemical Hazards

Symptoms of Exposure:

INHALATION: High concentrations of hydrogen so as to exclude an adequate supply of oxygen to the lungs causes dizziness, deeper breathing due to air hunger, possible nausea and eventual unconsciousness.

EYE CONTACT: None
SKIN CONTACT: None
CHRONIC EFFECTS: None
OTHER EFFECTS OF OVEREXPOSURE: None

Toxicological Properties:

- Hydrogen gas is inactive biologically and essentially nontoxic; therefore, the major property is the exclusion of an adequate supply of oxygen to the lungs.
- Hydrogen gas is not listed by OSHA as a carcinogen or potential carcinogen.
- Persons in ill health where such illness would be aggravated by exposure to hydrogen should not be allowed to work with or handle this product.

Table 3: Occupational Exposure Limits of Hydrogen Gas

Substance	OSHA PEL	NIOSH REL	ACGIH TLV	EU OEL	IDLH
Hydrogen gas	None	none	Simple asphyxiant	None	none

Source : NIOSH, OSHA, ACGIH, EU OSHA

Notations:

ACGIH - American Conference of Governmental Industrial Hygienists
NIOSH - National Institute of Occupational Safety and Health
OSHA - U.S. Occupational Safety & Health Administration
PEL - Permissible Exposure Limit (OSHA)
REL - Recommended Exposure Limit (NIOSH)
STEL - Short-Term Exposure Limit (generally 15 minutes)
OEL – Occupational Exposure Limits (EU)
EU – European Union
ST – Short term
TLV - Threshold Limit Value (ACGIH)
TWA - Time Weighted Average (8 hr)
IDLH – Immediately Dangerous to Life or Health (NIOSH)
A3 - confirmed animal carcinogen with unknown relevance to humans
A4 - not classifiable as a human carcinogen

Physical Hazards

Hydrogen gas is extremely flammable. It is easily ignited by heat, sparks or flames and will form explosive mixtures with air. Hydrogen is lighter than air and will rise and causing fires that are difficult to detect because it burns with an invisible flame. The following are the physical hazards involved with the handling, storage, and use of hydrogen gas:

- Confined Explosions (leakage of H_2 into buildings, contamination of high pressure H_2 storage facilities by air; and
- Unconfined Explosions(major rapid release into the atmosphere)

4. Generic Emergency Response

The general emergency response protocols are shown in **Table 4**.

Annex I: Emergency Response and Contingency Plan

MPPCL

Emergency Response and Contingency Plan

Integrated Management System

IMS-MAN-010	
Approved by: Johnny Tanis	Signature:

Review No.	Amendment Description:	Revision date	Prepared by:	Reviewed by:
0	First issue	02-28-2011	E. Pielago	A., Sangalang
1	- Section 6.2.1 – EPRPs subject to MPPCL-EHS-SP-00-008 Control of Documents provisions - Convert Appendix 1: Internal and External Emergency Resources into a form instead of record	03-13-2012	E. Pielago	G. Sta. Romana
2	New signatories	05-06-2013	C. Viado	E. Serrano
3	- Section 6.9 – Modified alarm testing schedule	11-28-2013	G. Palaruan	E. Serrano
4	- Section 6.4: Emergency Discovering and Reporting- added IP Phone Emergency Numbers - Annex 01: Fire Protection System Inspection-added new annex 01 - Appendix 1: Internal and External Emergency Resources-added IP Phone Emergency numbers - Appendix 3: Evacuation Alarm Test Records- modified alarm testing schedule - Appendix 4: MPPCL Emergency Communication Plan and Instructions-added IP Phone emergency numbers - Appendix 6: On-site Emergency Equipment List-removed Fire water system section	06-25-2014	G. Palaruan	E. Serrano
5	Full review	08-31-2017	J. Dagdag	E. Serrano
6	Periodic review and change in procedure number	11-15-2018	J. Baculo	E. Serrano

1.0 OBJECTIVES

This Emergency Response and Contingency Plan (ERCP) aims to:

- Identify potential emergency situations and potential accidents in Masinloc Power Partners Company Ltd. (MPPCL) that can have an impact to the health and safety of personnel and/or to the environment
- Ensure that MPPCL can effectively respond to actual emergency situations and accidents and prevent the associated adverse occupational health and safety (OH&S) consequences and environmental impacts
- Define the method to be followed and identify the elements to be used in the event of on-site and/or off-site emergencies involving any MPPCL facilities
- Address all aspects of both real and potential situations, which may occur on-site and/or off-site
- Provide the information for safe and successful participation in the required action to prepare for, and effectively manage, all incidents that constitute an emergency under this plan
- Effectively minimize the effects and consequences from emergency incidents by ensuring the associated risks and impacts are suitably identified, managed, controlled, and kept to a minimum in as professional manner as possible

2.0 SCOPE

This procedure covers all potential emergency situations and potential accidents associated to the significant OH&S hazards and environmental aspects of MPPCL. It is applicable to all facilities owned and/or operated by, under construction for, leased to, or otherwise used by MPPCL. Also included are those areas that may be affected by the consequences of an emergency incident resulting from any MPPCL operation. All areas inside the fence-line of the MPPCL Power Plant are covered in this plan.

3.0 DEFINITIONS

Accident	• Undesired event giving rise to death, ill health, injury, damage, or other loss.
Dangerous Substances	• Substances accidentally released in such a quantity that may result in serious harm to life, property, or the environment.
Emergency	• Hazardous or potentially hazardous situation involving the release or imminent release of dangerous substances that could result in serious adverse effects on the health and safety of persons, damage to the environment, or property damage and which may disrupt the continued safe operation of the facility. It could be the result of individual/group/organization actions, equipment failure, civil disturbances, and/or natural occurrences.
Hazards	• A situation with a potential for human injury, damage to property, damage to the environment, or some combination of these.
Incident	• Event that gave rise to an accident or had the potential to lead to an accident. An incident where no ill health, injury, damage or other loss occurs is also referred to as a "near-miss". The term 'incident' includes "near-misses".
Recovery Time	• The time required to bring a situation back to a normal condition or position from that of an emergency. (Generally, the objective of the Emergency Response Plan would be to provide sufficient direction to reduce the recovery time.)
Responders	• Persons identified in the emergency plan as being responsible for actions that are intended to minimize the risk, loss, and damage resulting from an emergency.

Risk	• A measure of the probability and severity of an adverse effect to health, property, or the environment. Risk is often estimated by the mathematical expectation of the consequences of an adverse event occurring i.e. the product of "probability x consequence".
Risk Reduction	• The process of reducing risks either by decreasing the chance and/or the consequences of a hazardous event.

4.0 RESPONSIBILITIES

Plant Manager	• Ensures that this procedure is implemented and maintained.
Department Managers/ Team Leaders	• Ensure that employees in their department/section are trained on the correct actions to take in the event of an emergency • Initiate employee incident investigation reports for employees who sustain injuries or illnesses while on the job • Coordinate emergency responses at his/her area • Verify that all employees have left the building during emergencies that require building evacuation
Operations Shift Leader	• Initiates emergency incident control set-up • Assumes the responsibilities as an Incident Commander during emergencies
Control Board Operator	• Assumes the responsibilities of On-scene Commander during emergencies on their areas of responsibility • Assumes the post of Incident Command Secretary • Interfaces between outside emergency responders and building personnel • Maintains Incident Event Log and other appropriate checklists
EHS Team	• Reviews all relevant processes, activities, and operations and identify potential emergency situations and potential accidents associated with MPPCL's significant OH&S hazards and environmental aspects • Ensures that each identified emergency have corresponding or applicable Emergency Preparedness and Response Procedure (EPRP) • Provides initial and periodic training on emergency preparedness to employees • Schedules and coordinates all emergency drills • Reviews existing EPRP, evaluate their sufficiency, and revised accordingly • Audits the ERCP to assure its continued effectiveness
MPPCL Emergency Response Team	• Performs the duties and responsibilities in firefighting or any other emergencies under the support of MPPCL that will control incipient fire stages and as auxiliary rescuer in case of emergency
Employees	• Know what to do in case of an emergency • Participate in all emergency trainings and drills
Records Officer	• Assists the ERT on the procedure and document requirements • Files all records required by the ERCP

Note: Refer to Appendix 2 for detailed discussion of MPPCL employee roles and responsibilities

5.0 PROCEDURE

5.1 Potential Emergency Identification and Assessment

MPPCL shall identify and assess potential emergencies associated with its significant environmental aspects and occupational health and safety hazards.

EHS Team with the support of the Process Owners, shall review all relevant processes, activities, and operations associated with MPPCL's significant aspects. In addition, the OH&S emergency identification and assessment is integrated in IMS-PRO-001 Hazard Identification, Risk Assessment, and Determining Controls.

EHS Team shall review records from the environmental aspects and impacts evaluation, and from the HIRADC and identify potential emergency situations associated with each identified significant aspect or hazard, and record these in the IMS-MAN-010-F01: EHS Emergency Preparedness and Response Matrix.

5.2 EPRP Development, Testing, and Revision

MPPCL shall develop Emergency Preparedness and Response Plan for each identified potential emergency that are associated with its significant environmental aspects and OH&S hazards.

5.2.1 EPRP Development

EHS Team with the support of the Process Owner, shall ensure that each identified potential emergency have corresponding or applicable EPRP. If EPRP already exist, EHS Team shall review these plans, evaluate their sufficiency, and revise accordingly.

For each identified potential emergency that has no corresponding or applicable EPRP, appropriate plans shall be developed. Each EPRP should address all credible emergency scenarios with significant risk and identify the following (as applicable):

- Plan activation procedures
- Evacuation and re-entry procedures
- Response organization and roles/responsibilities
- Mitigation of environmental impacts to include clean-up
- Response materials and equipment
- Community and regulatory agency notification
- Coordination with local community response authorities and resources
- Response training, communication, and agency notification
- Periodic tests and drills
- Post-response evaluation and documentation

The EPRP should satisfy all applicable legal and regulatory requirements for emergency preparedness and response. The EHS Team shall use the most credible emergency scenarios threatening significant environmental impacts and OH&S risks to drive the development of preventive measures and response plans.

Any new or revised EPRP shall be communicated to all employees, including site contractors and suppliers. Communication shall follow MPPCL-EHS-SP-00-006: Communication, Participation, and Consultation.

The EPRPs are controlled documents and shall be managed according to MPPCL-EHS-SP-00-008: Control of Documents.

5.2.2 EPRP Testing

At the beginning of each year; the EHS Team shall formulate the Annual Schedule of Drills using ***IMS-MAN-010-F02***: Annual Schedule of Drills. In doing so, they shall review the Incidents and Accidents Reports as well as the Drill Reports from the previous year and assess what drills need to be undertaken for the current year. They shall also decide on the type of drill (full-scale, functional, or tabletop) to be conducted. In addition, they shall identify and plan for those drills that will involve external organizations as well as take into account the needs of relevant interested parties, e.g. emergency services and neighbors.

Drills shall be conducted to test the EPRPs effectiveness in responding to emergency situations. The conduct of drills may be announced or unannounced. Drills involving external organizations shall also be conducted as part of the periodic assessment of the capabilities of these organizations in EPR.

The EHS Team shall conduct post-drill reviews and document the results using ***IMS-MAN-010-F03***: Emergency Preparedness and Response Drill Report, focusing on response effectiveness and ways to improve future readiness as well as organization and operational efficiency.

5.2.3 EPRP Revision and Update

The EHS Team shall review and/or revise the EPRPs to ensure that they are current, adequate, and in compliance to applicable regulations. They shall revise the EPRPs, as appropriate, to reflect any needed enhancements suggested by tests/drills, and to reflect any major changes in local materials use, operations, or equipment that could affect the likelihood or magnitude of impact of identified emergency scenarios.

Consistent with the focus on continual improvement, the EHS Team shall review emergency response performance after an incident has occurred. They should use this to determine if more training is needed or if EPRPs should be revised.

5.3 Emergency Levels

Emergency situations are categorized into three levels as follows:

5.3.1 Level (1) Emergencies—Minor Incident

A situation confined to a specific location that can be handled effectively with the manpower and equipment available at MPPCL and does not pose a danger to other areas of the facility. This type of situation would require implementation of the program in full and may involve evacuation of the affected area of plant.

Examples: Small local fires, containable chemical spills or leaks, etc.

5.3.2 Level (2) Emergencies—Site Emergency

A situation requiring assistance from the Plant's Emergency Response Team. Additional manpower and/or equipment in the immediate incident area are needed, but do not pose danger to the public. This type of incident would require implementation of the program in full and may involve evacuation of the affected area of plant.

Examples: Medium fires, medium chemical spills or leaks, explosions, release of flammable substances which could easily catch fire, etc.

5.3.3 Level (3) Emergencies—Evacuation

A major / catastrophic event, where all personnel must leave the incident area and proceed to the Designated Assembly Area. Under these circumstances, only essential personnel would remain in the emergency area to stabilize conditions as best as possible prior to final departure to the Assembly Point.

Examples: Mainly natural disasters (i.e. earthquakes and typhoons), large fires (i.e. fuel oil storage and coal pile fires), large chemical spills or leaks (i.e. bulk chemical spills), boiler explosion, major turbine breakdowns, large steam leaks into buildings, etc.

Summary of Emergency Levels

Level of Emergency	Local Equipment & Personnel	Site Equipment & Personnel	External Equipment & Personnel	Emergency Response Contingency Plan	Evacuation Alarm and Evacuation
(L1) Minor Incident	✓	✓	-	✓	✓ (if required)
(L2) Site Emergency	✓	✓	✓ (if required)	✓	✓ (if required)
(L3) Evacuation	✓	✓	✓	✓	✓

Emergency Level will be evaluated by the Incident Commander together with the assessment of the On-Scene Commander. In all cases where there is doubt on what level of emergency is at hand, it must be treated as a Site Emergency.

Special Note: Irrespective of level of emergency, if the On-scene Commander feels a head count is required, he must inform the Incident Commander and evacuation alarm should be initiated.

5.4 Emergency Discovering and Reporting

Discovery of emergencies can be by automatic or manual means.

5.4.1 Automatic Discovery

Certain emergency situations e.g. fire and fuel oil leakage may be discovered by the installed automatic components for fire, smoke, and level detection. Under these circumstances, notification to the Central Control Room (CCR) will be received automatically through the Main Fire Panel or Digital Control System (DCS).

Upon receiving such information, the on-duty Shift Leader / Incident Commander shall initiate the appropriate emergency response.

5.4.2 Manual Discovery and Communication

An emergency situation discovered by site personnel or contractor will require immediate reporting to the CCR using one or more of the following methods:

- Handheld Radio
- Onsite Paging System
- Telephone Communication
- Emergency number 222
- Intercom for communication with the Control Room
- IP Phone
  - Emergency number 4011
  - Emergency number 4012
  - Emergency number 4013
- Actuate emergency alarm by breaking the glass of nearest Break Glass Unit (in case of fire or explosion)

5.4.3 Emergency Reporting

It should be remembered that for a fast and efficient response to an emergency incident, the correct information is required by the ***Shift Leader*** to take appropriate actions. Therefore, it is essential for the ***Shift Leader*** to collect full detail of the incident such as:

- Name of the person who reports the incident
- Exact location of incident
- Nature of the emergency (e.g. fire, spill, injury, etc.)

Note: Do not release the telephone or radio channel until all information has been received and acknowledged. The CBO or ***Shift Lead*** shall be the one to release the phone.

5.4.4 Activities after Emergency Reporting

Only if it is safe to do so, and after reporting the emergency shall the person and/or persons discovering the emergency incident take steps to control the situation using the equipment immediately available. Where there is doubt or imminent danger exists, personnel should wait in a safe location until further assistance arrives and, only then, commence emergency control activities.

The appropriate action required to control the situation may include:

- Ensuring the safety of personnel and if necessary the rescue of victims
- Use of fixed and/or mobile firefighting equipment for containment, extinguishing the fire, dispersing gas/vapor clouds, protection of adjacent installations and personal protection
- Shutting down and isolating equipment
- Containing and/or controlling spills or leaks
- Communicating/relaying essential information to the CCR or Incident Control Centre

5.4.5 Incident Command System

To effectively control and manage emergency operations, it is essential that the emergency response be categorized into functional components and responsibilities.

The transition from normal operations to emergency operations and the delegation of authority from operations personnel to emergency response personnel must be clearly defined, as well as the transition from control by on-site personnel to that requiring the assistance of outside organizations.

The incident command system is put in place to ensure an organized and well-coordinated approach to effectively control and manage emergency operations. It provides an essential communication link and management structure to and from the incident scene, through a central gathering point, where information can be evaluated and categorized then assigned individual responsibility for implementation. It also provides a structure whereby all aspects of the emergency development can be closely monitored and assessed in the shortest possible time, enabling the appropriate action regarding site control, isolation and shutdown requirements, evacuation, etc.

The overall incident command system comprises of three main areas. These are:

- Incident Command
- On-Scene Command
- Emergency Assembly Area

These are discussed in the succeeding subsections.

5.4.6 Incident Command

The incident command is the hub of all emergency response activities. It acts as the final authority for decision-making throughout the emergency period and has complete responsibility for the management of the incident. It controls all emergency activities by establishing communication links with the emergency area, outside organizations, support groups, operating facilities, engineering groups, and critical information centers. It maintains an accurate log of events and initiates appropriate emergency action throughout a developing emergency to include manpower, equipment, medical evacuation, security, people, and traffic control, etc. It provides services to the emergency control force and instigates the setting up of rest areas, refreshments, medical assistance, relief crews, washing facilities, and changing areas.

The incident control system will cater for the differing levels of emergency:

- Level (1) Minor Incidents – Requiring on-site O&M personnel to respond and take the necessary corrective actions
- Level (2) Site Emergencies – Requiring the response by MPPCL Emergency Response Team but posing no danger to the public
- Level (3) Evacuation – Requiring all personnel to leave the premise and assemble at the designated assembly points (Appendix 5).

The following equipment should be provided and made immediately available in the Incident Command Center:

- General use telephones
- Current internal MPPCL and Philippine Telephone and Fax directories
- MPPCL Emergency Communication Plan
- Computer / email / printer facilities
- Time clock
- Site radio base-set (Only required in CCR)
- Site radios (2) spare batteries (2) battery charger (1) – will remain in CCR and can be obtained when required
- Up-to-date se of facility engineering drawings (1) set
- Emergency contingency operating procedures (1) set
- Vendor equipment manuals and contact list (1) set – if available
- Events log (1) plus spare
- MPPCL Internal and External Resources List
- Emergency Response and Contingency Plan (1) set
- Emergency evacuation plan, routes and assembly areas
- On-site emergency equipment list and location
- Site plan detailing exits, entrances, assembly points, facility layout
- White boards (2), markers
- Pens, pencils, writing pads, markers, corkboard, flip chart
- Material Safety Data Sheets (1) set
- First Aid Kit

Under no circumstances should any item above be removed from its designated location. All drawings, procedures, documents, and other reference materials shall be maintained with up-to-date copies. Communications equipment shall be regularly tested and examined (daily checks recommended) to ensure its immediate availability for use.

In circumstances where an alternative / secondary standby Incident Command Center has been designated, it is essential that all the items necessary for effectively dealing with emergency be duplicated to ensure the immediate use of the communication and control network in the event of a developing emergency.

5.4.7 On-Scene Command

The on-scene command will have full responsibility for assessing the overall emergency situation, magnitude, and potential threat to personnel, property, equipment, and the environment. The role of the on-scene command involves:

- Opening a communication link and providing information through the command network to develop an appropriate strategy for an emergency response in the shortest possible time
- Supervising and directing all on-scene actions to control the emergency (Fire Fighting, Rescue, Spill Control, Vapor Dispersal, and Shutdown of Equipment, etc.)
- Monitoring the activities at the emergency scene, relaying vital information to and from either the on-scene command or incident command center
- Controlling and coordinating all movements into and out of the emergency area and maintaining a log of critical events, manpower movement, etc.

5.4.8 Assembly Points

Assembly Points are areas where personnel assemble in case of an emergency. This should have "Assembly Point" signboard. Below are the designated Assembly Points:

- Assembly Point # 1 – Flagpole, in front of Admin Building
- Assembly Point # 2 – Open area beside the warehouse

5.5 Emergency Response

5.5.1 Emergency Response Action Plan

In emergency situations, the following steps should be observed:

- Identify the nature of the emergency and determine the extent of casualties if any
- Locate the source, identify hazards and any potential escalation
- Raise the local alarm, alert the emergency response groups, and activate the site warning system
- Mobilize the appropriate resources to isolate the hazard as much as possible and initiate remedial actions
- Initiate procedures for the protection of personnel, plant, property, and the environment
- Consider the need to evacuate non-essential personnel and the shutting down of the operation
- Implement procedures for the protection of emergency personnel and vital resources
- Account for personnel and log all events
- Activate emergency communications links, notify Leadership, the appropriate agencies and neighboring facilities where appropriate
- Liaise with emergency and other services on their arrival and call for further assistance as required
- Maintain all communication links to keep abreast of developments
- Ensure the means of giving and receiving information, advice, and assistance are functioning correctly
- Maintain good public relations
- Prepare plan for the restoration of facilities after the emergency
- Initiate incident investigation per MPPCL-EHS-SP-00-012: Incident Management, collate vital documents/ information, and obtain photographic record

5.5.2 Emergency Response Responsibilities

5.5.2.1 ***Operations Shift Leader***

Upon notification of personnel injury/fatality, immediately inform the MPPCL Emergency Response Team through the emergency hot line (preferably) or other means (radio, telephone, etc.) and send available first aider to help the victim until the MPPCL Emergency Response Team arrives. For all other cases, confirm with the ***On Scene Commander*** that the emergency is genuine, and then follow the procedure below:

- Initiate emergency incident control set-up and assume the responsibilities as an Incident Commander
- Notify Plant Manager, Managers and TLs, and give full details about the incident (this notification shall be carried out by designated personnel who is appointed by the ***Shift Lead***)
- Notify on-duty Emergency Response Team and designate area CBO to act as an On-scene Commander
- Notify MPPCL Emergency Response Team, if required
- Actuate Evacuation Alarm and give instructions on Public Address System for Specific Area Evacuation or Site Evacuation (as required)
- Call in emergency service (Ambulance, Firefighters, Police, etc.) if appropriate
- Consider emergency shut-down of equipment or plant as required

Important: Notifications issued to all MPPCL employees shall include details of the emergency (i.e. exact location, type and magnitude of fire, numbers of victims/injured, etc.) and the Emergency Services Response Point (ESRP) of the facility where the fire authority should report to. The current ESRP is located in front of the Administration Building Lobby. Inform the Main Gate guards to provide a free entrance for emergency crews.

- Maintain Incident Event Log and other appropriate checklists

- The following checklists are also provided:
  - Fire or Explosion Incidents
  - Environmental Incidents
  - Security Incidents
  - Medical Incidents

5.5.2.2 On Scene Commander

Upon notification of an emergency, the On Scene Commander shall proceed to the emergency scene with the required manpower and equipment (unless told differently) and:

- Work under the direct control of the Incident Commander
- Take the necessary steps to control the emergency which may include the following:
  - Safety and rescue of personnel
  - Use of fixed and mobile firefighting equipment (i.e. fire extinguishers, vapor cloud dispersals, etc.) for containment
  - Protection of adjacent facilities

5.5.2.3 Local Operator

Upon notification of an emergency, the Local Operator shall proceed to the emergency scene and assist the On Scene Commander by:

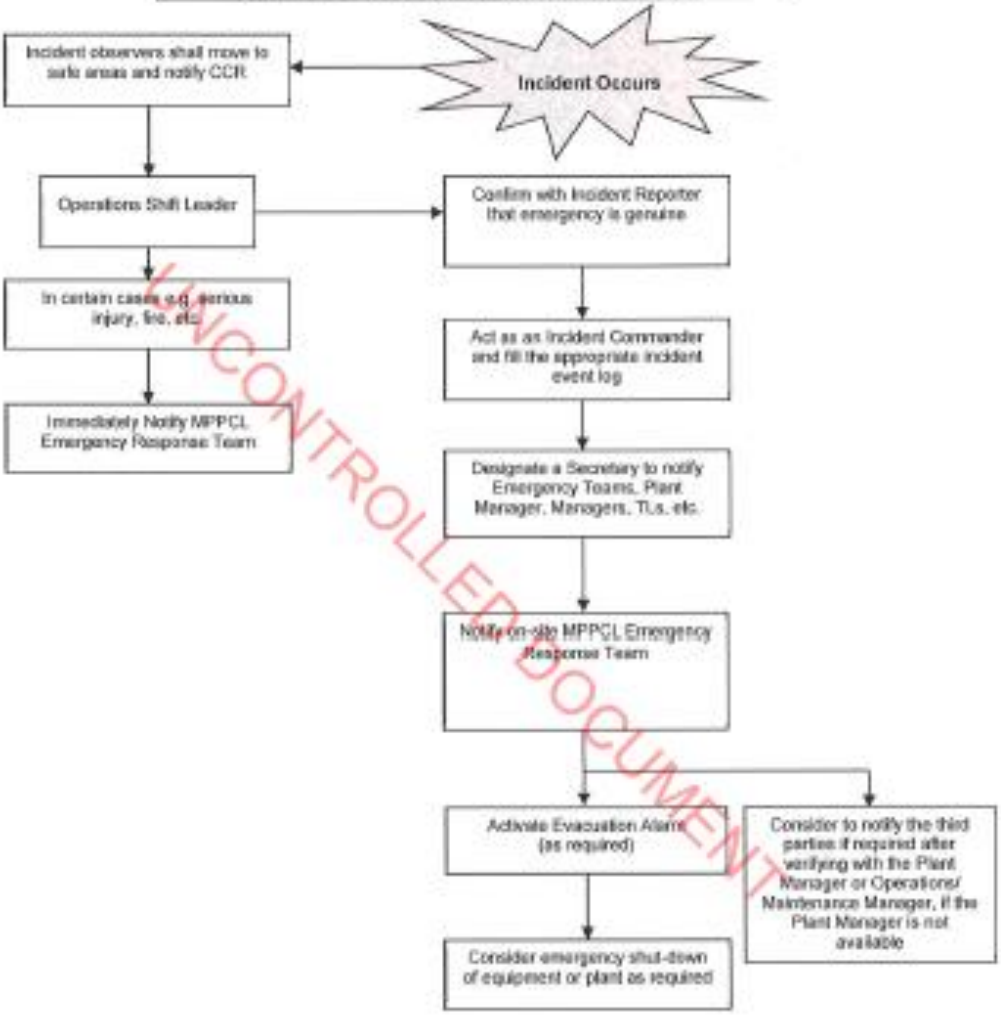
- Operation of Emergency Shutdown Devices in coordination with the On Scene Commander
- Isolation of equipment as per instruction of the On Scene Commander

5.5.2.4 All Other Site Personnel (Maintenance, Contractor, Visitors, etc.)

Upon hearing the site Evacuation Alarm, employees given a responsibility in this plan shall proceed to their designated area to perform their assigned tasks.

Other employees not given a specific responsibility in the plan should follow instructions given to the public address system (i.e. "Leave the Area" and "Report to the Assembly Point") and wait for further instructions.

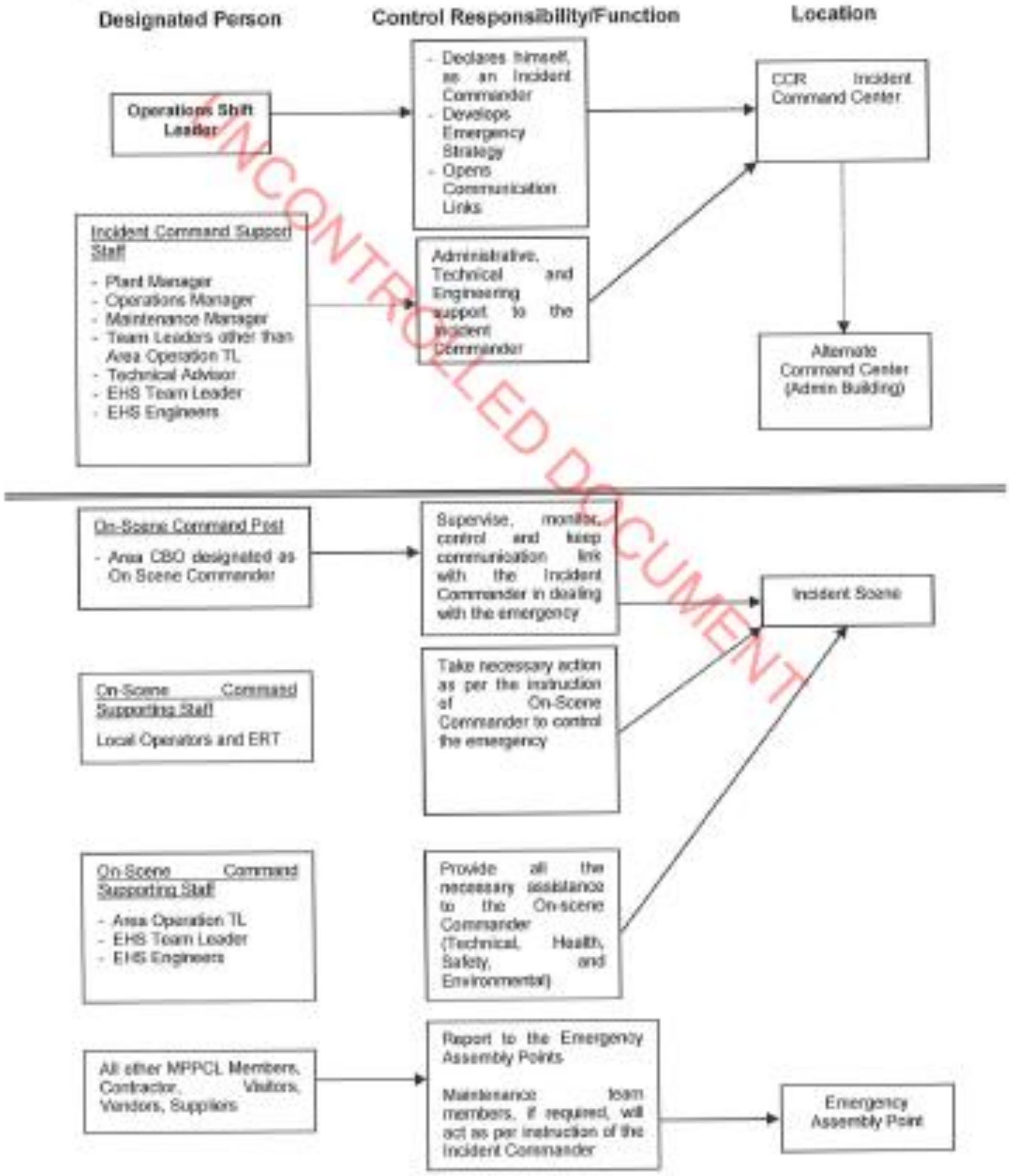
Operations Shift Leader Emergency Response Flowchart



5.5.3 Emergency Response Flow Chart Levels 1-2-3 Emergencies

Personnel not assigned under this ERCP should report to nearest Assembly Points and wait for further instructions. Where in the opinion of the On Scene Commander, the emergency situation is beyond the control of local resources (Manpower and Equipment) for Level 1 Emergency, a message should be sent to the Incident Commander requesting to step up emergency Level (2 or 3) according to the situation.

Emergency Response Flow Chart Levels 1-2-3 Emergencies



5.6 Evacuation

Evacuation shall only be authorized following a detailed review of the incident status and, where it is determined conditions are too dangerous for personnel to remain. This would normally indicate that no further action could be taken to safely control the situation with the manpower and resources available. Authorization to commence the evacuation process shall be only on the instructions of the Incident Commander, except in circumstances where a hand over of authority for the emergency has taken place. Under these circumstances, the designated person assigned the duties of the Incident Commander shall authorize the evacuation. Once evacuation is authorized, the MPPCL Evacuation Plan shall be implemented.

However, it is very unlikely that a full evacuation becomes necessary. When deemed necessary, two areas shall be considered: On-Site Evacuation and Off-Site Evacuation.

5.6.1 On-Site Evacuation

On-site evacuation could be of two types:

- Specific Area Evacuation – Fire or Gas detection alarm or Incident Commander instructions
- Site Evacuation – Communicated by actuation of the emergency Evacuation Alarm (High Pitch Sound – for 2 minutes) followed by Incident Commander verbal instruction on the Public Address system. Communication to remote areas shall be made by the best available established means.

Upon receipt of notification that a site evacuation is in progress, all personnel, except those that have assigned responsibilities under this ERCP, should proceed in an orderly and calm manner to the nearest Assembly Point and await further instructions. Where in the opinion of the Area Engineer (On-Scene Commander), that the emergency situation is beyond the control of local resources (Manpower and Equipment) for Level 1 Emergency, a message should be sent to the Incident Commander requesting to step up emergency Level (2 or 3) according to the situation.

Personnel should note that sometimes the nearest assembly point might not be the safest area to proceed to in the event of an emergency. Therefore, considerations must be given to the prevailing wind direction.

Note: Generally, vehicles are not to be used to evacuate the plant area. Evacuation to the Assembly Point will typically be done on foot. If no one at the Assembly Point has a radio or mobile phone, the Incident Commander will arrange a means of communication.

5.6.2 Head Counting

The first priority after Specific Area or Site Evacuation will be to carry out detailed personnel Head Count to determine that all site personnel are safe and out of danger. The Head Count shall be initiated and supervised by the Procurement Coordinator (for EAA1) and Warehouse Officer (for EEA2) from the Supply Chain Team with the help of his team members.

Following a satisfactory Head Count, all documentation and records relating to the incident shall be gathered together, filed, and to be reviewed by the investigation team.

Note: During weekend and night shifts, Operations personnel will be designated to do the head count.

5.6.3 Disabled Person(s) Evacuation

In accordance to this ERCP, the Plant Manager will identify those individuals (permanent employees) with a disability that would need consideration and assistance during an emergency evacuation and then two healthy MPPCL personnel (designee) will be assigned to them to assist in their safe evacuation. In the case of disabled visitors, the concerned MPPCL contact person will be responsible in ensuring the safety of their evacuation. This will apply to any kind of physical limitation, be that confinement to using crutches, cane, or walker, wheelchair; vision impaired; hearing impaired; etc.

When the Plant Manager is not available at the site or outside normal office working hours, the Operations Shift Leader will assign personnel for the assistance of those disabled individuals.

The assigned personnel should know the individual needs of the disabled person(s) in their care including:

- Whether someone can be removed from a wheel chair and carried
- What medications they take, allergies, medical problems that could be made worse (e.g. by smoke). Such awareness will assist all parties if an emergency occurs.

When site evacuation is declared by the Incident Commander, the designee should prepare and take action to evacuate the disabled person from hazardous area to the Assembly Point. The disabled person should be transported from his place to the recommended Assembly Point. If he or she cannot be evacuated without trained assistance, the Incident Commander will be informed for the number of disabled persons, type of disability, and specific location. Under such circumstances, the designee should stay with the disabled individual while a second person notifies. The disabled person should be kept at the safe location until trained rescuers arrive.

There could be situations where the affected person develops disability as a result of the emergency (e.g. chemical splash into the eyes, impaired hearing due to blast, etc.). Under such circumstances, the On-Scene Commander/Incident Commander will take the appropriate measures for rescue operation.

Below are the general guidelines in case of an emergency where the affected person develops disability as a result of the emergency:

a. If you are disabled:
- Be aware of persons in your area who could assist you
- Carry a whistle or other objects to help you attract attention (if you cannot speak loudly)
- Give clear instructions as to your needs and preferences

b. To help a disabled person:
- Ask disabled person if he/she needs help
- Do not move the person unless they have given you permission
- Move person up or down the stairs only if necessary
- Assist the disabled person to the nearest and safest exit
- Assist person to the designated Assembly Point

Below are the general guidelines in case of an emergency to help personnel with special needs:

a. Person(s) Unable to Walk:

Ask if the person needs assistance to evacuate. Offer to guide him/her to the emergency exit. If necessary, carrying options include using a two person lock arm position or having the person sit in a sturdy chair, preferably one with arms and drag the chair out of the building. Move person up or down stairs only if necessary for life safety.

b. Person(s) in Wheelchair(s):

Wheelchairs may have parts not intended for lifting. Batteries or life support equipment may be connected. Lifting the person could be harmful. Ask the person how you can help him/her. Below are guidelines to help a person in wheelchair:

- Determine if the person wants to be removed from the chair
- Determine if the person wants to be carried down a flight of stairs. This could be in forward or in backward position.
- Ask what type of assistance he/she will need after evacuation. Move person up or down stairs only if necessary for life safety.

c. Visually Impaired Person

Most visually impaired persons will be familiar with their immediate work area. In an emergency situation:

- Describe the nature of the emergency and offer to act as a "sighted guide" — offer your elbow and escort him/her to a safe place
- As you walk, describe where you are and advise of any obstacles
- When you have reached the Assembly Point, orient the individual to where you are and ask if further assistance is needed

d. Hearing Impaired Persons

Because persons with impaired hearing may not perceive emergency alarms, an alternative warning technique is required. Two methods of warning could be helpful:

Write a note describing the emergency and the nearest evacuation route e.g. Fire. Go out rear door to the right and down. Now!

Turn the light switch off and on to gain attention and then indicate through gestures what is happening and what to do

5.6.4 Off-Site Evacuation

Plant related and/or outside emergencies may require the evacuation of persons (who may be affected by the emergency) outside the facility as specified by the Incident Commander. Under such circumstances, the evacuation of person(s) and the control of external roadways, pedestrians, and vehicles will be the responsibility of MPPCL Security Coordinator along with MPPCL Security Services. Notification of the circumstances for evacuation and full details of the current emergency condition will be passed to the appropriate organizations by the Incident Commander from the Incident Command Center. Off-site evacuation in all circumstances will require the attendance of MPPCL designated person, by Incident Commander, who will play an active role in the overall coordination. The designated person will liaise with MPPCL Authority, to ensure the following:

- MPPCL expertise and services are immediately available
- Operational status on the emergency condition is continuously updated and information relayed to Incident Command Center
- Communication between Off-site locations and the Incident Command Center are maintained
- Manpower and equipment are mobilized and made readily available to perform emergency and permanent repairs

5.7 Safety Documents

When an order to evacuate is given or when an emergency evacuation alarm is activated, all work permits issued shall be treated as Released and personnel shall be prevented from continuing or restarting work until reissue of permit is authorized by OAPs of individual areas with respect of the work location.

5.8 Evacuation Alarm and All Clear Signal

All MPPCL personnel and contractors are trained to be familiar with the Emergency Alarm System. When the Evacuation Alarm sounds, follow instructions given on public address system (e.g. "Leave the Area", "Report to Assembly Point", etc.)

The Incident Commander has the sole responsibility to decide when the emergency situation has ended. Prior to this decision, the Incident Commander will give the emergency "All Clear" announcement. Upon notification of the emergency "All Clear", steps shall now be taken to begin the process of restoring the facilities to normal operation. However, the area in which the emergency took place should remain undisturbed until completion of the Incident Investigation.

When "All Clear" announcement is made, then it is safe to return to the work location. Below is a table showing the profile of Evacuation Alarm and All Clear Signal.

Facility Evacuation Alarm and All Clear Signal

Condition	Type of Alarm	Profile	Duration
Evacuation	Warbling Tone Alarm With Verbal Announcement		2 minutes
All Clear	Verbal Announcement	NA	NA

It is the responsibility of every site personnel (employees, contractor, visitors, etc.) to understand fully the emergency alarm system and the action to be taken upon hearing the alarm.

5.9 Evacuation Alarm Testing

Evacuation alarms shall be functionally tested every Wednesday at 1000 hours by the on-duty Control Board Operator. Prior to testing, he/she will make the necessary announcements to inform all MPPCL personnel about the test.

The information recorded shall be as follows:

- Date and time of test
- Result of test (Satisfactory, Failed, etc.) giving relevant details of all defects (What failed—Defects—Location/Zone—Action Taken)
- Signature of the person doing the test
- Results and evaluation

In all cases, defects shall be reported immediately to the concerned personnel to raise corrective action with high priority.

In the event of a total alarm failure and/or unavailability of the system due to prolonged maintenance and/or repair, alternative arrangements shall be made for raising the alarm in the event of emergency. Where changes are made, employees shall be notified immediately by the best possible means.

6.0 PROGRAM ADMINISTRATION

6.1 Enforcement

The implementation and continual improvement of the IMS-MAN-010 procedure shall be ensured through strict enforcement of the program, clear definition of roles and responsibilities, training of concerned parties, periodic audits and enforcement of appropriate actions for noteworthy compliance or deviations from the requirements of this procedure.

MPPCL management shall ensure that employees and contractors are recognized for meeting the requirements of this procedure and/or held accountable from any deviations from the elements of this program.

6.2 Audit

To ensure procedural requirements are effectively implemented, this procedure shall be audited periodically through the conduct of emergency drills, post drill and post incident assessments, and per MPPCL's IMS Internal Audit program.

6.3 Training

MPPCL employees and contractors who are / will be involved in IMS-MAN-010 activities shall be given initial and refresher training on the elements of this procedure and their individual responsibilities, following the 70-20-10 principle of learning and development. Employees shall complete initial training before being assigned to become part of the Emergency Response Team.

Retraining shall be provided when:

- *There is a change in assigned duties or responsibilities in this procedure;*
- *Post drill and post emergency assessments or audits reveal that there are deviations from or inadequacies in an employee's and/or contractor's knowledge of this procedure;*
- *There are any changes in this procedure; or*
- *Upon request.*

Training shall be based on each of the responsibilities identified in the Emergency Response Team table of organization.

7.0 ATTACHMENTS

- ***IMS-MAN-010-F01**: EHS Emergency Preparedness and Response Matrix*
- ***IMS-MAN-010-F02**: Annual Schedule of Drills*
- ***IMS-MAN-010-F03**: Emergency Preparedness and Response Drill Report*
- ***IMS-MAN-010-F04**: Internal and External Emergency Resources*
- ***IMS-MAN-010-F05: Evacuation Alarm Test Records***
- ***IMS-MAN-010-F06: Event Log and Incident Checklist***
- ***IMS-MAN-010-F06A: Fire or Explosion Checklist***
- ***IMS-MAN-010-F06B: Environmental Incident Checklist***
- ***IMS-MAN-010-F06C: Security Incidents***
- ***IMS-MAN-010-F06D: Medical Incidents***
- Appendix 1: Assembly Points
- ***Appendix 2: Roles and Responsibilities during Emergencies***

8.0 REFERENCES

- Accomplished ***IMS-PRO-001-F01***: Job Risk Assessment Rating Sheet
- Accomplished ***IMS-PRO-001-F02***: Workplace Risk Assessment Rating Sheet
- Accomplished ***IMS-PRO-031-F01***: Aspect & Impact Significance Rating Sheet
- Accomplished ***IMS-PRO-031-F02***: Environmental Compliance Obligations Register
- Accomplished ***IMS-MAN-002-F02***: Occupational Health and Safety Compliance Obligations Register
- MPPCL-EHS-SP-00-013: Incident Management
- ***All MPPCL Emergency Preparedness and Response Procedures***

Annex J: Emergency Response Protocols for Hydrochloric Acid, Sodium Hydroxide, and Industrial Diesel Oil

Potential Hazards	Public Safety	Emergency Response
HEALTH. Gas may cause dizziness or asphyxiation without warning. FIRE OR EXPLOSION. Hydrogen gas is extremely flammable. It is easily ignited by heat, sparks or flames and form explosive mixtures with air.	As an immediate precautionary measure, isolate spill or leak area for at least 100 meters in all directions. Keep unauthorized personnel away, stay upwind, keep out of low areas, and ventilate closed spaces before entering. PROTECTIVE CLOTHING. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection. EVACUATION Large Spill. Consider initial downwind evacuation for at least 800 meters. Fire. If tank, rail car or tank truck is involved in a fire, isolate for 1600 meters in all directions	FIRE Do not extinguish a leaking gas fire unless leak can be stopped. Small Fires → CO_2, dry chemical. Large Fires → Water spray or fog. Move containers from fire area if possible without risk. Fire involving tanks → Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire. SPILL OR LEAK Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Stop leak if you can do it without risk. Isolate area until gas has dispersed. FIRST AID • Move victim to fresh air and call the appropriate emergency medical service. • Give artificial respiration if victim is not breathing. • Administer oxygen if breathing is difficult. • Remove and isolate contaminated clothing and shoes. • Ensure that medical personnel are aware of the hazards of H_2 and take precautions to protect themselves.

Annex K: PEMAPS