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ES

Executive Summary

Coral Bay Nickel Corporation

1.0 PROJECT FACT SHEET

1.1 Background of the Project

Project Name:	CBNC Expansion Project (Tailing Storage Facility No.3 establishment and Increase in Co annual production limit)
Nature of Project:	Resource Extractive Industry (Mineral Processing)
Total Area and Volume of TSF3:	111 hectares 18.6 million cubic meters
Site Location:	Rio Tuba Export Processing Zone (RTEPZ), Barangay Rio Tuba, Bataraza, Palawan

1.2 Profile of the Proponent

Name of Proponent:	Coral Bay Nickel Corporation (CBNC)
Office Address:	Rio Tuba Export Processing Zone (RTEPZ), Barangay Rio Tuba, Bataraza, Palawan
Contact Person:	Engr. Arturo Manto *Vice President – Environmental Management*
Tel No.:	+632 5487110 / +632 8563930

1.3 Profile of the Preparer

EIA Preparer:	Gaia South, Inc.
Office Address:	7th Floor Montepino Bldg., Adelantado cor. Gamboa St., Legaspi Village, Makati City
Contact Person:	Liezyl S. Liton-Relleta *Project Director*
Tel No.:	(02) 893-5661

1.4 Project Background

Major Project Components

Table ES1 shows the comparative components of the existing operations of CBNC and its proposed expansion.

Table ES1. Comparative components of plant operations

Project Features	Existing Operations (Lines 1 and 2) ECC 0701-002-3721	Proposed Expansion	Combined Features
Approved area for operation	• Area of Plant Site: 44 hectares • Area of Pier Site: 19 hectares • TSF1: 90 hectares • TSF2: 207 hectares • Gotok Quarry: 13 ha	TSF3: 111 hectares	471 hectares
Capacity	25,000 DMT Ni per year	same	same
	1,875 DMT Co per year	625 DMT Co per year	2,500 DMT Co per year
Gotok Limestone Quarry (Capacity)	372,000 MT per year	Not Applicable (covered under separate ECC application)	
No. of Tailings Storage Facility	2	1	3
Tailings dam capacity	40 M m^3	18.6 M m^3	58.6 M m^3
Area of Tailings Storage Facility	• Tailings dam 1: 90 hectares • Tailings dam 2 : 207 hectares	Tailings dam 3: 111 hectares	408 hectares
Total Ore Requirement	2-2.5 Million DMT	same	same
Manpower	• During Operation: • Permanent: 600 • Contractual: 1,500	During Construction: • Contractors: 62 • Sub-con: 332	During Operation: • Permanent: 600 • Contractual: 1,550
Water Source	• Intake dam at the East Ibelnan River for Lines 1 and 2 water supply • Upper Togpon siltation pond and a 300,000 m^3 water reservoir as alternative sources of water	Same as existing	Same as existing
Water Requirement	30,000 cubic meters/day	Same as existing	Same as existing

Power Source	Maximum of 14.5 MW Coal-fired boiler and turbine power plant per Line
	• Breakdown for Line 1:
	  ○ 11 MW Coal-fired boiler and turbine power plant
	  ○ Back-up: two (2) units 1.5 MW each diesel generators, or 3 MW total
	• Breakdown for Line 2:
	  ○ 11 MW Coal-fired boiler and turbine power plant
	  ○ Back-up: Two (2) units of 1.64 MW each diesel generator, or 4.92 MW total
	• Additional: two (2) units of 0.072 MW each diesel generators, or 0.144 MW total installed at the pier site and 1.5 MW Diesel Generator installed at HPP Line 2 used as back-up power supply for the townsite
		Same as existing	Same as existing

Power Requirement	*About 135 Million kw-hrs/year	Same as existing	Same as existing
Causeway	380 m long, 3.5 m high, 14 m wide road and 17 m base width, concreted	Same as existing	Same as existing

Project Features	Existing Operations (Lines 1 and 2) ECC 0701-002-3721	Proposed Expansion	Combined Features
	surface		
Trestle	1,080 m long, 5 m high from sea level and 2.5 m wide.	Same as existing	Same as existing
Other facilities	• Effluent discharge facilities • Pier site (land-based operations) • Coal, ore and other raw materials, and finished products stockpiles	Same as existing	Same as existing
Shared Facilities with RTNMC and Unichamp Mineral Philippines, Inc. (UMPI)	• Access Roads (RTEPZ) • Macadam Road	Same as existing	Same as existing
Investment cost (PhP)	22.9 B	7.3 B	30.2 B

*Note:*Average of five (5) years power consumption as indicated in the Compliance Monitoring Report (CMR)*

2.0 PROCESS DOCUMENTATION

2.1 The Environmental Impact Assessment (EIA) Report

The proposed CBNC Expansion Project as per Environmental Management Bureau (EMB) Memorandum Circular 005-2014, is classified as Category A or Environmentally Critical Projects (ECP). The ECC application for an existing and to be expanded project under Category A, shall be applied to the EMB Central Office. An EPRMP shall be submitted as its documentary requirement. The EPRMP shall contain the following:

- Project Description;
- Assessment of Environmental Impacts;
- Environmental Management Plan;
- Environmental Risk Assessment (ERA) & Emergency Response Policy and Guidelines;
- Social Development Plan/Framework and IEC Framework;
- Environmental Compliance Monitoring;
- Decommissioning/Abandonment/Rehabilitation Policy; and
- Institutional Plan for EMP Implementation.

For the preparation of the EPRMP, CBNC contracted the services of Gaia South Inc., a third party Environmental Consultancy firm. To guide both the proponent and its preparer in the conduct of the Environmental Impact Assessment (EIA) and writing of the EPRMP, a Technical Scoping Meeting was conducted on July 7, 2016 at the CBNC Project Site. List of attendees of the meeting is provided in the Technical Scoping Report attached as **Annex ES1**. During the meeting, the EMB Case handlers, Review Committee Members, CBNC and Gaia South Inc. representatives agreed on the coverage of the Technical Scoping Checklist (**Annex ES2**).

2.2 Limitation of the Study

The Technical Scoping Checklist served as guide in limiting the imperative information needed in this EPRMP. Experts from different field of interest prepared this comprehensive report based on primary data gathered through actual fieldwork and secondary data sourced from the barangay and municipal offices and other related agencies such as the National Mapping and Resource Information Authority (NAMRIA), Palawan Council for Sustainable Development (PCSD), Philippine Institute of Volcanology and Seismology (PHIVOLCS), Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Bureau of Soils and Water Management (BSWM), and Mines and Geosciences Bureau (MGB), among others.

2.3 The Project Team

Table ES2 shows the roster of Gaia South team of experts who participated in the conduct and preparation of this report. Gaia South Inc. is a registered Firm Preparer of EIA Reports under the Philippine Environmental Impact Statement (EIS) System as per EMB MC 2013-003 with registration no. FPCO-006. The Certificate of Registration given to Gaia South Inc. is presented as **Annex ES3**. **Annexes ES4** and **ES5** are the Accountability Statements of CBNC and Gaia South, Inc., respectively.

Table ES2. List of EIA team members, their respective field of expertise and their preparer registration number

Consultant/Researchers	Module/Position	Registration No.
Liezyl S. Liton-Relleta	Project Director	IPCO-064
Ernesto Dela Cruz, PhD	Team Leader/Air Quality/Water Quality/ Technical Reviewer	IPCO-308
Emmanuel G. Ramos, PhD	Geology	IPCO-117
Perfecto Evangelista, PhD	Soils and Land use	IPCO-179
Edwino Fernando, PhD	Terrestrial Flora	-
Judeline Dimalibot, MSc	Terrestrial Fauna	IPCO-176
Davee Drake Medina, MSc	Hydrogeology	IPCO-174
Emiterio Hernadez, MSc	Flood Modelling and Sediment Transport Modelling	IPCO-244
Katherine Escalona, MSc	Marine Ecology Assessment	IPCO-180
Melanie Manaog, MSc	Technical Writer	IPCO-177
Thelma D. Dela Cruz, MSc	Environmental Risk Assessment	-
Merlyn Carmelita Rivera, PhD	Socio-economics	IPCO-298
Monette Bato, PhD	Public Health	-
Hanna Bermillo-Arriesgado, MSc	Technical Associate/Team Coordinator	IPCO-181
Danica Dela Rosa	Technical Associate	IPCO-175

2.4 The EIA Study Schedule and Area

The proposed expansion project will cover the construction of additional Tailings Storage Facility (TSF3) and increase the annual cobalt production limit of the current Hydrometallurgical Processing Plant (HPP). TSF3 and the HPP plant are located inside the Rio Tuba Export Processing Zone (RTEPZ) in Barangay Rio Tuba, Municipality of Bataraza, Province of Palawan. Specifically, TSF3 will be constructed at the northeastern side of the existing GP-4 Rehabilitation Area of the Rio Tuba Nickel Mining Corporation (RTNMC). Its location will fall within the boundaries of Barangays Rio Tuba and Ocayan. **Figures ES-1** and **ES-2** depict the location and vicinity maps of the proposed project, respectively. The proposed expansion area is within the “multiple-use zone” based on the Environmentally Critical Areas Network (ECAN) Map of the Palawan Council for Sustainable Development (PCSD) as illustrated in **Figure ES-3**. The site development plan is also included as **Figure ES-4** showing the major and auxiliary facilities of CBNC while the geographic coordinates including the proposed expansion area is listed in **Table 1.2.1**.

Table ES3 shows the study schedule for this particular EIA starting from fieldwork activities to the finalization of the EPRMP.

Table ES3. EIA study schedule

Activity	Period
Environmental and Social fieldwork	August to September 2016

Activity	Period
Date gap analysis	October 2016
Draft EPRMP writing	September to November 2016
Submission of EPRMP to EMB for 1st technical screening	December 2016
Submission of EPRMP to EMB for 2nd technical screening	April 2018
Submission of EPRMP to EMB for substantive review	April 2018
Finalization of EPRMP	*To be finalized*

2.5 The EIA Methodology

Various studies for land, water, air as well as the social aspects were conducted in such a way that all the technical, environmental and regulatory requirements dictated in the Technical Scoping Checklist were satisfied. Furthermore, this report is a product of the professional and scientifically acceptable methodologies and procedures by the DENR.

2.6 Public Participation

CBNC has been conducting its Information, Education, and Communication Campaign (IEC) as seen in Annex 5.2.1. During these meetings, the issues raised were concerns about the operation of the HPP and the proposed TSF3. Please refer to **Annex ES6** for the summary of issues during the IEC and FGD, as well as the MMT findings.

In the matrix of issues and concerns (**Annex ES6**), several items related to the operation of CBNC can be categorized into various aspects. Foremost is the implementation of the SDMP. According to the community members, there should be a separation of procurement needs for the SDMP to avoid delays in the implementation of Project, Program, and Activities (PPAs). Furthermore, to be able to be assured of sustainability of projects, appropriate trainings on financial management and other tools to attain profitability and good leadership must be pursued. Also, the identification of projects must be done by the members of the barangays who are definitely knowledgeable and aware of their needs. This must be implemented with the assistance and guidance of the ComRel and other experts.

The activities undertaken by the ComRel were also pointed out by the community members. There are times that the ComRel allegedly controlled all SDMP projects - even the purchase of materials and/or other supplies needed in the implementation of the PPAs. Moreover, IEC on project accomplishments and environmental protection must be conducted regularly according to the residents of the barangay.

Hiring by the company must give priority to the members of the community. Even women weighed in on the issue that more males are hired compared to females. It was likewise suggested that the company must be more transparent in reporting accident incidences.

The bad smell emanating from the CBNC plant site was a concern forwarded. Issues on water and soil pollution, and fish kill allegedly caused by CBNC must continuously be taken into consideration during regular IECs to explain to the residents how the company complies with the environmental standards.

The fear of water from the dam being washed out during strong rains has been broached by the residents. In this regard, a suggestion to conduct trainings on safety and disaster preparedness was forwarded.

There was also an issue that the IPs are given priority and preference in extending benefits and privileges by the company. The Muslims felt that they have been disregarded and left out.

Barangay Sapa SDMP fund is allegedly managed not by the barangay officials but by a certain person. The barangay feeding program and assistance to high school students have been held in abeyance to give way to the other projects led by a certain person. As reported, this has caused frustration on the part of the barangay official.

There were concerns aired out regarding the proposed TSF3. Foremost of this is the fear of the residents concerning the integrity and strength of the TSF3. They inquired whether the structure will not crack given the inclement weather conditions. Furthermore, the fear of landslides as a result of soil movement was stated. There were also concerns that water pumps might be adversely affected as a result of the proposed project.

The residents of Barangay Ocayan were concerned about the possibility of being relocated as a result of the project. Moreover, the Ocayan residents suggested if possible, to locate TSF3 in Barangay Sumbiling. According to them, Sumbiling has a lot of trees compared to their barangay. The trees, they said, will filter the dust and other emissions that may arise.

There were two (2) barangays that expressed frustration for being left out in the endorsement of the project. Representatives from Barangay Taratak mentioned that distance should not be the only basis in determining direct impact barangays. Other criteria, such as the degree of impacts should also be considered. They feel that they will be severely affected by the proposed project as well as Barangay Sandoval.

Table ES4 provides the summary of the EIA methodology.

Table ES4. The EIA methodology

Component	Description
Soil and Land Use	• Use of Comprehensive Land Use Plan (CLUP) of the Municipality of Bataraza for 2013 to 2023; Environmental Critical Areas Network (ECAN) Map; National Mapping and Resource Information Authority (NAMRIA) Map and Google Earth Imagery as references.
Geology and Geomorphology	• Use of available reports, geology literature and information to describe site's existing condition; Use of geological and seismological data lifted from publicly available international and local sources.
Pedology	• Soil characterization was made through a 30-cm borings in the representative sites of the soil mapping units of the soil type within the project area. • Eight soil sampling sites were established. • For each soil unit, erosion susceptibility was determined based on a contributing factor taken at a time. Food and Agriculture Organization (FAO) guidelines was used as reference. • Among the parameters considered were pH, total organic matter, total nitrogen, total organic carbon, and particle size) and heavy metal content such as cadmium (Cd), chromium (Cr), copper (Cu), Iron (Fe), manganese (Mn), potassium (K), and zinc (Zn). • The Final Erosion Susceptibility Rating, Soil Suitability Classification, and Erosion Susceptibility were also determined.

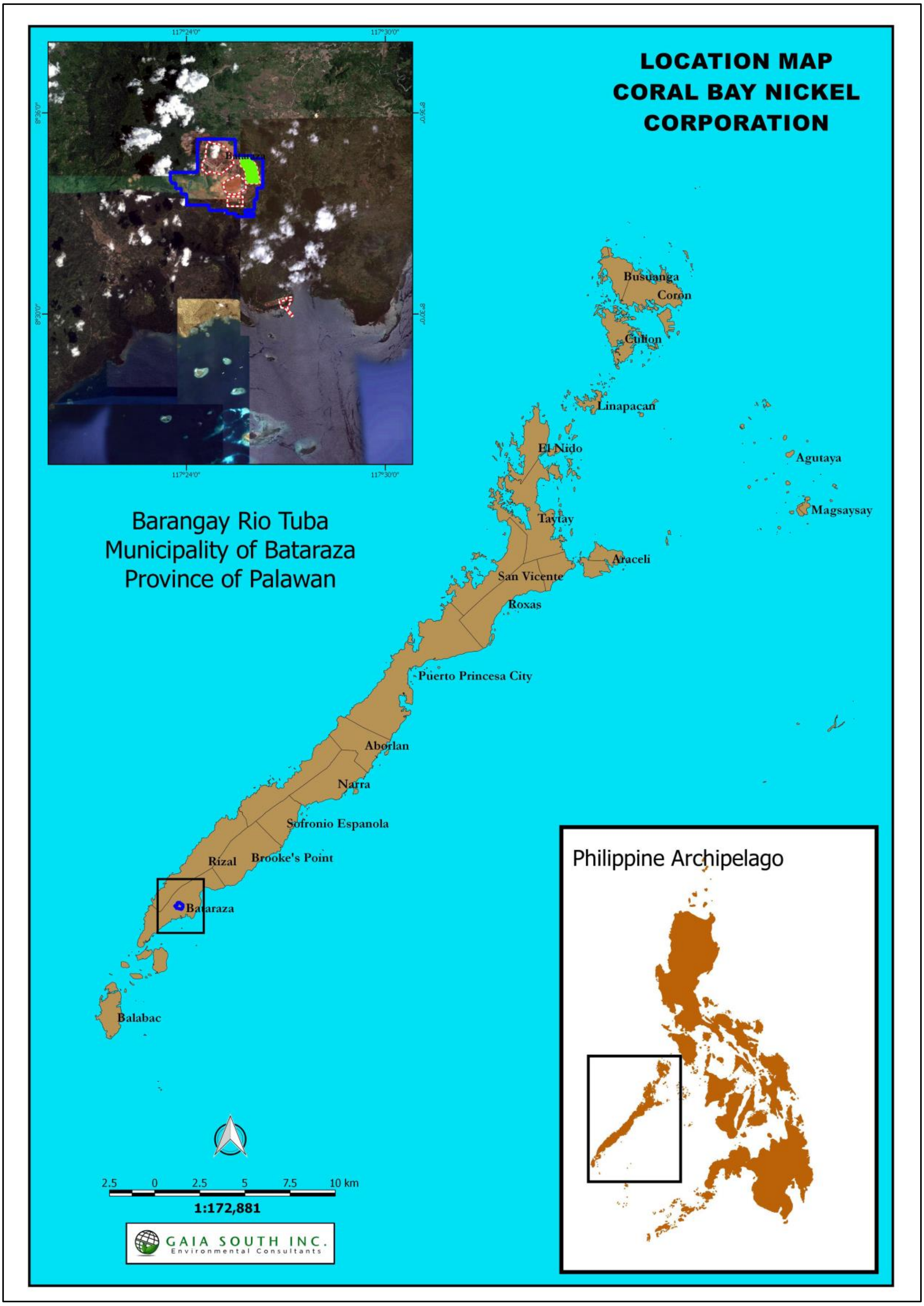


Figure ES-1. Location map of the proposed CBNC expansion project

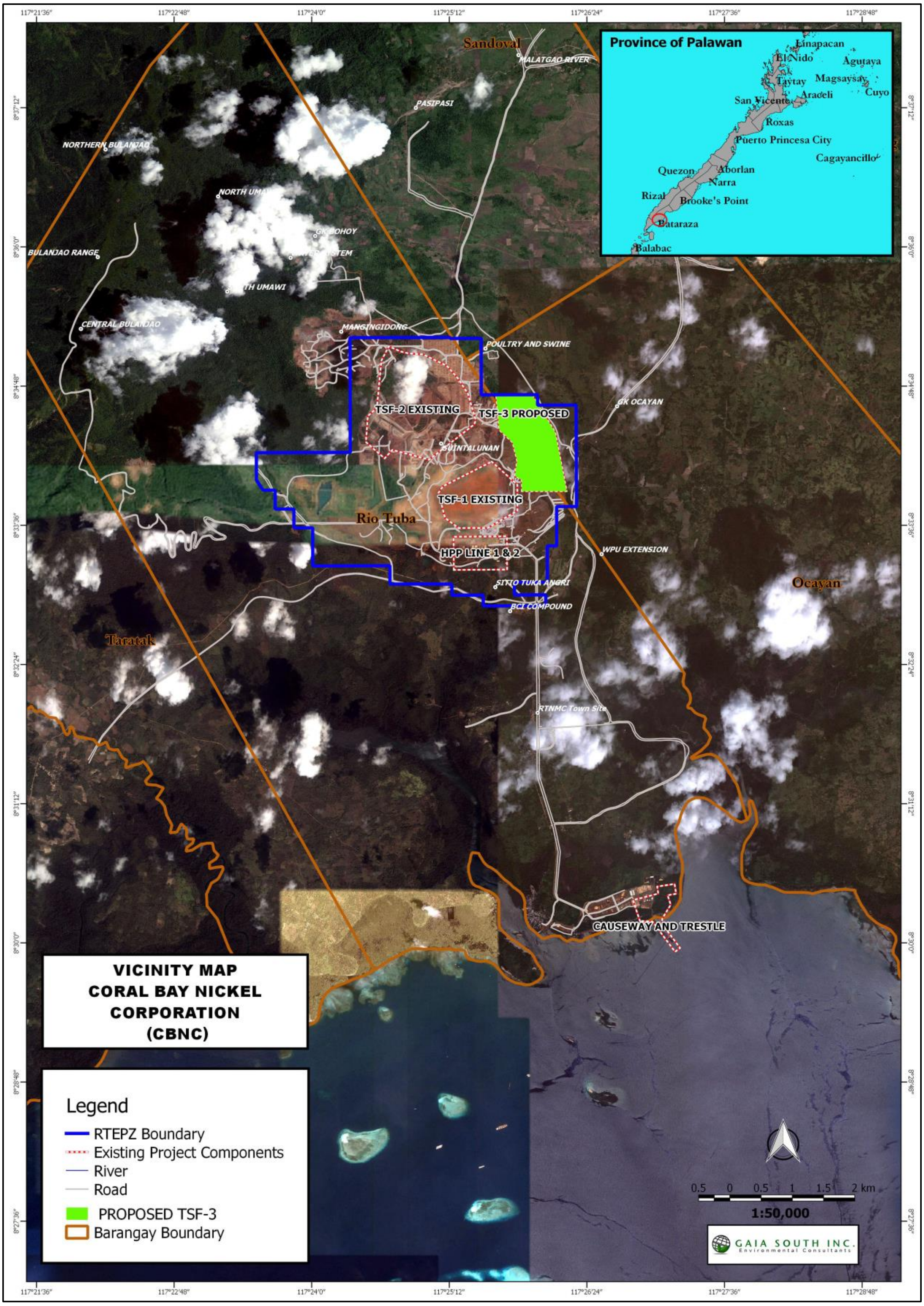


Figure ES-2. Vicinity map of the proposed CBNC expansion project

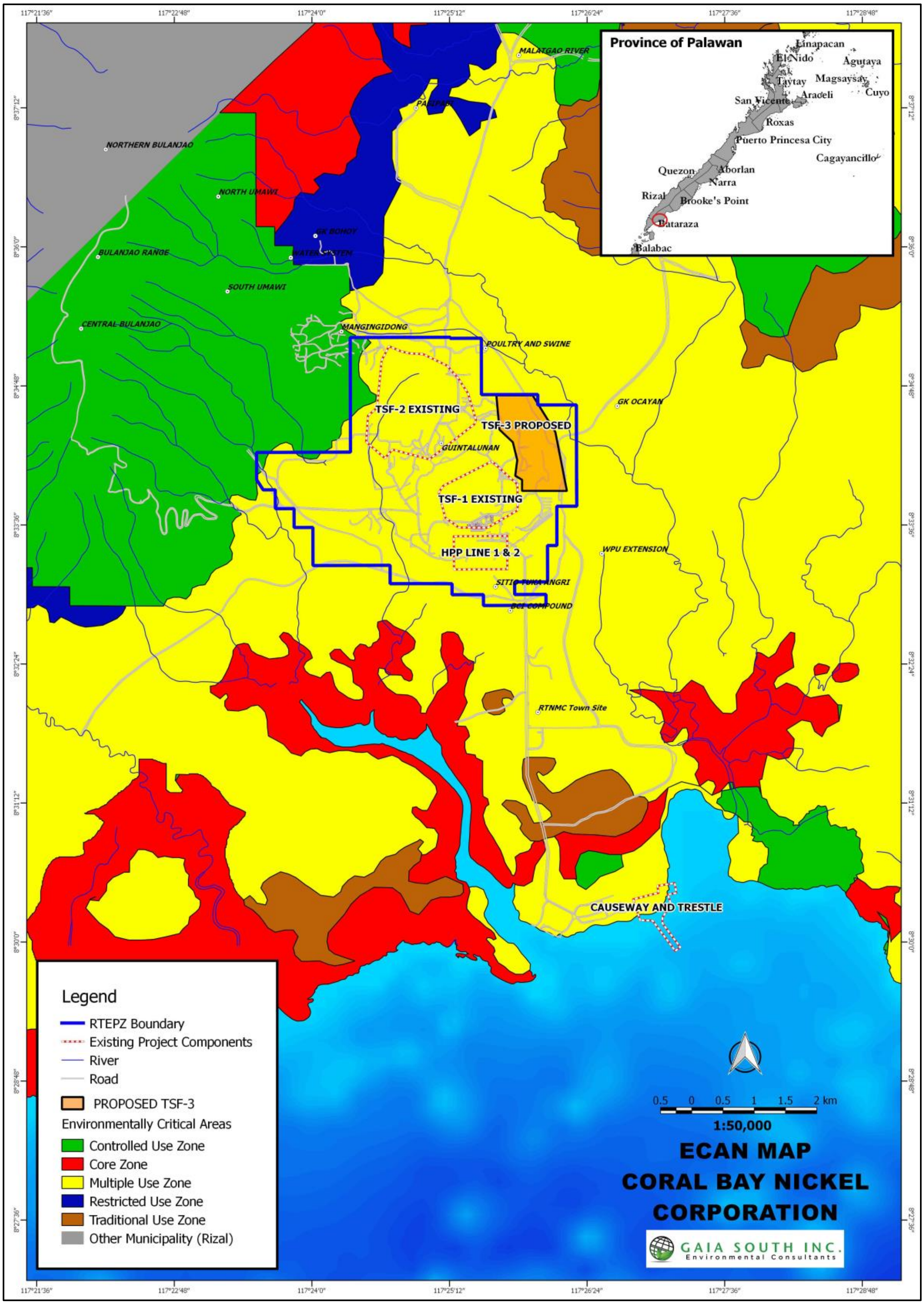


Figure ES-3. ECAN map of PCSD illustrating the location of TSF3 and CBNC HPP in a "Multiple-Use Zone"

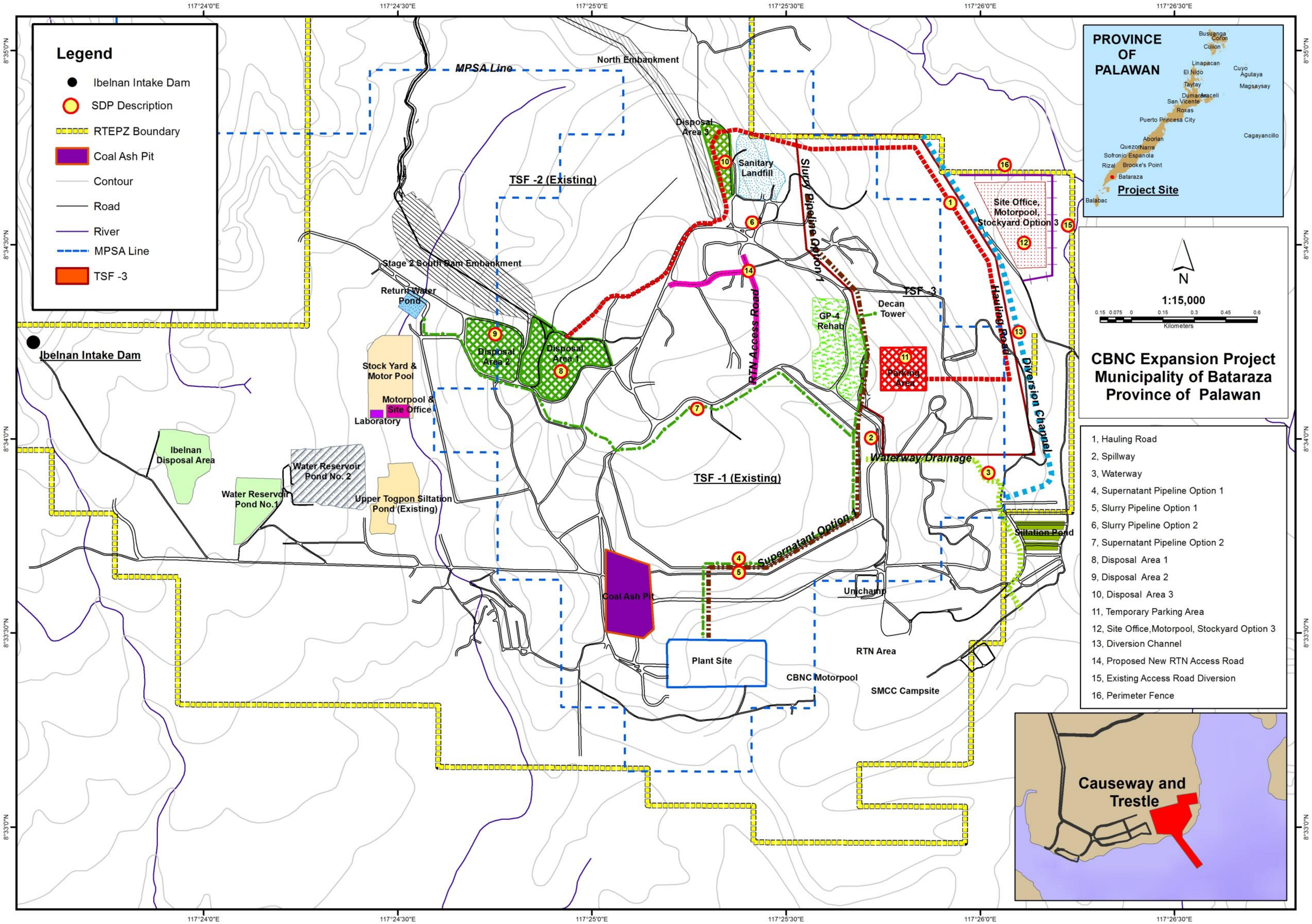


Figure ES-4. Site Development Plan of CBNC Expansion

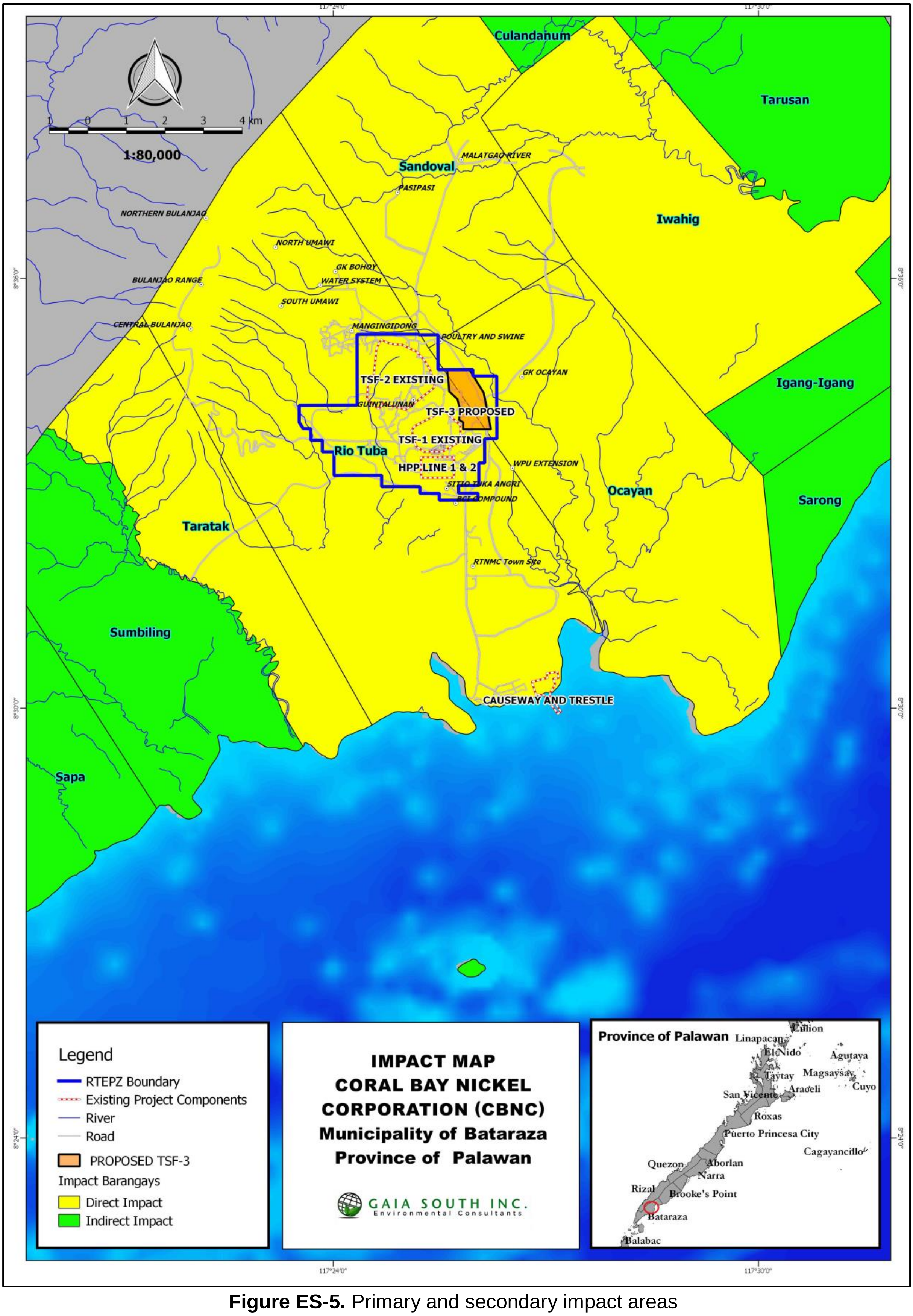


Figure ES-5. Primary and secondary impact areas

Table ES4 Con't.

Component	Description
Terrestrial Flora	• A reconnaissance survey of the area was initially undertaken to determine the potential locations of the vegetation sampling plots. • Sixteen plots were established. Each plot (10 m x 10 m) was divided into sub-plots using the four cardinal directions *i.e.,* subplot 1 (NE), subplot 2 (SE), subplot 3 (SW), subplot 4 (NW). In each subplot, an inventory of the vascular plants present was conducted. • Measurement of diameter at breast height (dbh) was undertaken for trees with more than 10 cm dbh. Smaller quadrats measuring 5 m x 5 m and 1 m x 1 m were also established within the 10 m x 10 m plot. The 5 m x 5 m quadrat was established to quantify the intermediate vegetation. A 1 m x 1 m quadrat was established to account for undergrowth vegetation. • Transect line established within the grassland was approximately 800 m long. Observation points were made every 200 m along the transect line. • Using the site development plan map provided, the location of the plots and transect line was determined and the plots were established. • Specimens (about 30 cm of twig with leaves and flowers and/or fruits) of species that were not readily identifiable in the field were collected, inserted between sheets of old newspapers, placed in large plastic bags, and preserved with denatured alcohol. These were subsequently processed as herbarium material for proper identification in the laboratory. • Among the parameters considered were density, dominance, frequency, Relative Frequency, Relative Dominance, Relative Frequency, and Importance Value.
Terrestrial Fauna	• Standard field methods and procedures were used for each taxon during the survey. • Four transects were established. Transect walks were done twice, once in the morning from 5:30-8:00am and 4:00-6:00 in the afternoon. • Direct and indirect transect identification such as tracks, signs and auditory cues, trapping and mist-netting were used. Microhabitat searches for amphibians and reptiles (herps) were done while conducting transect walk in the immediate vicinities of the transect line, 5 meters to the left and 5 meters to the right. • Diversity indices (species diversity, species richness were computed using the PAleontologicalSTatistics (PaST), ver. 1.42 by Hammer, Harper and Ryan (2016).
Hydrology/ Flood Modeling on the Dam Break Scenario for TSF3	• Use of meteorologic data sourced from the PAGASA and from the mine site rainfall monitoring station established by RTNMC from 1996 to 2015 and the automatic weather station established by Coal Bay Nickel Corporation (CBNC) that monitored maximum, minimum and mean temperature, among other parameters. • Conduct of water source inventory. • The monthly and annual PET in the area was computed using the Thornthwaite Method (Knödel, et al, 2007). • Since there are no long-term stream flow measurements for any river in Palawan, the discharge of Okayan and Tuba rivers were estimated from the long-term water balance of its watershed. The long-term water balance is expressed by the equation P = AET – Q – GR, where P, AET, Q and GR represent rainfall, actual evapotranspiration, stream discharge and groundwater recharge respectively (Sokolov and Chapman, 1974). • A hypothetical breaching of a dike was conceptualized using the 2D version of the HEC-RAS model wherein the assumed collapsed is about 10 m width at the bottom of the dike with 45 degree slopes each side.
Water Quality	• Use of the quarterly Self-Monitoring Report (SMR) of CBNC. • Collection of water samples from two (2) marine stations, one (1) effluent, one (1) surface freshwater and one (1) groundwater . The sampling was carried out on Sept 22, 2016. • Methodology for conducting the water quality assessment study in the project area was based on the Water Quality Monitoring Manual issued by the Environment Management Bureau and the Philippine National Standards for Drinking Water (PNSDW) specified by Department of Health Administrative Order No. 2007-12. The procedure for field assessment, site selection, sampling and analysis are specified in the above references. • The parameters considered were pH, temperature, total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), fecal coliform, total coliform, lead, arsenic, cadmium, zinc, copper, nickel, iron, manganese, chromium (hexavalent and total) and Oil and Grease.
Physical Oceanography	• The physical oceanography surveys were conducted south of Rio Tuba where Ocayan and Rio Tuba rivers drain to the Ocayan-Coral Bay, covering approximately 720 hectares of coastal sea. • An automatic water level logger was deployed at a fixed location within the CBNC's port on August 18, 2016 at 5:45 PM until August 20, 2016 at 5:00 PM to monitor the Bay's

Component	Description
	actual tidal fluctuations. • Sub-surface currents were observed from three stations using a drifter. A float board was attached with stainless fins which can be adjusted from 0.5 - 1.5 m, and was mounted on top with an airtight container to house a GPS which recorded the geographic location and hence, trajectory of the drift as it is moved by the ocean currents hitting the submerged fin of the drifter. • A bathymetrical survey was conducted covering about 720 hectares of the bay off the coast of Rio Tuba using Garmin GPSMAP® 421s with a dual frequency transducer (Sonar). For depth measurement, the operating frequencies were either at 50 kHz or at 200 kHz, which automatically switches alternately depending on the water depth.
Freshwater Ecology	• Secondary data from the previous EIAs conducted were used. • Sampling sites considered were two (2) stations within Ocayan River. • Plankton community was sampled by collecting 30L surface waters with a dipper. The water passed through a plankton net with mesh size of 65um. The net was backwashed by repeatedly dipping it to the water column to remove any clinging organisms. The sample collected from the cod end of the net was transferred to plastic bottles and treated with 1% formalin to preserve integrity of the collected samples. Bottles were transported to the laboratory for taxonomic identification. • Benthic community was sampled using a modified surber sampler. A Muslin cloth net was attached to a scoop frame, which was then deployed on flowing portion of the water body. Approximately 1 m^2 of the upstream portion was disturbed to dislodge benthic animals. Samples was preserved in ethyl alcohol and transported to the laboratory for taxonomic identification. • Heavy metals contents (arsenic, chromium, nickel, lead, mercury and cadmium) of fish caught in Ocayan river were tested.
Marine Ecology	*Plankton* • For the plankton sampling, ten (10) stations were considered. Sampling of the microscopic plankton made use of plankton net with 25µm diameter net. A 30-liter surface water was collected from each site and passed through the net. The collecting net was repeatedly back- washed to remove clinging organisms on the inside part of the net. The collected water at the cod-end of the net was transferred to a collecting bottle labeled with site name. Samples were treated with 1% formalin (v/v) as preservative and fixative. Samples were transported to the laboratory for taxonomic identification and density counting. *Fish and Corals* • Researchers in SCUBA gear lay fiber glass transect line haphazardly on the reef crest of each site with reef. Where there is no visible crest as in the case of coral bommies, the transect line is laid where there is flat surface. Percent cover (%) is taken by adding the length of each lifeform category over the total length of the transect line (English et al., 1996). Observations were also made for interesting biological species left and right of the transect. • For fish and corals, seven (7) sites were surveyed. *Seagrass* • For sites with seagrasses, a .5m x.5m quadrat was used to gather samples. The quadrat was further divided into smaller squares by nylon string every 10cm with each quadrat having 25 small squares. The quadrat was randomly thrown in the seagrass area five times to constitute a total sampling area of 1.25 m^2. For each quadrat, seagrass cover was estimated. Species were identified using field guide. • Seagrass assessment were conducted in five (5) sites. *Heavy metal contents of marine fish flesh* • Two (2) fish samples were collected from in-situ fishers. Species were segregated into trophic level. For this analysis, carnivores refer to groupers (Plectropomus and Epinephelus) while rabbitfish (Siganus) were referred to as herbivores. Samples for each trophic group was sent to the laboratory for heavy metal analysis, specifically for Arsenic (As), hexavalent chromium (Cr^{6+}), copper (Cu), nickel (Ni), and lead (Pb). These metals are known.
Meteorology	• Climatological data were obtained from PAGASA. The closest synoptic station of PAGASA relative to the proposed project site is the Puerto Princesa Synoptic Station in Palawan. This station has available record since 1981. Climatologic indicators for the area include mean temperature, rainfall, relative humidity, wind speed and direction. • Other relevant information gathered from PAGASA is the climate and typhoon frequency maps and the 2020 and 2050 climate projection (Climate Change in the Philippines, 2011).

Component	Description
Air Quality	• The ambient air quality at the project site was assessed following the DENR Administrative Order (DAO) 2000-81 (Implementing Rules and Regulations of the Philippine Clean Air Act of 1999). • Five sampling stations were established covering the proposed project site and the receptor area. The 24-hour ambient air quality sampling was conducted on August 2016. • The sampling procedures were based on USEPA, 40 CFR Part 50, (Appendix A, M, and L) and EMB Air Pollution Monitoring Manual (1994). A 24-hour ambient sampling for analysis of particulate matter 10 microns (PM10), total suspended particulate (TSP), gaseous pollutants (NO_2, and SO_2) and heavy metals (As Cd, Pb, Hg, Ni & Cr) was done for each sampling station. • Air sampling was conducted and analyzed by Industramach Corporation, a DENR accredited air quality sampler. The instrument used was a BGI PQ200 PM10 Sampler and a Graseby High Volume Sampler for TSP. For SO_2 and NO_2, a Graseby Gas Bubbler Sampler was used. The SO_2 and NO_2 samples were preserved in an icebox, PM10 and TSP filters were placed inside clean envelop. All samples were submitted to the laboratory for analysis. PM10 filters were analyzed at Industramach gravimetric/balance room.
Noise	• The same sampling stations (five stations) used for the CBNC EMP TSP monitoring were also used for noise level monitoring in compliance with the Environment Monitoring Plan of CBNC. • A Digital EXTECH 407764 sound meter that meets the American National Standard Institute (ANSI) standard was used in measuring noise level. The arithmetic median of the readings was taken and compared with the National Pollution Control Commission (NPCC-1981) noise standards.
People	• The baseline data was sourced from the barangay profiles provided by each barangay and the profile of Bataraza provided by the Municipal Planning and Development Office (MPDO). • A perception survey, focus group discussions (FGD) and key informant interviews (KII) were conducted for the direct impact barangays - Rio Tuba and Ocayan. • A total of 371 respondents for the perception survey were randomly selected from the two direct impact barangays, 334 for Rio Tuba and 37 for Ocayan. • FGDs were conducted in Taratak, Sandoval, and Iwahig as these had been identified in previous studies as impact areas and the team felt that focus should also be given them in terms of gathering more information for better planning and recommendation setting. • Key informant interviews were conducted with the barangay captains of the other indirect impact barangays - Sumbiling, Igang-igang, Sarong, Culandanum, and Tarusan. • The sample sizes for the household survey were determined with consideration of the household population size, the level of confidence, that is, 95% and margin of error of + or – 5%. The total combined sample size of three hundred seventy-one (371) respondents was derived using the Slovin's Formula.

2.7 Delineation of Impacts Areas

Currently, the CBNC operations consider 11 impact barangays that are covered by the Social Development and Management Program (SDMP). These are Barangays Rio Tuba, Ocayan, Taratak, Iwahig, and Sandoval as host barangays and as primary impact areas and six (6) neighboring barangays (Sumbiling, Sarong, Igang-igang, Culandanum, Tarusan, and Sapa), which are considered as secondary impact communities **(Figure ES-5)**.

The primary impact areas are delineated based on the following:

- Within the Rio Tuba Export Processing Zone (RTEPZ); and
- As host area for the plant facilities and haulage road.

No additional barangays will be adopted under the SDMP with the proposed TSF3 as it will be located within Barangays Rio Tuba and Ocayan.

The Municipality of Bataraza is considered as the Regional Impact Area (RIA) of the project as the impacts, mostly of social contributions may be experienced. The whole province of

Palawan will also be indirectly affected by the proposed project due to social benefits that will arise from the operations.

3.0 SUMMARY OF BASELINE CHARACTERIZATION

Table ES5 presents the summary of profile of the environment and people in the identified impact areas of the proposed project based on secondary information and actual observations.

Table ES5. Summary of profile of the environment and people

Component	Description
Land-use	• Based on the land use map of Bataraza, the project site is classified as mineral development area. • It should also be noted that the HPP and its auxiliary facilities and the proposed Tailings Storage Facility No. 3 are located within the 990 ha mining claims of RTNMC and specifically within the area Rio Tuba Export Processing Zone (RTEPZ). • Moreover, the area is a classified as a multiple-use zone based on the PCSD ECAN Map.

Geology	• The project site lies on gentle topography on the southern foot slopes of Bulanjao Mountain Range.
	• Southern Palawan in underlain by seven major rock units, listed below from oldest to youngest:
	    • Late Cretaceous Mt. Beaufort Ultramafics;
	    • Late Cretaceous to Early Eocene Espina Formation;
	    • Paleocene to Early Eocene Panas Formation;
	    • Oligocene Pandian Formation;
	    • Late Miocene Sayab Formation;
	    • Pliocene Iwahig Formation, and
	    • Quaternary Deposits.
	• The proposed site for the new tailings storage is mostly underlain by ultramafic rocks consisting of serpentinized harzburgite, dunite, peridotite, and pyroxenite.
	• Palawan including Brgy. Rio Tuba is located in a tectonically stable region. It lies several kilometers from known active faults and trenches that are the main seismic generators in the archipelago.

Pedology	• Tagburos clay loam as the soil type in the proposed TSF3 was subdivided into two (2) soil mapping units based on differences in slope ranges. • The soil mapping units are the Tagburos clay loam, 3-8% slopes, and Tagburos clay loam, 8-18% slopes. <u>Physical and Chemical Analysis</u> • Tagburos clay loam 3-8% slopes is a well-drained sandy loam to silty clay loam soil, soil reaction ranges from medium acid to neutral (pH 6.0 to pH 6.6). Nitrogen is very low (0.03-0.05%). Organic matter ranges from very low to low (1.38- 2.69%), while potassium is very high (1.06-11.1 cmol/kg). The natural fertility of this soil is low. • In this soil the heavy metals (cadmium, copper, lead and zinc) are below the contamination levels as prescribed by the Taiwanese standards for cadmium (5mg/kg), copper (200mg/kg), lead (500mg/kg), and zinc (500mg/kg). Chromium, which ranges from 870-2960 mg/kg is above the contamination level for chromium of 400 mg/kg as prescribed by the Taiwanese standard. Chromium Hexavalent is not detected. Iron, which ranges from 13.0-21.5% is above the range of Iron in soil. Manganese with 1560-2370 mg/kg is within the range of manganese in soil. • Tagburos clay loam, 8-18% slopes is a well-drained sandy loam soil (disturbed soil- formerly mining area). Soil reaction ranges from slightly acid to mildly alkaline (pH 6.1- 7.7). Nitrogen is very low (0.03%). Organic matter is very low (1.60-1.62%), while potassium is very high (1.9- 2.4 cmol/kg. Natural fertility of this soil is low. • In this soil the heavy metals (cadmium, copper, lead and zinc) are below the contamination levels as prescribed by the Taiwanese standards for cadmium (5mg/kg), copper (200mg/kg), lead (500mg/kg), and zinc (500mg/kg). Chromium, which ranges from 870-2,960 mg/kg is above the contamination level for chromium of 400mg/kg as prescribed by the Taiwanese standard. Chromium hexavalent is not detected. Iron, which ranges from 13.0-21.5% is above the range of Iron in soil. Manganese with 1,560-2,370 mg/kg is within the range of manganese in soil.

Component	Description
	<u>Final Erosion Susceptibility</u> • Based on the Soil Erosion Susceptibility Map, the forest on Tagburos clay loam with 8-18%, slopes is with "slight susceptibility to erosion". The Shrubland on Tagburos clay loam with 3-8% slopes is with "slight susceptibility to erosion". The grassland on Tagburos clay loam with 3-8% slopes are with "slight susceptibility to erosion". The bare area (mining area) on Tagburos clay loam with 3-8% and 8-18 % slopes are with "moderate susceptibility to erosion".
Terrestrial Flora	• Seventy-seven species of vascular plants belonging to 43 families were recorded in the area. These species include trees, shrubs, herbs, palms and vines. • The species richness of the project area constitutes only 2.20% of the estimated flowering plants (roughly 3,000–3,500) found in Palawan • The number of species recorded is relatively few due to its existing land-use. The project site is part of the active mining area of RTNMC and previously used as stockpile area for lateritic soil for processing and export. • In the project area, there are 14 species in the threatened plant list based on PCSD Resolution 15-521, Series 2015 and DENR DAO 2007-01. • Among these 14 species, one (1) species and a large tree palm endemic to Palawan, *banga* (*Orania paraguanensis*), is under the c*ritically endangered* (CR) category, while another, the pitcher plant *kuong-kuong* (*Nepenthes philippinensis*), also endemic to Palawan, is in the *Endangered* (EN) category. • At least 10 species are in the *Vulnerable* (VU) category and one species in the *Other Wildlife Species* (OWS) / Lower Risk / least concern (LR/lc) category. • The IUCN Red List (IUCN 2016) also includes four species recorded from the project site as threatened, viz. *guijo* (*Shorea guiso*) – Critically endangered (CR); *antipolo* (*Artocarpus blancoi*) – Vulnerable (VU); and *batíno* (*Alstonia macrophylla*) and *amáyan* (*Angelesia splendens*) – Lower risk / least concern (LR/lc).
Terrestrial Fauna	• There were 35 species of birds, four (4) mammals (2 volant and 2 non-volant), and 11 herps (7 amphibians and 4 reptiles). • The highest number of species of terrestrial vertebrates was recorded from the Southern side of the proposed TSF3. • Most of the birds are specialist feeders with 37% of them insect eaters or are insectivorous. Frugivores, nectarivores, and omnivores comprise 8-9% each, while carnivores comprise 6%. The rest of the specialists comprise 3%. • Avian endemicity is at 26% and those that are deemed resident and resident/migrant species comprise 3% each. • There were only four (4) species of mammals caught in the nets and live traps. Two of these were volant and two (2) were non-volant. • All of the species of mammals are classified under Least Concern by the IUCN. • Eleven species of herps (7 amphibians and 4 reptiles) were caught by hand during herping • Sixty-four percent of the species of herps are residents while 36% are endemic to Palawan. • As for conservation status, one endemic species *Hylarana moellendorffi* is classified as Near Threatened because of the destruction of its habitat and maybe due to climate change. • *Limnonecthes acanthi*, also an endemic species is classified as Vulnerable because it is collected for food and its habitat is continually destroyed.
Hydrogeology	• The proposed TSF3 lies within the Ocayan River Watershed and the area surrounding it is drained by the Ocayan River. • A portion of the TSF3 site and the adjacent areas to the west and north used to be mining area of RTNMC. The creek that drains this area is the westernmost tributary of Ocayan River and is called Tagpisa Creek. • Tuba River drains the southeastern section of Bulanjao Range and the lowlands southeast of the mountain range, which comprises large portions of barangays Taratak and Rio Tuba. • Water balance analysis reveals that the annual rainfall, actual evapotranspiration, groundwater recharge and stream discharge within the watershed of Ocayan River amounts to 208.2, 88.5, 16.7 and 103 million cubic meters (MCM) while that of Tuba River respectively amounts to 131.4, 56.5, 10.5, and 64.4 MCM. • A Level 3 water system installed by RTNMC and CBNC serve the domestic water requirements of Bgy. Rio Tuba and also the townsite and offices of RTNMC and CBNC. • Barangays Sandoval and Iwahig and many portions of Ocayan, Igang-Igang and Sarong were also connected to a Level 2 water system likewise developed by RTNMC and CBNC in 2013. • RTNMC also has five (5) wells and are presently maintained for use in the crushing plant operations of RTNMC and CBNC and for emergency purposes.

Component	Description
Physical Oceanography	• Coral Bay near CBNC port area was influenced by a mixed semi-diurnal tide cycle. A mixed semidiurnal tide cycle is characterized by having two low and two high tides of different heights within a cycle. • Based on the observations during the time of sampling, wind velocities is about 4.38 meters per second on average blowing from the NW-SW direction. • The average sub-surface current is in the range of 0.08 to 0.22 m/s, with the lower value representing areas near the coast and higher values measured farther offshore and therefore represent the open sea sub-surface flows. • Results of the survey indicate that the general direction of the wind during the field survey was eastward which was basically influenced by the *Habagat* or the Southwest monsoon. • Based on the model, water movement within Coral Bay is faster during tidal ebbing compared to high tidal events based on the coastal circulation patterns.
Water Quality	• The fecal coliform count of the sampled groundwater was 5.1 MPN/100 ml and shows exceedance from the drinking water standards and from Class A guide values of DAO 2016-08. Note that total coliform is >23 MPN/100 ml confirms the fecal coliform finding. • For the aesthetic/primary parameters pH, temperature, oil and grease, and total suspended solids, most values throughout 2015 were in agreement with either the PNSDW 2007 or the DAO 2016-08 guide values. • For the heavy metals, all parameters were within the new DAO 2016-08 Class A guide values except for nickel which indicated a slight exceedance from the 0.020 guide value with an actual result of 0.027 mg/L. • The results indicate that the control freshwater bodies, those that have not received any of the plant discharges, generally conform to the Class C beneficial use criteria. • The results show that average of monthly values are generally within the marine water quality standards for Class SC waters except for some exceeding values for lead at station TS (Tagdalungon Shoreline). The values for both stations (0.10 and 0.155 mg/L, respectively) were above the 0.05 mg/L guide value set by DENR. The above-standard values were detected during the months of Jan-Feb and July-September. The Sept 2016 report for Pb was, however, below the detection limit of 0.02 mg/L.
Freshwater Ecology	• Ocayan River is generally depauperate of phytoplankton with total density for both stations only at 10s and 100s level only. • The profile is typical of lotic waters that do not retain much nutrients and particulates in the water column. • Upstream Ocayan is dominated by nauplius larvae, a larval stage of crustaceans. This indicates abundance of the group in the water column. In contrast, the rotifers dominate downstream portion of Ocayan. • Upstream Ocayan had five (5) documented species of bethic organisms while the downstream part has four (4). The insect group dominates in both sites, particularly the Heptageniidae, an order under insect family Ephemeroptera (mayflies). • Change in the benthic profile is very apparent when data is compared with 2005 and 2001 sampling results. There is no change in species richness profile from Ocayan upstream station but there is a change in the composition. Earlier sampling from the station showed a high dominance (hundreds of individuals per square meter) of Hydropsichidae, an order of Trichopteran insects (caddishfly) with moderate tolerance to pollution. The dominance extends downstream in 2005. • Toxic metals found in four most common fish species form Ocayan showed levels are below detectable limits except for Pb.
Marine Ecology	• The Mooring Dolphin (S1) has a live coral cover of 18.3%. Much of the benthic cover is composed of silted-over coral colonies comprising more than 75% of the bottom. • The site is notable for bleached massive coral colonies as well as tabulate corals overgrown with algae. • The Causeway (S3) is an artificial structure where hard substrate was made available for coral recruitment. • Among the three secondary impact sites, Small Sandbar (S7) has the highest live coral cover at 34.28%. The coral colonies occur on sandy bottom as bommies and on some hard substrate co-occuring with seagrasses. • Ameril Island (S9) has live coral cover of more than 35% while Ursula (S10) has more than 26%. Both sites exhibit good coral growth clear of silt deposits and clear waters. Bleached corals were not observed in both sites unlike other sites. • In terms of species richness, S6, S8 and S9 all has about 40 species. On the other hand, density is highest at 3.2 individuals per meter square at S2, a site where highest fish biomass was also documented at 182.2 g/m^2. • Among the ten sampling sites, four (4) had seagrasses: S3,S4, S7 and S8

Component	Description
	• Generally, there is low diversity and density of phytoplankton from all sites. • Cadmium was found to have 6-7 times than the Australia's standard for and more than 20 times than EU's food grade. • Lead (Pb) content of the herbivore sample exceeds EU standard by two-folds. Like Cadmium, Lead (Pb) is also a natural contaminant of fossil fuels which may be related to increased sea-going transportation in the area. • All other heavy metal species showed concentrations lower than standards.
Meteorology	• The climate in the project area is of Type III under the Modified Corona Classification of Philippine Climate. • This type of climate is relatively dry from January to April and wet throughout the year. • CBNC has three rainfall stations in Rio Tuba, which are located at Guintalunan, Mangingidong and at the Pier site. • The rainy season occurs from May to December with October being the rainiest month. • From June to February, the mean temperature is fairly constant at 26.37 to 26.93°C, with January being the coldest month. • The mean temperature exceeds 28°C during April and May, which are the warmest months of the year. The annual average temperature in the area is 26.96°C. • There are several types of wind systems that affect the province. Wind speed range from 1.0 m/s during the months of July and August to a maximum of 2.3 m/s in January. Mean annual wind speed is 1.9 m/s on general E direction. • In the Palawan area, the typhoon passage frequency is one (1) cyclone per year mostly in Northern Palawan.
Air and Noise	• The results for PM_{10} measurement show an average of 34.02 ug/Nm3 which is below the guide value of 150 µg/Ncm. The highest value was recorded at AQ-2 or Lower Kinurong. • The results for the five sampling stations show conformity to DAO 2000-81 ambient air quality guideline values for TSP, which is 230 µg/Ncm. • Total suspended particulates were below the limit and ranged only between 42.7 and 68.8 ug/Ncm during the time of sampling and averaged only 54.16 ug/Ncm. This was even lower than the measurements taken in the CBNC 2015 monitoring which ranged between 77.85 and 146.94 ug/Ncm, and averaged 124.3 µg/Ncm. • The SO_2 values for the four stations were also below the 180 ug/Ncm Guide Value, ranging only from 5.0 to 9.3 ug/Ncm and averaged 7.92 µg/Ncm. • The NO_2 values were also below the guide value of 150 µg/Ncm and averaged only 3.8 µg/Ncm, with values falling between 2.8 and 4.9 µg/Ncm. The 2015 average was 1.72 µg/Ncm and is lower than the 2016 result. • For the heavy metals arsenic, cadmium, and lead, the values recorded were all within the ambient air quality guide values. • The other heavy metals nickel, mercury, and chromium were generally not present in the ambient air except for AQ-1 which showed a Ni value of 0.18 and AQ-4 which registered a 0.1 Hg level during the time of sampling. • The 2015 ambient noise monitoring data shows that the average for all sites falls within the DENR ambient noise standard. The daytime average for all sites is 67 as against the guide value of 70. However, sites such as Stn 5-8 were exceeding the guide value. • Annual average GHG over the 8-year period is 404,019 MT $CO_{2\text{-}e}$.
Socio-economics	*Bataraza* • In the 2010 Census of Population and Housing released by NSO, the total population of Bataraza was 63,644. • Based on the 2008 CBMS survey results, Bataraza has 7,561 households. • The 2008 CBMS results showed that the basic literacy rate of persons with ages 10 years old and above in the municipality was 79.34%. • Employment rate in the municipality stood at 91.69% or 8,419 employed individuals from its labor force population of 9,182. *Host/Direct Impact Barangays* **Barangay Rio Tuba** • The population of Rio Tuba in 2013 survey is 17,689. • The average percentage increase in household population for 2013 and 2014 is 10.9% and 10.93% • Household accounts show that out of 4,544 households in 2013 Household Actual Survey (HHAS) it has increased by 372 with a total of 4,196 in the year 2014 survey. This represents 7.21% increase for one (1) year after census was previously conducted. • The profile of occupation showed a high percentage of permanent employment in the private sector. Owning a business can also be interpreted as self-employed which is applicable to

Component	Description
	farm owners and other occupations. • Income per capita is high. Poverty incidence is low. Magnitude of families living below poverty threshold is low. • Commercial enterprises are thriving. There are many medium sized stores, mostly located in barangay proper. The service sector is also growing with the rise of many commercial establishments. • The predominant religion was Roman Catholic closely followed by Islam. This is due to the ethnic background of the settlers in the area from Luzon and from the Sulu group of islands. • The ethnicity is diverse in the barangay. The different ethnic groups found to be present in the barangay were Tagalogs, Cebuano, Tausug, Manaranao, Mapun, Ilonggo, Cuyunun, Ilocano, Pangutaran, Bicolano, Palaw'an, and Boholano. **Barangay Ocayan** • Based on the 2007 NSO Census of Population declared in the Barangay Profile of Barangay Ocayan, the total population was 1,780 with 846 males and 936 females. • In 2007, there were 308 households with an average of 6 persons per household. • The barangay has five (5) pre-school/day care centers, five (5) public elementary schools and one (1) private preschool facility. • There were two (2) ethnic groups – the *Cuyunen* and *Palaw'an* - noted in the barangay. • There were a total of 616 employed residents. Of this number, four were employed locally while 612 were self-employed. There were four (4) residents employed as teachers while 28 as skilled workers. • Farming has been ranked as number one major source of income while fishing was ranked number two. Business was ranked third as their major source of livelihood. **Socio-Economic Survey** • For Rio Tuba, 84.13% or 281 of the respondents was composed of spouses while only 11.97% of the married and single heads of the household was available for the interview. There were also children, of legal age (2.69%), who served as respondents during the survey. In Ocayan, 25 or 67.57% of the interviewed were heads of the family while 10 or 27.03% were spouses. • Majority (50%) of the respondents of Rio Tuba had resided in the area for more than 10 years while 20.36% had lived there since birth. • With Ocayan residents, 17 or 45.95% had been living in the barangay since birth. There were 16 or 43.24% who had resided there for more than 10 years. Only four (4) respondents stated that they have stayed in the barangay from 1-10 years. • It was reported by 209 of the respondents from Barangay Rio Tuba that illegal drug trade and use was a community problem besetting the area. Aside from this, limited sources of income, limited access to education, prostitution, dirty and polluted environment and health issues were some of the problems experienced in the barangay. Conversely, Ocayan respondents saw the lack of income opportunities as well as health problems in the locality. • Three hundred sixteen or 94.61% of respondents from Rio Tuba and 36 or 97.30% from Ocayan were aware and know of the presence of the various inter-related companies existing in their community. • When asked about their knowledge of the planned CBNC Expansion Project for the TSF3 and increase in cobalt annual limit, 211 or 63.17% in Barangay Rio Tuba and 9 or 24.32% from Ocayan responded in affirmation. However, there were 113 or 33.83% in Rio Tuba who had no idea of the proposed project. • It has been mentioned by the Barangay Rio Tuba respondents that the positive impacts they foresee from the proposed CBNC expansion project are provision of more employment to local residents, increase in business and livelihood, industrialization of the company, increased tax collection and revenue for the barangay and municipality, increased land values, more community projects and better solidarity in the community. • All these responses had likewise been forwarded by the Barangay Ocayan respondents. • About 306 or 91.62% of the respondents from Barangay Rio Tuba agreed to pursue the expansion of the TSF3 and the increase in annual cobalt production. There were only four (4) or 1.2% who did not agree and 24 or 7.19 who had no opinion. On the other hand, 25 or 67.57% agreed that the proposed project will be able to provide more jobs and development to the community. Six or 16.22% had no opinion while five (5) or 13.51% disagreed. • One hundred sixty-five or 49.40% from Barangay Rio Tuba strongly agreed in accepting the project while 150 or 44.91% agreed to the project. There were only two (2) people or 0.60% who strongly disagreed. There were also two (2) or 0.60% who had no opinion. The Ocayan respondents strongly agreed (14 or 37.84%), agreed (9 or 24.32%), disagreed (5 or 13.51%), strongly disagreed (2 or 5.41%).

Component	Description
Public Health	• There is a fluctuating trend in the mortality rate across all ages from 2011 to 2015. Infant mortality rate as well as maternal death rate also showed fluctuating trends. The infant mortality rate in 2014 was exceptionally low in 2014 at 0.2 per 1,000 population. • Recorded crude birth rate in the Municipality of Bataraza in 2015 was at 24.30, which indicated an increasing trend from 2012, which was at 20.84. • The leading cause of diseases in the impact barangays in Bataraza, Palawan is upper respiratory tract infection (URTI) which consistently ranked first from 2011 to 2015. Listed among the leading causes of infectious diseases from the same period are diarrhea, skin diseases, malaria, typhoid fever and pulmonary tuberculosis**.** Among the leading causes of non-infectious diseases are hypertension, urinary tract infection (UTI), bronchial asthma, anemia, animal bite, and age-related illnesses. • The leading cause of death in the 11 impact barangays in Bataraza, Palawan from years 2011 to 2015 is hypertension (HPN). Most of the leading causes of death for the covered period are not related to communicable diseases with the exception of pulmonary tuberculosis (PTB). **<u>Municipal and BLGU Health System and Facilities</u>** • Primary health care delivered by the Municipal Rural Health Unit (RHU), located at the Poblacion, are services limited to preventive and promotive services such as immunization, health and nutrition education, and family planning and routine check-ups. • All of the leading causes of infection showed fluctuating trends from 2011 to 2015 with URTI being the leading cause of diseases in the 11 impact barangays in Bataraza Palawan during the mentioned period while Hypertension (HPN) and urinary tract infection (HPN) were the leading causes of non-infectious disease for the same period. • The leading cause of death in the 11 impact barangays in Bataraza, Palawan from years 2011 to 2015 is hypertension (HPN). Most of the leading causes of death for the covered period are not related to communicable diseases with the exception of pulmonary tuberculosis (PTB) and are classified as degenerative (senility), lifestyle (cancer, heart disease, and diabetes), Obygyne-related (still birth), and others**.** • In 2011, a doctor, a dentist, a medical technician, and a sanitary inspector take care of the 63,644 population of Bataraza, Palawan. There is one (1) nurse for every 21,215 residents in the municipality, one (1) midwife for every 4,546 resident, and one (1) active barangay health worker for every 350 resident in the municipality. • The impact barangays in Bataraza each has its own health center. A birthing clinic managed by a midwife beside the health center was recently put up in Barangay Taratak. The impact barangays regularly receive assistance from CBNC in the form of medical subsidy **<u>RTNFI Hospital</u>** • Complementing the role of the Municipal RHU in health service delivery is the RTNFI Hospital, which is located within the RTN Townsite about 35 km from the town proper. It has 30 beds and five (5) bassinets. It is a primary hospital with capability for emergency operations.

4.0 IMPACTS MANAGEMENT AND MONITORING PLAN

The potential impacts to the environment and people of the proposed expansion project were identified and presented in **Chapter 3 - Impact Management Plan**. The matrices also include the management and mitigating measures for each impact. Monitoring plan is presented in **Chapter 6 – Environmental Compliance Monitoring Plan**.

5.0 CONTINGENT, LIABILITY AND REHABILITATION FUND

A Memorandum of Agreement (MOA) was executed on July 28, 2003 among RTNMC, CBNC, MGB-IVB, Provincial Government of Palawan, Municipal Government of Bataraza, PCSD, residents of Brgy. Rio Tuba, residents of Brgy. Ocayan; *Katutubong Palawan*, HARIBON Foundation, and Bataraza Christian Muslim PalawanoAsso., Inc. (BACHRISMUPAL).*Section 1* of the MOA states that RTNMC/CBNC shall establish a Mine Rehabilitation Fund (MRF), which is in compliance with *Section 181* of DENR Administrative Order 2010 – 21. The current MRF of RTNMC/CBNC is in two (2) forms: Monitoring Trust Fund (MTF) and Rehabilitation Cash Fund (RCF). The MTF committed as per MOA to cover the expenses of the monitoring activities is PhP 50,000.00 and the current amount deposited in the Development Bank of the Philippines (DBP) is PhP 64,430.02. On the other hand, the RCF committed as per MOA to ensure compliance with the approved rehabilitation activities is PhP 5,000.000.00 and the current amount deposited is PhP 5,240,034.90. In addition, an Environmental Trust Fund (ETF) was established by CBNC. The current amount of ETF as deposited in DBP is PhP 287,949.85.

1 Project Description

Coral Bay Nickel Corporation

1.1 PROJECT BACKGROUND

1.1.1 Background of the Project

Project Name:	**CBNC Expansion Project (Tailing Storage Facility No.3 establishment and Increase in Co annual production limit)**
Nature of Project:	**Resource Extractive Industry (Mineral Processing)**
Total Area and Volume of TSF3:	**111 hectares** **18.6 million cubic meters**
Site Location:	**Rio Tuba Export Processing Zone (RTEPZ)** **Barangay Rio Tuba, Municipality of Bataraza** **Province of Palawan**

1.1.2 Profile of the Proponent

Name of Proponent:	**Coral Bay Nickel Corporation (CBNC)**
Office Address:	**Rio Tuba Export Processing Zone (RTEPZ)** **Barangay Rio Tuba, Municipality of Bataraza** **Province of Palawan**
Contact Person:	**Engr. Arturo Manto** **Vice President- Environmental Management**
Tel No./Fax No.:	**+632 5487110 / +632 8563930**

1.1.3 History of the Project

On 10 July 2002, RTNMC was granted an Environmental Compliance Certificate (ECC No. 0201-021-313, **Annex 1.1.1**) for the Hydrometallurgical Processing Plant (HPP) Project, which includes the 13.0-ha limestone quarry in Sitio Gotok, Barangay Iwahig, Municipality of Bataraza. In a letter received by the Environmental Management Bureau (EMB) on August 27, 2002, RTNMC requested for the amendment of the aforementioned ECC (**Annex 1.1.2**). The letter included a copy of the Joint Statement of RTNMC and CBNC in which the companies agreed that CBNC will be the lead company in implementing the then proposed HPP Complex Project. The requested amendments included the transfer of ownership and responsibility of the following components:

1. HPP;
2. Hydrogen Sulfide Production Plant;
3. 9.9 MW Coal-Fired Power Plant;
4. Water Piping Facilities;
5. Two (2) Tailings Dam and its management;
6. Pier site operations which are land-based;

7. Coal and sub-material stock management; and
8. Product shipment, among others.

while RTNMC will retain ownership and responsibility for the following:

1. Gotok Limestone Quarry;
2. Water Intake Dam;
3. Causeway and trestle;
4. Ore supply and pile management;
5. Siltation ponds and canals management; and
6. Road maintenance and other existing RTNMC facilities.

As supporting documents to the request for ECC amendment, RTNMC submitted a copy of the Memorandum of Agreement (MOA) on ECC No. 0201-021-313 and SEC Certificate and Articles of Incorporation and By-Laws of CBNC on September 12, 2002 (**Annex 1.1.3**).

The office of the EMB Director gave its response on the request for ECC amendment on December 4, 2002 (**Annex 1.1.4**). In the letter, it was stated that the office does not split or divide the conditions of the ECC but it may acknowledge any agreement that can be entered between RTNMC and CBNC in relation to the ECC. The letter also stated that RTNMC should submit a duly signed Deed of Assignment and Responsibilities between RTNMC and CBNC and other related documents.

On December 5, 2002, the Records Section of the EMB Central Office received the Deed of Assignment signed by the President of both corporations and the signed MOA (**Annex 1.1.5**). The office of the EMB Director acknowledged the receipt of the said documents in a letter dated February 12, 2003 (**Annex 1.1.6**).

In 2006, CBNC applied for an ECC for the Line 2 of its HPP Project and was approved on February 1, 2007 with reference code ECC-0701-002-3721 (**Annex 1.1.7**). This ECC supersedes the ECC No. 0201-021-313 issued for the HPP Line 1. A summary of the project timeline is provided in **Table 1.1.1**.

Table 1.1.1. Timeline of the approval and transfer of responsibilities

Date		Supporting Document
July 10, 2002	ECC (Ref no. 0201-021-313) for the HPP Project was granted to RTNMC	Copy of the ECC (**Annex 1.1.1**)
August 27, 2002	The letter addressed to DENR Secretary Heherson Alvarez thru EMB Director Julian Amador requesting for the amendment of ECC No. 0201-021-313 was received by the EMB Central Office Records Section.	Letter dated August 26, 2002 (**Annex 1.1.2**)
September 12,2002	A copy of the Memorandum of Agreement between RTNMC and CBNC on the assignment of rights and its obligations in the ECC No. 0201-021-313 was received by the EMB Central Office Records Section.	Letter dated September 6, 2002 (**Annex 1.1.3**)
December 4, 2002	EMB Central Office sent a letter of response to the letter of RTNMC dated August 26, 2002.	Letter dated December 4, 2002 (**Annex 1.1.4**)
December 5, 2002	A copy of the Draft Deed of Assignment on the Delineation of Responsibilities of RTNMC and CBNC was received by the EMB Central Office Records Section.	Letter dated November 8, 2002 (**Annex 1.1.5**)
February 24, 2003	The letter of EMB Central Office acknowledging the receipt of the photocopy of	Letter dated February 12, 2003 (**Annex 1.1.6**)

Date		Supporting Document
	Deed of Assignment on the Delineation of Responsibilities of RTNMC and CBNC in compliance with ECC No. 0201-021-313 was received by RTNMC.	
February 1, 2007	The ECC (Ref. Code 0701-002-3721) for the Line 2 HPP Project of CBNC was granted. This ECC supersedes ECC No. 0201-021-313.	Copy of the ECC (**Annex 1.1.7**)

In February 15, 2008, the ECC was amended again to allow the increase in the annual production limits of nickel of the two (2) lines from 20,000 DMT to 25,000 DMT. This has been attained without any additional equipment but with the application of favorable and improvement concepts during continuing research and development conducted when Line 1 started its operation. Proportionately, the annual cobalt production limit was also increased from 1,500 DMT to 1,875 DMT, based on the prevailing ore sources then.

Once again, CBNC is seeking for the amendment of its ECC, hence the preparation of this Environmental Impact Assessment (EIA). With CBNC's continuous operation, one of the major components of the plant's environmental management plan, the Tailings Storage Facility (TSF) 2, will be completely filled up by 2024. For this reason, CBNC is applying to amend its ECC to include the construction and operation of a third TSF as part of its mitigating measures. In addition, CBNC will apply for the increase in the annual cobalt production **limit** of the HPP and the removal of the Gotok Limestone Quarry component in its ECC as this was part of the agreement to assign all mining operations to RTNMC.

This EIA shall focus on the following:

(1) Construction and operation of a new and third TSF (No.3); and
(2) Increase in annual production of cobalt from 1,875 DMT to 2,500 DMT due to the disproportionately higher Co content of the ore and its more positive reaction to the improvements on the production process as cited above.

Simultaneously, RTNMC is applying for a separate ECC covering the components of the 13.0 ha Gotok Limestone Quarry located within the 84.5 ha-Mineral Production Sharing Agreement (MPSA 213-2005-IVB).

As an additional requirement, CBNC has secured a Strategic Environmental Plan (SEP) from Palawan Council for Sustainable Development (PCSD) for its proposed project. The SEP Clearance was issued on April 2, 2018 (**Annex 1.1.8**).

1.2 PROJECT LOCATION AND AREA

1.2.1 Project Location and Area

The proposed expansion project will cover the construction of an additional TSF and increase the annual cobalt production **limit** of the current HPP. TSF 3 and the HPP complex are located inside the Rio Tuba Export Processing Zone (RTEPZ) in Barangay Rio Tuba, Municipality of Bataraza, Province of Palawan. Specifically, TSF3 will be constructed at the northeastern side of the existing GP-4 Rehabilitation Area of the Rio Tuba Nickel Mining Corporation (RTNMC). Its location will fall within the boundaries of Barangays Rio Tuba and Ocayan. **Figures 1.2.1** and **1.2.2** depict the location and vicinity maps of the proposed project, respectively. The proposed expansion area is within the "multiple-use zone" based on the Environmentally Critical Areas Network (ECAN) Map of the Palawan Council for Sustainable Development (PCSD) as illustrated in **Figure 1.2.3**. The site development plan is also included as **Figure 1.2.4** showing the major and auxiliary facilities of CBNC while the geographic coordinates including the proposed expansion area is listed in **Table 1.2.1**.

Table 1.2.1. Geographic coordinates of the project components

Project Component	Perimeter/Boundary points (Based on OCT/TCT/etc.)	Latitude	Longitude
TSF-3 (Proposed)	Corner 1	8º 34’ 11.41”	117º 25’ 39.73”
	Corner 2	8º 34’ 17.12”	117º 25’ 39.79”
	Corner 3	8º 34’ 19.27”	117º 25’ 36.22”
	Corner 4	8º 34’ 27.34”	117º 25’ 37.33”
	Corner 5	8º 34’ 36.62”	117º 25’ 35.08”
	Corner 6	8º 34’ 43.19”	117º 25’ 28.14”
	Corner 7	8º 35’ 0.94”	117º 25’ 26.62”
	Corner 8	8º 35’ 0.79”	117º 25’ 45.61”
	Corner 9	8º 34’ 41.76”	117º 25’ 57.35”
	Corner 10	8º 34’ 11.22”	117º 26’ 3.18”
TSF- 2 (Existing)	Corner 11	8º 35’ 26.78”	117º 24’ 30.62”
	Corner 12	8º 35’ 23.99”	117º 24’ 37.12”
	Corner 13	8º 35’ 23.05”	117º 24’ 41.12”
	Corner 14	8º 35’ 22.52”	117º 24’ 48.52”
	Corner 15	8º 35’ 16.51”	117º 25’ 0.96”
	Corner 16	8º 35’ 9.89”	117º 25’ 6.76”
	Corner 17	8º 35’ 2.02”	117º 25’ 11.83”
	Corner 18	8º 34’ 48.24”	117º 25’ 15.87”
	Corner 19	8º 34’ 46.07”	117º 25’ 14.99”
	Corner 20	8º 34’ 28.03”	117º 24’ 51.34”
	Corner 21	8º 34’ 33.24”	117º 24’ 32.17”
	Corner 22	8º 34’ 28.84”	117º 24’ 28.09”
	Corner 23	8º 34’ 37.39”	117º 24’ 18.36”
	Corner 24	8º 34’ 50.79”	117º 24’ 19.44”
	Corner 25	8º 34’ 55.02”	117º 24’ 24.19”
	Corner 26	8º 35’ 19.5”	117º 24’ 26.74”
TSF-1 (Existing)	Corner 27	8º 34’ 26.83”	117º 25’ 24.05”
	Corner 28	8º 34’ 14.74”	117º 25’ 37.40”
	Corner 29	8º 34’ 1.35”	117º 25’ 37.34”
	Corner 30	8º 33’ 52.47”	117º 25’ 21.67”
	Corner 31	8º 33’ 52.64”	117º 25’ 6.5”
	Corner 32	8º 33’ 57.93”	117º 24’ 59.44”
	Corner 33	8º 34’ 10.89”	117º 24’ 56.15”
	Corner 34	8º 34’ 14.28”	117º 24’ 58.55”
HPP Line 1 and 2 (Existing)	Corner 35	8º 33’ 48.14”	117º 25’ 3.9”
	Corner 36	8º 33’ 48.11”	117º 25’ 31.78”
	Corner 37	8º 33’ 30.95”	117º 25’ 31.76”
	Corner 38	8º 33’ 30.98”	117º 25’ 3.89”
Causeway, trestle and other associated facilities (Existing)	Corner 39	8º 30’ 39.76”	117º 26’ 36.38”
	Corner 40	8º 30’ 43.04”	117º 26’ 49.63”
	Corner 41	8º 30’ 46.65”	117º 26’ 49.07”
	Corner 42	8º 30’ 47.96”	117º 26’ 58.17”
	Corner 43	8º 30’ 42.86”	117º 26’ 58.96”
	Corner 44	8º 30’ 42.17”	117º 26’ 54.50”
	Corner 45	8º 30’ 37.24”	117º 26’ 56.09”
	Corner 46	8º 30’ 30.20”	117º 26’ 51.62”
	Corner 47	8º 30’ 27.25”	117º 26’ 51.62”
	Corner 48	8º 30’ 14.88”	117º 27’ 00.82”
	Corner 49	8º 30’ 12.94”	117º 26’ 58.19”
	Corner 50	8º 30’ 28.68”	117º 26’ 46.48”
	Corner 51	8º 30’ 28.95”	117º 26’ 39.94”

1.2.2 Project Site Accessibility

The project site is accessible by land from Puerto Princesa City via the south road passing through the Municipalities of Aborlan, Narra, Sofronio Española, and Brooke's Point. Travel time is approximately five (5) hours. A bus company and commercial utility vans service the route. The private airplane of RTNMC flies directly to Rio Tuba from Puerto Princesa Airport. The commercial flight via Philippine Airlines, Cebu Pacific, and AirAsia from Manila takes about one (1) hour to reach Puerto Princesa Airport.

1.2.3 Delineation of Impact Areas

The CBNC has 11 impact barangays that are currently covered by its Social Development and Management Program (SDMP). These are Barangays Rio Tuba, Ocayan, Taratak, Iwahig, and Sandoval as host barangays and as primary impact areas and six (6) neighboring barangays (Sumbiling, Sarong, Igang-igang, Culandanum, Tarusan, and Sapa), which are considered as secondary impact communities (**Figure 1.2.5**).

The primary impact areas are delineated based on the following:

1. Within the Rio Tuba Export Processing Zone (RTEPZ); and
2. As host area for the plant facilities and haulage road.

There will be no additional impact barangays that will be affected by the proposed TSF3 as it will be located within Barangays Rio Tuba and Ocayan.

The Municipality of Bataraza is considered as the Regional Impact Area (RIA) of the project as the socio-economic impacts will also be felt by the LGU. The whole province of Palawan will also be indirectly affected by the proposed project due to social-economic benefits that will arise from the operations.

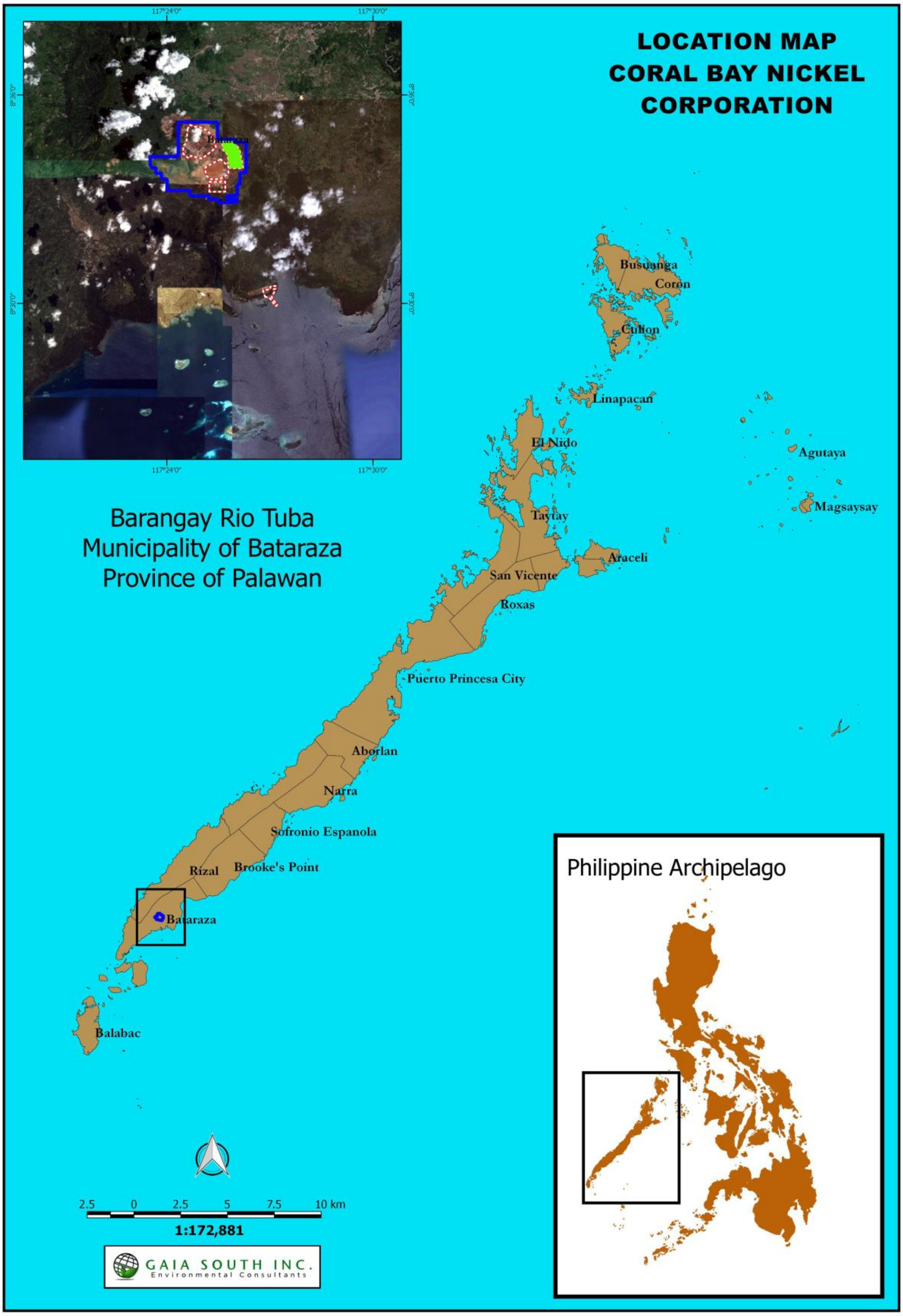


Figure 1.2.1. Location map of the proposed CBNC expansion project

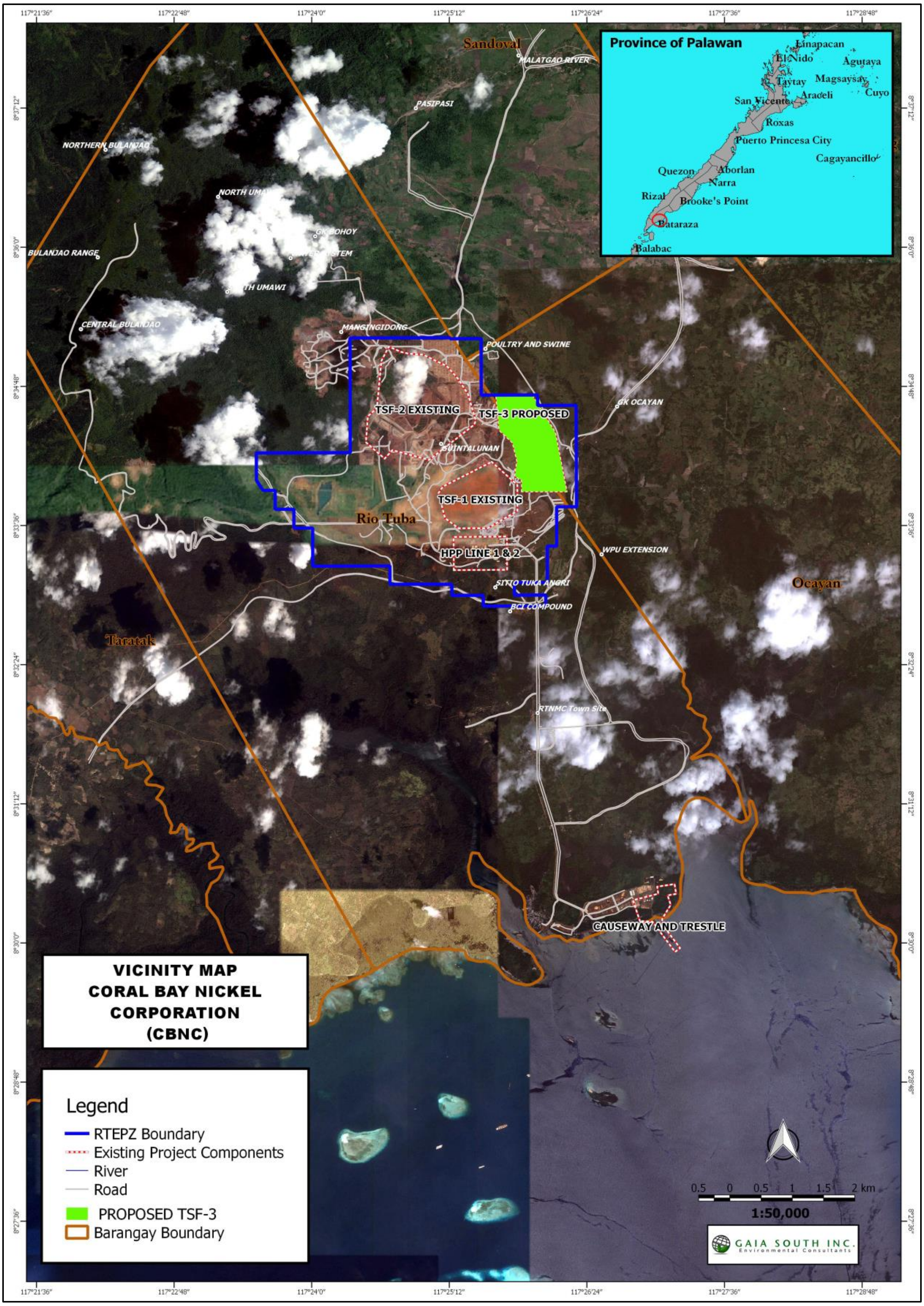


Figure 1.2.2. Vicinity map of the proposed CBNC expansion project

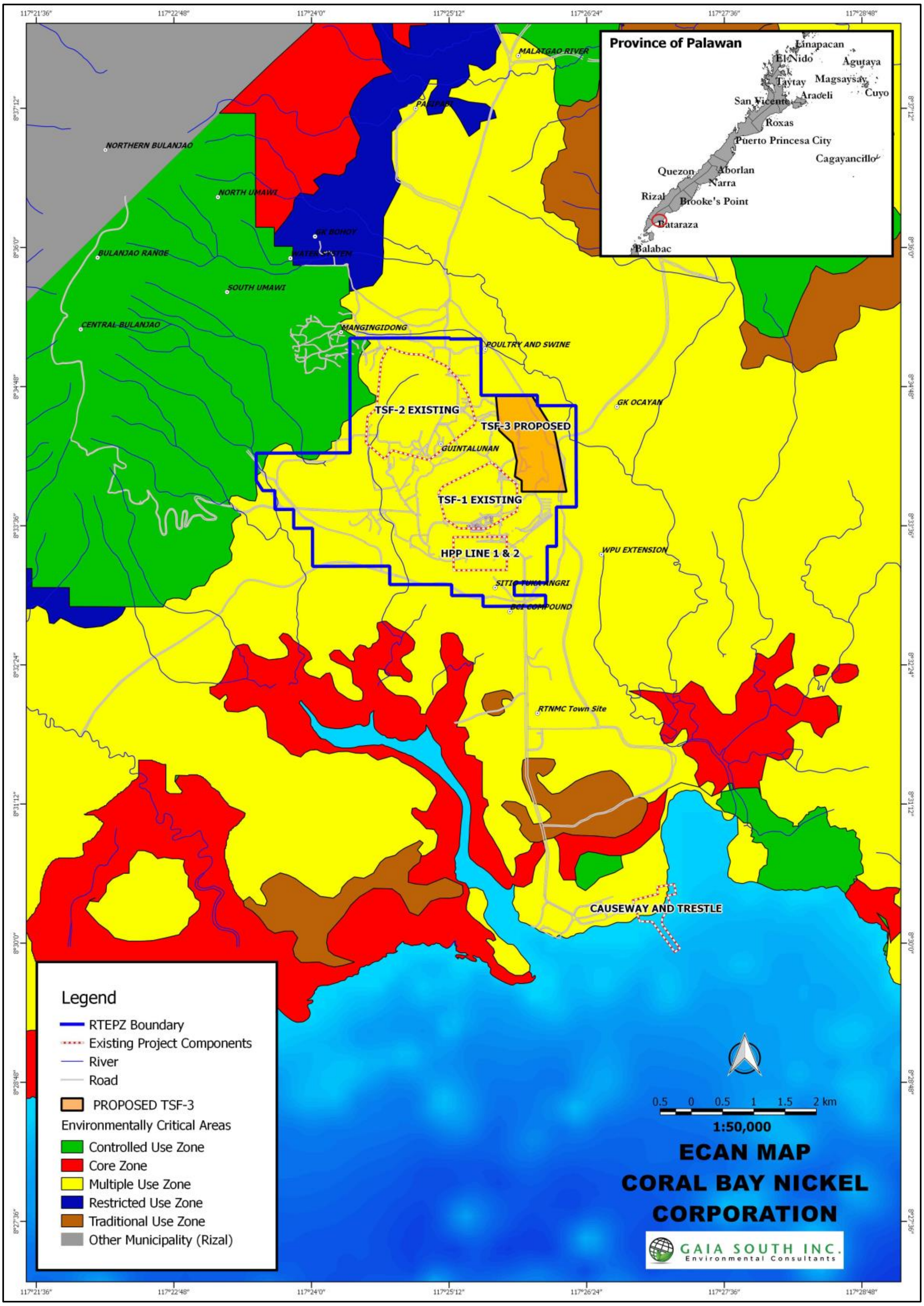


Figure 1.2.3. ECAN map of PCSD illustrating the location of TSF3 and CBNC HPP in a "Multiple-Use Zone" *Source: PCSD ECAN Map*

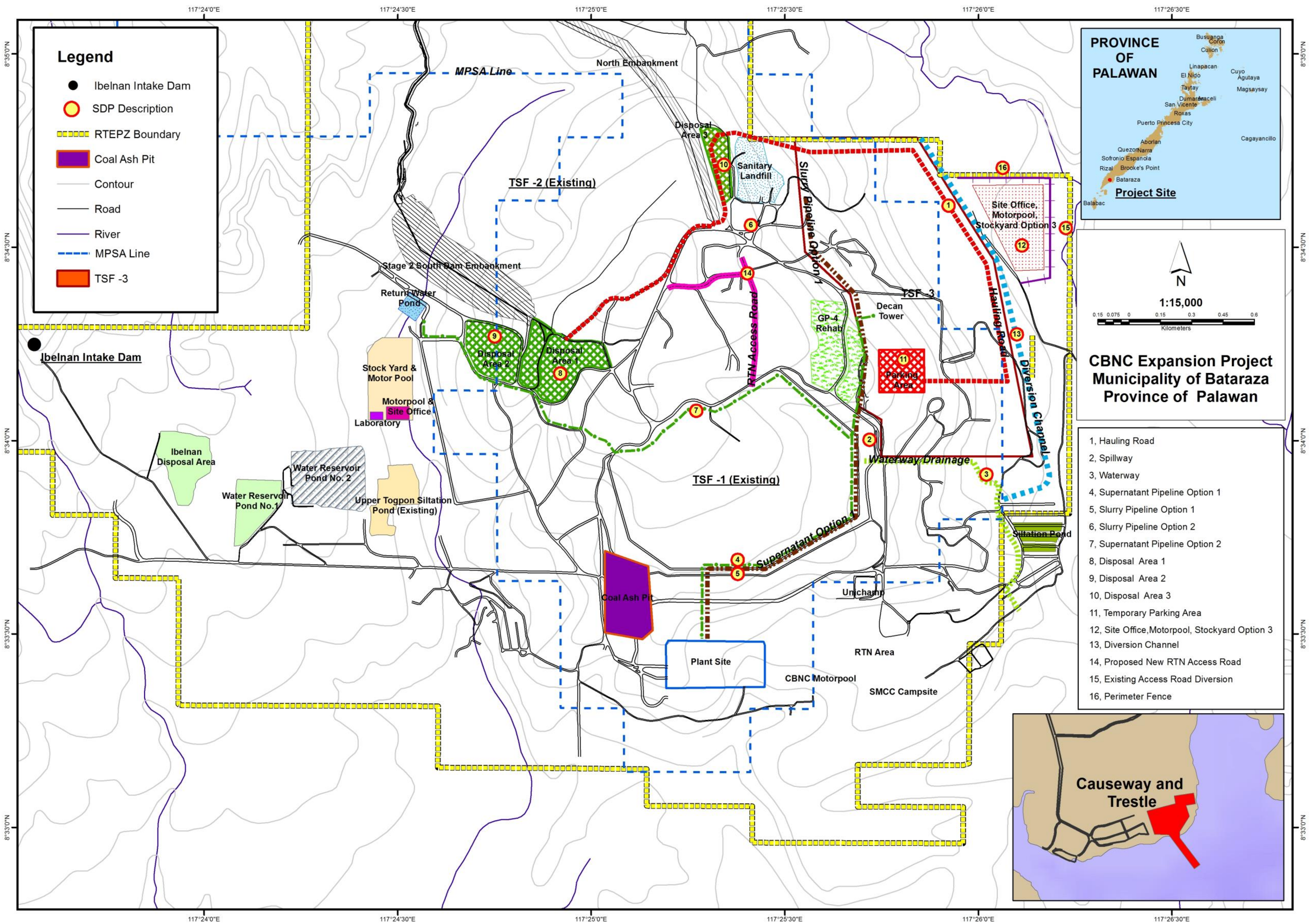


Figure 1.2.4. Site Development Plan

1.3 PROJECT RATIONALE

Tailings Management and Storage

The construction and operation of the Tailings Storage Facilities (TSF) are part of the commitment of CBNC in implementing the approved environmental management measures prescribed in the Environmental Impact Assessment (EIA) studies conducted for the then proposed HPP Line 1 and Line 2 projects.

During operation, the tailings produced are directed to the TSF for proper storage/disposal to prevent degradation of the nearby water bodies. Since the start of the operation of the HPP, two (2) TSFs were constructed. TSF1 was operated from 2005 to 2010 while TSF2 has been in operation since 2010 up to present. With the continuous operation, TSF2 is expected to last up to 2022. Due to this, CBNC has proposed the construction of TSF3 as management measure for the tailings after TSF2 has been decommissioned.

Employment Generation for the Local Residents and Continuous Employment of Current Manpower

With the construction of the proposed TSF3, there is no need to stop the operation of the HPP at the time the TSF2 becomes full and no longer capable of receiving production wastes. Continuous operation of the HPP guarantees continuous employment of the current manpower.

Social Development and Management Program (SDMP) and Corporate Social Responsibility (CSR)

Continuous operation will also ensure the unhampered implementation of the Programs/Projects/Activities under the SDMP and the CSR. Residents of the impact barangays will be able to receive the assistance in accordance with their proposed schedule as reported in the submitted Annual SDMP Plan.

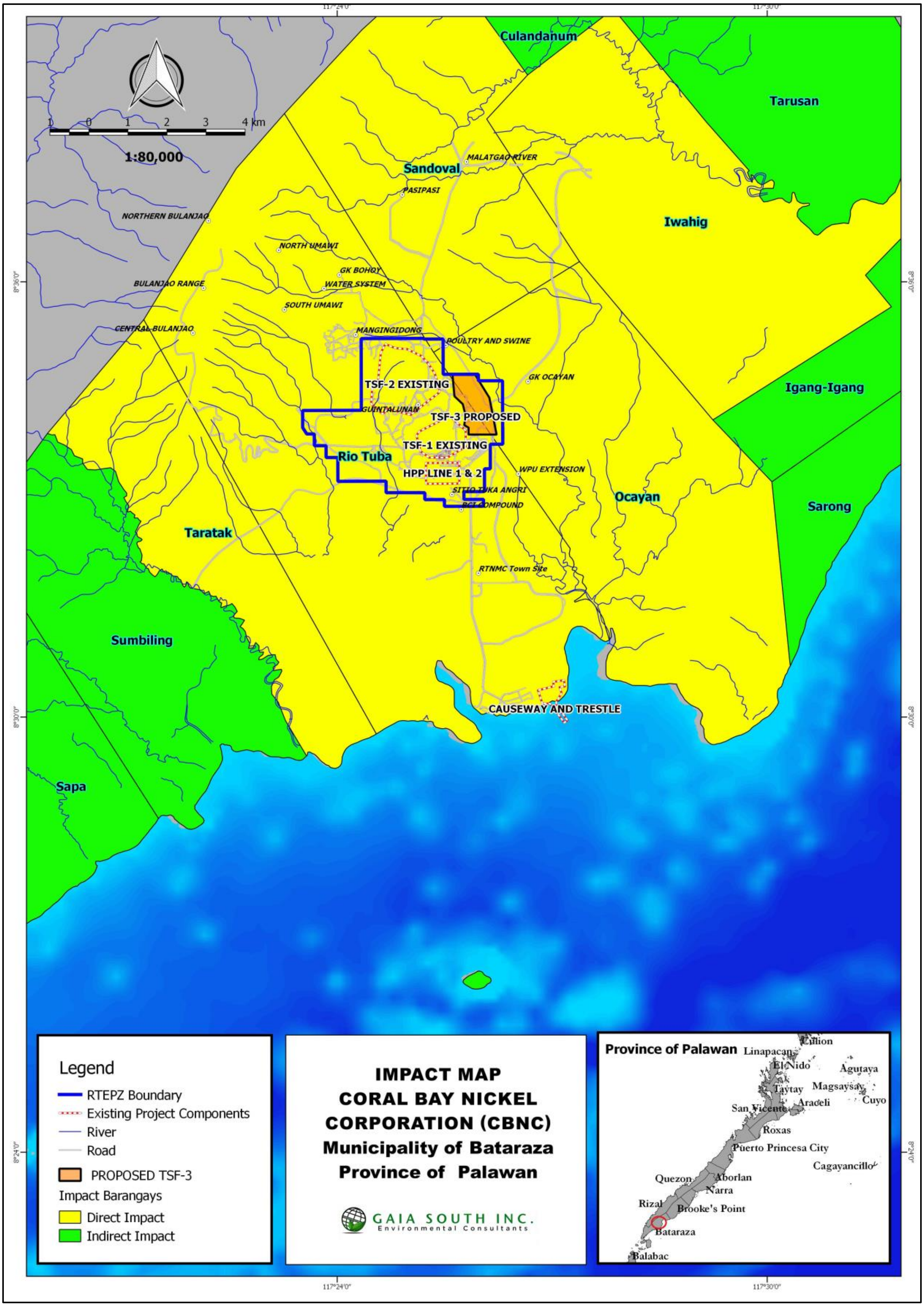


Figure 1.2.5. Primary and secondary impact areas

1.4 PROJECT ALTERNATIVES

The following matrix shows the various project alternatives and project considerations (**Table 1.4.1**).

Table 1.4.1. Project alternatives and considerations

Aspect	Standard Criteria	Options Considered	Assessment
Handling of plant tailings through the construction of TSF No.3	• Location • Applicability • Process Integration	At present, two (2) TSFs exist within the MPSA and PEZA areas: • TSF1 – Located north of the HPP, constructed in 2004 and operated from 2005 to 2009. • TSF2 – Located northeast of the HPP, constructed in 2008 and operated in 2010 (after TSF No.1 was completely used up) up to present. • The option earlier considered is the possibility of increasing the embankment heights of the existing dams to increase total holding capacities.	• TSF2 will be fully loaded by year 2022. Therefore, there is a need to construct TSF No.3 to sustain the operations of the HPP. • TSF1, which was constructed up to 68 masl and its embankment was already rehabilitated. Although it can still be raised up to the maximum design level of 75 masl, this poses some risk to the HPP located downstream. • TSF2 was constructed up to its maximum design level of 80 masl already. • Thus, TSF3 must be constructed somewhere else. The chosen site is the mined-out area of RTNMC in Guintalunan Pit, which is located within the RTEPZ. • The bulk of the capital investment shall be for the construction and operation of TSF3. This will include all equipment and accessories needed in the handling of tailings slurry and supernatant.
• Power generation	• Availability • Total power requirement	• CBNC shall continue to utilize the existing coal-fired power plants, and back-up diesel generators for the operation of the HPP Lines 1 and 2. • The construction and operation of TSF3 will not increase power requirements since TSF2 will eventually be stopped. • The total power requirement of the entire HPP plant during operation is about 135 million kw-hrs/year. • Likewise, the increase in Co production will not increase power requirement either because there will be no additional equipment to be installed.	• CBNC have its own Self-Generating Power Facility. It provides the power requirements of the plant and of the staff housing community. • With the continued HPP plant operation and associated facilities (e.g. coal fired power plant and other equipment), some greenhouse gas emissions will continue to be generated. • CBNC will pursue its in-house reforestation activities as well as its commitment to the National Greening Program (NGP) in order to continue providing "sinks" for these gases.
Water management system	• Availability • Location of water source • Total water requirement	• The main source of water supply for the operation of the HPP is the East Ibelnan River, which flows about 3 km west of the processing plant. • The available alternative option for the source of water supply during dry month is the water	• The volume of water in Ibelnan River is way more than sufficient to supply the operational water requirement of CBNC. • TSF3 construction is a civil work and requires minimal amount of water. Once

Aspect	Standard Criteria	Options Considered	Assessment
		impounded at the Upper Togpon siltation pond and a 300,000 m^3 water reservoir. • For the proposed project expansion, specifically for Co production, there will be no change in the water source and requirement.	completed, tailings will be stored in TSF3 after TSF2 is fully used. • The proposed increase in Co production will not require additional water since the same ore tonnage will be processed.
Erosion control	• Method of management	• Control measures for soil erosion include the following: 1) erosion control or minimization of soil erosion events especially during the construction of embankments; and 2) sediment control involving trapping of suspended soil at the nearby waterways during TSF3 development.	• CBNC has long been practicing erosion control measures, which is proven effective in a long-term period. • The latest successful practice is the construction and operation of TSF2.
Siting of facility	• Availability • Potential Use of the Land to be converted	• The dam is located within the mining area of RTNMC. The design is made to prevent washing away of tailings to adjacent areas and natural drainage. • Areas outside the RTNMC mining area.	• Selection of the area was based on safety and practicability. • Mined-out areas were preferred than area outside the RTNMC mining area. For projects such as the TSF, the potential value of the land to be converted should be considered. Since the mined-out areas are considered disturbed and within the Multiple Use Zone classification of the ECAN, there will be no conversion of land in terms of use.

No Project Option

The tailings storage facilities of CBNC are built to manage the tailings that result from processing low grade ores. Thus, the "no project" option shall result to premature cessation of CBNC operations. As a consequence:

- Mineral resources, *i.e.* low grade ores from RTNMC, will not be utilized efficiently;
- TSF2 will not be sufficient to address the additional tailings that will be produced by the operation in next coming years; and
- Economic and social benefits of the project, which include employment, SDMP, CSR projects, and government revenues will cease.

1.5 PROJECT COMPONENTS

Table 1.5.1 shows the comparative components of the existing operations of CBNC and its proposed expansion.

Table 1.5.1. Comparative components of plant operations

Project Features	Existing Operations (Lines 1 and 2) ECC 0701-002-3721	Proposed Expansion	Combined Features

Project Features	Existing Operations (Lines 1 and 2) ECC 0701-002-3721	Proposed Expansion	Combined Features
Approved area for operation	• Area of Plant Site: 44 hectares • Area of Pier Site: 19 hectares • TSF1: 90 hectares • TSF2: 207 hectares • Gotok Quarry: 13 ha	TSF 3: 111 hectares	471 hectares
Capacity	25,000 DMT Ni per year	same	same
	1,875 DMT Co per year	625 DMT Co per year	2,500 DMT Co per year
Gotok Limestone Quarry (Capacity)	372,000 MT per year	Not Applicable (Covered under separate ECC application)	
No. of Tailings Storage Facility	2	1	3
Tailings dam capacity	40 M m^3	18.6 M m^3	58.6 M m^3
Area of Tailings Storage Facility	• Tailings dam 1: 90 hectares • Tailings dam 2 : 207 hectares	Tailings dam 3: 111 hectares	408 hectares
Total Ore Requirement	2-2.5 Million DMT	same	same
Manpower	During Operation: • Permanent: 600 • Contractual: 1,500	During Construction: • Contractors: 62 • Sub-con: 332	During Operation: • Permanent: 600 • Contractual: 1,550
Water Source	• Intake dam at the East Ibelnan River for Lines 1 and 2 water supply • Upper Togpon siltation pond and a 300,000 m^3 reservoir as alternative sources of water	Same as existing	Same as existing
Water Requirement	30,000 cubic meters/day	Same as existing	Same as existing
Power Source	Maximum of 14.5 MW Coal-fired boiler and turbine power plant per Line • Breakdown for Line 1: ○ 11 MW Coal-fired boiler and turbine power plant ○ Back-up: two (2) units 1.5 MW each diesel generators, or 3 MW total • Breakdown for Line 2: ○ 11 MW Coal-fired boiler and turbine power plant ○ Back-up: Two (2) units of 1.64 MW each diesel generator, or 4.92 MW total • Additional: two (2) units of 0.072 MW each diesel generators, or 0.144 MW total installed at the pier site and 1.5 MW Diesel Generator installed at HPP Line 2 used as back-up power supply for the townsite	Same as existing	Same as existing
Power Requirement	*About 135 Million kw-hrs/year	Same as existing	Same as existing
Causeway	380 m long, 3.5 m high, 14 m wide road and 17 m base width, concreted surface	Same as existing	Same as existing
Trestle	1,080 m long, 5 m high from sea level and 2.5 m wide.	Same as existing	Same as existing
Other facilities	• Effluent discharge facilities • Pier site (land-based operations) • Coal, ore and other raw materials, and finished products stockpiles	Same as existing	Same as existing

Project Features	Existing Operations (Lines 1 and 2) ECC 0701-002-3721	Proposed Expansion	Combined Features
Shared Facilities with RTNMC and Unichamp Mineral Philippines, Inc. (UMPI)	• Access Roads (RTEPZ) • Macadam Road	Same as existing	Same as existing
Investment cost (PhP)	22.9 B	7.3 B	30.2 B

Note: *Average of five (5) years power consumption as indicated in the Compliance Monitoring Report (CMR)

The current operations of CBNC has a total footprint of 360 has. With the proposed project, this will increase to 471 has, including TSF3. **Table 1.5.2** presents the facilities and structures of the current operations.

Table 1.5.2. CBNC project facilities

Project Component	Area (ha)
1. Plant site	**44**
• Ore preparation	0.5
• High pressure acid leach	0.8
• Neutralization, CCD/Thickening and Final Neutralization (includes limestone storage)	4.8
• Zinc removal and sulfurization	2.0
• H_2S Plant	0.7
• Power plant	2.1
• Office and canteen	0.1
• Laboratory and workshop	0.2
• Chemical/sulfur yard and warehouse	0.5
• Spare parts storage and MS warehouse	0.1
• Sanitary Landfill	3.8
• East Ibelnan River Intake dam	0.14
• Upper Togpon Siltation Pond	9.2
• Water Reservoir in Togpon (300,000m^3-capacity)	8.1
• Treated Water Facility	0.7
• Coal Ash Pit	9.0
• Open areas/Access Roads	1.26
2. Port facilities	**19**
• Chemical warehouse	0.5
• Coal stockyard	2.8
• CH_3OH and H_2SO_4 tank farm	1.7
• Slaked lime and sulfur storage yard	2.0
• Stockyard	0.5
• Siltation pond	0.3
• Causeway	0.57
• Trestle	0.57
• Open areas/Access Roads	10.06
3. TSF 1	**90**
4. TSF 2	**207**
Total Footprint	**360**

1.5.1 Existing Operation

1.5.1.1 Hydrometallurgical Processing Plant Facilities

<u>Mixed Sulfide Process</u>

The HPP process is designed to produce Nickel/Cobalt Mixed Sulfide (MS) at high recovery rate by the acid leaching method using low-grade ore and laterite as raw materials. The acid leach method uses sulfuric acid at high pressure in an autoclave. The pregnant solution is transformed into nickel/cobalt sulfide by reacting with hydrogen sulfide (H_2S). The latter is generated on-site in the hydrogen sulfide facility.

The primary objective of the process is to leach nickel (Ni) and cobalt (Co) by sulfuric acid, minimize the leaching of iron (Fe), aluminum (Al), and silicon (Si), and recover Ni/Co sulfide by using hydrogen sulfide. **Figure 1.5.1** shows the plant layout of Lines 1 and 2.

Hydrogen Sulfide Facility

The Hydrogen Sulfide Facility (HSF) is designed to meet daily consumption of 21.7 MT/day for each line and the fluctuation in plant capacity from 70 to 120%. CBNC has a license to use the technology of Sumitomo Seika Chemicals, which is the only hydrogen sulfide synthesizer in Japan and its operations have continued and operated under the direct supervision of the said company.

The safety features are built into the plant facilities which are all interlocking and redundant safety and emergency devices and systems.

As hydrogen sulfide is a poisonous, combustible and corrosive gas, special attention is needed for its safe treatment and production. The following are the inherent safety features built in the plant facilities and operations.

Facility Design

- All facilities are closed systems to prevent gas leakage;
- Hydrogen sulfide production can be easily terminated by stopping the supply of hydrogen;
- A Distribution Control System (DCS) is installed to eliminate human error except for the sulfur melting process;
- Gas detector is installed within the production area to detect gas leakage;
- Around the dangerous area of the HSF, a hydrant is installed for firefighting;
- Around the HSF, sufficient open spaces are provided for firefighting;
- The open structure of the HSF is adopted to disperse any leakage easily;
- In hazardous areas, electrical equipment and wiring method are installed based on API (Americas0w+vc an Petroleum Institute) standard; and
- The facility has other safety devices against other chemical contingencies.

Interlocking and Redundant Safety and Emergency Device and Systems

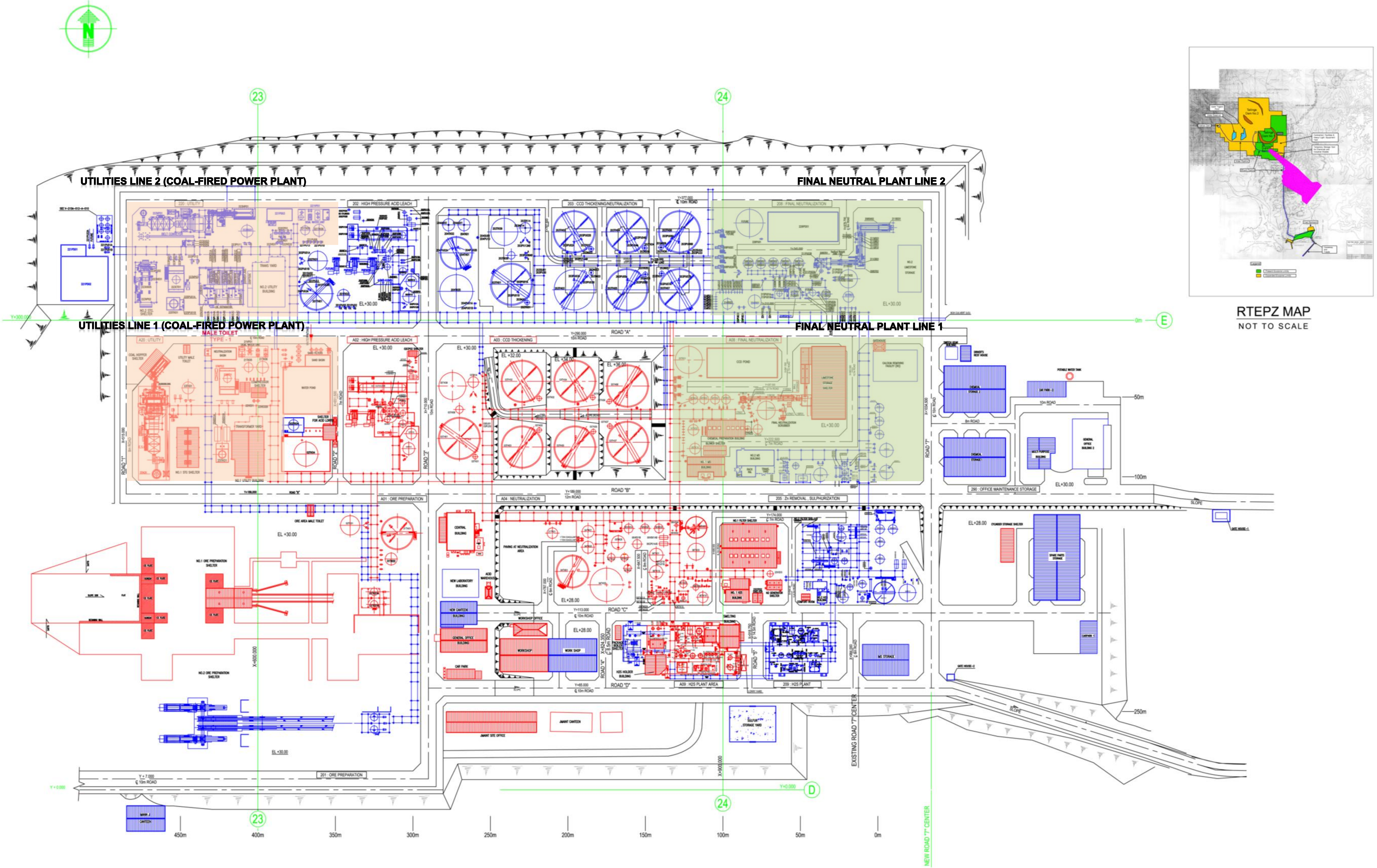
- **H_2S Reactor guard**

Step 1: At HPA (High Pressure Alarm) level, i.e. 0.3 atm, the operator reduces the hydrogen feed load.

Step 2: With increased pressure at HPZ (High Pressure Inter Locking), i.e. 0.4 atm, the hydrogen interlocking valves 1 and 2 are closed to protect the reactor.

- **H_2S Gasholder guard**

Gas holder is controlled between LLA (Low Level Alarm) to HLA (High Level Alarm) in normal operating conditions.



SITE DEVELOPMENT PLAN

SCALE 1:1200m

Figure 1.5.1. Plant layout of the Hydrometallurgical Processing Plant

Step 1: At LLA level, i.e. setting point of 1,000 mm (40 N m^3), the operator calls to the HPP Plant to decrease consumption of H_2S. At HLA, i.e. setting point of 3,500 mm (140 Nm^3), the hydrogen flow rate is decreased.

Step 2: At LLZ (Low Level Inter Lock), i.e. Setting point of 500 mm (20 N m^3), the compressor automatically shuts down. AT HLZ (High Level Inter Lock), i.e. setting point of 4000 mm (160 N m^3), the valve supplying H_2 automatically shuts down.

In normal condition, the gasholder is operated to have a capacity which is enough to hold released H_2S gas at emergency conditions.

Step 3: With further increase in pressure reaching HH, i.e. 15 Kpa H_2S reaction will automatically stop by high pressure interlock.

- **H_2S GW Scrubber**
  - Scrubber in the HSF is installed for emergency.
  - During emergency, the reaction of the scrubber with H_2S is as follows:

    $$H_2S + NaOH \rightarrow Na_2S + H_2O$$

  - Since most H_2S gas is removed at the scrubber, exhaust gases are introduced to a large scale scrubber at the HPP plant directly where unreacted H_2S is treated finally.
  - The generated Na_2S is recovered as NaSH in the HPP plant.
    - Emergency exhaust gas from a H_2 – PSA (Pressure Swing Adsorption) equipment is released to atmosphere at vent stack. At the vent stack, a small amount of steam is added constantly to prevent electronic sparks. The purpose of the steam is to suppress the generation of flame as H_2 gas may react with O_2 in the atmosphere.

- **Prevention of Disaster**
  - Enough fire hydrants to extinguish fire in the production area from two (2) directions are installed. Fire extinguishers are also in place.
  - Large volume tanks (>100 m^3) storing combustible liquid (methanol and diesel tanks) are equipped with nozzles that discharges N_2 into the tank. This system is called N_2 blanket. The purpose of discharging N_2 into the tank is to disperse or prevent the inflow of oxygen from the atmosphere. By eliminating the contact of O_2 with the stored liquids, combustion will be prevented.
  - Emergency broadcast system is installed for operators working outside.

- **Protective Equipment and Devices**
  - Air respiratory device such as Self-contained Breathing Apparatus (SCBA) and air line mask, safety goggles, gloves, clothes, shoes, boots, and shower are provided.

Power Supply and Distribution System

To supply the power requirement, the power system has a total capacity of about 30.272 MW that includes 2 x 11 MW coal-fired boiler and turbine generator (**Plate 1.5.1**) and back – up power consisting of two (2) units of 1.5 MW diesel generators for line 1, three (3) units of 1.64 MW diesel generators for line 2 and two (2) units of 0.176 MW diesel generators at the pier site. Note that the boiler has sufficient capacity to supply the steam requirement for the HPAL process (30% of the capacity) and power generation (70% of the capacity). The location of the Coal-fired boiler and turbine and generator is provided in **Figure 1.5.1**.

Coal-Fired Power Plant

The 2x11 MW Coal-Fired Power Plant of CBNC utilizes the Pulverized Coal-Fired Boiler technology. Components of the coal power plant are provided in **Table 1.5.3**.

Table 1.5.3. Major components and support facilities of the Coal-Fired Power Plant

Component	HPP Lines 1 and 2 11 MW each line
BOILER SYSTEM	
Description	Stocker type, travelling grates Bi-drum natural circulation
Boiler Efficiency	88.75%
Boiler Capacity	105 TPH/boiler
Low NOx Burner	
	N/A
Electrostatic Precipitator	
Quantity	1-unit for each boiler
Flue-gas flow Rate	65.5 m^3/sec
Efficiency Rate	94.8%
Smokestack	
Design/Description	40 meter high steel stack integrated with CEMS & COMS
BOILER FUEL SYSTEM	
Fuel type and volume requirement	Coal (gravel like) 16.94 TPH (design)
Annual Fuel Consumption	Coal: 148,400 tons-each boiler (design) Diesel: 200 l/year-each boiler (for start-up) Fire wood: 0.5 ton/year-each boiler
Coal Unloading Facility	
Type	Jetty – Coal hauled from barge to coal yard by dump trucks
Capacity	Hauling dump truck capacity = 13 tons
Coal Conveyor Quantity / Capacity	N/A
Mode of Coal Delivery	via ships/barges
Coal Storage (Stacking-Reclaiming)	
Height of Stacker	35 meters
Cross-sectional Base of stacked coal	Rectangular
Coal Stacker-Reclaimer type	N/A
Stacker-Reclaimer Quantity / Capacity	N/A
Coal Storage Area	
Description	Open space with concrete ground
Storage Capacity	60,000 tons
Total Area	24,000 m2
Coal Crusher and Pulverizer	
Crusher Quantity / Capacity	N/A
Pulverizer Quantity & Capacity	N/A
Coal Silos	
Quantity / Capacity	500 m^3 (375 tons)
Ash Collection and Storage	
Vol. of Ash to be Generated	Fly Ash: 0.291 t/h for L1 boiler 0.242 t/h for L2 boiler
	Bottom Ash: 0.156 t/h for L1 boiler 0.410 t/h for L2 boiler
Ash-handling description	L1 boiler: Dry-type, pneumatic (positive)

Component	HPP Lines 1 and 2 11 MW each line
	L2 boiler: Dry-type, pneumatic (vacuum)
Storage and disposal description	Ash silos / Dump to ash pit by dump truck
STEAM TURBINE AND AUXILIARIES	
Turbine type	Horizontal, impulse, multi-stage, multi-valve, axial flow condensing, extraction and geared (both line)
Turbine Efficiency	74% (both line)
Generator Efficiency	97.6% (at 11000 kW, PF: 0.8) – both line
Condensate and Feed-water System	
Description	Exhaust steam are being condensed and return to Boiler Feed Water (BFW) tank for re-use. BFW are pass through the deaerator for heating and removal of O_2, two (2) types of chemicals are being injected to deaerator storage tank to adjust pH and remove O_2 chemically. BFW is being injected into the steam drum through BFW pump passing economizer to further heat it up. (same system in both line).
Boiler Feed Pump	2 unit each line. Type: Multi-stage centrifugal pump, motor driven (370 kW, 460 V,60 HZ)
Condensate Pump	2 units each, type: Centrifugal pump, Motor: 11 kW, 460V, 60 Hz
Cooling Water System	
Condenser Type	Surface Cooling Condenser
Source of cooling water	Freshwater
Water requirement	2,100 m^3/hr
Cooling Water treatment	Sodium hypochlorite, Corrosion inhibitor, Calcium chloride
CW Pump Specification	3 unit each line (2 working + 1 standby); 132 kW, 460V,60Hz; Head: 30 m
Other Auxiliary	pumps and coolers
GENERATOR SYSTEM	
Generator Type	STG: Synchronous generator, 1800 rpm (both line)
Generator Rated Power	STG: 11 MW (13,750 kVA), (both line)
Others	4,160 V 3 phase, 60 Hz, 4P, 1908 Amp, Exciter: output 75 kW, voltage 120 V, star connection, F sorts insulation (both lines)
TRANSFORMERS, ELECTRICAL and I&C SYSTEMS	
Main Transformer	L1: 3 units – 2,000 KVA, 4,160/480 V, 1 unit 1,600 kVA, 4,160/4A, 4160/480 L2: 4 units – 2,000 kVA, 4,160/480 V, 1 unit 1,600 kVA, 4,160/4A, 4,160/480
Start-up Stand by Transformer	N/A
Others	4 unit 1000kVA , 4,160/4A, 4,160/480 for both lines
Generator Circuit breaker	L1: STG: VCB, 3,000 amp, 25kAIC, DEG: VCB, 2 unit 630 amp, 25kAIC L2: STG: VCB, 3,000 amp, 25kAIC, DEG: VCB, 3 unit 630 amp, 25kAIC
Switchyard and Switching Station	4,160 V, 3Φ, 3W, 60 Hz, 2,500 A, 25kA, SYM (RMS) 1 sec (for both lines)
I&C system	N/A
DC system/Station battery	600 AH (both lines)
SUPPORT FACILITIES	
Compressed Air System	
Description	Both lines 1 and 2 have its own compressors (5 units at L1 and 4 units at L2 – same specs) parallel connected and controlled by Group Control Panel (GCP). The GCP enable the system to operate efficiently.
Air compressors (Qty/Capacity)	9 x 9 m^3/min
Water Treatment Plant	
Components and Description	De-mineralized water treatment
Capacity	90 m^3/hr
Sludge Disposal	
Description	No sludge produced
Fire-Protection System	
Components	Outdoor water hydrants, fire extinguisher and fire alarm detection system
Weir and Pumping Station	
Source	River, rain water

Component	HPP Lines 1 and 2 11 MW each line
Total Capacity	876,242 m^3 [Reservoirs 1 and 2]
Usage	350,500 m^3 [During summer]
Percent Utilization	60 – 70%
Noise Pollution Prevention System	
Components	Vent silencer, suitable enclosure

Diesel Generators

As stated previously, in addition to the Coal-fired Power Plant, CBNC also utilizes diesel generators. Provided in **Table 1.5.4** are the specification of the generators.

Table 1.5.4. Specifications of the diesel generators

Facilities	Location	Manufacturer/ Maker	Model	Speed, RPM	No. of cylinders
Line 1					
Two (2) units of 1.5 MW Diesel Engine Generators	HPP 1, CBNC Plant Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Caterpillar	3516B	1,800	16
	HPP 1, CBNC Plant Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Caterpillar	3516B	1,800	16
Line 2					
Two units of 1.64 MW Diesel Engine Generators	HPP 2, CBNC Plant Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Niigata	6L28HLX	720	6
	HPP 2, CBNC Plant Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Niigata	6L28HLX	720	6
Pier Site					
Two units of 0.072 MW Diesel Engine Generators	CBNC Pier Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Denyo	S6D125E-2-A	1800	6
	CBNC Pier Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Denyo	S6D125E-2-A	1800	6
Townsite					
One unit of 1.5 MW Diesel Engine Generators	HPP 2, CBNC Plant Site, RTSEZ, Rio Tuba, Bataraza, Palawan	Niigata	6L28HLX	720	6

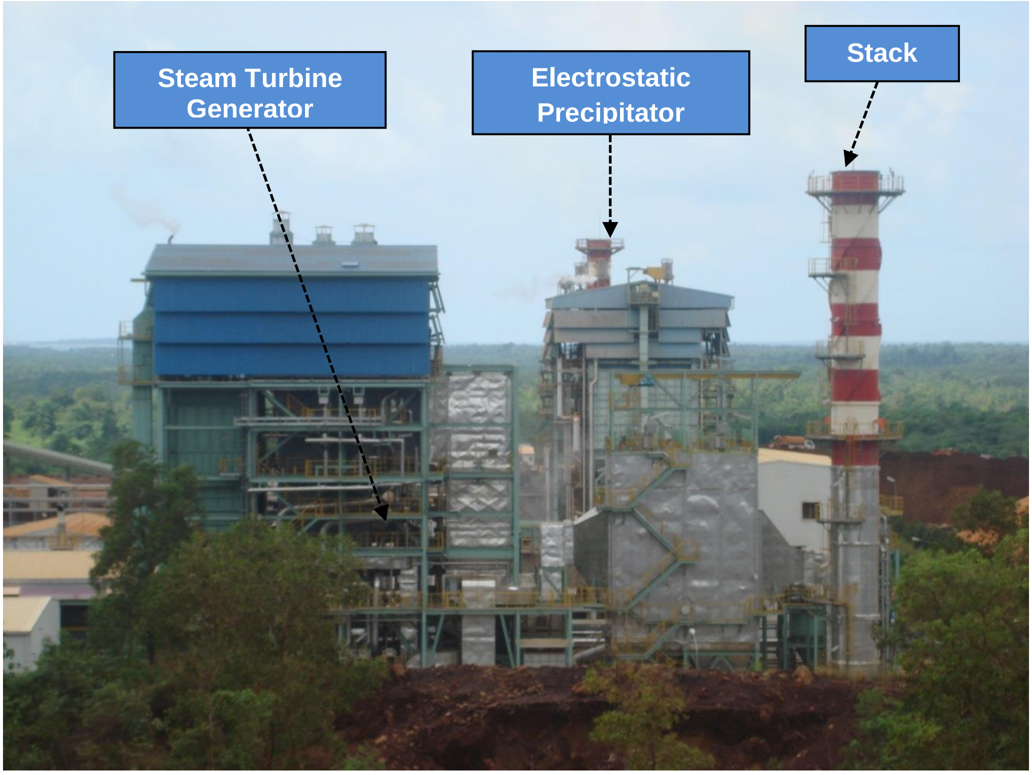


Plate 1.5.1. 14.4 MW Coal-fired power boiler that produces steam for turbine generator at the HPP complex

1.5.1.2 Support Facilities

Water Supply and Distribution System

For a maximum mixed ore feed of 1,250 MT/hour, the water requirement is 13.0 MT/min for wet season and 15.33 MT/min for dry season. The main source of water supply for the plant is the East Ibelnan River Intake dam (**Plate 1.5.2**), located 3 km west of the HPP. Raw water is transported to the plant site through a 3.8-km long pipeline with the aid of booster pumps. The raw water is passed through a sand filtration, and the treated water is stored into two (2) intake water ponds each with 3,000 m^3 capacity.

As an alternative source of water during the dry months, CBNC is also utilizing the water impounded at the Upper Togpon siltation pond and a 300,000 m^3 water reservoir (**Plate 1.5.3**) for the production process. In addition, the plant is recycling about 20% of the cooling and wash water from the HPP.

Table 1.5.5. CBNC project facilities

Source	Water Requirement		Permits Issued by NWRB
	Wet Season	Dry Season (Additional source)	
East Ibelnan River Intake dam	9.2 MT/Min	7.7 MT/Min	Water Permit No. 17998
Upper Togpon Siltation Pond (433,175m^3)	3.8	3.23 MT/min (good for 60 days)	-
Water Reservoir in Togpon (300,000m^3)	-	**4.4** MT/min (good for 60 days) Note: only 90% of the capacity can be consumed	Water Permit No. 17998
Total	13.0	**15.33**	

Plate 1.5.2. East Ibelnan River Intake Dam

Plate 1.5.3. A view of the 300,000 cu. M. water reservoir

Port Facility (Causeway and Trestle)

The port facility is situated on a 36 hectare area and includes a 380 m long x 14 m wide causeway (**Plate 1.5.4**) built of boulders and gravel with concrete covering/paving and connected to a 1,080 m long southwest trending trestle mounted on steel piles. The facility also includes a chemical warehouse (4,536 m^2), coal stockyard (24,000 m^2), slaked lime and sulfur storage yard (13,025 m^2), and tank farm for methane and sulfuric acid (11,557 m^2).

Mounted on steel piles, the trestle (**Plate 1.5.5**) supports the 250-mm diameter stainless steel sulfuric acid and 200-mm diameter carbon steel pipe for the methanol. The trestle is 5 m above the sea level and 2.5 m wide. It has a structure that supports the pipelines of outgoing effluent and incoming sulfuric acid and methanol. It also has a walkway for inspection purposes. The 250-mm diameter effluent pipe can also be found here.

Plate 1.5.4. The 380m long causeway

Plate 1.5.5. The 1,080m long trestle

Shared Facilities

There are facilities within Barangay Rio Tuba which are being used by CBNC and two (2) other companies operating within the area. These include the access road within the RTEPZ shared with RTNMC and Unichamp Mineral Philippines, Inc. (UMPI) and the Macadam Road connecting the plantsite to the piersite shared with RTNMC only.

In terms of accommodation, CBNC houses most of its employees within the 40-hectare Townsite developed by the RTNMC. The townsite has a population of 2,167, mostly company employees and their families. This facility provides water and power supply for the occupants. In case new workers will be hired, the RTNMC Townsite will be able to accommodate these new employees by expanding the area. A total of 5 hectares is intended for additional housing projects which can accommodate about 224 families.

1.5.1.3 Pollution Control and Waste Management Facilities

Waste generation from the HPP complex mainly comes from the production process. These are composed of tailings solids and effluent from the MS production and the dry and wet ash from the power generation. Other waste generated includes free acids from the HPAL and H_2S production process. These are however re-circulated back to the production system.

Tailings Storage Facilities

The HPP operations, which produces an annual combined capacity of 44,000 MT of mixed sulfide product, containing approximately 24,000 DMT Nickel and 2,000 DMT cobalt, generates about 2.8 million DMT of tailings a year.

Tailings Solids

The tailings solids to be generated have the following composition:

- Neutralized Residue – The CCD7 thickener underflow tailings slurry containing about 1,240,000 dry MT/year (DMT/y) of the leach residue is neutralized to pH 8.5 with lime and slaked lime in four (4) final neutralization tanks. This neutralized slurry is then pumped to the tailings dam.
- Neutralized Gypsum - About 650,000 DMT/y of neutralized gypsum generated from the neutralization section is treated together with the leach residue filter in the CCD circuit. This is finally discharged to the tailings dam via the second neutralization of the Barren Liquor Treatment.
- Gypsum Sludge - About 330,000 DMT/y of gypsum sludge from the second neutralization of the Barren Liquor treatment is discharged to the tailings dam via the second neutralization of the Barren Liquor Treatment.

Based on analysis, the tailings solids have the following composition:

Table 1.5.6. Composition of tailings solids

Element/Ion	% Composition
Nickel (Ni)	0.1
Cobalt (Co)	0.0 [a]
Magnesium (Mg)	0.7
Manganese (Mn)	0.5
Zinc (Zn)	0.0 [a]
Iron (Fe)	31.5
Al (Aluminum)	1.4
Chromium (Cr)	1.4
Silicon (Si)	5.1
Calcium (Ca)	7.9
Sulfate (SO_4)	18.2

Source: CBNC, 2006
Note: [a]This is due to rounding off.

Tailings Effluent

The tailings dam effluent, also called supernatant, is pure water. It is taken out of the tailings dam after the solid part of the tailings has settled. The tailings slurry that enters the dam has a pH of 8 to 8.5 and temperature of 60°C to 70°C. Its stay at the dam allows the solids to settle and the effluent to cool down (**Plate 1.5.6)**. Other characteristics of the final tailings effluent are shown in **Table 1.5.7**.

Table 1.5.7. Composition of tailings dam effluent

Parameters	Effluent
Nickel (Ni), g/L	< 0.001
Cobalt (Co) , g/L	< 0.001
Magnesium (Mg) , g/L	< 0.070
Manganese (Mn) , g/L	< 0.001
Zinc (Zn) , g/L	< 0.001
Iron (Fe) , g/L	< 0.001
Al (Aluminum) , g/L	< 0.001
Chromium (Cr) , g/L	< 0.0001
Calcium (Ca), g/L	0.550
pH	7.600
Temperature (°C)	30.800
Dissolved oxygen, mg/L	5.400
Total Suspended Solids, mg/L	11.600

Source: CBNC, 2006

Plate 1.5.6. Tailings discharge to the dam

The two (2) existing tailings dam were designed to collect and impound the materials generated from the process of Lines 1 and 2. The materials used in the dam construction include sand, gravel and laterite that were available at the RTNMC Mine site area.

After settling of the tailings solids, the water part or supernatant is pumped towards the sea through two (2) 9-km long 250 mm diameter steel pipes traversing along the Macadam Road, 380 m long causeway and 1,080 m long southwest trending trestle and then discharged at the end portion of the trestle to the sea bottom about 10 feet from the seawater surface. As mentioned in the previous section, prior to the discharge of the supernatant, the tailings undergo the following process:

a. Neutralization of its acidity and precipitation of its impurities; and
b. Sedimentation at the tailings dam.

Approximately 30-40% of the supernatant is recycled to the HPP.

TSF1 is located north of the HPP while TSF2 is located about 2.5 km northwest of the HPP enclosing the previously constructed Magas-magas siltation pond. TSF1 has been filled up to about 6.7 M DMT of tailings. TSF2, on the other hand, has a capacity of 40 M m^3 which is good for 15 years of HPP Lines 1 and 2 operations. To date, the remaining life of the dam is six (6) years. **Plate 1.5.7** shows the aerial view of the TSF 1.

Plate 1.5.7. Aerial View of the TSF 1 as of July 2013

TSF1 was constructed in two (2) stages with an embankment elevation at EL60 masl during the 1st stage and the embankment elevation was increased to EL67.5 masl during the second stage. The materials used in the dam construction include sand, gravel and laterite that are available within the mining area of RTNMC. TSF1 operated from 2005 to 2010 (6 years) impounding about 6,785,500 DMT (4 M m^3) of tailings.

TSF2 was constructed with two (2) embankments (North and South) raised to the ultimate level of 80 masl. Maximum embankment heights are about 48 m at the southern embankment and 15 m at the northern embankment. The embankments are 1.27 kms and 1.92 kms long, respectively. These embankments are located on either side of natural saddles, which run east-west through the site. The surface or catchment area of the dam footprint would be about 207 hectares. Since the start of its operation in 2010, it has impounded about 22,619,266 m^3 of tailings as of January 2018. The remaining capacity is 10.4 M m^3 (7.8 M DMT) which is equivalent to six (6) years of operation.

TSF3 will be constructed after the issuance of the ECC and other necessary permits. It will take six (6) years in time for the decommissioning of the TSF2. Additional details on the TSF3 are provided in the **Table 1.5.8**.

Table 1.5.8 Details of the TSF of CBNC

Tailing Storage Facility	Area	Tailings Dam Capacity	Volume of Tailings Impounded	Life Span (years)
TSF1	90 ha	7 M m^3	4 M m^3 (6,785,500 DMT)	6
TSF2	207 ha	33 M m^3	22,619,266 m^3 as of Jan 2018	15

Tailing Storage Facility	Area	Tailings Dam Capacity	Volume of Tailings Impounded	Life Span (years)
Proposed TSF3	111 ha	18.6 M m^3	-	5
Total	408	58.6 M m^3		26

Solid and Hazardous Wastes Management

Ash Pit

Wet and dry ash generated by power generation facility is disposed in the ash pit. Fine ash particles that goes with the flue gas is recovered in the electrostatic precipitator (EP) and the same is disposed in the ash pit. With a 40 MT/day of ash generated, the 428,026 m^3 ash pond can be used for 30 years. The ash pit is a mined-out area located northeast of the HPP complex with top elevation of 33 m. Since both the ash pit and the TSF, were constructed within the mined out area where soil are non-permeable, installation of the bottom lining was not considered. The soil within the area serves as natural lining to the ash pit preventing leachate from contaminating the groundwater.

As part of the periodic maintenance of the ash pit on a weekly basis, the disposed ash is covered with laterite to minimize exposure to wind. For monitoring, coal ash samples are also subjected to regular Toxicity Characteristic Leaching Procedure (TCLP) test to determine the characteristics of the heavy metals and the leaching behavior.

Annex 1.5.1 shows the latest result of the coal ash analysis and the report on coal ash sampling and analysis prepared by CBNC attesting that the generated coal ash is non-hazardous.

Hazardous Waste Temporary Storage Facility

Hazardous wastes generated by the HPP complex (**Table 1.5.9**) are treated by a DENR-accredited hazardous waste treater. While waiting for transport, these are properly contained and stored in CBNC's temporary hazardous waste storage area, which has an emergency containment bund wall and oil and water separator.

Table 1.5.9 Summary of hazardous waste generated, 2017

Hazardous Waste				Amount, ton
HW No.	Class	Nature	Cataloguing	
I101	Waste oils	Liquid	Used Oil	20.34
I101	Waste oils	Liquid	Grease	1.8
I104	Waste oils	Solid	Oil-Contaminated Rugs	2.46
I104	Waste oils	Solid	Used Oil Filters	0.01
D407	Mercury & Mercury Compounds	Solid	Busted Fluorescent Lamps	0.08
D407	Mercury & Mercury compounds	Solid	Busted CFL Bulbs	0.02
B299	Other acid waste	Solid	Used filter cloth	3.03
C399	Unknown Alkali wastes (pH>12.5)	Liquid	Other alkali waste	0.08
C399	Sodium hydrosulfide	Solid	Other alkali waste	-
C399	Stellakit	Liquid	Other alkali waste	-
B299	Unknown acid wastes (pH<2.0)	Liquid	Other acid waste	-
M506	Waste electrical and electronic equipment	Solid	Defective computers, monitor, printers	-
G704	Assorted non-halogenated organic solvents	Liquid	Other non-halogenated organic compounds	-

Source: CBNC SMR, 4th Quarter of 2017

All movements of hazardous wastes are covered by Permit to Transport as well as Certificate of Treatment by the DENR-Accredited TSD (Treatment, Storage & Disposal) Facility upon final treatment/disposal.

Sanitary Landfill

To separate biodegradable and non-biodegradable wastes, color-coded trash bins are distributed in strategic locations within the HPP Complex. Company-hired trucks collect garbage on a daily basis and dispose to the 3.8-ha sanitary landfill (GP-28), which is covered by a separate ECC.

Other Pollution Control Measures

Installed in the plant are various pollution control equipment to ensure that all waste materials are treated and disposed of properly. These include the following:

- Wastewater treatment plant;
- Spillage handling system; and
- Air pollution control facility (*i.e.* EP and scrubbers).

These measures are further discussed in *Section 1.6.6* of this Chapter.

1.5.2 Proposed Expansion Project

The proposed TSF3 will be situated at the northeastern portion of the existing GP-4 rehabilitation area of RTNMC. It will have a total area of approximately 111 has, embankment length of 2,350 m, inside area of 555,000 m^2, cut volume of 26,750,000 m^3, embankment volume of 4,730,000 m^3 at an elevation of 42 m, and a total capacity of 18,605,000 m^3 at 39.5 m elevation. Assuming no changes in the current production capacity of the plant, the TSF3 is estimated to last up to five (5) years.

Geological and Soil Investigation was conducted at the TSF3 site. The result of the study indicates that the site is divided into the west side (hilly area with Serpentinite foundation) and the eastern side (Alluvial Lowland with Limestone foundation). The results of the investigation are attached as **Annex 1.5.2**.

Figure 1.5.2 presents the design detail of TSF3. The construction materials to be used differ from each zone, which shall be sourced from the same mined-out area where the TSF3 will be constructed. The core zone shall be filled with impervious earth material which provides water tightness. The rock zone, on the other hand will be filled with rock of all sizes, which support the less stable core material at the same time provide the stability and durability of the dam body. Filter zone, which is further classified into fine filter zone and coarse filter zone shall be filled with the following materials:

- Fine filter zone - well graded sand which will form a fine filter on the downstream face of the clay core to prevent piping of fines within core zone; and
- Coarse filter zone - well graded gravel which is grading compatible with fine filter material.

Tailings discharge from the HPP to TSF3 will be approximately 26,000 m^3/day with around 30-40% solids by weight. The supernatant portion is about 18,720 m^3/day and this is distributed approximately 75% (14,040 m^3/day) to be discharged to the sea and 25% (10,300

m^3/day) to be recycled to the HPP during rainy days when raw water supply is sufficient. During dry season, all of the supernatant water is recycled to the plant. Effluent from TSF3 will also be transported the same way as TSF1 and 2.
Specific details on the composition of the tailings dam effluent were discussed in *Section 1.5.1.3*.

Table 1.5.10. Specification of the Proposed Tailings Storage Facility 3

TSF3	Value
Capacity	18,605,000 m^3 (at 39.5 m elevation)
Life-span	5 years
Tailings discharge from HPP to TSF 3	26,000 m^3/day
% solid	Approx. 30-40 (7,000 m^3/day)
% liquid	Approx. 60-70 (18,720 m^3/day)
Evaporation Rate	4 mm/day
Rainfall Rate	8 mm/day

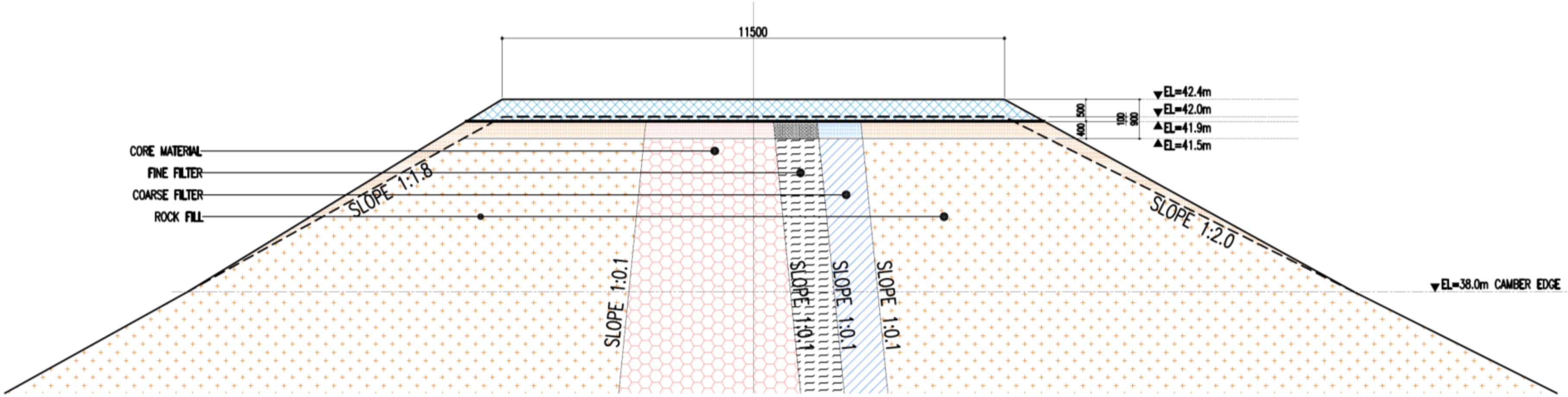
The increase in Co production will not require additional facilities since cobalt is only a by-product in the production of nickel. This means production control is mainly on nickel and not on cobalt.

The metal recovery of cobalt from 2007-2015 is very good. This means more Co will be produced if Co content of ore feed increased. No additional acid or other chemicals will be added to the present consumption in processing as well as no increase in negative environmental impact will result from increased Co production.

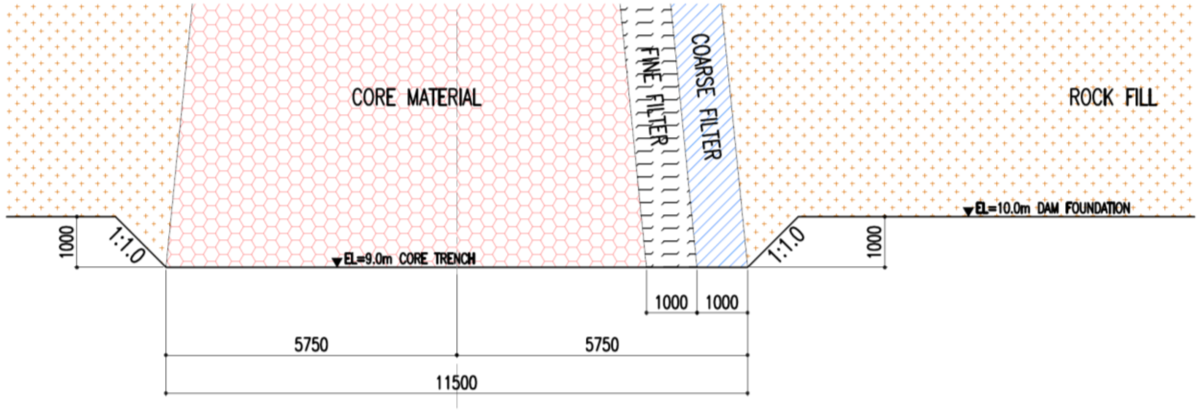
Table 1.5.11. Historical metallurgical data of cobalt of CBNC

Year	Head Assay		%Co/ %Ni ratio	Actual Production		Actual Recovery		Co%/%Ni Ratio (D)	Projected Production	
	%Ni	%Co		Ni DMT(B)	Co DMT(A)	Ni%	Co%		Ni DMT	Co DMT
2007	1.306	0.095	0.073	10,077	756	86.34	89.22	1.033	25,000	1,875
2008	1.328	0.082	0.062	10,562	700	85.04z	92.20	1.084	25,000	1,738
2009	1.100	0.082	0.075	17,034	1,404	87.15	98.79	1.134	25,000	2,261
2010	1.100	0.091	0.083	19,357	1,502	84.83	96.51	1.138	25,000	2,136
2011	1.310	0.091	0.069	22,494	1,744	85.67	95.46	1.114	25,000	2,091
2012	1.258	0.110	0.087	23,891	2,269	85.75	92.76	1.082	25,000	2,486
2013	1.205	0.100	0.083	23,588	2,110	85.04	91.52	1.076	25,000	2,400
2014	1.207	0.091	0.075	24,019	1,822	87.12	87.40	1.003	25,000	1,842
2015	1.174	0.093	0.073	23,632	1,928	87.19	90.10	1.033	25,000	2,040

Source: CBNC, 2016
*Notes: 2007 – Reference year; Projected Co DMT = (A/B)*C*(D/1.033)*



CREST DETAIL



CORE TRENCH DETAIL

Source: CBNC, 2016

Figure 1.5.2. Crest and core trench detail of TSF 3

1.6 PROCESS/TECHNOLOGY

1.6.1 Raw Materials

1.6.1.1 Ore

The feed for the process are low-grade nickel ores that are already mined and stockpiled in the mine site. Almost 18.8 million DMT of ore is stockpiled at the RTNMC mine site. Based on the table below, 2.9 million DMT will be consumed annually.

Table 1.6.1. Annual consumption of ores

Ore Type	Raw Ore (DMT)	-2mm (DMT)
HFO	250,000	200,000
LGSO	750,000	600,000
Laterite	1,875,000	1,500,000
Total	2,875,000	2,300,000

Table 1.6.2. Specifications of feed for HPP, -2mm size of low-grade nickel ores

Ore Type	Ni (%)	Co (%)	Fe (%)	Mn (%)	Cr_2O_3 (%)	ZnO (%)	MgO (%)	SiO_2 (%)	Al_2O_3 (%)	CaO (%)
HFO	2.10	0.078	27.24	0.46	1.22	0.026	1.89	34.0	1.09	0.037
LGSO	1.73	0.102	34.48	0.64	1.91	0.036	6.70	26.8	2.17	0.017
Laterite	1.06	0.092	45.68	0.72	2.84	0.037	2.24	12.6	4.18	0.012
Mixed	1.26	0.094	42.25	0.70	2.55	0.036	3.67	16.84	3.58	0.014

Other Raw Materials

Aside from the raw ore, the process will consume other materials such as sulfuric acid, limestone, lime, methanol, sulfur and the propriety flocculant. **Table 1.6.3** lists the annual requirements for these materials.

Table 1.6.3. Materials consumption

Materials	Requirement (DMT/y)
Sulfuric acid (98%)	570,000
Limestone	500,000
Lime	130,000
Methanol	7,000
Sulfur	16,500
Flocculant	1,500

Table 1.6.4.Historical (2005-2017) and projected (2018-2026) consumption of limestone

Years	Limestone Consumption (WMT)
2005	67,590.45
2006	120,592.64
2007	136,244.88
2008	204,748.01
2009	372,582.43
2010	413,189.55
2011	431,046.06
2012	514,100.20
2013	540,663.96
2014	486,108.15
2015	434,029.20
2016	358,878.45
2017	427,355.95
2018**	417,100.00
2019	417,100.00
2020	417,100.00
2021	417,100.00
2022	417,100.00
2023	417,100.00
2024	417,100.00
2025	417,100.00

Years	Limestone Consumption (WMT)
2026	417,100.00

*Note:*Combined supplies from Bohol and Gotok Limestone Quarry*
***2018-2026 data from CBNC Production dated 5/9/2018*

Table 1.6.5. Chemical element balance for the annual production of 24,000 DMT Nickel (mixed sulfide)

Content	Ore Feed	-2 mm ore	Autoclave residue	Gypsum from Pre-neutralization	ZnS	MS Products	Gypsum from Barren Neutralization	Gypsum from Final Neutralization
Ni	33,808	27,046	1,432	158	25	24,000	308	392
Co	2,657	2,126	97	16	5	1,875	20	28
Mg	43,367	34,694	6,235	327	-	23	608	9,913
Mn	19,864	15,891	1,937	-	20	20	-	13,778
Zn	896	717	251	-	623	8	5	5
Fe	1,324,269	1,059,415	1,025,514	25,715	20	3	9,690	420
Al	66,557	53,245	26,735	14,408	40	40	8,198	268
Cr	51,950	41,560	44,630	275	3	3	133	13
Si	152,957	122,366	104,737	419	-	-	1,045	18
Ca	557	446	1,112	289,007	-	38	55,953	33,740
Oxide, O	1,178,319	942,655	-	-	-	-	-	-
Sulfate, SO_4	-	-	24,130	314,350	-	-	126,233	66,244
Sulfide, S	-	-	-	-	-	15,993	-	-

1.6.1.2 Power Source and Requirements

The total power demand for the HPP complex is approximately 18,000 kW: MS Plant (17,300 kW) and mining/townsite (300 kW). This is about 80% of the power plant's capacity. For a 330-day operation, the power consumption would be about 135,000 kW-hr.

1.6.1.3 Water Source and Requirements

The annual water requirement for the HPP complex is approximately 9,900,000 m^3 which is being sourced from the East Ibelnan River, Upper Togpon siltation pond and a 300-m^3 reservoir as alternative water source and recycled tailings supernatant. Refer to **Figure 1.6.2** for the water balance of the HPP complex.

1.6.1.4 Fuel Requirement

Fuel requirements are coal for the power plant and heavy oil and diesel for heavy equipment, emergency power and for 40 service vehicles needed for the plant operations. Summarized in **Tables 1.6.6** and **1.6.7** are the fuel consumption in constructing TSF3 the requirements for the operation of the whole HPP complex and its associated facilities, respectively.

Table 1.6.6. Diesel fuel consumption for TSF3 construction

Year	Consumption (L)
2016	325,000
2017	383,000
2018	2,430,000
2019	4,632,000
2020	3,287,000
2021	1,942,000
2022	597,000
2023	504,000
Total	**14,100,000**

Source: CBNC, 2016

Table 1.6.7. Fuel consumption during operation

	Heavy oil	Diesel oil	Coal	Unit
Consumption	No Consumption	4,000,000	213,000	L/y, MT/yr
Procurement		14,000	-	barrels/tanker
Mobility		700,000	-	L/y
Ore transport		1,400,000	-	L/y
Emergency power		800,000	-	L/y
Tailings dam		400,000	-	L/y

The 700,000 L per year diesel fuel consumption are for the following vehicles presented in **Table 1.6.8**.

Table 1.6.8. List of mobile equipment being utilized during the operation of the whole HPP complex and its associated facilities

Type of Vehicle	Model	Number
4x4 Pick up	Mitsubishi Strada	14
	Nissan Navara	1
4x2 Pick up	Isuzu D-Max	1
	Toyota Hi-Lux	1
	Nissan Frontier	1
4x4 Wagon	Suzuki Jimny	3
4x4 SUV	Mitsubishi Pajero	1
	Mitsubishi Montero	2
Van	Toyota Hi-Ace	4
	Nissan Urvan	1
	Toyota Grandia	5
	Toyota S Grandia	2
Mini-Van	Suzuki APV	1
Ambulance	Mitsubishi L300	1
	Toyota Noah	1
Multicab	Suzuki Multicab	1
Total		**40**

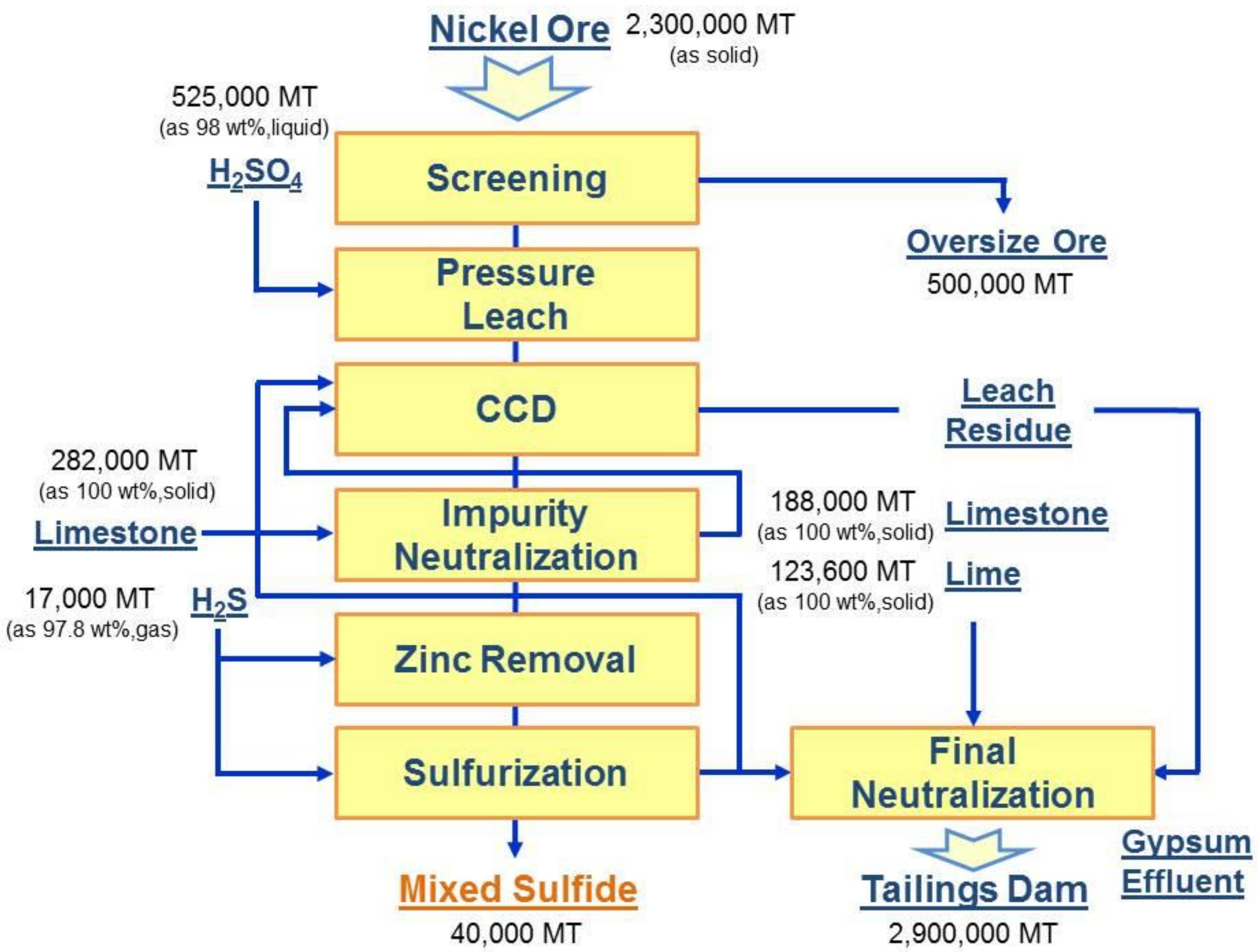


Figure 1.6.1. Material balance of the CBNC HPP (25,000 DMT Nickel + 2,500 DMT/ year

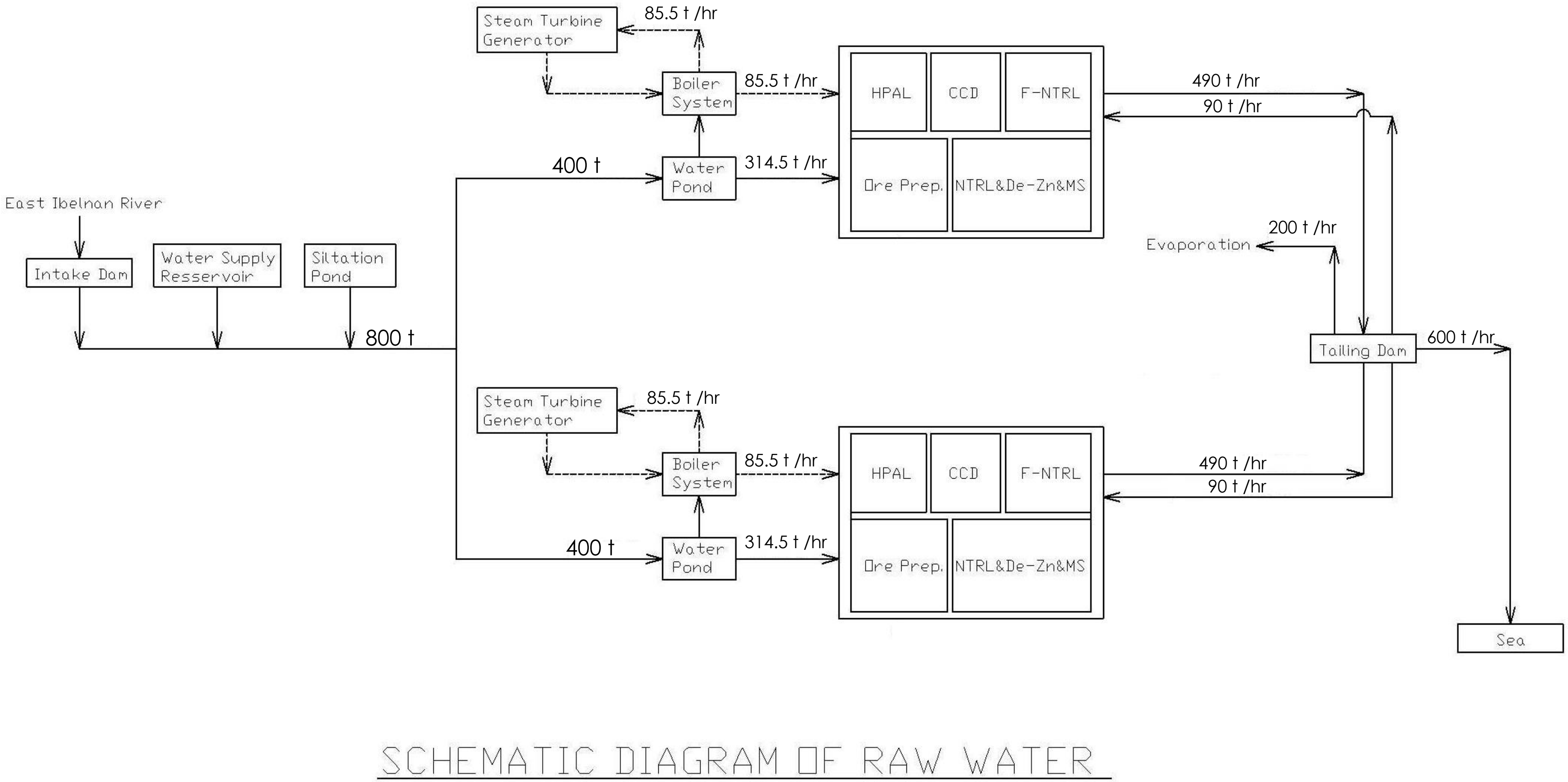


Figure 1.6.2. Water balance of CBNC HPP (25,000 DMT Nickel + 2,500 DMT Cobalt/ year)

1.6.2 The Manufacturing Process

1.6.2.1 Mixed Sulfide Process

The production of mixed sulfide involves seven (7) stages. **Figure 1.6.3** shows the simplified Process Flow Diagram. The process stages are discussed below:

Ore preparation

The process involves screening out from the feed ore particles with more than 2 mm size fraction. This is to remove the coarser grain size of low grade Ni ore, which contains more magnesium oxide (MgO) than the finer grained ore. MgO require higher acid consumption at the autoclave. The -2 mm fraction is slurrified, thickened and stored at the HPAL feed storage tank.

High Pressure Acid Leach (HPAL)

The ore slurry is subjected to three (3) stages of pre-heating before being fed to the autoclave together with sulfuric acid and steam to selectively leach Ni and Co. After passing through three (3) stages of flashing or depressurization, the pressure leached slurry from this process is sent to the Counter-Current Decanter.

Counter-Current Decanter

The depressurized pressure leach slurry is fed to the seven-stage Counter Current Decantation (CCD) circuit to recover the nickel and cobalt-rich solutions from the barren leached solids. The underflow from the last thickener is discharged to the tailings treatment area at maximum solid density and minimum nickel and cobalt liquor concentration. The pregnant solution or nickel and cobalt-liquor from the first CCD thickener overflow is sent to the neutralization circuit. The washed tailings from CCD 7 are neutralized by limestone and sent to the final neutralization stage.

Neutralization

The pregnant solution from the CCD area is sent to the neutralization tanks where limestone is added in the tanks to regulate pH at 3.0 to 4.0 to precipitate Fe and Al. The neutralized solution containing the reaction product gypsum is sent to the neutralization thickener together with the flocculants to improve settling rates and is separated into neutralized solution and neutralized gypsum slurry. The neutralized gypsum slurry is sent to CCD 3, while the neutralized solution is sent to for the Zinc Removal area.

Zinc Removal

The neutralization thickener overflow is pumped to the zinc removal tanks and contacted with hydrogen sulfide gas to precipitate Zn and Cu. The entire discharge stream from the zinc precipitation tanks is directed to the zinc-free liquor polishing filters. The zinc sulfide fines sluiced from the polishing filters are re-pulped and then pumped to the final neutralization stage.

Sulfurization

The neutralization solution stripped of its Zn impurities is reacted with hydrogen sulfide (H_2S) in the range of pH 2.5 and 3.0 to recover more than 99% of Ni and Co as Ni/Co mixed sulfide (MS). Impurities such as manganese (Mn) and magnesium (Mg) remain in the solution. The sulfurized slurry is sent to the sulfide thickener and is separated into sulfurized solution and sulfide slurry. The sulfide slurry is washed and dehydrated by pressure filter and is separated as mixed sulfide slurry. The sulfide slurry is washed and dehydrated by pressure filter and is separated as mixed sulfide (MS) while the sulfurized solution is sent to the Barren Liquor Treatment (Area 7). MS products are packed in flexible plastic containers.

Barren Liquor Treatment

The barren sulfurized solution from the Sulfurization Area is sent to the polishing filters where any fines recovered are re-pulped and returned to the MS reactors. The filtrate goes through an H_2S stripping column then to the CCD water surge tanks to be used as wash water for the CCDs. A small excess portion is directed to the final neutralization stage together with the zinc sulfides and the bulk of the leached residue from CCD no. 7.

Limestone slurry is added to raise the pH to 6, then, slaked lime is added next further increase the pH to alkaline levels of 8.0 to 8.5. Here, most of the remaining dissolved manganese and magnesium precipitates. The neutralized tailing is then pumped to the tailings dam.

1.6.3 H_2S Production Process

Methanol and demineralized water are mixed and vaporized by heating, and then mixed gas is reacted on the catalyst to generate crude hydrogen (H_2) gas. This crude H_2 gas is fed to PSA (Pressure Swing Adsorption) unit and purified to more than 99.9% by volume. The high purity H_2 gas is fed to the H_2S reactor.

On the other hand, flake sulfur is melted by low pressure (LP) steam and fed to the H_2S reactor from where crude H_2 is generated. This is eventually purified to 98% by volume H_2S gas.

The process flow diagram of the hydrogen sulfide production is presented in **Figure 1.6.4.**

1.6.4 Power Generation Process

The process involves the production of steam from a coal-fired boiler to run the steam turbine. Demineralized water is circulated to the boiler to heat the water to 400°C. The superheated steam drives the turbine and generates electrical power.

After water is expanded at the turbine, the saturated steam is transformed to its saturated phase (partly water, partly steam) and condensed into the liquid form at the condenser. The water is again made to pass through the feed water pump before being utilized at the boiler. The simplified diagram of the power generation process is presented in **Figure 1.6.5**.

1.6.5 Wastewater Treatment Process

During the MS production process, neutralization of tailings and pregnant solution is being done to recover nickel and cobalt from the ores. After Ni and Co is recovered, all wastewater and tailings are sent to the final neutralization tanks for final treatment. Lime slurry and limestone is added to increase pH from 6 to 8.0 to 8.5. The simplified process of wastewater treatment is presented as **Figure 1.6.6.**

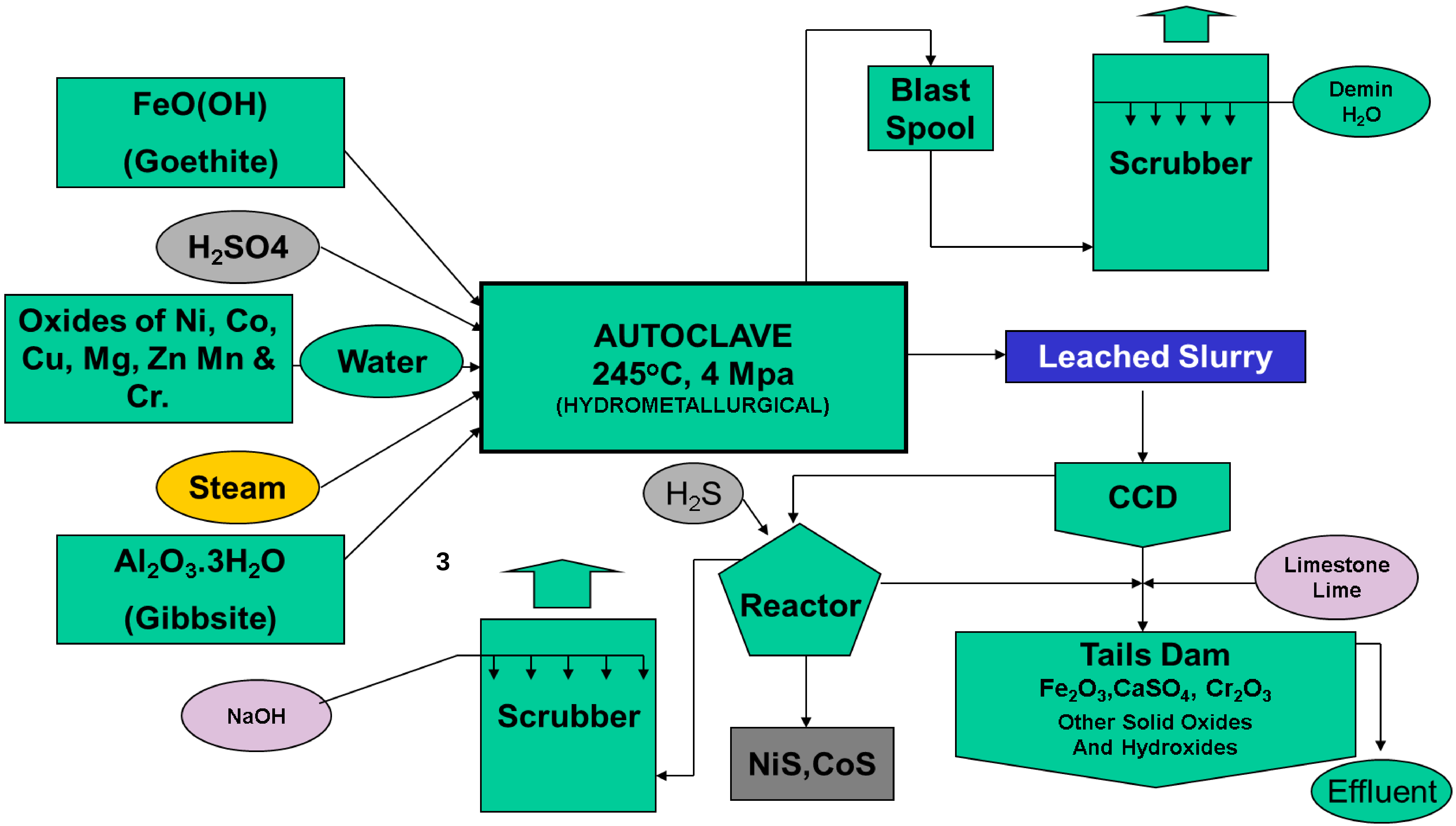


Figure 1.6.3. Simplified Process Flow Diagram

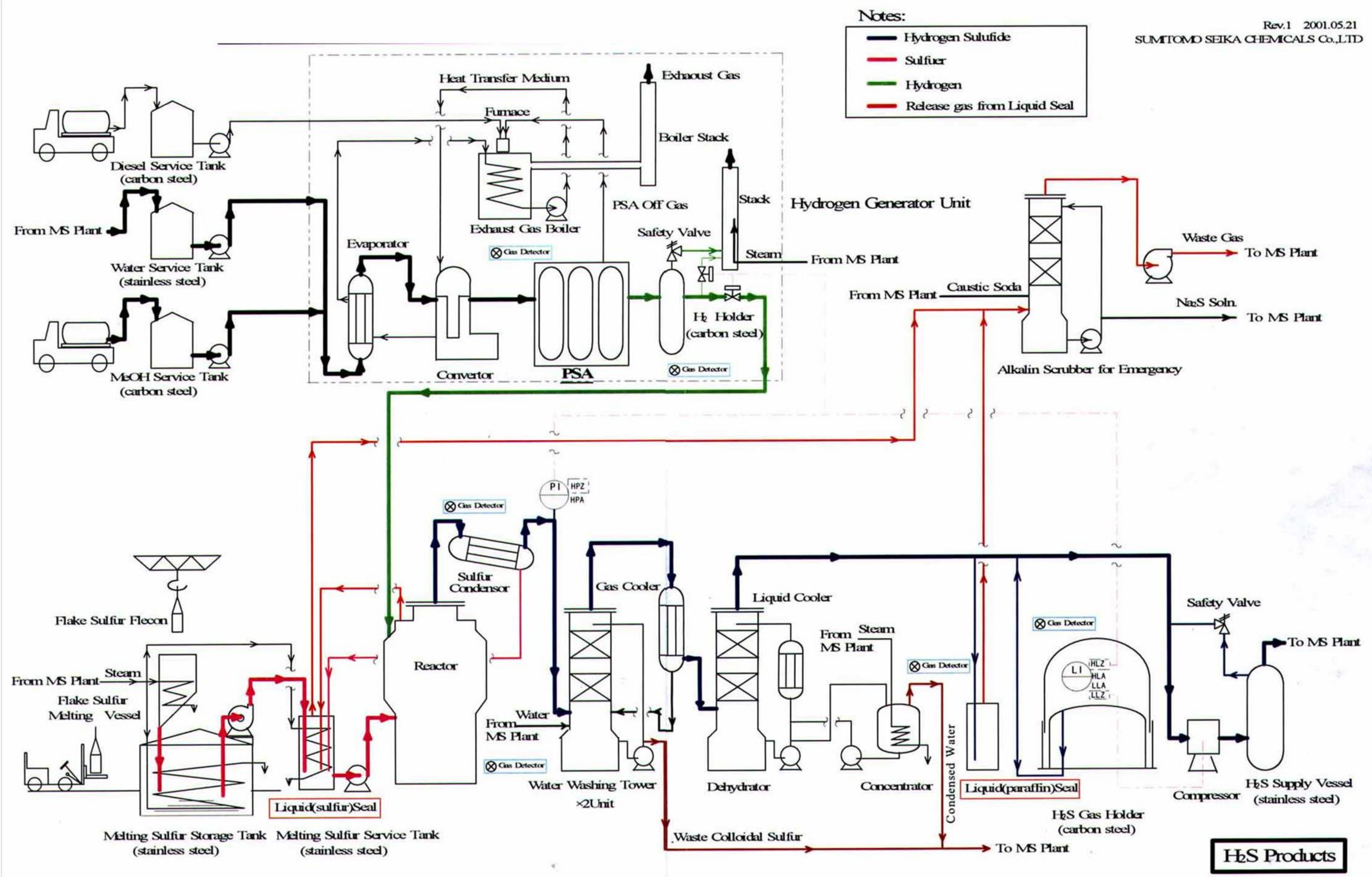


Figure 1.6.4. H_2S Process Flow Diagram

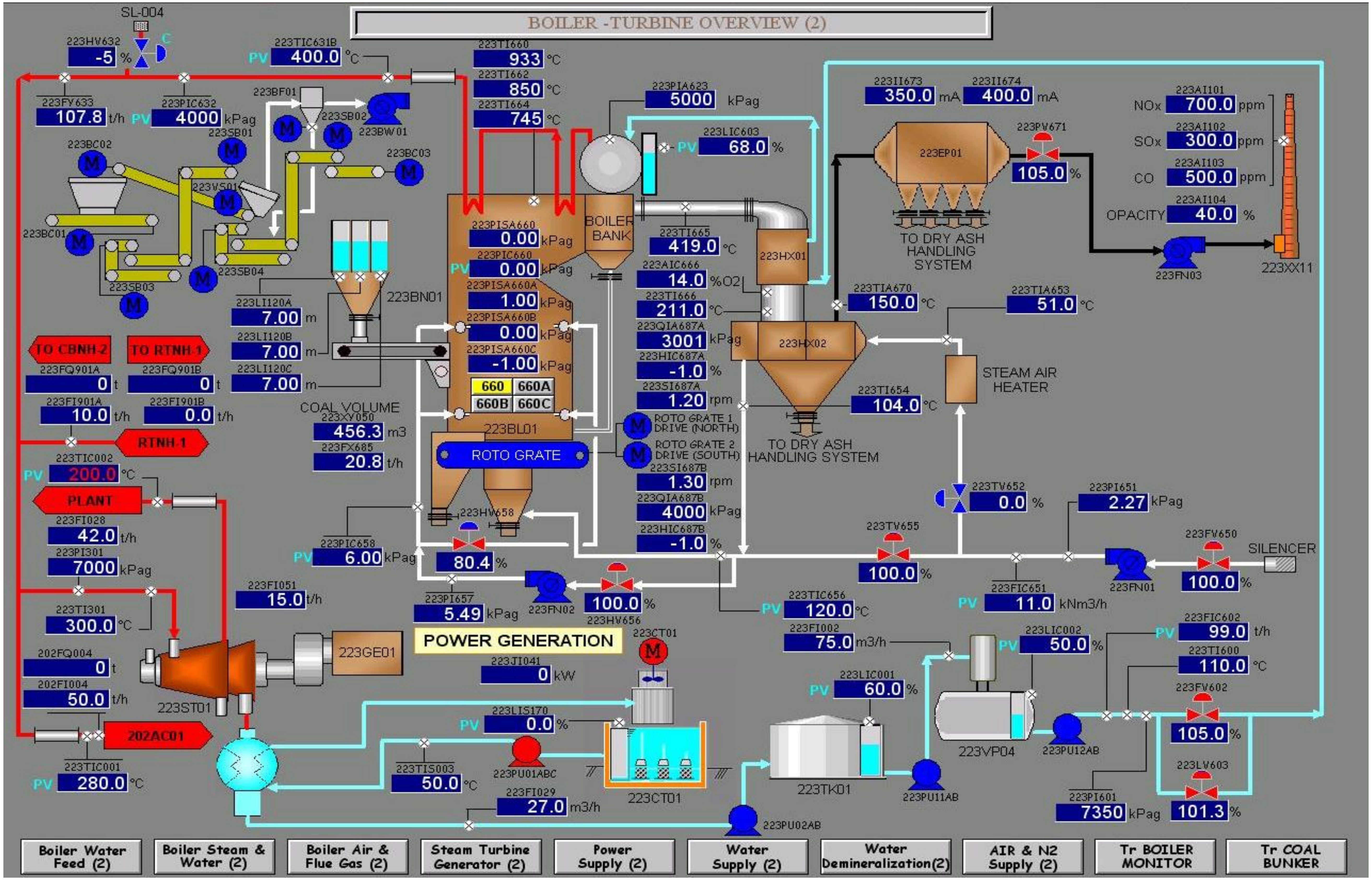


Figure 1.6.5. Simplified diagram of the power generation process

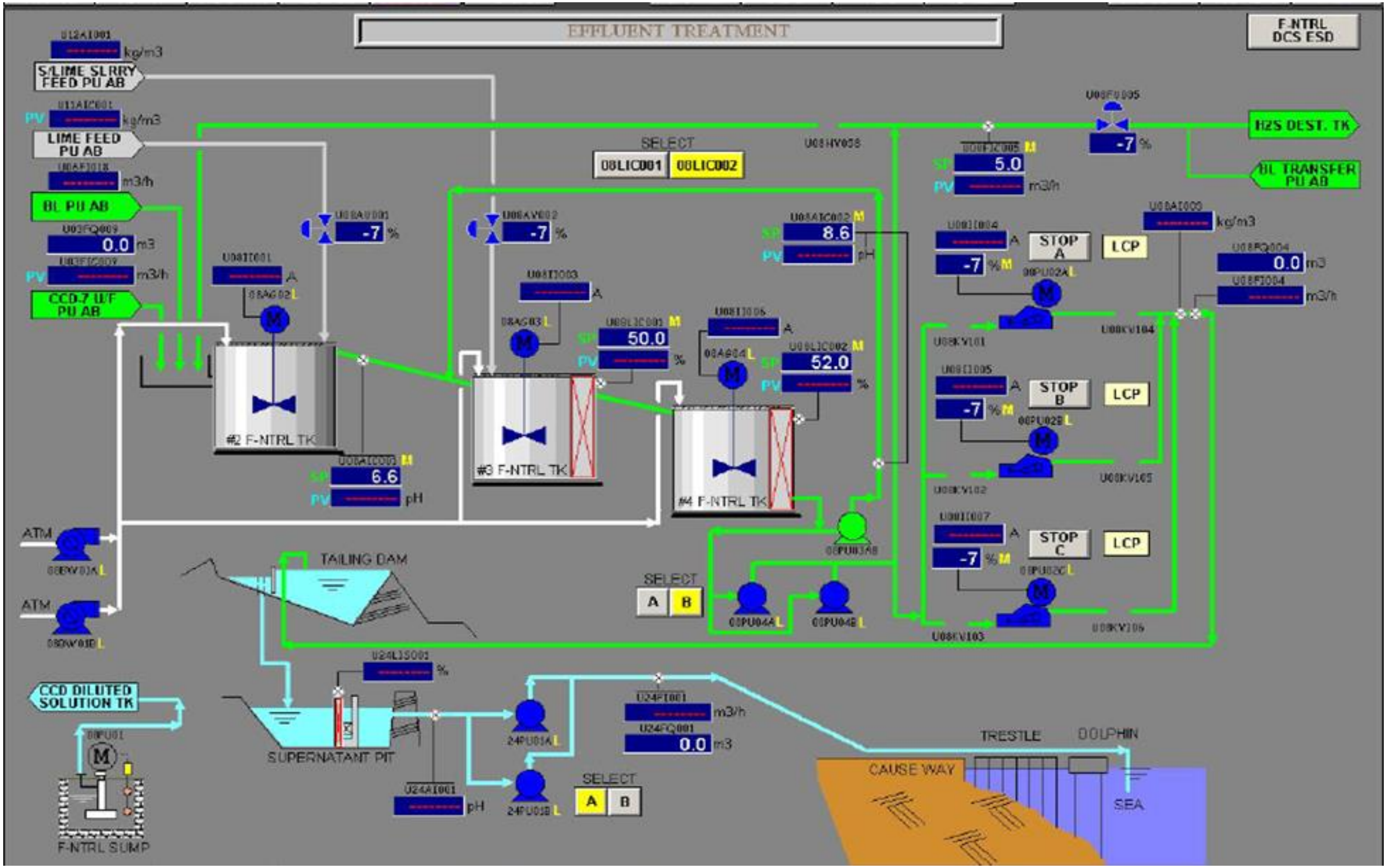


Figure 1.6.6. Simplified diagram of the wastewater treatment process

1.6.6 Pollution Control Measures

Wastewater Treatment Plant

The wastewater treatment plant is an essential component of the HPP complex (**Plate 1.6.1**). The pressure leached slurry from the CCD after removal of the pregnant solution is neutralized in the water treatment plant to reduce acidity and precipitate other dissolved metals such as Cr, Al, Fe, Mn, Mg and others before disposal to the tailings dam.

Spillage Handling System

In the event of spill or loss of containment, alarms will be activated and the affected area will be isolated immediately. Necessary shut off procedures will be conducted to control and prevent further spill. A designated spill response team will carry out the clean-up and the decontamination of the affected area.

Table 1.6.9. Different types of spillage with the corresponding emergency response plan

Type of Spillage	Procedures are in Place	Particular activity to handle the spillages	Treatment of contamination
Oil and Fuel Spillage	Existing Procedures and Spillage Control Facilities are in place	Use of secondary containment pans and if ever there is accidental spillage on the ground; Cleaning and recovery of contaminated soil	Contaminated soil will be treated as Haz Waste under RA 6969
Tailings Spillage	TSF2 Emergency Response Plan	Clean-up of spilled tailings	Spilled tailings will be brought to TSF2 for storage

Plate 1.6.1. The wastewater treatment plant

Air Pollution Control Facilities

The power plant was designed to meet the emission standards in accordance with RA 8749 - Philippine Clean Air Act by adopting the most stringent standard established for the combustion of coal and by installation of technological advancement to minimize emissions among power plants. The air emission control measures primarily use EP (**Plate 1.6.2**) and a continuous emission monitoring system (CEMS), which are installed in each smoke stack for monitoring purposes.

The EP removes almost all suspended solids carried by the flue gas by creating electrical field around it. Through this, the dust particles are being charged to saturation causing them to migrate towards the EP collecting plates and gathered as dry ash.

Scrubbers to remove pollutants from emitted gases are installed in applicable processes all throughout the plant. Four H_2S scrubbers are in operations at the Mixed Sulfide plant. The released used steam coming from the two (2) autoclaves passes through scrubbers to remove acid mist before it is emitted to the atmosphere.

1.6.7 Fire Protection System

The following equipment are installed at strategic location within the HPP Plant complex:

- Fire hydrant
- Fire extinguishers;
- Gas detectors;
- Smoke detectors;
- Fire alarm system; and
- Fire emergency generators.

Plate 1.6.2. Electrostatic Precipitator (EP) installed in the plant site

1.6.8 Noise Control

Safety office conducts monthly noise monitoring at strategic locations within the HPP complex using EXTECH 5-in-1 Environmental Meter. The monitoring areas include the following:

- HPAL Lines 1 and 2 Drum washer vibrating screen
- New Shakeout machine at Ore Prep. Line 1
- Ore Prep. Lines 1 and 2, d) 01 Washer pump area
- Heater pumps 1 and 2, f) HPAL 1 and 2 Scrubber (Level 2-5th)

- O2 Generator
- LEWA Lines 1 and 2
- STG Lines 1 and 2
- ID Fan Line 1
- Cooling Tower 1 and 2
- Air Compressor 1 and 2
- MS1 Feed Line from 2nd – 4th level
- Top Level MS2 Feed Line
- FNRTL Blower 1
- Nitrogen Compressor Lines 1 and 2
- Filter cloth Jet washing Ms1 and 2
- Ball Mill
- FNTRL Scrubber MS
- FNTRL Blower Line 2
- Limestone Crusher MS2
- Compressor Vacuum area MS2
- Return Water pond and Decant Tower (TSF2)

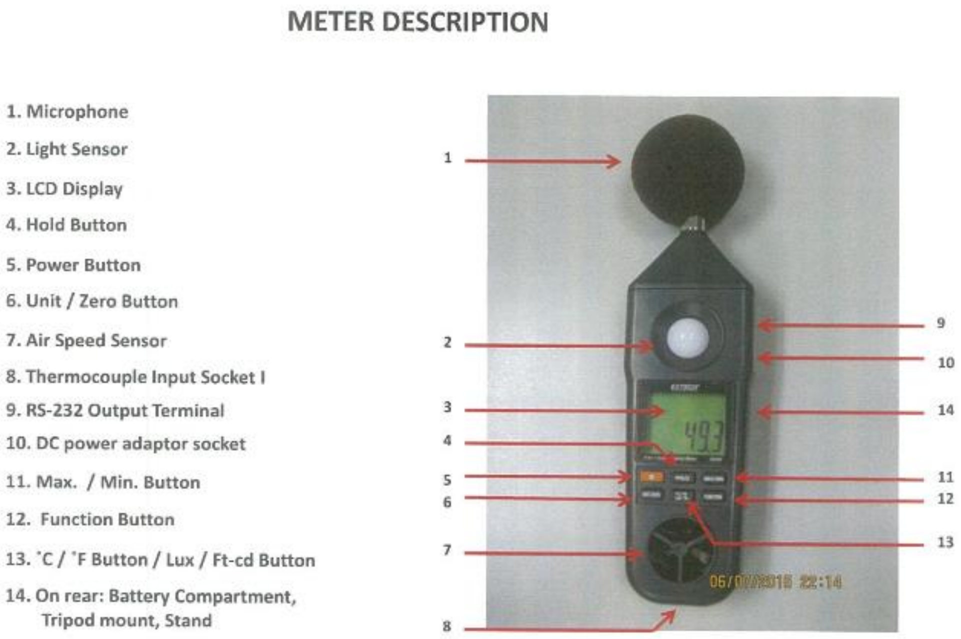


Plate 1.6.3. EXTECH 5-in-1 Environmental Noise Meter

1.6.9 HS Facility

The HS Facility is a closed system to prevent gas leakage. The system is equipped with a DCS to eliminate human error except for the sulfur melting process. A gas detector is installed within the production area to detect gas leakage. The detection limits for H_2S at different locations around the plant are listed in **Table 1.6.10**. A scrubber in the HSF is installed for emergency situations.

Table 1.6.10. H_2S detection limits

Location	Specific Area	H_2S Gas Concentration
Plant Site 1st Stage	Process Area	5 – 29 ppm
	Outside Process Area	1 – 9 pm
Plant Site 2nd Stage	Process Area	>30 ppm
	Outside Process Area	>10 ppm

Location	Specific Area	H_2S Gas Concentration
RTNMC	Warehouses/ Assay Laboratory/ Upper Kinurong Area	>1 ppm

1.7 PROJECT SIZE

The annual production output of CBNC from the operation of HPP Lines 1 and 2 will be about 24,000 MT of nickel but the annual production of Co will increase from 1,875 to 2,500 MT due to the high Co content of ore.

To enhance the continuing operation of CBNC, an additional TSF will be established having a total capacity of 18.6 M m^3.

1.8 DESCRIPTION OF PROJECT PHASES

The project implementation of TSF3 is divided into four (4) major phases: pre-construction phase, construction phase, operational phase, and abandonment phase. The pre-construction and the construction phases are also considered pre-operational phases and estimated to last for approximately 55 months (**Table 1.8.1**). The construction phase will commence after the issuance of all necessary permits and certification including the amended ECC considering the establishment of TSF3 and increase in annual Co production. The operational phase shall start as soon as TSF3 have been completed and commissioned.

1.8.1 Pre-construction Phase

The proposed TSF3 will be constructed on a 111 m^2 aggregate lot within the RTEPZ. Generally, the construction phase will involve conventional earthworks including site clearing, installation of temporary facilities, construction of access roads, mobilization of heavy equipment, foundation investigation (drilling), etc:

a. Soil Investigation
b. Survey Works and Lay-outing
   Sumitomo Mitsui Construction Corp. (SMCC) survey will lay-out and provide temporary benchmark (BM) to the following:
   - Lay-out for excavation.
   - Marking and lay-out of survey control point.
   - Lay-out for unsuitable material prior to cutting.
   - Marking and lay-out for decant system.
   - Lay-out for decant system pipe.
c. Mobilization
   - Provision of parking area and motorpool for trucks and heavy equipment.
   - Provision of laboratory and stockyard area.
   - Mobilization and arrangement of materials including guardhouse.
- Provision of disposal area for unsuitable materials.
- Provision of stockpile area.

d. Site Clearing and Grubbing
- Equipment to be used are backhoe, dump truck and bulldozer.
- Provide watchman, traffic aides and spotter to guide the equipment.
- Secure Tree Cutting Permit.
- Existing Ore stockpiles to be removed by other prior to the commencement of embankment construction work.
- Stripped surface following removal of stockpiles to be surveyed. Minor alignment and level adjustment may be necessary.

- Manual cutting will be used only in small trees.
- Keep a safe distance between workers and heavy equipment.
- Cut trees will be placed at a designated tree stockpile location.

e. Access Road Construction

- Heavy equipment to be used are backhoe, dump truck, bulldozer, road grader and vibro-roller for road widening.
- Surveyor will lay-out 20-m wide access road which will serve as access for heavy equipment and service vehicle.
- Use of excavated materials for backfilling.
- Fill the access road with rock materials when necessary.
- Vibro-roller will be used to compact the backfilled soil.
- Provide watchman, spotter and traffic enforcers to guide the equipment.
- Equipment should be in good condition and approved by the mechanic prior to operation.
- Sufficient lightning should be in provided for overtime work exceeding 6:00 PM.
- Provide minimum PPE requirements for all personnel.
- Provide road signages such as intersection, speed limit, crossings and other signages that can help eliminate possible traffic accidents.
- All drivers should be oriented regarding the traffic rules and regulation of RTN and CBNC Safety.
- Keeping a safe distance between workers and heavy equipment is required. Provision of reflectorized vest for all watchmen, spotters and traffic enforcers will also be mandated.

1.8.2 Construction Phase

General Construction Works

The projected general mobilization at the site will take about nine (9) months. This will involve the following activities:

- Site clearing and development for the preparation of the proposed TSF3 area; and
- Stock yard construction for Core and Filter Materials.

The main civil construction works will be facilitated by SMCC group. Civil construction covers a period of approximately 55 months that include the following activities:

- Filling;
- Under drainage line;
- Tailing delivery line;
- Monitoring and Check Boring;
- Road Work; and
- Canal Excavation.

<u>Materials Needed for the Construction of TSF3</u>

Rockfill Dam with sloping upstream core consists of three (3) major zones within the proposed embankment, namely, Core Zone, Filter Zone and Rock Zone, depending on the range of variation in the character and gradation of the available material. The permeability of each zone is designed to increase toward the outer slopes.

The purpose of each zone is as follows:

- <u>Core zone</u> filled with impervious earth material provides water tightness;

- Rock zone filled with rock of all sizes support the less stable core material and provide the stability and durability of the dam body. Selected rock zone shall be filled with hard and durable rock, which are slightly weathered to fresh rock, and provide the stability and especially durability of the dam body; and
- Filter zone is further classified into two (2) zones, namely fine filter zone and coarse filter zone. Fine filter zone shall be filled with well graded sand which will form a fine filter on the downstream face of the clay core to prevent piping of fines within core zone. Coarse filter zone shall be filled with well graded gravel which is grading compatible with fine filter material.

The following equipment and materials shall be used during the construction phase:

- 8 submersible pumps (25kW each)
- 8 generator sets (60kVA each)
- 1 unit 4x4 vehicle
- 2 units supernatant pumps, 90kW each (24PU01AB) @ RWP
- 2 units supernatant booster pumps, 90kW each (24PU02 & 03)
- 2 units supernatant pumps, 160kW each (224PU01AB) @ RWP
- 2 units supernatant booster pumps, 160kW each (224PU23 & 24)
- Tailings Pipeline and spigots
- Supernatant pipelines from RWP to Pier site
- Piezometer
- Extensometer
- HDPE Boat for Pond Monitoring
- Flow meters for supernatant (24FI001, 224FI001 and 224FI202)
- Handheld radios

In addition to the abovementioned equipment and materials, mobile equipment presented in **Table 1.8.2** shall also be utilized for the construction of the proposed TSF3.

Table 1.8.2. List of mobile equipment to be used during the TSF3 construction

Description	Model	Specification	Number
Bulldozer	CAT-D11R	103t	1
	CAT-D10T	68t	2
	CAT-D9T	51t	3
	CAT-D8T	39t	3
	KOMATSU-D85PX	27t	2
	CAT-D6NLGP	17t	3
Excavator	HITACHI-EX1200	5.0m3	2
	HITACHI-ZX870LCR	3.4m3	1
	HITACHI-ZX870LCH	3.4m3	2
	HITACHI-ZX470H	1.9m3	3
	HITACHI-ZX330LC	1.4m3	5
	CAT-320DRR	0.8m3	1
	CAT-320E	0.8m3	4
Wheel Loader	CAT-966H	4.1m3	1
	CAT-966K	4.1m3	1
Motor Grader	CAT-16H	4.88m	1
Vibration Roller	SAKAI-SV512D	10t	2
	SAKAI-SV510DV	10t	1
	SAKAI-SV513	10t	2
Crusher	KOMATSU-BR380JG	33t	2
Heavy Dump Truck	CAT-773E	55t	9
	CAT-773F	55t	3
	CAT-740	37t	3
	KOMATSU-HM400	37t	7
Crawler Dump	HITACHI-EG110	11t	2

Description	Model	Specification	Number
Water Tanker	MITSUBISHI-WATER 12kl	10kl	2
Vacuum Truck	MITSUBISHI	10T	1
Fuel Tanker	FELL14kl	12kl	3
Cargo Truck with Crane	4tUNIC	4t	3
Truck	Worker (10t)	10t	2
	Worker (4t)	2t	1
	Worker (2t)	2t	2
Total			**80**

1.8.3 Operational Phase

The HPP plant operates on a three (3) shift basis per day for the whole year. It is foreseen to be in good operation for another 25 years.

1.8.4 Abandonment Phase

The HPP will run for about 25 years or until the plant can still process low grade nickel ore from mining operations. The TSF3 is estimated to have an economic life of five (5) years. After which, the programmed closure activities as indicated in CBNC's Final Decommissioning Plan shall be implemented which maybe similar to the rehabilitation program for TSF1. As for TSF3, drainage works, drying of tailings, treatment of residual supernatant and revegetation are the programmed closure activities upon reaching its maximum capacity.

1.9 MANPOWER REQUIREMENT

The current operation of HPP Lines 1 and 2 has a total of 600 permanent employees and 1,500 contractual workers. For the proposed expansion, the manpower requirement during the construction phase of TSF3 is expected to be 394 workers. Majority of these will be unskilled workers during the initial phase of construction involving site preparation, earthworks and civil construction. A total of 50 additional employees will be employed during the operational phase. Note that the increase in annual production of Co requires no additional manpower. Therefore, CBNC shall utilize the existing workforce in its plant operation. The estimated manpower for the construction of TSF3 is listed in **Table 1.9.1** while the manpower of the whole plant including the proposed expansion is listed in **Table 1.9.2**.

Table 1.9.1. Estimated manpower during the construction of TSF3

Workforce	Requirement
Manager/Technical	70
Skilled Labor (Welder, Electrician, Operator, Rigger, Operators)	88
Unskilled Labor (please identify)	200
Others (Security Guard)	36
Total	**394**

Source: CBNC, 2016

Table 1.9.2. Estimated manpower during the operations of the whole plant

Workforce	Current Operation	Current Operation + TSF3
Permanent	600	600
Contractual	1,500	1,550
Total	**2,100**	**2,150**

1.10 PROJECT INVESTMENT COST

The estimated cost for the proposed CBNC expansion project is approximately PhP 7.3 billion or 154,000,000 USD.

Table 1.8.1. Construction schedule of TSF3

Activities	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Mobilization/ Demobilization																								
2. Quarry site, Excavation of Foundation, Temporary Road		Motor pool, stockyard							Excavation of Dam Foundation, Stock of Rock, and Core Materials															
3. Dam Filling															Filling									
4. Drainage, Foundation of Pipeline																								
5. Supplementary Structure (Spillway; Decant System)															Spillway									
6. Slurry Pipeline																								

2 Assessment of Key Environmental Impacts

Coral Bay Nickel Corporation

This chapter presents the conditions of the project area and its vicinities before any form of mobilization. The discussion also includes the monitoring data of Coral Bay Nickel Corporation (CBNC) and additional information that will describe the proposed site for Tailings Storage Facility (TSF) No. 3. This chapter also identifies the most effective strategies for management and monitoring.

2.1 LAND

This section presents the baseline and impact assessment for the land use and classification, geology, pedology, and the terrestrial ecology. Sampling procedures in the conduct of the baseline data are detailed in **Annex 2.1.1** based on the agreed scope with the Review Committee members (RevComm) during the Technical Scoping Meeting.

2.1.1 Land Use and Classification

2.1.1.1 Methodology

Secondary data from the provincial government of Palawan, municipal government of Bataraza, Palawan Council for Sustainable Development (PCSD) and the various EIA studies conducted by the the Preparers were used as references for this particular section including the 2009-2019 Comprehensive Land Use Plan (CLUP) of Bataraza and Environmentally Critical Areas Network (ECAN) maps of PCSD.

2.1.1.2 Baseline Conditions

Land Use of Bataraza based on ECAN Map

The land use of the province of Palawan is dependent on Republic Act 7611 (RA 7611) or the Strategic Environmental Plan (SEP). The SEP is a comprehensive framework for sustainable development of Palawan attuned with protecting and enhancing the natural resources and environment of the province. It is aimed at guiding the local government of Palawan and the government agencies concerned in the formulation and implementation of plans, programs, and projects affecting the province (Sec. 4, R.A. 7611). The SEP identified the ECAN which defines the basis for the development programs of the island. An ECAN Map for the Municipality of Bataraza was been prepared by PCSD in 2004 (**Annex 2.1.2**) and approved in January of 2006.

In March of same year, Resolution No. 30, Series of 2006 of the *Sangguniang Bayan* of Bataraza was filed to amend this ECAN Map (**Annex 2.1.3**). Another resolution, Resolution No. 68, Series of 2006 was filed on October 2006 and seeks furher amendment of the zonation of Barangays Rio Tuba and Taratak and reflect the amendment into the Municipal Comprehensive Land and Water Use Plan (CLWUP) of Bataraza Municipality. Discussions were made between the PCSD and the Sanguniang Panlalawigan regarding the modification of the ECAN Map and the approval of the CLUWP of the Municipality of Bataraza.

The Municipality of Bataraza afterwards proceeded to revise its Comprehensive Land Use Plan (CLUP) covering the period 2009-2018. On January 2010, the *Sangguniang Panlalawigan* approved the revised CLUP (refer to **Annex 2.1.4**). Four general land uses within the municipality was identified in the revised CLUP. These are 1) settlement/built-up areas; 2) agricultural areas; 3) forest areas; and 4) special use areas. Five different categories are classified under the special use areas such as 1) open grassland/pasture; 2) mining and quarrying area; 3) infrastructure facilities; 4) cemetery and dumpsites; and 5) water uses (swamps/mangroves/wetlands/inland water bodies). **Table 2.1.1** summarizes the different land uses in Bataraza.

Table 2.1.1. Different land uses of Bataraza with corresponding land area

Category	Area Utilization	
	Area (has.)	% to Total Area
1. Forest & Forest Use Categories	33,064.86	45.53
1.1 Production Forest	13,344.86	-
1.2 Protection Forest	19,720.06	-
2. Agriculture	22,511.44	31.00
3. Built up Areas	2,500.00	3.44
4. Special Uses		-
4.1 Mining and Quarrying	**5,262.50**	**7.25**
4.2 Open Grassland/Pasture	1,452.74	2.00
4.3 Infrastructure	300.00	0.41
4.4 Other uses		
4.4.1 Dumpsites	10.00	0.01
4.4.2 Cemetery	15.00	0.02
4.5 Water Uses		
4.5.1 Mangroves and nipa swamps	7,357.57	10.13
4.5.2 Inland water bodies	147.44	0.20

Source: Municipality of Bataraza Comprehensive Land Use Plan, 2009-2019

Based on the above land use of Bataraza, the project site is classified as mineral development area (**Figure 2.1.1**). It should also be noted that the HPP and its auxiliary facilities and the proposed Tailings Storage Facility No. 3 (TSF3) are located within the 990 ha mining claims of RTNMC and specifically within the Rio Tuba Export Processing Zone (RTEPZ).

Moreover, the area is classified as a **"multiple-use zone"** based on the 2006 PCSD ECAN Map (**Figure 2.1.2**).

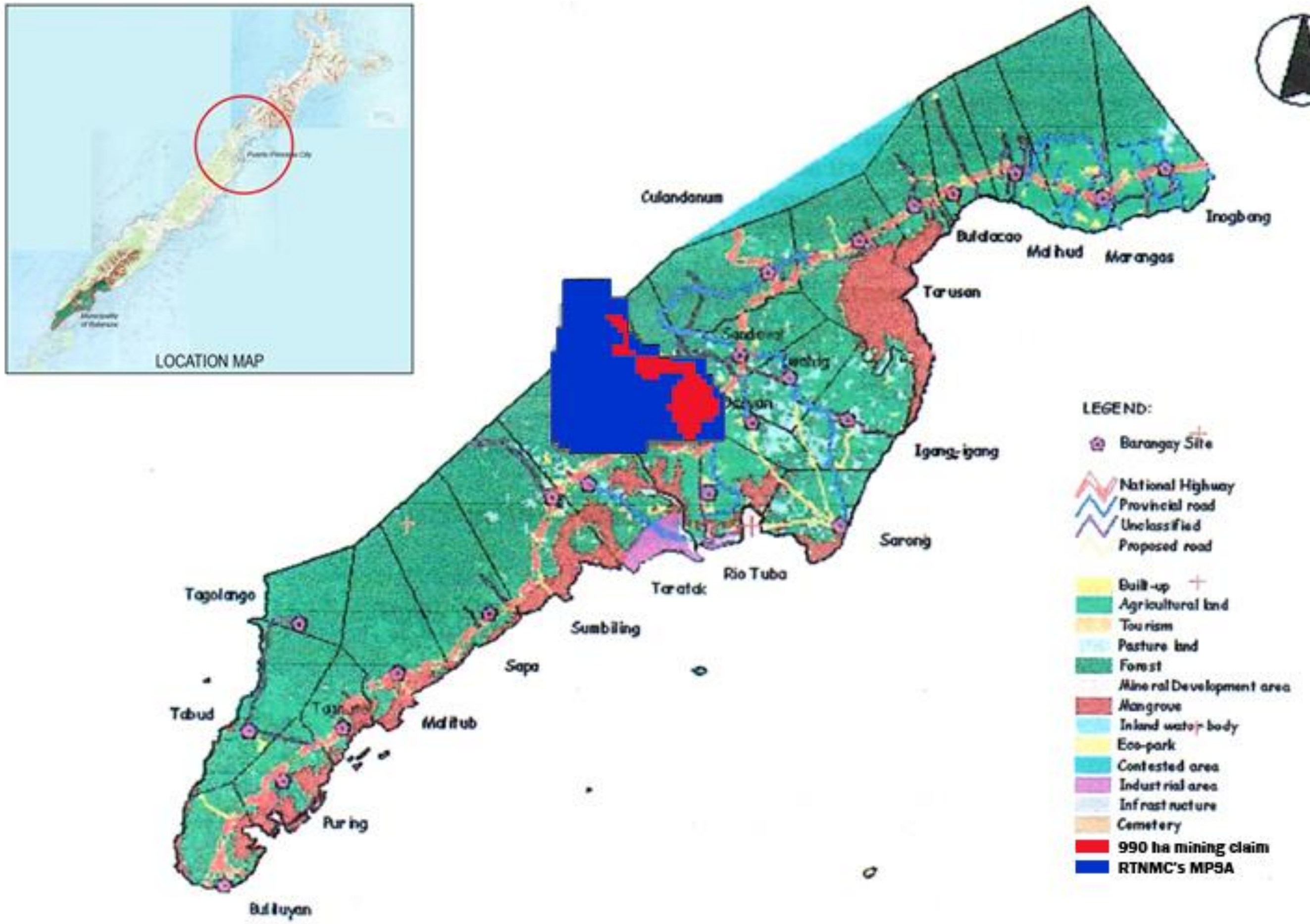


Figure 2.1.1. The Mineral Development Zone of the Municipality of Bataraza (Source: CLUP, 2009)

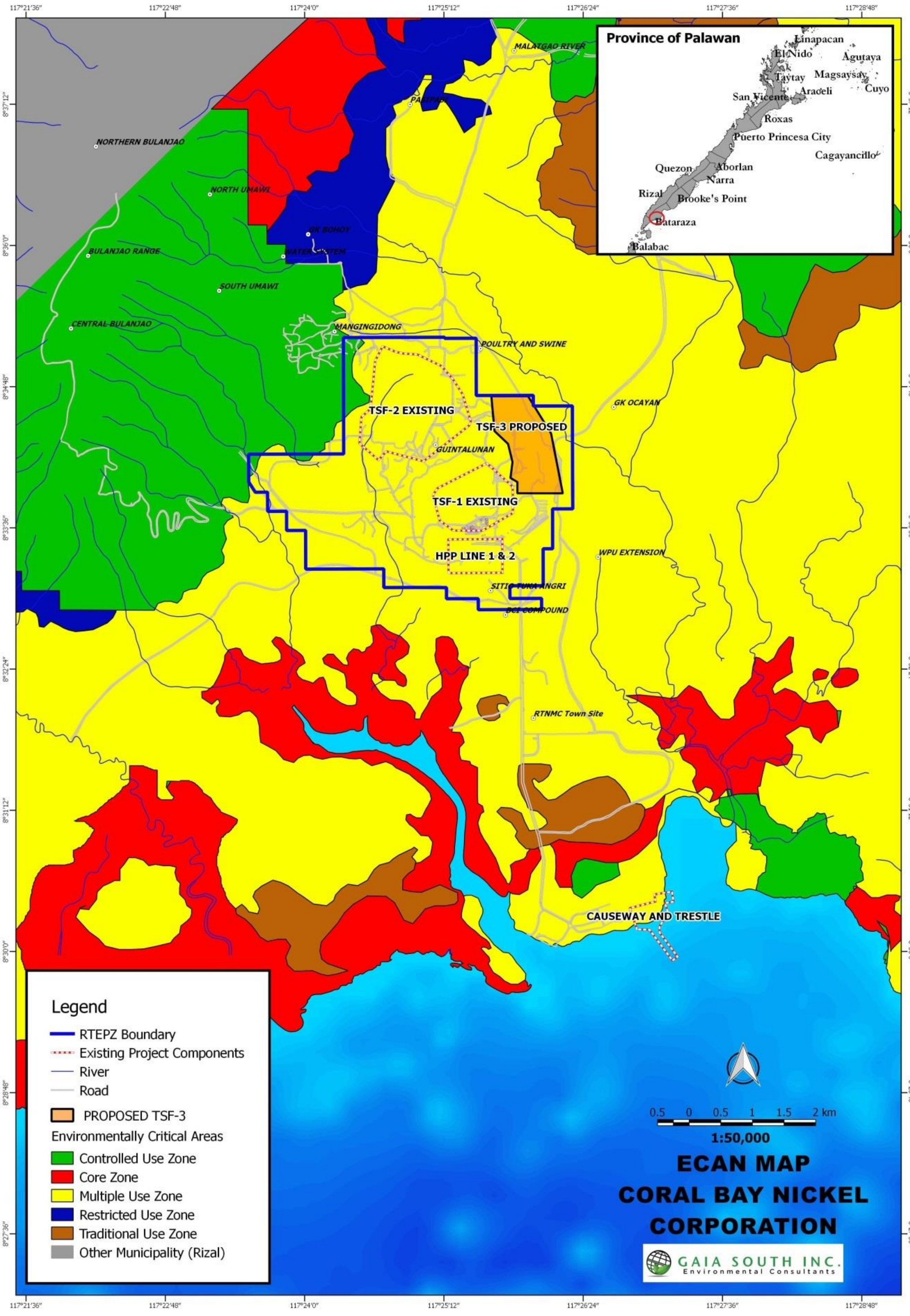


Figure 2.1.2. Environmentally Critical Area Network (ECAN) Map generated by Gaia South (Source: PCSD, 2006)

Classification of the Project Site based on Proclamation No. 2146/Tenurial Issues due to Ancestral Domain Claims

In accordance with Presidential Proclamation No. 2146 (series of 1981), the project is considered an Environmentally Critical Project (ECP) under Resource Extractive Industries as it is involved in the processing of metalliferous ores, specifically nickeliferous laterite. Furthermore, the area is an Environmentally Critical Area (ECA) as it is traditionally occupied by Indigenous People (IP). There are no conflicting tenurial/land issues within the project site based on the Certification issued by the National Commission on Indigenous People's (NCIP) Provincial Office indicating that no Ancestral Domain Title (CADT) has been issued within the project site (**Annex 2.1.5**).

Landcover and Vegetation of the Project Area

The proposed TSF3 location is mostly devoid of vegetation. The site is an active mining area, which will cease operations by 2027. The southeastern portion of the site on the other hand is planted with small agoho (*Acacia auriculiformis*) and some species of shrubs. Most of the area is also covered with grasses (talahib, *Saccharum spontaneum)* and some species of weeds. Detailed discussion on vegetation is presented in the proceeding section.

Plate 2.1.1. Existing land cover of the proposed project site

2.1.1.3 Impact Assessment

CBNC within its years of operation has no pending issue on land use as the entire facility is within the "Multiple-Use Zone" based on the ECAN Map of PCSD. CBNC will lease additional lands/areas to RTNMC to construct the TSF3. A Supplemental Agreement to the existing Infrastructure Agreement with RTNMC on CBNC's lease of additional parcel/s of land owned or developed by RTNMC is attached as **Annex 2.1.6**.

CBNC has also secured endorsements from the impact barangays (**Annex 2.1.7**).

The following matrix summarizes the potential impacts that may be brought by the proposed projects.

Table 2.1.2. Impacts assessment and mitigation for land use and classification

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Change/ inconsistency in land use, slope and subsurface geomorphology Although the proposed site is currently a disturbed area due to mining, the construction of the proposed TSF3 area will continuously and significantly change the original landform, slope and underground geomorphology in the project area. The terrain will be transformed into basin-like formation after the construction of TSF3. There will be no change in land use. After operations, the site will appear to be flat and the final land use will be identified in cooperation with the all the stakeholders.		✓	✓	✓	• CBNC should strictly follow the site development plan and work only within the specified area. • Maintain vegetation cover in the designated buffer zones and in the peripheries of the access roads, TSF3, and HPP facility. Bufferzones and vegetated peripheries are part of the 132 ha-area for rehabilitation/plantation program of CBNC. • CBNC and RTNMC will identify the final land use in their FMR/DP in cooperation with the PCSD, LGU, IP communities and other stakeholders.
Encroachment in Environmentally Critical Areas (ECA) There are no conflicting tenurial/land issues within the proposed project site since there are no Certificate of Ancestral Domain Title (CADT) issued within the project area. On the otherhand, it should be emphasized that Palawan is considered a critical area with its wide biodiversity.		✓	✓		• CBNC should only be restricted on developing the proposed area for TSF3 based on plan and follow the conditions indicated in the SEP Clearance and MOA with RTNMC. • The vegetation cover in the designated buffer zones and in the peripheries of the access roads, TSF3, and HPP facility should be maintained and enhanced.
Possible tenurial land issues There are no conflicting tenurial/land issues within the proposed TSF3.					The CBNC through the SDMP and its CSR Policies has provided several asssitance to the IP community in Bataraza including the establishment of Gawad Kalinga (GK) housing sites, sponsorship of festivals, and construction of tribal halls.
Impacts to visual aesthetics The new TSF will impair the aesthetic view of Mt. Bulanjao.					Similar with TSF1 and TSF2, slopes will be vegetated to improve visual aesthetics as well as to contribute to the slope stability.
Devaluation of land value as a result of improper solid waste management and other impact The construction of TSF3 will require excavation of unsuitable soil materials to prepare the site. The operations of the TSF3 will not generate significant volume of solid wastes					The excavated soil will be reused as embankment material or will be disposed to a suitable location within the RTNMC mining site and provided with soil erosion protection measures. All waste materials from the operations of TSF3 will be subjected to the waste management

and waste materials will be disposed to the waste disposal site within the RTNMC.					program that is in place within the CBNC Complex that promotes segregation, reuse and recycling.

2.1.2 Geology/Geomorphology

2.1.2.1 Methodology

The following discussion is based on the available geologic maps and reports gathered from the Mines and Geosciences Bureau (MGB), Philippine Institute of Volcanology and Seismology (PHIVOLCS), and other related geologic studies conducted on site. Detailed sampling procedures in gathering of the baseline data are included in **Annex 2.1.1**.

2.1.2.2 Baseline Conditions

Regional Tectonic Setting

The geology of Palawan is considered different from the rest of the Philippines. The crust in northern side of the island was derived from the Eurasian Plate that drifted southward with the opening of the South China Sea. In southern Palawan, the rock units are primarily ophiolitic or uplifted oceanic material that are obducted onto the continental crust.

Stratigraphy

The oldest rock formations in southern Palawan are the Cretaceous sedimentary rocks and basalt flows unconformably overlain by turbidites. The ophiolitic rocks of the Palawan ophiolite belt consists the oceanic crust materials that thrusted over the continental crust.

Southern Palawan in underlain by seven major rock units, listed below from oldest to youngest (**Figure 2.1.3**).

- Late Cretaceous Mt. Beaufort Ultramafics;
- Late Cretaceous to Early Eocene Espina Formation;
- Paleocene to Early Eocene Panas Formation;
- Oligocene Pandian Formation;
- Late Miocene Sayab Formation;
- Pliocene Iwahig Formation, and
- Quaternary Deposits.

The Mt. Beaufort Ultramafics underlies the southern portion of Bulanjao Range at central Bataraza and composed the core of Mt. Sarab. It is the main constituent of the Palawan Ophiolite (Pena, 2007) and composed of serpentinized harzburgite, dunite, peridotite, and pyroxenite. The harzburgite and cumulate dunite mainly consists the complex.

The Espina Formation occupies the northeastern section of Bulanjao Range. It consists of basalt, shale, limestone, and chert that represent the sedimentary cover of the Palawan Ophiolite. The basalt shows abundant pillow structures and generally highly fractured. The shale is indurated and the limestone is dense and fossiliferous.

Outcropping extensively southeast and southwest of Bulanjao Range is the Panas Formation. It is composed of interbedded, turbiditic, highly indurated, and sparsely fossiferous sandstone and shale.

STRATIGRAPHY OF PALAWAN

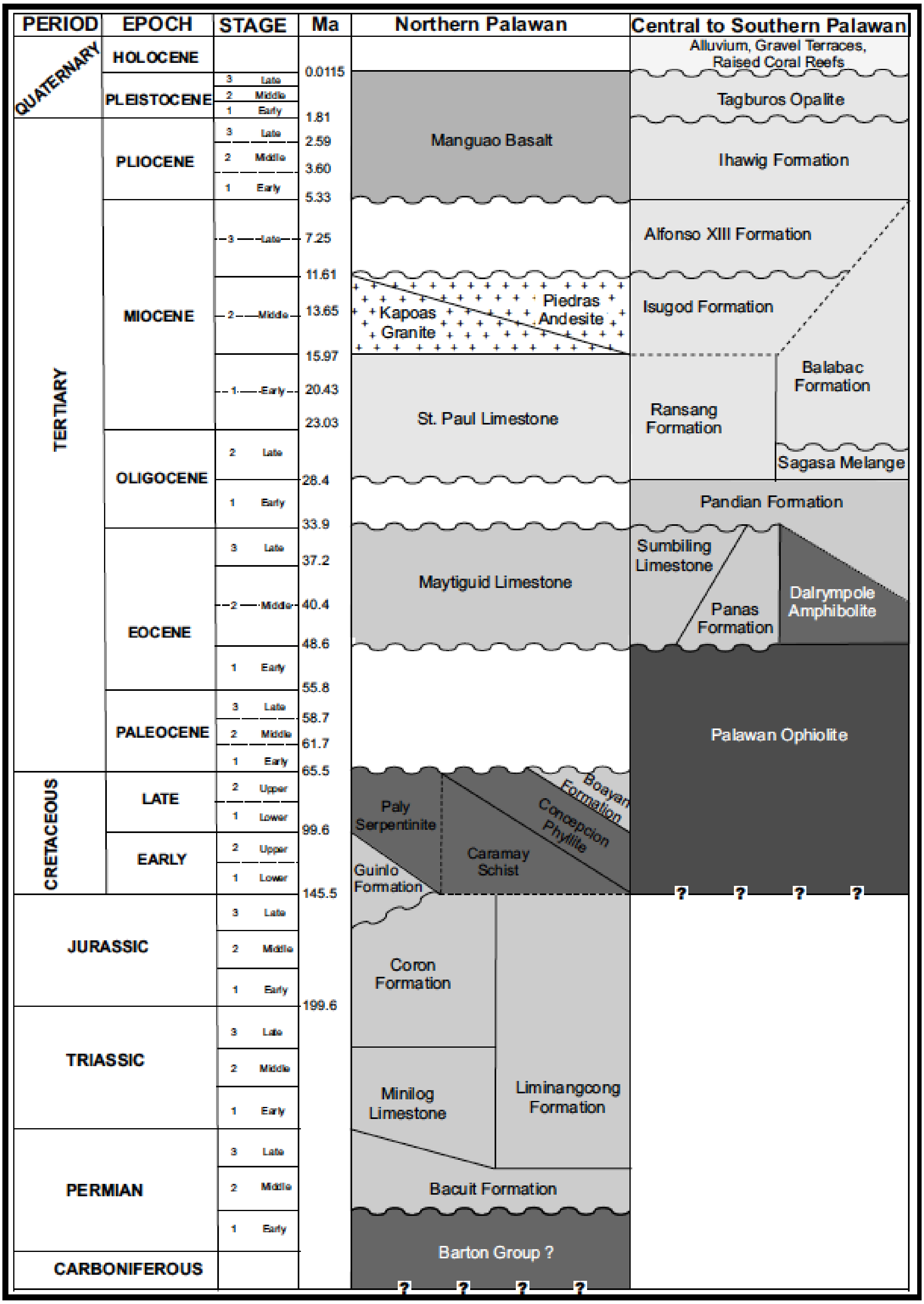


Figure 2.1.3. Stratigraphic Column of Southern Palawan.
Source: MGB (Aurelio and Pena, eds., 2004).

The Pandian Formation refers to the massive sandstone extensively distributed in the western side of Southern Palawan. It is made up of massive, coarse-grained, arkosic sandstone intercalated with indurated dark gray mudstone and silty shale. Beds of conglomerate are observed near the base.

The Sayab Formation composed of gently dipping interbeds of sandstone and shale. The sandstone is light gray to reddish brown and consists mainly of fine to medium grained quartz. The shale is silty and occasionally laminated. It unconformably overlies the Panas Formation to the east of Bulanjao Range in Southern Rio Tuba.

The Iwahig Formation refers to the rocks distributed in the western and eastern parts of southern Palawan. It is composed of two (2) members: the Panoyan Limestone and the Pusok Conglomerate. The limestone unit is creamy white to beige, massive, and coralline. The clastic unit is made up of chert, limestone, and indurated sediments.

The youngest rocks in the area are the Quaternary alluvial and limestone deposits. The alluvium, which covers the coastal area and plains, composed of consolidated to unconsolidated gravel, pebbles, sand, and silt derived from older rocks. The limestone consists of raised coral reefs that gently dip seaward.

Structures

The primary structural feature in the region is the thrust fault marking the boundary between the ultramafic rocks and the sedimentary capping the ophiolite and the interbedded sandstone and shale. The thrusting caused intense shearing and faulting along the margins of the ophiolite and folding, faulting, and jointing in the adjacent rocks (Cabrera, 1985). The fault and fold structures generally trend north and northeast.

<u>Site Geology</u>

The proposed site for the new tailings storage is mostly underlain by ultramafic rocks consisting of serpentinized harzburgite, dunite, peridotite, and pyroxenite. The harzburgite is dark-colored, coarse-grained, and composed predominantly of olivine and orthopyroxene minerals. The dunite is medium to fine-grained and olive green in color. Both the harzburgite and dunite exhibits serpentinization. The pyroxenite is dark-colored, coarse-grained and occurs only as small bodies that probably formed as a result of partial magmatic differentiation (Cabrera, 1985). The intercalated sandstone and shale underlie the northern side of the prospect. The rock units are interbedded, highly indurated, and sparsely fossiliferous (Pena, 2007). **Figures 2.1.4** and **2.1.5** are the regional geologic map of southern portion of Palawan and geology around the proposed project site.

Fluvial Geomorphology

<u>Drainage</u>

The river systems in the area mostly flow from the Bulanjao Range towards the flatlands then unloads in Coral Bay. The nearest river in the site is the Ocayan River that passes through the northwestern tip of the boundary. It continuously flows southeast until it reaches the Ocayan Bay. The source of Okayan River is composed of several merging creeks and river in the upper reaches of Bulanjao.

Seismicity and Other Geologic Hazards

Earthquake

Palawan is located in a tectonically stable region. It lies several kilometers from known active faults and trenches that are the main seismic generators in the archipelago. The nearest active trench to the site is the Sulu Trench about 307 kilometers to the east. **Figure 2.1.6** is the map of PHIVOLCS showing the distribution of tectonic features in the Philippines.

Historical earthquakes in Palawan Island revealed events with magnitudes less than 6. These earthquakes recorded from 1907 to the present occurred in the northern end of the island and offshore to the south. **Table 2.1.3** lists the earthquake occurrences in Palawan based on the data from PHIVOLCS.

Table 2.1.3. List of recorded earthquakes in Palawan Island from 1907 to present

Date	Time	Latitude	Longitude	Depth (km)	Local Magnitude
2001 Aug. 31	16:41:32.36	8.02	117.66	40	4.6
1982 Sept. 24	19:54:7.40	10.65	119.21	33	3.4
1981 June 18	22:47:14.50	10.59	119.68	50	4.0
1978 June 14	12:49:18.50	7.56	116.38	33	5.7
1956 Feb. 13	22:39:50	10.50	119.50	33	-

Palawan is situated more than 300 kilometers west of Sulu and Negros Trenches. Furthermore, there are no mapped faults within the island.

Seismic Ground Shaking Hazards

Ground shaking effects caused by an earthquake is measured by seismic acceleration. It evaluates the distance-dependent distribution of seismic energy in the Philippines using the analysis of time, space, and size distribution of earthquakes. The seismic energy attenuation relation used is based on the work of Fukushima and Tanaka (1990) for Japan and has been applied to western Pacific Island settings. Thenhaus et al. (1994) estimated peak horizontal ground acceleration that has a 10% probability of being exceeded in 50 years for rock and soil conditions in the Philippines.

Figure 2.1.7 shows the three maps illustrating the acceleration (g) amplitudes, represented by the contour, for rock and soil conditions for the Philippines. It is apparent that no contour crosses the Palawan Island. The data may suggest that the peak acceleration that may be experience in Palawan will be less than 0.3 g for soft soil and 0.2 g for medium soil and rock. To further estimate the peak acceleration that can result from the earthquake generated from the nearest trenches in the site a calculation was made using the empirically derived formulas. **Table 2.1.4** present the acceleration values for the soil and rock conditions in the proposed site.

Table 2.1.4. Peak Ground Acceleration values for soil and rock conditions in the project site

Seismic Generator	Approximate Distance from site (km)	Magnitude	%g	Peak Ground Acceleration (PGA)			
				Rock	Hard Soil	Medium Soil	Soft Soil
Sulu Trench	307	8.0	0.0100	0.0060	0.0100	0.0080	0.0130
Negros Trench	595	7.7	0.0004	0.0003	0.0004	0.0004	0.0006

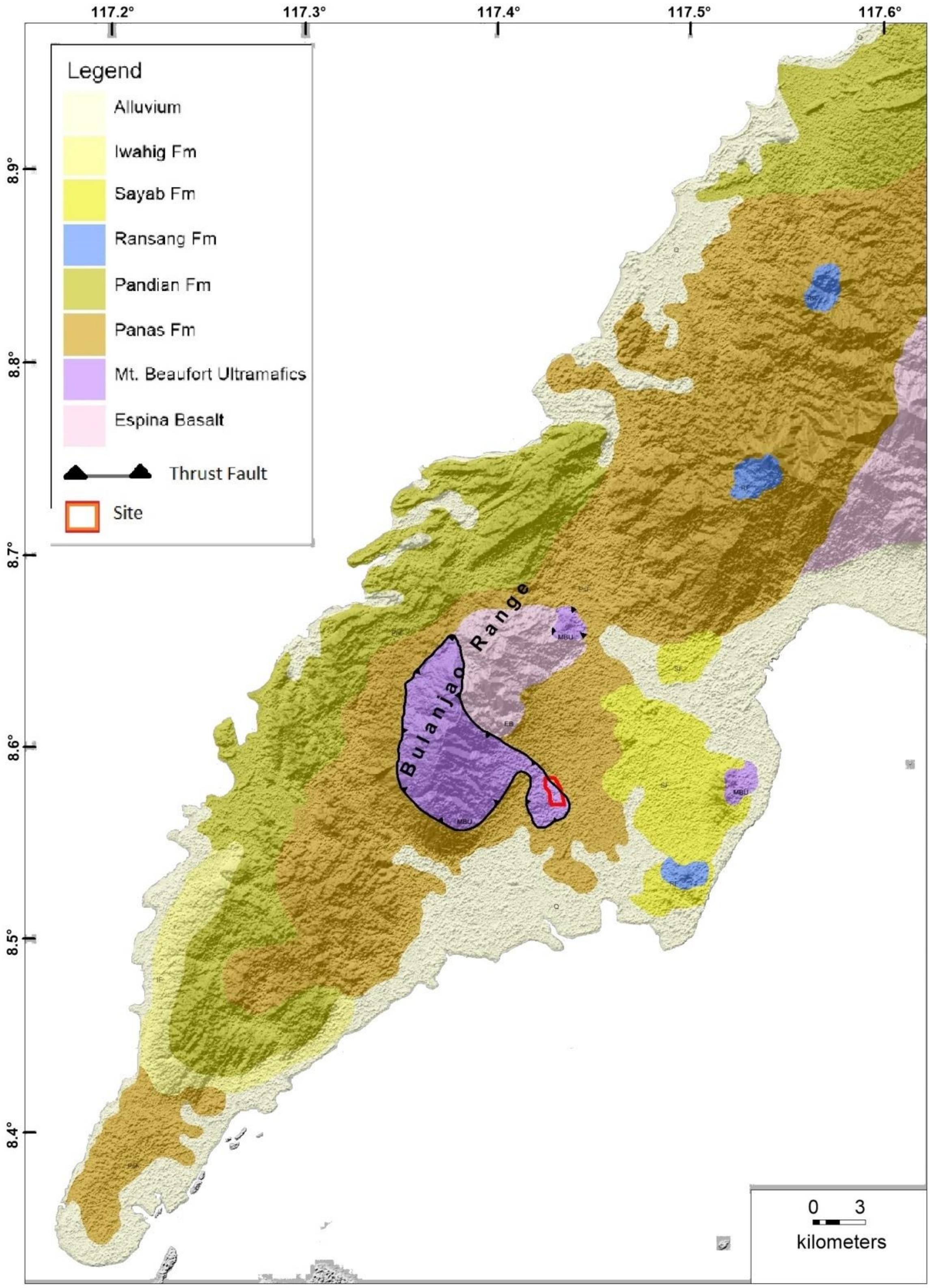


Figure 2.1.4. Map showing the regional geology of the southern portion of Palawan.

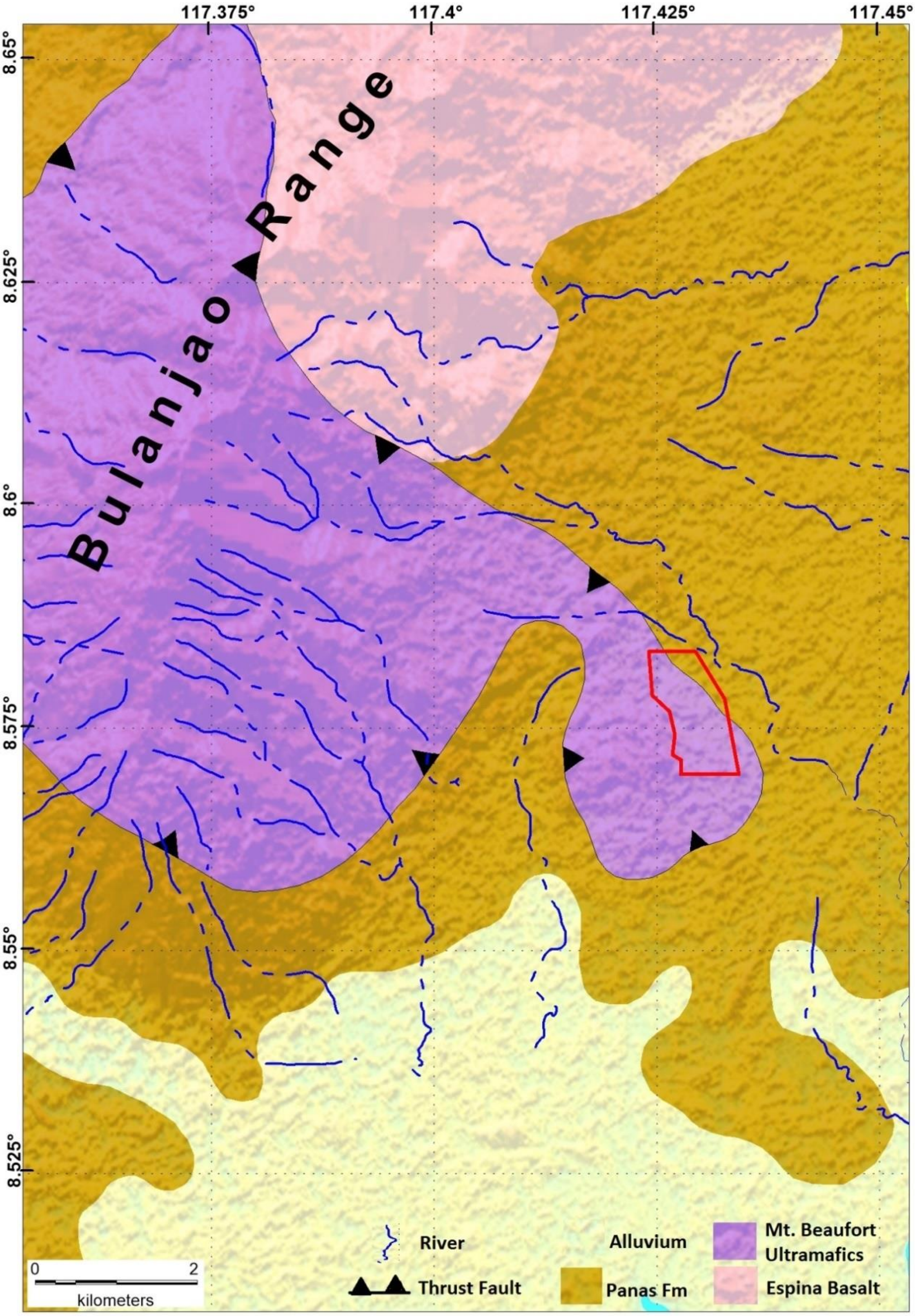


Figure 2.1.5. Geology within the vicinity of the proposed TSF3.

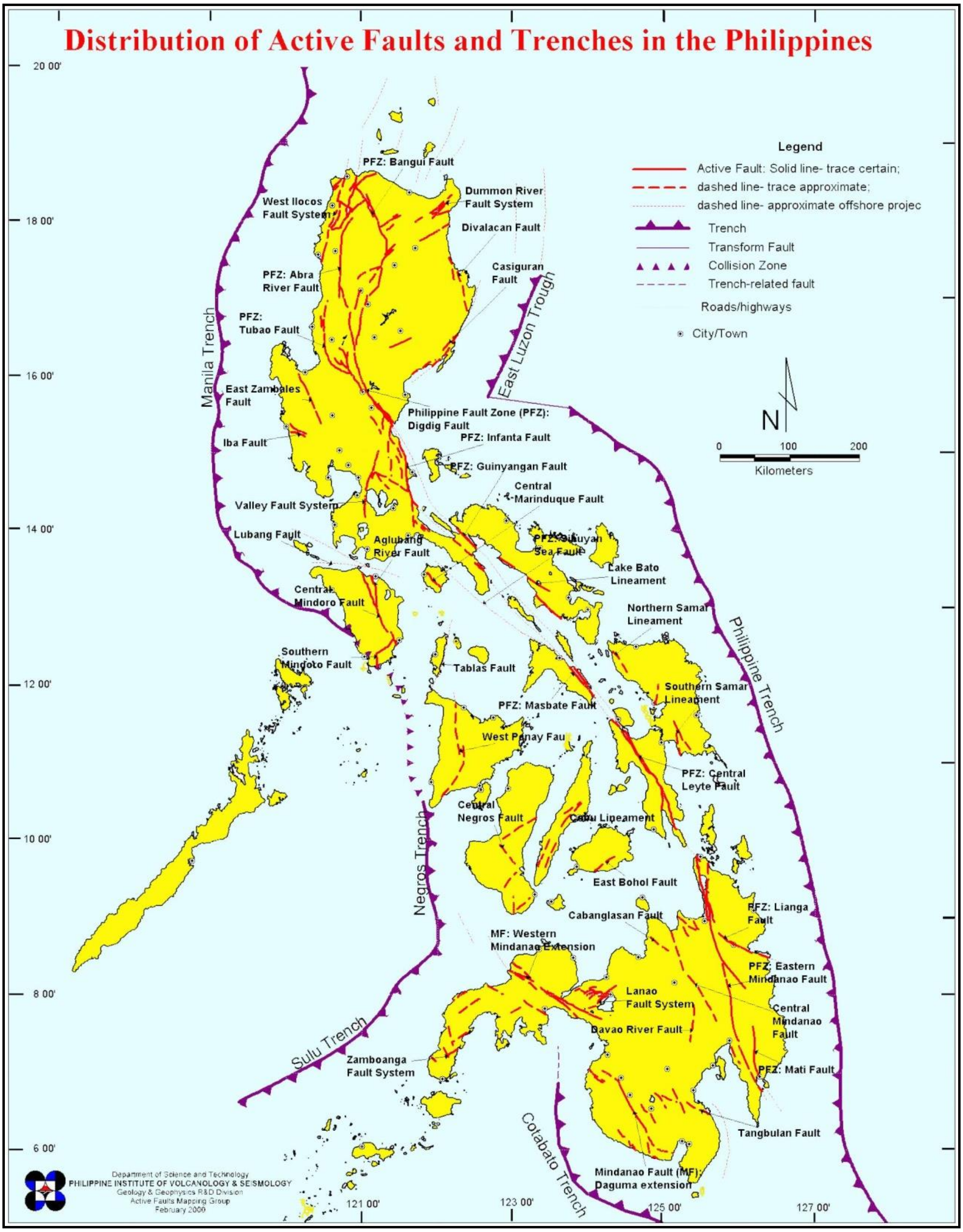
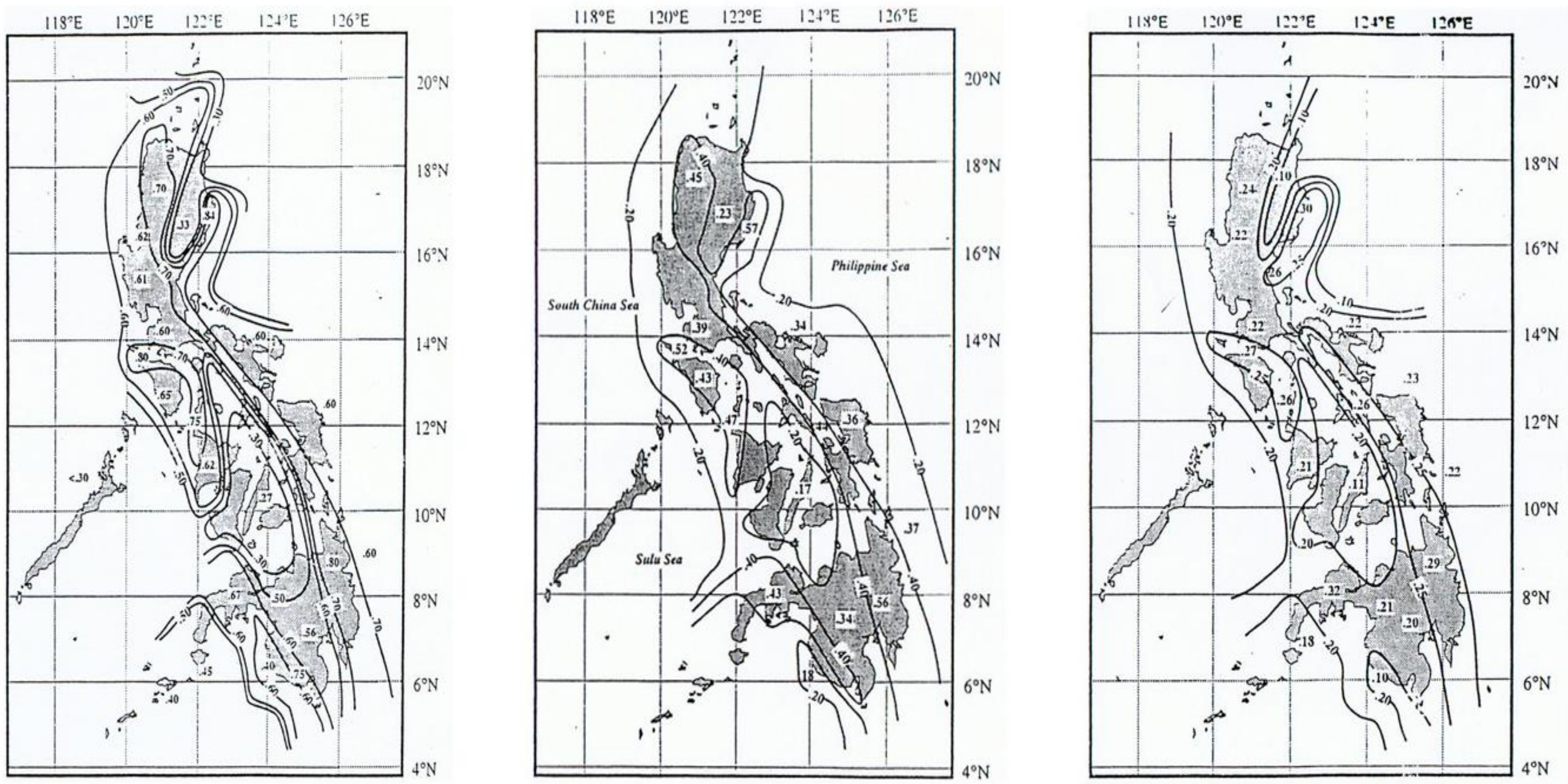


Figure 2.1.6. Tectonic map of the Philippines showing the active fault and trenches.



Map showing peak horizontal acceleration amplitudes in soft soil for the Philippine region. Acceleration values have a 10% probability of exceedance in 50 years. Contours are in terms of the acceleration of gravity (g).

Map showing peak horizontal acceleration amplitudes in medium soil for the Philippine region. Acceleration values have a 10% probability of exceedance in 50 years. Contours are in terms of the acceleration of gravity (g).

Map showing peak horizontal acceleration amplitudes in rock for the Philippine region. Acceleration values have a 10% probability of exceedance in 50 years. Contours are in terms of the acceleration of gravity (g).

Figure 2.1.7. Peak acceleration (g) map for the Philippines for soft soil, medium soil, and rock conditions. Palawan apparently lies outside the acceleration amplitudes denoted by the contour.

Bulanjao Range, which is characterized by rugged to very rugged is susceptible to landslides. Slides may occur in portion of the slopes with residual or lateritic soil and weathered portion of rock material. The location of the proposed site, less than 3 kilometers of Bulanjao Range, makes it less vulnerable to the effects of possible soil and rock slides.

Liquefaction and Subsidence

Liquefaction happens when a partially of fully saturated loose soil loses strength in response to change in stress condition like earthquake shaking or an increase in load. The soil causes to behave like a liquid. The rock units that underlain the northern portion of the site are composed of sandstone interbedded with mudstone and siltstone. The condition of these rock units in the subsurface layer and its competence must be fully assessed and incorporated in the final design of the storage facility. The ultramafic rocks, which mostly underlie the site, are considered competent and less susceptible to liquefaction and subsidence.

Lateral Spread

Lateral spread may happen along and around the boundary of the contact of the ultramafics and the sedimentary rock units marked by the thrust fault. The change in the lithology may account for difference in the confining pressure and may cause the upper layer of the soil of the sedimentary units to lose competence because of the load. Loading may then cause deformation of the layer near the weaker zone or along and around the fault contact. Geotechnical assessment must then be considered in the design of the foundation. Other mitigating measures can also be applied to prevent or lessen the impact of lateral spread.

2.1.2.3 Impact Assessment

Considering the aseismic nature of Palawan, the absence of volcanoes in the region, the generally naturally resistant nature of the underlying rocks to mass movement in Mount Bulanjao and the surrounding areas, it can be consulced that no significant geohazard has occurred prior to the operation of CBNC and up to the present. However, as part of its institutional policy, CBNC has implemented a management system that includes procedures to address the threats of geological hazards to their operations. This would include:

a. Management of all external hazards identified in the ERA of its EPRMP. The latest revision of its Emergency Response and Preparedness Program (ERPP) was submitted to the Mines and Geosciences Bureau (MGB) on November 28, 2016 for approval;

b. A quarterly IEC is being conducted at the barangay level, and also in schools and LGUs;

c. Regular monitoring of the environment, including that of the tailings pond area by the Mine Environmental Protection and Enhancement Office (MEPEO) as well as by the MMT (quarterly) and by its own internal self-monitoring team (quarterly), EPEP (annual) and annual integrated report to MGB;

d. CBNC is committed to comply with all regulatory requirements as per DAO 96-40;and

e. In the event if any accident or threat that may arise from its tailings disposal facility, CBNC has the necessary protocol that incorporates Awareness and Preparedness for Emergencies at Local Level (APELL) and Disaster Risk Management Measures (DRMM to ensure that such accident or threat is immediately coordinated with the LGU and surrounding communities.

Also, to ensure that the new tailings dam shall be safely designed, constructed and operated, CBNC has undertaken the following actions specific for the proposed project:

- The proposed tailings dam was designed by Hatch, Inc., The seismic design criteria is suitable for Zone 4;
- Soil Investigation was conducted and the report is provided as **Annex 2.1.8.** In the report, the results of the safety analysis at the cross section of the TSF3 was provided;
- Data and information used for the tailings pond design such as the geological, topographic, hydrologic and plant operation specifics are accurate and up-to-date;
- An automated weather station was acquired to ensure that rainfall, wind, humidity and temperature and other parameters that can affect the operation and integrity of the dam are monitored;
- Strict implementation of a quality assurance program for the materials to be used in the construction of the causeway and dam; and
- A stringent screening and QA/QC system has been installed to select and monitor the performance of contractors and sub-contractors that are tasked for building the tailings dam.

Lastly, it should be noted that over the 12 years of operation, CBNC has maintained an accident-free operation of its tailings disposal system. The company has not had any lost time events related to the operation of its tailings dam, nor has it had any occasion in which its tailings dam has experienced any spillage, failure or breaches. This attests to the sound policy and stringent procedures that the company implements in the design, construction, operation and eventual decommissioning of its tailings disposal facilities.

Rehabilitation of TSF1 was also conducted successfully. The rehabilitation efforts included the measures to ensure the physical stability of the dam including planting of tree species at the slopes of embankment and installation of decant system to prevent accumulation of rainwater and overtopping of the embankment.

The detailed safety features of the tailings dam is presented in *Chapter 4 - Environmental Risk Assessment.*

The following matrix summarizes the potential impacts that may be brought by the proposed project.

Table 2.1.5. Impacts assessment and mitigation for geology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Change in slope and subsurface geomorphology Construction of the tailing storage will employ excavation and grading that will slightly change the generally flat topography in the proposed site except for those areas that are elevated. The subsurface geology will not be changed.		✓	✓		• The vegetation cover vegetation cover in the designated buffer zones and in the peripheries of roads and quarry area should be maintained to minimize slope failure. • Grading shall then be properly planned together with temporary stockpile for the excavated soil and rock materials.
Inducement of subsidence, liquefaction, landslides Liquefaction results when loose sand and soil in the subsurface undergo stress such as earthquake and loading. Lateral spread may occur in and around the fault contact of ultramafics and sedimentary rocks due to difference in confining pressure of rock materials.		✓ ✓	✓ ✓		A geotechnical assessment will be conducted to determine the stability of the the rock units that underlain the site. Other engineering measures such as mulching to strengthen the area around the fault and boundary of contact can be done. On the other hand, the inherent characteristic of the tailings and the design of the dam will allow the tailings to harden as the tailing is stored for a long time and the liquid part evaporates which ensures stability of the dam structure. This will be supplemented by the installation of a rain water decant system similar with TSF1 to prevent accumulation of rainwater and overtopping of the embankment. The slopes will also be vegetated to prevent soil erosion and landlsides.

CBNC has an approved Environmental Protection and Enhancement Program (EPEP) and has a detailed management measures to address geological, geomorphological and other hazards associated with the costruction and operations of a TSF.

2.1.3 Pedology

2.1.3.1 Methodology

Soils assessment involved the review of existing literature and maps of the project area as well as site verification and sampling conducted last August 19-20, 2016 to characterize soils and determine the physico-chemical properties of the proposed project site for TSF3 and adjacent surroundings.

Soil characterization was done through a 30-cm borings in the representative sites selected from various soil mapping units of the soil type within the project area. Site selection was done using the project location map relative to the location of the terrestrial ecology assessment and the NAMRIA topographic map with a 1:50000 scale. Geographical position of each observation/sampling location was recorded using a GPS.

Soil profiles were determined following the Food and Agriculture Organization (FAO) guidelines for soil profile descriptions. Soil samples were collected for physico-chemical analyses (pH, total organic matter, total nitrogen, total organic carbon, and particle size) and heavy metal content such as cadmium (Cd), chromium (Cr), copper (Cu), Iron (Fe), manganese (Mn), potassium (K), and zinc (Zn). The analysis was done by CRL Environmental Corporation, a-DENR accredited laboratory facility.

By comparing the plant environmental requirements with the physico-chemical properties of the soils, the Qualitative Suitability Classification was a determined. Soil erosion susceptibility or erosion potential of the project area was mapped using the soil mapping units. For each soil unit, erosion susceptibility was determined based on a contributing factor taken at a time. The individual susceptibility assessments were then aggregated to form a composite erosion susceptibility score for the soil unit. The contributing factors include rainfall, soil erodibility, vegetation or landuse, and slope.

The following data were used in the study:

- PAGASA's rainfall data as collected in Puerto Princesa City station;
- Erodibility of the various soil mapping units was determined following the results of the field assessment and physical analysis;
- Vegetation or land use was assessed in the field. This was supplemented by the interpretation of google earth imageries; and
- The slope of the soil mapping unit.

Description of Sampling Locations

Table 2.1.6 shows the coordinates of the soil sampling locations while **Figure 2.1.8** depicts the map.

Table 2.1.6. Geographic coordinates of the soil observation sites

Station No.	Northing	Easting	Description
1	8°33'59.0	117°25'45.34	Reforestation Area
2	8°34'7.57	117°26'5.82	Secondary Growth Forest
3	8°34'29.68	117°26'0.67	Secondary Growth Forest
4	8°34'26.98	117°25'58.40	Grassland
5	8°34'32.8	117°25'51.11	Secondary Growth Forest
6	8°34'45.87	117°25'36.35	Secondary Growth Forest
7	8°34'41.92	117°25'50.09	Grassland
8	8°34'32.41	117°25'55.70	Grassland

2.1.3.2 Baseline Conditions

Soils of the Project Area

Tagburos clay loam as the soil type in the proposed TSF3 was subdivided into two (2) soil mapping units based on differences in slope ranges.

The soil mapping units are the Tagburos clay loam, 3-8% slopes, and Tagburos clay loam, 8-18% slopes.

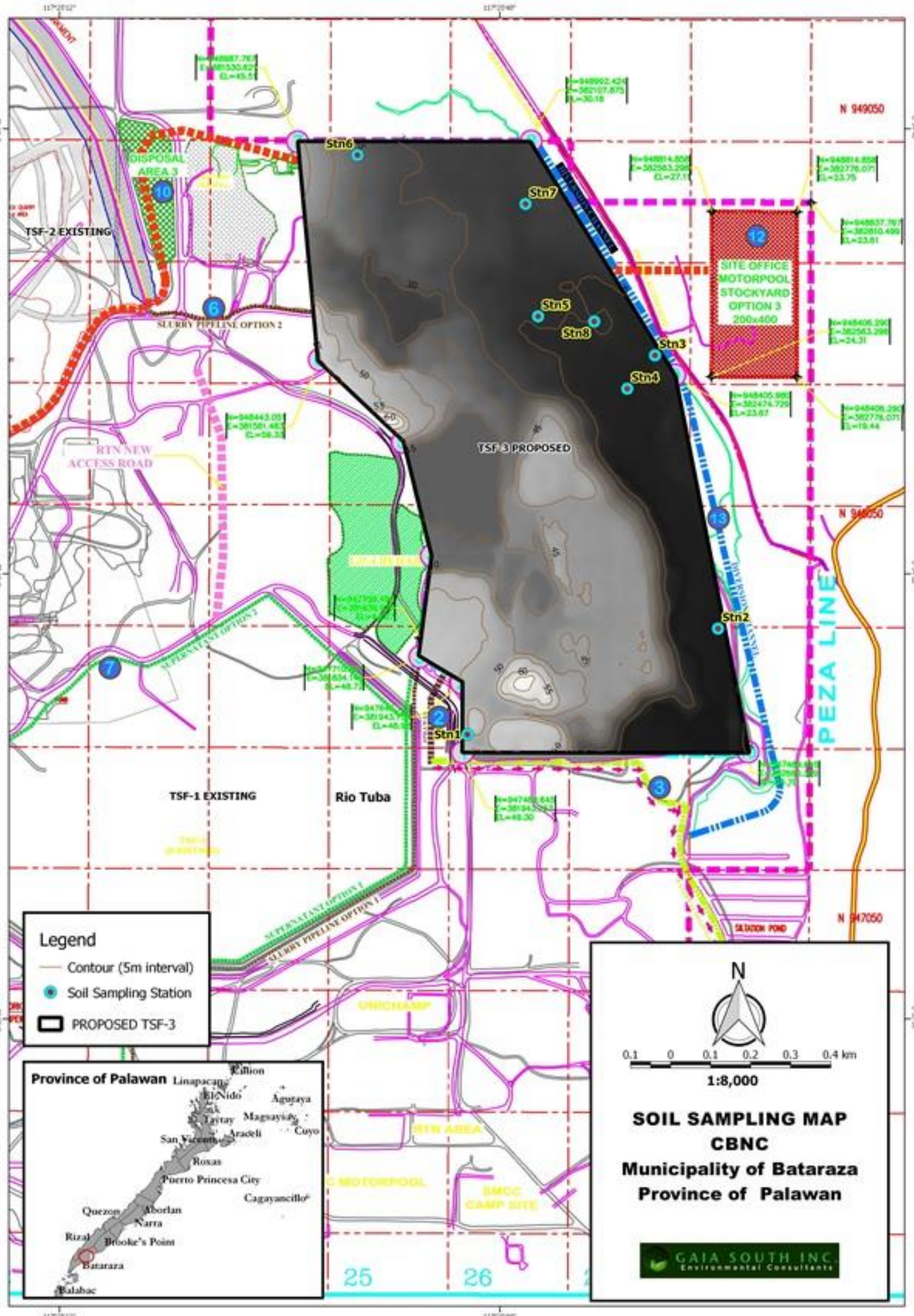


Figure 2.1.8. CBNC pedological assessment sampling area

Tagburos clay loam, 3-8% slopes occurs on the eastern half of the proposed TSF3, while Tagburos clay loam, 8-18% slopes occurs on the western half of the project area.

Tagburos clay loam, 3-8% slopes as represented by soil observation/station 2,3,4,5,7 and 8 is a well drained sandy loam to silty clay loam soil. Soil reaction ranges from medium acid to neutral (pH 6.0 to pH 6.6). Nitrogen is very low (0.03-0.05%). Organic matter ranges from very low to low (1.38- 2.69%), while potassium is very high (1.06-11.1 cmol/kg). The natural fertility of this soil is low.

In this soil the heavy metals (cadmium, copper, lead and zinc) are below the contamination levels as prescribed by the Taiwanese standards for cadmium (5 mg/kg), copper (200 mg/kg), lead (500 mg/kg), and zinc (500mg/kg). Chromium, which ranges from 870-2960 mg/kg is above the contamination level for Chromium of 400 mg/kg as prescribed by the Taiwanese standard. Chromium hexavalent is not detected. Iron, which ranges from 13.0-21.5% is above the range of Iron in soil. Manganese with 1,560-2,370 mg/kg is within the range of manganese in soil.

Tagburos clay loam, 8-18% slopes as represented by soil observation/station 1 and 6 is a well-drained sandy loam soil (disturbed soil- formerly mining area). Soil reaction ranges from slightly acid to mildly alkaline (pH 6.1- 7.7). Nitrogen is very low (0.03%). Organic matter is very low (1.60-1.62%), while potassium is very high (1.9- 2.4 cmol/kg). Natural fertility of this soil is low.

In this soil the heavy metals (cadmium, copper, lead and zinc) are below the contamination levels as prescribed by the Taiwanese standards for cadmium, copper, lead and zinc. Chromium with 913-1,460 mg/kg is above the contamination level for chromium of 400 mg/kg as prescribed by the Taiwanese standard. Hexavalent chromium was not detected in the sample. Iron with 11.3 and 20.7% is above the range of iron in soil. Manganese with 1,460 and 2,350 mg/kg is within the range of Manganese in soil.

Table 2.1.7 summarizes the results of the physico-chemical characteristics lof the soil types in the area while **Figure 2.1.9** shows the soil map. **Annex 2.1.9** includes the certificate of analysis of the soil samples from CRL laboratories.

Table 2.1.7. Soil physico-chemical properties

Soil properties	Standard Value	Tagburos clay loam, 3-8% slopes						Tagburo clay loam, 8-18% slopes	
		Stn2	Stn3	Stn4	Stn5	Stn7	Stn8	Stn1	Stn6
Physical Properties									
Drainage	-	Well-drained	Well-drained	Well-drained	Well-drained	Well-drained	Well-drained	Well-drained	Well-drained
Slope (%)	-	3-8	3-8	3-8	3-8	3-8	3-8	8-18	8-18
Grain Size									
Gravel, % content	-	-	32	-	5	5	-	14	16
Sand, % content	-	49	33	2	62	24	2	51	36
Silt, % content	-	38	31	59	30	53	58	30	42
Clay, % content	-	13	4	39	3	17	39	5	6
Soil Texture*	-	Loam	Sandy loam	Silty clay loam	Sandy loam	Silt loam	Silty clay loam	Sandy loam	Sandy loam
Chemical Properties									

Soil properties	Standard Value	Tagburos clay loam, 3-8% slopes						Tagburo clay loam, 8-18% slopes	
		Stn2	Stn3	Stn4	Stn5	Stn7	Stn8	Stn1	Stn6
pH	-	6.1	6.1	6.5	6.0	6.6	6.3	7.7	6.1
Total Organic Matter, %	-	1.53	2.69	1.38	2.24	1.45	2.05	1.50	1.62
Total Nitrogen, %	-	0.03	0.05	0.03	0.05	0.03	0.04	0.04	0.3
Potassium (K), cmol/Kg	-	1.4	11.1	1.5	1.2	1.1	1.06	2.4	1.9
Heavy Metals									
Cadmium (Cd), mg/Kg	**5	1.1	0.8	0.9	1.0	0.8	0.9	0.9	1.0
Chromium (Cr), mg/Kg	**400	2,960	1,420	1,150	1,740	870	1,210	913	1,460
Copper (Cu), mg/Kg	**200	25	13	11	12	11	13	10	16
Iron (Fe), %	***0.3-10	21.5	13.3	15.8	20.9	13.0	16.4	11.3	20.7
Lead (Pb), mg/Kg	**500	21	165	15	20	14	15	16	19
Manganese, (Mn), mg/Kg	***30-5,000	2,260	1,960	2,170	2,370	1,990	1,560	1,460	2,350
Zinc (Zn), mg/Kg	**500	137	93	106	108	83	96	75	106
Hexavalent chromium (Cr^{+6}), mg/Kg	****2	ND	ND	ND	ND	ND	ND	ND	ND

*Notes:*Soil samples taken from disturbed soil- former mining area*
ND= Not Detected
***Taiwan standard for assessment of soil contaminated with heavy metals (mg/Kg): Cadmium=5; Copper=200; Lead=500; Zinc=500; Chromium=400*
****Leeper, 1978*
*****U.S. EPA, 2010*

Soil Erosion Susceptibility of the Project Area

Rainfall, soil erodibility, vegetation/landuse, and slope are the four (4) contributing factors to erosion. To determine the extent of erosion susceptibility within the project area, three (3) degrees of susceptibility are defined for each of the four contributing factors. These are "slightly susceptible" "moderately susceptible", and "highly susceptible".

Rainfall

The degree rating for rainfall is shown in **Table 2.1.8** while the rainfall data of Puerto Princesa City from 1971 to 2000 is included as **Annex 2.1.10**. Data shows that there are two (2) wet months (with more than 200 mm/mo) with October as the wettest month having 222.3 mm of rainfall. The remaining 10 months are with low to moderate rainfall with February having the least rainfall of 23.7 mm. It can be concluded that the erosion susceptibility rating for the whole project area is "slight".

Table 2.1.8. Erosion Susceptibility based on Rainfall

Degree of Susceptibility	Rainfall Type
Slightly	Areas with 5 to 6 dry months and 3 to 4 wet months
Moderately	Areas with 5 to 6 dry months and 5 to 6 wet months
	Areas with 2 to 4 dry months and 5 to 6 wet months
Highly	Areas with 5 to 6 dry months and 3 to 4 wet months with one or more months of 500mm or more rainfall per month
	Areas with 5 to 6 dry months and 5 to 6 wet months with one or more months of 500mm or more rainfall per month

Source: Bruce,1982

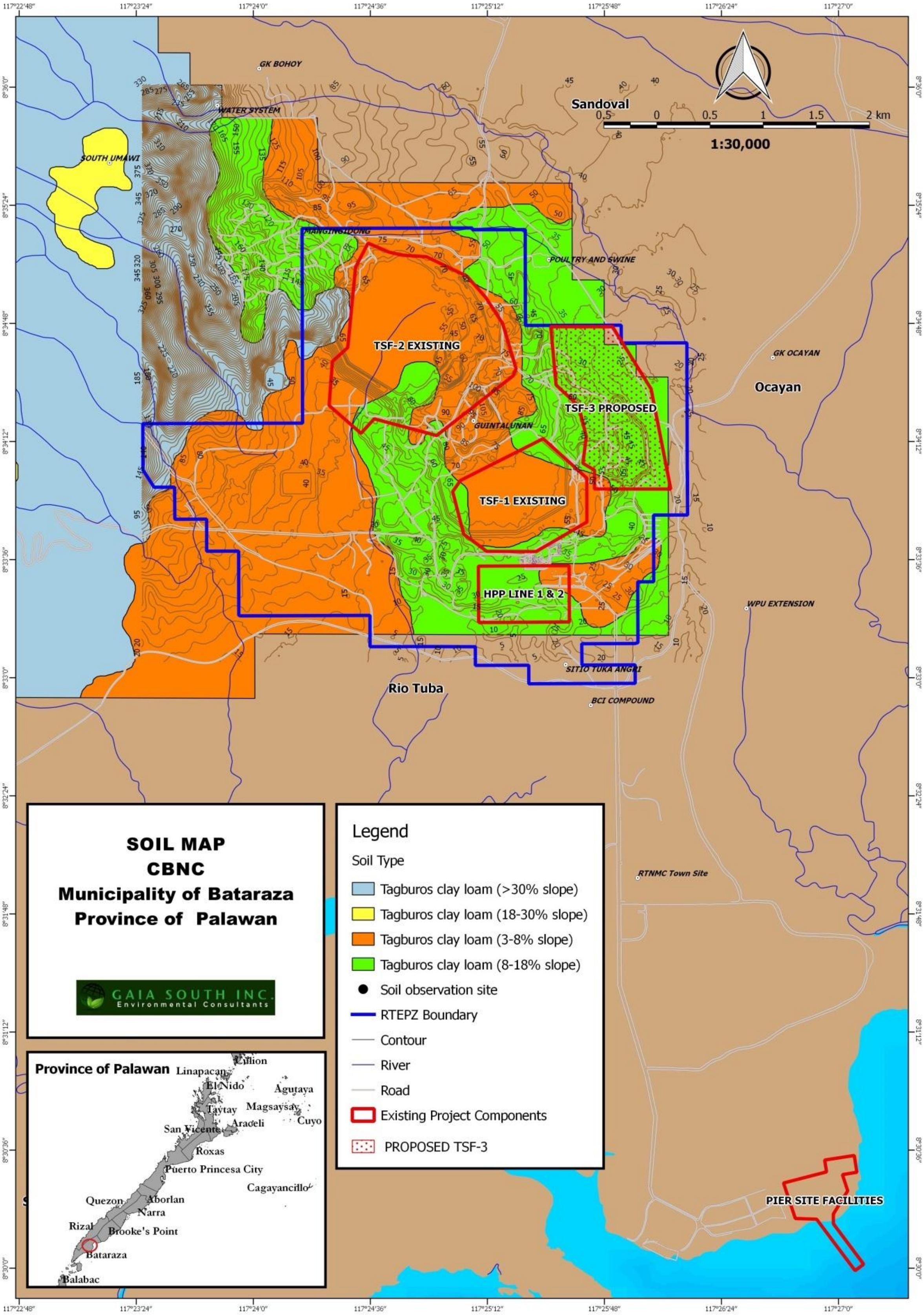


Figure 2.1.9. Soil map of CBNC project area

Soil Properties

The susceptibility score for soil type is shown in **Table 2.1.9**. The criteria that were used are the soil depth and clay-silt fraction. Tagburos clay loam with more than 100 cm soil depth and < 60% clay-silt fraction is with "slight susceptibility to erosion".

Table 2.1.9. Erosion Susceptibility Based on Soil Properties

Degree of Susceptibility	Soil Depth and Texture
Slightly	Areas with 50 to 100cm solum and 60 to 100% clay-silt fraction
	Areas with greater than 100cm solum and 0 to 60 percent clay-silt fraction
	Unclassified soils of the mountain
Moderately	Areas with 50 to 100cm solum and 0 to 60% clay-silt fraction
	Areas with greater than 100cm solum and 60 to 100% clay-silt fraction
Highly	Areas with less than 50cm solum and 0 to 100% clay-silt fraction

Source: Bruce, 1982

Notes: Solum is made up of surface soil and subsoil. Clay-silt fraction is percent total of clay and silt particles determined through mechanical analysis of topsoil.

Landuse/Vegetation

The degree rating for land-use/vegetation is shown in **Table 2.1.10**. **Figure 2.1.10** shows that the proposed area is currently a disturbed site being a mining area of RTNMC. Patches of Agoho trees are found at the areas that were part of the rehabilitation program of RTNMC. Based on **Table 2.1.10**, the forest plantation and shrubland are with "slight susceptibility to erosion". The grassland is with "moderate susceptibility to erosion". The bare area is with "high susceptibility to erosion".

Table 2.1.10. Erosion Susceptibility based on Vegetation and Crops Grown

Degree of Susceptibility	Type of Crops/Ground Cover
Slightly	Areas grown to paddy rice
	Areas permanently planted to coconut, mixed orchard, fruit trees, etc.
	Areas covered with dense forest/shrubs, tall grasses and pine trees
Moderately	Areas grown to sugar cane
	Open grassland
	Areas with thin growth of deciduous forest with scattered kaingin clearings Areas, sloping planted to coconut or fruit trees intercropped with upland row crops (corn, cassava, sweet potato, etc.)
Highly	Areas of diversified upland row crops – corn, cassava, upland rice, mungbean, pineapple, etc.
	Areas planted to tobacco
	Areas with thin growth of short grasses with patches of kaingin clearings; Sparsely vegetated land; Bare area

Source: Bruce, 1982

Four (4) landuse/ vegetation units were identified and mapped in the project area. These are: Forest; Shrubland; Grassland; and Bare area (Mining area). Forest plantation as Forest exists in the southwestern corner of the proposed TSF3. Shrubland exists in the northern part of the project area. Grassland exists in the northeastern part of the proposed TSF3. The mining area as bare area exists in the western half of the project area from north to south.

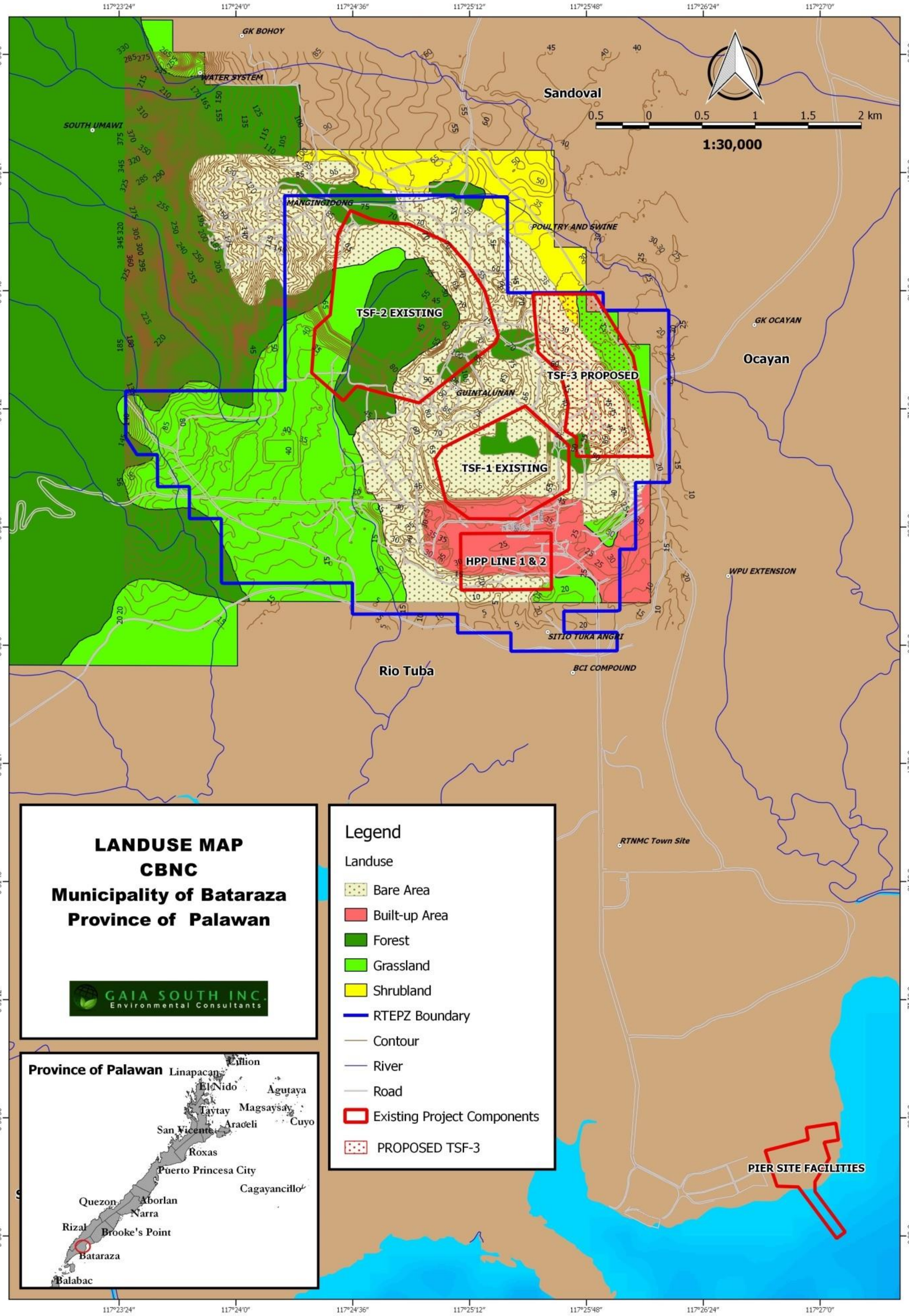


Figure 2.1.10. CBNC land use map

Slope

As shown by the slope in the soil map (**Figure 2.1.9**) and **Table 2.1.11**, Tagburos clay loam with 3-8% slopes is characterized as “slightly susceptibility to erosion” while Tagburos clay loam with 8-18% is characterized as “moderately susceptibile to erosion”.

Table 2.1.11. Erosion Susceptibility based on Slope

Degree of Susceptibility	Slope Range
Slightly	Areas with slope between 0 and 8%
Moderately	Areas with slope between 8 and 18%
Highly	Areas with slope greater than 18%

Source: Bruce, 1982

Final Erosion Susceptibility Rating

The final rating as shown in **Table 2.1.12** was formed by aggregating the erosion susceptibility ratings of each soil unit. This further shows the decision rule on the composite or final erosion susceptibility index. **Figure 2.1.11** present the Soil Erosion Susceptibility Map, which shows the result of erosion susceptibility ratings.

Table 2.1.12. Composite Erosion Susceptibility Decision Rule

Individual Susceptibilities (Rainfall – landuse – slope – soil)	Final Degree of Erosion Susceptibility
S – S – S – S	Slightly
M – M – M – M	Moderately
H – H – H – H	Highly
H – M – H – H	Highly
H – S – M – M	Moderately
H – M – M – H	Moderately

Source: Bruce, 1982
Note: S is slightly susceptible, M- moderately susceptible, and H- highly susceptible.

Based on the Soil Erosion Susceptibility Map, the forest on Tagburos clay loam with 8-18%, slopes is with “slight susceptibility to erosion”. The Shrubland on Tagburos clay loam with 3-8% slopes is with “slight susceptibility to erosion”. The grassland on Tagburos clay loam with 3-8% slopes are with "slight susceptibility to erosion". The bare area (mining area) on Tagburos clay loam with 3-8% and 8-18 % slopes are with "moderate susceptibility to erosion”.

Soil Suitability Classification

A qualitative suitability classification was made by comparing the plants environmental requirements with the physico-chemical properties of the soil mapping units (**Tables 2.1.7** and **2.1.13**). Results showed that the forest tree species (example: Narra, Molave, Auriculiformis and Mahogany) are suitable in all the identified soil mapping units in the project area, with low fertility as the limitation. The fruit bearing trees (example: Tamarind, Jackfruit, Kamachile, and Guyabano/Atis) are all suitable in the identified soil mapping units, with low fertility as the limitation. Coconut, Mango and Banana are suitable in Tagburos clay loam with 3 – 18% slopes, with low fertility as the limitation. Cassava and Peanut are only suitable in Tagburos clay loam with 3-8% slopes, with low fertility as the limitation (**Table 2.1.14**).

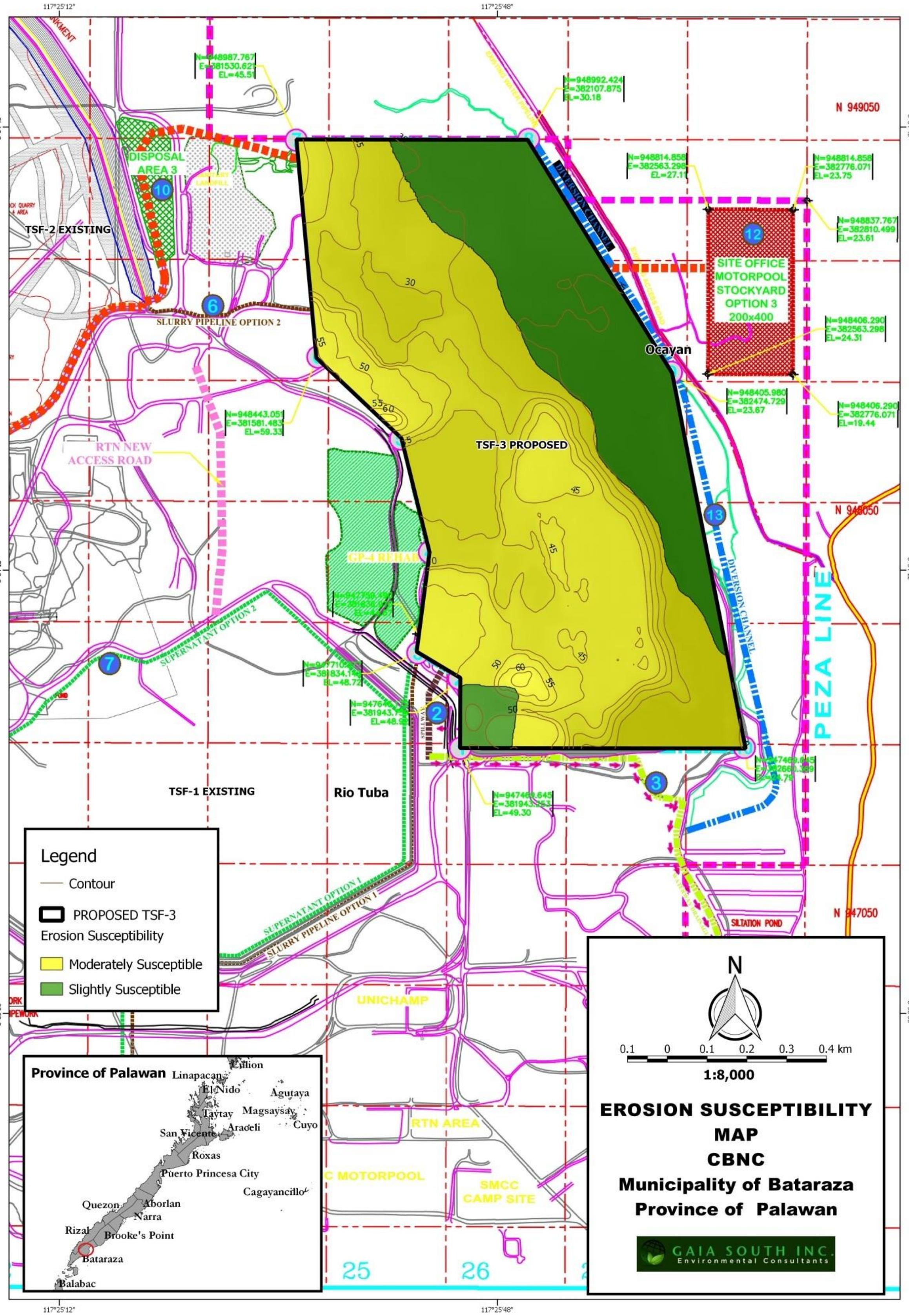


Figure 2.1.11. CBNC erosion susceptibility map

Table 2.1.13. Environmental requirements of selected plants

Plant	Slope (%)	Soil Depth (cm)	Drainage	Soil pH	Soil Texture	Soil Fertility
Narra	0>50	≥45	Moderately well	5.0-7.5	Loamy to structured clay	Low to medium
Molave	0>50	≥45	Moderately well to well drained	5.0-7.5	Loamy to clay	Low to medium
Auriculiformis	0>50	≥45	Moderately well to well drained	4.5-7.5	Loamy to clay	Low to medium
Mahogany	0>50	>75	Moderately well to well drained	5.0-7.5	Loamy to clayey	Low to medium
Tamarind	0>50	≥45	Moderately well somewhat poorly drained	4.0-8.0	Sandy loam to clay loam	Low to medium
Coconut	0-30	>75	Moderately well	6.0-7.5	Sandy loam to clay loam	Medium
Jackfruit	0>30	≥45	Moderately well somewhat poorly drained	5.0-7.5	Loamy to clayey	Low to medium
Kamachile	0>30	≥45	Moderately well to well drained	5.0- 7.5	Sandy loam to clay loam	Low to medium
Mango	0-30	≥75	Moderately well somewhat poorly drained	4.5-7.0	Loamy to clayey	Medium
Banana	0-30	≥45	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Medium
Guayabano/ Atis	0≥45	≥45	Moderately well	4.5-6.5	Sandy loam to clay loam	Low to Medium
Cassava	0-8	≥75	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Low to Medium
Peanut	0-8	≥45	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Medium to high

Table 2.1.14. Qualitative suitability classification

Plant	Tagburos clay loam, 3-8% slopes	Tagburos clay loam, 8-18% slopes
Narra	S*	S*
Molave	S*	S*
Auriculiformis	S*	S*
Mahogany	S*	S*
Tamarind	S*	S*
Coconut	S*	S*
Jackfruit	S*	S*
Kamachile	S*	S*
Mango	S*	S*
Banana	S*	S*
Guayabano/ Atis	S*	S*
Cassava	S*	NS
Peanut	S*	NS

*Notes: S- Suitable; *- Suitable but with low fertility as limitation; NS- Not Suitable*

2.1.3.3 Impact Assessment

CBNC has successfully implemented the rehabilitation of TSF1 and has submitted the rehabilitation plan for TSF2 once it has reached its full capacity. The Rehabilitation Plan for TSF1 basically covered the final measures to address soil erosion and possible collapse of the dam embankments and improvement of soil quality of the areas inside the TSF1 in order to facilitiate plant regeneration and growth. Based on the data from CBNC the tailings were covered with topsoil and carbonized rice hull to augment the soil nutrient content. After a trial planting, species of vines, grasses and herbs were successfully planted and grown. As of 2016, a large section of the TSF surface area is vegetated (**Plate 2.1.2)**.

Currently, the slopes stabilization activites for TSF2 are being conducted. Coconets are installed to encourage the growth of grasses and other plant species **(Plate 2.1.3)**.

Plate 2.1.2. Panoramic view of the TSF1 taken from the top of the embankment (photo taken in July 2016)

Plate 2.1.3. Slope of TSF2 laid with coconets

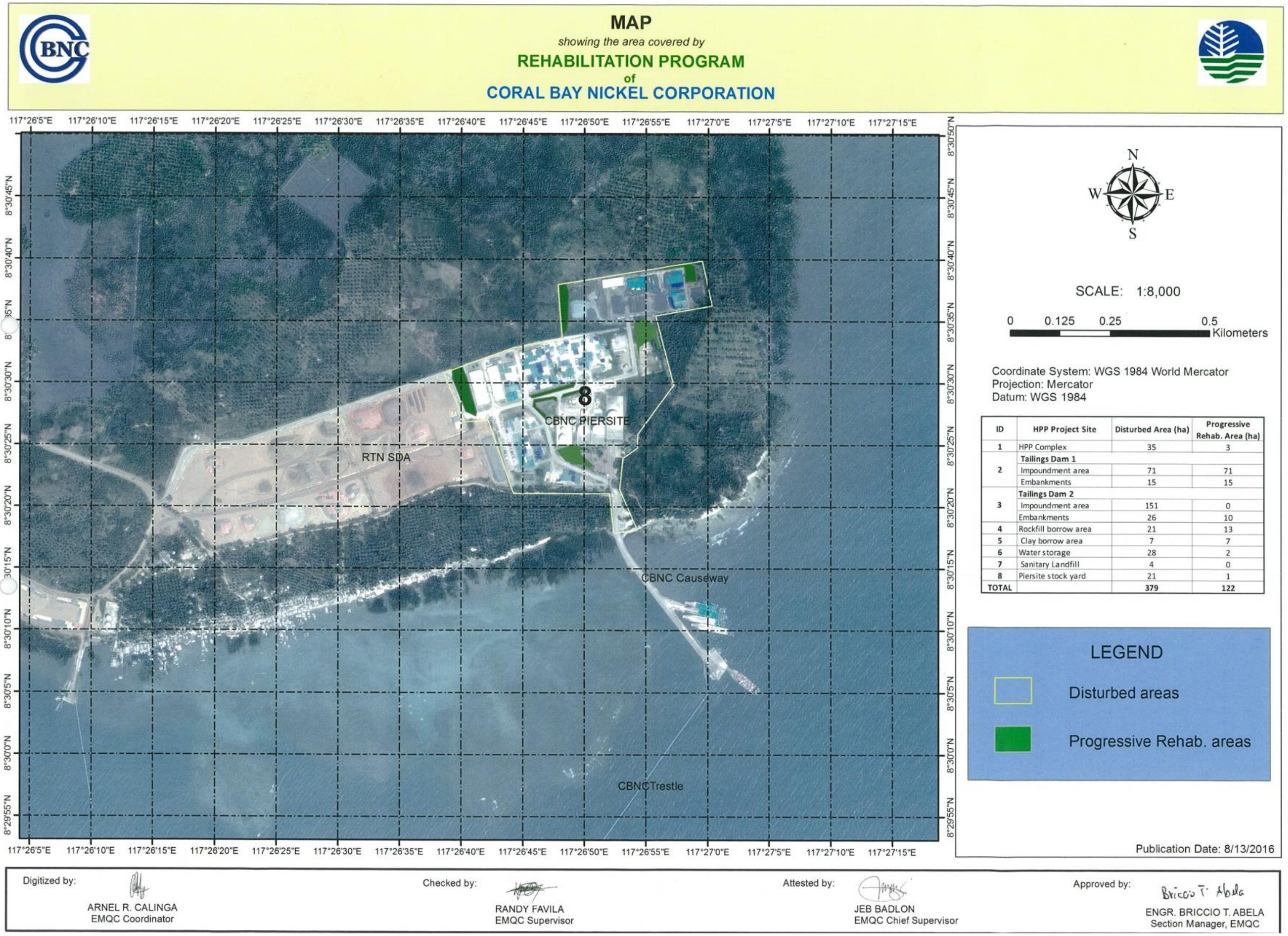
Plate 2.1.4. Slopes with visible vegetation (photo taken in July 2016)

Aside from TSF2, the borrow area for TSF1 and 2 are also being rehabilitated. Twenty out of the 28 hectares is planted with various species of grass and tree species to stabilize the slopes and manage soil erosion. As of June 2016, a total of 440,376 are planted and the survival rate is 92.49%.

Moreover, data provided by CBNC reported that a total of 0.81 ha area is planted with 2,027 seedling of Narra, Batino, Agoho and other species at the view deck of TSF2 to manage soil erosion and largely as part of the mine rehabilitation plan for the mining areas of RTNMC.

Along the plant site, the slopes surrounding the HPP plant have been successfully stabilized by planting various species of grasses. The slopes are regularly maintained to ensure that soil erosion is avoided. Please see **Figures 2.1.12** and **2.1.13** for the rehabilitation program of CBNC.

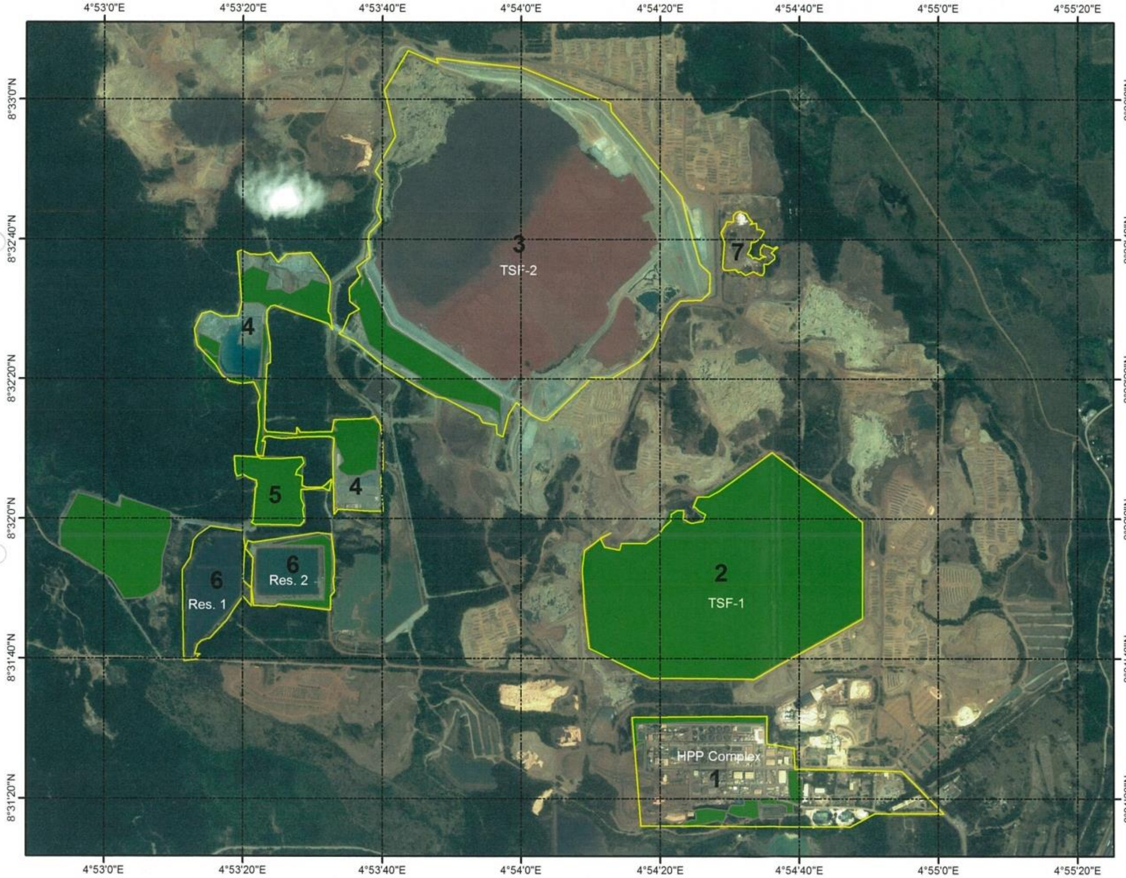
During the construction of TSF3, CBNC shall continue to monitoring the activities and ensure minimal soil disturbance of surrounding areas.



ID	HPP Project Site	Disturbed Area (ha)	Progressive Rehab. Area (ha)
1	HPP Complex	35	3
2	**Tailings Dam 1**		
	Impoundment area	71	71
	Embankments	15	15
3	**Tailings Dam 2**		
	Impoundment area	151	0
	Embankments	26	10
4	Rockfill borrow area	21	13
5	Clay borrow area	7	7
6	Water storage	28	2
7	Sanitary Landfill	4	0
8	Piersite stock yard	21	1
TOTAL		379	122

Figure 2.1.12. Rehabilitation program of CBNC along the piersite

MAP
showing the area covered by
REHABILITATION PROGRAM
of
CORAL BAY NICKEL CORPORATION



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W E
S

SCALE: 1:17,000
0 0.25 0.5 1 Kilometers

Coordinate System: WGS 1984 World Mercator
Projection: Mercator
Datum: WGS 1984

ID	HPP Project Site	Disturbed Area (ha)	Progressive Rehab. Area (ha)
1	HPP Complex	35	3
2	**Tailings Dam 1**		
	Impoundment area	71	71
	Embankments	15	15
3	**Tailings Dam 2**		
	Impoundment area	151	0
	Embankments	26	10
4	Rockfill borrow area	21	13
5	Clay borrow area	7	7
6	Water storage	28	2
7	Sanitary Landfill	4	0
8	Piersite stock yard	21	1
TOTAL		**379**	**122**

LEGEND
Disturbed areas
Progressive Rehab. areas

Digitized by: ARNEL R. CALINGA, EMQC Coordinator
Checked by: RANDY FAVILA, EMQC Supervisor
Attested by: JEB BADLON, EMQC Chief Supervisor
Approved by: Briccio T. Abela
ENGR. BRICCIO T. ABELA, Section Manager, EMQC

Figure 2.1.13. Rehabilitation program of CBNC near the HPP project area

The following matrix summarizes the potential impacts that may be brought by the proposed project.

Table 2.1.15. Impacts assessment and mitigation for pedology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Soil erosion/ loss of topsoil/ overburden** Soil erosion will occur once an area is cleared of its vegetation cover particularly areas with slope. Though the proposed project area for TSF3 is already a disturbed site because of mining activity, Soil erosion at the peripheries of the area is still expected especially during rainy events and civil works. Soil erosion at the borrow pit areas will also occur during the extraction of materials.		✓	✓		Soil erosion will be managed by the implementation following measures: • Clearing and excavation works should be done during the drier months or days of the year (January-May), if possible. • Vegetation cover of the buffer zones surrounding the HPP site and its facilities inclduing TSF3 and the access roads shall be maintained or restored and enhanced. • Selective clearing of vegetation cover and implementation of progressive rehabilitation program will be implemented at the borrow areas. • Access roads for the construction of the dam shall use exising roads and drainage systems shall be installed around the proposed TSF3 facility. All water draining from the construction sites shall be directed towards temporary silt retention ponds or connected to the siltation ponds at the RTNMC minesite. • Cut off channels shall be installed to divert stormwater from flowing through the construction area. • Top soil from borrow areas shall be recovered and stored in run-off controlled spoils disposal area. The recovered topsoil shall be used in the progressive rehabilitation program defined in the EPEP. • Silt fences shall be installed at the identified erosion prone areas around the proposed TSF3 project site. • Establishment of silt/rock traps and check dams to reduce flow of surface run off and minimize ground scouring and subsequent material transport by surface run-off and allow settlement before water enters the silt ponds.
• **Change in soil quality/ fertility** Change in soil quality or fertility on the ground surface will occur during disturbance of soil brought about by civil works (the site is a mining area, top soil was removed previously and therefore no change in soil fertility will occur during the construction stage). The proposed TSF3 site will be a mined out area by June 2019. At this stage, all topsoil has been removed on site and thefore soil quality/fertility will not be affected. During the operations stage, slopes of the embankments			✓	✓	The following measures are recommended to be implemented: • At the borrow areas, overburden with topsoil will be saved and stored properly for use in the future rehabilitation activities. • After the decommissioning of the borrow areas, rehabilitation will be immediately coducted following the methods and procedures that is successfully implemented by CBNC in their other rehabilitation sites. For TSF3, the following measures are recommended: • Planting of grass and other plant species will be done at the embankment during the oeprations phase. The accumulation of detritus materials will help improve soil quality and upon decommissioning, the embankments will have amore improved soil quality, which will allow for faster rehabilitation. • TSF3 upon decommissioning will be rehabilitated following the approved land use. However, rehabilitation of the site is possible based on TSF1. The improvement of the soil fertility can be done by putting back topsoil and by using rice hull. As the soil is gradually recolonized by plants, the

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
will be reinforced by planting grasses and this will have a positive impact on soil fertility as the detritus will allow nutrients to accumulate. However, upon the decommissioning of TSF3, the tailings will be devoid of any nutrients and will require intervention to improve soil quality and subsequent rehabilitation program.					detrital materials will improve soil quality.
• **Soil contamination with hydrocarbon residues** Hydrocabon residues contain toxic materials to plants and animals. Fuel leaks from the use of heavy equipment, hauling trucks and other vehicles during the construction stage is the common cause of contamination. Leaked fuel can also be leached and carried thru runoff to the nearest surface waters or percolate to the groundwater and pose as a risk to human health.		✓	✓		The minimize fuel leaks, the following measures are recommended: • Regular maintenance of vehicles and heavy equipment will be conducted to check for leaks. Maintenance activities should be conducted in the motorpool to contain fuel leaks. • The temporary motorpool that will be established at the construction site shall be installed with Oil and Water Separator (OWS) to capture spillages. The OWS should be maintained monthly and oil residues removed, stored in leak proof containers prior to transport and treatment by an accredited transporter and treater. • Fuel oil storage areas should be provided with concrete bund to protect from spillages. Moreover, waste materials contaminated with hydrocarbon residues should be stored in leak proof containers and collected and treated by accredited contractors.

2.1.4 Terrestrial Flora

2.1.4.1 Methodology

Description of Sampling Locations

An assessment of the flora in the 111-hectare proposed project area of CBNC in Rio Tuba, Bataraza, Palawan was conducted. A reconnaissance survey of the area was undertaken initially to determine the potential locations of the vegetation sampling plots. Using the site development plan map provided, the location of the plots and transect line was determined. The plots were established within the second-growth forest while a transect line was established within the grassland (**Figure 2.1.14** and **Table 2.1.16**).

Within the second-growth forest, the plots were established randomly. Each plot (10 m x 10 m) was divided into sub-plots using the four (4) cardinal directions *i.e.,* subplot 1 (NE), subplot 2 (SE), subplot 3 (SW), subplot 4 (NW). This method was applied so that inventory and assessment of the area will be systematic, and to avoid double counting. In each subplot, an inventory of the vascular plants present was conducted.

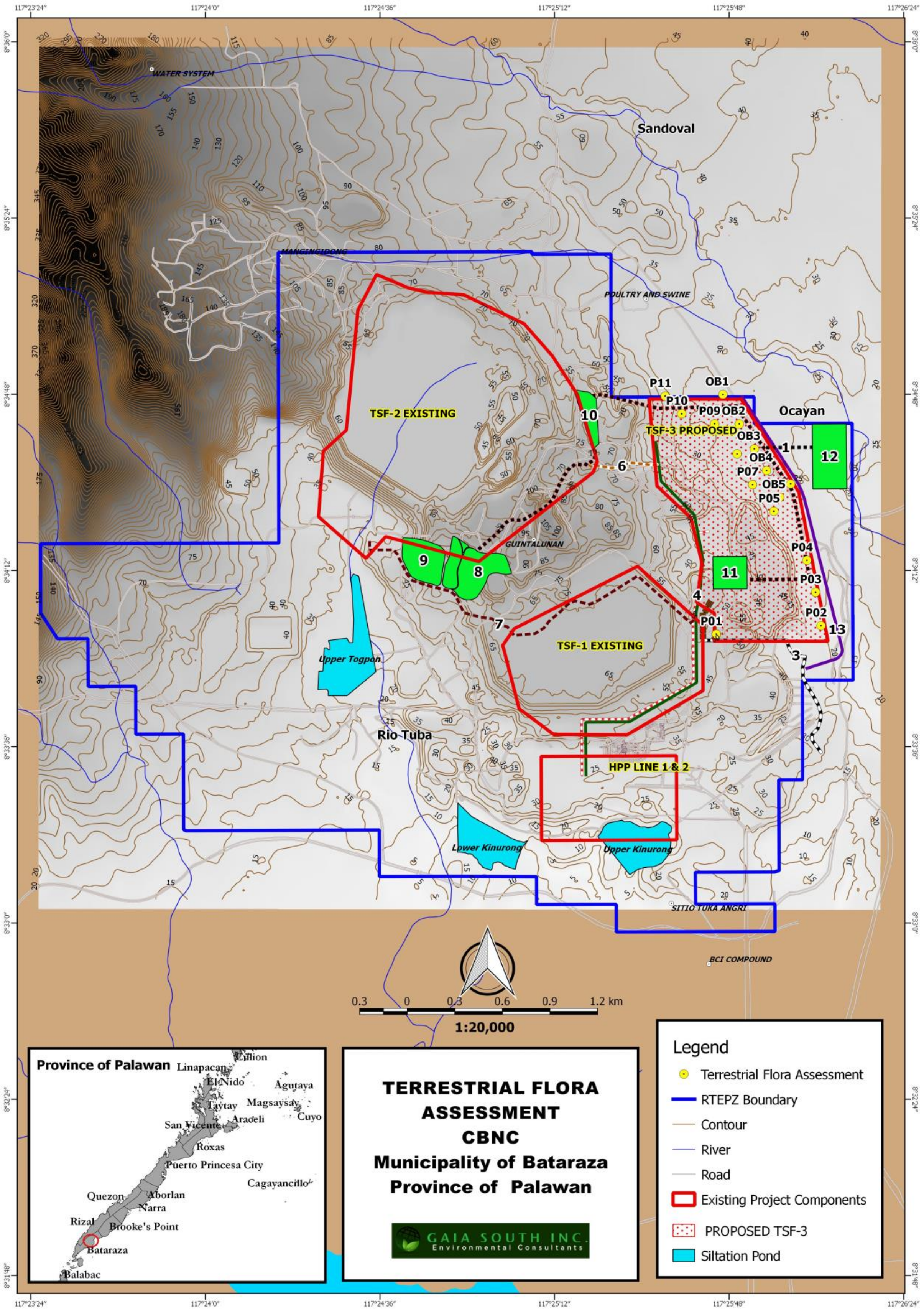


Figure 2.1.14. Sampling map for terrestrial flora assessment

Measurement of diameter at breast height (dbh) was undertaken for trees with more than 10 cm dbh. Smaller quadrats measuring 5 m x 5 m and 1 m x 1 m were also established within the 10 m x 10 m plot. The 5 m x 5 m quadrat was established to quantify the intermediate vegetation such as poles and saplings with dbh 3-5 cm, while the 1 m x 1 m quadrat was established to account for undergrowth vegetation with less than 3 cm dbh such as seedlings, vines, herbs, ferns and fern allies. For the intermediate vegetation, only the number of individuals of each species was recorded. Whereas, the number of individuals was counted and percent cover of each species was estimated in the undergrowth vegetation.

Table 2.1.16. Relative location and elevation of the sampling stations in the proposed TSF3 site at CBNC, Bataraza, Palawan

Plot	North	East	Elevation (m)	Notes
OB1	8°34'47.92"	117°25'46.70"	36	Observation points (OB1–OB5) along the 800 m-long transect line within the grassland area. This whole site is water-logged and swampy and dominated by the exotic grass *Brachiaria humidicola* (**Plates 2.1.5** and **2.1.6**). Native plants that are present in this area include the climbing fern *Stenochlaena palustris* (**Plate 2.1.7**), and scattered individuals of the sedge *Machaerina disticha, Phyllanthus balgooyi* (**Plate 2.1.8**), and the Palawan endemic *Pandanus reticulatus* (**Plate 2.1.9**). The particular area near OB4 appeared to be an old reforestation area planted with *Acacia auriculiformis* with a single remaining living individual (33 cm dbh) (**Plate 2.1.10**).
OB2	8°34'41.92"	117°25'50.09"	36	
OB3	8°34'36.84"	117°25'53.18"	35	
OB4	8°34'32.41"	117°25'55.70"	35	
OB5	8°34'26.98"	117°25'58.40"	35	
P01	8°33'59.00"	117°25'45.34"	65	This area is a small stand of the exotic *Leucaena leucocephala* (**Plate 2.1.11**) and bordered on the east with wild bananas. Near this plot is a tall tree of *Terminalia pellucida* (approximately 25 m tall, 70 cm dbh) (**Plate 2.1.12**).
P02	8°34'0.73"	117°26'6.94"	44	Hillslope area with second-growth forest dominated by *Alstonia macrophylla* (**Plate 2.1.13**). *Protium connarifolium, Dillenia luzoniensis, Angelesia splendens,* and *Nepenthes philippinensis* are the other common plants here. The exotic grass *Brachiaria humidicola* is again present in the open spaces.
P03	8°34'7.57"	117°26'5.82"	39	Also hillslope area (**Plate 2.1.14**) with second-growth forest with more individuals of *Protium connarifolium* and *Buchanania microphylla*. Other species in this area include *Cratoxylum formosum* and *Macaranga bicolor.*
P04	8°34'14.09"	117°26'4.02"	38	This area (**Plate 2.1.15**) is dominated by *Gymnostoma nobile* with *Protium connarifolium, Buchanania microphylla,* and *Glochidion coronulatum.*
P05	8°34'24.10"	117°25'57.22"	38	Dense second-growth vegetation (**Plate 2.1.16**) with *Alstonia macrophylla, Glochidion coronulatum, Syzygium* sp., *Phyllanthus balgooyi, Acacia auriculiformis, Dillenia luzoniensis* and *Dinochloa acutiflora. Machaerina disticha, Alpinia foxworthyi,* and *Melastoma malabathricum* are common in the open spaces.
P06	8°34'29.68"	117°26'0.67"	34	Small dense second-growth vegetation (**Plate 2.1.17**) in swampy area dominated by the small-medium sized tree, *Elaeocarpus floribundus. Stenochlaena palustris, Pandanus reticulatus, Machaerina disticha,* and *Nepenthes philippinensis* are common here.
P07	8°34'29.53"	117°25'52.82"	34	Dense second-growth vegetation near edge of open area with *Myristica guateriifolia* and dense tangle of climbing bamboo (*Dinochloa acutiflora*) (**Plate 2.1.18**).
P08	8°34'35.80"	117°25'49.62"	41	Second-growth vegetation with *Orania paraguanensis* (**Plate 2.1.19**) and tangles of climbing bamboo (*Dinochloa acutiflora*), *Uncaria* sp., and rattans (*Calamus microspherion, Calamus longipes*).

Plot	North	East	Elevation (m)	Notes
P09	8°34'41.95"	117°25'44.98"	42	Part of old reforestation site with *Acacia auriculiformis, Imperata cylindrica, Saccharum spontaneum,* and *Brachiaria humidicola* and a few individuals of *Alstonia iwahigense* (**Plate 2.1.20**).
P10	8°34'44.00"	117°25'38.21"	49	Remnant of forest with *Shorea guiso, Pinanga curranii, Garcinia* sp., *Syzygium* sp., *Terminalia pellucida,* and the rattans *Calamus microsphaerion* and *Korthalsia robusta* (**Plate 2.1.21**).
P11	8°34'47.60"	117°25'34.79"	48	Remnant of forest with *Intsia bijuga, Gymnostoma nobile, Polyscias aherniana, Elaeocarpus* sp., *Actinodaphne multiflora, Rinorea bengalensis, Plectocomia elongata, and Dinochloa acutiflora.*

Plate 2.1.5. The water-logged and swampy grassland area (estimated at 15 hectares) of the proposed TSF3 site of Coral Bay Nickel Corporation.

Plate 2.1.6. The exotic grass Brachiaria humidicola is the dominant species in the grassland area.

Plate 2.1.7. The native climbing fern *Stenochlaena palustris* in the grassland area.

Plate 2.1.8. *Phyllanthus balgooyi* occurs as isolated individuals in the Brachiariahumidicola-dominated grassland area.

Plate 2.1.9. The Palawan endemic *Pandanus reticulatus* occurs as scatteredclumps in the grassland area.

Plate 2.1.10. *Acacia auriculiformis* in OB4 of the transect line in the grassland area.

Plate 2.1.11. The small stand of *Leucaena leucocephala* in PO1 near Corner 1 of the proposed site.

Plate 2.1.12. View from near Corner 5 looking south with the tall *Terminalia pellucida* near PO1. **(Inset)** The same *Terminalia pellucida* tree in **A**, estimated to be approximately 25 m tall with a stem dbh of 70 cm.

Plate 2.1.13. Hillslope area with second-growth forest in PO2 dominated by *Alstonia macrophylla*. *Protium connarifolium*, *Dillenia luzoniensis*, *Angelesia splendens*, and *Nepenthes philippinensis* are the other common plants here. The exotic grass *Brachiaria humidicola* is again present in the open spaces.

Plate 2.1.14. Another hillslope area with second-growth forest in PO3 with more individuals of *Protium connarifolium* and *Buchanania microphylla*. Other species in this area include *Cratoxylum formosum* and *Macaranga bicolor.*

Plate 2.1.15. Area on a low hillslope in PO4 dominated by *Gymnostoma nobile* with *Protium connarifolium, Buchanania microphylla,* and *Glochidion coronulatum.*

Plate 2.1.16. Dense second-growth vegetation in PO5 with *Alstonia macrophylla*, *Glochidion coronulatum*, *Syzygium* sp., *Phyllanthus balgooyi*, *Acacia auriculiformis*, *Dillenia luzoniensis* and *Dinochloa* sp., *Machaerina disticha*, *Alpinia foxworthyi*, and *Melastoma malabathricum* are common in the open spaces.

Plate 2.1.17. Dense second-growth vegetation in PO6 in the swampy area dominated by the small-medium sized tree, *Elaeocarpus floribundus. Stenochlaena palustris, Pandanus reticulatus, Machaerina disticha,* and *Nepenthes philippinensis* are present here.

Plate 2.1.18. Dense second-growth vegetation in PO7 near edge of open / barren area with *Myristica guateriifolia* (tree in the center) and dense tangle of climbing bamboo (*Dinochloa* sp.)

Plate 2.1.19. The critically endangered tree palm, *Orania paraguanensis,* in secondgrowth forest in PO8 with *Macaranga bicolor* and tangles of climbing bamboo (*Dinochloa* sp.), *Uncaria* sp., and rattans (*Calamus microspherion, Calamus longipes*).

Plate 2.1.20. Part of an old reforestation site in PO9 with *Acacia auriculiformis, Imperata cylindrica, Saccharum spontaneum,* and *Brachiaria humidicola* and a few individuals of *Alstonia iwahigense.*

Plate 2.1.21. Remnant of degraded forest in P10 with *Shorea guiso* (buttressed tree on the left hand side of photo), *Pinanga curranii, Garcinia* sp., *Syzygium* sp.*, Terminalia pellucida,* and the rattans *Calamus microsphaerion* and *Korthalsia robusta.*

Plate 2.1.22. Part of the estimated 77 hectares of barren area near the center of the proposed TFS3 site shown in **Plate 2.1.12** as viewed from near Corner 5.

On the other hand, the transect line established within the grassland was approximately 800 m long. Observation points were made every 200 m along the transect line. The same procedures with second-growth forest were made in quantifying the vegetation in this ecosystem. Detailed sampling procedures in the conduct of the baseline data are detailed in **Annex 2.1.1**.

Collection of Specimens

Specimens (about 30 cm of twig with leaves and flowers and/or fruits) of species that were not readily identifiable in the field were collected, inserted between sheets of old newspapers, placed in large plastic bags, and preserved with denatured alcohol. These were subsequently processed as herbarium material for proper identification in the laboratory later.

Data Analysis

The data was analyzed using the following formula:

$$\text{Density} = \frac{\text{Number of Individuals of a Species}}{\text{Area of the Plot}}$$

$$\text{Dominance} = \frac{\text{Basal Area of a Species}}{\text{Area of the Plot}}$$

$$\text{Frequency} = \frac{\text{Number of Quadrats where a species occurs}}{\text{Total Number of Quadrats}}$$

$$\text{Relative Density} \quad (\text{RDe}) = \frac{\text{Density of a Species}}{\text{Total Density of all Species}} \times 100$$

$$\text{Relative Dominance} \quad (\text{RDo}) = \frac{\text{Dominance of a Species}}{\text{Total Dominance of all Species}} \times 100$$

$$\text{Relative Frequency} \quad (\text{RF}) = \frac{\text{Frequency of a Species}}{\text{Total Frequency of all Species}} \times 100$$

$$\text{Importance Value} \quad (\text{IV}) = \text{RDe} + \text{RDo} + \text{RF}$$

2.1.4.2 Baseline Conditions

General Description and Species Composition of the Site

A complete list of species for the inventoried project site is given in **Table 2.1.17**. There were 77 species of vascular plants recorded belonging to 43 families in the area. These species include trees, shrubs, herbs, palms and vines. The species richness of the project area constitutes only 2.20% of the estimated flowering plants (roughly 3,000–3,500) found in Palawan (Madulid, 2002). The number of species recorded is relatively few due to its existing land-use. The project site is part of the active mining area of RTNMC and previously used as stockpile area for lateritic soil for processing and export.

Table 2.1.17. Checklist of the vascular plants within the proposed TSF3 of CBNC, Rio Tuba, Bataraza, Palawan with notes on their growth habit, geographical distribution, and conservation status

Common Name	Scientific Name	Family	Remarks*
auri	*Acacia auriculiformis* Benth.	Fabaceae	Tree. Exotic species; Native of Australia, Papua New Guinea, and Moluccas.
pusó-pusó	*Actinodaphne multiflora* Benth.	Lauraceae	Small tree. Endemic to Philippines (Luzon, Mindoro, Guimaras, Basilan, Mindanao).

Common Name	Scientific Name	Family	Remarks*
	Aglaia sp.	Meliaceae	
tuló	*Alphitonia excelsa* (Fenzl) Reiss ex Endl.	Rhamnaceae	Medium tree. Borneo. Moluccas, Philippines (Luzon, Mindoro, Palawan, Panay, Guimaras, Negros, Leyte, Samar, Dinagat, Mindanao), N Australia.
langkawás	*Alpinia foxworthyi* Ridley	Zingiberaceae	Terrestrial herb. Endemic to Palawan. Vulnerable (VU)
Palawan ditá	*Alstonia iwahigensis* Elmer	Apocynaceae	Tree. Philippines (Palawan), Borneo. Vulnerable (VU)
batíno	*Alstonia macrophylla* Wall. ex G.Don	Apocynaceae	Tree. Philippines (Luzon, Palawan), Borneo.
amáyan	*Angelesia splendens* Korth.	Chrysobalanaceae	Tree. Philippines (Palawan, Panay, Samar, Mindanao), SE Asia.
tiágkot	*Archidendron clypearia* (Jack) Nielsen	Fabaceae	Small tree. Sumatra, Peninsular Malaysia, Java, Borneo, Philippines (Luzon, Palawan, Panay, Negros).
	Ardisia sp.	Primulaceae	Shrub.
antipólo	*Artocarpus blancoi* (Elmer) Merr.	Moraceae	Large tree. Endemic to Philippines (Batanes, Luzon, Mindoro, Palawan, Negros, Cebu, Mindanao).
tabón-tabón	*Atuna racemosa* Raf.	Chrysobalanaceae	Large tree. Philippines (Luzon, Masbate, Palawan, Mindanao), Java, Borneo, to Polynesia
dilak-bangúhan	*Baccaurea odoratissima* Elmer	Phyllanthaceae	Small tree. Medium tree. Philippines (Palawan), Borneo.
balóiboi	*Baccaurea philippinensis* (Merr.) Merr.	Phyllanthaceae	Medium tree. Philippines and Moluccas.
koronivia grass	*Brachiaria humidicola* (Rendle) Schweick.	Poaceae	Grass. Exotic, native of Africa. Introduced as a forage grass for cattle.
palínlin	*Buchanania microphylla* Engl.	Anacardiaceae	Tree. Hainan and Philippines (Luzon, Palawan, Panay, Guimaras, Cebu).
labsikan	*Calamus longipes* Griff.	Arecaceae	Rattan. Philippines (Luzon, Polillo, Catanduanes, Samar, Palawan, Mindanao).
kulakling	*Calamus microsphaerion* Becc.	Arecaceae	Rattan. Philippines (Palawan), Borneo.
	Canthium sp.	Rubiaceae	Medium tree.
magtúngod	*Carallia borneensis* Oliv.	Rhizophoraceae	Medium tree. Borneo (Sabah), Philippines (Palawan, Mindanao), New Guinea.
kalíngag	*Cinnamomum mercadoi* Vidal	Lauraceae	Small-medium tree. Throughout the Philippines. Endemic. OTS LR/nt
	Clerodendrum sp.	Verbenaceae	
kakáag	*Commersonia bartramia* (L.) Merr.	Malvaceae	Small tree. Indochina, throughout Se Asia, to Polynesia. Widespread in the Philippines.
sandalino	*Connarus semidecandrus* Jack	Connaraceae	Woody vine. Andaman Island to Melanesia. Widespread in the Philippines.
salinggógon	*Cratoxylum formosum* (Jack) Dyer	Clusiaceae	Small tree. Indo-China to Moluccas. Widespread in the Philippines.
patálsik	*Decaspermum fruticosum* Forst.	Myrtaceae	Small tree. Myanmar through SE Asia, N Australia. Throughout the Philippines.
	Desmodium sp.	Fabaceae	
malakátmon	*Dillenia luzoniensis* (Vidal) Martelli ex Durand & Jackson	Dilleniaceae	Scandent shrub-small tree. Endemic to Philippines (Luzon, Palawan). Vulnerable (VU)
kulís-dagá	*Dimorphocalyx denticulatus* Merr.	Euphorbiaceae	Small tree. Malay Peninsula, Borneo, Philippines (Luzon, Palawan, Mindanao).
	Dimorphocalyx sp.	Euphorbiaceae	
bikal	*Dinochloa acutiflora* (Munro) S.Dransfield	Poaceae	Climbing bamboo. Taiwan, Philippines (Luzon, Mindoro, Palawan, Leyte).
malasambál	*Dracaena angustifolia* (Medik.) Roxb.	Asparagaceae	Shrub. Widespread in the Philippines. Also India to SE Asia and Australia.
malángau	*Elaeocarpus floribundus* Blume	Elaeocarpaceae	Small-medium tree. In the Philippines recorded only from Palawan. Also in India, Myanmar, Thailand, Indochina, Malay

Common Name	Scientific Name	Family	Remarks*
			Peninsula, Java, Borneo.
	Evodia sp.	Rutaceae	Medium tree.
	Ficus glareosa Elmer	Moraceae	Shrub-small tree. Endemic to Palawan.
tibíg	*Ficus nota* (Blanco) Merr.	Moraceae	Medium tree. N Borneo and Philippines.
	Ficus sp.	Moraceae	
baling-uái	*Flagellaria indica* L.	Flagellariaceae	Vine. Africa, tropical Asia, to Australia, Marianas Islands. Widespread in the Philippines.
bunóg	*Garcinia benthami* Pierre	Clusiaceae	Medium tree. Vietnam, Philippines (Palawan, Balabac).
kakáua	*Glochidion coronulatum* C.B.Rob.	Phyllanthaceae	Shrub-small tree. Endemic to Philippines (Luzon, Palawan, Leyte).
	Goniothalamus sp. 1	Annonaceae	
	Goniothalamus sp. 2	Annonaceae	
Palawan agohó	*Gymnostoma nobile* (Whitmore) L.A.S.Johnson	Casuarinaceae	Medium–large tree. Philippines (Palawan), Borneo.
cogon	*Imperata cylindrica* (L.) Raeusch.	Poaceae	Grass. Trop. Africa, Asia, Australia, Polynesia. Very common weedy plant.
ípil	*Intsia bijuga* (Colebr.) O.Kuntze	Fabaceae	Large tree. Madagascar throughout Asia to N Australia. Widespread in the Philippines. Vulnerable (VU).
kalalias	*Korthalsia robusta* Blume	Arecaceae	Rattan. Philippines (Palawan, Balabac), Borneo, Sumatra.
ípil- ípil	*Leucaena leucocephala* (Lam.) de Wit	Fabaceae	Tree. Exotic species; Native of Tropical America.
	Litsea sp. 1 (juvenile specimen)	Lauraceae	
nitó	*Lygodium circinnatum* (Burm.) Sw.	Lygodiaceae	Vine. India to S China, across SE Asia to the Solomons. Throughout the Philippines.
hamíndang	*Macaranga bicolor* Muell.-Arg.	Euphorbiaceae	Small-medium tree. Endemic to Philippines (Luzon, Polillo, Mindoro, Panay, Biliran, Leyte, Mindanao).
binúnga	*Macaranga tanarius* (L.) Muell.-Arg.	Euphorbiaceae	Small-medium tree. Nicobar & Andaman Islands, throughout SE Asia, New Guinea, NE Australia, Melanesia, & Micronesia. Throughout the Philippines.
tikog, barokibok	*Machaerina disticha* (C.B.Clarke) T.Koyama	Cyperaceae	Herb. Philippines (Luzon, Mindoro, Palawan, Mindanao). Also in Boneo, Sulawesi, Waigeo Is.
malatúngau	*Melastoma malabathricum* L.	Melastomataceae	Shrub. India to New Guinea, including Philippines.
dugúan-mabólo	*Myristica guatteriifolia* A.DC.	Myristicaceae	Myanmar to Lesser Sunda Islands, including Philippines (Babuyan, Luzon, Palawan, Mindanao).
lisák	*Neonauclea bartlingii* (DC.) Merr.	Rubiaceae	Medium tree. Luzon, Mindoro, Palawan, Mindanao.
kuong-kuong	*Nepenthes philippinensis* Macfarl.	Nepenthaceae	Scandent herb. Endemic to Palawan. Endangered (EN).
kapulásan	*Nephelium ramboutan-ake* (Labill.) Leenh.	Sapindaceae	Medium tree. India to Myanmar, Malay Peninsula, Sumatra, Borneo, Philippines (Luzon, Mindoro, Palawan, Leyte, Samar, Mindanao, Basilan, Sulu). Vulnerable (VU).
pakóng kalábaw	*Nephrolepis biserrata* (Sw.) Schott	Nephrolepidaceae	Terrestrial fern. Widespread in distribution. USA, Mexico, the West Indies, Central America, South America, Africa, Southeast Asia.
	Olax sp.	Olacaceae	
banga	*Orania paraguanensis* Becc.	Arecaceae	Tree palm. Known only from Palawan and Banguey Is. (Sabah, Borneo). Regarded as a Critically Endangered (CR) species.
	Pandanus reclinatus Martelli	Pandanaceae	Low shrub. Endemic to Philippines (Palawan).
butád	*Parkia speciosa* Hassk.	Fabaceae	Large tree. S Thailand, Sumatra, Malay

Common Name	Scientific Name	Family	Remarks*
			Peninsula, Borneo, Philippines (Palawan). OTS LR/nt
	Paspalum sp.	Poaceae	Grass.
	Phanera aherniana Perkins var. *subglabra* (Merr.) Bandyop et al.	Fabaceae	Woody vine. Philippines (Palawan). Also in Borneo (Sabah).
manglás	*Phyllanthus balgooyi* Petra Hoffm. & A.J.M.Baker	Phyllanthaceae	Shrub-small tree. Philippines (Palawan), Borneo. Vulnerable (VU)
Curran abíki	*Pinanga curranii* Becc.	Arecaceae	Small tree palm. Endemic to Philippines (Palawan). Vulnerable (VU).
laánan	*Plectocomia elongata* Mart. ex Blume var. *philippinensis* Madulid	Arecaceae	Rattan. Endemic to Philippines (Samar, Leyte, Mindanao, Palawan).
doklói	*Polyscias aherniana (Merr.) Lowry & G.M.Plunkett*	Araliaceae	Small-medium tree. Philippines, Borneo, Moluccas.
	Premna depauperata Merr.	Lamiaceae	Small-medium tree. Endemic to Philippines (Palawan).
marángub	*Protium connarifolium* (Perkins) Merr.	Burseraceae	Small tree. Endemic to Philippines (Palawan). Vulnerable (VU)
lágo	*Prunus grisea* (C.Muell.) Kalkm.	Rosaceae	Medium tree. Philippines (Luzon, Mindoro, Palawan, Sibuyan, Cebu, Bohol, Leyte, Mindanao), Sulawesi, Lesser Sunda Is., Moluccas, New Guinea.
tuák	*Rinorea bengalensis* (Wall.) Kuntze	Violaceae	Medium-large tree. India to Caroline Islands, including Philippines. Rare.
talahib	*Saccharum spontaneum* L.	Poaceae	Grass. Africa to N Australia. Throughout the Philippines.
guijo	*Shorea guiso* (Blanco) Blume	Dipterocarpaceae	Large tree. Throughout the Philippines. Also S Vietnam, SE Thailand, Malay Peninsula, Sumatra, Borneo.
	Smilax sp. (juvenile plant)	Smilacaceae	
dilimán	*Stenochlaena palustris* (N.L.Burm.) Bedd.	Blechnaceae	Climbing fern. India, throughout SE Asia, Australia, Pacific Islands. Widespread in the Philippines.
	Syzygium sp. 1 (young leaves red)	Myrtaceae	
	Syzygium sp. 2	Myrtaceae	
	Syzygium sp. 3	Myrtaceae	
	Syzygium sp. 4	Myrtaceae	
pandakáki	*Tabernaemontana pandacaqui* Poir.	Apocynaceae	Shrub. Throughout Philippines. Also Taiwan, Sulawesi.
dalínsi	*Terminalia pellucida* C.Presl	Combretaceae	Medium-large tree. Endemic to Philippines (Luzon, Palawan, Sulu).
mabálod	*Timonius arboreus* Elmer	Rubiaceae	Tree. Endemic to the Philippines (Luzon, Mindoro, Palawan, Sibuyan, Ticao, Panay, Guimaras, Negros, Samar, Leyte, Mindanao).
anabióng	*Trema orientalis* (L.) Blume	Cannabaceae	Tree. Tropical Africa, Sri Lanka, India, SE Asia (including Philippines), New Guinea, Australia, Solomon Is., Marianas, Polynesia.
	Uncaria sp.	Rubiaceae	Woody vine.
hairy-leaf molave	*Vitex pinnata* L.	Lamiaceae	Tree. India, Sri Lanka, Cambodia, Malay Peninsula, Borneo, Sumatra, Java, Sulawesi, Philippines (Mindoro, Culion, Palawan, Tawi-Tawi).

*Note: *Conservation status follows DENR DAO 2007-01.*

In general, the project site can be subdivided into three (3) areas, namely: barren area, grassland, and second-growth forest.

Barren area. This is an exposed and open area devoid of any vegetation except for a few, isolated clumps of the sedge *Machaerina disticha* and other pioneer plants. It is the largest part of the site with an area of approximately 77 hectares.

Grassland area. This is an area of about 15 hectares that is characteristically water-logged and swampy. It is mainly dominated by an exotic species koronivia grass (*Brachiaria humidicola*). Other associated species in the grassland are tikog (*Machaerina disticha*), the scandent fern dilimán (*Stenochlaena palustris*), and the Palawan endemic low shrub *Pandanus reticulatus*. Isolated individuals of *Phyllanthus balgooyi* occur in areas adjacent to the second-growth forest.

Second-growth forest. This vegetation occupies an area of approximately 19 hectares. That portion of this vegetation on the southern part of the proposed site mainly includes early pioneer trees such as kakáag (*Commersonia bartramia*), batíno (*Alstonia macrophylla*), Palawan agohó (*Gymnostoma nobile*), palínlin (*Buchanania microphylla*), kakáua (*Glochidion coronulatum*), marángub (*Protium connarifolium*), and malakátmon (*Dillenia luzoniensis*). The open, bare areas are usually occupied by koronivia grass (*Brachiaria humidicola*)*, talahib* (*Saccharum spontaneum*)*, cogon* (*Imperata cylindrica),* and the sedge tikog (*Machaerina disticha*). Sometimes, the pitcher plant *Nepenthes philippinensis* may occur here. The small area of this vegetation towards the northern part of the site is mainly heavily degraded forest with a few remnant large trees such as guijo (*Shorea guiso*), dugúan-mabólo (*Myristica guatteriifolia*), Palawan ditá (*Alstonia iwahigensis*), and the rare tree palms banga (*Orania paraguanensis*) and Curran abíki (*Pinanga curranii*), saplings of kapulásan (*Nephelium ramboutan-ake*) and tuák (*Rinorea bengalensis*), and tangles of rattans and climbing bamboos. The second-growth forest also includes individuals of auri (*Acacia auriculiformis*) as remnants of reforestation sites.

Structure, Relative Values, and Importance Values of the Different Zones

Second-growth forest. The vegetation of the second-growth forest is composed of few large trees but filled with many small-diameter trees. The large trees present in the second-growth forest were guijo (*Shorea guiso*), dugúan-mabólo (*Myristica guateriifolia*), and Palawan ditá (*Alstonia iwahigensis*). Among the tree species, guijo is the most dominant species in the canopy stratum with an Importance Value (IV) of 37.92 (**Table 2.1.18**). This species had the largest average diameter with a dbh of 75 cm and had an estimated density of 10 individuals per hectare. The total basal area of guijo is 3.68 m^2 per hectare. Batíno (*Alstonia macrophylla*) ranked second to guijo terms of IV with a value of 36.64. The estimated density of this species is 80 individuals per hectare with an average dbh of 14.1 cm. Batíno is the most abundant species in the project site.

Table 2.1.18. Density, average dbh, basal area and Importance Value of the species found in canopy stratum of the second-growth forest within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan.

Species	Density (per ha)	Average dbh (cm)	Basal Area (m^2 ha^{-1})	Importance Value
Shorea guiso	10	75.0	3.68	37.92
Alstonia macrophylla	80	14.1	1.08	36.64
Syzygium sp. 4	40	19.5	1.01	20.84
Acacia auriculiformis	30	21.7	1.00	18.56
Myristica guateriifolia	20	25.5	0.85	18.32
Gymnostoma nobile	30	11.7	0.27	15.35
Syzygium sp.1	30	11.0	0.24	15.11
Glochidion coronulatum	30	10.3	0.21	14.84

Species	Density (per ha)	Average dbh (cm)	Basal Area (m^2 ha^{-1})	Importance Value
Alstonia iwahigensis	10	33.0	0.71	11.69
Polyscias aherniana	20	11.5	0.18	9.13
Elaeocarpus floribundus	20	11.0	0.16	8.98
Baccaurea odoratissima	10	22.0	0.32	8.20
Orania paraguanensis	10	21.0	0.29	7.95
Nephelium ramboutan-ake	10	19.0	0.24	7.49
Prunus grisea	10	19.0	0.24	7.49
Carallia borneensis	10	15.0	0.15	6.70
Buchanania microphylla	10	12.0	0.09	6.23
Canthium sp.1	10	12.0	0.09	6.23
Cratoxylum formosum	10	12.0	0.09	6.23
Protium connarifolium	10	11.0	0.08	6.10
Trema orientalis	10	11.0	0.08	6.10
Alphitonia excelsa	10	10.0	0.07	5.98
Artocarpus blancoi	10	10.0	0.07	5.98
Evodia sp.1	10	10.0	0.07	5.98
Intsia bijuga	10	10.0	0.07	5.98
Total	**460**	**-**	**11.3222**	**300**

In the intermediate stratum, there were 44 species observed. The most common species were marángub (*Protium connarifolium*) and malángau (*Elaeocarpus floribundus*). The estimated densities of both species were 400 individuals per hectare each (**Table 2.1.19**). Marángub had the highest IV with a value of 13.64. This is followed by malángau with an IV of 12.12. Other dominant species were palínlin (*Buchanania microphylla*), kakáua (*Glochidion coronulatum*) and amáyan (*Angelesia splendens*). These five (5) species comprised 29% of the total IV. It is noticeable that the IV of the species in this community did not differ much. The IV gradually decreases from the most dominant species to the uncommon species. The estimated density of the intermediate vegetation is approximately 4,400 individuals per hectare.

Table 2.1.19.Density and Importance Value of the species found in intermediate stratum of the second-growth forest within the proposed TSF3 of the CBNC Rio Tuba, Bataraza, Palawan

Species	Density (per ha)	Importance Value
Protium connarifolium	400	13.64
Elaeocarpus floribundus	400	12.12
Buchanania microphylla	240	11.52
Glochidion coronulatum	240	11.52
Angelesia splendens	240	10.00
Alstonia macrophylla	160	8.18
Macaranga tanarius	160	8.18
Commersonia bartramia	120	7.27
Syzygium sp. 4	120	5.76
Timonius arboreus	120	5.76
Acacia auriculiformis	160	5.15
Ardisia sp.1	160	5.15
Evodia sp.1	160	5.15
Rinorea bengalensis	160	5.15
Alstonia iwahigensis	80	4.85
Clerodendrum sp.1	80	4.85
Goniothalamus sp.1	80	4.85
Dimorphocalyx denticulatus	80	3.33
Carallia borneensis	80	3.33
Decaspermum fruticosum	80	3.33
Dillenia luzoniensis	80	3.33
Myristica guateriifolia	80	3.33
Syzygium sp. 5	80	3.33

Species	Density (per ha)	Importance Value
Aglaia sp.1	40	2.42
Alphitonia excelsa	40	2.42
Polyscias ahernianum	40	2.42
Baccaurea philippinensis	40	2.42
Calamus longipes	40	2.42
Cinnamomum mercadoi	40	2.42
Dimorphocalyx sp. 1	40	2.42
Tabernaemontana pandacaqui	40	2.42
Ficus glareosa	40	2.42
Ficus nota	40	2.42
Garcinia benthami	40	2.42
Goniothalamus sp .2	40	2.42
Gymnostoma nobile	40	2.42
Actinodaphne multiflora	40	2.42
Neonauclea bartlingii	40	2.42
Olax sp.1	40	2.42
Phyllanthus balgooyi	40	2.42
Premna depauperata	40	2.42
Syzygium sp.1	40	2.42
Terminalia pellucida	40	2.42
Vitex pinnata	40	2.42
Total	**4400**	**200**

The undergrowth stratum of the second-growth forest is relatively sparse with an estimated density of the 950 individuals per 100 m^2 (**Table 2.1.20**). Mostly, the undergrowth is dominated by bikal (*Dinochloa acutiflora*) and tikog (*Machaerina disticha*). Bikal had an IV of 20.83 while tikog had an IV of 17.67. Other species quite abundant were nito (*Lygodium circinnatum*) and *Syzygium* sp.4. Other noteworthy species found were butád (*Parkia speciosa*), manglás (*Phyllanthus balgooyi*), langkawás (*Alpinia foxworthyi*), and labsikan (*Calamus longipes*). Similar with the intermediate stratum, it is also noticeable that the IV of the species in this stratum does not vary much and is gradually decreasing from the most common species to the uncommon species.

Table 2.1.20. Density and Importance Value of the species found in undergrowth stratum of the second-growth forest within the proposed TSF3 of the CBNC Rio Tuba, Bataraza, Palawan.

Species	Density (per 100 m^2)	Importance Value
Dinochloa acutiflora	130	20.83
Machaerina disticha	100	17.67
Lygodium circinnatum	60	13.46
Syzygium sp. 4	90	11.85
Alpinia foxworthyi	40	8.97
Angelesia splendens	20	6.87
Pandanus reclinatus	20	6.87
Imperata cylindrica	40	6.59
Nephrolepis biserrata	40	6.59
Syzygium sp.1	40	6.59
Brachiaria humidicola	30	5.54
Protium connarifolium	30	5.54
Smilax sp.1	30	5.54
Stenochlaena palustris	30	5.54
Dillenia luzoniensis	20	4.49
Ficus glareosa	20	4.49
Ficus sp.1	20	4.49
Saccharum spontaneum	20	4.49
Syzygium sp. 5	20	4.49
Vitex pinnata	20	4.49
Buchanania microphylla	10	3.43

Species	Density (per 100 m^2)	Importance Value
Calamus longipes	10	3.43
Commersonia bartramia	10	3.43
Dracaena angustifolia	10	3.43
Flagellaria indica	10	3.43
Leucaena leucocephala	10	3.43
Litsea sp.1	10	3.43
Myristica guateriifolia	10	3.43
Neonauclea bartlingii	10	3.43
Parkia speciosa	10	3.43
Phyllanthus balgooyi	10	3.43
Syzygium sp. 2	10	3.43
Vine sp.1 *(juvenile)*	10	3.43
Total	**950**	**200.0**

Grassland. This area is an old siltation pond that is now dominated by koronivia grass (*Brachiaria humidicola*). Koronivia grass comprised a total of 134.90 IV or about 67% of the total IV (**Table 2.1.21**). The estimated density of this grass is about 1460 individual per 100 m^2. Other noteworthy species in the grassland is dilimán (*Stenochlaena palustris*). Dilimán is growing in association of koronivia grass. However, the growth of dilimán is limited only in areas where water is abundant. Other species present were tikog, talahib, auri, and manglás.

Table 2.1.21. Density and importance value of the species found in undergrowth stratum of the grassland within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan.

Species	Density (per 100 m^2)	Importance Value
Brachiaria humidicola	1460	134.90
Stenochlaena palustris	280	26.33
Machaerina disticha	40	13.29
Saccharum spontaneum	40	13.29
Acacia auriculiformis	20	12.20
Total	**1840**	**200.0**

Across the grassland, only a few trees and saplings of auri (*Acacia auriculiformis*) were observed. This species was only observed in OB4 along the transect line which is an old reforestation area. The estimated density of auri (including saplings) is about 600 individuals per hectare (**Tables 2.1.22** and **2.1.23**).

Table 2.1.22. Density, average dbh, basal area and importance value of the species found in canopy stratum of grassland within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan.

Species	Density (per ha)	Average dbh (cm)	Basal Area (m^2 ha^{-1})	Importance Value
Acacia auriculiformis	40	22.0	1.9	300.0
Total	**40**	**22.0**	**1.9**	**300.0**

Table 2.1.23. Density and importance value of the species found in intermediate stratum of Grassland within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan.

Species	Density (per ha)	Importance Value
Acacia auriculiformis	560	200
Total	560	200.0

Barren area. No noteworthy vegetation was observed in this area except for the presence of few and scattered clumps *Machaerina disticha*. This species is native sedge usually found in open areas of ultramafic forest.

Diversity

Diversity index is a mathematical measure of species diversity in a particular community. It provides more information about community composition than simply species richness (*i.e.* the number of species present) and it also take the relative abundances of different species into account. In the project site, the overall Shannon diversity index of the second-growth forest and grassland ecosystems are is 3.323 and 1.063, respectively (**Table 2.1.24**). Based on the 1998 Fernando biodiversity scale, the diversity index is high. High diversity index means that this ecosystem supports many species and has the ability to withstand some environmental impacts. There are 75 species present within the second-growth forest and the number of individuals of each species does not vary much from each other. For example, marángub (*Protium connarifolium*) and malángau (*Elaeocarpus floribundus*) are the two species with highest IV in the intermediate stratum. The density of marángub and malángau is 400 individuals per hectare each. The number of individuals of each species in the ecosystems within the second-growth forest ranges from 40-400 individuals. The number of individuals of each species gradually decreases from the most common species to the uncommon species.

Table 2.1.24. Overall diversity indices of the second-growth forest and grassland ecosystems within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan.

Land Cover	Shannon's Diversity Index	Shannon Evenness
Second-growth forest	3.323	0.95
Grassland	1.063	0.66

On the other hand, the diversity index of the grassland area is very low. Very low diversity index means that this ecosystem supports only few species. For instance, there are only five species present in the gras0sland and the number of individuals of each species vary much from each other. Koronivia grass had the highest IV in this ecosystem. The density of this species is 1460 individuals per 100 m^2. In comparison, dilimán ranked second to koronivia grass in terms of IV in the undergrowth stratum, but the density of this species is only 280 individuals per 100 m^2. The number of individuals of each species in the second-growth forest ranges from 20–1460 individuals. With this range, the number of individuals of each species abruptly decreases from the most common species to the uncommon species.

Conservation Status

Threatened species is a general term to denote species or subspecies considered as critically endangered, endangered, vulnerable or other accepted categories of wildlife whose population is at risk of extinction (DENR DAO 2007-01). Each category is defined below and adopted from Fernando *et al.* (2008) as used in the Philippines following Republic Act 9147, the 'Wildlife Resources Conservation and Protection Act'.

Critically endangered (CR) species refers to a species or subspecies that is facing extremely high risk of extinction in the wild in the immediate future.

Endangered (EN) species refers to species or subspecies that is not critically endangered but whose survival in the wild is unlikely if the causal factors continue operating.

1. *Vulnerable* (VU) species refers to species or subspecies that is not critically endangered or endangered but is under threat from adverse factors throughout their range and is likely to move to the endangered category in the near future.
2. *Other Threatened Species* (OTS) refers to a species or subspecies that is not critically, endangered, endangered nor vulnerable but is under threat from adverse factors such as over collection, throughout its range and is likely to move to the vulnerable category in the near future. This shall include varieties, formae, or other infraspecific categories. This is similar to the Lower Risk / near threatened (LR/nt) category of IUCN.
3. *Other Wildlife Species* (OWS) refers to non-threatened species of plants that have the tendency to become threatened due to destruction of habitat or other similar causes as may be listed by the Secretary upon recommendation of the National Wildlife Management Committee. This shall include varieties, formae, or other infraspecific categories. This is similar to the Lower Risk / least concern (LR/lc) category of IUCN.

In the project area, there are 14 species in the threatened plant list (**Table 2.1.25;** see also **Table 2.1.17**) based on PCSD Resolution 15-521, Series 2015 and DENR DAO 2007-01. Among these 14 species, one species and a large tree palm endemic to Palawan, banga (*Orania paraguanensis*), is under the *Critically endangered* (CR) category, while another, the pitcher plant kuong-kuong (*Nepenthes philippinensis*), also endemic to Palawan, is in the *Endangered* (EN) category. At least 10 species are in the *Vulnerable* (VU) category and one species in the *Other Wildlife Species* (OWS) / Lower Risk / least concern (LR/lc) category (**Table 2.1.25**).

Table 2.1.25. List of threatened plant species found within the proposed TSF3 of the CBNC, Rio Tuba, Bataraza, Palawan based on PCSD Resolution 15-521, Series 2015 and DENR DAO 2007-01.

Common Name	Scientific Name	Family	Conservation status
banga	*Orania paraguanensis*	Arecaceae	Critically endangered
kuong-kuong, Palawan pitcher plant	*Nepenthes philippinensis*	Nepenthaceae	Endangered
langkawás	*Alpinia foxworthyi*	Zingiberaceae	Vulnerable
Palawan ditá	*Alstonia iwahigensis*	Apocynaceae	Vulnerable
kalíngag	*Cinnamomum mercadoi*	Lauraceae	Vulnerable
malakátmon	*Dillenia luzoniensis*	Dilleniaceae	Vulnerable
Palawan agohó	*Gymnostoma nobile*	Casuarinaceae	Vulnerable
ipil	*Intsia bijuga*	Fabaceae	Vulnerable
kapulásan	*Nephelium ramboutan-ake*	Sapindaceae	Vulnerable
Curran abíki	*Pinanga curranii*	Arecaceae	Vulnerable
manglás	*Phyllanthus balgooyi*	Phyllanthaceae	Vulnerable
marángub	*Protium connarifolium*	Burseraceae	Vulnerable
dilak-bangúhan	*Baccaurea odoratissima*	Phyllanthaceae	Other Wildlife Species

On the other hand, the IUCN Red List (IUCN 2016) also includes four species recorded from the project site as threatened, viz. guijo (*Shorea guiso*) – Critically endangered (CR); antipolo (*Artocarpus blancoi*) – Vulnerable (VU); and batíno (*Alstonia macrophylla*) and amáyan (*Angelesia splendens*) – Lower risk / least concern (LR/lc).

2.1.4.3 Impact Assessment

Rehabilitation and reforestation of the disturbed areas within the MPSA of RTNMC is a combined effort of CBNC and RTNMC. CBNC is mainly responsible for the rehabilitation of the areas used for their facilities including the TSF1 and some sections in TSF2. Progressive rehabilitation was started in 2011 and as of March 2015, about 132 ha hectares are being rehabilitated. After decommissioning of TSF2, this will be rehabilitated similar to the activities conducted with TSF1.

The visible success of the rehabilitation activities of CBNC is TSF1 **(Plate 2.1.23)**. Prior to its decommissioning in 2010, CBNC has drawn the rehabilitation plan which focused on four (4) major objectives: These are:

- Physical Stability;
- Visual Acceptability;
- Achieve Productivity; and
- Self-Sustainability.

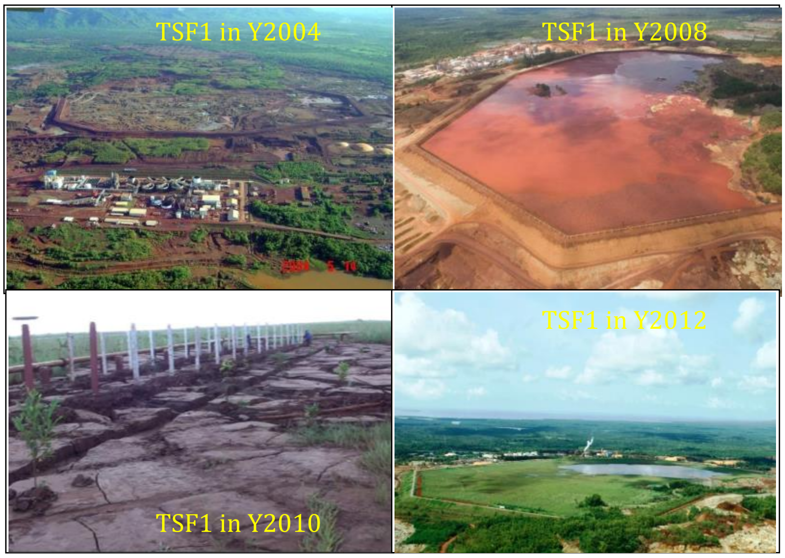


Plate 2.1.23. Aerial view of TSF1 from the start of operations in 2004 until its partial rehabilitation in 2012

Ensuring the physical stability was required to make sure that the embankments will not collapse by installing a water decanting system to prevent overtopping and by stabilizing the embankment slopes to prevent soil erosion. Inside the TSF, regular monitoring, soil drilling and testing were conducted to determine if the tailings surface are ready for planting.

The rehabilitation of TSF1 involved three (3) stages, which included laying of topsoil on the tailings surface, enhancement of soil by providing nutrients, and trial planting. Once topsoil was laid, enhancement of the soil was undertaken using carbonized rice hull and added with vermi compost to ensure that there are sufficient nutrients to support the growth of plants.

Trial planting was done in a small area inside the TSF1 to determine the best species to be used. Subsequently different species of vines, grasses and herbs such as *Brachiaria humidicola, Stylosanthes seabrana, Centroema pubescens*, wild sugar cane (*Saccharum spontaneum*), napier grass (*Pennistum purpurium*), banana and elephant ear (*Xanthosoma robustum*) were used. Other grass species have spontaneously grown.

Currently, CBNC has established a demo farm inside the TSF1. Cash crops such as vegetables, fruit trees including Dragon Fruit, ornamental plants, orchids, medicinal plants and other species are grown. Vegetables and fruits grown supply some of the requirements of the CBNC staff houses.

Plate 2.1.24. Plant species inside the TSF1

The demo farm is maintained by residents of Rio Tuba who are members of the IP community. Aside from providing direct employment to 608 persons, Pandan species that grows inside the TSF are sources of raw materials used for basket weaving. These baskets are made by the caretakers and are sold locally which also contributes to their income. The carbonized rice hull used as soil enhancer is also bought from local residents, which also provides them with additional income.

Aside from floral species, the TSF is alo encouraging the growth of butterflies known as pollinating agents. The presence of pollinators can enhance the seed production of different plant species and subsequently the availability of seeds for natural regeneration of the TSF1 and nearby areas. Citrus species such as kalamansi are planted which are considered as source of food for the caterpillars.

It should be noted that CBNC was awardee of Presidential Mineral Industry Environmental Award (PMIEA) from 2014 to 2017 **<u>and the best Mining Forest Award for Mineral Processing Category in 2014, 2015 and 2016 for its efforts to rehabilitate TSF1.</u>**

Aside from TSF1, other areas for progressive rehabilitation include areas within the HPP Complex, Water Storage and Port area including causeway:

Table 2.1.26. CBNC's Progressive Rehabilitation Area

HPP Project Site	Disturbed Area (hectares)	Progressive Rehabilitation Area (hectares)
HPP Complex	35	3
Tailings Storage Facility 1	86	86
Tailings Storage Facility 2	205	38
Water Storage	28	2
Sanitary Landfill	4	0
Port area including causeway	36	3
Total	**394**	**132**

Source: CBNC 4th Quarter Self-monitoring and 2nd Semester Compliance Report for Year 2017.

Data from CBNC indicates that in 2016, about 54,343 seedlings have been planted by the company which covers about 28.7 has of the 122 ha occupied by the HPP facilities. Most of these 54,343 trees are indigenous. In addition, about six species planted are fruit bearing trees such as rambutan, badak, balimbing, camias, kurisom and maraitom which might be used to attract wildlife. Part of the 54,343 seedlings were used to replace the seedlings that did not survived at TSF2 rock quarry area at Magas-magas and unsuitable material disposal area at Ibelnan.

Furthermore, the company participated in the nationwide forest rehabilitation program of the government through National Greening Program (NGP) by planting 20,000 seedlings within 2 has of mangrove in Barangay Sumbiling, Bataraza in 2015.

In addition to the joint reforestation efforts of RTNMC and CBNC, CBNC also independently operates and maintain a nursery and conduct reforestation in the HPP buffer zones and within the plant site. The HPP Nursery and Clonal Lab is an ECC conditionality and its operations is directly supervised by the EMQCS Section Manager with 17 staffs. The TSF and other HPP Facility and the Nursery are also locations for continuing research to seek innovative solutions to manage the impacts of the HPP operations.

Plate 2.1.25. At the view deck of TSF2

Plate 2.1.26. Mangrove planting at the causeway

Plate 2.1.27. Vegetated sloopes of the HPP Plant site

Table 2.1.27. Revegetation accomplishment for Year 2016

HPP Project Site	Number of Seedlings Planted	Covered Area (hectares)
HPP Complex	380	0.152
Tailings Storage Facility 1	30,991	19.338
Tailings Storage Facility 2	13,367	5.347
North of TSF-1 & TSF-2 Disturbed area	9,605	3.842
Total	**54,343**	**28.679**

Source: CBNC 4th Quarter Self-monitoring and 2nd Semester Compliance Report for Year 2016.

The following matrix summarizes the potential impacts that may be brought by the proposed project.

Table 2.1.28. Impacts assessment and mitigation for Flora

Key List of Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Vegetation removal and loss of habitat The biggest impact of the TSF3 Project of CBNC on the terrestrial flora biodiversity on the project site will be the direct removal and loss of habitats owing to the very nature of project development. These impacts will be concentrated in the areas of the second-growth forest and the grassland. However, the proposed site is a disturbed area and thus, the loss of habitat is not considered as a significant impact.		✓	✓	✓	CBNC has the facility to manage the impact to flora based on its commitment and current success of its rehabilitation to rehabilitate the impact areas of its operations as well as surrounding areas defined in their EPEP. The management of floral impact of the proposed TSF3 can be mitigated by the following activities: (i) A full **inventory** and **mapping** of all the plants (>15cm dbh) within the TSF3 area; many of the species already have been listed in this report, but can be supplemented by additional surveys. The mapping will also determine the number of mature trees to be cut which needs a Permit to Cut from the DENR.
Threat to the existence and/or loss of native species The native plants in the project site are unique in that they have evolved biological mechanisms to tolerate, and thrive on the toxic metal-rich ultramafic soils. Thus, they are often endemic to this type of soil. Because of the restricted distribution of the plant species and the expected clearing of all the vegetation to make way for the project, all of the species in the impact area will be totally lost. Many species will face the certainty of local extinction		✓	✓	✓	(ii) A **Native Plant Rescue Program** – This will be a major effort and an integral part of the Biodiversity Conservation Action Plan and that of the TSF3 Project itself. It should strictly be implemented and closely monitored continuously. The primary goal of this program is to save the plants from certain destruction and prevent local extinction of the rare and threatened species directly affected by the project. **Annex 2.1.11** shows the details of the Biodiversity Conservation Action Plan that will serve as guide of the Company in enhancing the terrestrial ecosystem in the area.
Threat to the abundance, frequency, and distribution of species Except for the common pioneer species, many of the native plant species are naturally restricted in their geographic distribution. Their abundance in the local landscape in Bataraza is expected to be reduced, if not, totally eliminated.		✓	✓		Large suitable individuals/representative living specimens of all the rare and threatened plant species identified in the impact area shall be translocated temporarily to the nursery for later transplanting to a secure area of similar soils or habitat within an identified area the MPSA for ***ex situ* conservation**. It will require an understanding of native plant physiological needs for successful rescue transplanting. Other propagules of the species, *e.g.* seeds and seedlings (when available), and stem cuttings shall be collected and propagated in the nursery. On the otherhand if the affected species are already being propagated in the nursery these can be nurtured and used as planting material in the planting program. (iii) Maintenance of the existing nursery to ensure

Key List of Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
					that adequate number of seedlings will be produced for the planting program of CBNC. As much as possible, CBNC must ensure that the species being propagated are endemic to the area. (iv) Civil work activities should strictly be implemented only within the designated construction site of TSF3 to avoid removal of plant species present at the peripheries of the proposed project site.
Hindrance of access to wildlife Clearing of the second-growth forest and the grassland due to establishment of the TSF3 and other facilities will lead to the loss of habitats. Thus, wildlife species living in these ecosystems will be displaced. However, the progressive rehabilitation of CBNC and RTNMC has provided pockets of green areas where these wildlife species can temporarily seek shelter until they can migrate to the nearby forested areas.		✓	✓		Selective clearing will be implemented. Only areas needed for the dam construction and other facilities will be cleared. The Progressive rehabilitation program will be maintained. This will provide green corridors for disturbed wildlife to migrate to nearby areas

2.1.5 Terrestrial Fauna

2.1.5.1 Methodology

The fauna survey conducted in 2016 focused on four (4) terrestrial vertebrate groups of Philippine wildlife; birds, mammals, amphibians and reptiles (herps). Standard field methods and procedures were used for each taxon during the survey. Direct and indirect transect identification such as tracks, signs and auditory cues, trapping and mist-netting were used. Microhabitat searches for amphibians and reptiles (herps) were done while conducting transect walk in the immediate vicinities of the transect line, 5 m to the left and 5 m to the right.

This module also presents the summary of species assemblage between the terrestrial vertebrate wildlife survey in 1996 and 2016, as well as the monitoring results from 2013-2017.

The methods and sampling techniques used for each taxon are discussed below. Detailed sampling procedures in the conduct of the baseline data are presented in **Annex 2.1.1**.

Birds

Direct observations were done while doing the transect walks in the morning at 5:30-8:00, and in the afternoon at 3:30-6:00 or before the sun sets. Mist netting was employed to confirm species occurrence and distribution as well as identification of cryptic species of birds. The nets were set in the afternoon and checked in the morning of the next day. For each site, two (2) sets of nets with three nets per were set serially. Two sets of nets, composed of three (3) nets/set are serially arranged horizontally and are installed in areas near or along the transect lines where bats and birds are perceived to fly or pass through during the day (birds) and night (bats and nocturnal birds) along the transect line. These nets were also used to catch volant mammals during the night. Nets were checked early morning of the next day 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 (2) main techniques employed in the survey of mammals. Mist nets were set and positioned in strategic points of the sampling sites; in flyways, across established trails in the southern side and at the forest edge, and openings near the forest interior in the northern side. The nets were set and opened at 6:00 pm and removed the following morning at 6:00am after retrieval of catch (bats). Net watching for insectivores was done at 6:00-8:00pm. 25 live traps (for each site), were baited with roasted coconut laced with peanut butter and were laid near the vicinity of the mist nets, under roots of trees, rocks and near the 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. Herping were done in Transects 1, 2 (canals dammed area near the road, grassland) and 3 and 4 combined (river, canal and wetlands) for two hours at 7:00-9:00pm.

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

Determination of Diversity Indices

Diversity indices (species diversity, species richness were computed using the PAleontologicalSTatistics (PaST), ver. 1.42 by Hammer, Harper and Ryan (2016).

Description of Sampling Locations

The faunal assessment established four sampling sites where transect survey were. Transect walks were done twice, once in the morning from 5:30-8:00am and 4:00-6:00 in the afternoon (**Figure 2.1.15**). The locations and short description of each site are also shown in **Table 2.1.29**.

Table 2.1.29. Geographic coordinates of the terrestrial faunal assessment at the proposed CBNC expansion area

Sites	Transect		North	East	Remarks
South Eastern Side (Pt. 10)	1	Start	08˚33'56.1"	117˚26'10.4"	Some trees but mostly grassland (reeds), the TSF3 on one side and waterlogged grassland on the other side
		End	08˚34'16.4"	117˚26'03.5"	
Western Side (Pts. 2-6)	2	Start	08˚34'1.8"	117˚25'46.9"	In front of the RTNMC Rehabilitation Farm, also near the decommissioned and rehabilitated TSF1
		End	08˚34'27.7"	117◦25'35"	
North Side (Pt.7-8)	3	Start	08˚35'25.2"	117˚25'21.1"	Patch of Second growth forest on the northern side of TSF3
		End	08˚34'45.6"	117˚25'52.2"	
Eastern Side (Pts. 8-9)	4	Start	08˚34'45.6"	117˚25'52.2"	Secondary forest to grassland; wetland
		End	08˚34'26.6"	117˚26'04.2"	

2.1.5.2 Baseline Conditions

Species Richness

Fifty species of terrestrial vertebrates were observed and recorded in four (4) sites at the TSF3 in July 2016. There were 35 species of birds, four (4) mammals (2 volant and 2 non-volant), and 11 herps (7 amphibians and 4 reptiles). The highest number of species of terrestrial vertebrates was recorded from the Southern side of the proposed TSF3.

Birds

Of the 35 species of birds, 27 species or 77% were observed from Transect 1, 21 species from Transect 3, 10 species from Transect 3, and only eight (8) species from Transect 2. There were more species and individuals observed from Transects 1 and 4 because these were the sites which are away from the activity site and where remnants of a secondary forest still remain. Although there were more trees in Transect 2 near the rehabilitation site of RTNMC, very few species were observed. The survey sites were located within the active mining and mined out areas of RTNMC and are thus devoid of vegetation and highly disturbed. The paucity of the number of species of birds can be caused by the lack of trees where birds can feed, roost and perch on.

Only one (1) species of bird was common to all sites, *Hirundo tahitica*, a species which is common in disturbed sites, during early morning and late afternoon and in rainy weather. The list of species is shown in **Table 2.1.30**.

Table 2.1.30. List of bird species observed and recorded from four survey sites

Common Names	Scientific Name	Transects			
		1	2	3	4
Common Iora	*Aegithina tiphia*	1	-	-	-
Plain-throated tailorbird	*Anthreptes malacensis*	-	-	7	-
Richard's pipit	*Anthus rufulus*	1	-	-	-
Asian glossy starling	*Aplonis panayensis*	6	3	-	-
Cattle egret	*Bubulcus ibis*	2	-	-	10
Plaintive cuckoo	*Cacomantis merulinus*	-	-	-	1
Lesser coucal	*Centropus bengalensis*	1	-	-	3

Common Names	Scientific Name	Transects			
		1	2	3	4
Emerald dove	*Chalcohaps indica*	1	-	-	-
Yellow-throated leafbird	*Chloropsis palawanensis*	1	-	-	-
Olive-backed sunbird	*Cinnyris jugularis aurora*	4	-	1	1
Zitting cisticola	*Cisticola juncidis*	2	-	-	5
Glossy swiftlet	*Collocalia esculenta*	3	-	-	-
White-vented shama	*Copsychus niger*	1	-	1	-
Slender-billed crow	*Corvus enca*	-	-	1	1
Japanese Quail	*Coturnix japonica*	-	1	-	-
Palawan Bulbul	*Alophoixus frater*	-	-	1	3
Wandering-whistling duck	*Dendrocygna arcuata*	2	-	-	-
Pygmy flowerpecker	*Dicaeum pygmaeum*	2	-	2	-
Ashy drongo	*Dicrurus leucophaeus*	12	2	-	4
Spot-throated Flameback	*Dinopium everetti*	-	-	-	3
Little egret	*Egretta garzetta*	8	-	1	3
Zebra dove	*Geopelia striata*	4	-	-	4
Pacific swallow	*Hirundo tahitica*	75	15	8	89
Cinnamon bittern	*Ixobrychus cinnamomeus*	2	-	-	1
Pied triller	*Lalage nigra*	-	-	-	2
Chestnut munia	*Lonchura atricapilla*	6	2	-	25
Scaly-breasted munia	*Lonchura punctulata*	62	15	-	33
Rufous tailorbird	*Orthotomus sericeus*	1	-	2	1
Eurasian tree sparrow	*Passer montanus*	-	-	-	2
Palawan flowerpecker	*Prionochilus plateni*	1	-	-	-
Black-headed bulbul	*Pycnonotus atriceps*	4	-	-	-
Ashy-fronted bulbul	*Pycnonotus cineirifrons*	3	2	4	-
Spotted dove	*Streptopelia chinensis*	3	-	-	1
Blue-paradise flycatcher	*Terpsiphone cyanescens*	5	-	-	1
White-collared kingfisher	*Todirhamphus chloris*	1	5	-	7

Comparison of Diversity Indices Among the Survey Sites for Avifauna in 2016

The diversity indices of bird species were compared between the survey sites and are presented in **Figure 2.1.16**. As was mentioned, the highest number of species was recorded in the Southeastern side of TSF3 designated as Transect 1 with 27 followed by Transect 4, with 21 then 10 species from Transect 3 and eight (8) species from Transect 8. The same pattern was observed with the abundance of birds except that there were more individuals counted in Transect 2 (45) than in Transect 3 (10) which had more species. Clearing of the area near Transect 3 is nearly completed and what have remained are patches or clumps of trees. There were more trees in Transect 2 because of the reforestation, although species used are not indigenous or native.

Species diversity is moderate in Transects 1, 3 and 4, and low in Transect 2. Transect 1 had the highest value because it was where the number of species and abundance is highest. The habitats in Transect 1 were varies with trees on one side and the other side is grassland with some water logged areas. The presence of a variety of habitats may have been favorable for a number of species of birds from the ground level and up the trees.

Species richness is very high in Transect 1 and high in Transect 4, moderate in Transect 3 and low in Transect 2. Evenness is moderate in Transects 1 and 4, high in Transect 2 and very high in Transect 3.

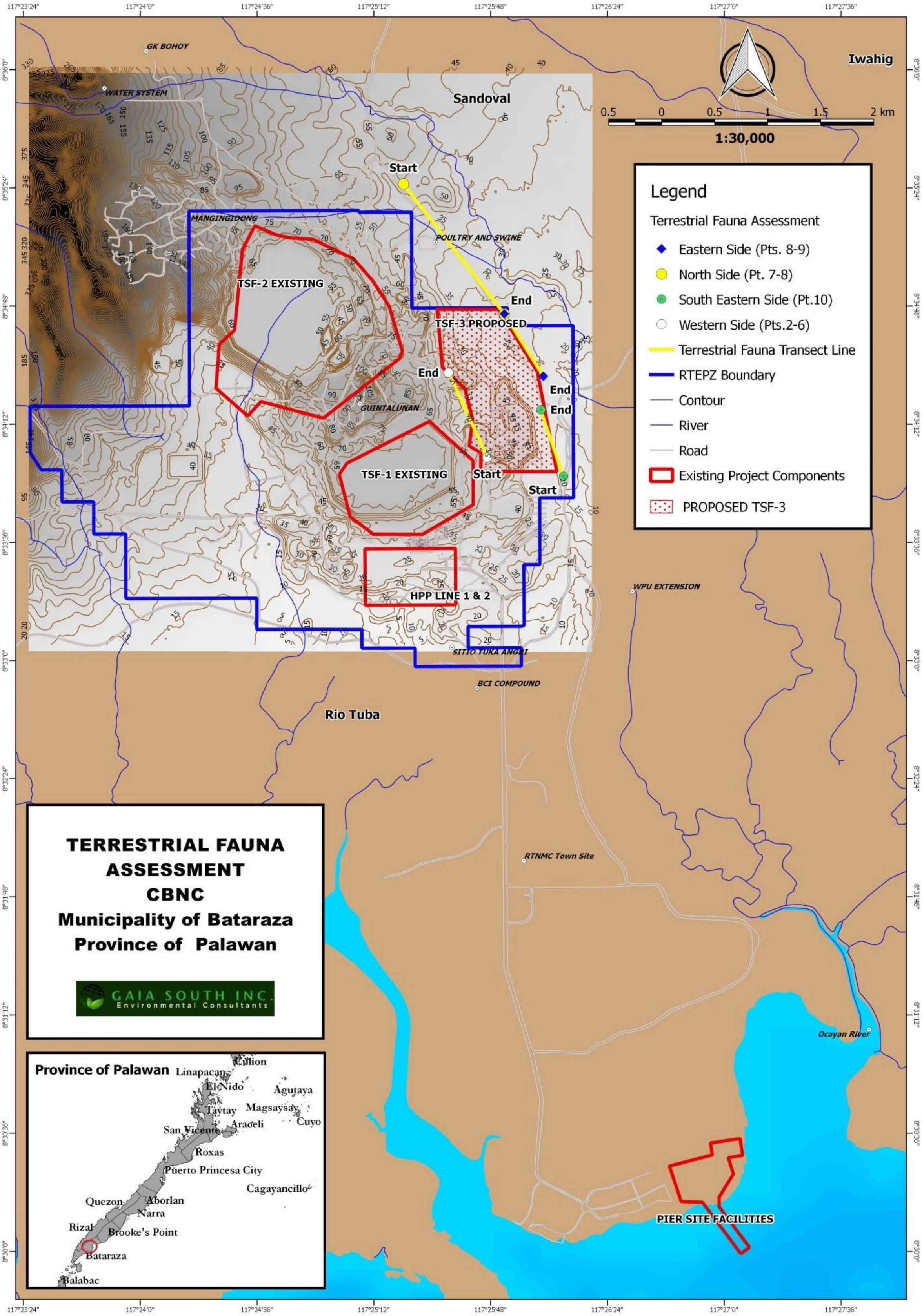
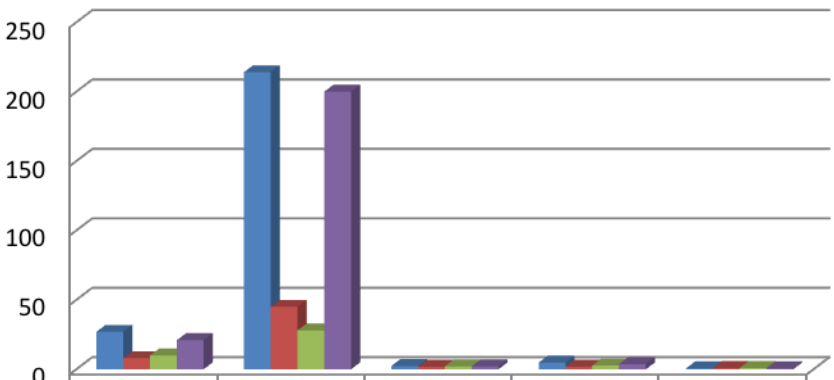


Figure 2.1.15. Sampling map for terrestrial fauna assessment within the CBNC expansion area



	No. of Species	Abundance	Species Diversity	Species Richness	Evenness
Transect 1	27	214	2.357	4.845	0.7151
Transect 2	8	45	1.845	1.839	0.8874
Transect 3	10	28	2.159	2.701	0.9388
Transect 4	21	200	2.155	3.775	0.7077

Figure 2.1.16. Comparison of diversity indices between the survey sites.

Conservation and Ecological Status

The different habitats, feeding guilds, distribution and conservation status of birds recorded during the survey of terrestrial fauna are presented in **Table 2.1.31**.

Table 2.1.31. Habitat, feeding guild, distribution and conservation status of birds recorded during the 2016 terrestrial fauna survey

Species	Habitats	Distribution	Conservation Status (IUCN)
Aegithina tiphia	Forest and Scrublands	Resident	LC
Alophoixus frater	Grassland/open country	Endemic	LC
Anthreptes malacensis	Lowland and montane Forests	Endemic	LC
Anthus rufulus	Grassland/open country	Resident	LC
Aplonis panayensis	semi-open habitats/Open country	Resident	LC
Bubulcus ibis	Grassland/open country	Resident	LC
Cacomantis merulinus	Open Country, marshes	Resident/Migrant	LC
Centropus bengalensis	Forest/grassland/open country	Resident	LC
Chalcohaps indica	Forest/grassland/open country	Resident	LC
Chloropsis palawanensis	Forests	Endemic	LC
Cinnyris jugularis aurora	Forest/grassland/open country	Resident	LC
Cisticola juncidis	Forest	Resident	LC
Collocalia esculenta	Forest/grassland	Endemic	LC
Copsychus niger	Grassland/open country	Resident	LC
Corvus enca	Forest/grassland/open country	Resident	LC
Coturnix japonica	Ground Dweller	Accidental	NT
Dendrocygna arcuata	Wetlands	Resident	LC
Dicaeum pygmaeum	Forest	Endemic	LC
Dicrurus leucophaeus	Forest	Resident	LC
Dinopium everetti	Forest	Endemic	NT
Egretta garzetta	Wetlands	Migrant	LC
Geopelia striata	Grassland/open country	Resident	LC
Hirundo tahitica	Grassland/open country	Resident	LC
Ixobrychus cinnamomeus	Reed beds	Resident	LC
Lalage nigra	Grassland/open country	Resident	LC
Lonchura atricapilla	Grassland/open country	Resident	LC
Lonchura punctulata	Grassland/open country	Resident	LC
Orthotomus sericeus	Lowland/mangrove Forests	Resident	LC
Passer montanus	Forest/grassland/open country	Resident	LC

Species	Habitats	Distribution	Conservation Status (IUCN)
Prionochilus plateni	Forest	Endemic	LC
Pycnonotus atriceps	Grassland/open country	Resident	LC
Pycnonotus cineirifrons	Forests	Endemic	not evaluated
Streptopelia chinensis	Grassland/Open country	Resident	LC
Terpsiphone cyanescens	Forest	Endemic	LC
Todiramphus chloris	Wetlands/Grassland/Open Country	Resident	LC

There are 13 different habitats identified to be occupied by birds recorded in the survey sites. Thirty one percent of the species of birds inhabit both forest and grassland, 23% are purely forest dwellers, and 14% thrive in a combination of forest, grassland and open country. Habitat preference of birds characterizes the TSF3 area which was extremely disturbed and degraded because of earth moving, excavation and clearing activities in the area. Birds which were observed and recorded are those which thrive in disturbed environments and have adapted to the condition of the area.

Most of the birds are specialist feeders with 37% of them insect eaters or are insectivorous. Frugivores, nectarivores, and omnivores comprise 8-9% each, while carnivores comprise 6%. The rest of the specialists comprise 3% each e.g., frugivores, granivores etc. There were also species which were combination feeders such as frugivores/insectivores (11%) while insectivore/carnivore and herbivore/granivores are at 3% each.

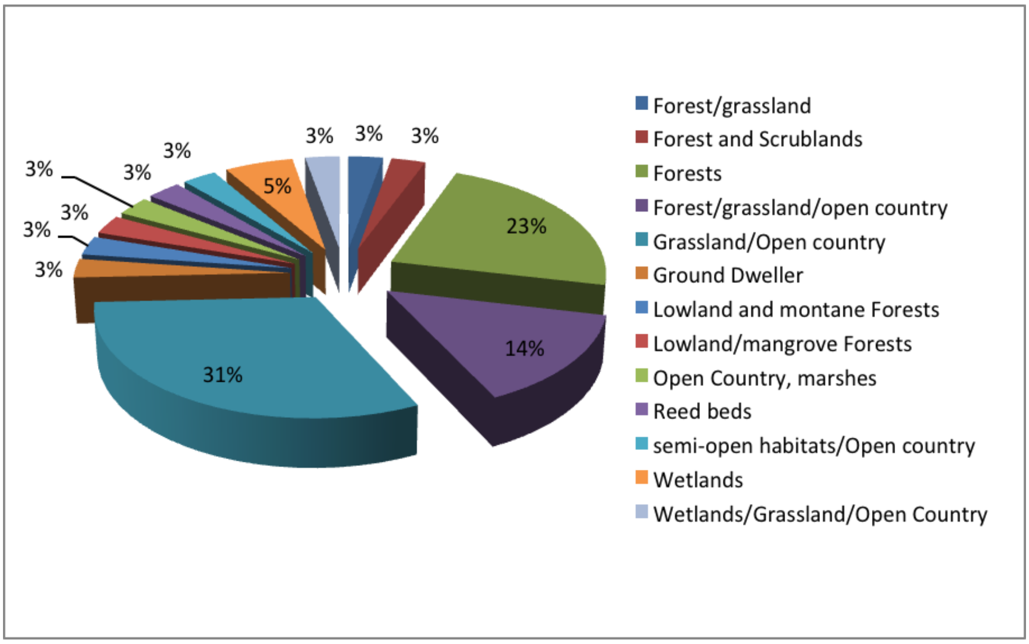


Figure 2.1.17. Species of birds (%) occupying different habitats

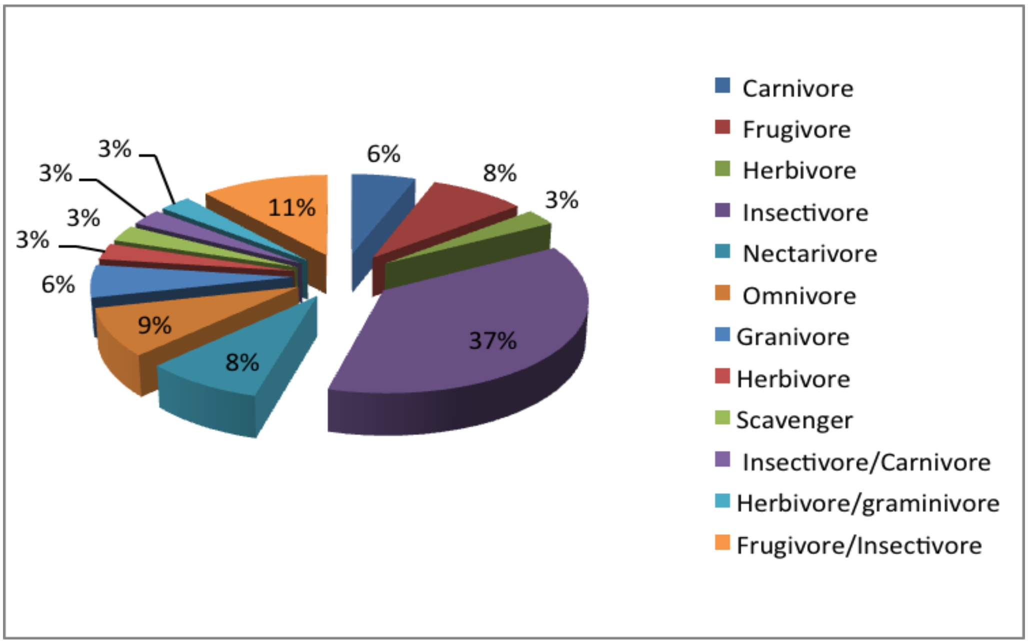


Figure 2.1.18. Percentage of bird species occupying different feeding-guilds

Figure 2.1.17 shows the percentage of species of birds according to their distribution. It shows that most of the birds are residents (65%). Endemicity is at 26% and those that are deemed resident and resident/migrant species comprise 3% each. One species was classified as Accidental by the WBCP list for 2016, *Coturnix japonica* or the Japanese Quail. According to the definition by Wikipedia, these species are "introduced, alien, exotic, non-indigenous or non-native; it is a species living outside its native distributional range and arrived by human activity either deliberate or by accident…"

Mammals

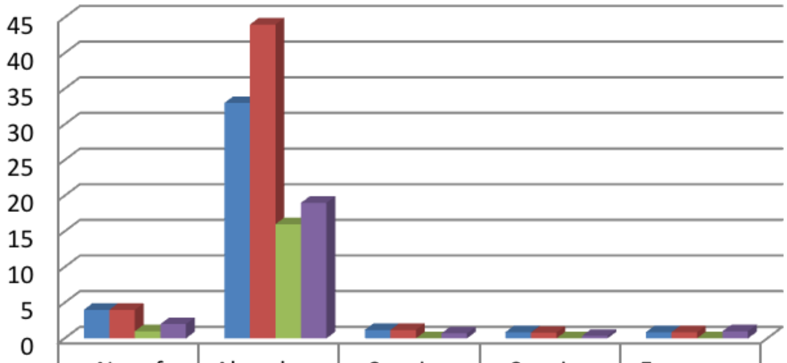
There were only four (4) species of mammals caught in the nets and live traps. Two of these were volant and two (2) were non-volant. All four (4) species were caught in Transects 1 and 2 with *Cynopterus brachyotis* the most common. Only two (2) species were caught in Transect 4 and only one in Transect 3 (**Table 2.1.33**).

Table 2.1.32. List of mammalian species observed from the proposed TSF3 site

Common Names	Scientific Name	Transects			
		1	2	3	4
Short-nosed fruit bat	*Cynopterus brachyotis*	22	25	16	13
Common Rousette	*Rousettus amplexicaudatus*	6	1	-	6
Oriental House Rat	*Rattus tanezumi*	3	13	-	-
Malayan Field Rat	*Rattus tiomanicus*	2	5	-	-

Comparison of Diversity Indices Among the Survey Sites for Mammalian Species

There were very few species of mammals recorded during the survey and very low abundance. Species diversity and richness in all four sites is very low with Transect 3 having a zero value (for species diversity richness and evenness). Transect 1 had the highest value for species diversity and richness. Again, this is because of the characteristic of the area, having a more diverse vegetation type which may be favorable for the species. Transect 2 had the highest number of individuals counted because the site where the nets were set were near the rehabilitation areas of RTNMC and TSF1 where fruit trees and other crops are planted. The rainy weather may have affected the activity of these taxa during the sampling.



	No. of Species	Abundance	Species Diversity	Species Richness	Evenness
Transect 1	4	33	1.182	0.858	0.8528
Transect 2	4	44	1.172	0.7928	0.8458
Transect 3	1	16	0	0	0
Transect 4	2	19	0.6918	0.3396	0.998

Figure 2.1.19. Comparison of diversity indices of mammals between survey sites

Conservation and Ecological Status

The preferred habitat, distribution and conservation status of mammals are presented in the table below (**Table 2.1.33**). The species of mammals observed and recorded in the survey areas live in different habitats where one (1) volant species, *Cynopterus brachyotis* lives and is adapted to different habitats, and the other in caves and crevices (*Rouseattus amplexicaudatus*). *Rattus tanezumi* is abundant in all habitats because it is a pest while the other rodent, *R. tiomanicus* is a forest dweller except where there are dipterocarps. Except for *R. tanezumi* which is introduced, invasive and a pest in human habitations, farms and even in forests, all the other three species are residents.

All of the species of mammals are classified under Least Concern by the IUCN which means that these species are common, abundant and are not in any way in danger of being threatened in their habitat range.

Table 2.1.33. Habitats, distribution and IUCN conservation status of volant and non-volant mammals recorded and observed during the 2016 survey

Species	Habitats	Distribution	Conservation Status (IUCN)
Cynopterus brachyotis	Lower montane forests, dipterocarp forests, gardens, mangrove and strand vegetation	Resident	LC
Rousettus amplexicaudatus	Roosts in caves, crevices and old tombs; found in a variety of habitats	Resident	LC
Rattus tanezumi	abundant in all habitats	Introduced	LC
Rattus tiomanicus	primary and secondary forest	Resident	LC

Reptiles and Amphibians (Herps)

Eleven species of herps (7 amphibians and 4 reptiles) were caught by hand during herping done in the canals around site for the proposed TSF3, in the river traversing Transect 3 and the marshes in the grassland near Transects 1 and 4. Six of the species were recorded from Transect 1, four (4) from Transect and five (5) species from Transects 3 and 4. There were equal number of amphibians in Transects 1, 3, and 4 with *Limnonectes acanthi* common to both sites. There were three (3) species of reptiles each both in Transects 1 and 2. There was only one (1) species of amphibian caught in Transect 2 because it was basically a reforestation and a grassland area which is dry during the day.

The green-crested lizard, *Bronchocoela cristatella* was observed in all the sites. The list of herps is shown in **Table 2.1.34**.

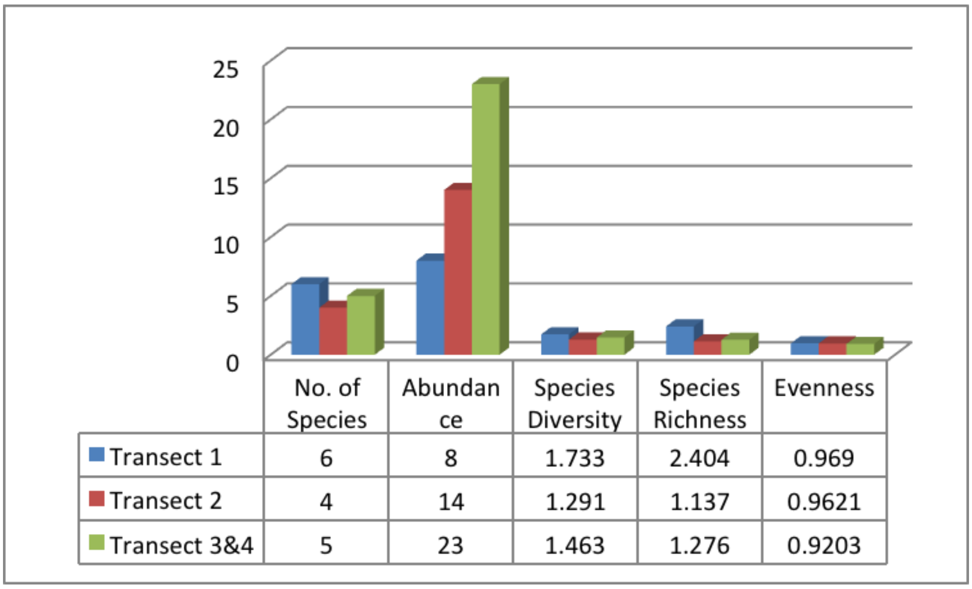
Table 2.1.34. Species of herps observed during the survey at TSF3

Common Names	Scientific Name	Transects		
		1	2	3 and 4
Chinese Edible Frog	*Hoplobatrachus rugulosus*	1	-	-
Moellendorf's Variable-backed frog	*Hylarana moellendorffi*	1	-	-
Philippine Toad	*Ingerophrynus philippinicus*	-	-	10
Busuanga Wart Frog	*Limnonectes acanthi*	2	-	2
Puddle frog	*Occidozyga laevis*	-	-	2
Common Tree Frog	*Polypedates leucomystax*	-	1	-
Palawan Rock FRog	*Staurois nubilus*	-	-	1
Green crested lizard	*Bronchocoela cristatella*	2	7	8
Striped bronzeback	*Dendrelaphis caudolineatus*	1	5	-
Palawan gecko	*Gekko palawanensis*	1	-	-
Keeled rat snake	*Ptyas carinata*	-	1	-

Comparison of Diversity Indices Among the Survey Sites for Herps

Species diversity in all sites is low with Transect 1 having the highest value followed by Transects 3 and 4 and the lowest is in Transect 2. Species richness is moderate in Transect 1 and low in the rest of the transects. Evenness is high in all the sites (**Figure 2.1.20**).

Because of the rain, the grassland in Transect 1 was denuded with water while herping in the river and along the canal in Transects 3 and 4, yielded a higher number of species than in Transect 2 which is mostly grassland.



	No. of Species	Abundance	Species Diversity	Species Richness	Evenness
Transect 1	6	8	1.733	2.404	0.969
Transect 2	4	14	1.291	1.137	0.9621
Transect 3&4	5	23	1.463	1.276	0.9203

Figure 2.1.20. Comparison of diversity indices of herps between survey sites.

Conservation and Ecological Status

The habitat, distribution and conservation status of the species of herps observed during the survey are presented in **Table 2.1.35**. Majority of the species are forest dwellers, whether terrestrial or aquatic.

Table 2.1.35. Habitat, distribution and conservation status of herps observed and recorded during the survey of terrestrial fauna at TSF3

Species	Habitats	Distribution	Conservation Status (IUCN)
Hoplobatrachus rugulosus	Paddy fields, irrigation, fishponds and forest pools	Introduced	LC
Hylarana moellendorffi	forests, streams and rivers	Endemic to Palawan	NT
Ingerophrynus philippinicus	forests, plantations, gardens, rivers	Endemic to Palawan	LC
Limnonectes acanthi	forests, rivers, marshes, etc.	Endemic to Palawan	VU
Occidozyga laevis	forests, rivers, marshes, etc.	Resident	LC
Polypedates leucomystax	terrestrial and freshwater habitats	Resident	LC
Staurois nubilus	lowland forests, rivers	Resident	LC
Bronchocoela cristatella	forests	Resident	LC
Dendrelaphis caudolineatus	forests	Resident	LC
Gekko palawanensis	tropical and moist forests and areas of rocky substrate	Endemic to Palawan	LC
Ptyas carina	forests, cultivated areas, plantations	Resident	LC

Sixty-four percent of the species of herps are residents while 36% are endemic to Palawan. One species, *Hoplobatrachus rugulosus* is introduced and invasive which preys on the endemic and resident species. It was introduced to Bataraza by somebody who wanted to utilize it for food and for business.

As for conservation status, one (1) endemic species *Hylarana moellendorffi* is classified as Near Threatened because of the destruction of its habitat and maybe due to climate change. *Limnonecthes acanthi*, also an endemic species is classified as Vulnerable because it is collected for food and its habitat is continually destroyed.

<u>Species assemblage between the terrestrial vertebrate wildlife survey in 1996 and in 2016</u>

The following discussion presents the EIA findings for terrestrial flora in 1996 and 2016. It should be noted that considering the massive changes in area from these periods, the sampling stations already differed from the baseline made in 1996.

A total of 88 species of terrestrial vertebrates were documented during the surveys conducted in 1996 and 2016. Of these, 56 were birds, 13 mammals, and 19 herpetofauna (amphibians and reptiles).

Birds

The total number of species of birds is the same for both years of survey/assessment with 36. However, 20 of those species were only recorded in 1996 and in 2016, 20 were new records and were not recorded previously in 1996. Of these, 15 species are common to both survey periods.

The differences in the number of species present might be because in 1996, more than three (3) sites were surveyed while in 2016, survey and data gathering was only done at the vicinity of the proposed TSF3. Another reason may be the continuous change in the landscape and vegetation brought about by mining activities, construction of roads, tailings dams, etc., which disturbed the wildlife.

Table 2.1.36. List of species of birds documented in 1996 and 2016.

Scientific Name	Survey Period	
	1996	2015
Aegithina tiphia		x
Alophoixus frater	x	x
Anthreptes malacensis		x
Anthus rufulus	x	x
Aplonis panayensis	x	x
Apus pacificus	x	
Batrachostomus sp.	x	
Bubulcus ibis	x	x
Butorides striata	x	
Cacomantis merulinus		x
Caprimulgus macrurus		x
Ceyx erithaca	x	
Chalcohaps indica	x	x
Chloropsis palawanensis		x
Chrysocolaptes lucidus	x	
Cinnyris jugularis aurora	x	x
Cisticola juncidis		x
Collocalia esculenta	x	x
Collocalia troglodytes	x	
Copsychus niger	x	x
Corvus enca	x	x
Coturnix japonica		x
Cyornis lemprieri	x	
Dendrocygna arcuata		x
Dicaeum pygmaeum	x	x
Dicrurus hottentottus	x	x
Dinopium everetti		x
Egretta garzetta		x
Eurystomus orientalis cyanocolis	x	
Gallus gallus		x
Geopelia striata		x
Gracula religiosa palawanensis	x	
Halcyon coromanda	x	
Hirundo tahitica		x
Ixobrychus cinnamomeus		x
Ixos plawanensis	x	
Lalage nigra		x
Lanius cristatus	x	
Lonchura atricapilla	x	x
Lonchura leucogastra palawan	x	
Lonchura punctulata		x
Mulleripicus pulverulentus	x	
Nectarinia sperata	x	
Oriolus chinensis chinensis	x	
Orthotomus sericeus	x	x
Passer montanus		x
Phylloscopus trivirgatus	x	
Prionichilus plateni	x	x
Prioniturus platenae	x	
Pycnonotus atriceps		x
Pycnonotus cineirifrons		x
Streptopelia chinensis	x	x
Tanygnathus lucionensis	x	
Terpsiphone cyanescens		x
Todiramphus chloris	x	x
Zosterops montanus	x	

Mammals

A total of 13 species of mammals were recorded in 1996 and 2016, 11 of which were documented in 1996 and only four (4) in 2005. All of the 11 species recorded in 1996 were not in the 2016 list, and the four (4) species documented in 2016 were not observed and listed in 1996. Most of the species of mammals documented in 1996 were non-volant and were native and endemic to Palawan. The main reason why these species were no longer in the area could be because of the disturbance of habitats in the area. There were more forests in the areas surveyed in 1996. Mining activities caused the scraping off of the topsoil including its vegetation which removed the natural habitats of wildlife. This could have eliminated the food sources and shelter of mammals specially the endemic and native species.

There were no species of volant mammals documented in 1996 but there were two (2) in 2016. Maybe, netting was not done. All the non-volant mammals caught in the traps in 2016 are introduced, invasive and are household and agricultural pests.

Table 2.1.37. List of species of mammals documented in 1996 and 2016.

Scientific Name	Monitoring Period	
	1996	2016
Cynopterus brachyotis		x
Hylopetes nigripes	x	
Hystrix pumila	x	
Macaca fascicularis	x	
Maxomys panglima	x	
Mydaus marchei	x	
Nannosciurus sp	x	
Paradoxurus hermaphroditus	x	
Rattus tanezumi		x
Rattus tiomanicus		x
Rousettus amplexicaudatus		x
Sundasciurus steeri	x	
Sus ahoenobarbus	x	

Herpetofauna

Nineteen species of herps (6 amphibians and 13 reptiles) were documented, 10 (all reptiles) in 1996 and 11 (7 amphibians and 4 reptiles) in 2016. Eight of the 10 species recorded in 1996 were not listed in 2016 while nine (9) of the 11 were not in the 1996 list. This may be because frogging or herping along rivers, streams and creeks was not conducted in 1996 while in 2016, amphibians were caught during frogging/herping along a river, a water containment area near the TSF3 and small puddles along the transects. Only the Palawan Gecko, *Gekko palawanensis* and the Philippine toad, *Ingerophrynus philippinicus* are common to both periods.

Table 2.1.38. List of species of herps documented in 1996 and 2016.

Scientific Name	Monitoring Period	
	1996	2016
Bronchocoela cristatella		x
Calliophis intesitinalis	x	
Crocodylus porosus	x	
Dendrelaphis caudolineatus		x
Draco volans	x	
Gekko palawanensis	x	x
Hemidactylus frenatus	x	
Hoplobatrachus rugulosus		x
Hylarana moellendorffi		x
Ingerophrynus philippinicus	x	x
Limnonectes acanthi		x
Mabuya multifasciata	x	
Occidozyga laevis		x
Ophiophagus hannah	x	
Polypedates leucomystax		x
Pytas carina		x
Python reticulatus	x	
Staurois nubilus		x
Varanus palawanensis	x	

2.1.5.3 Impact Assessment

The CBNC is now operating two (2) HPP in Rio Tuba. To monitor the effects of CBNC operations on fauna (terrestrial vertebrates), impact areas near/adjacent to the plants (Kinurong, Ibelnan and Lower Bulanjao), near the pier (Nagoya), a rehabilitated decommissioned tailings dam (TSF1) and one island (Ursula) are surveyed and monitored annually.

As can be observed from the result of five (5)-year monitoring of fauna, the total number of species of terrestrial vertebrates in the areas monitored vaired; increasing from 2013 to 2015, slightly decreased in 2016 and significantly decreased in 2017. **Table 2.1.39** shows the tally of species from 2013-2017.

Table 2.1.39. Tally of species from 2013 to 2017

Taxa	Monitoring Period				
	2013	2014	2015	2016	2017
Birds	63	64	67	67	59
Mammals	10	11	11	11	11
Herps	12	12	14	13	14
Total	**85**	**87**	**92**	**91**	**84**

Again, by referring back to the data presented in the baseline section, it can be concluded that each survey from 1996 to the 2016, the number of wild fauna species variy and different species were observed in each monitoring activity in the span of 20 years. This indicates that there may be more wild fauna species present on site and that with the variability of habitats in the area, the habitat is able to support larger number of species compared with the records of individual studies.

On the other hand, the disturbance to wildlife population could not be attributed to the operations of the HPP but may be caused by the deforestation. This is observed along the Ibelnan, Kinurong and Nagoya areas[1]. Deforestation in the surrounding forests of the

[1] http://www.philstar.com/business/2011/05/25/689080/sifting-fact-fiction

RTNMC and CBNC may be attributed to the continuing harvest of timber for domestic consumption by the locals living near the aforementioned areas. Some areas are being cleared for the construction of para-military camps such as in Ibelnan. Some forests are cleared and converted to farms such as in the barangay adjacent to Kinurong.

One other cause that can be attributed to the decrease in the number of species are the recent long hot, dry seasons, which caused the drying up of the understorey vegetation and accumulation of forest litter which when dried may cause the spread of forest fires during summer months. The disastrous forest fires that occurred in 1998 caused significant damage to the Bulanjao Range and Mt. Mantalingahan tip and were further aggravated by the El Niño phenomenon.

The prolonged summer also cause the drying up of the stream in Ibelnan and the ponds in Kinurong and diminished water sources for wildlife. As a management measure, CBNC replanted mangroves in Nagoya, reforested Kinurong area, and mobilize personnel to guard the Ibelnan Intake Dam and the entire Ibelnan area against the entry of illegal loggers from nearby communities. It also helps in the protection of Lower Bulanjao area by including it as one of its original monitoring sites although it is under the area of responsibility of the RTNMC.

From the discussion on the previous section, the success of the rehabilitation activities for TSF1 paved the way for the establishment of floral communities at the site, which to some extent have a positive impact for wild fauna. Aside from providing habitat, among the species planted are fruit trees and vegetables that are sources of food for wild fauna. It can be assumed that the availability of food sources can further attract wildlife species.

The habitat formed by the TSF1 can served as a vital link for fauna species towards its movement to the surrounding forests including the Mount Bulanjao. In the long run, the Final Mine Rehabilitation Program that is aimed to reforest the site could have a positive impact to wildlife.

Furthermore, the rehabilitation of TSF1 has proven that a nickel mine tailings dam can be utilized for the production of food safe enough for human consumption.

The adoption of Ursula Island by CBNC as one of its areas of responsibility has helped in re-establishing the status of the island as a “Bird Sanctuary and Game Refuge”. The island is the habitat of two (2) important bird species, *Caloenas nicobarica* (Nicobar Pigeon) and *Ducula pickeringii* (Grey Imperial Pigeon), which is found only in the island at Southern Palawan. *Ducula pickeringii* is considered Vulnerable by the IUCN while *Caloenas nicobarica* is Near Threatened. The CBNC, as part of its CSR commitments sponsored the program on the management of rodent pests in the island, which is one of the causes of the decline of the bird population. Rodents prey on eggs and nestlings of birds. It is noteworthy to mention that due to this, around 500 or more individuals of the bird species, *Ducula bicolor* (Pied Imperial Pigeon) were counted in one survey afternoon. Moreover, guards have been deployed in cooperation with the LGU and the DENR.

COMPARISON OF THE SPECIES ASSEMBLAGE OF THE TERRESTRIAL VERTEBRATE WILDLIFE MONITORING OF CBNC FROM 2013 TO 2017 WITH THE SURVEY AT THE PROPOSED TSF3 IN 2016

The monitoring of terrestrial vertebrate wildlife at the vicinity and areas surrounding CBNC is done annually in six (6) sites (since 2005). In this report, the monitoring results of the last five (5) years are compared with the data of the survey done at the TSF3 in 2016.

The proposed TSF3 is just about 200-300 meters away from the TSF1 which has been rehabilitated by the CBNC since it was decommissioned a few years back. During the survey of wildlife for the TSF3, about a quarter of the TSF1 has already been planted with bananas, papayas, assorted vegetables, flowers and shrubs. It has become a showcase for rehabilitation projects of denuded and degraded sites resulting from mining and nickel production.

About 166 species of terrestrial vertebrate wildlife has been documented during the five (5) - year monitoring and during the survey at TSF3. Of these, 114 are birds, 18 mammals and 34 herps.

Birds
Table 2.1.40 below shows a comparison of the species documented through five (5) years of wildlife monitoring at the CBNC and the 2016 survey at the TSF3.

The average number of species of birds documented annually for the past five (5) years (2013-2017) of monitoring CBNC is 64, which is higher than what was recorded at the proposed TSF3 with only 36. Of the 114 species of birds listed since 2013, only 20 or 17.54% are common.

The reason why there is a lesser number of species listed at the proposed TSF3 is because it is a disturbed site with very few trees and a forest patch which is not a good habitat for terrestrial vertebrates because it is very near the main activity/operations area of the RTNMC and the proposed TSF3. The dominant vegetation are grasses which during the wet season are submerged in water (marshland). It is also near a public road. The CBNC sites had a variety of habitats; disturbed and intact forests, agro-forests, agro-forest near beaches, disturbed forests, etc., which harbor diverse species of wildlife, specially birds.

Table 2.1.40. Species of birds documented in 6 sites for the CBNC monitoring of terrestrial vertebrate wildlife (2013-2017) and at the proposed TSF3 in 2016.

Species		Monitoring Period of CBNC					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
1	*Accipiter trivirgatus*			✓	✓		
2	*Accipiter soloensis*					✓	
3	*Aegithina tiphia*	✓	✓	✓	✓	✓	✓
4	*Aethopyga shelleyi*		✓	✓	✓	✓	
5	*Alcedo meninting*		✓	✓	✓	✓	✓
6	*Alophoixus frater*	✓	✓	✓	✓	✓	✓
7	*Anthreptes malacensis*	✓	✓	✓		✓	✓
8	*Anthus rufulus*	✓	✓	✓			✓
9	*Aplonis panayensis*	✓	✓	✓	✓	✓	✓
10	*Arachnothera dilutior*		✓	✓		✓	✓
11	*Ardea cinerea*			✓			
12	*Ardea intermedia*		✓				
13	*Ardeola bacchus*					✓	
14	*Artamus leucorynchus*			✓	✓	✓	✓
15	*Bubulcus ibis*	✓					

Species		Monitoring Period of CBNC					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
16	*Butastur indicus*						✓
17	*Butorides striata*		✓	✓			✓
18	*Cacomantis merulinus*	✓	✓	✓	✓		✓
19	*Cacomantis sepulchlaris*			✓			
20	*Caloenas nicobarica*			✓	✓	✓	✓
21	*Caprimulgus macrurus*	✓	✓	✓	✓	✓	✓
22	*Centropus bengalensis*					✓	✓
23	*Centropus sinensis*		✓	✓	✓	✓	✓
24	*Centropus bengalensis*		✓		✓		
25	*Ceyx erithaca*		✓	✓			
26	*Chalcopaps indica*	✓	✓	✓	✓	✓	✓
27	*Chloropsis palawanensis*	✓	✓	✓	✓	✓	✓
28	*Cinnyris jugularis*	✓	✓	✓	✓		
29	*Cisticola juncidis*	✓	✓	✓	✓	✓	
30	*Collocalia esculenta*	✓	✓	✓	✓	✓	✓
31	*Collocalia troglodytes*						✓
32	*Columba vitiensis*						✓
33	*Copsychus niger*	✓	✓	✓	✓	✓	✓
34	*Corvus enca*	✓	✓	✓	✓	✓	✓
35	*Coturnix chinensis lineata*					✓	
36	*Coturnix japonica*	✓					
37	*Cyornis rufigastra*						✓
38	*Dendrocygna arcuata*	✓	✓	✓	✓	✓	✓
39	*Dicaeum pygmaeum*	✓	✓	✓	✓	✓	✓
40	*Dicrorus hottentotus palawanensis*	✓	✓				✓
41	*Dicrorus leucophaeus*		✓	✓	✓	✓	
42	*Dinopium javanensi everetti*	✓	✓				
43	*Dryocopus javensis*			✓			
44	*Ducula bicolor*			✓	✓	✓	✓
45	*Ducula pickeringii*		✓	✓	✓	✓	✓
46	*Ardea alba*		✓		✓	✓	✓
47	*Egretta eulophotes*						✓
48	*Egretta garzetta*	✓	✓	✓	✓	✓	✓
49	*Egretta sacra*			✓	✓	✓	✓
50	*Eudynamys scolopacea*						✓
51	*Excalfactoria chinensis*			✓			
52	*Falco peregrinus*					✓	✓
53	*Ficedula platenae*			✓			
54	*Gallinula chloropus*				✓		
55	*Gallus gallus*	✓			✓		✓
56	*Geopelia striata*	✓	✓	✓	✓	✓	✓
57	*Glareola maldivarum*			✓			
58	*Gracula religiosa palawanensis*		✓	✓	✓	✓	✓
59	*Haliaeetus leucogaster*		✓	✓			✓
60	*Hirundo rustica*		✓		✓	✓	✓
61	*Hirundo tahitica*	✓	✓	✓	✓	✓	✓
62	*Hypothymis azurea*		✓	✓	✓		
63	*Iole palawanensis*			✓			✓
64	*Irena puella*		✓		✓		✓
65	*Ixobrychus cinnamomeus*	✓					
66	*Ixobrychus eurhythmus*			✓			
67	*Lalage nigra*	✓	✓	✓	✓	✓	✓
68	*Leptocoma calcostetha*			✓	✓		
69	*Leptocoma sperata*		✓	✓	✓	✓	✓
70	*Lonchura atricapilla*	✓	✓	✓	✓	✓	✓
71	*Lonchura leucogastra palawana*			✓	✓	✓	

	Species	Monitoring Period of CBNC					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
72	*Lonchura punctulata*	✓	✓	✓	✓	✓	✓
73	*Macronous gularis*		✓	✓	✓		
74	*Macropygia phasianella*				✓	✓	
75	*Malacocincla cinereiceps*		✓	✓			
76	*Megapodius cumingii*			✓	✓	✓	
77	*Mesophoyx intermedia*					✓	
78	*Mixornis gularis*						✓
79	*Monticola solitarius*			✓	✓		
80	*Ninox scutulata*				✓		
81	*Nisaetus cirrhatus*				✓		
82	*Oriolus chinensis*						✓
83	*Orthotomus sericeus*	✓	✓	✓	✓	✓	✓
84	*Otus mantananensis*			✓	✓		
85	*Pachycephala grisola*						✓
86	*Pandion haliaetus*		✓		✓	✓	
87	*Passer montanus*	✓	✓	✓	✓	✓	✓
88	*Pelargopsis capensis*		✓	✓	✓	✓	
89	*Pericrocotus cinnamomeus*					✓	✓
90	*Periparus amabilis*			✓		✓	✓
91	*Phoenicophaeus curvirostris*		✓	✓	✓	✓	✓
92	*Phylloscopus trivirgatus*					✓	
93	*Pitta sordida*		✓	✓	✓	✓	
94	*Porzana pusilla*	✓			✓		
95	*Prioniturus platenae*				✓		
96	*Prionochilus plateni*		✓	✓	✓	✓	✓
97	*Ptilinopus leclancheri*				✓		
98	*Pycnonotus atriceps*	✓	✓		✓	✓	✓
99	*Pycnonotus cinereifrons*	✓	✓	✓	✓	✓	✓
100	*Pycnonotus plumosus*		✓				
101	*Rhipidiura nigritorquis*		✓	✓	✓	✓	✓
102	*Sitta frontalis*			✓			
103	*Spilornis cheela*		✓		✓	✓	
104	*Streptopelia bitorquata*						✓
105	*Streptopelia chinensis*	✓				✓	
106	*Strix seloputo*		✓				
107	*Tanygnathus lucionensis*		✓	✓	✓	✓	✓
108	*Terpsiphone cyanescens*	✓	✓	✓	✓	✓	✓
109	*Todiramphus chloris*	✓	✓	✓	✓	✓	✓
110	*Treron vernans*				✓		✓
111	*Trichastoma cinereiceps*				✓	✓	
112	*Tringa brevipes*					✓	
113	*Zapornia pusilla*					✓	
114	*Zosterornis hypogrammicus*					✓	

Mammals

Very few mammalian species (only 4) were documented at the proposed TSF3 during the 2016 survey while the average number of species documented at the CBNC sites is 10.8, monitored from 2013-2015. Only one species, *Rattus tiomanicus* is a new record which has not been documented in any of the CBNC monitoring sites. Two species of volant mammals are common, *Cynopterus brachyotis* and *Rousettus amplexicaudatus*. Again the reason for this is that, TSF3 is a disturbed site with few trees and is mostly grassland which is underwater and food availability is nil or none for mammals.

Table 2.1.41. Species of mammals documented in 6 sites for the CBNC monitoring of terrestrial vertebrate wildlife (2013-2017) and at the proposed TSF3 in 2016.

Species		Monitoring Period					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
1	*Cynopterus brachyotis*	✓	✓	✓	✓	✓	✓
2	*Eonycteris spelea*		✓	✓	✓	✓	✓
3	*Macaca fascicularis*		✓	✓	✓	✓	✓
4	*Macroglossus minimus*		✓	✓	✓	✓	✓
5	*Maxomys panglima*		✓	✓		✓	
6	*Megaderma spasma*					✓	
7	*Mydaus marchei*		✓	✓			
8	*Paradoxorus harrmaphroditus*					✓	
9	*Pteropus vampyrus*				✓	✓	✓
10	*Rattus exulans*						✓
11	*Rattus tanezumi*	✓	✓	✓	✓	✓	
12	*Rattus tiomanicus*	✓					
13	*Rhinolophus acuminatus*		✓	✓	✓		
14	*Rousettus amplexicaudatus*	✓	✓	✓	✓	✓	✓
15	*Suncus murinus*		✓	✓	✓		
16	*Sundascirus steerii*		✓	✓	✓	✓	✓
17	*Sus barbatus ahoenobarbus*						✓
18	*Tupaia palawensis*				✓		✓

Herpetofauna

The monitoring of herpetofauna in the CBNC sites from 2013-2017 and the survey at TSF3 yielded 34 species of amphibians and reptiles. Of the 11 species documented during the survey at the proposed TSF3, only one species of reptile *Ptyas carina,* is a new record. Relatively, quite a number of species of herpetofauna was documented at TSF3 because one third of the area at TSF3 is 'wetlands' which are good habitats for amphibians.

Table 2.1.42. Species of herpetofauna documented in 6 sites for the CBNC monitoring of terrestraial vertebrate wildlife (2013-2017) and at the proposed TSF3 in 2016.

Species		Monitoring Period					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
1	*Ahaetulla prasina*						✓
2	*Boiga dendrophila multicincta*			✓	✓		
3	*Broncocoela cristatella*	✓		✓	✓		
4	*Caretta caretta*			✓			
5	*Coelognathus erythrurus*		✓				
6	*Cyrtodactylus annulatus*						✓
7	*Dasia graffini*						✓
8	*Dendrelaphis caudolineatus*	✓				✓	✓
9	*Dendrelapis pictus*				✓		
10	*Dogania subplana*					✓	
11	*Draco volans/palawanensis*					✓	
12	*Eutropis multifasciata*			✓			
13	*Fejervarya cancrivora*		✓		✓	✓	
14	*Gecko palawanensis*	✓	✓	✓	✓	✓	✓
15	*Hemidactylus frenatus*		✓		✓		✓
16	*Hoplobatrachus rugolusos*	✓			✓		
17	*Hylarana nicobariensis*		✓			✓	
18	*Ingerana mariae*					✓	
19	*Ingerophrynus philippinicus*	✓		✓	✓	✓	
20	*Kaloula pulchra*		✓	✓			
21	*Lamprolepis smaragdina*						✓
22	*Limnonectes acanthi*	✓	✓	✓	✓		
23	*Lycodon capucinus*		✓				
24	*Megophrys ligayae*		✓	✓			
25	*Occidozyga laevis*	✓	✓				

Species		Monitoring Period					
		TSF 3 2016	CBNC 2017	CBNC 2016	CBNC 2015	CBNC 2014	CBNC 2013
26	*Parvoscincus palawanensis*						✓
27	*Polypedates leucomystax*	✓	✓				
28	*Ptyas carina*	✓					
29	*Pulchrana moellendorffi*	✓	✓	✓	✓	✓	✓
30	*Sanguirana sanguinea*				✓	✓	✓
31	*Sphenomorphus palawanensis*					✓	
32	*Staurois nubilus*	✓	✓	✓	✓	✓	✓
33	*Tropidolaemus subannulatus*			✓	✓		
34	*Varanus palawensis*		✓	✓	✓		✓

The following matrix summarizes the potential impacts that may be brought by the proposed project.

Table 2.1.43. Impacts assessment and mitigation for terrestrial fauna

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Loss of habitat and threat to the existence and/or loss of important species ***Birds*** Monitoring of birds in areas around TSF3 shows that there are 35 species recorded in the site. Thirty one (31) percent of the species inhabit both forest and grassland, 23% are purely forest dwellers and 14% thrive in a combination of forest, grassland and open country. This shows that most of the species are tree and forest dependents although some inhabit grassland and open country. The scraping off of vegetation, whether trees or grassland will cause the loss of habitat of this taxon, especially ground and understorey dwellers such as quails, waterbirds and other ground feeding species. The TSF3 and surrounding areas has already been extremely disturbed and degraded because of earth moving, excavation and clearing activities in the area. 37% of bird species are insect eaters or are insectivorous. Frugivores, nectarivores, and omnivores comprise 8-9% each, while carnivores comprise 6%. The rest of the specialists comprise 3% each e.g., frugivores, granivores etc. There were also species which were combination feeders such as frugivores/insectivores (11%) while insectivore/carnivore and herbivore/granivores are at 3% each. Removal of the forest for the construction of the TSF3 would deprive the birds of nesting, roosting and feeding trees. If the food resource is depleted or exhausted, the tendency for birds or any animal is to transfer to areas where food is available and plentiful. It is expected that the number of species will decrease specially those that are sensitive to habitat	✓	✓	✓		• Maintain vegetation cover in the designated buffer zones and in the peripheries of roads and quarry area • The patch of forest at the north and northeastern part of TSF3 should not be disturbed including the river running through it • CBNC will rehabilitate the decommissioned TSF similar to TSF1, which is now a habitat for birds, insects and other wildlife species. • There is a need to conduct a long-term wild fauna monitoring to cover various habitats, sampling procedure and sampling times to consider the previous studies.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
loss and environmental disturbances (noise, dust and presence of humans). ***Mammals*** Very few species of mammals; 2 volant and 2 non-volant, were observed around the TSF3 area, all of which are common and not endangered. The two species of non-volant mammals are agricultural and household pests. There were very few individuals of mammals caught except for *Cynopterus brachyotis* which thrive in agricultural lands, forests, and mangrove. The construction of TSF3 may not affect the mammals in the area because there are no fruiting trees, and as in the case of *Rousettus amplexicaudatus* no caves or crevices where it roosts. It is hypothesized that the mammals caught in the nets are not from the forest patch in the northern and northeastern side of TSF3 but from Ocayan or Buhoy and were just passing through in search of food (fruits). But those caught in the northern part of TSF3 may be roosting in the forest patch and removing the vegetation may affect their existence. ***Herps*** Quite a number of species of herps (10) were caught during herping for two (2) nights. This is almost the same number of species recorded during annual monitoring conducted in the 6 sites at CBNC. Of all the terrestrial vertebrate taxa, herps especially amphibians are the most affected because of their dependence on water and cool environment. Thirty six percent (36%) of the herps are endemic to Palawan. *Hylarana moellendorffi* is considered Near Threatened while *Limnonectes acanthi* is Vulnerable. Most of the herps in the list were caught on the eastern side of TSF3. This area is mostly grassland and reeds with almost no forest cover. It is however inundated with water and is more or less a marshland which is very favorable to the existence of amphibians. In the map for the proposed TSF3, it is depicted that an equipment depot or a holding area for large trucks and equipment will be constructed in the northeastern side across the road to the highway and Ocayan. If that is the case, the forest in the northern side will be affected as well as the marshy grassland which is the habitat of amphibians. This would dry up the area and will result to habitat loss, which will prove detrimental to this group of animals specially those which are endemic and those which are in the endangered list.					

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
A river runs through the forest in Station 3 and 4 of the survey sites. The passage of trucks and heavy equipment might render the river muddy and affect the trees, which will have an effect on amphibians, volant mammals and birds.					
Threat to the abundance, frequency, and distribution of species There are several endemic species observed on site however, as they are mobile, these species can migrate to adjacent areas with better vegetation cover. The presence of these endemic species on site indicates that areas adjacent to the area are able to support their requirements to survive.		✓	✓		CBNC should continue to invest in the progressive rehabilitation of TSF1, the borrow areas and in the future for TSF2 in order to rehabilitate the degraded habitat. The successful rehabilitation of these sites will provide additional habitat for wildlife species. As these areas are within the project site, disturbance will be minimal.
Hindrance to access to wildlife The felling of trees and the clearing of vegetation will hinder the mobility of wildlife species specially tree and ground dwellers. Eventually, loss of access will result to loss of species.		✓	✓		It is necessary to maintain green corridors within the project site in order to allow wildlife species to move from one place to another.

2.2 THE WATER

This section presents the baseline and impact assessment for hydrology, hydrogeology, physical oceanography, water quality, freshwater, and marine ecology. Detailed sampling procedures in the conduct of the baseline data are provided in **Annex 2.1.1**.

2.2.1 Hydrology/Hydrogeology

2.2.1.1 Methodology

Hydrologic Survey

The assessment for hydrology and hydrogeology was based on available secondary data relative on the current condition of the site. Existing data on the surface water and groundwater resources were also used and were validated as part of the field assessment conducted last August 18-21, 2016. Moreover, water source inventory within the area was conducted including onsite measurements of electrical conductivity and pH.

Flood Modelling

The focus of flood modeling is the watershed where the CBNC plant is located. An integrated hydrological and hydrodynamic model to simulate flooding conditions in the area is used to estimate the river flows for a 100-year flooding event, under the baseline (present) and climate-projected 2020 and 2050 rainfall conditions.

For an integrated hydrological and hydraulic modeling, computation directly applies the river discharge upstream of the catchment to generate runoff which is simultaneously routed downstream across the topographic 2D grid. 2D refers to the hydraulic modeling where the floodplain is modeled using two-dimensional methods. Using a grid of topography data the model will estimate not only how high and how fast water will flow but will also calculate the direction of flow across the 2D grid.

The model consists of a short-term storm event simulation module for flooding by overflow from river and deals with the flash flood event with a time scale within a couple of hours to one day.

Areal Coverage of the Flood Model

The sub-basins covered by the river network are delineated for use in the rainfall-on-the-mess flood modeling taking into consideration the location of the proposed mining development. The sub-basins were delineated using GIS and are based on freely available 30 m digital elevation model (DEM) for Bataraza, Palawan and its various river systems surrounding the project area, the result of which is shown in **Figure 2.2.1**.

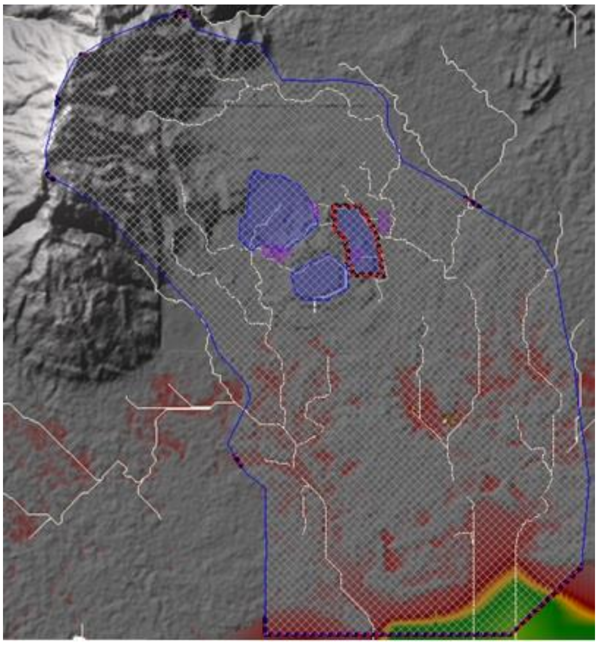


Figure 2.2.1. The extent of the 2D flood model (blue polygon) overlayed in the GIS-generated river networks surrounding the Project Area using the detailed DTM complemented with the publicly available 30-m DEM.

Hydraulically, the river systems surrounding the CBNC's expansion project area eventually drains towards the Bay. The interconnected network of rivers and creeks upstream are partly affected by tidal fluctuations due to its connection to the open sea. Broadly speaking, channel flows are easier to model accurately with a 1D hydraulic network model (e.g. based on the 1D St-Venant Equations), while 2D models are better suited to modelling overland flows (e.g. based on the 2D shallow water equations).

For this purpose, the latest version of free software called HEC-RAS, developed by the Hydrologic Engineering Center of the US Corps of Engineers, is used. It is devoted to fluid flow simulations, especially shallow water flows, such as floods, and dam breaks. The method implemented in HEC-RAS is a numerical finite volume method used to solve the shallow water equations. Some mathematical explanation of the method is given in the HEC-RAS User Manual [HEC-RAS, 2016]. In two (2) dimensions, the domain is discretised into finite number of elements. HEC-RAS then evolves the conserved quantities (water depth and momenta) with respect to time to obtain the numerical solution to a given problem.

2.2.1.2 Baseline Conditions

Watershed Characterization

Climate

Based on the Modified Coronas Climate Classification System of the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA, 1992), much of the southern half of Palawan, as demarcated longitudinally, experiences a Type III Climate. This includes the entire Bataraza Municipality where the proposed TSF3 of CBNC is to be located.

The Type III climate is characterized by a long rainy season that does not have a pronounced maximum rain period and a short dry season lasting only 1 to 3 months. Areas with a Type III climate are exposed to the Southwest Monsoon and tropical cyclones, but are partly shielded from the Northeast Monsoon and the North Pacific Trades.

The Southwest Monsoon is a cloudy, hot, humid and wet seasonal wind current (Williams et al., 1993) that prevails from May to November and brings a high amount of rainfall to much of the country.

The Northeast Monsoon and is a cloudy to partly cloudy and less humid seasonal wind current that occurs from November to March (Williams et al., 1993). It approaches the country from the northeast, and cools and sheds much of the moisture through orographic precipitation as it moves southwest. It is then relatively dry when it reaches the central and western sections of the country including the southern half of Palawan.

The North Pacific Trades or Easterlies blow through the country from the east from April to early May (Williams et al., 1993). This extremely warm wind current is responsible for the hot weather during this period.

Tropical cyclones originate in the Pacific Ocean and pass through the country in a northwesterly direction. These bring additional rain to the area. The tropical cyclone frequency map of PAGASA (PAGASA, 1992) indicates that the entire Palawan Island endures an average of 1 tropical cyclone per year.

Rainfall

RTNMC maintains three (3) rainfall stations in the vicinity of its mining claims. These stations are located at the Mangingidong, Guintalunan and Piersite areas of Brgy. Rio Tuba, and have been operating since the early eighties. **Table 2.2.1** lists the average monthly and annual rainfall as recorded from these stations in the last 20 years while **Figure 2.2.2** illustrates the corresponding rainfall trend.

Table 2.2.1. Average Monthly and Annual Rainfall

Period	Average Rainfall (mm)		
	Mangingidong Station	Guintalunan Station	Piersite Station
January	211	120	86
February	70	68	34
March	84	81	51
April	182	110	62
May	174	219	126

Period	Average Rainfall (mm)		
	Mangingidong Station	Guintalunan Station	Piersite Station
June	347	262	182
July	283	304	229
August	254	276	178
September	303	317	212
October	384	320	226
November	215	171	146
December	166	165	126
Annual	**2,672**	**2,412**	**1,658**

Source: 1996-2015 record of Mangingidong, Guintalunan and Piersite stations

Table 2.2.1 and **Figure 2.1.2** reveal that the area receives an average rainfall ranging from 1,658 to 2,672 mm per year. The difference in the amount of rainfall recorded by these stations is apparently due to orographic effects since the Mangingidong and Guintalunan stations are located in mountainous areas with the former being relatively higher, while the Piersite Station is near the coastline. The rainy season evidently starts at April and lasts up to January with June to October being the period of highest rainfall. February and March constitute the dry season in the area.

Rainfall within Ocayan and Tuba River Watersheds

Based on the Thiessen Polygon Method, the rainfall on 38%, 44% and 18% of the watershed area of Ocayan River may be respectively attributed to the rainfall recorded by the Mangingidong, Guintalunan and Piersite stations. On the other hand, the rainfall of these stations respectively account for 38%, 29% and 23% of rainfall at the Tuba River watershed. **Table 2.2.2** details the monthly and annual rainfall at these watersheds.

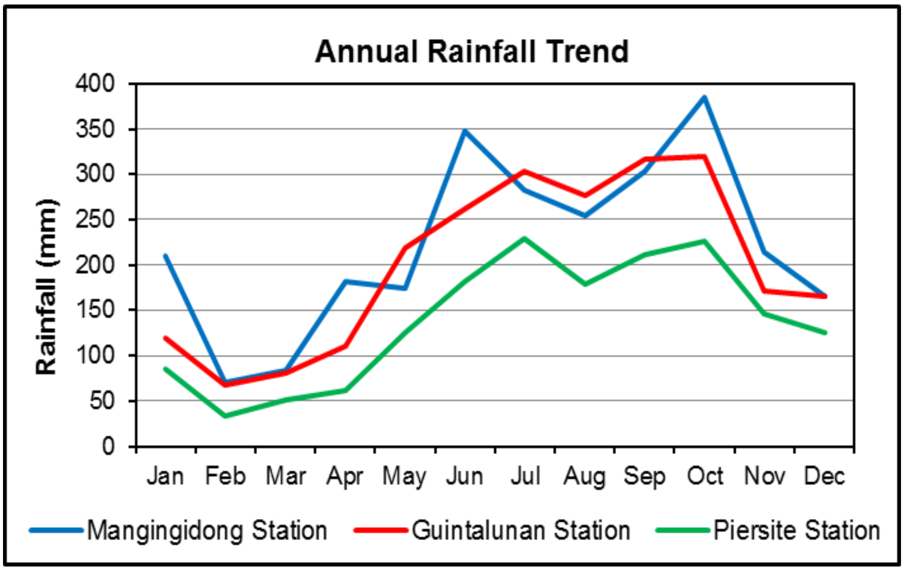


Figure 2.2.2. Monthly Rainfall Trend

Table 2.2.2. Average Rainfall at Okayan and Tuba River Watersheds

Period	Okayan River Watershed	Tuba River Watershed
	Rainfall (mm)	
January	148	146
February	62	61
March	77	75
April	129	126
May	185	181

Period	Okayan River Watershed	Tuba River Watershed
	Rainfall (mm)	
June	280	276
July	282	279
August	250	245
September	293	287
October	328	323
November	183	182
December	158	156
Annual	**2,375**	**2,338**

Source: PAGASA

Temperature

RTNMC also monitored other weather parameters including daily minimum, maximum and mean temperature from 1980 to 1999. CBNC on the other hand, installed an automatic weather station in their HPAL plant in Barangay Rio Tuba in 2004 that likewise tracked maximum, minimum, and mean temperature, among other parameters.

Table 2.2.3 enumerates the minimum, maximum and mean monthly temperature culled from the weather data of RTNMC and CBNC in the last 20 years. The table indicates that the area is generally warm, having an average annual temperature of 27.1°C. The hottest period occurs on April and May where the average monthly temperature reached 28.1°C. The coldest month is January, which has an average temperature of 26.4°C.

Table 2.2.3. Minimum, Maximum and Mean Temperature

Month	Temperature (°C)		
	Minimum Temp. (°C)	Maximum Temp. (°C)	Mean Temp. (°C)
January	22.6	29.3	26.5
February	22.5	30.5	27.0
March	23.0	31.1	27.6
April	23.9	32.1	28.4
May	24.2	32.0	28.3
June	23.3	31.7	27.3
July	23.1	30.8	26.8
August	23.3	30.4	27.1
September	22.9	30.4	26.8
October	23.1	30.3	26.8
November	23.2	30.7	27.1
December	23.0	29.8	26.9
Annual	23.2	30.8	27.2

Source: 1996-2015 temperature data of RTNMC and CBNC

Evapotranspiration

Evapotranspiration is the amount of water that is released to the atmosphere through evaporation from soil and surface-water bodies and also through plant transpiration. Potential evapotranspiration (PET) is the evapotranspiration that would occur if sufficient water is always available while actual evapotranspiration (AET) is the evapotranspiration that occurs from the actual water available.

The monthly and annual PET in the area was computed using the Thornthwaite Method (Knödel, et al, 2007). This method is useful when only a few weather parameters are available since it only requires the mean monthly temperature and the mean monthly duration of daylight in the area.

The mean monthly temperature was taken from the RTNMC and CBNC temperature data of the last 20 years while the mean monthly daylight duration was obtained from the daylight duration data presented in Cruff and Thompson (1967). The monthly and annual AET were then estimated from the PET values using the Turc-Pike Equation (Xu and Singh, 2004). **Table 2.2.4** lists the computed monthly and annual PET and AET values.

Table 2.2.4. Monthly and Annual PET and AET

Period	PET (mm/mo)	AET (mm/mo)
January	91	76
February	97	52
March	104	62
April	114	87
May	114	100
June	100	99
July	95	94
August	98	94
September	95	92
October	95	90
November	98	85
December	96	80
Annual	1,197	1,010

Table 2.2.4 also shows that the AET varies widely throughout the year. It is highest in May where it averages of 100 mm per month. It then begins to drop and reaches its lowest monthly average of 52 mm in February before increasing again. The annual estimated AET in the area is 1,010 mm. This constitutes 38 to 61% of the annual rainfall in the area.

Drainage Systems

The proposed TSF3 of CBNC lies within the western section of Ocayan River watershed. Since a portion of the TSF3 site used to be mining area of RTNMC, the creek that drains this site has been channeled to a siltation pond to allow suspended solids to settle and clarify the water. The outflow of this pond is then diverted to another siltation pond that drains into the adjacent Tuba River. **Figure 2.2.3** displays the extent of the Ocayan and Tuba rivers.

Ocayan River

The proposed TSF3 lies within the Ocayan River Watershed and the area surrounding it is drained by the Ocayan River. The headwaters of this river originate at the eastern flank of Bulanjao Range and the hills at the southern portions of barangays Sandoval and Igang-Igang. These tributaries flow in a general south direction through hills and gently sloping lowlands that include large portions of Barangays Rio Tuba and Ocayan, and smaller sections of barangays Sandoval, Iwahig, Igang-Igang and Sarong. The tributaries coalesce into the wide but short main channel of the river before draining at Coral Bay in Sea Sulu. The lower reach of this river exhibits estuarine conditions.

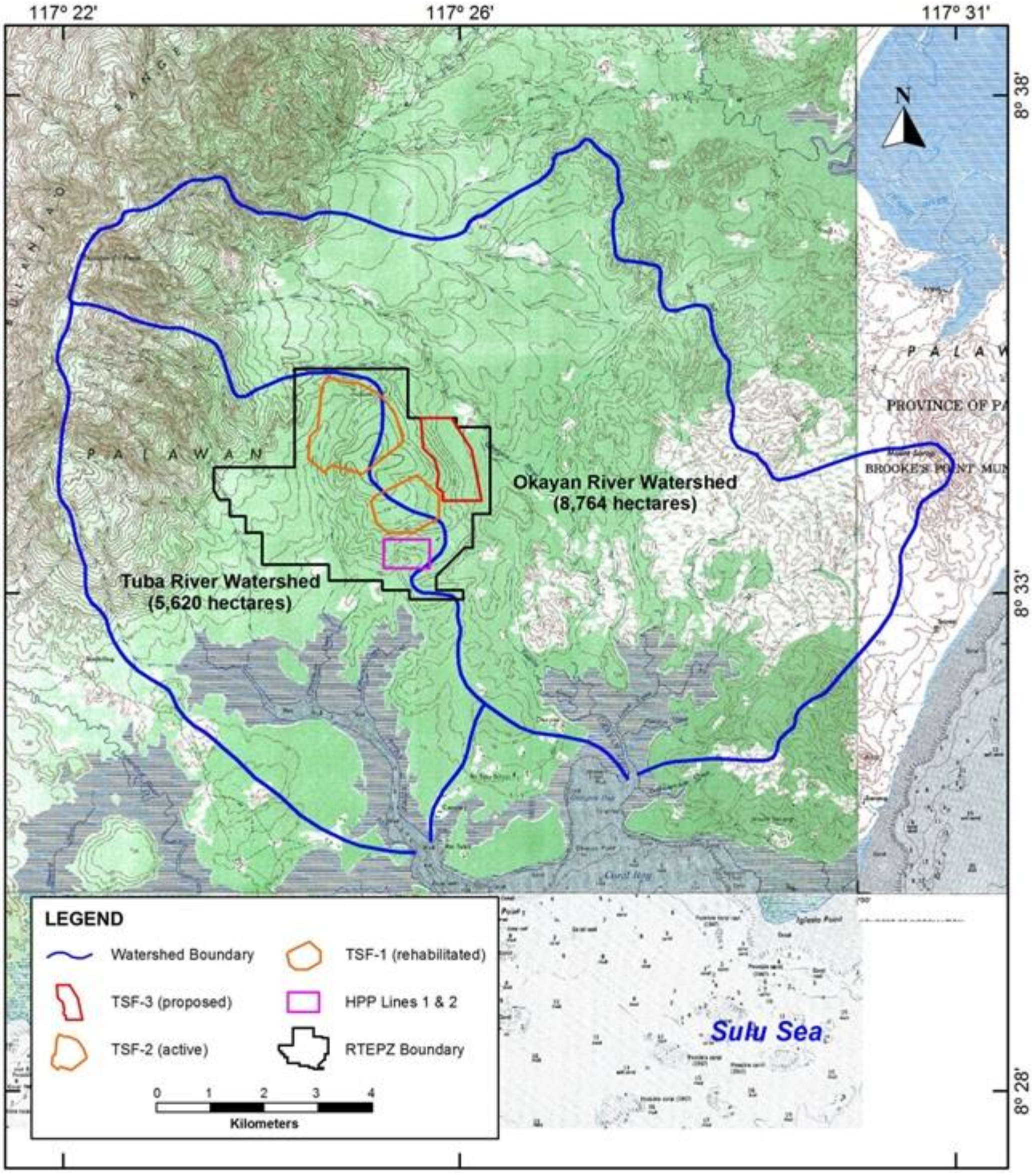


Figure 2.2.3. Drainage System and Watershed Map of CBNC project area

Ocayan River spans a watershed area of 8,764 hectares. The upper watershed area is mountainous while the middle portion is hilly to gently sloping and generally cultivated. Swampy land characterizes the lower catchment area of the river.

The main tributary of Ocayan River is 10 to 11 m wide and crosses the highway linking Barangay Rio Tuba with Bataraza town proper. At the time this tributary was examined in August 2016, it flowed slightly cloudy water that is being used for bathing and washing clothes by nearby residents (**Plate 2.2.1**).

Ocayan River displays a dendritic drainage pattern. Intermittent creeks characterize all of its first-order tributaries and some of the second-order tributaries. The third-order limbs of the river are perennial in nature. At its mouth, Ocayan River is a fourth-order river.

The first and second-order tributaries of Ocayan River are youthful streams that actively dissect the course on which they flow. On the other hand, the third-order branches of the river as well as its main channel exhibit a mature stage of development.

Tagpisa Creek

A portion of the TSF3 site and the adjacent areas to the west and north used to be mining area of RTNMC. The creek that drains this area through intermittent, first-order tributaries is the westernmost tributary of Ocayan River and is called Tagpisa Creek.

The creek previously drained into the lower reaches of Ocayan River. However, during the previous mining operations of RTNMC at Guintalunan Pit, the creek was made to pass through the Tagpisa Siltation Pond that was constructed farther downstream from the TSF3 site and then diverted through a canal into the Upper Kinurong Siltation Pond which flows into the Tuba River.

The upper section of Tagpisa Creek which was observed to be 1 to 3 m wide and less than a meter deep drains the runoff from the TSF3 area. Only the lower segment of Tagpisa Creek continues to reach Okayan River. The realignment of the upper segment of Tagpisa Creek was however done long before the CBNC operated in the area.

The outflow from Tagpisa Siltation Pond would have naturally drained into the lower section of Tagpisa Creek to eventually reach the main trunk of Ocayan River. However, as a means to institute additional sediment control measures to runoff from the former mining operations in the vicinity of the proposed TSF3, the outflow from Tagpisa Siltation Pond was routed out of the watershed of Okayan River through a diversion canal into the Upper Kinurong Siltation Pond which lies within the adjacent Tuba River watershed. After additional settling of suspended sediments, the outflow from Upper Kinurong Siltation Pond is discharged at the lower reach of Tuba River. **Figure 2.2.4** shows the realignment of Tagpisa Creek.

At the time of inspection in August 2016, slightly turbid and moderately turbid water was observed at Tagpisa Creek respectively upstream and downstream from the TSF3 area. The moderately turbid water then reverted to being slightly turbid after passing through the Tagpisa Siltation Pond.

Plates 2.2.2 and **2.2.3** show sections of the Tagpisa Creek that are respectively upstream and downstream from the TSF3 area while **Plate 2.2.4** displays the diversion canal which conveys the outflow from Tagpisa Siltation Pond to the Upper Kinurong Siltation Pond.

Plate 2.2.1. The main tributary of Ocayan River as viewed at the downstream side of Ocayan Bridge along the highway. The river has a muddy to gravelly bed and its water is used for irrigating farmlands and for bathing and washing clothes.

Plate 2.2.2. A section of Tagpisa Creek that is upstream from the proposed TSF3.

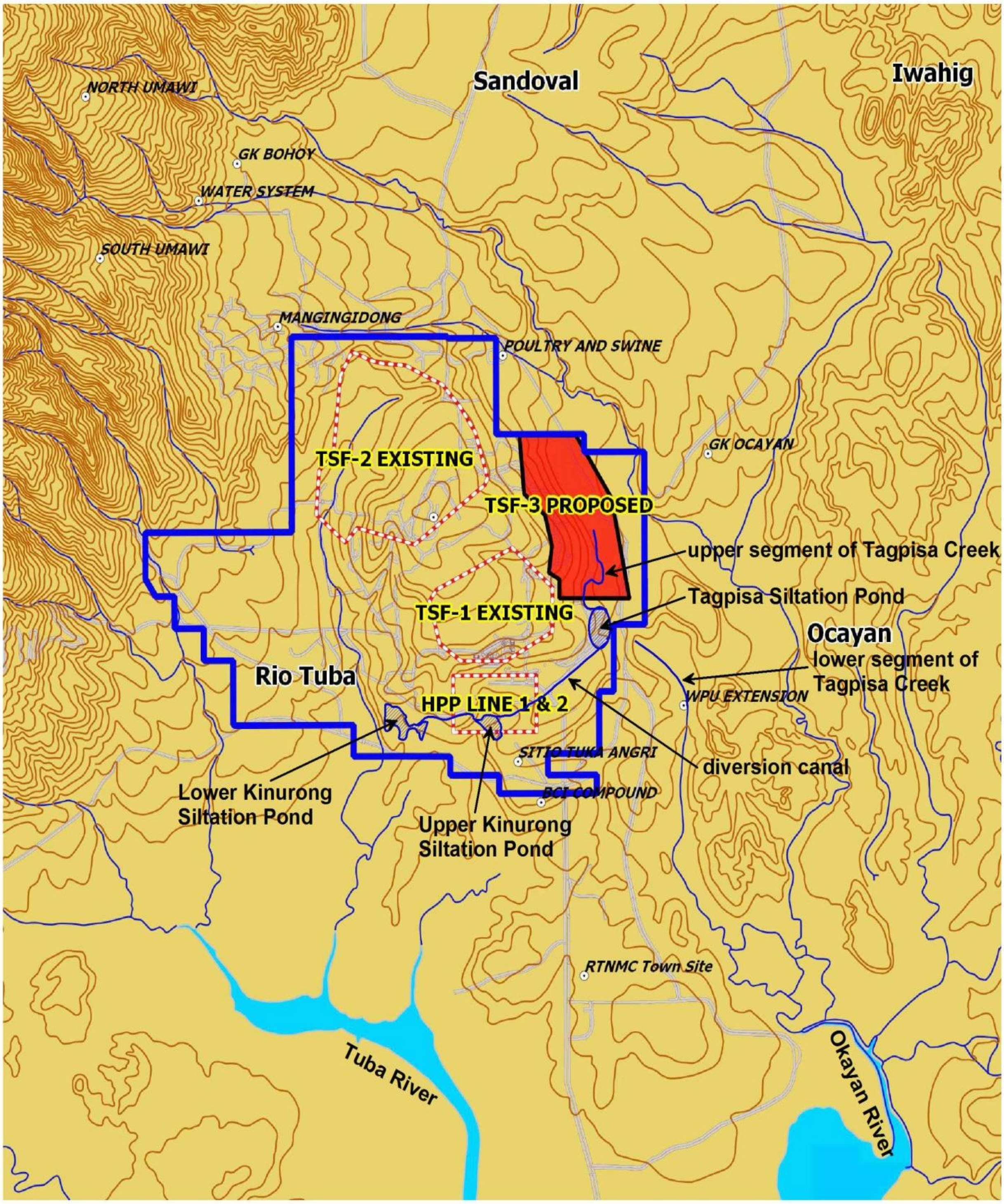


Figure 2.2.4. Realignment of Tagpisa Creek

Plate 2.2.3. Downstream section of Tagpisa Creek after draining the proposed TSF3 area. The water is turbid because a portion of the TSF3 site is a mined out area. The creek then flows into the Tagpisa Siltation Pond for sediment settling.

Plate 2.2.4. This diversion canal routes the outflow from Tagpisa Siltation Pond to the Upper Kinurong Siltation Pond which is within the adjacent Tuba River watershed. The water is notably clearer after passing through the Tagpisa Siltation Pond.

A northwestern tributary of Ocayan River that is called Umawi Creek serves as the source for the Level III water system that supplied Barangay Rio Tuba and the RTNMC townsite and mine offices.

Tuba River

Tuba River drains the southeastern section of Bulanjao Range and the lowlands southeast of the mountain range, which comprises large portions of Barangays Taratak and Rio Tuba. The river flows southeast and empties at Coral Bay in Sulu Sea. The lower reach of this river displays estuarine conditions. Tuba River encompasses a watershed area 5,620 hectares.

Tuba River, the water body that presently receives the flow from Tagpisa Creek, also displays a dendritic drainage pattern. Intermittent creeks likewise characterize all of its first-order tributaries and some of the second-order tributaries. The third-order branches of the river maintain perennial flow. At its mouth, Tuba River remains to be a third-order river.

The first and second-order tributaries of Tuba River as well as some its third-order limbs exhibit a youthful development stage while the lower reach and main trunk of Tuba River are at a mature stage of development.

Two (2) tributaries of this river drain a portion of the present mining area of RTNMC and the areas occupied by the rehabilitated TSF1 and active TSF2 of CBNC. These tributaries are therefore channeled to the Upper and Lower Togpon Siltation Ponds and the Upper and Lower Kinurong Siltation Ponds before discharging into the main trunk of Tuba River.

Stream Flow and Water Balance of Ocayan and Tuba River Watersheds

Since there are no long-term stream flow measurements for any river in Palawan, the discharge of Ocayan and Tuba Rivers were estimated from the long-term water balance of its watershed. The long-term water balance is expressed by the equation $P = AET – Q – GR$, where P, AET, Q and GR represent rainfall, actual evapotranspiration, stream discharge and groundwater recharge respectively (Sokolov and Chapman, 1974).

The rainfall and actual evapotranspiration in the area are already discussed in the above sections. The evapotranspiration values which are presented as depth were multiplied by the catchment areas of these rivers to convert them to volume.

The amount of groundwater recharge is estimated from the hydraulic conductivities of the rocks that underlie the Ocayan and Tuba River watersheds which consists of fractured ultramafic rocks and generally clayey to sandy sedimentary rocks. Fractured ultramafic rocks and clayey to sandy sedimentary rocks attain hydraulic conductivity values ranging from 10^0 to 10^1 meters per day (m/d) and 10^{-3} to 10^2 m/d respectively (Brassington, 2007). These are low to high hydraulic conductivity values such that a groundwater recharge of approximately 8% of the rainfall is considered to be appropriate for the area.

The monthly and annual estimates of stream discharge of Ocayan and Tuba Rivers are then generated using the water balance equation and the rainfall, actual evapotranspiration and groundwater recharge within its watershed.

Table 2.2.5 summarizes the water balance for both watersheds. The table reveals that the annual rainfall, actual evapotranspiration, groundwater recharge and stream discharge within the watershed of Ocayan River amounts to 208.2, 88.5, 16.7 and 103 million cubic meters (MCM) while that of Tuba River respectively amounts to 131.4, 56.5, 10.5 and 64.4 MCM. The stream discharge, actual evapotranspiration and groundwater recharge in both watersheds take up 49%, 43% and 8% of the rainfall, respectively.

Table 2.2.5. Water Balance Summary

Period	Okayan River Watershed (8,764 has.)				Tuba River Watershed (5,620 has.)			
	P	AET	GWR	Q	P	AET	GWR	Q
	MCM							
January	13.0	6.7	1.0	5.3	8.2	4.3	0.7	3.3
February	5.5	4.6	0.4	0.5	3.4	2.9	0.3	0.3
March	6.7	5.4	0.5	0.8	4.2	3.4	0.3	0.5
April	11.3	7.6	0.9	2.8	7.1	4.8	0.6	1.7
May	16.2	8.7	1.3	6.2	10.1	5.6	0.8	3.8
June	24.5	8.6	2.0	13.9	15.5	5.5	1.2	8.7
July	24.7	8.2	2.0	14.6	15.7	5.2	1.3	9.2
August	21.9	8.3	1.8	11.9	13.8	5.3	1.1	7.4
September	25.6	8.1	2.1	15.5	16.2	5.2	1.3	9.7
October	28.7	7.9	2.3	18.5	18.2	5.1	1.5	11.6
November	16.0	7.4	1.3	7.3	10.2	4.7	0.8	4.7
December	13.9	7.0	1.1	5.8	8.8	4.5	0.7	3.6
Annual	**208.2**	**88.5**	**16.7**	**103.0**	**131.4**	**56.5**	**10.5**	**64.4**
% of P		**43**	**8**	**49**		**43**	**8**	**49**

Water Source Inventory

The barangays that encompass the Ocayan River Watershed include Rio Tuba, Ocayan, Sandoval, Iwahig, Igang-Igang, and Sarong. All these barangays belong to the municipality of Bataraza. Residents of these barangays used to rely on wells and springs for their domestic water requirements. The wells are public and private shallow dug wells and drilled wells cased with 38 to 102 mm diameter G.I. pipes (**Plate 2.2.5**). They reach 6 to 49 m depth and are fitted with hand pumps and sometimes electric centrifugal pumps.

The more reliable and durable public wells are those installed by the Pilipino-Aleman Proyekto ng Tubig sa Palawan (PALTUBIG) project in the 1990s, which was funded by the Federal Republic of Germany (**Plate 2.2.6**). Many of the PALTUBIG wells function up to the present.

The springs that were used for domestic purposes are invariably depression springs whose water comes out when the water table intersects an abrupt break in the land slope (**Plate 2.2.7**). Residents used these springs mainly for bathing and washing clothes. The spring that served as a major water source for domestic and agricultural use prior to the operations of CBNC was the Oning Spring. This spring continuous to flow large amounts of water that

Plate 2.2.5. Shallow cased wells such as this one in Brgy. Ocayan used to be the main source of domestic water in the area surrounding the proposed TSF3.

Plate 2.2.6. The PALTUBIG well of Sitio Gotok, Brgy. Sandoval was constructed in the mid 1990s. It still serves as an important water source especially when the supply from the Level II water system is temporarily disrupted.

is still used for agricultural purposes. It is now used only occasionally for domestic purposes with the presence of the Level 2 water system in the area, which was constructed by CBNC and RTNMC in 2013.

Plate 2.2.7. The Oning Spring in Brgy. Sandoval used to be a major water source of residents in the area prior to the installation of the Level 2 water system. It is still being used occasionally for washing and bathing.

<u>Present Sources of Water</u>

In 2010 a Level III water system was installed by RTNMC and CBNC to serve the domestic water requirements of Brgy. Rio Tuba and also the townsite and offices of RTNMC and CBNC. The barangay now almost exclusively relies on this water system whose source is Umawi Creek, which is a tributary of Ocayan River that originates at the eastern slopes of Mount Bulanjao.

Barangays Sandoval and Iwahig and many portions of Ocayan, Igang-Igang and Sarong were also connected to a Level II water system likewise developed by RTNMC and CBNC in 2013. The source of this water system is Baracbaracan Creek, which is a tributary of Iwahig River that similarly originates at the eastern slopes of Mount Bulanjao.

Both water systems employ intake dams to divert raw surface water to a series of screens and settling ponds to filter debris and settle suspended sediments. The water is then chlorinated before distribution by gravity flow through a network of pipes along the national road and barangay roads.

Plates 2.2.8 and **2.2.9** display the Umawi Creek upstream from the intake dam of the Level 3 water system and the treatment facility of this water system, while **Plates 2.2.10** and **2.2.11** show the water treatment facility of the Baracbaracan Level II water system and one of its outlets in Bgy. Sandoval.

RTNMC also installed five (5) deep wells in the 1980s and 1990s to supply water to its townsite and mine offices which are located within Brgy. Rio Tuba. These sites now rely also on the Umawi Creek water system for its water supply. Except for the first well which was abandoned in the 1990s because of saltwater contamination, the RTNMC wells are presently maintained for use in the crushing plant operations of RTNMC and CBNC and for emergency purposes (**Plates 2.2.12** and **2.2.13**).

Plate 2.2.8. The Umawi Creek immediately upstream from the intake dam of the Level III water system.

Plate 2.2.9. The raw water treatment facility of the Level 3 water system fed by Umawi Creek. This facility has several screens and settling ponds to filter and settle suspended solids prior to chlorination.

Plate 2.2.10. The Umawi Creek immediately upstream from the intake dam of the Level III water system.

Plate 2.2.11. The raw water treatment facility of the Level 3 water system fed by Umawi Creek. This facility has several screens and settling ponds to filter and settle suspended solids prior to chlorination.

Plate 2.2.12. The Umawi Creek immediately upstream from the intake dam of the Level III water system.

Plate 2.2.13. The raw water treatment facility of the Level III water system fed by Umawi Creek. This facility has several screens and settling ponds to filter and settle suspended solids prior to chlorination.

Plate 2.2.14. A series of screens and settling ponds at the raw water treatment facility beside Baracbaracan Creek filter the water of the Level II before it is chlorinated and piped to the users.

Plate 2.2.15. An outlet of the Level II water system serves a cluster of houses beside an inner road in Brgy. Sandoval.

Plate 2.2.16. The well casing and riser pipe of RTNMC Water Well No. 2 (WW2) which is labeled W-6 in the water source location map.

Plate 2.2.17. The pump house and water truck outlet of RTNMC Water Well No. 3 (WW3) which is labeled W-7 in the water source location map.

Figure 2.2.5 shows the location of the Umawi and Baracbaracan intake facilities and the more important wells in the vicinity of the proposed TSF3 while **Table 2.2.6** summarizes the water source data.

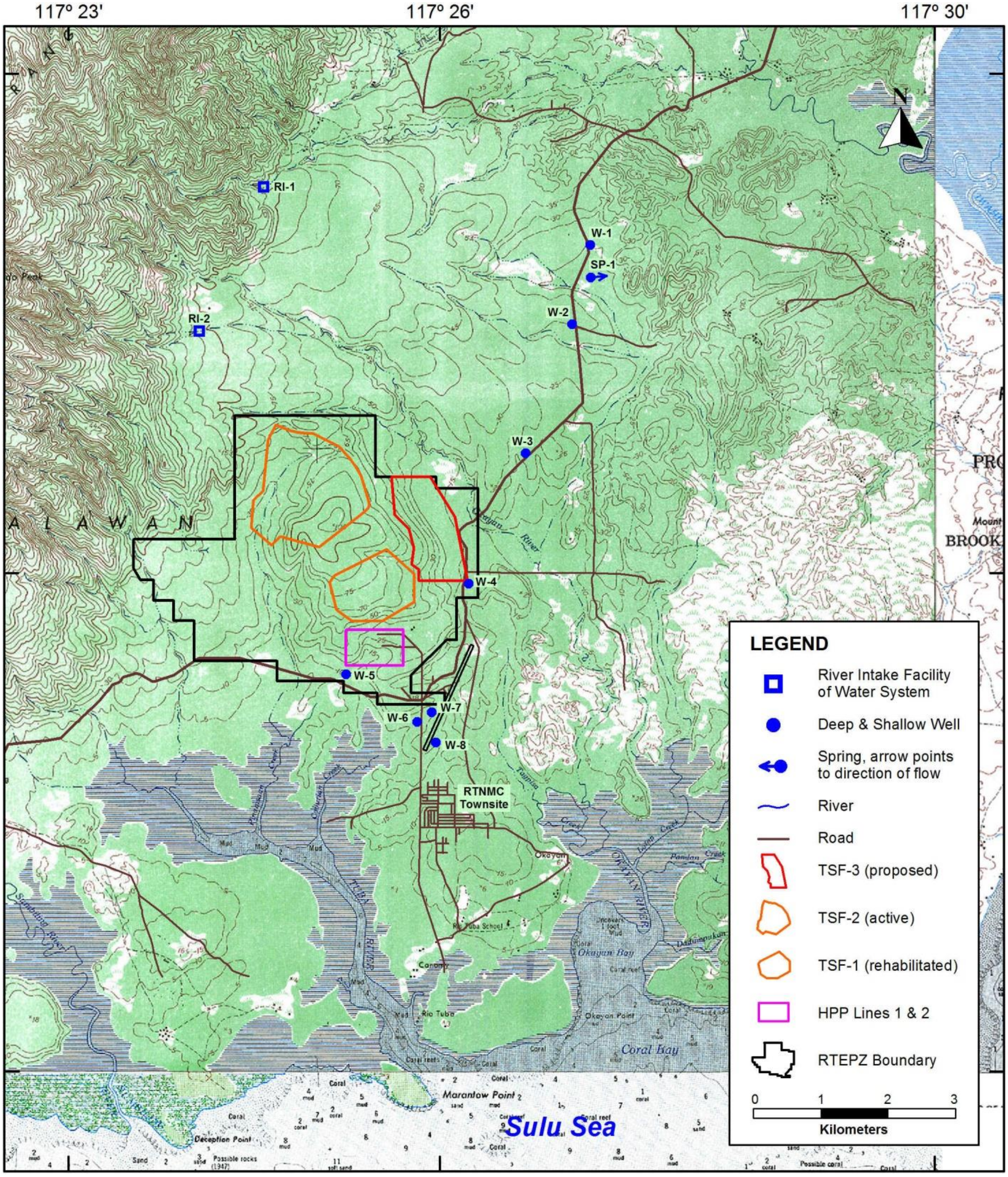


Figure 2.2.5. Water source location map

Aside from the abovementioned wells, many shallow wells with hand pumps and dug wells exist in the lowlands to the east and southeast of the proposed TSF3. However, since this area is already supplied by a water system, these wells are barely used and are often left to deteriorate. These wells have not been included in the inventory.

Table 2.2.6. Summary of Water Source Inventory

Water Source ID	Type	Name / Location	Owner	Depth (m)	Casing	EC*	pH	Physical Appearance	Remarks
RI-1	River intake	Baracbaracan Creek, Brgy. Sandoval	RTNMC & CBNC	-	-	163	7.5	Clear, odorless	Supplies domestic water to barangays Sandoval, Iwahig, Ocayan, Culandanum, Igang-Igang & Sarong.
RI-2	River intake	Umawi Creek, Brgy. Okayan	RTNMC & CBNC	-	-	204	7.6	Clear, odorless	Supplies water to Bgy. Rio Tuba and the RTNMC townsite & mine offices.
W-1	Deep Well	Paltubig Well, Brgy. Sandoval	BWSA Bicol Village	21	102	-	-	Clear, odorless	Not operational, needs gasket replacement.
W-2	Deep Well	Paltubig Well, Brgy. Sandoval	BWSA Gotok	22.4	102	580	7.6	Clear, odorless	Used by approx. 500 families living in Kulantood to Bicol Village for drinking, cooking, washing and bathing particularly when supply from the Level II water system is disrupted.
W-3	Deep Well	Paltubig Well, Brgy. Ocayan	BWSA Okayan	45.7	100	653	7.4	Clear, odorless	Used by approx. 200 families for drinking, cooking, washing and bathing particularly when supply from the Level II water system is disrupted.
W-4	Deep Well	Paltubig Well, Brgy. Ocayan	BWSA Tagpisa	15.6	102	484	7.5	Clear, odorless	Used by approx. 100 families at Sitio Tagpisa, GK and Tagpisa 2 for drinking, cooking, washing and bathing particularly when supply from the Level II water system is disrupted.
W-5	Deep Well	RTNMC WW5, Brgy. Rio Tuba	RTNMC	18.7	300	215	7.2	Turbid, odorless	Inactive for 1 year, resumed operation in July 2016. Supplies process water for the RTNMC and CBNC crushing plant.
W-6	Deep Well	RTNMC WW2, Brgy. Rio Tuba	RTNMC	34	300	803	7.1	Turbid, odorless	Supplies process water for the RTNMC crushing plant.
W-7	Deep Well	RTNMC WW3, Brgy. Rio Tuba	RTNMC	35	300	-	-	-	Well is inactive since July 2016 and needs new turbine pump.
W-8	Deep Well	RTNMC WW4, Brgy. Rio Tuba	RTNMC	49	300	534	7.7	Slightly turbid, odorless	Maintained on standby, used during brownouts to supply process water for RTNMC crushing plant.
SP-1	Spring	Oning Spring, Brgy. Sandoval	-	-	-	215	7.3	Highly turbid, odorless	Used only for washing and bathing by nearby residents.

Aquifer Characteristics

The geology of the area and the findings of the water source inventory, particularly the presence of wells that range from 3 to 49 m depth, indicate that shallow unconfined aquifers as well as deeper, presumably confined aquifers exist in the lowlands to the east and southeast of Mount Bulanjao. The shallow confined aquifers consist of the silty to gravelly deposits in the Quaternary Alluvium, the upper, weathered portions of the sandstones in the Panas and Sayab Formations, and also the upper, weathered portions of the limestone in the Iwahig Formation. The confined aquifers also consist of these types of deposits that occur at more than 20 m depth and are overlain by generally impermeable clay, mudstone and shale layers.

Considering the shifting, intertonguing nature of alluvial deposition, the folded and bedded nature of the Panas and Sayab formations, and the limited extent of the limestone and conglomerate members of the Iwahig Formation, the unconfined and confined aquifers in the area are not expected to be thick nor extensive but instead thin and locally disconnected.

Both types of aquifers yield generally clear and odorless groundwater that is abundant during the rainy season. During the dry season, the yield of the shallow unconfined aquifers sharply diminishes compared to the deeper aquifers.

Distribution of Hydrogeologic Units

Based on the geology of the area and the findings of the water source inventory, the area of the proposed TSF3 and its immediate surroundings may be delineated into three (3) hydrogeologic units.

The first hydrogeologic unit consists of the rugged mountains and foothills of Bulanjao Range. These are underlain by ultramafic rocks, spilitic basalt flows, pillow basalts, and chert of the Mt. Beaufort Ultramafics and Espina Formation. Being generally hard and dense but moderately fractured, these rocks are deemed to be slightly permeable only and are expected to yield little amounts of groundwater.

The hilly to gently undulating terrain that is underlain by the folded and dipping rocks of the Panas, Sayab and Iwahig formations constitute the second hydrogeologic unit. The moderately consolidated nature of the sandstones in the Panas and Sayab formations and the massive but vuggy characteristic of the limestone in the Iwahig Formation render them relatively porous and permeable. They are able to store and yield slight to moderate amounts of groundwater.

Unconsolidated to loosely consolidated gravel, sand, silt and clay of the Quaternary Alluvium and the raised coral reefs along river valleys and beaches that are also Quaternary in age comprise the third hydrogeologic unit. Their high degree of porosity and permeability permit them to store and transmit relatively large amounts of groundwater. The aquifers in alluvial deposits and raised coral reefs located near the shoreline are however prone to saltwater intrusion.

Figure 2.2.6 illustrates the hydrogeologic map of the area prepared according to this classification scheme.

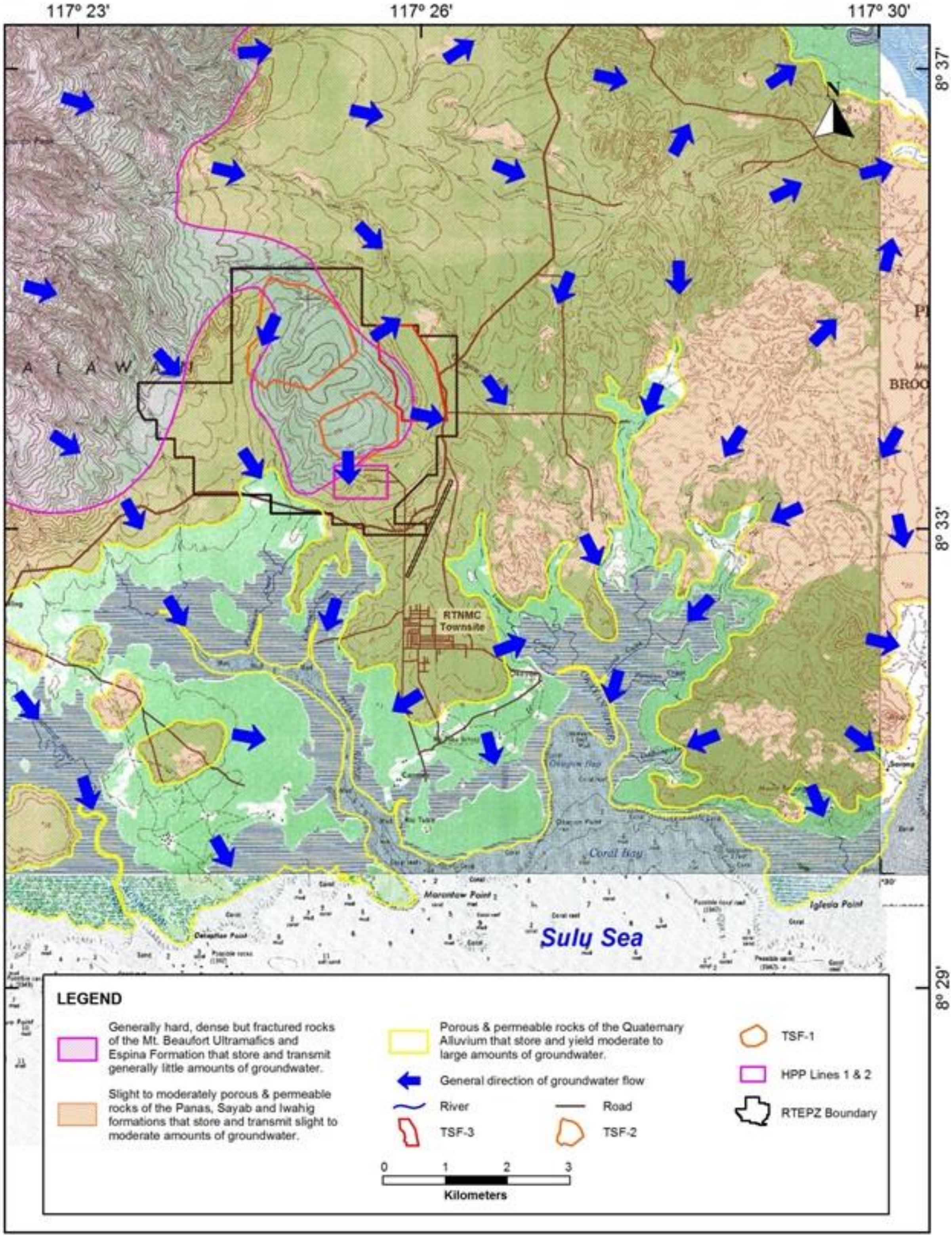


Figure 2.2.6. Hydrogeologic Map

Groundwater Levels, Flow Direction and Recharge

The presence of dug wells and shallow wells in the lowlands adjoining the proposed TSF3 indicates that the groundwater level in these areas is not more than 6 meters below the ground. The groundwater level in low-lying areas even intersects the land surface as indicated by the presence of depression springs like Oning Spring (SP-1).

Groundwater moves from high to low elevation head and will therefore follow the topographic gradient. This means that from Mount Bulanjao, the groundwater will move downward in all directions and travel across the surrounding alluvial and coastal plains following the general flow direction of the drainage systems in the area. The groundwater will ultimately discharge at the surrounding seas.

The aquifers in the vicinity of the project site are replenished from direct rainfall infiltration, interflow from the tributaries of the Iwahig and Ocayan rivers and groundwater movement from high to low areas. Based on the water balance in **Table 2.2.5**, the area absorbs approximately 8% of the rainfall as groundwater recharge.

2.2.1.3 Impact Assessment

Depletion of Water Resources/ Water Competition

The HPP operations of CBNC require around 30,000 m^3 of water per day. The water for the processing plant is mainly sourced from the East Ibelnan River through an intake dam and a pipeline that conveys the water to the processing plant. Additionally, the Upper Togpon Siltation Pond and a 300,000 m^3 reservoir serve as standby sources of water particularly during the summer months. The proposed increase in cobalt production and construction of the TSF3 will not increase the present water requirement.

CBNC as a practice also recycles wastewater. Approximately 30-40% of the supernatant are recycled back to the HPP while 20% of the cooling and wash water is also reused.

The East Ibelnan River drains the eastern flank of Mt. Bulanjao and is a tributary of the main Ibelnan River which connects to the main trunk of Tuba River. Prior to the construction of the HPP, the Ibelnan River was used for washing clothes and bathing by residents of Rio Tuba, mainly during the summer months. The residents come from as far as the barangay proper and carry out these domestic activities on the upstream side of the Ibelnan Bridge which lies along the municipal road from barangays Rio Tuba to Sumbiling. Currently, the creek is still being used by residents for domestic purposes since the flow of both the East and the West Ibelnan River is maintained. Approximately 10% as required by the NWRB is allowed to flow out from the Ibelnan Intake Dam.

As a means to provide a better source of water for all types of domestic use, RTNMC and CBNC installed a Level 3 water system in 2010 whose source is the Umawi Creek at the eastern slopes of Mount Bulanjao. This water system serves much of Rio Tuba and the townsite and offices of RTNMC and CBNC. The Ibelnan River continues to discharge significant amounts of water that is still occasionally used for washing and bathing by residents who live near the creek.

On the other hand, the Upper Togpon Siltation Pond and the 300,000 m^3 reservoir collect water from headwaters of the Togpon Creek that similarly drain the eastern flank of Bulanjao Range. This creek is situated to the east of Ibelnan River and merges with Kinurong Creek farther downstream from the Lower Togpon and Lower Kinurong siltation ponds before connecting to the main channel of Tuba River. Togpon Creek was not used as a source of domestic water prior to the construction of the HPP and it is still not a source of domestic water at the present time.

Flood Modelling

Design Storm for the Project Area

The model hyetograph using a centre-concentrated pattern is prepared using the Rainfall-Intensity-Duration-Frequency curve (RIDF) at Puerto Princesa City, Palawan Synoptic Station (reference: RIDF of Selected Synoptic PAGASA Station, *Attachment 4.3* of *"Specific Discharge Curve, Rainfall Intensity Duration Curve, Isohyet of Probable 1-day Rainfall"*, FCSEC, March 2003).

From this RIDF, the model hyetograph for the 100-year flood return period was derived. Likewise, the projected changes of this 100-year return period rainfall in years 2020 and 2050 under the PAGASA medium-range emission scenario in the province of Palawan were derived and is shown below:

Table 2.2.7. Projected 100-year return period for rainfall in years 2020 and 2050

Time (hour)	100-year Rainfall, mm (Baseline event)	100-year Rainfall, mm (Year 2020 Projection)	100-year Rainfall, mm (Year 2050 Projection)
1	2.13	2.55	2.72
2	2.05	2.45	2.62
3	2.38	2.85	3.04
4	2.82	3.37	3.61
5	3.07	3.67	3.93
6	3.53	4.22	4.51
7	4.18	5.00	5.34
8	5.13	6.14	6.56
9	6.62	7.92	8.46
10	9.24	11.05	11.81
11	15.14	18.11	19.36
12	35.38	42.31	45.23
13	78.94	94.41	100.93
14	21.58	25.81	27.59
15	11.56	13.83	14.78
16	7.78	9.30	9.95
17	5.73	6.85	7.33
18	4.64	5.55	5.93
19	3.77	4.51	4.82
20	3.23	3.86	4.13
21	2.84	3.40	3.63
22	2.44	2.92	3.12
23	2.47	2.95	3.16
24	2.15	2.57	2.75
TOTAL	**238.80**	**285.60**	**305.31**
MAX	**78.94**	**94.41**	**100.93**

For the hydrologic component, **Figure 2.2.7** is the screen-grab of the input hyetograph for a 100-year design rainfall event and the corresponding flow hydrograph based on hydrologic model results for CBNC sub-catchment. These outputs (including the flow hydrographs computed for sub-catchments) were used in the modelling of the extent of floods within the project area.

In practice, model accuracy is assessed by comparison of water surface profiles with gauge observations in the channels. Despite the absence of such gauging stations in the area, the model was set-up and applied to predict and visualize the extent of the possible flood inundation given the readily available information in the project area.

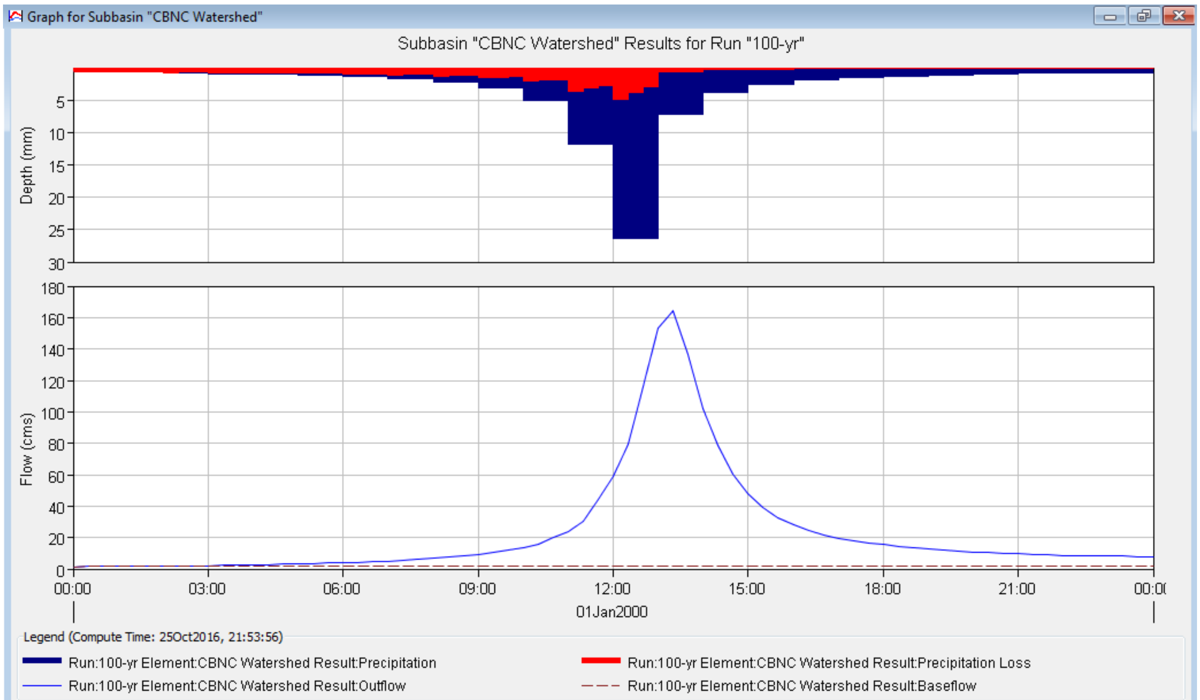


Figure 2.2.7. The rainfall hyetograph for a 100-year rainfall event (upper portion) and the flow hydrograph output (lower portion) using the HEC-HMS hydrologic model.

To simulate extreme flood situation in the proposed project area, a flood magnitude that may occur at least once in a hundred years on average (a 100-year flood) is used to run the hydraulic model.

As for the initial conditions in the model runs, it was assumed that the water surface elevation at the downstream boundary (at the mouth of the river that meets the open sea) is taken to be about one (1) meter above the mean sea level which corresponds to high tide level. Specifying higher-than-normal tide level would ensure decreased water surface profiles in the river mouth, which may provide backwater effects and is therefore representative as extreme event for flood scenario modeling.

An initial simulation runs for about 6 hours using 3 mm of rainfall to the catchment is used for appropriate antecedent condition (so called 'warm start') before running the computations for the design storm to remove depressions in the DEM that were not directly connected to the drainage system. The 3 mm was based on the magnitude of rainfall before and after the design 24-hour storm hyetograph.

Figures 2.2.8 to **2.2.11** below show the simulated maximum flood depth including portions of the floodplain for a 100-year return period. The model shows the general trends of floodplain inundation. Most of the floodwaters are confined in the main rivers and tributaries, with some patches of inundation visible near the riverbanks indicating overflows and those isolated areas representative of depression storages in the catchment.

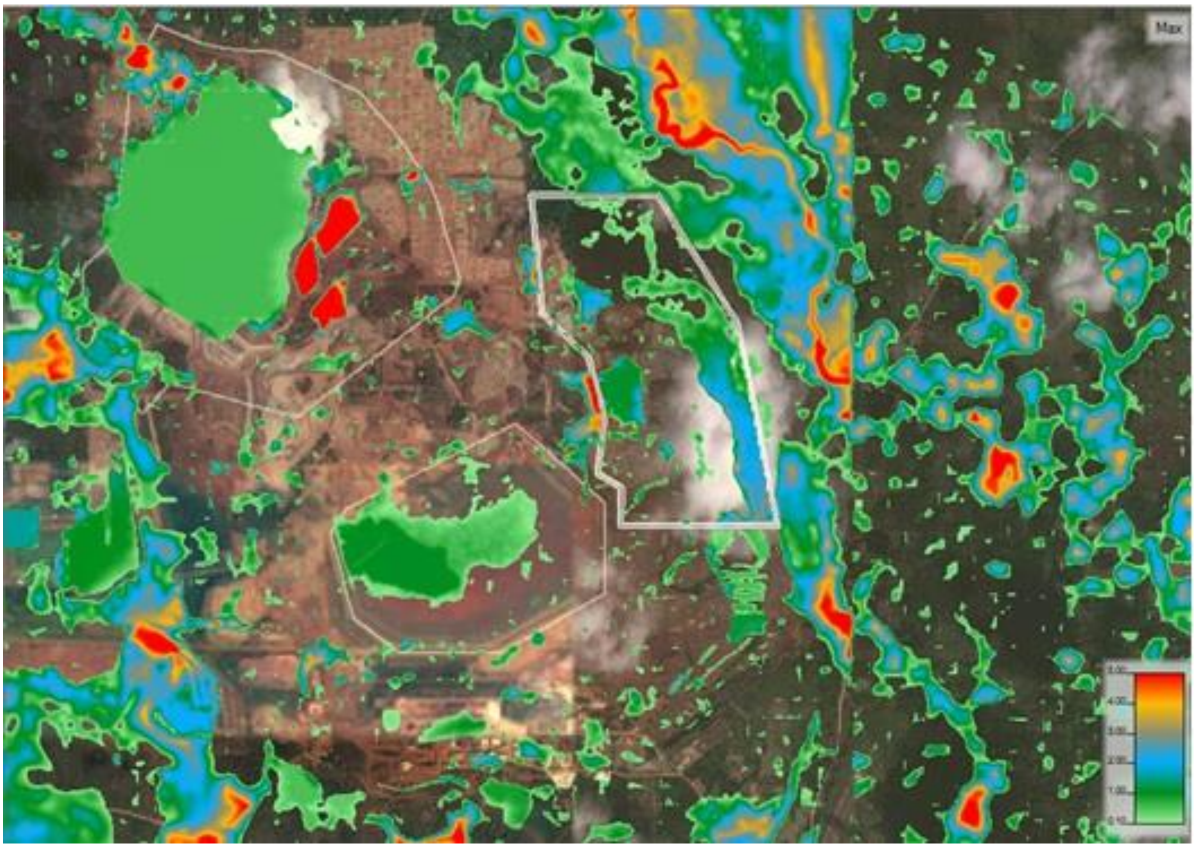


Figure 2.2.8. The predicted flood inundation maps within the sub-basins surrounding the CBNC project area for a 100-year flood event using the baseline climactic condition.

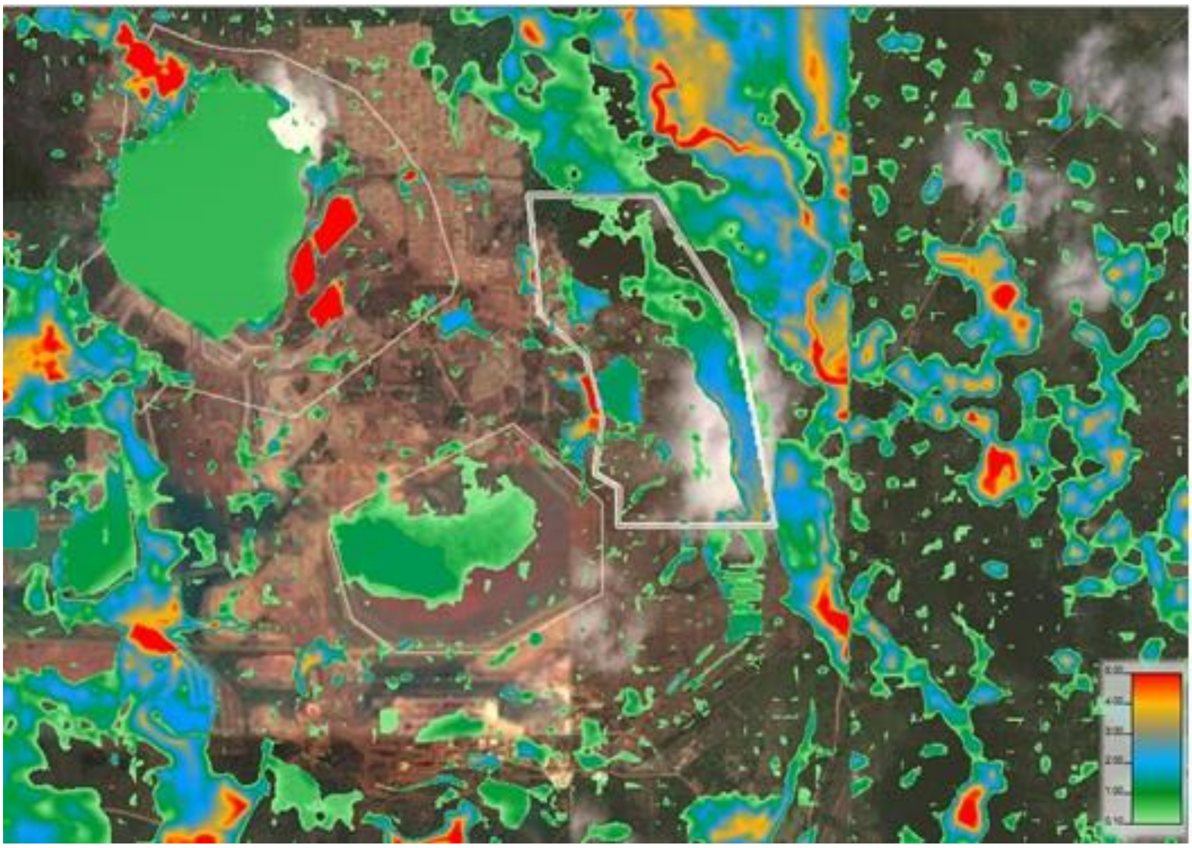


Figure 2.2.9. The predicted flood inundation maps within the sub-basins surrounding the CBNC project area for a 100-year flood event using the PAGASA 2020 climactic condition.

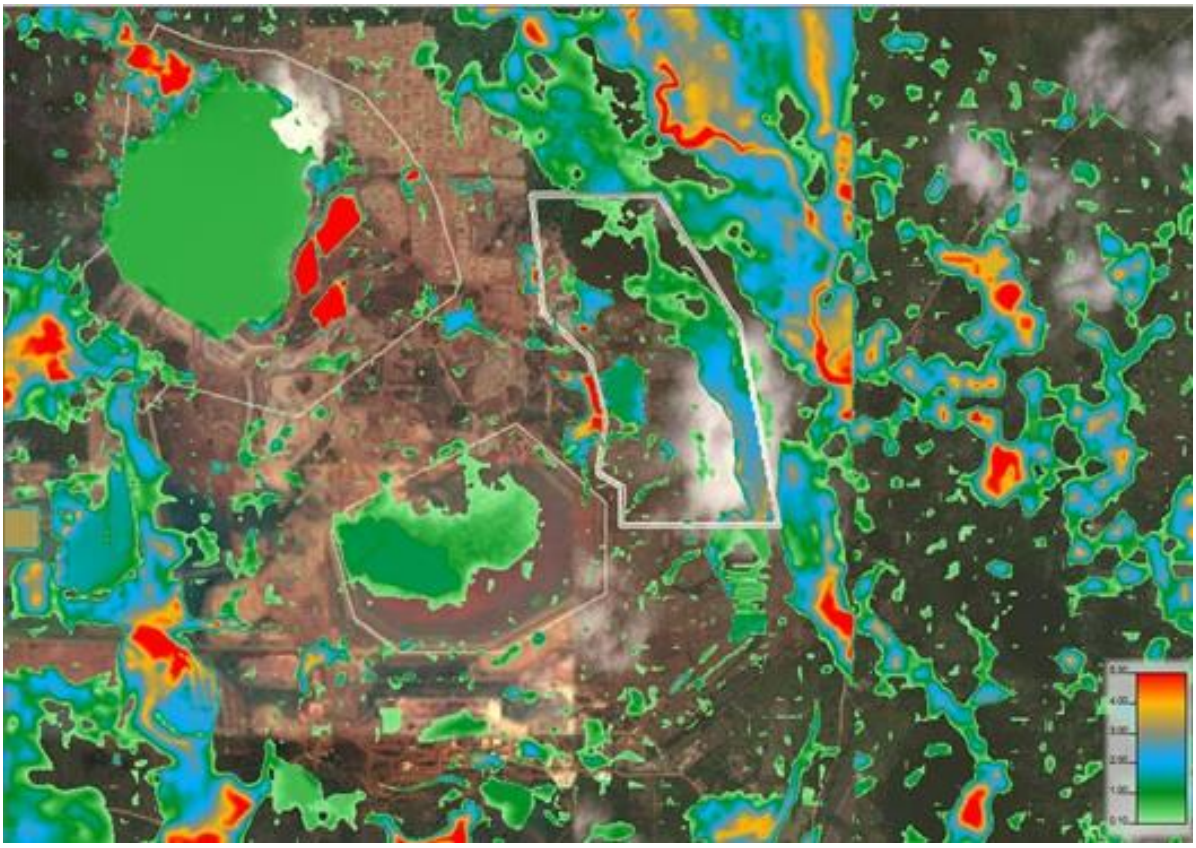


Figure 2.2.10. The predicted flood inundation maps within the sub-basins surrounding the CBNC project area for a 100-year flood event using the PAGASA 2050 climatic condition.

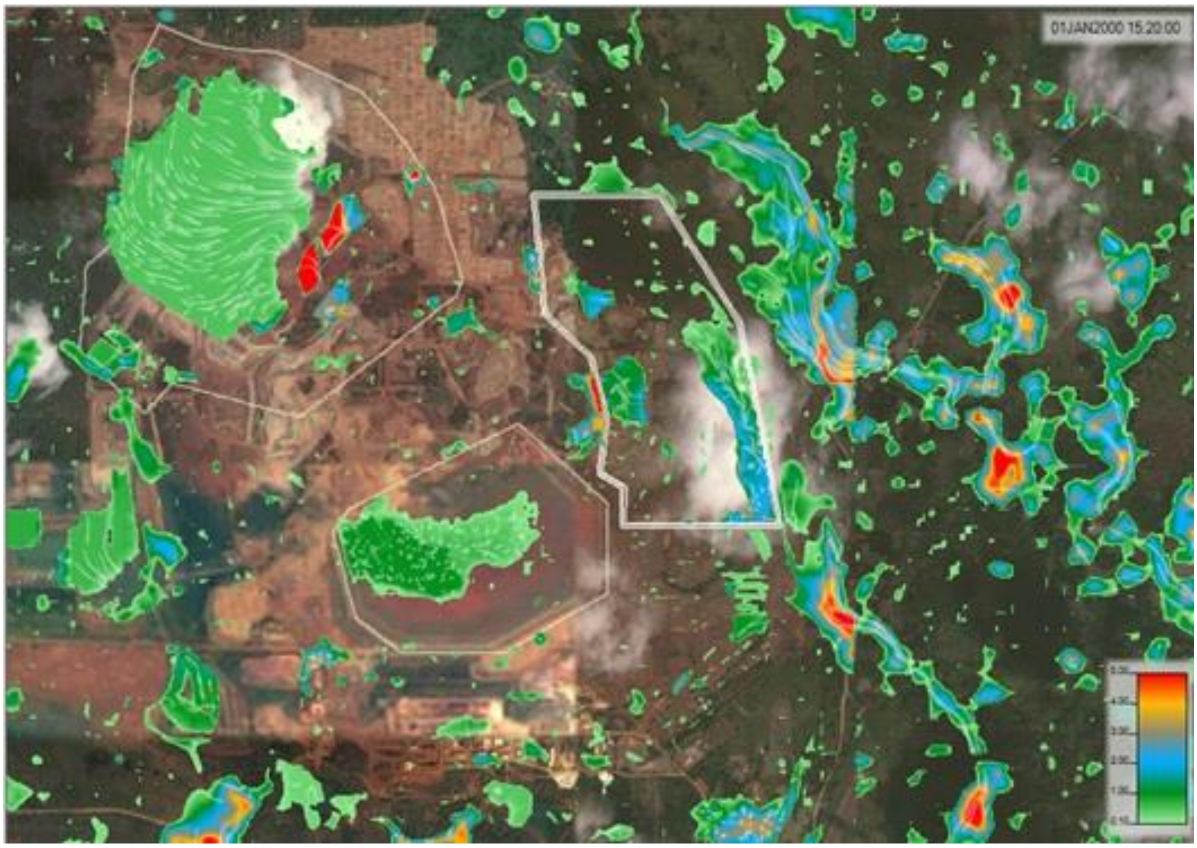


Figure 2.2.11. A snapshot during the peak of flood showing the predicted flood velocity plot (white lines) for a 100-year flood event using the baseline climatic condition.

The 2D methodology provides detailed hydrology to all parts of the modelled catchment. This can provide some difficulties with standard mapping and planning processes and as such, filtering of the model results were applied, specifically, flood depths less than 0.10 m have been removed from the mapping by making this threshold value transparent in the figures presented. It should be noted that the mapping depicts the maximum flood depth at any given location. The maximum flood depth is the deepest water recorded throughout the 100-year flood computations. This will tend to display maximum depths for short duration storms at the upstream catchment, and maximum depths for the longer duration, accumulated floods as it flow towards the bottom of the catchment. The flood maps include flood extents, flood depths, and flood hazard.

For convenience of displaying results, the flood study area was zoomed in to the project site to show and exhibit the flood map in sufficient detail. Given these maps, the modeling predicts that the vicinity of the existing and proposed temporary storage facility (TSF) areas is moderately prone to riverine floods for both simulations of present and post-development. This is due to the fact that the TSF area is located in rather mild sloping terrain, where most of the flood prone areas located east of the project. Some natural and man-made depression area located in close proximity with the creeks and road networks helps in partially storing the excess runoff which would otherwise flow directly into the open sea. There is likewise a marginal increase in terms of flood depths for the 2020 and 2050 rainfall change scenario.

From the velocity vector plots overlaid in the given map, high flood events occur at the main channel while the inundation areas are within the riverbanks and depression areas specially those located in the downstream and midstream portions of the catchment.

From the maps, it can be seen that some portions in the project site are moderately prone to overland flooding due to some changes in elevation brought by physical development of the site. With appropriate engineering interventions however, flooding in the area will remain to be minimal.

Note that while the model output is highly dependent on the topographic inputs, which in this study, is too coarse to warrant micro-level analysis of flooding especially at the downstream portion, the result is quite promising. With better detailed model inputs, the maps generated can be used to determine which areas are vulnerable to flood which can then serve as guides in the preparation of flood defenses and other flood mitigating measures.

Dam Break Scenario for TSF3

Tailings Storage Facilities (also called Tailings dams) impound large amounts of mine tailings, coal slurry, and other industrial muds and wastes. One of the potential hazards of storing such wastes is the potential occurrence of accidental spillages due to overtopping or a breach in the section of a storage dike or containment structure. Being mud-like or in a semi-solid waste that flows more slowly than water, breaches in tailings dams generally lack the massive, instantly destructive force of a catastrophic water dam break. However, they have a very high potential to cause severe environmental, social, and economic harm. In addition to damages caused by physical inundation, the released material is often toxic or otherwise harmful to people and the environment.

To visualize the extent of spillage in case such accident occurs in the site, the model was set-up to allow breaking of the south section of TSF3 dike once the storage level reaches the

42 m elevation and letting it flow downstream due to actions of gravity. As designed, TSF3 can accommodate 18.605 million cubic meters of mine tailings at an average elevation of 39.50 m.

A hypothetical breaching of a dike was conceptualized using the 2D version of the HEC-RAS model wherein the assumed collapsed is about 10 m width at the bottom of the dike with 45 degree slopes each side. The breach is further assumed to be due to piping failure, where seepage through the dam section erodes the soil materials, creating a flow path through the embankment. The formation time of the breach is assumed to be 4 hours, with an elevation of 41 m triggering the start of the breach. Also, direct rainfall and inflows from tributaries where purposely set to zero to ensure that the resulting propagation of mine spillage downstream can be attributed solely to the TSF3 source.

Typical causes of dam failure include, but not limited, to the following:

- weak foundation - where the soil or rock below the dam is too weak to support the dam.
- during seismic events - where the tailings slurries (including the material used for the dam) may liquefy.
- Piping failure - if seepage within or beneath the embankment causes erosion along its flowpath, which may result in local or general failure of the embankment.
- Overtopping of dams or even the excessive rises in the level of the water ponding on the slurries in the impoundment, caused by inflow from heavy rainfall events, can also cause failures of dam.

In the study of Strachan (2001) for example, the relative frequency of different sources of problems with both water and tailings impoundments were analyzed. For tailings dam, this distribution of causes were found: slope instability (24%) earthquake (17%), overtopping (15%), foundation (11%), seepage (11%) structural (8%) erosion (3%) mine subsidence (1%) and unknown causes (10%). In terms of dam failure over time, a study by Azam (2010) indicated that for a world inventory of 18,401 mine sites, the failure rate over the last 100 years is estimated to be 1.2%.

Failure of the dam is a very complicated process; and factoring in the best management practices within which the dam's mine tailings are placed and disposed over time during the operation may increase the margin of safety, it may not be enough to determine its stability or finding the weakest portion within which potential dam failure may occur.

As such, hypothetical scenarios thru numerical modeling were made just to provide potential hotspots in case such failure occurs.

Figures 2.2.12 to **2.2.15** are the snapshots of the propagation of the flood wave as a result of the hypothetical breaching of said dike section.

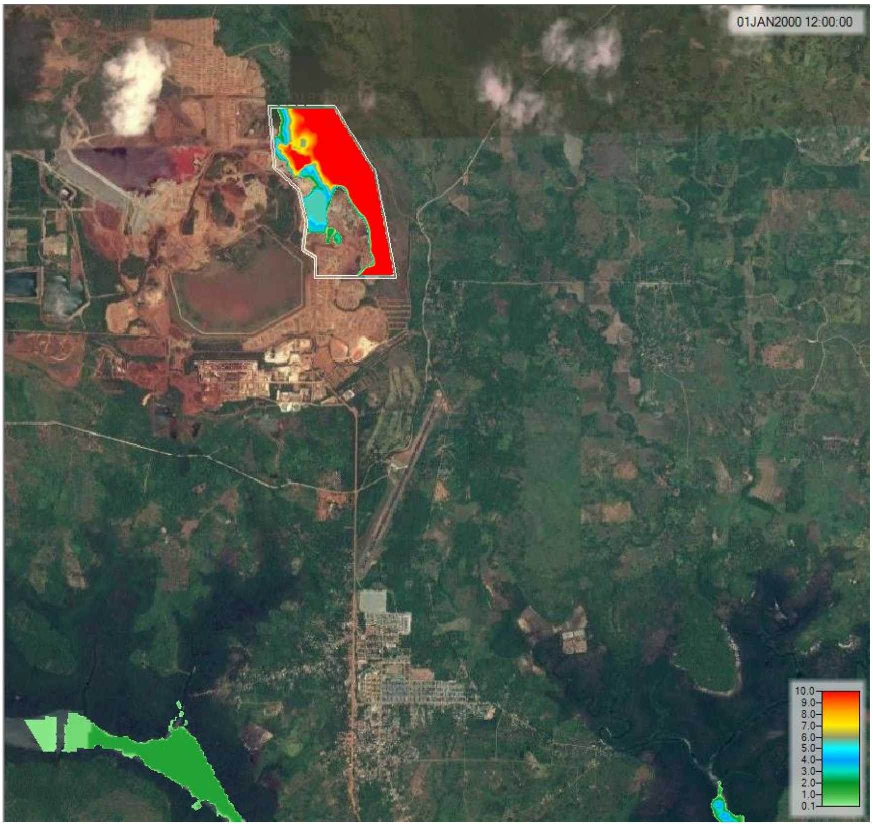


Figure 2.2.12. The depth of the stored materials in TSF3 just before the dike breach.

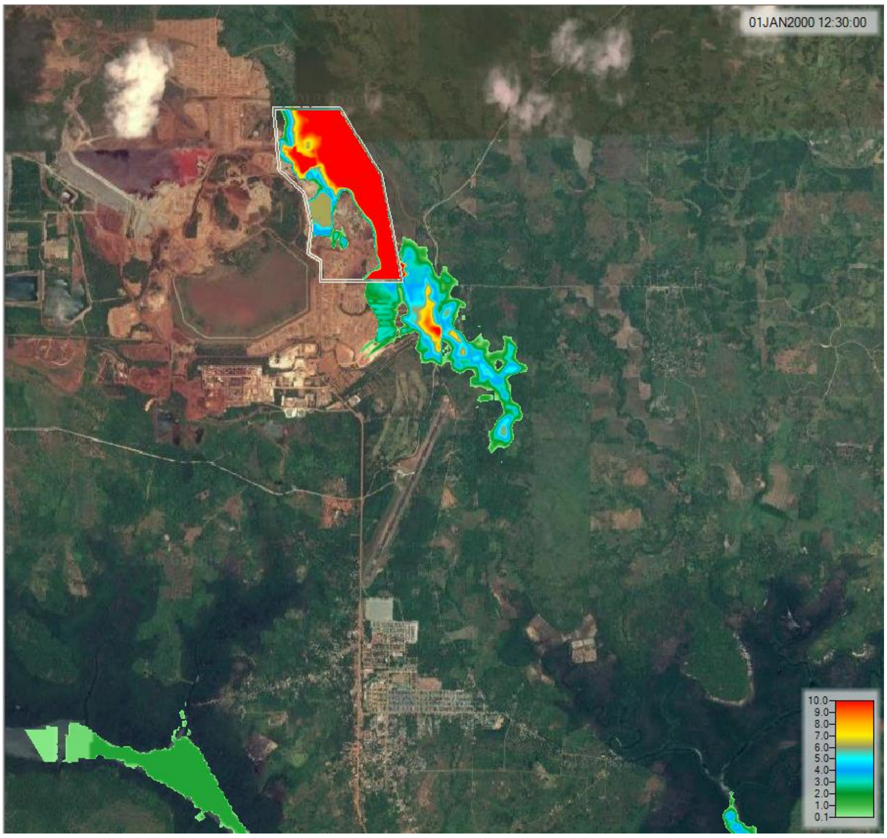


Figure 2.2.13. Predicted depth and spreading of waste spillage 30 minutes after the hypothetical dike breach.

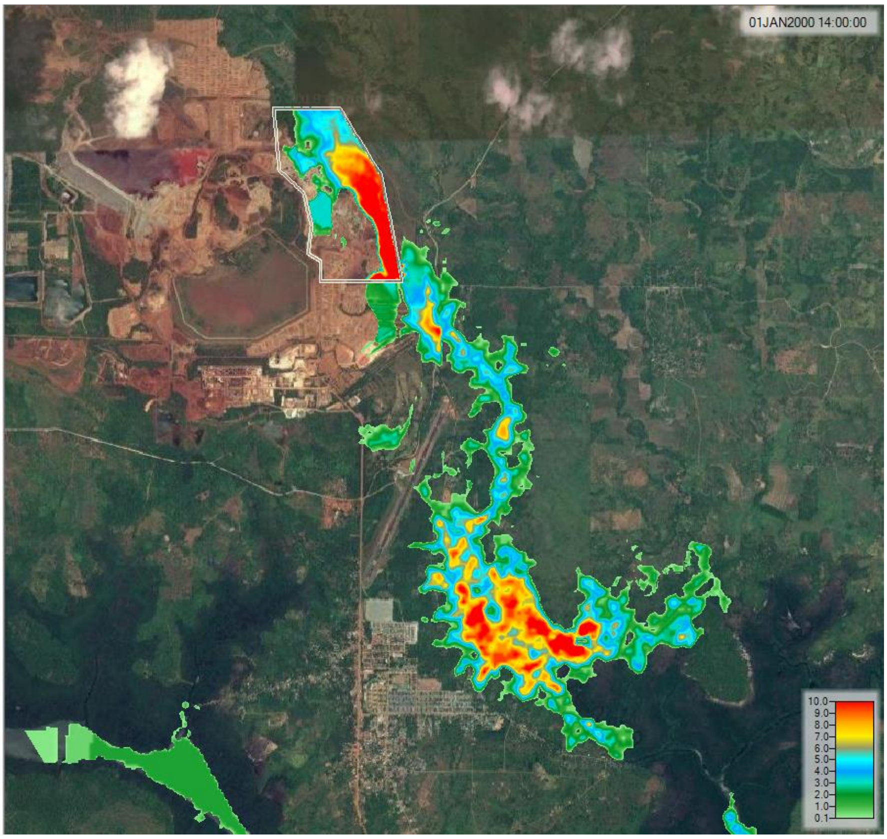


Figure 2.2.14. Predicted depth and spreading of waste spillage two (2) hours after the hypothetical dike breach.

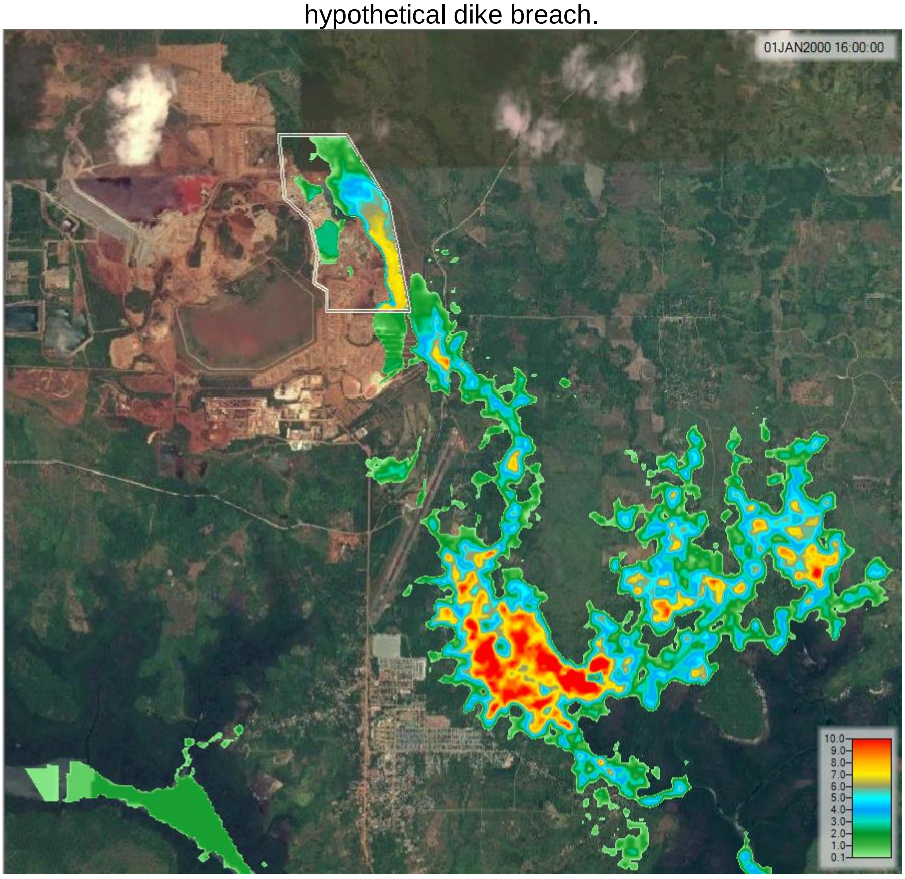


Figure 2.2.15. Predicted depth and spreading of waste spillage four (4) hours after the hypothetical dike breach. Notice the almost empty reservoir as most of the stored materials flow out into the downstream area of the project.

The maximum flood depth is then derived by taking the maximum predicted water depth throughout the dam-break flood computations, as shown in **Figure 2.2.16**. From this generated maximum depth map, which can be used as a 'dam failure inundation hazard map', it can be deduced that area southwest of TSF3 has high potential for inundation with depth of more than 5 meters in some critical areas. Notice also the possible blockage of a roadway traversing the area which may potentially affect transportation and mobility of resources. The existing runway of the airport is predicted to be away from the pathways of flood and is therefore free from possible effects of the dam failure.

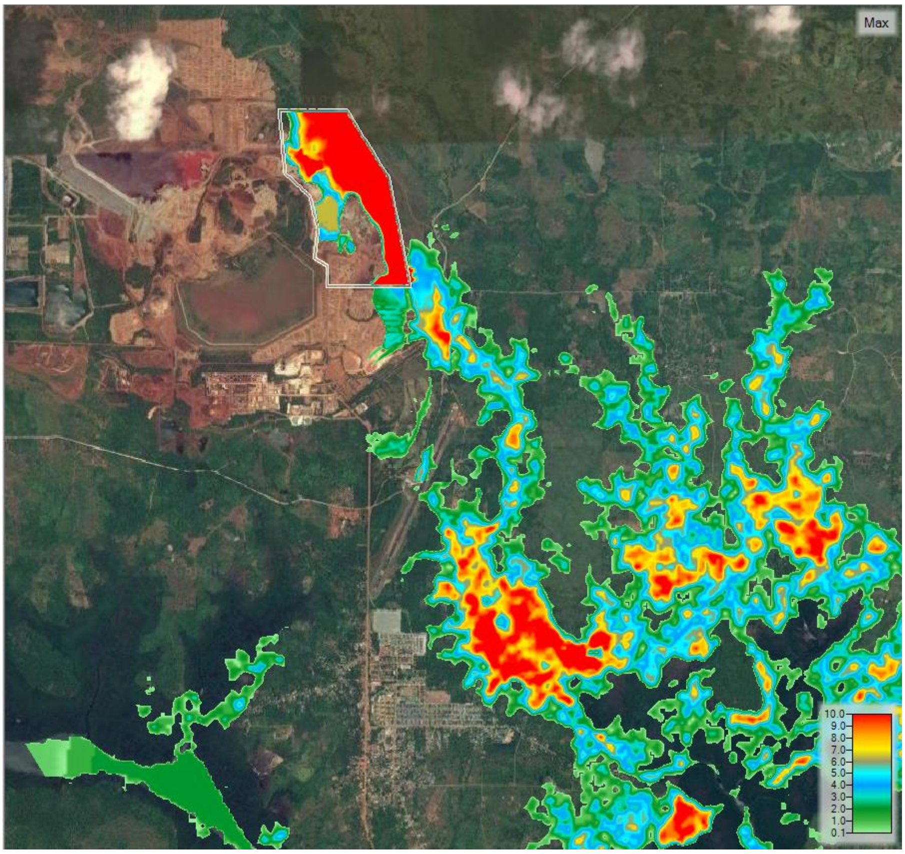


Figure 2.2.16. Predicted maximum depth and extent of spreading of waste spillage showing the potential 'hotspots' of the pathways of sediment-laden flows in case of TSF3 dam failure.

In summary, the results of this scenario runs indicate potential impacts to the downstream communities of the project in the event of storage dam failure. However, flood peak and arrival time used in this model and the uncertainties associated with the breach parameters used, especially breach width, breach depth and breach development time may cause uncertainty in flood peak and arrival time.

Further, the potential high velocity flows associated with dam break floods can cause significant scour of waterways. This enlargement in channel cross-section is neglected since the equations for sediment transport, sediment continuity, dynamic bed form friction etc. are not included in the governing equations of the HEC-RAS model. The narrow channels with minimal flood planes are subject to over-estimation of water elevation due to significant channel degradation. The resulting floods from dam failure carries significant amount of transported debris, which may accumulate at very narrow cross sections, resulting in water level variation at downstream locations. This aspect has been neglected due to limitations in modeling of such complicated physical process.

Nevertheless, despite the inability of the existing 2D version of HEC-RAS model to simulate the sediment transport patterns as a result of dam breach, the resulting hazard inundation map can be used to identify potential hotspots of the pathways for sediment-laden flows, which the CBNC management may integrate in their disaster risk reduction and management planning and in its IEC activities during its project implementation.

Table 2.2.8. Impacts assessment and mitigation for hydrology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Pre-Construction	
Change in drainage morphology The morphology of existing drainage lines will not change at any phase of the project.					
Inducement of flooding Localized flooding may occur if Tagpisa Creek, the Tagpisa and Upper Kinurong siltation ponds, and other tributaries of Ocayan River become heavily silted. Heavy Flooding is not experienced on site however, CBNC have installed contingency measures in case heavy flooding occur.		✓	✓	✓	Regular desilting of the Tagpisa Creek and siltation ponds should be done to lessen the chance of sediment laden runoff from reaching the other tributaries of Ocayan River. Constructing a levee along the east side of Tagpisa Creek will minimize the chance of siltation at the other tributaries of Ocayan River.
Reduction in stream volumetric flow Stream flow will not reduce at any phase of the project.					
Change in stream depth The depths of Tagpisa Creek, the diversion canal and other tributaries of Ocayan River may lessen if they become heavily silted.		✓	✓	✓	This may be prevented by regularly desilting the said waterways. Constructing a levee along the east side of Tagpisa Creek will minimize the chance of siltation at the other tributaries of Ocayan River and the corresponding change in their depths.
Depletion of water resources/ competition in water use Surface water may become unfit for irrigation and domestic use while groundwater recharge to shallow aquifers may become less in areas affected by siltation. Deep aquifers will however not be affected. The location of Oning Spring is shown in the water source location map while a picture of the spring is exhibited in the discussion on water source inventory. The location of Oning Spring is actually far from the CBNC plant. There are no other springs in the vicinity of the CBNC		✓	✓	✓	The adverse effects may be minimized by regularly desilting the Tagpisa Creek and the Tagpisa and Upper Kinurong siltation ponds. Constructing a levee along the east side of Tagpisa Creek will lessen the chance of siltation at the other tributaries of Ocayan River. CBNC has implemented water conservation measures. Around 30-40% of supernatant is recycled back to the HPP while 20% of cooling and wash water are also re-used. CBNC also constructed a 300,000 m^3 water reservoir for impounding excess water during the dry months and is being used as water source during the dry months. The water impounded at the Upper Togpon Siltation Pond is also used as water source during the dry

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Pre-Construction	Options for Prevention or Mitigation or Enhancement
plant that are or have been used as a domestic water source therefore, CBNC will have minimal impact on groundwater availability. However, the presence of many active shallow wells in the area prior to the operations of CBNC and up to the present indicate that the groundwater level in the area is shallow and has not significantly lowered over time. Please note that because of the gravitational force acting on groundwater, pitcher pumps and simple jetmatic pumps cannot draw water when the groundwater level is deeper than 7 meters.					months.
Release of toxic tailings if there is dam breach/dam break The possibility of dam breach will release considerable volume of tailings that may contain toxic and radioactive materials that are harmful to humans and other living things.			✓		The tailings generated from the operations of CBNC does not contain any radioactive or toxic materials. Analysis of the tailings indicated the following composition: • Nickel (Ni): 0.1 • Cobalt (Co): 0.0 [a] • Magnesium (Mg): 0.7 • Manganese (Mn): 0.5 • Zinc (Zn): 0.0 [a] • Iron (Fe): 31.5 • Al (Aluminum): 1.4 • Chromium (Cr): 1.4 • Silicon (Si): 5.1 • Calcium (Ca): 7.9 • Sulfate (SO_4): 18.2

Note: [a]This is due to rounding off.

2.2.2 Physical Oceanography

2.2.2.1 Methodology

The physical oceanography surveys were conducted south of Rio Tuba where Ocayan and Rio Tuba rivers drain to the Ocayan-Coral Bay, covering approximately 720 hectares of coastal sea. The purpose of the survey was to obtain bathymetric data, tidal fluctuation, wind influence, surface current, and sub-surface current which are used as inputs to simulate the hydrodynamics of the Bay and its influence in the transport and dispersion of sediments or pollutants in particular, which come from the adjacent rivers (Ocayan and Rio tuba rivers). **Figure 2.2.17** shows the coverage of the physical oceanography survey.

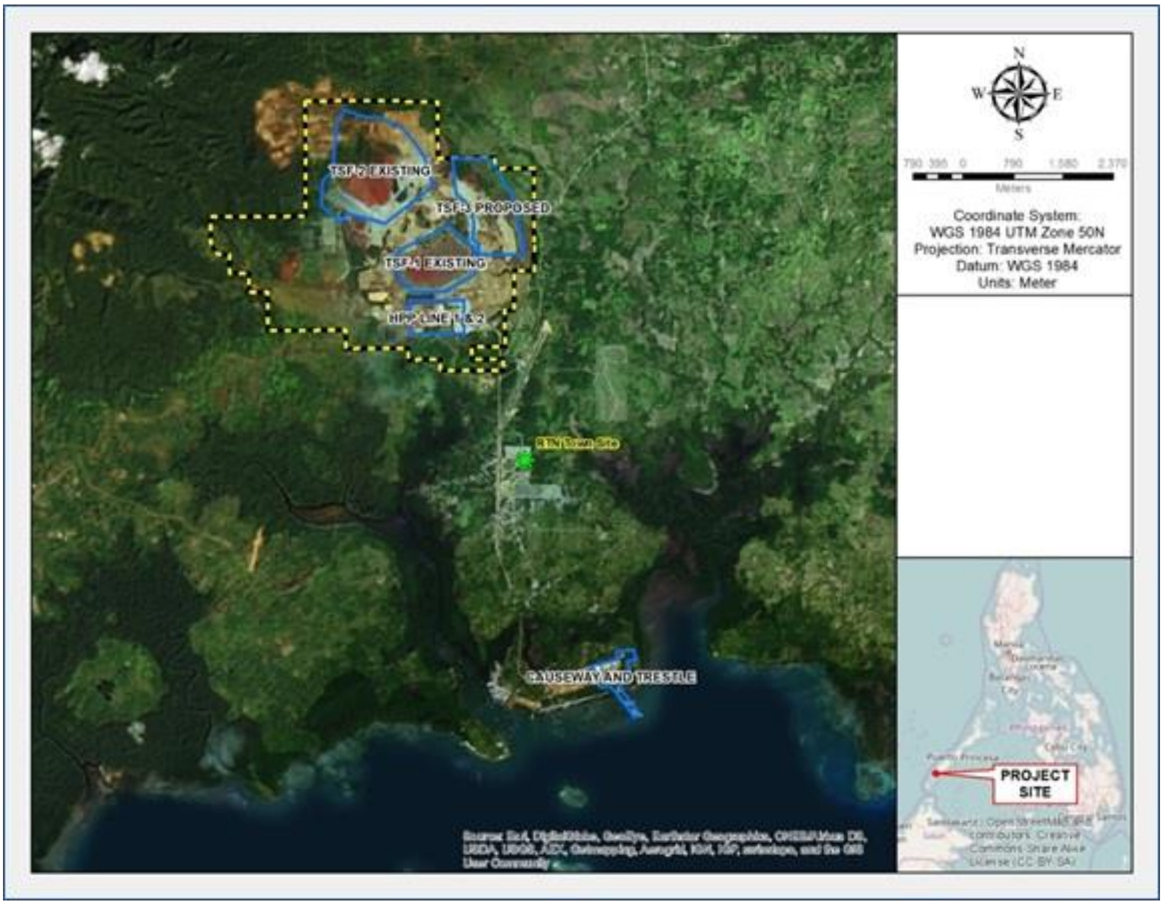


Figure 2.2.17. CBNC Physical oceanography survey coverage

Tidal Fluctuation

An automatic water level logger was deployed at a fixed location within the CBNC's port on August 18, 2016 at 5:45 PM until August 20, 2016 at 5:00 PM to monitor the Bay's actual tidal fluctuations. This shall also serve as reference in the correction of depth sounding readings in the bathymetrical survey, such that the depths represented are reckoned from the mean sea level.

Wind Influence, Surface Current, and Sub-surface Current

Wind as one of the principal driving forces influencing most coastal processes, constitutes vital information for physical oceanography and is therefore included in the field observation. A portable digital anemometer was used to measure wind speed. Wind and surface current directions were determined using the compass function of the GPS. Water (sea) surface current was also observed using a digital current meter.

In this survey, sub-surface currents were observed from three stations using a drifter. A float board was attached with stainless fins which can be adjusted from 0.5 - 1.5 meters, and was mounted on top with an airtight container to house a GPS which recorded the geographic location and hence, trajectory of the drift as it is moved by the ocean currents hitting the submerged fin of the drifter.

Plate 2.2.18. Drifter set-up used to track sub-surface current trajectory

Plate 2.2.19. Actual use of drifter with the submerged stainless fins to track sub-surface current trajectory

Bathymetry

A bathymetrical survey was conducted covering about 720 hectares of the bay off the coast of Rio Tuba using Garmin GPSMAP® 421s with a dual frequency transducer (Sonar). For depth measurement, the operating frequencies were either at 50 kHz or at 200 kHz, which automatically switches alternately depending on the water depth.

Using a motorized boat hired for the purpose, the echo sounder was attached at a sufficient depth within the boat outrigger, and the depths and locations were recorded at regular time interval as the boat traverses a pre-defined routes. Post-processing of the depth readings were then used to generate contour lines which represent points of equal depth in the seabed, similar to a topographic map representing a configuration of a given land area. Using GIS, the generated bathymetric contour lines were overlaid on a NAMRIA topographic map of the area to relate land topography and the strait's seabed configuration. for use in the hydrodynamics model to describe in more detail the physical oceanographic processes in the area.

Physical Oceanography thru Hydrodynamic Modelling

To help quantify the effect of coastal circulation and pollutant dispersion on the downstream coastal study area, the hydrodynamic model was used to simulate the effect of the representative tidal events occurred from August to September, 2016.

2.2.2.2 Baseline Conditions

Tidal Fluctuation

The tidal fluctuation observed at the CBNC port from August 18 – 20, 2016 was crossed referenced with a simulation from a tide prediction model (Delft-dashboard) which is used for the boundary conditions of the hydrodynamic model (discussed below). During the observation period, the Bay was influenced by a mixed semi-diurnal tide cycle. A mixed semidiurnal tide cycle is characterized by having two low and two high tides of different heights within a cycle.

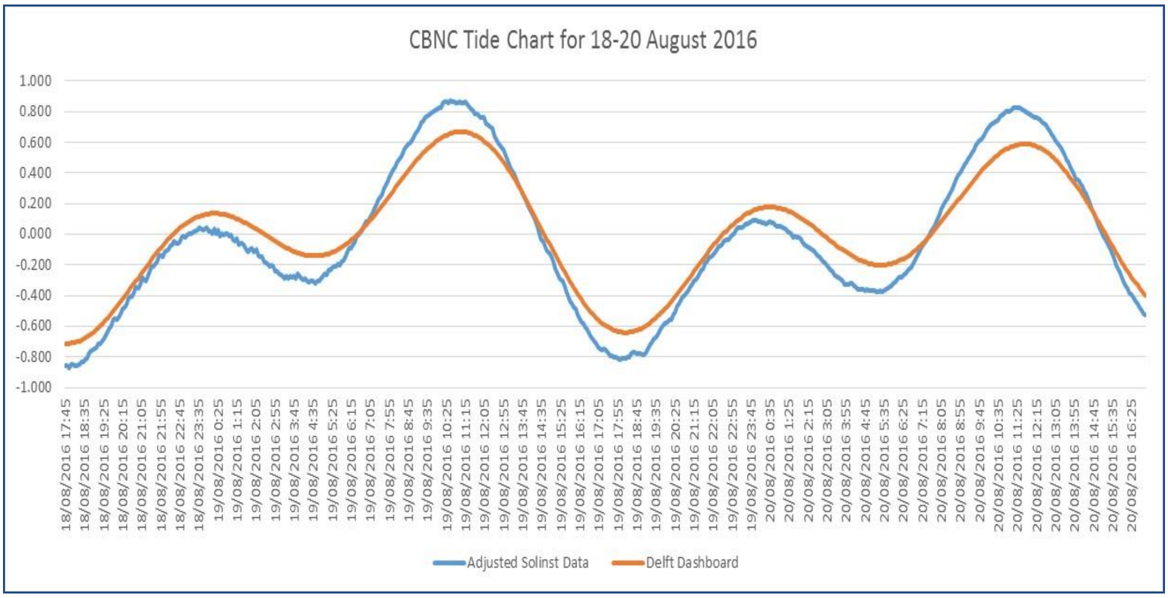


Figure 2.2.18. Observed actual tidal fluctuation (blue line) compared with a tide prediction software, Delft Dashboard

Bathymetry, Wind Influence, Surface Current, and Sub-surface Current

Readings from the transducer sensor component (i.e., transmitter) of the echo sounder were cross-referenced with the NAMRIA bathymetrical map for validation. **Figure 2.2.19** below show the processed bathymetry/seabed configuration generated using ArcGIS10.

Based on the observations during the time of sampling, wind velocities is about 4.38 meters per second on average blowing from the NW-SW direction.

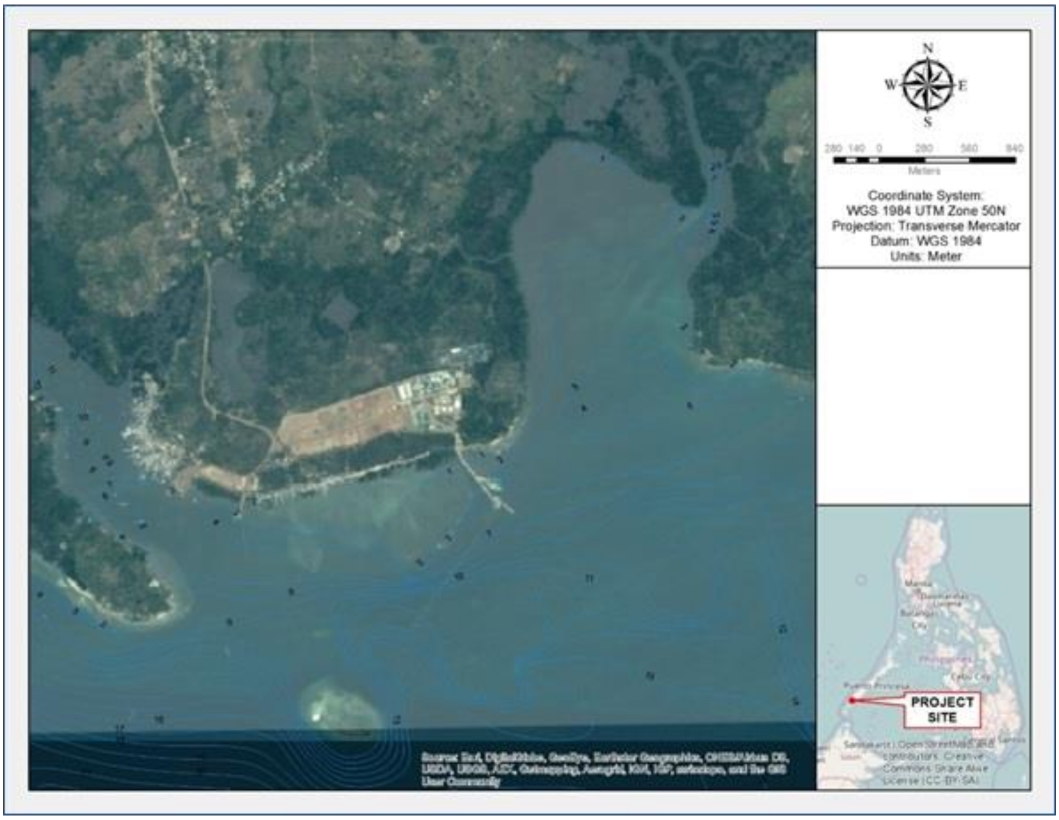


Figure 2.2.19. Bathymetric map generated from the oceanographic survey

Table 2.2.9. Summary of wind and water surface current flow velocities and directions on three observation stations

Station	Time	Surface Flow Velocity (m/s)	Surface Flow Direction	Wind Velocity (m/s)	Wind Direction
Stn1	8:58 AM	0.26	ENE	4.13	NW
Stn2	10:01 AM	0.32	ENE	4.63	SW
Stn3	11:10 AM	0.18	WSW	4.37	SW

Sub-surface currents (deep circulation) typically follow seafloor contours and affect the bottom of the ocean – hence they are called bottom or contour currents. Bottom currents are generally slow moving (less than 10 cm per second), but in areas where flow is constricted by seabed topography they can increase to more than 1 m per second.

Bottom currents are responsible for transporting, sorting and depositing large volumes of sediment, especially fine-grained silts and muds. They also sculpt a variety of large- and small-scale morphological features on the seafloor. The largest are broad mounds of fine-grained sediment called 'sediment drifts', which can be many tens of kilometres across, and kilometres thick. These form when steady bottom currents are able to accumulate sediment over very long timescales

Based on the drift measurement taking into account the start and end time of measurement as logged by the GPS, as well as the computed aggregate length travelled based on recorded coordinates, the average sub-surface current is in the range of 0.08 to 0.22 meters per second, with the lower value representing areas near the coast and higher values measured farther offshore and therefore represent the open sea sub-surface flows.

Table 2.2.10. Summary of sub-surface current flow velocities and directions on three observation stations.

Drift Track	Location in UTM Coordinate System (Zone 50)				Total distance drifted (m)	Time log		Total time drifted (sec)	Average drift current velocity (m/s)	General Trajectory
	Start		End			Start	End			
	(X coord, Y coord)		(X coord, Y coord)							
Drift track 01	548,475.0	938,394.8	548,770.5	938,477.8	309.84	8:58:51	9:27:54	1743	0.178	E
Drift track 02	549,799.0	938,628.3	550,207.9	938,678.2	368.22	10:01:23	10:29:20	1677	0.220	E
Drift track 03	550,709.5	940,600.3	550,844.6	940,649.7	147.55	11:10:02	11:38:07	1685	0.088	ENE

Results of the survey indicate that the general direction of the wind during the field survey was eastward which was basically influenced by the Habagat or the Southwest monsoon. Surface currents are normally influenced by the prevailing wind as observed in stations 1 and 2. However, in the 3rd station, the surface current tended towards the origin of the wind. This was due to the proximity of the observation location to the land mass. The surface current read was deemed to be the tidal wave returning from the land or the so called ebbing. Sub-surface currents on the three (3) stations generally moved eastward. This was so probably due to the general movement of the gyre affecting the Sulu Sea which is surrounded the islands of Palawan, Sulu archipelago, Visayas, and Borneo.

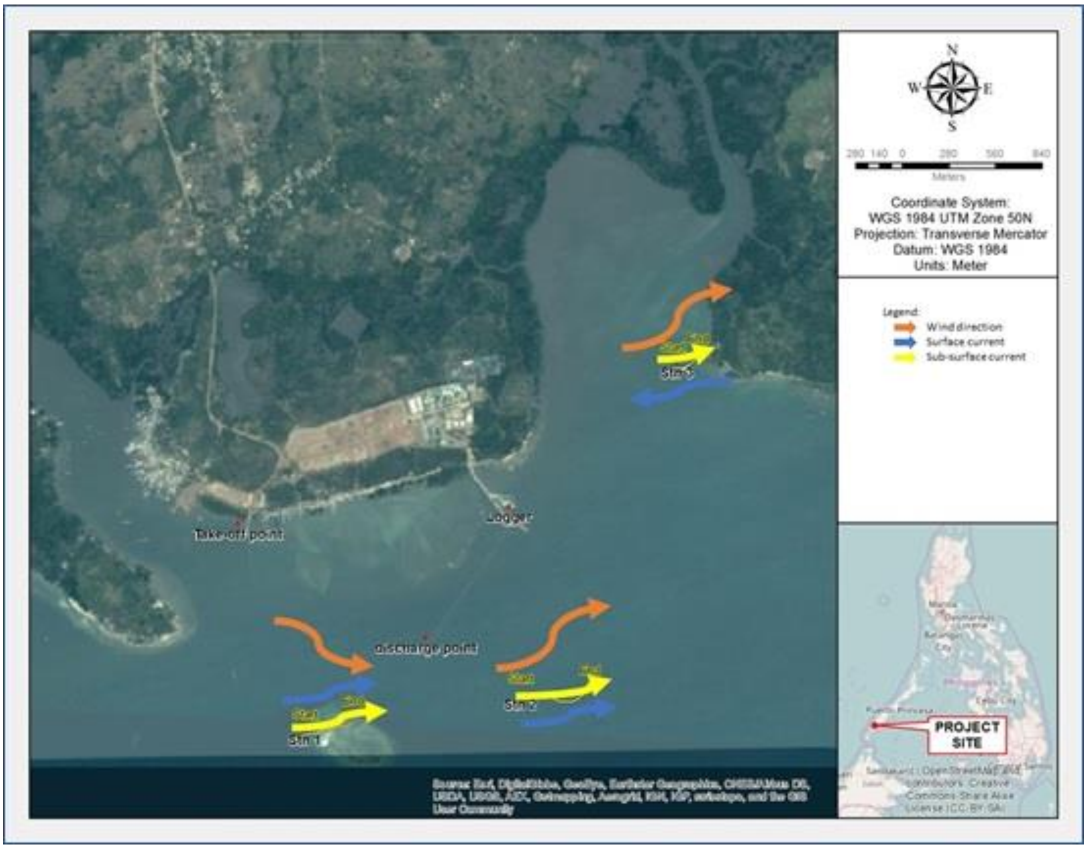


Figure 2.2.20. Illustration of wind direction, water surface current, and sub-surface current trajectories on three observation stations

While both winds and tidal forces significantly influence current circulation in coastal environments, currents were predominantly governed by tides in Ocayan and Coral Bay (and Sulu Sea), particularly in the study area. The results of the hydrodynamic simulation demonstrated tidal ebbing and flooding dictating current movement and mass transport within and out of the Bay. This may have been brought by the complicated topography and coastal configuration of the study site.

Figures 2.2.21 and 2.2.22 show the depth-average current for habagat wind conditions (wind speed of 4 m/s from the southwest, the magnitude of which is based on the observations during the surveys) during tidal flooding and ebbing. The bottom panels show the predicted current speeds as a function of time. The direction axis indicates the direction the current is heading towards.

Using a wind speed of 4 m/s blowing from the southwest (the so-called habagat wind), the model runs revealed that from the open waters off Sulu Sea, the flow velocity field is directed towards the northeast with magnitudes in range of 2-8 cm/s near the coast and moderately exceeding 10 cm/s far offshore. Swift currents are also predicted at the vicinity of Arrecife Island and the adjoining shallow coral reef areas with magnitudes in the range of 15 cm/s shown as yellow arrows in the figures.

Near the shore, the direction of alongshore currents follows more or less the direction the wind is blowing into, which is towards the north and is flowing parallel to the configuration of the coast.

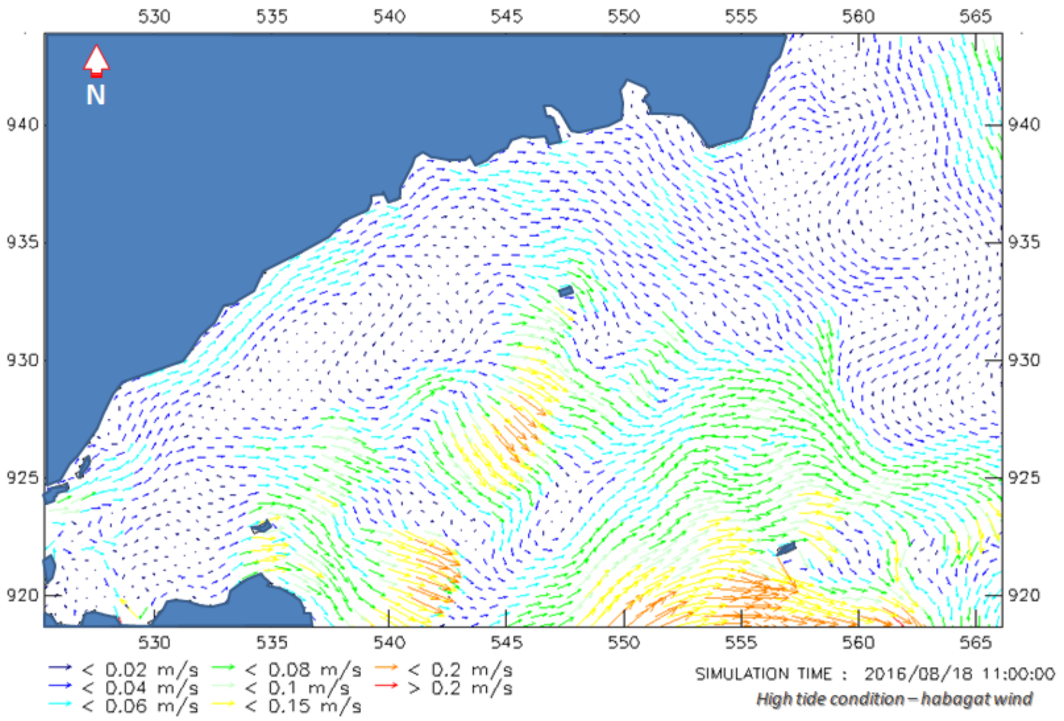


Figure 2.2.21. Predicted currents in the project area during tidal flooding (habagat wind condition).

During tidal ebbing, the flow velocity field far offshore is directed to flow outwards of the Bay with numerous weak clockwise movement (or 'gyre') forming offshore with flow magnitudes of about 8 to 15 m/s which is a bit weaker than during high tides. This predicted circular movement is formed due to the counteracting flows from the Sulu Sea which is directed northeast and of the southwest direction flow visible near the area of Iglesia Point. Also notice the rather fast flow velocities southwest of Arrecife Island, which is mainly due to the shallow depths on these areas.

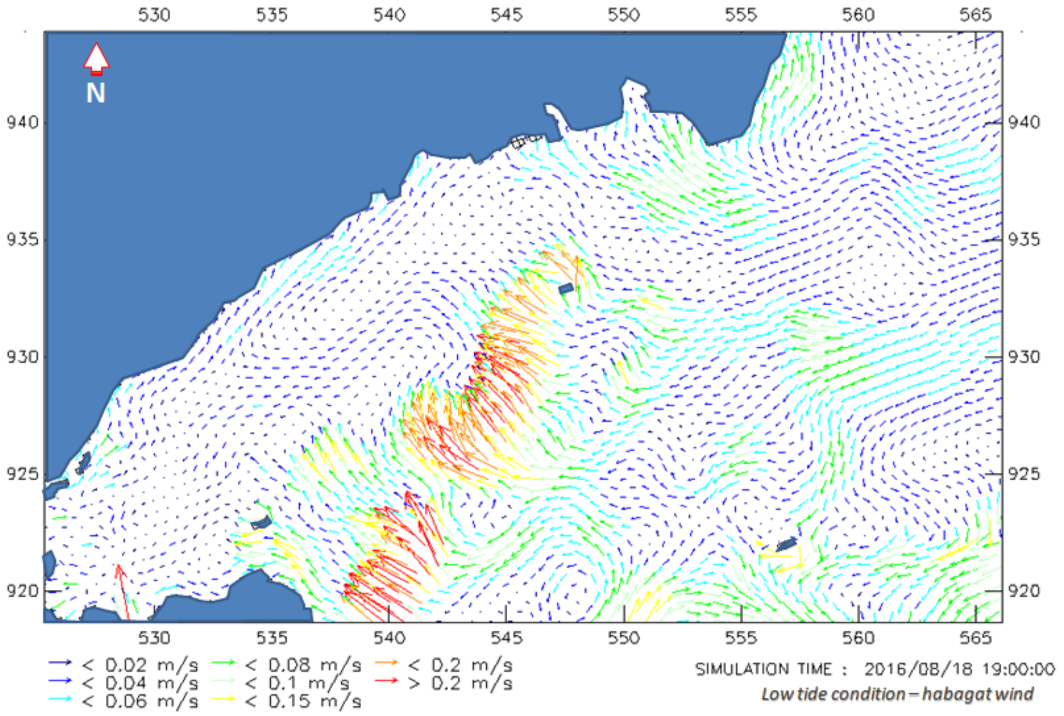


Figure 2.2.22. Predicted currents in the project area during tidal ebbing (habagat wind condition).

Under *amihan* wind conditions scenario, with a wind velocity input of 4 m/s and blowing from the northern direction, the model results revealed westward flow direction in the Bay during tidal flooding, with flow velocity fields in the range of 4 to 8 m/s near the coastline, regardless of tidal conditions (**Figure 2.2.23**). Compared with the habagat wind scenario, the flow velocities in the middle of the Bay is weaker due to influence of the wind blowing opposite to the direction of the tidal flood which is coming from the open waters of Sulu Sea.

During tidal ebbing, the model predicts similar trend wherein flow is directed towards the southwest and out of the Bay with weak northeast flow vectors influenced by the influx of waters by the open Sulu Sea (**Figure 2.2.24**). Just offshore of Iglesia Point, the flow rushes out towards the southwest similar to the predicted currents for Habagat wind scenario but with higher flow magnitudes exceeding 10 m/s, with generally weaker velocities near the coast than is predicted during tidal flooding.

Based on these two (2) figures, it appears that water movement is faster during tidal ebbing compared to high tidal events based on the coastal circulation patterns as predicted by the model. Likewise, the magnitude of currents predicted by the model is in agreement with the drift current measurement conducted off the coast of Rio Tuba. The results of this hydrodynamic model setup were then used to drive the sediment transport model which is discussed in detail in the preceding sections.

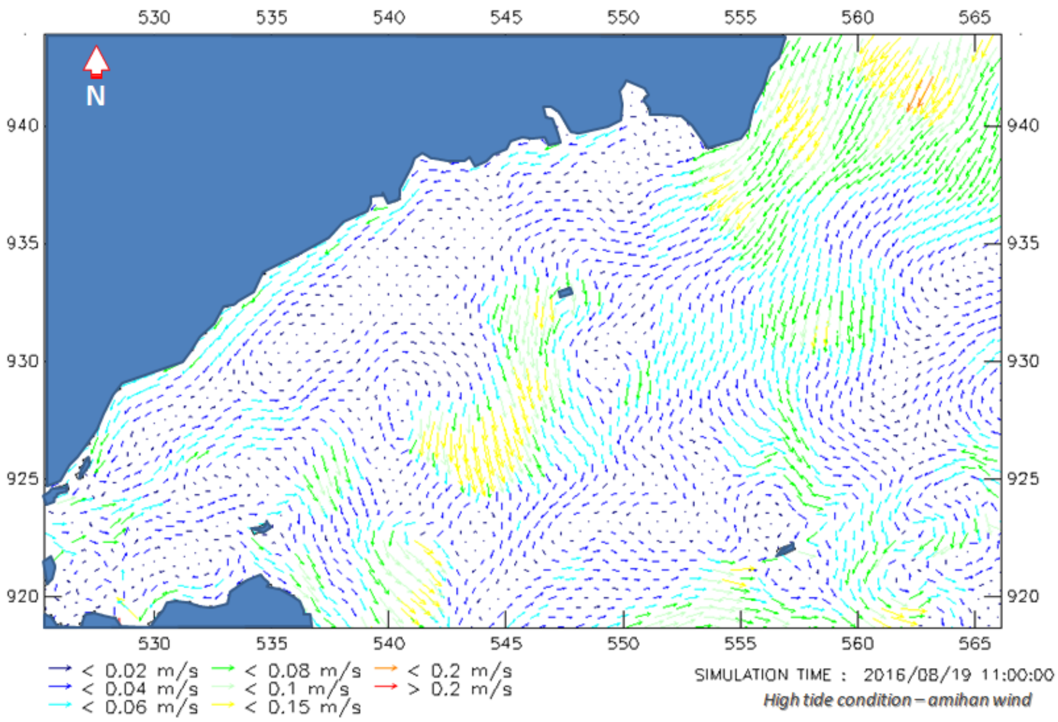


Figure 2.2.23. Predicted currents in the project area during tidal flooding (amihan wind condition)

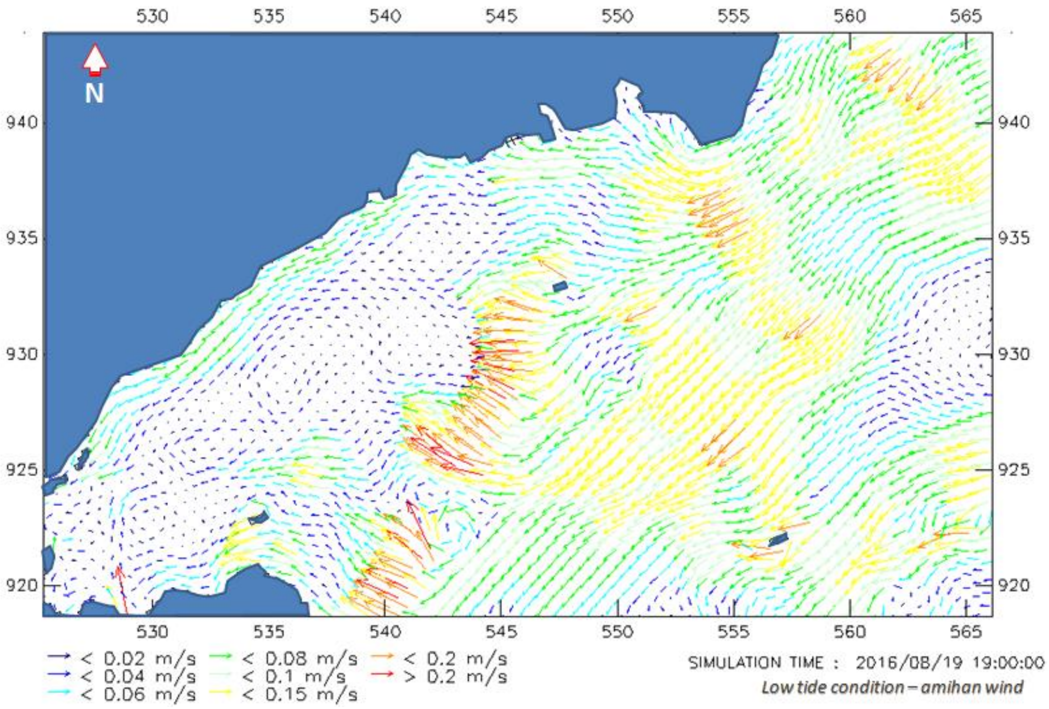


Figure 2.2.24. Predicted currents in the project area during tidal ebbing (amihan wind condition).

2.2.2.3 Impact Assessment

To assess the potential impact of upstream watershed development such mining and ore processsing on sediment dispersal patterns in the downstream coastal area, scenario simulations were executed for quantitative analysis.

In this study, representative wind fields observed for the month of August 2014 were used to predict the transport and dispersion of sediment plume. This particular month was chosen as the wind direction varies from easterly to westerly wind, wind speeds ranging from 1- 3 m/s which is ideal for low mixing potential. Periods of flood and ebb tides in the Bay were particularly described in the hydrodynamic characterization of the scenario simulations.

Due to the lack of detailed sediment information that will support a full blown sediment transport modeling, an alternative conservative tracer modeling (with sediment as constituent) was utilized for this study to investigate the transport and movement of suspended matter/sediment within the study domain. The transport of sediment is computed in exactly the same way as the transport of any other conservative matter/constituent, such as oil, salinity, heat, and others. This is because every aspect of transport phenomena is based in two primary concepts: the conservation laws, and the constitutive equations. The conservation laws, which in the context of transport phenomena are formulated as continuity equations, describe how the quantity being studied must be conserved. The constitutive equations describe how the quantity in question responds to various stimuli (e.g., applied forces) via transport.

In determining the amount of suspended sediment loadings for consideration in the tracer study, TSF3 has an estimated storage volume of 18.605 million cubic meters. Assuming half of that was accidentally released due to dike breach, and further assuming that 0.10% of that volume of released sediment load eventually enters the Bay (with sediment density of 1,200 kg/m^3), the amount of sediment released to the sea is assumed to be about 4.30 kg $\cdot$ s^{-1} for an assumed 30-day released period.

Note that storm water flowing from disturbed areas of the mining and ore processing site will be directed into existing and proposed siltation ponds. At present, there is a series of siltation ponds for RTNMC and CBNC area, which include diversion canals and settling ponds to arrest possible release of undesirable pollutants into the coastal area through Togpon Creek. Thus the scenario presented here is deemed to be extreme with probability of occurrence to be low. However, for purposes of planning during accidental spillage, these scenario simulations can serve as guide to determine which coastal areas are vulnerable to prevent and minimize further spreading in the event it reaches the coast. **Figures 2.2.25** to **2.2.36** depict the sediment dispersion using tracer modeling.

The transport and dilution of continuous release of tracer in the assumed discharge points were simulated for at least 25 days in the model, to allow build up of the far field tracer concentrations over many tidal cycles. Results were examined over a spring cycle using tidal data from September 2016. The time duration of pollutant released in the project area is assumed to be continuous throughout the simulation period of 25 days although this may seem unrealistic since accidental spillages may not go unnoticed beyond a couple of days and that usually, a few hours after such accidental release, emergency measures are started to be in place to contain the same. Nevertheless, this scenario where made to assess extreme event where inadequate response to such event may lead to such occurrences.

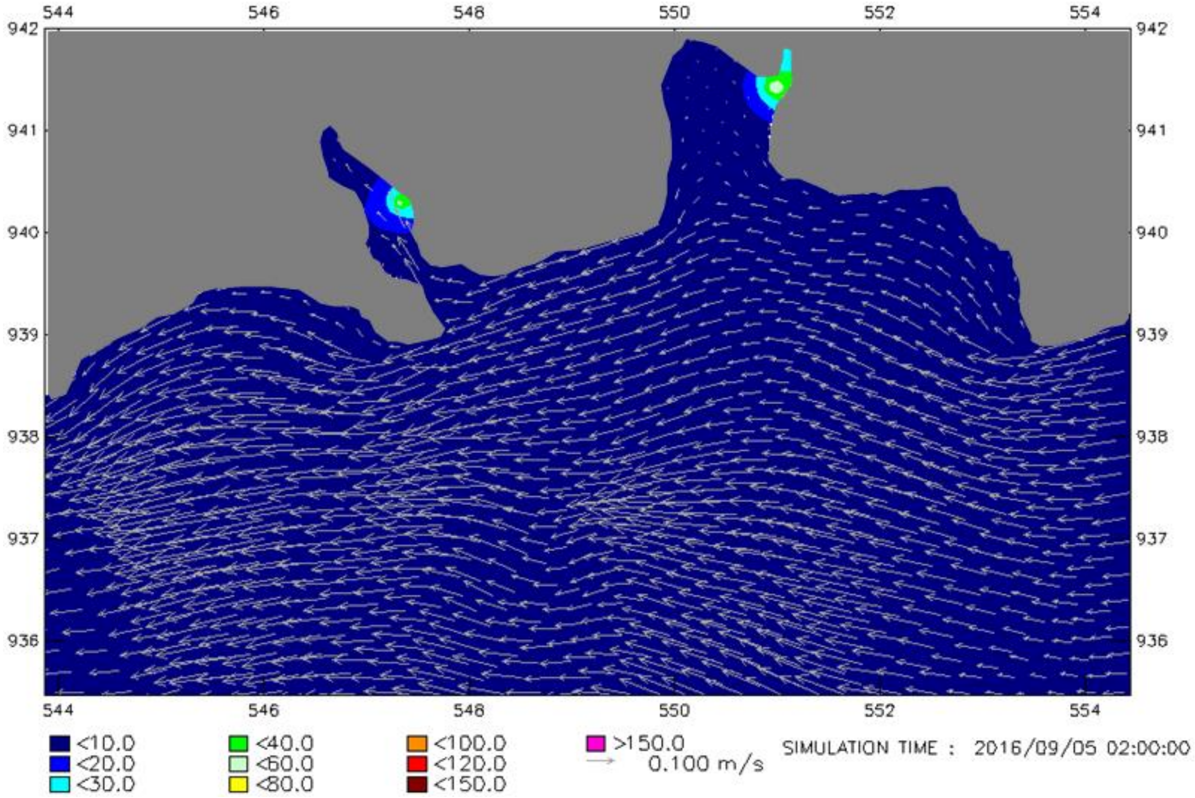


Figure 2.2.25. Simulated sediment tracer plume (legends in mg/L) after 2 hours of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

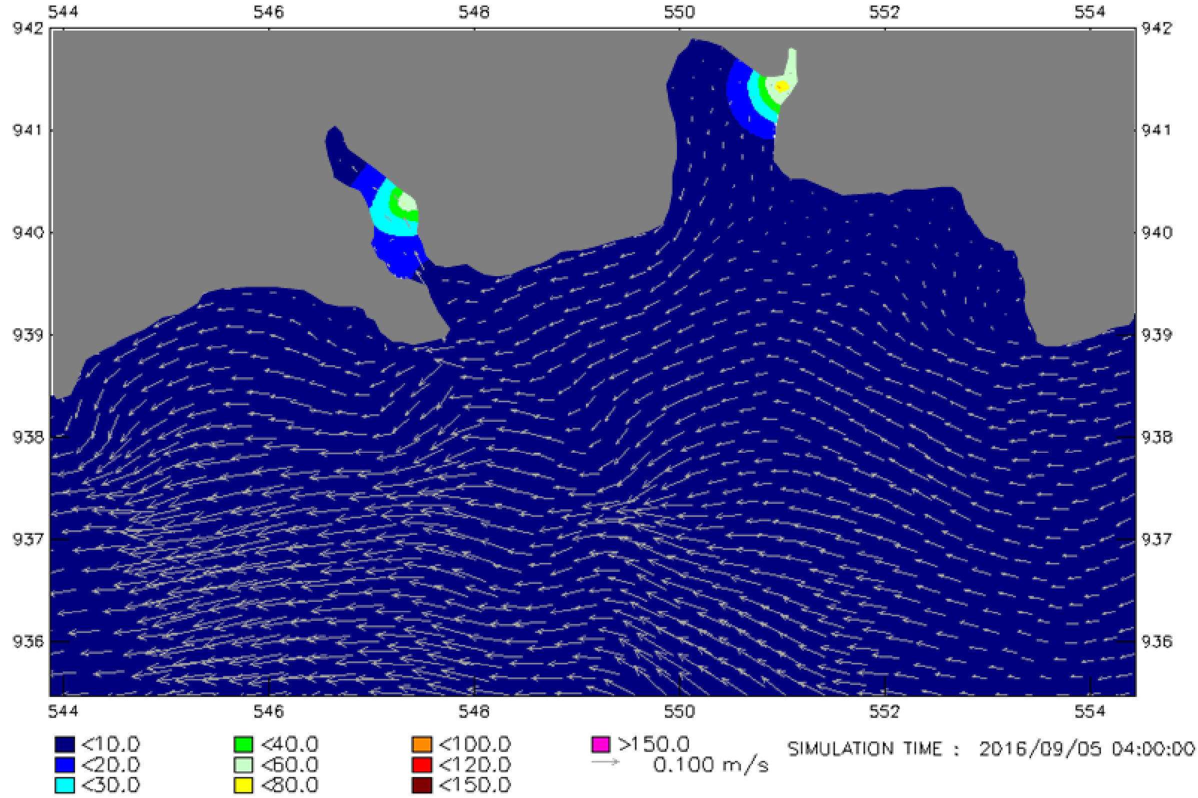


Figure 2.2.26. Simulated sediment tracer plume (legends in mg/L) after 4 hours of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

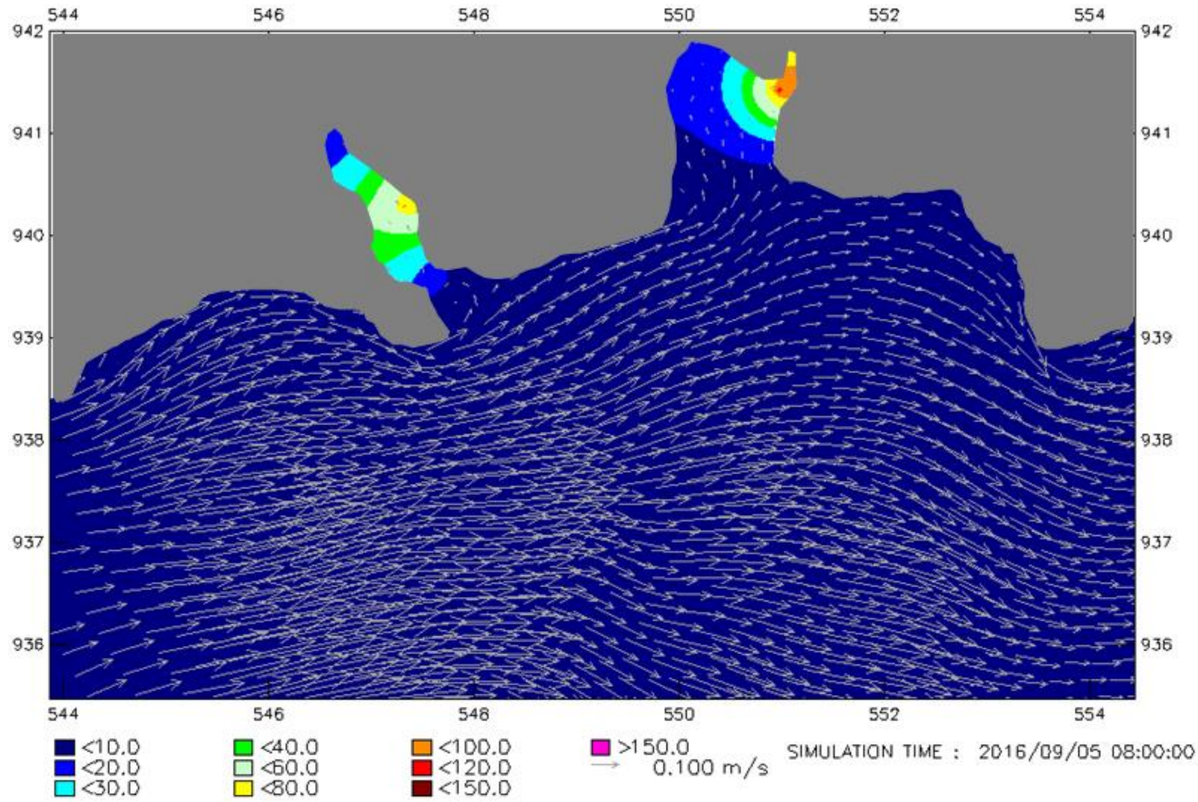


Figure 2.2.27. Simulated sediment tracer plume (legends in mg/L) after 8 hours of continuous releases of sediment from the two downstream river mouths connected to the Bay using the actual August 2014 wind data.

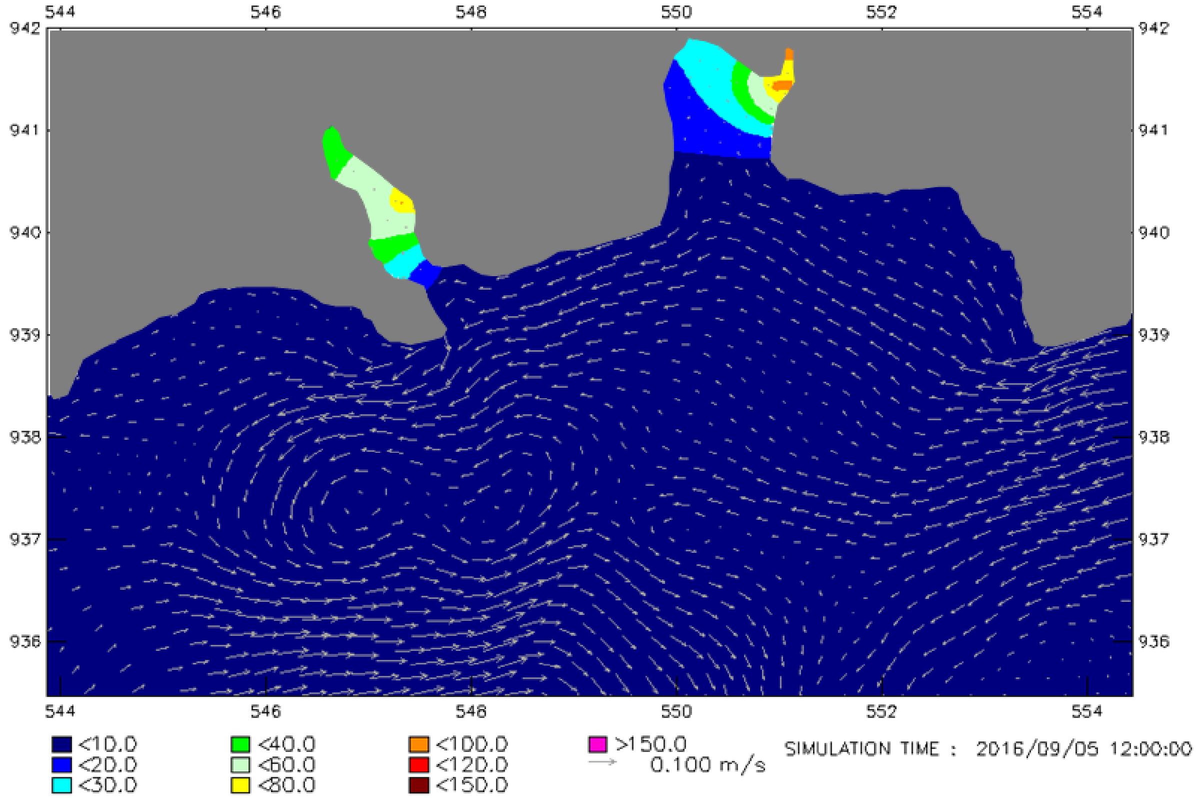


Figure 2.2.28. Simulated sediment tracer plume (legends in mg/L) after 12 hours of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

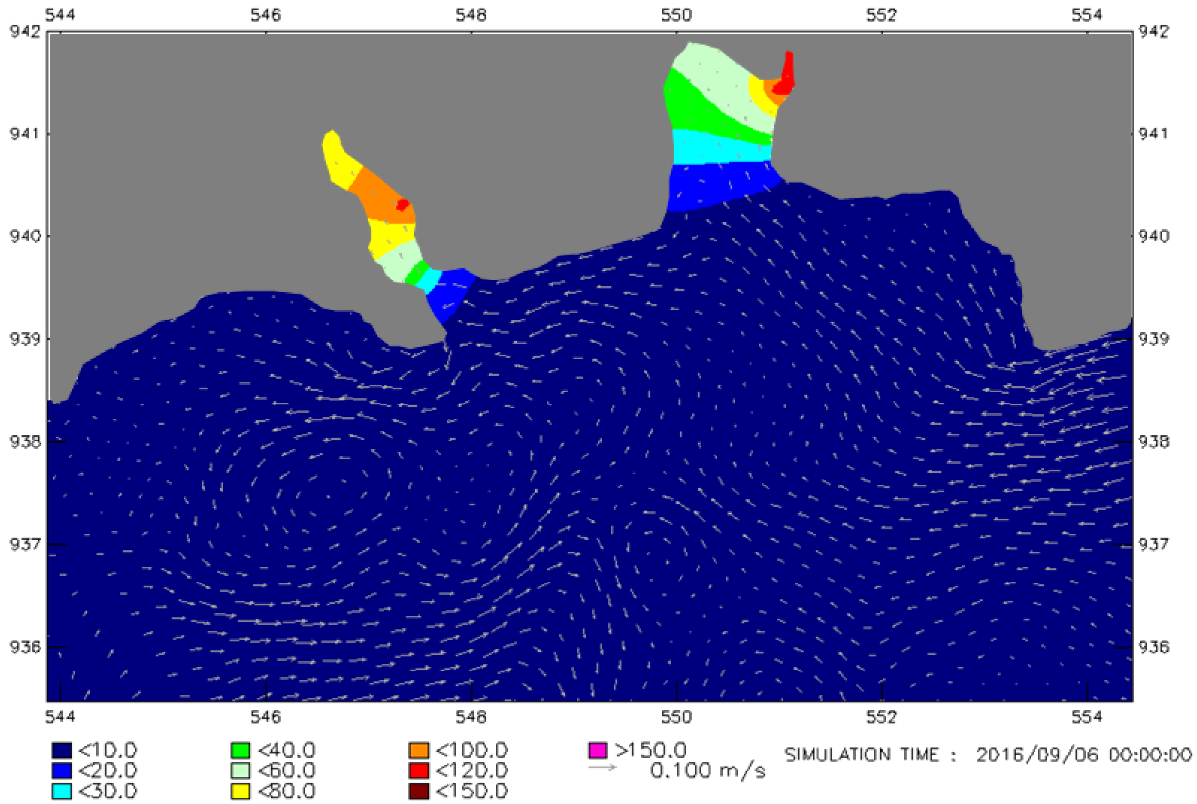


Figure 2.2.29. Simulated sediment tracer plume (legends in mg/L) after 24 hours of continuous releases of sediment from the two downstream river mouths connected to the Bay using the actual August 2014 wind data.

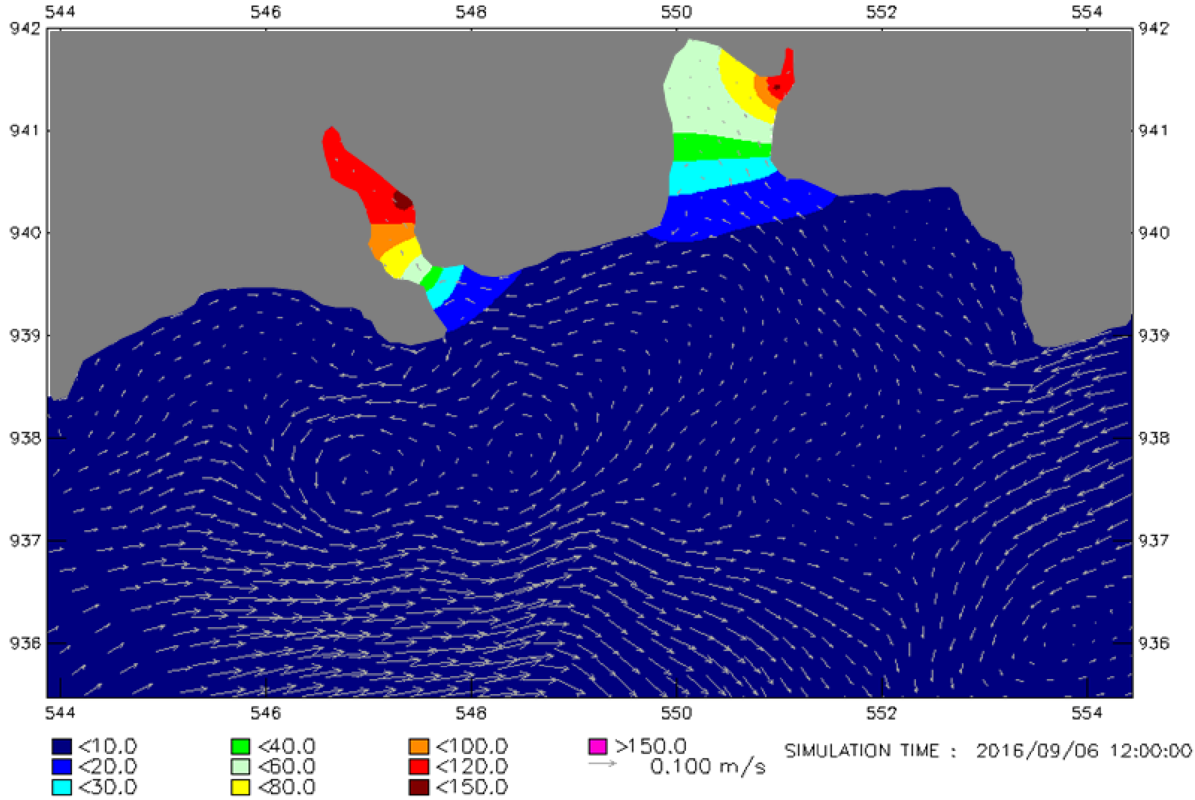


Figure 2.2.30. Simulated sediment tracer plume (legends in mg/L) after 1.5 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

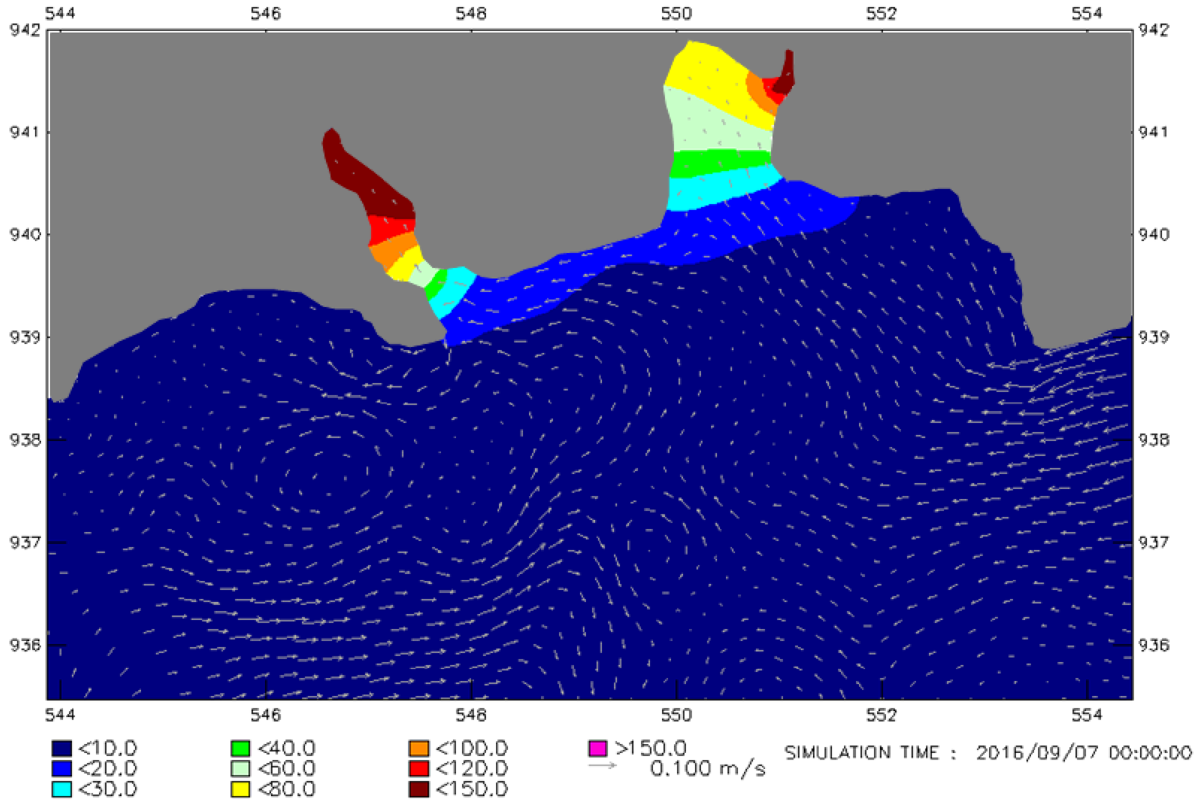


Figure 2.2.31. Simulated sediment tracer plume (legends in mg/L) after 2 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

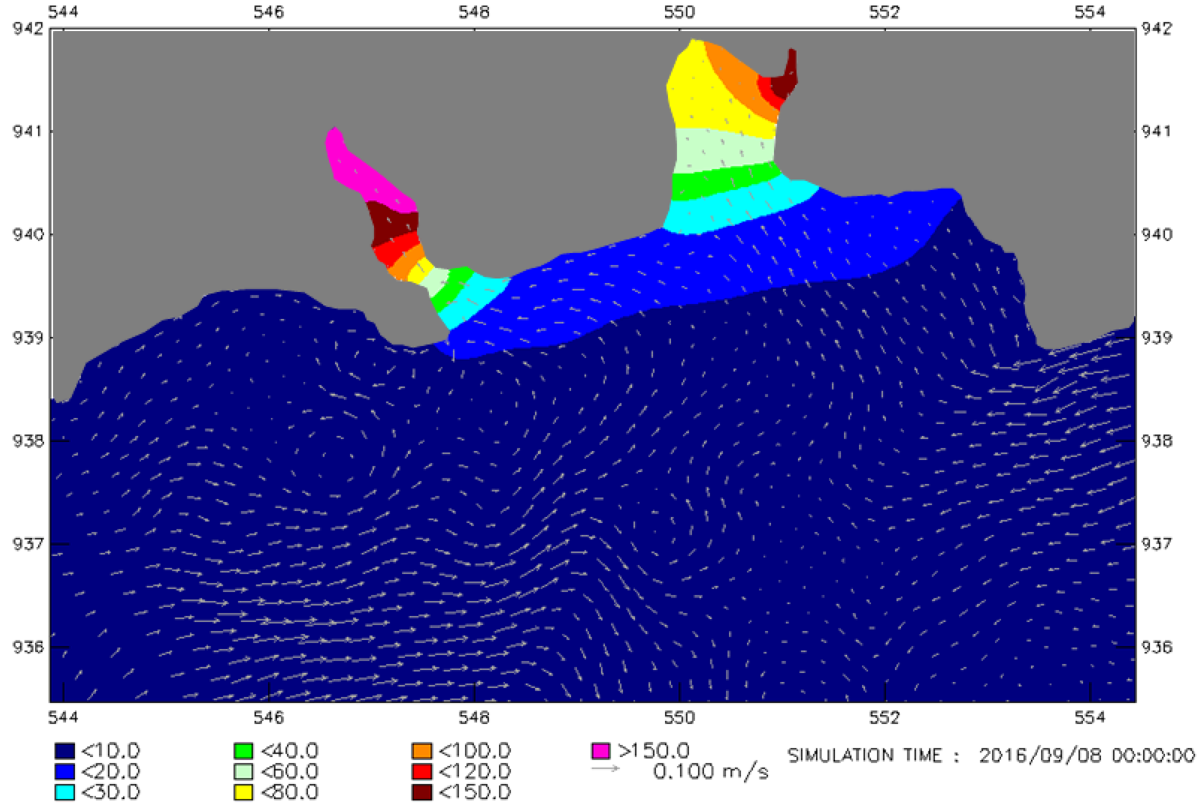


Figure 2.2.32. Simulated sediment tracer plume (legends in mg/L) after 3 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

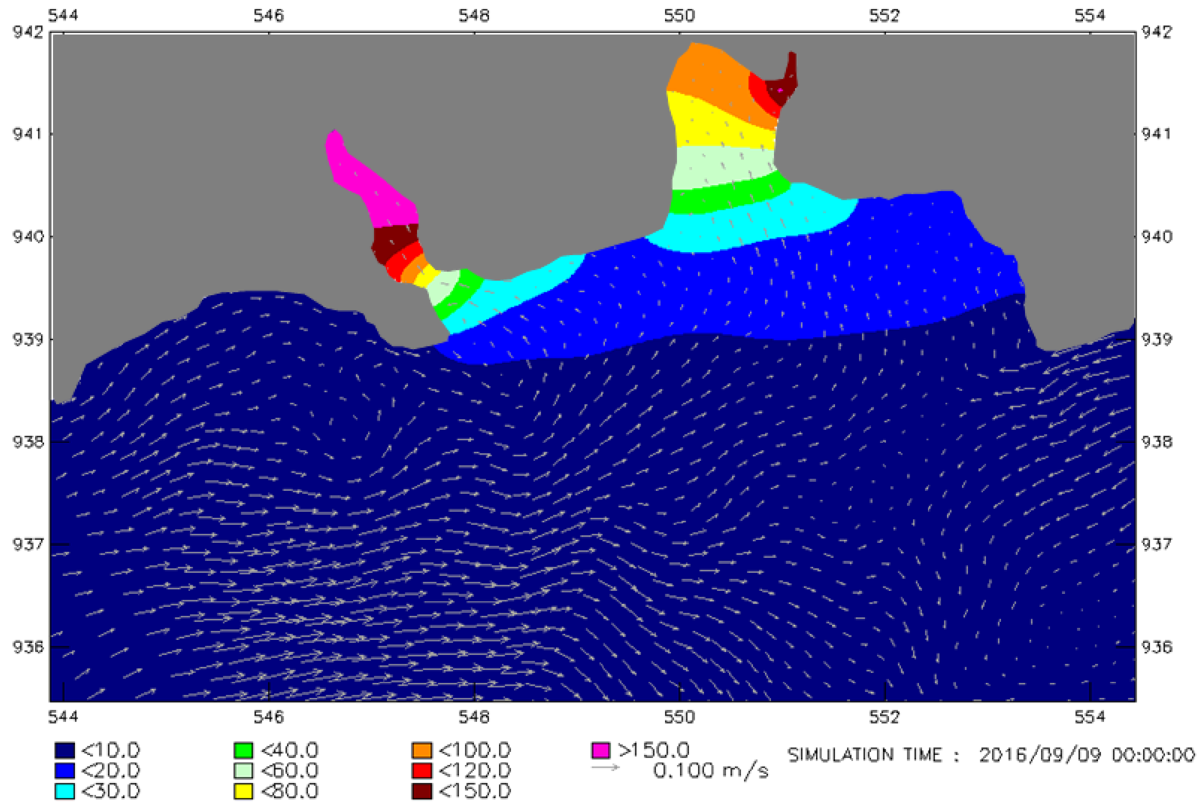


Figure 2.2.33. Simulated sediment tracer plume (legends in mg/L) after 4 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

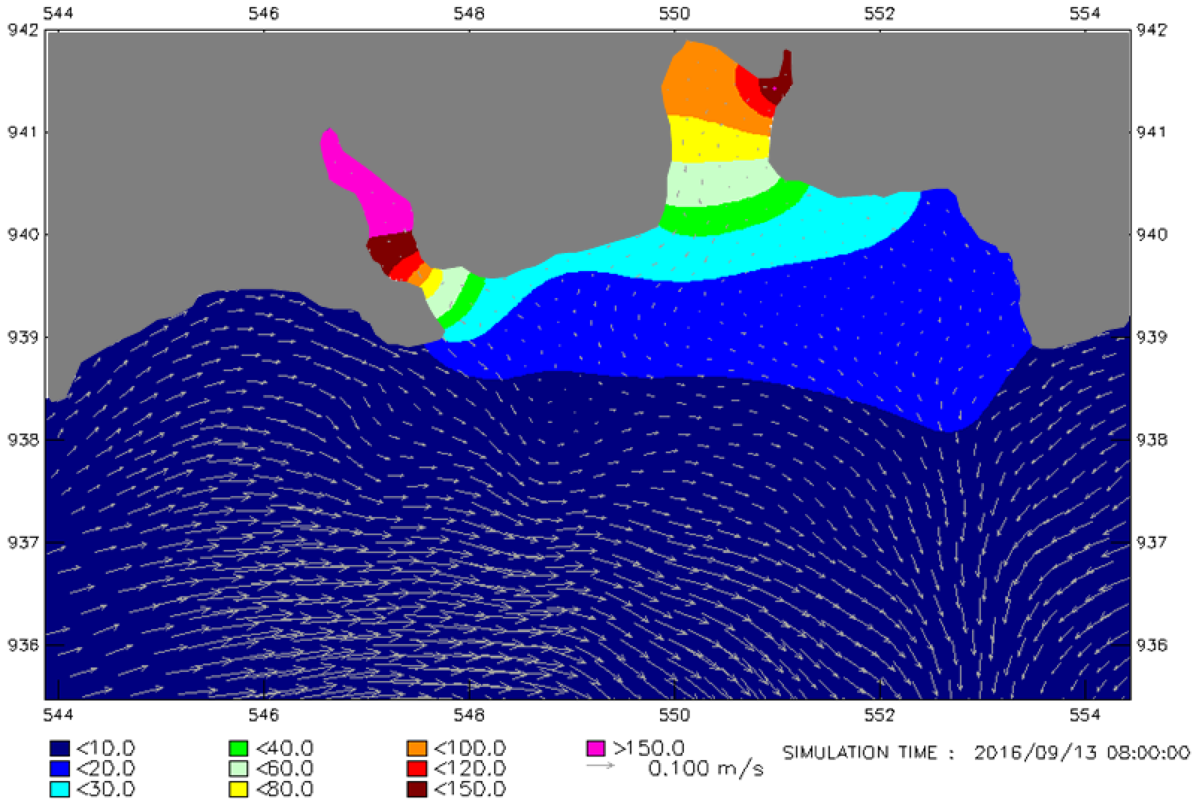


Figure 2.2.34. Simulated sediment tracer plume (legends in mg/L) after 8.3 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

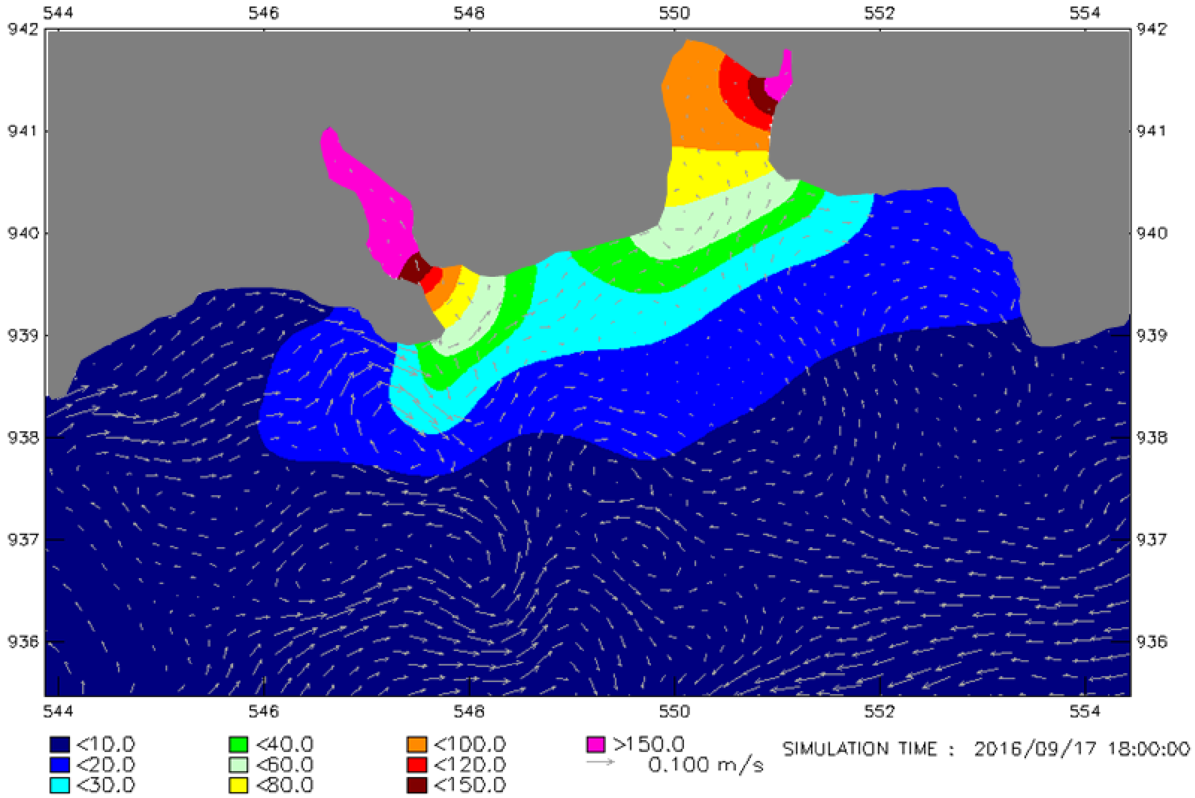


Figure 2.2.35. Simulated sediment tracer plume (legends in mg/L) after 12.75 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

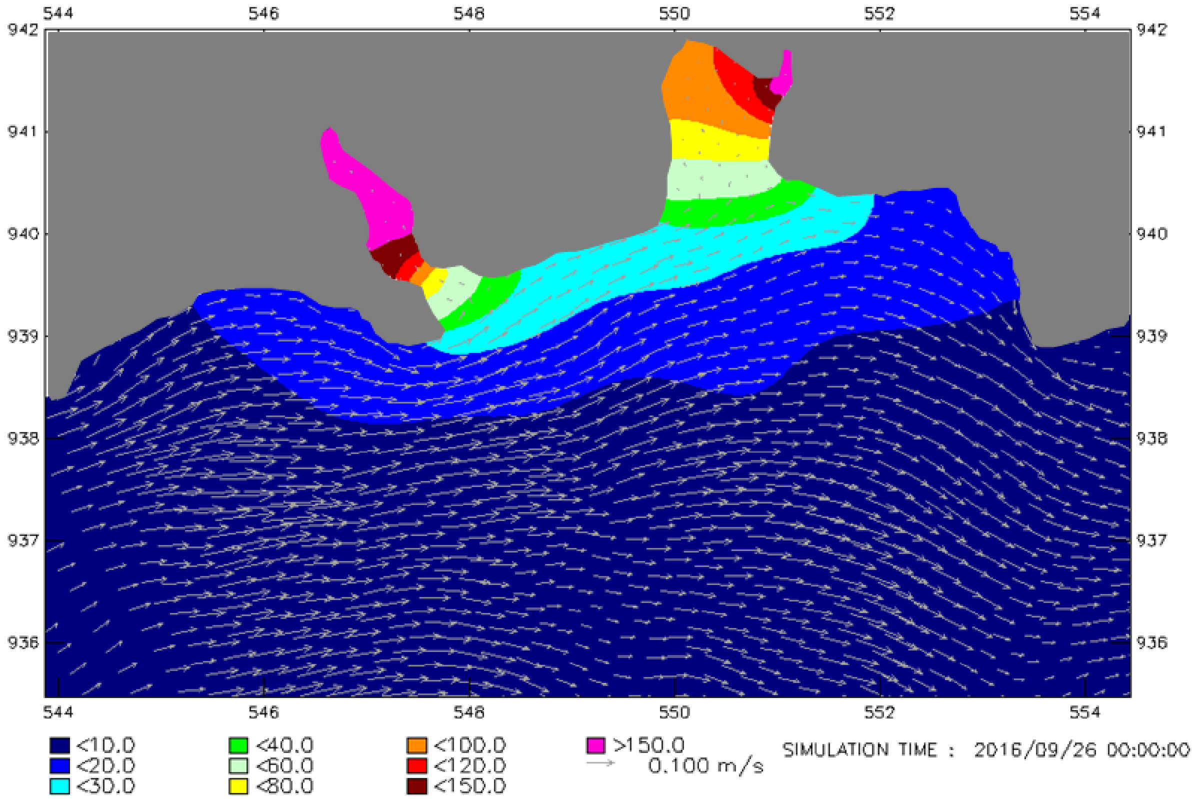


Figure 2.2.36. Simulated sediment tracer plume (legends in mg/L) after 25 days of continuous releases of sediment from the two (2) downstream river mouths connected to the Bay using the actual August 2014 wind data.

Table 2.2.11. Impacts assessment and mitigation for Physical Oceanography

List of Key Impacts	Phase Occurrence: Pre-Construction	Phase Occurrence: Construction	Phase Occurrence: Operation	Phase Occurrence: Abandonment	Options for Prevention or Mitigation or Enhancement
Sediment Dispersal The results of the model runs are shown in the next succeeding figures. Some of the results of the 25-day simulation of sediment tracers incorporating the effects of surface winds, and the rise and fall of tides are presented. Therefore, the snapshots cover most of the interesting patterns that may be expected during flooding and ebbing and also during slack water (**Figure 2.2.27** to **2.2.29)**. **Figure 2.2.30** shows the extent of maximum sediment tracer plume simulated by the model for the 25-days period, under the actual wind field conditions monitored in the project area. The extent of maximum tracer map was derived by taking the maximum predicted values for this particular scenario in every computational grid cell for the entire 25-day simulation period which is then integrated into a single map.			✓	✓	In case of dam break and spillage to the coastal sea, high concentrated plume will remains within the Tuba River. The immediate response is to arrest further spread of tailings by installing silt curtains near the discharge of Togpon Creek or other containment tools. The area farther out to the sea is expected to have lesser concentration. The tailings dam is designed considering all safety measures and the manner of tailings disposal in which the tailings will be deposited from the dam embankment and the purpose is to maintain a beach of tailings from the embankment as a further safeguard against water seepage which can weaken the embankments.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
From the results of this scenario, it appears that despite the variability of the wind directions and magnitude, the area extent of the high concentrated plumes (red areas in the figure) appears to be confined inside the tidal-affected river mouth, as compared to low concentrated tracer moving alongshore as it is transported by the prevailing coastal currents. As can be seen in the series of maps previously presented, low flow velocities represented by small gray arrows resulting from calm wind speed represents the worst case condition, where the mixing of tracers are low, while a windy condition appears to effective dilution of the tracers.					Emergency spillway is included in the design which will prevent overtopping and weakening of the structure.

2.2.3 Water Quality

2.2.3.1 Methodology

To assess the baseline condition of water bodies in the project area, sampling was conducted at the project site on September 15, 2016 and the results analyzed by CRL laboratories.

The methodology used for conducting the water quality assessment study in the project area was based on the Water Quality Monitoring Manual issued by the Environment Management Bureau and the Philippine National Standards for Drinking Water (PNSDW) specified by Department of Health Administrative Order No. 2007-12. The procedure for field assessment, site selection, sampling and analysis are specified in the above references. Results of the analysis were compared with standard values cited in the Revised Water Quality Guidelines and General Effluent Standards (DAO 2016-08) and the PNSDW.

To assess the environmental performance of CBNC with respect to water quality, data over a period of three years (2015-2017) was plotted and compared to the water quality guide values. Both discharge and receiving water body requirements were reviewed.

Description of Sampling Stations

A total of 23 sampling stations are regularly monitored by CBNC and reported to EMB through its Self-Monitoring Reports (SMR) and Compliance Monitoring Reports (CMR). The description and coordinates area presented in **Table 2.2.12** while **Figure 2.2.37** shows the sampling location map. Note that these included both effluent streams and receiving water bodies.

Out of these, one (1) groundwater, one (1) surface water, two (2) marine, and one (1) effluent station were selected for the 2016 sampling. These are highlighted in **Table 2.2.12**.

For the groundwater quality monitoring, CBNC monitors Deepwell no. 5. CBNC also monitors water seepage pressure (piezometer readings) from the TSF2 impounded tailings water through its embankment to determine if TSF2 impounded tailings infiltration/ground seepage has an effect to the ground water.

Since the previous monitoring reports covered only parameters agreed in its Environmental Monitoring Plan under the previous water quality guidelines, the 2016 sampling covered parameters specified in the new DAO 2016-08 guidelines. These are specified in **Tables 2.2.15** and **2.2.16**.

Tables 2.2.13 and **2.2.14** present the water quality parameters for both groundwater and surface water that were analyzed.

Table 2.2.12. Geographic coordinates of the water quality assessment

Station	Coordinates		Type	Description
W5	N 08° 33' 07.0"	E 117° 25' 19.6"	GW	Groundwater at Water well No. 5
RW1	N 08° 33' 29.73"	E 117° 25' 14.78"	SW	Raw Water Intake (from Ibelnan/Reservoir/Upper Togpon)
SW1	N 08° 34' 14.9"	E 117° 23' 33.7"	SW	Ibelnan Intake Dam
S11	N 08° 29' 46.7"	E 117° 26' 50.2"	MW	Marine water at 37 m NE of Supernatant Water Discharge Point
S12	N 08° 29' 40.9"	E 117° 26' 38.2"	MW	Marine water at 375 m NW of Supernatant Water Discharge Point
S13	N 08° 29' 30.4"	E 117° 26' 50.7"	MW	Marine water at 375 m SW of Supernatant Water Discharge Point
S14	N 08° 29' 41.5"	E 117° 27' 01.4"	MW	Marine water at 37 m SE of Supernant Water Discharge Point
S15	N 08° 29' 38.2"	E 117° 26' 49.5"	MW	Marine water at supernatant Water Discharge Point
S16	N 08° 30' 1.4"	E 117° 27' 4.81"	MW	Marine water at west side of end of causeway
S17	N 08° 31' 20"	E 117° 25' 24"	MW	Estuarine Water at Rio Tuba River
S18	N 08° 27' 14.10"	E 117° 26' 52"	MW	Ameril Island (Control Station)
S19	N 08° 30' 25.79"	E 117° 28' 5.16"	MW	Barangakash (Control Station)
S20	N 08° 34' 30.19"	E 117° 26' 19.69"	MW	Ocayan River, Upstream
S21	N 08° 31' 40.39"	E 117° 27' 8.83"	MW	Ocayan River, Downstream
TS	N 08° 30' 2.54"	E 117° 26' 18.15"	MW	Marine water at Tagdalungon shoreline
CP	N 08° 30' 34.05"	E 117° 27' 4.57"	Effluent	Coal Pond
DC	N 08° 33' 18.5"	E 117° 25' 27.2"	Effluent	HPP Canal Discharge to Upper Kinurong Siltation Pond
E	N 08° 30' 3.13"	E 117° 27' 6.02"	Effluent	Supernatant Water sampling Port at Causeway
L	N 08° 34' 45.9"	E 117° 25' 28.3"	Effluent	Categorized Sanitary Landfill at GP-28 Discharge Water
S4	N 08° 33' 11.9"	E 117° 24' 58.7"	Effluent	Lower Kinurong Siltation Pond Discharge
S5	N 08° 33' 32.2"	E 117° 24' 40.4"	Effluent	Lower Togpon Siltation Pond Discharge
S6	N 08° 33' 9.5"	E 117° 24' 48.9"	Effluent	Confluence of Togpon and Kinurong Siltation Ponds Discharge
S7	N 08° 33' 55.17"	E 117° 24' 54.68"	Effluent	Downstream of Confluence

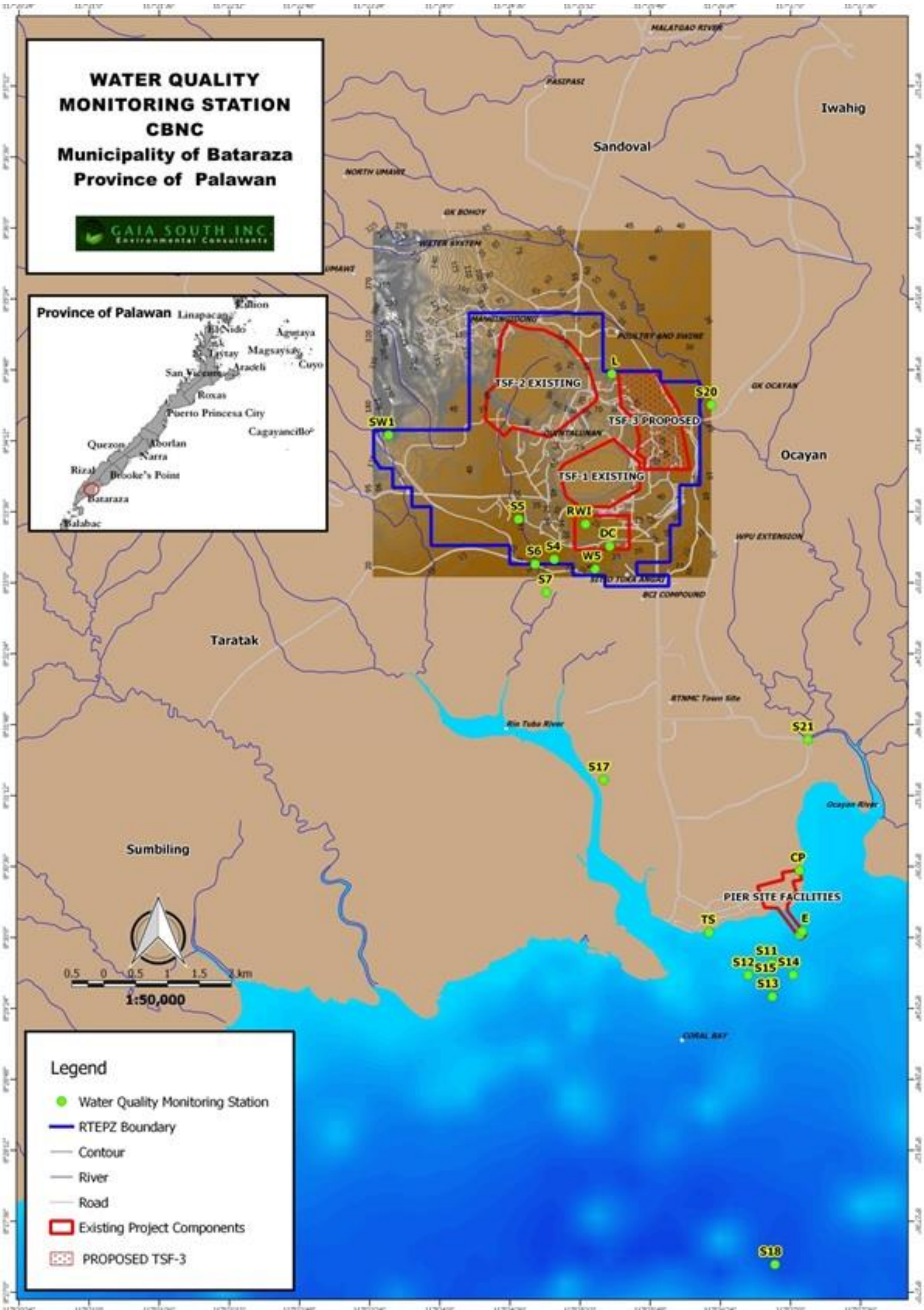


Figure 2.2.37. Sampling map for CBNC water quality assessment

Plate 2.2.20. Station SW1- Ibelnan Intake Dam

Plate 2.2.21. Station W5 - Groundwater at Water well No. 5

Plate 2.2.22. Station S13 - Marine water at 375 m SW of Supernatant Water Discharge Point

Plate 2.2.23. Station TS - Marine water at Tagdalungon shoreline

Plate 2.2.24. Station E - Supernatant Water sampling Port at Causeway

Table 2.2.13. Water quality parameters for groundwater use

Constituent	Parameter
Groundwater	
Microbiological	Fecal coliform (total coliform only as additional indicator)
Inorganic Constituents	lead, arsenic, cadmium, zinc, copper, nickel, iron, manganese, chromium hexavalent
Aesthetics/Primary Parameters	pH, Temperature, Total Suspended Solids (TSS), Biochemical Oxygen Demand(BOD)*, Chemical Oxygen Demand (COD)*, Oil and Grease

*Note: *Taken only as reference*

Table 2.2.14. Water quality parameters for surface water (freshwater and marine) and effluent

Constituent	Parameter
Freshwater and Marine water bodies	
Primary Parameters	pH, temperature, total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand* (COD), fecal coliform, total coliform
Secondary Parameters, Metals	lead, arsenic, cadmium, zinc, copper, nickel, iron, manganese, chromium (hexavalent and total)
Secondary Parameters, Organics	oil and grease
Effluent	
Primary Parameters	pH, temperature, TSS, DO, BOD, COD, fecal coliform, total coliform*
Secondary Parameters, Metals	lead, arsenic, cadmium, zinc, copper, nickel, iron, manganese, chromium (hexavalent and total)
Secondary Parameters, Organics	Oil and Grease

Water samples were compared to the respective DENR standard. Results of analysis for groundwater sampling were characterized using the guidelines provided in the "Philippine National Standards for Drinking Water 2007" and with Class A standards provided in DAO 2016-08. The latter was also used to characterized the physico-chemical and bacteriological characteristics of surface waters, both freshwater and marine. Guide values for Class C and Class SC were used for comparison.

Annex 2.2.1 shows the laboratory results of the water quality analysis.

2.2.3.2 Baseline Conditions

Groundwater Quality

The results of the September 2016 sampling and the averages for CBNC 2017 groundwater quality monitoring for the Deep-well No. 5 (Station code W5) are shown in **Table 2.2.15**.

The fecal coliform count of the sampled groundwater was 5.1 MPN/100 ml which exceeded the drinking water standards and the Class A guide values of DAO 2016-08. Note that total coliform is >23 MPN/100 ml confirms the fecal coliform finding. This water source is not fit for drinking unless treated properly. At best, for the microbial parameter, it would qualify as Class B with beneficial use for bathing and other primary contact recreation.

For the aesthetic/primary parameters pH, temperature, oil and grease, and total suspended solids, most values throughout 2016 were in agreement with either the PNSDW 2007 or the DAO 2016-08 guide values. The same can be observed for the 2017 monitoring results.

For the heavy metals, all parameters were within the new DAO 2016-08 Class A guide values except for nickel which indicated a slight exceedance from the 0.020 guide value with an actual result of 0.027 mg/L. This would indicate that the groundwater only qualifies as Class C with respect to this parameter and its beneficial use would be only be for fisheries, livestock watering and irrigation.

Table 2.2.15. Results of groundwater sampling analysis in Coral Bay Nickel Corporation

Parameters	Unit	PNSDW 2007	DAO 2016-08 Class A	Sep-16	2017 Jan-Apr (DRY)	2017 May-Dec (WET)
pH		6.5-8.5	6.5-8.5	7.0	7.45	7.46
Temp	°C	-	26-30		27.825	25.03
BOD5	mg/L	-	3.0	2.0	-	-
COD	mg/L	-		5.8	-	-
TSS	mg/L	-	50.0	4.0	3.05	1.84
Oil & Grease	mg/L	-	1.0	0.8	-	-
Total Coliforms	MPN/100ml	<1.1	-	>23	-	-
Fecal Coliforms	MPN/100ml	<1.1	<1.1	5.1	-	-

Parameters	Unit	PNSDW 2007	DAO 2016-08 Class A	Sep-16	2017 Jan-Apr (DRY)	2017 May-Dec (WET)
Pb	mg/L	0.010	0.010	0.001	-	-
Cr^{+6}	mg/L	-	0.010	<0.003	-	-
As	mg/L	-	0.010	<0.001	-	-
Cd	mg/L	-	0.0030	<0.0003	-	-
Zn	mg/L	5.000	2.000	-	0.055	0.034
Cu	mg/L	1.000	0.020	-	0.0275	0.010
Ni	mg/L	0.020	0.020	-	-	
Fe	mg/L	1.000	1.000	-	<0.04	<0.04
Mn	mg/L	0.400	0.20	-	<0.020	0.04

Monitoring results for Deepwell No. 5 over the last three (3) years 2015-17 are shown in **Figure 2.2.38**. Values fall within range of the standard (6.5-8.5). Other parameters such as the heavy metals were non-detected.

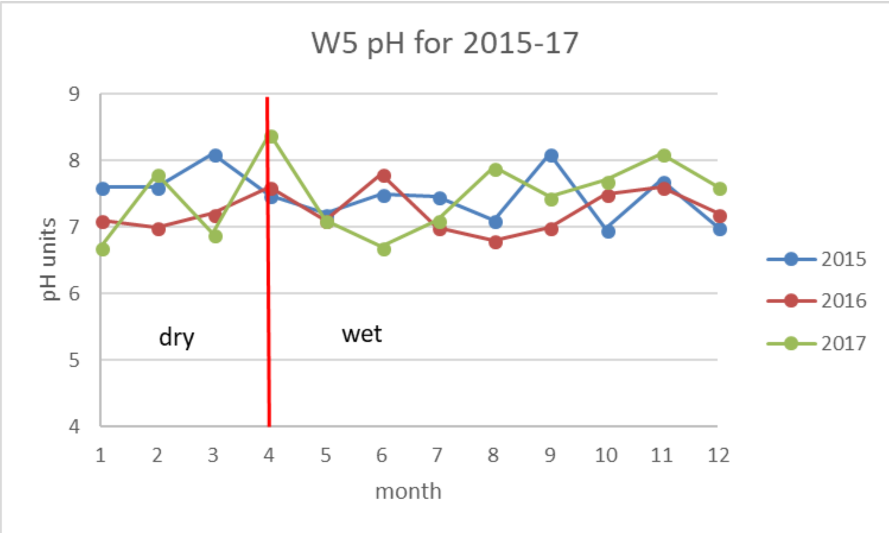


Figure 2.2.38. pH values for W5 (Deepwell #5) for dry (Jan-Apr) and wet season (May-Dec)

Surface (Freshwater) Quality

The baseline condition of freshwater bodies in the project site can be derived from the monitoring of water at the Ibelnan Intake Dam (SW1) which is used for the plant's process requirements. This station represents conditions of the water body prior to its use in the plant.

Table 2.2.16 shows the results of the 2017 monitoring for the station SW-1 (dry and wet season). The results of the Sept 2016 analysis are also included here.

Table 2.2.16. Results of freshwater analysis in Ibelnan Intake Dam (Stn SW-1)

Parameters	Unit	DAO 2016-08 Class C	SW1 2017 dry	SW-1 2017 wet	SW-1 Sep 2016
pH		6.5 - 8.5	7.425	8.24	8.1
DO	mg/L	$5.0_{(min)}$	6.375	6.65	-
Temp	°C	3°C	24.4	25.125	-
TSS	mg/L	80	0.45	1.51	<2.5
BOD	mg/L	7	-	-	<1
COD	mg/L	-	-	-	5.8
Fecal Coliforms	MPN/100ml	200	-	-	11
Total Coliforms*	MPN/100ml		-	-	33
Cr^{6+}	mg/L	0.01	0.005	0.01	<0.003
Pb	mg/L	0.05	<0.02	<0.02	<0.05

Parameters	Unit	DAO 2016-08 Class C	SW1 2017 dry	SW-1 2017 wet	SW-1 Sep 2016
Zn	mg/L	2	0.03	<0.04	-
Cu	mg/L	0.02	0.023	0.0225	-
Ni	mg/L	0.2	-	-	-
Fe	mg/L	1.5	0.04	<0.04	-
Mn	mg/L	0.2	<0.02	<0.02	-
As	mg/L	0.02	<0.001	<0.001	-
$Hg_{(total)}$	mg/L	0.002	<0.0001	<0.0001	-
Cd	mg/L	0.005	<0.003	<0.003	<0.006
Oil & Grease	mg/L	2	<1.0	<1.0	0.4

*Note: *for reference only*

Parameters	Unit	DAO 2016-08 Class C	SW1 2017 dry	SW-1 2017 wet	SW-1 Sep 2016
pH		6.5 - 8.5	7.425	8.24	8.1
DO	mg/L	$5.0_{(min)}$	6.375	6.65	-
Temp	°C	3°C	24.4	25.125	-
TSS	mg/L	80	0.45	1.51	<2.5
BOD	mg/L	7	-	-	<1
COD	mg/L	-	-	-	5.8
Fecal Coliforms	MPN/100ml	200	-	-	11
Total Coliforms*	MPN/100ml		-	-	33
Cr^{6+}	mg/L	0.01	0.005	0.01	<0.003
Pb	mg/L	0.05	<0.02	<0.02	<0.05
Zn	mg/L	2	0.03	<0.04	-
Cu	mg/L	0.02	0.023	0.0225	-
Ni	mg/L	0.2	-	-	-
Fe	mg/L	1.5	0.04	<0.04	-
Mn	mg/L	0.2	<0.02	<0.02	-
As	mg/L	0.02	<0.001	<0.001	-
$Hg_{(total)}$	mg/L	0.002	<0.0001	<0.0001	-
Cd	mg/L	0.005	<0.003	<0.003	<0.006
Oil & Grease	mg/L	2	<1.0	<1.0	0.4

The results indicate that the control freshwater bodies, those that have not received any of the plant effluent discharges, generally conform to the Class C beneficial use criteria.

Monitoring results for the past 3 years are shown in **Figures 2.2.39** and **2.2.40**. For pH, average for dry season (Jan-Apri) was 7.4 while for wet season (May-Dec), it was 7.92. For dissolved oxygen, the values were all above 5.0 mg/L for the past 3 years. Other parameters such as the heavy metals were practically non-detected for the three (3)-year period.

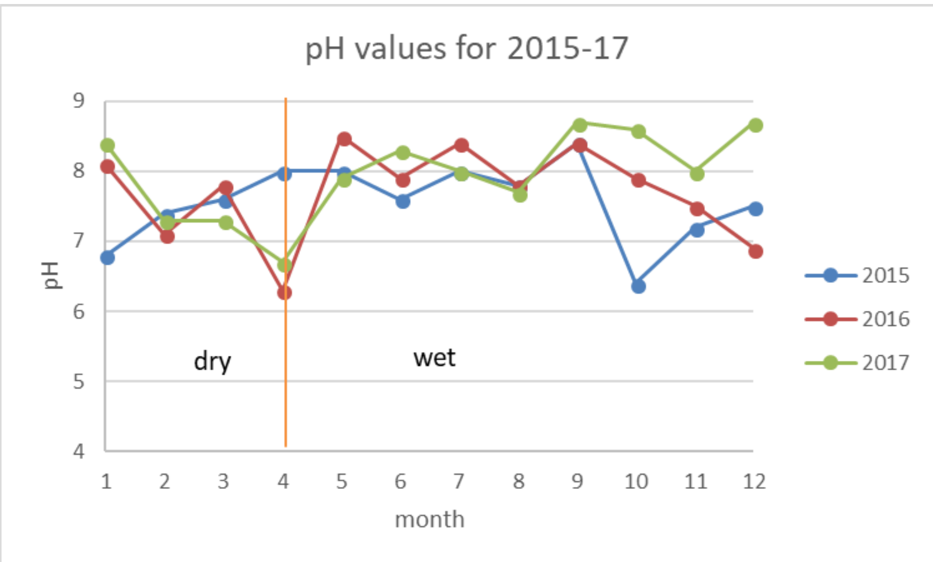


Figure 2.2.39. pH values for SW-1 (Ibelnan) for dry (Jan-Apr) and wet season (May-Dec)

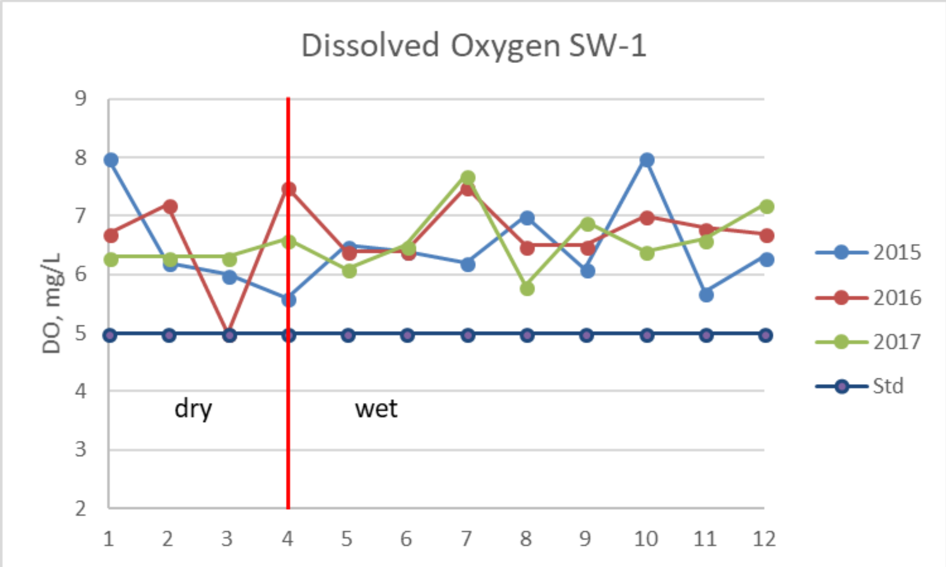


Figure 2.2.40. Dissolved Oxygen for SW-1 (Ibelnan) for dry (Jan-Apr) and wet season (May-Dec)

Monitoring results for the past three (3) years also showed not significant deviation from the prescribed guide values for Class SC.

Marine Water Quality

The results of the September 2016 sampling for marine water stations are reported in **Table 2.2.17**. These stations are generally adjacent to the discharge points of the treated tailings dam effluent and other effluents of the plant.

The results show that the values are generally within the marine water quality standards for Class SC waters.

Table 2.2.17. Results of marine water analysis, CBNC, Brgy. Rio tuba, Bataraza, Palawan

Parameters	Unit	DAO 2016-08 Class SC	S12 Sep 2016	TS Sep 2016
pH		6.5 - 8.5	7.90	7.50
DO	mg/L	5.0$_{(min)}$	-	-
Temp	°C	25-31	-	-
TSS	mg/L	80	<2.5	3.30
BOD	mg/L	n/a	<1	<1
COD	mg/L	-	111	94
Fecal Coliforms	MPN/100ml	200	110	130
Total Coliforms*	MPN/100ml	-	170	130
Cr^{6+}	mg/L	0.02	<0.003	<0.003
Pb	mg/L	0.05	0.02	<0.02
Zn	mg/L	0.8	-	-
Cu	mg/L	0.02	-	-
Ni	mg/L	0.06	-	-
Fe	mg/L	1.5	-	-
Mn	mg/L	0.4	-	-
$Cr_{(total)}$	mg/L	-	-	-
As	mg/L	0.02	<0.01	<0.01
$Hg_{(total)}$	mg/L	0.002	-	-
Cd	mg/L	0.005	<0.006	<0.006
Oil & Grease	mg/L	3	-	0.50

*Note *for reference only*

Monitoring of pH and dissolved oxygen for the past three (3) years are presented in **Figures 2.2.41** and **2.2.42**. The monitoring data for dissolved oxygen showed not significant deviation from the prescribed guide values for Class SC except for two wet season periods (Dec 2015 and June 2016).

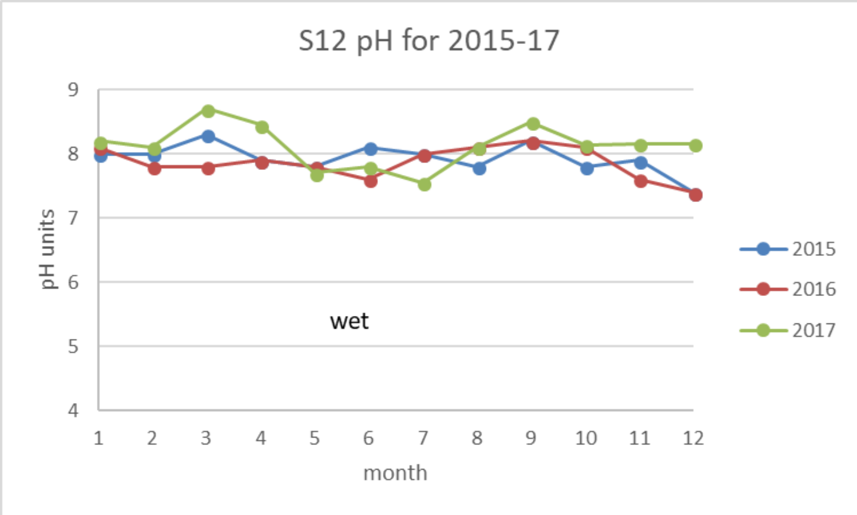


Figure 2.2.41. pH values for S12 (Marine water) for dry (Jan-Apr) and wet season (May-Dec)

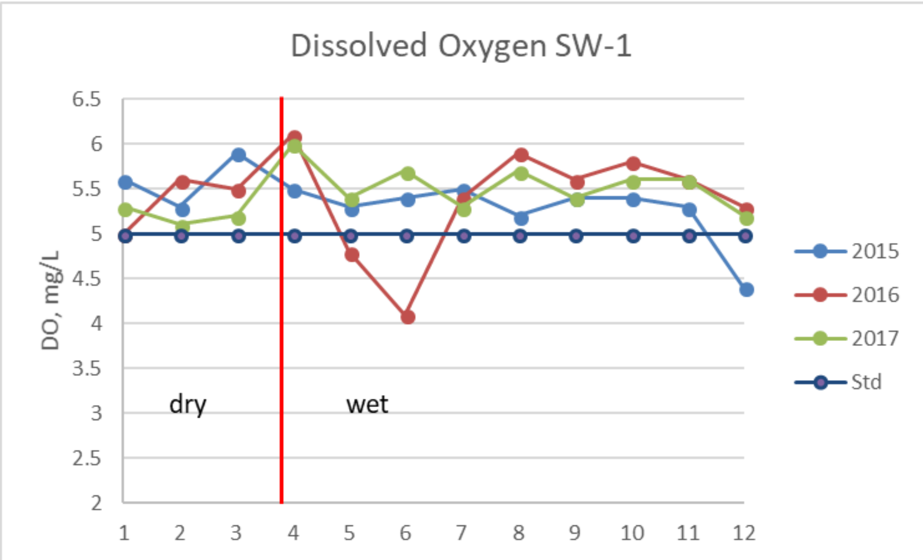


Figure 2.2.42. Dissolved Oxygen for S12 (Marine water- near discharge pt.) for dry (Jan-Apr) and wet season (May-Dec)

Effluent Water Quality

The quality of the effluent discharge of CBNC was also checked during the September 2016 sampling. The results are tabulated below in **Table 2.2.18** together with the recent CBNC monitoring (December 2016) of the same station.

Table 2.2.18. Results of effluent (Station E) analysis, CBNC, Brgy. Rio tuba, Bataraza, Palawan

Parameters	Unit	DAO 2016-08 Effluent Class SC	E Dec 2016	E Sep 2016
pH		6.5 - 8.5	7.6	6.6
DO	mg/L	5.0$_{(min)}$	5.5	5.5

Parameters	Unit	DAO 2016-08 Effluent Class SC	E Dec 2016	E Sep 2016
TSS	mg/L	100	4	58
BOD	mg/L	100	-	1
COD	mg/L	200	-	32
Fecal Coliforms	MPN/100ml	400	-	49
Total Coliforms*	MPN/100ml	10,000	-	240
Cr^{6+}	mg/L	0.10	<0.01	<0.003
Pb	mg/L	0.10	<0.01	0.05
Ni	mg/L	0.30	<0.1	-
Fe	mg/L	7.5	0.06	-
Mn	mg/L	4.0	0.9	-
As	mg/L	0.04	<0.01	<0.01
$Hg_{(total)}$	mg/L	0.004	<0.0001-	-
Cd	mg/L	0.01	<0.003	<0.006

*Note:*for reference only*

Environmental Performance

CBNC monitors the performance of its effluent quality on a monthly basis. All parameters listed above have been measured for the five (5)-year period reported here. Monthly results were plotted to determine occurrences of above-standard values. Discussed here are the critical parameters: hexavalent chromium and lead. Other heavy metals were generally within the effluent standards for Class SC discharges.

The wastewater of CBNC is treated in-plant and delivered to the tailings pond before discharge to Coral Bay. The tailings pond retains the settleable solids containing residual heavy metals. The effluent discharge to Coral Bay is monitored through sampling point E.

Monitoring data for Pb for the period 2011-2015 at effluent discharge point E is plotted in **Figure 2.2.43**. Out of the 57 sampling points, there was no exceedance from the 0.50 mg/L guide value for Pb (DAO 1990-35).

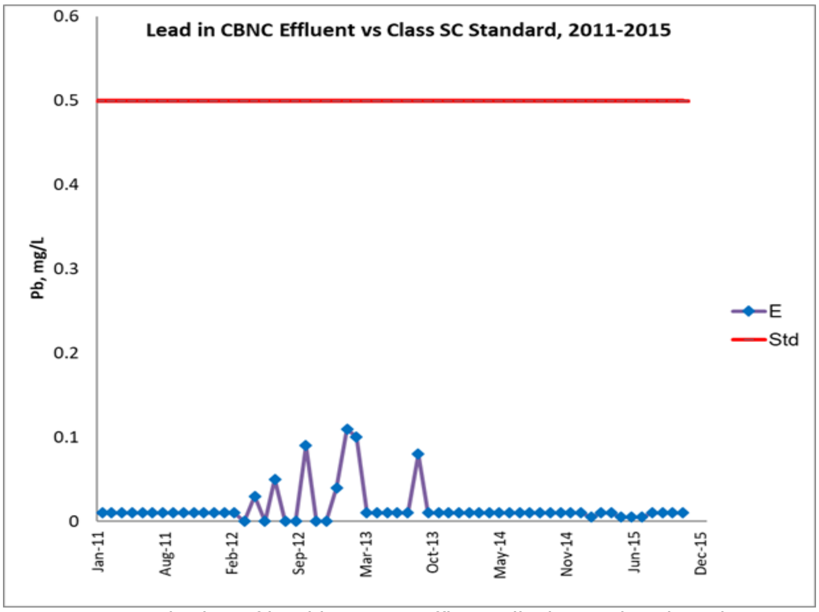


Figure 2.2.43. Monitoring of lead in CBNC effluent discharge (Station E), 2011-2015

Lead concentration in CBNC effluent for the period of 2016-2017 were also plotted in **Figure 2.2.44** and compared with the new effluent standard. The values reported were only between 0.01-0.02 mg/L as against the new guide value of 0.05 mg/L.

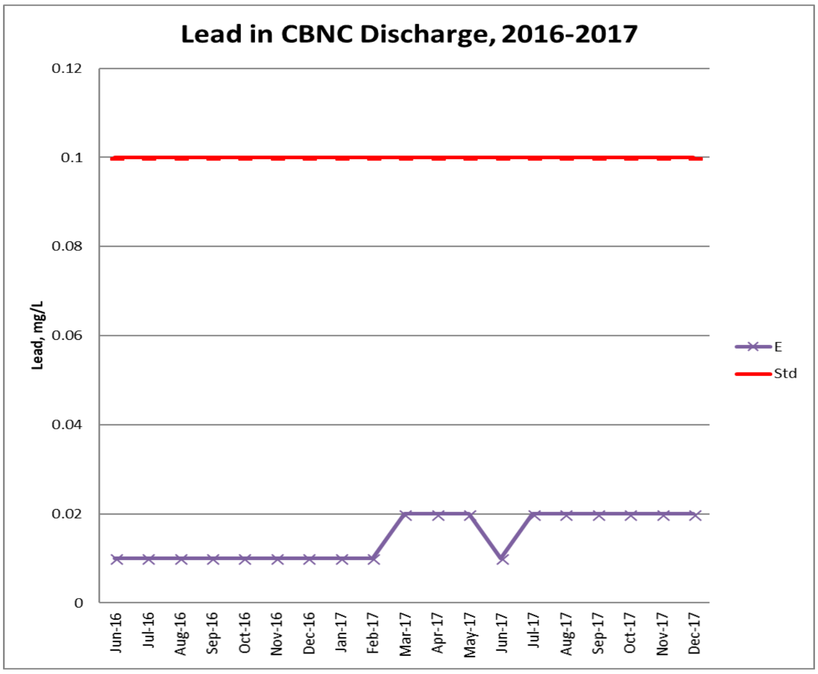


Figure 2.2.44. Monitoring of lead in CBNC effluent discharge (Station E), 2016--2017

A sampling point near the discharge (S15, discharge point at Dolphin) was also monitored for lead and only one exceedance (0.14 mg/L) out of 57 sampling occasions during the same period was observed (Mar 2013) (**Figure 2.2.45**). For the 2016-17 period where the new standard is applied, there were no exceedances observed (**Figure 2.2.46**).

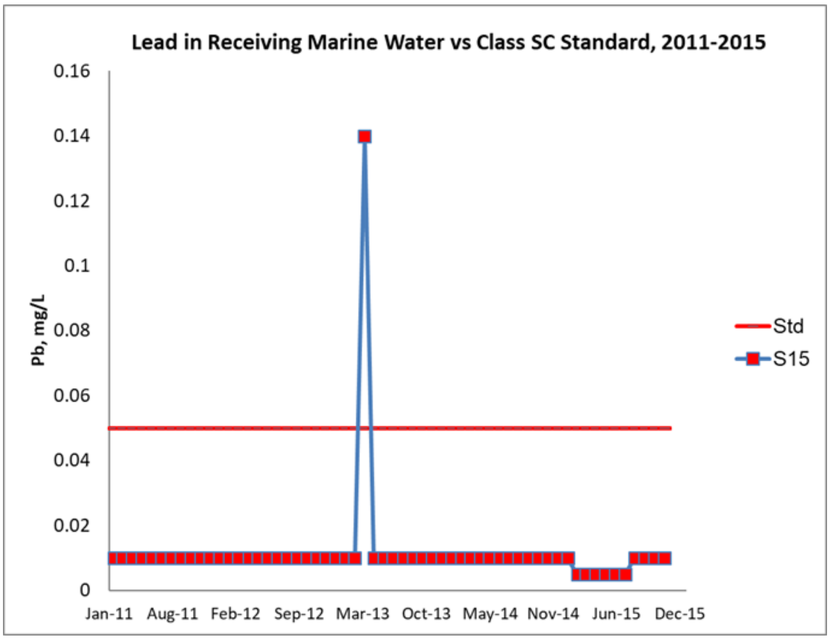


Figure 2.2.45. Monitoring of lead in receiving marine water (Station S15), 2011-2015

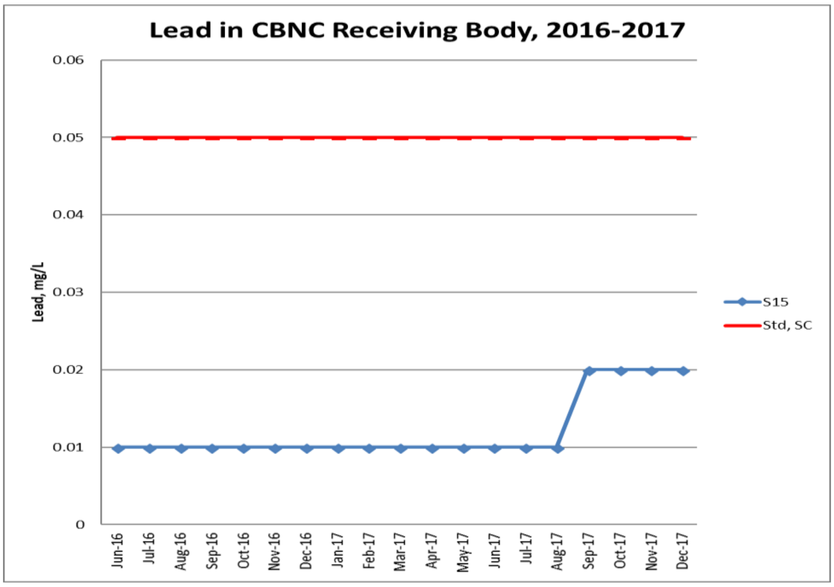


Figure 2.2.46. Monitoring of lead in CBNC effluent discharge (Station S15), 2016—2017

For hexavalent chromium at Station E, the plot of values recorded over the period is shown in **Figure 2.2.47**. Values higher than the effluent standard of 0.2 mg/l were not observed during the period. For the 2016-17 period where the standard is now 0.1 mg/L, **Figure 2.2.48** also showed no exceedance.

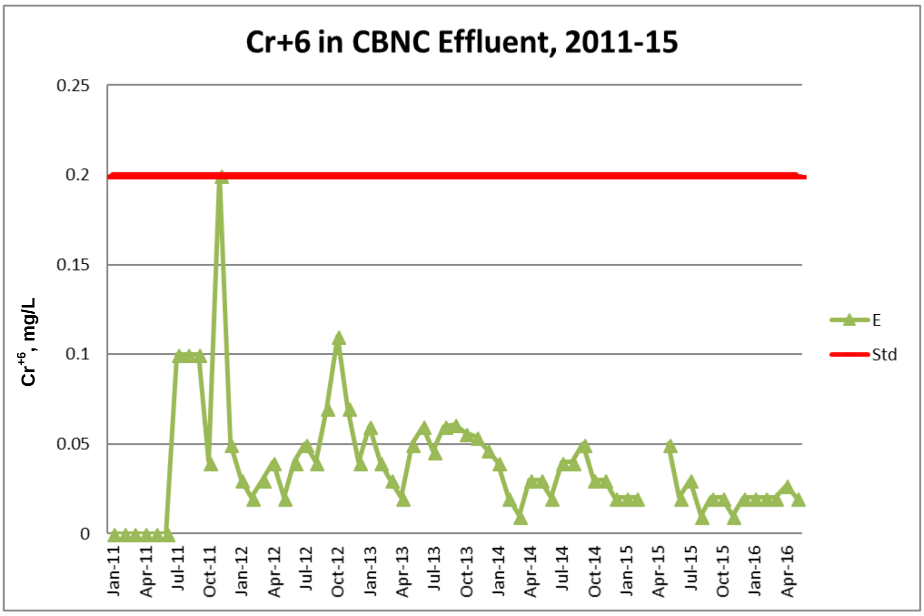


Figure 2.2.47. Monitoring of hexavalent chromium in CBNC effluent discharge (Station E), 2011 to May 2015

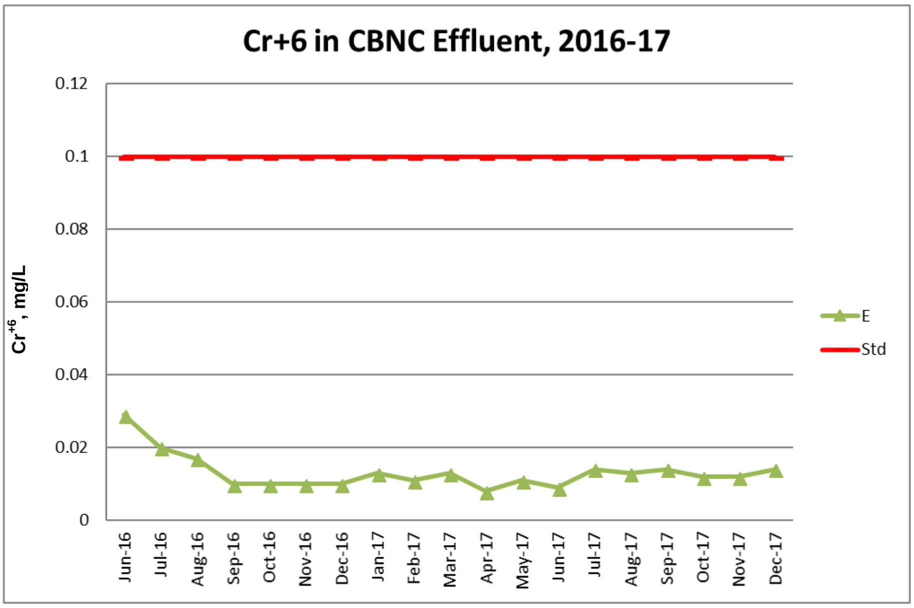


Figure 2.2.48. Monitoring of hexavalent chromium in CBNC effluent discharge (Station E), Jun2016 to 2017

Likewise, the concentration of hexavalent chromium in the receiving water body at S15 were also within the guide value of 0.10 mg/L (DAO 1990-34) (**Figure 2.2.49**) and 0.05 mg/L (DAO 2016-08).

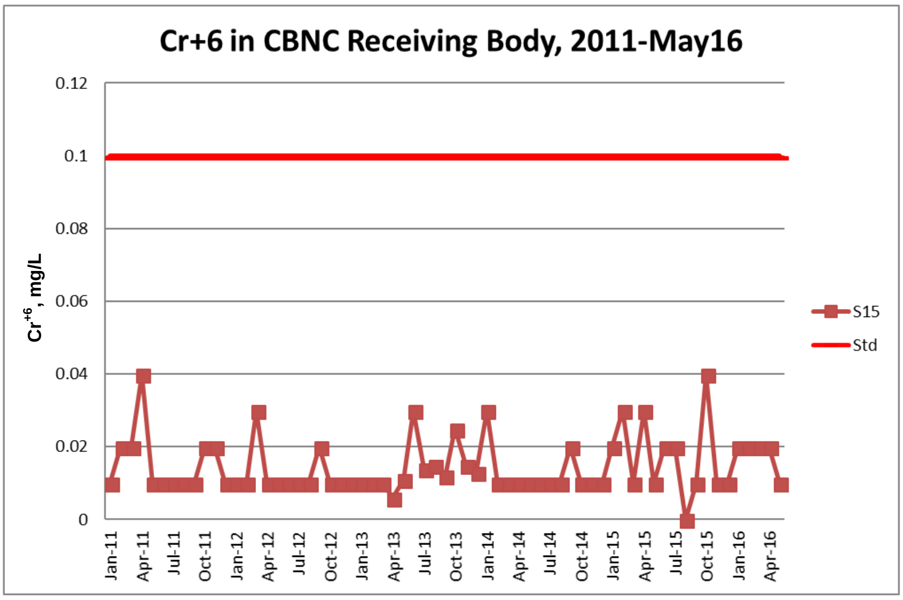


Figure 2.2.49. Monitoring of lead in receiving marine water (Station S15), 2011-May2016

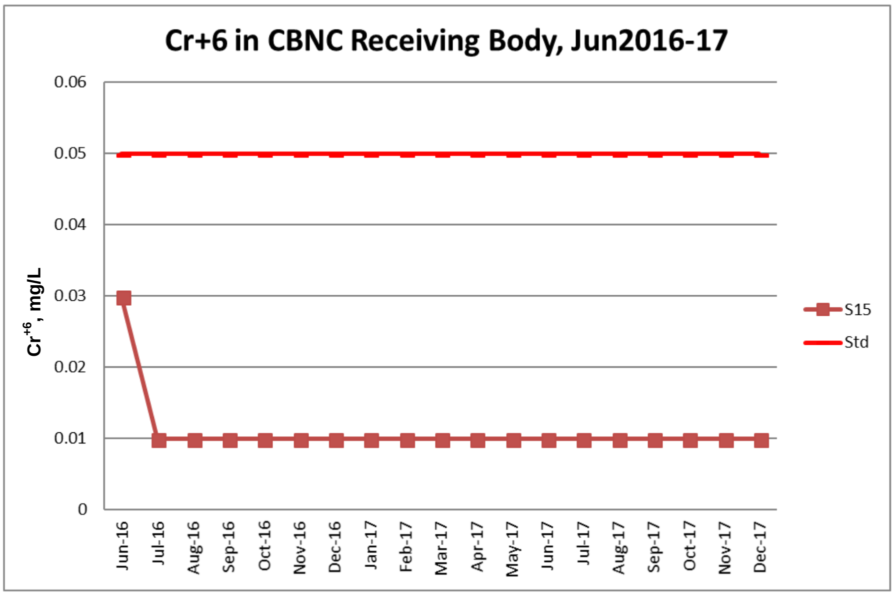


Figure 2.2.50. Monitoring of lead in receiving marine water (Station S15), Jun2016-17

2.2.3.3 Impact Assessment

CBNC maintains a wastewater treatment plant (WWTP) that treats liquid wastes generated during the HPP process. There are two (2) types of wastewater generated from the operations of the HPP. One is from the effluent generated during the mixed sulfide process and temporarily stored at the TSF and the other from the storm water generated at the HPP Plant.

Upon settling of the tailings, the supernatant part of the tailings is disposed directly to Nagoya beach via the 9 km pipeline running along Macadam Road towards the causeway and 1.08 km trestle. Around 30-40% of the effluent generated is re-circulated back to the HPP to be used again in the process. This minimizes the volume of effluent discharged and at the same time limit the use of freshwater.

The storm water generated at the 12.5-hectare HPP area is discharged to the Upper Kinurong siltation pond and then to lower Kinurong siltation pond to settle all solids and at the same time the residual heavy metals in the solids.

The analysis of the five (5)-year monitoring data (2011 to 2015) of the HPP project reported no episodes of exceedance from their wastewater discharges based on DAO 1990-35. Likewise, the recent period (2016-17) also passed the new DAO 2016-08 guide values.

This indicates that the treatment process is generally effective. The HPP wastewater treatment plant involves the neutralization of tailings, precipitation of heavy metals and wastewater by adding limestone and lime slurry. The quality of these wastewaters are measured daily at the plant using automated instruments. The Environment Management Office of CBNC also conducts monthly testing of samples from the two (2) outlets with the use of portable instruments for physical properties and assay laboratory equipment for the chemical compositions. A Horiba Multi-tester is used on-site for the measurement of physical characteristics of water samples and at the laboratory, an ICP or induction-coupled plasma analyzer is used.

The TSF2 and in the future TSF3 will be equipped with an Emergency Effluent Spillway in case a heavy volume of rainfall occurs. The spillway is designed to prevent overtopping. The emergency spillway of TSF2 will drain towards Upper Togpon Pond that can handle any spilled tailings or effluents. For TSF3, the emergency spillway will be designed to drain towards the Lower Kinurong Pond. Aside from the WTP, CBNC has an Emergency Response Plan including the Institutional arrangements that defines the protocol and responsibilities in case oil and chemical spills including the release of tailings in case of dam breach. The ERP is periodically updated and CBNC personnel are required to undergo training to enhance skills in handling emergency situations.

The HPP and the chemical unloading, and storage areas are also equipped with alarms and automatic spill containment system. To further safeguard against chemical spills, an emergency containment pond is installed at the plant site that is capable of storing any chemical leaks. The transport of H_2S0_4 and Methanol from the pier to the HPP is done by truck through the Macadam Road and a safety system is well established that is also known to the residents and establishments in Macadam Road. In its more than a decade of operations, there have been no occurrence of spills and accidents that cause a major environment impact including loss of life during transport of chemical along Macadam Road.

As part of the commitment of CBNC to improve its environmental performance, continuing research studies are supported by the management to develop alternative interventions to manage the impact of the HPP operations. One study supported is the conduct of field assessment to search for plant or algal species that can hyperaccumulate heavy metals. These plants may have the potential for the removal of heavy metal pollutants from soils and waters (phytoremediation), and the revegetation of degraded land.

Currently, CBNC are using charcoal gabions and plants reed species at the mouth of the Upper Togpon and Lower Kinurong Siltation Ponds to manage the concentrations of Cr^{6+} of the effluent discharged downstream to Tuba River.

Table 2.2.19. Impacts assessment and mitigation for water quality

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Degradation of groundwater and surface water quality from fuel leaks Oil spills during construction and operation may potentially contaminate the groundwater table and surface waters. Oil-contaminated wastewater may be generated during operation of heavy equipment and power generation and could be	✓	✓	✓	✓	CBNC maintains a motor pool area that is equipped with an Oil Water Separator (OWS). Periodic desludging of the OWS is done and all sludges are temporarily stored in leak proof containers and transported and treated by an DENR accredited laboratory. A hazardous waste storage area is installed at the plant site to temporarily store hazardous wastes including fuel-contaminated materals. The storage site is fenced, acess limited and provided with warning signs. CBNC has a protocol on the proper handling and storage of diesel, fuel oil and lubricants. These are stored in covered

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
carried by runoff or discharged to the nearest water body hence degrading the quality of the water body.					areas with impermeable flooring including proper bund walls. Emergency procedures regarding oil spill are in place. Employees are regularly trained to enhance their skills in handling emergencies. OWS are installed at various locations in the HPP which was proven to be effective in containing oil leaks within a confined area and reducing oil in wastewater effluents. During the construction of TSF3, these protocols on handling and storage of fuel and oil materials will be maintained. All vehicles and heavy equipment will be checked daily for leaks and maintenance will be conducted only in the motor pool. All vehicles and heavy equipment used in the construction will be parked only in the motor pool at the end of each working day. Fuel and oil contaminated materials will be collected and stored in leak proof container, stored in the hazardous waste storage area and transported and treated by an DENR-accredited laboratory.
Degradation of surface water quality (freshwater and marine water from chemical spills and effluent discharges Effluent discharges from the tailings dam and spillages of chemicals may introduce deleterious heavy metals and hazardous chemicals that may affect the marine ecosystem. Fugitive dust may travel to nearby surface bodies and contaminate the water.		✓	✓	✓	The effluent discharges from the tailings dam have undergone treatment and have passed the effluent standards. HPP will maintain the operation of the WWTP to ensure that all effluent discharged comply with the standards. All monitoring requirements will be maintained to ensure strict compliance to the requirements. Annual maintenance of the WWTP and the chemical unloading, transport and storage systems will be done to ensure that these facilities are safe including the spill containment facilities. The tailings dam is designed to remove settleable solids, leaving the dissolved and finely suspended particles with heavy metals in the final discharge. The concentration of heavy metals such as lead and hexavalent chromium is expected to meet the discharge requirements, as seen in the 5-year monitoring of effluent discharges. The recycling of effluent back to the process will also assist in reducing the volume of discharges. Dust suppression by water spray will be provided at all transfer points in the ore handling system. Installation of dust extraction facility at the head chute of each conveyor and at the discharge chute of the crusher will control dust emissions thereby reducing suspended solids in the runoff water.

2.2.4 Freshwater Biology

2.2.4.1 Methodology

There are no freshwater body that can be directly affected by the building of the new TSF. However, Ocayan River may be impacted in the event of dam breaching or accidental spillage. As Ocayan River had been an impact area of previous EIAs, secondary data were used.

Description of Sampling Stations

Sampling sites considered were two (2) stations within Ocayan River (**Table 2.2.20; Figure 2.2.51**). Upstream is within Sitio Bohoy most proximate to the access road. The station is shallow (15-35 cm depth) with rocky-sandy-silt bottom. Downstream station, on the other hand is located in Sitio Pasi-Pasi. Relative to the upstream station, it has deeper waters of more than a meter on bends. Bottom is also rocky-sandy-silt.

Table 2.2.20. Geographic coordinates of the freshwater ecology assessment

Station	Location	Description
Upstream Ocayan (Buhoy)	8˚35.892' N 117˚24.217' E	The station is located upstream of Ocayan River beside the access road to Sitio Buhoy. Vegetation is mainly grass and substrate is rocky-sandy-silty. The water depth ranges from 15-35 cm at the sampling site
Downstream Okayan	8˚35.468' N 117˚25.320' E	The station is located just bedside the road going to Sitio Pasi-Pasi. The substrate is rocky-sandy-silty type. Vegetation is composed of grassland/residual forest type. This is also used for monitoring water quality. Water depth ranges from 10 cm to more than a meter deep.

Source: RTNMC Bulanjao EIS, 2015

Both stations were observed to have multiple uses for household (bathing and laundry) and economic (fishing) uses.

2.2.4.2 Baseline Conditions

Phytoplankton

Ocayan River is generally depauperate of phytoplankton with total density for both stations only at 10s and 100s level only (**Table 2.2.21**). The diatoms (Baccilariophyta) are the most specious as well as the most dominant on both stations.

Table 2.2.21. Phytoplankton density of the Ocayan River, August 2015

Taxa	Density (n/L)	
	Upstream Ocayan (Buhoy)	Downstream Okayan
Cyanophyta	6	5
Chlorococcos	3	-
Spirulina	1	-
Oscillatoria	2	5
Bacillariophyta	17	23
Melosira	3	-
Merismopedia	-	4
Nitzchia	-	3
Navicula	-	5
Pleurosigma	4	-
Pseudonitzchia	2	-
Rhizosolenia	3	-
Surirella	3	11
Phyrhophyta	2	0
Diplopsalis	2	-
Euglenophyta	1	0
Euglena	1	-
Chlorophyta	7	39
Spirogyra	7	39
TOTAL DENSITY (N/L)	**39**	**105**
SPECIES RICHNESS	**10**	**6**

Source: RTNMC Bulanjao EIS, 2015

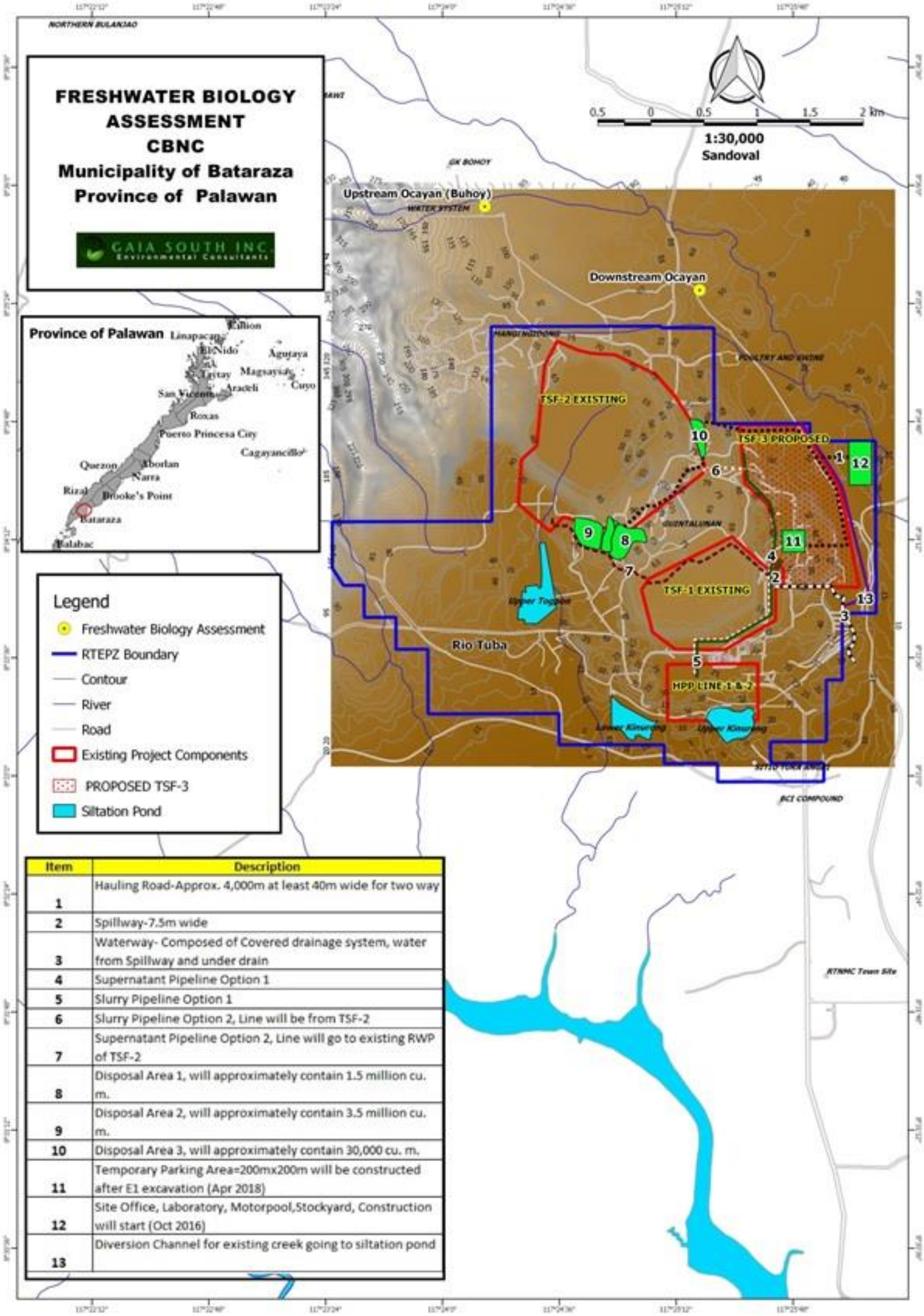


Figure 2.2.51. Sampling map for freshwater ecology assessment

The profile is typical of lotic waters that do not retain much nutrients and particulates in the water column. The flushing action of the flow also flushes biological particulates limiting residence of immotile particles such as plankton.

Phytoplankton profile within Ocayan downstream showed change in profile from highly dominated by only one (1) species to a more diverse species composition (**Table 2.2.22**). In 2001, Ocayan downstream station had *Trichodesmium* bloom, an indicator or artificial organic loading.

Table 2.2.22. Comparative profile of phytoplankton density and species richness between 2015 and 2001 sampling at the Ocayan River

Parameter	Ocayan upstream (Buhoy)		Ocayan downstream	
	2001	2015	2001	2015
Total Density (N/L)	-	39	50,500	105
Species Richness	-	10	1	6

Source: RTNMC Bulanjao EIS, 2015

Zooplankton

Upstream Ocayan is dominated by nauplius larvae, a larval stage of crustaceans. This indicates abundance of the group in the water column. In contrast, the rotifers dominate downstream portion of Ocayan. The group is a primary particulate organic matter consumers in freshwater bodies primarily those from natural sources. Riparian vegetation may have provided much of the organic load in the river coupled with silt from land. Overall, density is more than 8,000 individuals per m^3 of water in the Upstream Ocayan, twice more than the density in the downstream area.

Table 2.2.23. Zooplankton profile of Ocayan River, August 2015

Taxa	Density (n/L^3)	
	Upstream Ocayan (Buhoy)	Downstream Ocayan
Larval Bdelloid rotifer	1373	-
Loricate rotifer	-	2157
Adult Arcellidae		1078
Larval Tintinids	1029	-
Nauplius larva	5147	-
Nematoda larvae	-	1078
Unidentified egg	686	-
Total Density (N/L^3)	8235	4313

Source: *RTNMC Bulanjao EIS, 2015*

No other data is available to compare 2015 profile. Monitoring report done in 2005 reported absence of zooplankton indicating complete decoupling of trophic interaction between the primary producers and the primary consumer possibly affected by incompatibility of ecological conditions where both cannot occur.

Benthos

Upstream Ocayan had five (5) documented species of bethic organisms while the downstream part has four (4). The insect group dominates in both sites, particularly the Heptageniidae, an order under insect family Ephemeroptera (mayflies). The group is of the best indicators of water quality with most of the orders under the family having very low tolerance to organic pollution.

Table 2.2.24. Benthic profile of Okayan River, August 2015

Taxa	Density (n/m^2)	
	Upstream Ocayan (Buhoy)	Downstream Ocayan
Crustacea		
Decapod (crab)	1	-
Decapod (shrimp)	1	-
Insecta		
Peltoperlidae	2	2
Heptageniidae	19	6
Hydropsichidae	2	2
Chironomidae	-	1
Total Density (N/m^2)	25	11
Species Richness	5	4

Source: RTNMC Bulanjao EIS, 2015

Change in the benthic profile is very apparent when data is compared with 2005 and 2001 sampling results (**Table 2.2.25**). There is no change in species richness profile from Ocayan upstream station but there is a change in the composition. Earlier sampling from the station showed a high dominance (hundreds of individuals per square meter) of Hydropsichidae, an order of Trichopteran insects (caddishfly) with moderate tolerance to pollution. The dominance extends downstream in 2005.

In Ocayan downstream, there is a general downtrend in the number of insect families from 2001 to 2015. Earliest sampling showed a very high diversity, especially of insect orders from the site. Diversity went down from 28 in 2001 to 8 in 2004, and to only four (4) in 2015. Change in the diversity indicates changes in the ecological conditions of the river.

Table 2.2.25. Comparative profile of benthos between 2015 and 2001 sampling of the Ocayan River

Taxa	Density (n/m^2)				
	Ocayan upstream (Buhoy)		Ocayan downstream		
	2005	2015	2001	2005	2015
Mollusca					
Thiaridae	-	-	+	-	-
Crustacea					
Decapod (crab)	-	+	-	-	-
Decapod (shrimp)	-	+	-	+	-
Insecta					
Peltoperlidae	-	+	-	-	+
Heptageniidae	-	+	+	-	+
Hydropsychidae	+	+	+	+	+
Beatidae	-	-	+	+	-
Caeridae	-	-	-	+	-
Ephemerallidae	+	-	+	+	-
Psephenidae	-	-	+	+	-
Tipulidae	+	-	+	+	-
Chironomidae	-	-	+	-	+
Lilellulidae	+	-	+	-	-
Perlidae	+	-	+	+	-
Dysticidae	-	-	+	-	-
Elmidae	-	-	+	-	-
Gyrinidae	-	-	+	-	-
Helodidae	-	-	+	-	-
Caenidae	-	-	+	-	-
Leptophlebiidae	-	-	+	-	-
Siphlonuridae	-	-	+	-	-
Hydrometridae	-	-	+	-	-
Naucoridae	-	-	+	-	-

Taxa	Density (n/m^2)				
	Ocayan upstream (Buhoy)		Ocayan downstream		
Pleidea	-	-	+	-	-
Noctuidae	-	-	+	-	-
Calopterygidae	-	-	+	-	-
Ryacophilidae	-	-	+	-	-
No. of Families	5	5	23	8	4

Source: RTNMC Bulanjao EIS, 2015

Heavy metal contents of freshwater fish

Toxic metals found in four (4) most common fish species in Ocayan River showed levels are below detectable limits except for Pb (**Table 2.2.26**). Lead (Pb) is a common impurity found in fossil fuels and contamination is often associated with atmospheric deposition as well as inland transport from run-off. Ingestion of lead concentrations beyond tolerable limits had been proven to cause neurological damage most observable to the young than the adults, among other toxic effects (*www.cdc.gov*).

Table 2.2.26. Heavy metal concentrations in different fish species caught in Ocayan River, August 2015

Heavy Metals	Biological Samples [Concentration (mg/kg)]				RDA Trace
	Pantat (carnivore)	*Paet* (planktivore)	*Tilapia* (omnivore)	*Martiniko* (omnivore)	
As	<0.010	<0.010	<0.010	<0.010	
Cr	<0.020	<0.020	<0.020	<0.020	0.05 - 0.2 *
Ni	<0.200	<0.200	<0.200	<0.200	0.3-0.7 **
Pb	3.430	4.520	5.390	5.500	0.5***
Hg	0.02	0.004	0.004	0.004	40***
Cd	<0.030	<0.030	<0.030	<0.030	0***

*Notes: *mg/day; **mg/Kg; ***mg (WHO allowable limit)*
Source: RTNMC Bulanjao EIS, 2015

2.2.4.3 Impact Assessment

The shift in the community composition and profile of plankton and benthic population may be inconclusive because of difference in timing of sampling and missing data. Moreover, the water from the project site do not drain directly to Ocayan River and the the impacts to water quality and subsequently to freshwater organisms can be considered to be caused by other anthropogenic factors.

As part of the ECC conditionalities for the HPP Project, fish tissue analyses for heavy metals are conducted bi-annually. For freshwater species, CBNC are rearing different fish species at the Lower Kinurong Siltation Pond and Culimbawang Creek. Siltation ponds and the reared fish are tested for fish tissue heavy metals content. To maintain the flow of the Ibelnan Creek, the design of the intake dam at the East Ibelnan River allows at least 10% of the streamflow as required by NWRB regulations. Streamflow of the West Ibelnan River remains unobstructed which contributes to the flow during the dry months. CBNC has also installed and maintained the fish ladder at the intake dam. The fish ladder was installed to allow migratory fish to travel upstream.

Table 2.2.27. Impacts assessment and mitigation for freshwater ecology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-onstruction	Construction	Operation	Abandonment	
Threat to existence and/or loss species of important local and habitat and threat to abundance, frequency and distribution of species Accidental breaching of dam which may result to spillage of large amount of tailings that will decimate freshwater species downstream of the project site. This impact will be long term.	✓	✓	✓	✓	The design of the dam and the tailings disposal process ensures that embankment becomes sore stable as more tailings are stored. This decreases the probability of dam breach and release of tailings. Future monitoring activities should be consistent with previous sampling in terms of timing and biotic samples. Missing data from uncollected biotic information may lead to incorrect projection of impacts or wrong attribution of causative factors.

2.2.5 Marine Biology

2.2.5.1 Methodology

Plankton

Planktonic organism are algal and animal species that live within the water column either as part of their life cycle or as a permanent habitat. Phytoplankton forms the base of primary productivity in the aquatic environment taking advantage of dissolved nutrients. Zooplankton, on the other hand, are the microscopic animals and their larvae that form the primary consumers establishing the first link to harvestable biomass from the sea.

Sampling of the microscopic plankton makes use of plankton net with 25 µm diameter net. A 30-L surface water was collected from each site and passed through the net. The collecting net was repeatedly back- washed to remove clinging organisms on the inside part of the net. The collected water at the cod-end of the net was transferred to a collecting bottle labeled with site name. Samples were treated with 1% formalin (v/v) as preservative and fixative. Samples were transported to the laboratory for taxonomic identification and density counting.

Fish and corals

Researchers in SCUBA gear lay fiber glass transect line haphazardly on the reef crest of each site with reef. Where there is no visible crest as in the case of coral bommies, the transect line is laid where there is flat surface. Percent cover (%) is taken by adding the length of each lifeform category over the total length of the transect line (English et al., 1996). Observations were also made for interesting biological species left and right of the transect.

Using the same transect line, an observer makes visual census of fish every 5 meter-distance. Taxonomic identity of fishes was noted in an underwater slate while their lengths were approximated. For schooling fish, density was approximated. Biomass was computed from a length-weight ratio specific to the species of family (Labrosse et al., 2002). Total density, on the other hand, were computed by multiplying the count data with the area covered by the transect.

Seagrass

For sites with seagrasses, a 0.5 m x 0.5 m quadrat was used to gather samples. The quadrat was further divided into smaller squares by nylon string every 10 cm with each quadrat having 25 small squares. The quadrat was randomly thrown in the seagrass area five times to constitute a total sampling area of 1.25 m^2. For each quadrat, seagrass cover was estimated. Species were identified using field guide.

Heavy metal contents of marine fish flesh

Fish samples were collected from in-situ fishers. Species were segregated into trophic level. For this analysis, carnivores refer to groupers (*Plectropomus* and *Epinephelus*) while rabbitfish (*Siganus*) were referred to as herbivores. Samples for each trophic group was sent to the laboratory for heavy metal analysis, specifically for arsenic (As), hexavalent Chromium (Cr^{6+}), copper (Cu), nickel (Ni) and lead (Pb). These metals are known.

Description of Sampling Stations

Sampling sites were the same sites that are used in monitoring studies (**Table 2.2.28**). This is to ensure a continual provision of data given different contexts of time without prejudice to factors other than the probable project impacts. Sites were arranged based on their distance from the project commensurate to the probable severity of impact in case of dam breaching.

Primary impact areas are sites most proximate to the coastline. Ocayan River may be the primary recipient of tailings in the events of dam breaching, so is the reef nearest to it (Barangkas). All other primary impacts sites are also primary impact sites of previous expansion projects. Secondary impact sites are those that are relatively offshore while control sites are site that may be affected even in extreme events. Control sites serves as the standard ecological condition from which project impact may be measured.

Table 2.2.28. Geographic coordinates of the marine ecology assessment

Site	Location	GPS location	Coral and fish	Seagrass*	Plankton	Water quality
Primary Impact Sites						
S1	Mooring Dolphin	N8° 29' 40.9" E117° 26' 46.7"	/		/	/
S2	Discharge	N8° 29' 39.9" E117° 26' 49.2"			/	/
S3	Causeway	N8° 30' 00.4" E117° 26' 13.5"	/	1	/	/
S4	Ocayan	N8° 30' 51.9" E117° 27' 32.0"		/	/	/
Secondary Impact Sites						
S5	Barangkas	N8° 30' 25.3" E117° 28' 05.3"	/		/	/
S6	Marantaw	N8° 29' 37.5" E117° 25' 47.6"	/		/	/
S7	Small Sandbar	N8° 29' 24.7" E117° 26' 29.9"	/	/	/	/
Control Sites						
S8	Big Sandbar	N8° 28' 44.5" E117° 26' 27.5"		/	/	/
S9	Ameril Is.	N8° 26' 53.4" E117° 25' 37.0"	/		/	/
S10	Ursula Is.	N8° 20' 51.4" E117° 31' 32.4"	/	2	/	/

Notes:
[1] N8° 30' 06.8" E117° 26' 53.4"
[2] N8° 20' 21.2" E117° 31' 04.4"

For this study, there are three (3) primary impact sites for fish and corals, two (2) impact sites for seagrasses, and four both for plankton and water quality data. Of the three (3) secondary impact sites, all were considered for fish and corals, plankton, and water quality, and only one for seagrass. There are three (3) control sites, two for coral and fish, one for seagrass, and all three (3) for plankton and water quality.

2.2.5.2 Baseline Conditions

Corals

The Mooring Dolphin (S1) has a live coral cover of 18.3% (**Table 2.2.29**). Much of the benthic cover is composed of silted-over coral colonies comprising more than 75% of the bottom. The site is notable for bleached massive coral colonies (**Plates 2.2.21** to **2.2.22**) as well as tabulate corals overgrown with algae. Bleaching is a phenomenon where symbiotic algae of corals leave their hosts associated with elevated temperature (Slavov et al., 2016) that is usually associated with El Niño. The corals appear white as algal cells give color to the polyps and eventually die. Algae provides photosynthates to individual coral polyps which comprise their only source or sugar for energy.

On the other hand, the discharge pipes (S2) are covered with fouling organisms, mostly sponges and ascidians, with sporadic occurrence of encrusting coral recruits (**Plate 2.2.27**). The pillars also recruited soft corals as well as gorgonians.

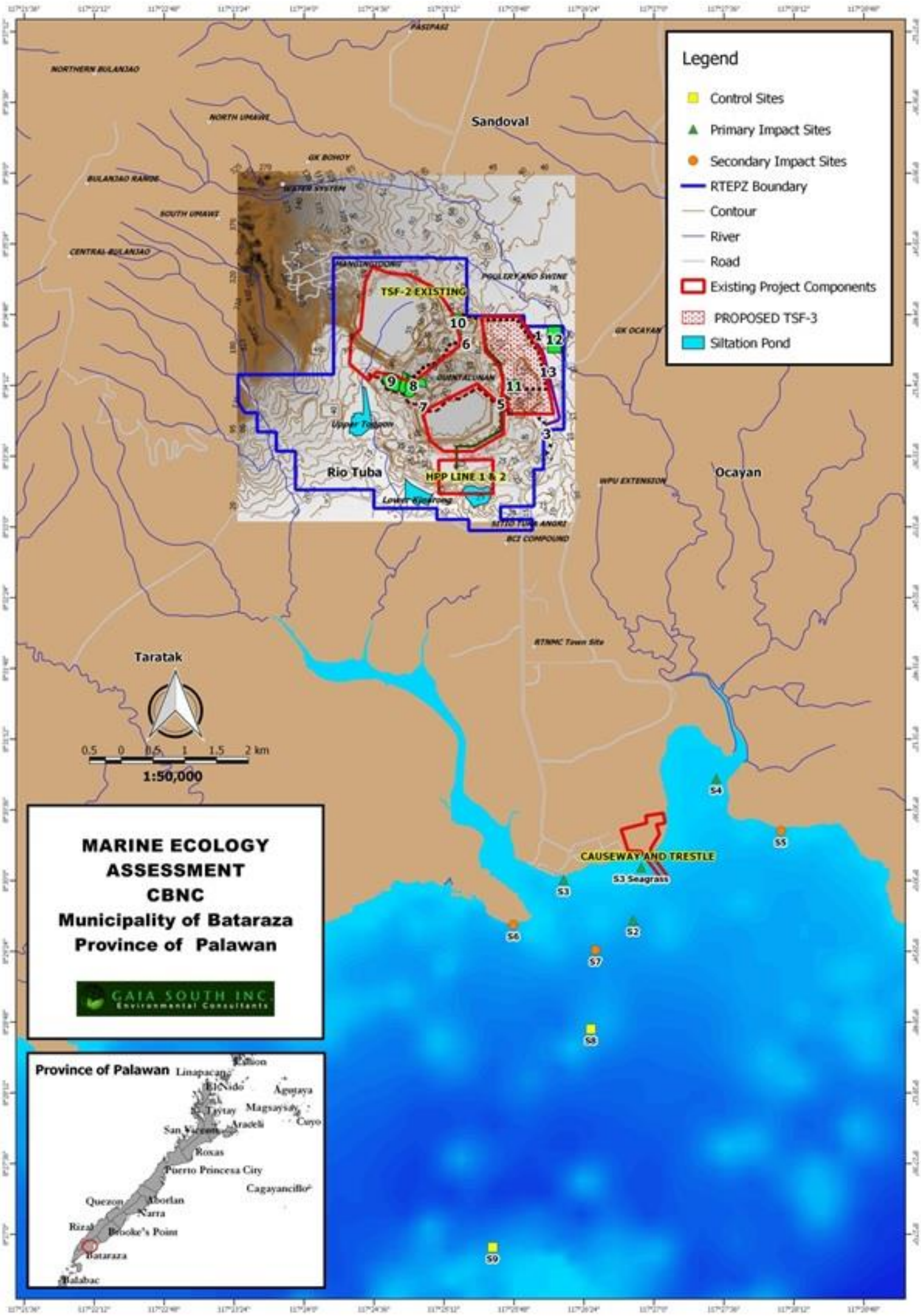


Figure 2.2.52. Sampling map for marine ecology assessment of CBNC expansion area

Plate 2.2.25. A branching coral with dead colonies overgrown with algae on the background and bleached colonies partially covered with algae on the foreground in Mooring Dolphin site (S1).

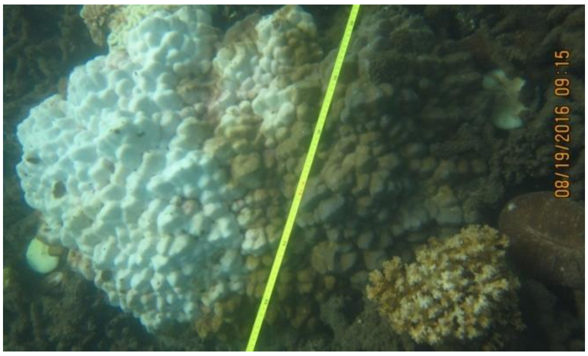


Plate 2.2.26. A partially bleached submassive coral colony in Mooring Dolphin site (S1).

Plate 2.2.27. Commercially important fish species - *Caesio* sp., swim against the backdrop of bleached corals in S1.

Plate 2.2.28. Commercially important fish species - Barracuda swim against the backdrop of bleached corals in S1.

Plate 2.2.29. A fully bleached colony on the foreground against dead coral colonies overgrown with algae on the background.

Plate 2.2.30. Massive *Porites* fully bleached.

Plate 2.2.31. The discharge pipes (S2) are fully encrusted with colorful sponges.

Plate 2.2.32. Soft coral on the pillars of the discharge pier.

Table 2.2.29. Coral reef profile of the sampling sites, Coral Bay, Palawan, August 2015 (% Cover)

Lifeform	S1	S3	S5	S6	S7	S9	S10
Corals	**18.3**	**39.36**	**26.36**	**15.34**	**34.28**	**35.24**	**26.44**
branching	1.22	0.66	2.30	4.04	7.94	26.2	15.14
encrusting	1.82	7.58	2.14	1.00	1.98	-	1.92
massive	7.24	11.76	14.24	1.24	20.5	3.80	2.74
solitary	1.46	-	1.32	2.18	0.28	1.44	-
sub massive	6.56	17.78	6.36	5.70	2.94	3.36	4.58
foliose	-	1.58		1.18	0.64	0.44	2.06
Others	**4.68**	**0.00**	**0.18**	**2.06**	**0.00**	**0.40**	**0.20**
grass	4.32	-	-	-	-	-	-
soft coral	0.12	-	0.18	-	-	-	-
sponge	0.24	-		2.06			0.20
CLAM	-	-	-	-	-	0.40	-
Abiotic factors	**77.02**	**60.64**	**73.46**	**82.6**	**65.72**	**64.36**	**33.36**
sand	0.80	2.40	0.40	4.66	20.44	6.62	2.50
silt	0.60	6.86	-	-	-	-	-
dca	75.62	-	73.06	77.94	45.28	57.74	30.86
rocks	-	51.38	-	-	-	-	-

The Causeway (S3) is an artificial structure where hard substrate was made available for coral recruitment. This study initiates the documentation of the recruited corals on the area to complement the fish population being monitored. While the hard substrate available for coral growth is limited to the rocks as base of the pier, it nevertheless showed a good cover at more than 39% (**Plates 2.2.29** to **2.2.30**). Rocks overgrown with turf algae still consist of more than 51% of the bottom.

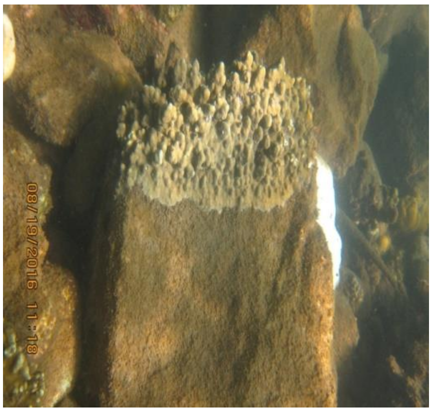


Plate 2.2.33. Recruited corals showing significant cover in S3 despite the unconsolidated nature of the pier base.

Plate 2.2.34. Another photo of recruited corals have shown significant cover in S3 despite the unconsolidated nature of the pier base.

Plate 2.2.35. A giant clam

Plate 2.2.36. Moray eel

Among the three (3) secondary impact sites, Small Sandbar (S7) has the highest live coral cover at 34.28%. The coral colonies occur on sandy bottom as bommies and on some hard substrate co-occuring with seagrasses (**Plates 2.2.33** to **2.2.34**). Generally, the area has low relief. Barangkas (S5), a secondary impact area if Ocayan will be affected has more than 26% live coral cover.

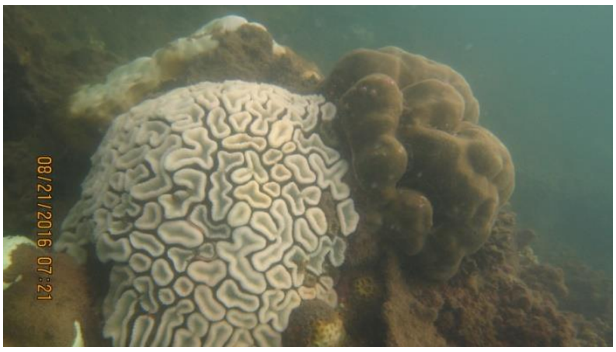


Plate 2.2.37. *Favia* corals in S5

Plate 2.2.38. A thicket of the iridescent Acropora from S6.

Plate 2.2.39. Bleached Favia from S6.

Plate 2.2.40. A thicket of branching and digitate coral in Small Sandbar (S7). Note of the bleached colonies.

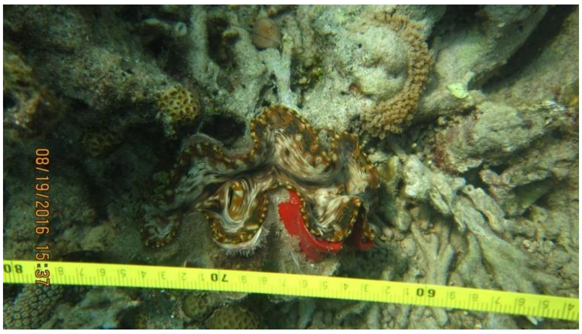


Plate 2.2.41. A rock clam (Crassostrea) among the coral colonies.

Plate 2.2.42. A group of shrimpfish hovering among dead corals (S7).

Ameril Island (S9) has live coral cover of more than 35% while Ursula (S10) has more than 26%. Both sites exhibit good coral growth clear of silt deposits and clear waters. Bleached corals were not observed in both sites unlike other sites. Despite this, comparison with previous data showed a general decline of live coral cover from 2012 (**Figure 2.2.53**). The trend is sustained on all sites with decline ranging from 20-50% of the corals.

From 2012 to 2016, changes in the proportion of live coral cover over other marine benthic lifeforms showed variability. Trend however clearly showed a decrease in live corals and an increase in dead coral covered with algae through time. The trend is consistent on all sites indicating variability because of sampling is overridden by ecological processes that resulted to the observed trend. Physical observation showed an increase in the incidence of bleached coral colonies, particularly for this year. Bleaching is a physiological phenomenon where coral colonies loose their symbiotic zooxanthellae resulting to bleached appearance. Long term bleaching results to death of colonies.

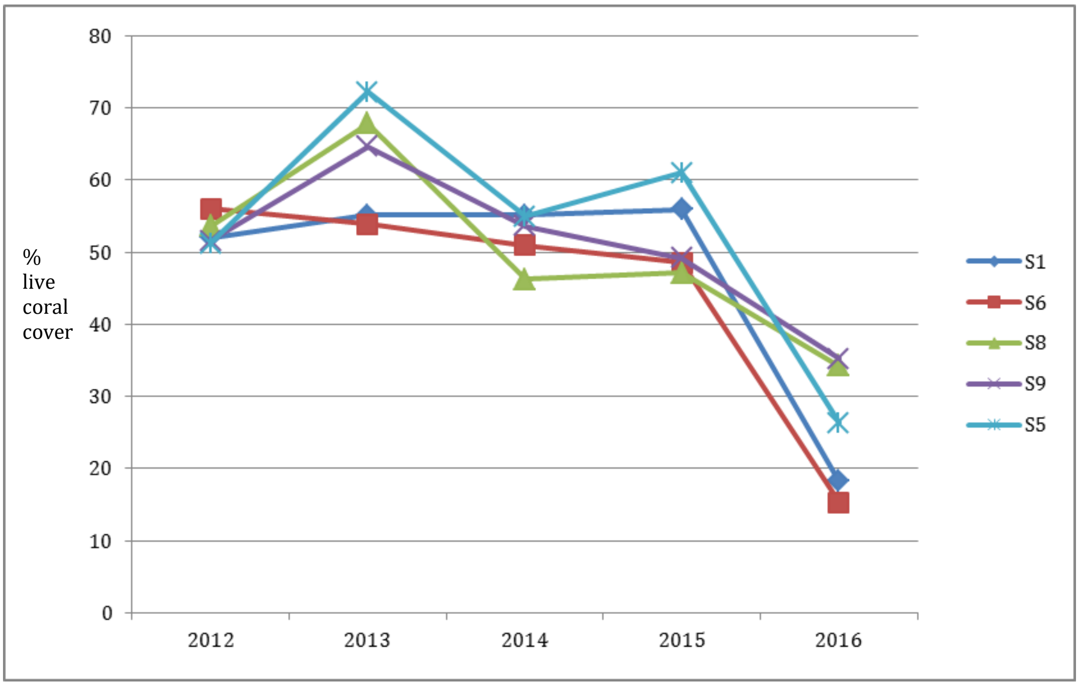


Figure 2.2.53. Trend in live coral cover in all coral sampling sites from 2012 to 2016.

One possible scenario on the decrease in live coral cover is the El Niño phenomenon that started second half of 2015 and lasted first half of this year (Binker, 2015). The event caused warming of ocean surfaces which created bleaching events on some sites within Palawan (*www.msi.upd.edu.ph/*). Possibly all sampling sites may have been affected with the more offshore sites experience bleaching first (hence absence of bleached colonies but increase in dead coral cover) and the inland stations later. Organic particulate are also known factor that interact with climatic factor that enhances bleaching making inshore sites more vulnerable (Higucho et al., 2015).

Fish

All sites where coral covers were documented were also covered by fish survey including the Discharge pipe (S2). In terms of species richness, S6, S8 and S9 all have about 40 species (**Table 2.2.30**). On the other hand, density is highest at 3.2 individuals per meter square at S2, a site where highest fish biomass was also documented at 182.2 grams per meter square. This was followed by S1 with 2.65 individuals per meter square estimated density but with only 28.53 grams per meter square harvestable biomass. Big Sandbar (S8) comes in second to S2 in terms of biomass at more than 54 grams per meter square.

Table 2.2.30. Fish community observed from sampling sites, Coral Bay, Palawan, August 2015 (fish count)

Family	Scientific Name	S1	S2	S3	S5	S6	S8	S9	S10
Acanthuridae	*Acantharus lineatus*	1	7	-	-	-	-	-	4
	Acanthurus blochii	-	15	-	-	-	-	-	4

Family	Scientific Name	S1	S2	S3	S5	S6	S8	S9	S10
	Ctenochaetus striatus	-		5	16	7	3	5	4
	Zanclus cornutus	-	5	-	-	1	-	-	-
Apogonidae	*Apogan nigrofasciatus*	-	-	-	-	25	-	15	-
	Apogon compressus	-	-	12	-	-	-	-	-
	Apogon cyanosoma	-	-	25	-	-	-	-	-
Balistidae	*Rhineacanthus verrucosus*	1	-		-	-	-	-	-
Caesionidae	*Caesio caerularea*	55	-	-	-	-	-	-	-
	Caesio cuning	75	-	-	-	-	-	90	-
	Caesio teres	-	-	-	-	-	-	10	-
	Pterocaesio tile	50	72	-	-	-	-	-	
Carangidae	*Carangoides orthogrammus*	-	58		-	-	2	-	
	Seriola lalandi		-	-	-	-	-	1	-
Centriscidae	*Aeoliscus strigatus*	-	-	-	-	5		-	-
Chaetodontidae	*Chaetodon punctatofasciatus*	-	-		-	-	1	2	2
	Chaetodon trifascialis	-	-	-	-	1	-	-	-
	Chaetodon ulietensis	-	-	-	-	2	-	-	-
	Chaetodon vagabundus	-		1	-		-	2	
	Coradion chrysozonus	-	-	-	-	-	3	-	-
	Hemochus varius	7	-	-	1	-	-		-
	Henoichus acuminatus	1	-	-	-	-	1		-
	Henoichus singularius	-	-	-	-	1	-	-	-
	Henoichus varius	-	-	-	-	-	1	-	-
Ephippididae	*Platax pinnatus*	-	-	-	-	-	1	-	-
Haemulidae	*Plectorhinchus lineatus*	-	-	-	-	1	1	1	-
	Plectorhinchus orientalis	-	-	-	-		2		-
Holocentridae	*Myripristis adusta*	5	-	-	-	-	-	-	-
	Myripristis berndti	20	-	12	5	-	-	7	-
	Myripristis violacea	-	-	15	-	-	-	-	-
	Sargocentron melanospilos	-	-	15	-	-	-	-	-
Kyphosidae	*Kyphosus vaiglensis*	-	2	-	-	-	-	-	
Labridae	*Bodianus diana*	-	-	1	-	-	1	-	-
	Bodianus loxozonus	1	-	1	-	-	-	-	-
	Bodianus mesothorax	-	-	-	-	-	-	1	-
	Cheilinus bimaculatus	-	-	-	1	-	-	-	-
	Cheilinus fasciatus	1	-	-	1	-	-	3	-
	Choerodon anchorago	-	-	-	-	-	-	1	-
	Cirrhilabrus cyanapleura	-	-	-	-	-	1	-	1
	cirrhilabrus fasciatus	-	-	-	-	3	-	-	-
	Cirrihilabrus cyanopleura	-	-	-	-		-	1	-
	Coris aygola	-	-	-	-	-	-	1	1
	Halichoeres melanurus	-	-	-	1	1	-	-	-
	Halichoeres ornatissimus	-	-	-	1	-	-	-	-
	Halichoeres scapularis	2	-	2	-	1	-	-	-
	Halichoeres trimaculatus	-	-	-	1	1	1	3	2
	Labroides bicolor	-	-	-	-	-	-	1	-
	Labroides dimidiatus	1	-	-	1	1	-	-	-
	Stethojulis bandanensis	-	-	-	-	-	-	6	-
	Thalassoma hardwicke	1	-	-	-	1	1	3	1
	Thalassoma lunare	2	-	-	-	3	3	7	-
	Thalassoma lutecens	4	-	-	-	2	2	1	-
	Thalssoma lunare	-	-	-	-	-	1	-	-
Lethrinidae	*Lethrinus harak*	-	-	-	2	6		-	-
	Lethrinus olivaceus	-	-	-	-	-	2	-	-
Lutjanidae	*Lutjanus argentimaculatus*	1	5	-	-		1		-
	Lutjanus biguttatus	-	-	4	-	-	-	-	-
	Lutjanus bohar	-	23	-	-	-	-	-	-
	Lutjanus decussatus	1		4	-	1	2	1	1
	Lutjanus fulviflamma	1	-	8	-	-	2	-	-
	Lutjanus kasmira	-		5	-	2	-	-	1
Mullidae	*Parupeneus barberinus*	-		-	5	-	-	-	1
	Parupeneus multifasciatus	-		-	6	-	1	-	

Family	Scientific Name	S1	S2	S3	S5	S6	S8	S9	S10
Nemipteridae	*Pentapodus caninus*	-		-	-	-	-	1	
	Scolopsis bilineatus	-		2	-	1	2	3	
	Scolopsis monogramma	-		V	-	1	2	-	3
Pempheridae	*Pampheris vernicolensis*	55			-	-	-	-	
Pomacanthidae	*Centropyge bicolor*	-			-	-	1	-	
	Chaetodon octofasciatus	2		3	-	-	-	2	
	Chelmon rostratus	1			-	-	2	-	
	Genicanthus melanospilos	5			-	-	-	-	
	Parachaetodon ocellatus	1			-	-	-	-	
	Abudefduf sexfasciatus	15	5	10	-		56	18	22
	Amblyglyphidodon curacao	40		2	-	65	10	15	-
	Amphiprion clarkii	-	-	-	-	1	-	-	-
	Chaetodon mesoleucus	-	-	-	-	-	2	-	-
	Chromis margaritifer	-	-	-	2	15		-	-
	Chromis viridis	-	-	-	3	20	67	-	-
	Chromis weberi	30	-	25		30	22	-	-
	Chromis xanthura	-	-	-	2	15	-	-	5
	Chrysiptera parasema	-	-	-	3	3	-	-	-
	Chrysiptera rollandi	-	-	-	-	25	11	5	
	Chrysiptera unimaculata	35		12	5	25	25	-	6
	Ctegastes fasciolatus	-	-	-	-	-	17	-	-
	Dascyllus aruanus	-	-	-	-	-	-	4	-
	Dascyllus reticulatus	7	-	-	-	-	-	-	-
	Dascyllus trimaculatus	-	-	-	-	5	-	-	-
	Dischistodus melanotus	-	-	-	-	-	-	2	-
	Neoglyphidodon melas	-	-	-	-	-	3	50	-
	Neoglyphidodon nigroris	15			6	22	7		15
	Neopomacentrus azysron	-	-	-	-	36	-	-	-
	Pomacentrus coelestis	-	-	-	1	-	-	25	-
	Pomacentrus moluccensis	20			10	40	19	10	-
	Stegastes fasciolatus	15	-	18	-	30	-	-	-
Scaridae	*Cetoscarus bicolor*	-	-	-	-	-	-	7	-
	Scarus bleekeri	1	-	1	1	-	3	1	4
	Scarus flavipectoralis	-	-	-	-	-	2	1	-
	Scarus niger	-	-	-	-	-	1	-	-
	Scarus schegeli	2		15		5	1	-	-
Serranidae	*Aethaloperca rogaa*			1		1	-	-	1
	Cephalopholos argus	-	-	-	-	-	-	2	-
	Plectopomus oligocanthus	-	-	-	-	-	-	1	-
	Pseudanthias pleurotaenia	-	5			20	-	-	-
Siganidae	*Siganus argenteus*	-	-	35	15	15	-		-
	Siganus doliatus	9	-	-	-	25	19	6	-
	Siganus guttatus	7	-	32		15	3		-
	Siganus stellatus	5	-	-	-	-	-	-	-
	Siganus vulpinus	-	-	-	-	9	3	5	2
Sphyraenidae	*Sphyraena genie*	35	-	-	-	-	11	50	
No. of Species		**38**	**10**	**26**	**22**	**42**	**44**	**40**	**19**
Density (N/m^2)		**2.65**	**3.28**	**0.71**	**0.45**	**2.45**	**1.61**	**1.85**	**0.80**
Biomass (g/m^2)		**28.52**	**182.12**	**8.80**	**6.85**	**24.01**	**52.71**	**32.91**	**30.97**

The high density and high biomass at S2 is due to the occurrence of schooling fishes of commercial value like scissortails (Caesionidae) and jacks (Carangidae). On the other hand, species-rich sites are mostly due to ecologically important species such as damselfishes (Pomacentridae). Speciousness results from numerous but small species in the community while high biomass is from large individuals. It can be noted that fish biomass is mostly determined by pelagics and species richness is determined by reef-associated species. The topographical relief provided by the pillars in S2 offer refuge to fishes.

Trends in fish density showed erratic development from 2012 to present (**Figure 2.2.54**). For most sites with reefs, computed density went down most probably due to the decrease in live coral cover (see coral discussion). Coral reefs both provide habitat and food for species which understandably goes down as live corals are overrun by turf algae. Only S2 showed increased density through the years.

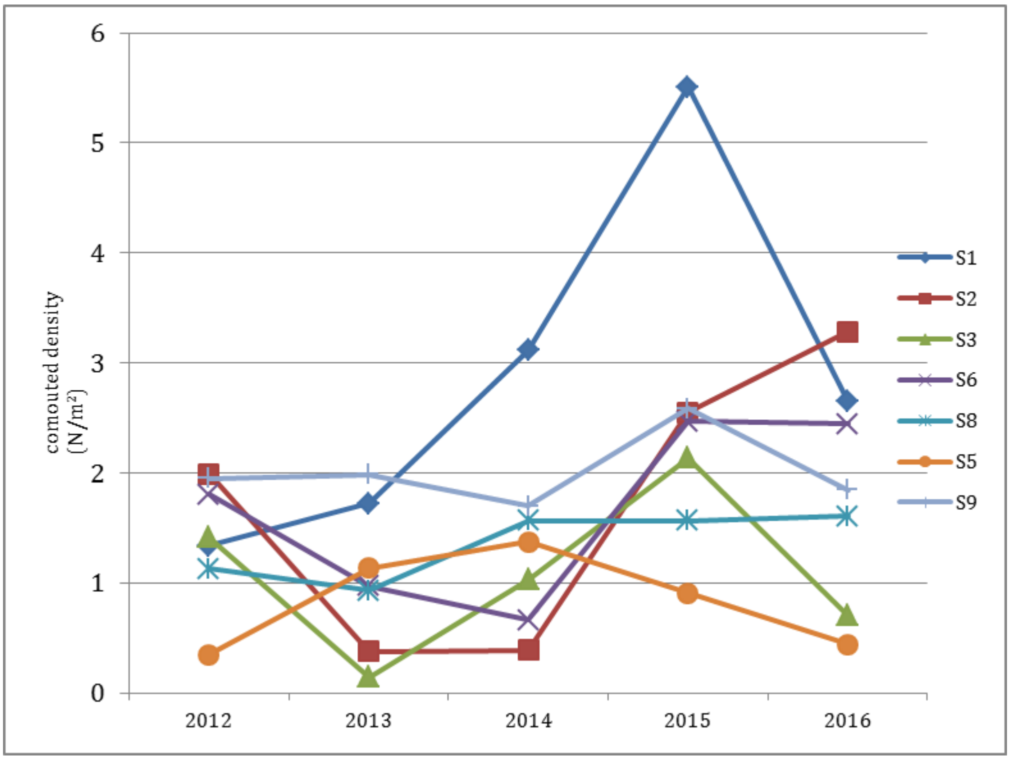


Figure 2.2.54. Trend in computed fish density from 2012 to 2016.

Seagrass

Among the ten sampling sites for this study, four (4) had seagrasses: S3, S4, S7 and S8 (**Table 2.2.31**). Causeway (S3) has a multi-specific seagrass bed composed of *Cymodocea-Halodule* patches with sporadic occurrence of *Enhalus* with a total estimated cover of 78.84%. Ocayan site (S4), on the other hand, has only an estimated cover of 10% mainly from stands of *Enhalus*. The site experience regular burial events as evident by thick fine silt cover of the bottom which allows *Enhalus* to thrive. The species is known to be resistant to burial (Duarte, 2000).

Table 2.2.31. Species listing of seagrass species, CBNC, August 2015

Species	S3 Causeway	S4 Okayan	S7 Small Sandbar	S8 Big Sandbar	S10 Ursula
Cymodocea sp.	/	/	/	/	/
Enhalus sp.	/			/	
Halodule sp.	/		/	/	/
Halophila sp.			/		
Syringodium sp.			/	/	
Estimated Cover (%)	78.4	10.0	74.0	80.8	48.6

Both Sandbar sites (S7 and S8) bear mult-ispecific seagrass beds with very good cover of 74% and 80.8% respectively.

There is variability of estimated cover from 2014 to 2016 among the study sites (**Table 2.2.32**). This variability may not necessarily mean changes in the cover because of environmental events, rather, it may be due to the variability of specific location of the transect/quadrat used. Specific concern may be raised on S4 but the stable presence of *Enhalus* indicates reflected variability may be due to quadrat location.

Table 2.2.32. Trend in species richness and estimated cover of seagrass, CBNC, August 2015

Site	Year	No. of species	Est. Cover (%)
S3	2014		74.67
	2015	7	61.50
	2016	3	78.40
S4	2014		63.12
	2015	1	63.12
	2016	1	10.00
S7	2014		69.35
	2015	6	68.53
	2016	74	74.00
S8	2014		52.98
	2015	8	42.70
	2016	4	80.80

Seagrass community showed variability inherent to the taxa. On the average, seagrass cover is increasing.

Plankton

Generally, there is low diversity and density of phytoplankton from all sites (**Table 2.2.33**). Relative to each other, S3 has the highest density at more than 1,600 cells per liter of water, mostly from diatoms. Diatoms, considered the "grasses of the ocean", are photosynthetic single-celled algae with silicate capsules that form the base of the food chain in the aquatic environment. They are expected to be of high density in bodies of water where biomass is harvested.

Table 2.2.33. Phytoplankton profile of marine waters, CBNC, August 2016, count (no/L)

Taxa	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Cyanobacteria	-	-	-	15	55	-	13	-	29	25
Lyngbya	-	-	-	2	-	-	4	-	-	-
Trichodesmium	-	-	-	13	55	-	9	-	29	25
Diatoms	168	290	1,626	500	694	35	115	667	173	211
Amphora	-	-	-	-	-	-	-	-	-	-
Asterionella	-	-	-	26	-	-	-	-	-	-
Bacillaria	-	-	-	20	-	-	-	23	-	-
Bellarochea	-	-	-	-	-	-	-	-	-	-
Campylodiscus	27	-	-	25	-	-	-	9	-	-
Climocosphenia	-	-	-	-	-	-	-	-	-	-
Coscinodiscus	51	47	780	47	-	-	17	105	9	-
Diatoma	-	-	-	28	-	-	-	11	-	-
Diploneis	-	-	-	-	-	-	-	9	-	-
Ditylum	37	-	152	33	-	-	18	96	-	-
Eunotia	-	-	-	-	-	-	3	-	-	-
Fragillaria	-	-	-	-	-	-	-	-	-	-
Guinardia	-	-	-	-	-	-	-	-	3	-
Licmophora	-	-	-	-	-	-	31	-	-	-
Lioloma	-	-	-	48	-	-	-	-	-	-
Melosira	-	-	102	15	-	8	14	-	35	-
Navicula	-	17	-	41	-	11	-	18	-	15
Nitschia	-	-	-	-	-	-	-	-	-	-

Taxa	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Odontella aurita	-	-	35	50	-	-	9	15	-	-
Odontella mobiliensis	-	29	13	-	-	-	-	-	2	-
Pleurosigma	-	101	241	102	-	-	9	152	10	67
Rhabdonema	-	-	-	-	-	-	-	-	-	-
Rhizosolenia	35	47	140	35	56	5	7	113	116	-
Stephanophysis	-	-	66	30	-	11	-	47	-	-
Surirella	-	-	-	-	-	-	7	50	-	20
Thalassionema	18	50	-	-	-	-	-	18	-	-
Thalassiorsira	-	-	-	-	-	-	2	-	2	-
Dinoflagellates	16	170	62	77	80	51	33	261	46	37
Ceratium furca	11	102	50	35	-	3	11	56	25	-
Ceratium macroceros	-	-	-	-	-	-	-	59	-	-
Ceratium tripos	-	-	-	-	-	-	-	8	-	-
Ceratocorys	-	-	-	-	-	-	-	-	-	-
Dinophysis caudata	-	13	-	-	-	-	-	-	-	-
Dinophysis miles	-	-	-	-	-	5	-	-	-	-
Diplopsalis	6	26	-	40	-	16	8	71	21	-
Gonyaulax spinifera	-	-	-	-	10	14	6	13	-	-
Gyrodnium	-	-	-	-	-	-	2	-	-	-
Ostreopsis	-	-	-	-	-	-	-	-	-	-
Phalacroma	-	-	-	-	-	-	8	-	-	-
Prorocentrum	-	-	-	-	-	-	-	-	-	-
Protoperidinium	-	30	-	2	34	12	-	55	-	-
Total Count (N/L)	184	461	1,692	592	828	86	161	928	248	272
Species Richness	7	10	9	18	4	9	16	19	9	4

While the phytoplankton showed low density, zooplankton showed densities of 50,000 cells per cubic meter of water to more than 300,000 cells per cubic meter of water. These densities indicate a highly active secondary productivity and reproduction. Larval forms of many marine organisms take the planktonic forms as larvae.

Table 2.2.34. Zooplankton profile of marine waters, CBNC, August 2016, Count (n/m^3)

Taxa	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Adult forms	18,750	108,750	97,500	71,000	72,688	130,500	14,625	19,500	35,250	66,000
Calanoid copepod	-	-	15,875	14,000	-	3,750	4,125	-	10,500	30,000
Chaetognaths (Arrow worms)	2,500	9,750	-	10,000	-	-	-	-	-	-
Crab zoae	-	-	-	3,000	-	-	-	-	-	-
Cyclopoid copepod	15,625	86,250	73,750	41,000	53,500	126,750	10,500	9,000	24,750	21,000
Flatworm	-	-	-	-	-	-	-	-	-	-
Foraminiferan	-	-	-	-	-	-	-	-	-	10,000
Harpactocoid copepod	-	12,750	-	-	6,813	-	-	10,500	-	-
Larvacean	-	-	-	-	-	-	-	-	-	-
Nematode	-	-	-	3,000	-	-	-	-	-	15,000
Polychaete	625	-	-	-	-	-	-	-	-	-
Tintinids	-	-	-	-	-	-	-	-	-	-
Larval forms	34,375	150,750	210,250	48,000	68,938	96,375	18,750	172,500	102,750	-
Balanus nauplius	-	-	26,500	27,000	6,938	375	1,125	36,750	8,250	66,000
Bivalve veliger	-	27,750	-	8,000	-	4,875	9,750	24,750	35,250	-
Decapod zoea	2,500	-	-	-	-	4,125	-	18,000	5,250	14,000
Gastropod veliger	-	-	11,375	-	7,938	-	-	14,250	-	-
Nauplius and copepodite	26,250	123,000	160,750	20,000	53,750	87,000	7,875	78,000	54,000	18,000
Polychaete trocophore	5,625	-	-	-	-	-	-	750	-	34,000
Total Density (N/m^3)	**53,125**	**259,500**	**307,750**	**126,000**	**141,625**	**226,875**	**33,375**	**192,000**	**138,000**	**274,000**
Total No. of Taxa	**6**	**5**	**5**	**8**	**5**	**6**	**5**	**8**	**6**	**8**

As phytoplankton are the primary producers that are being consumed by zooplankton, the former should be more numerous than the latter. However, due to differences in longevity and life cycle, there may be disjunction in the density. Phytoplankton reproduces faster and may be able to compensate on their density difference with zooplankton.

Heavy metal content of marine fish flesh

Cadmium was found to have 6-7 times than the Australia's standard for and more than 20 times than EU's food grade (**Table 2.2.35**). The element is released to the environment by smelting and mining but is also a natural contaminant of fossil fuels (*www.atsdr.cdc.gov*), the most probable source. Increased traffic of boats in the area may have increased ambient Cadmium concentration. The relatively higher concentration of the herbivore sample than the carnivore sample may be a site-specific difference but may indicate uptake through the food chain.

Table 2.2.35. Heavy metal from fish flesh, August 2016

Heavy Metal Species	Trophic Group		Standards	
	Carnivore (mg/kg)	Herbivore (mg/kg)	Australia (mg/kg)	EU (mg/kg/week)
Cr^{+6}	<0.10	<0.10		
As	<0.10	<0.01	1.00	
Cd	1.31	1.47	0.20	0.05
Cu	0.88	0.70	70.00	
Pb	<0.30	0.79	1.50	0.30

Lead (Pb) content of the herbivore sample exceeds EU standard by two-folds. Like Cadmium, Lead (Pb) is also a natural contaminant of fossil fuels which may be related to increased sea-going transporation in the area.

All other heavy metal species showed concentrations lower than standards.

2.2.5.3 Impact Assessment

Increased sea surface temperature remains the most important factor that induces bleaching but it may be exacerbated by other variables such as increased organic matter and siltation. The HPP operations however cannot be directly attributed to the current decline in the benthos population as the incidence is coral bleaching is a worldwide event. Likewise, the increase in silt and organic materials maybe a result of other anthropogenic factors.

Fish community, on the other hand, showed erratic trend, but generally computed density is increasing. It is important to note, however, that on sites S2 where the Causeway and threstle are located, the fish density increases which indicates that the limited access to the site provides protection to fish. In addition, the observed fishes were larger in size, which can contribute to the replenishment of the fish stocks along Okayan and Coral Bay which can benefit the fishing population.

During the 2001 EIA, mangroves and corals were observed near the proposed causeway site. Trained divers were tasked to thoroughly survey the proposed route of the causeway and trestle to determine if there will be mangroves and other marine communities that will be damaged by the construction and operations of the causeway. The original alignment of the causeway and threstle was revised to avoid significant coral colonies.

In addition, drainage pipes were installed along the causeway to facilitate passage of water from the sides of the causeway. Results of the sediment transport modeling conducted for the proposed project have indicated that the causeway may block the passage of sediments and essential nutrients that could negatively affect the mangroves and coral reef near the causeway.

In more than 10 years of CBNC's operation, there were no reported incidences of spillages during unloading of chemcials from the transport ships including leaks of storage tanks along the coastal areas that affected the marine species. The chemicals storage tanks are made up of steel and enclosed in a bund that are corrosion resistant and capable of holding 100% of the total storage volume. Emergency procedures to contain and clean up wastes are also defined in their ERP.

CBNC also supported the establishment of two (2) Marine Protected Areas (MPA) along Coral Bay near Barangay Sarong and near Ameril Island. The MPAs are targetted to be the source of fingerlings to improve fish population along the coastal areas of Bataraza and subsequently, benefit the fishing population of Bataraza**.**

Table 2.2.36. Impacts assessment and mitigation for marine ecology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-onstruction	Construction	Operation	Abandonment	
Threat to existence and/or loss species of important local and habitat and Thread to abundance, frequency and distribution of species	✓	✓	✓	✓	
Impacts during the construction phase of the project will result to increased available loose materials, which may be carried by run-off to water bodies. More particulates in the water column will result in the lower phytoplankton population because of decreased photosynthesis. Fish will move out from murky waters to avoid damage to gills.					All stormwater from the construction site will be diverted towards the siltation pond located at the mining areas of the RTNMC. Thus, siltation will be limted. During oeprations, the slopes of the embankment will be vegetated to manage soil erosion snd further siltation.
During the operation phase, impacts will likely result from continuous use of the Causeway for import and export of materials, and from effluent discharges. Current condition will likely be sustained unless interactions with natural environmental variability (such as warm sea surface temperature) create conditions which may worsen condition.					The dam stability is ensured through its design and tailings disposal process. Including the installation of an emergency spillway in case heavy precipitation occurs. The water draining from the spillway will be directed towards the siltation ponds.
Accidental breaching of the dam may dump tailing materials into Tuba and Ocayan Rivers and eventually to sea and the nearest reef, Barangkas (S5). Corals and other benthic organisms will be suffocated or buried by silt. Increased particulates in the water column will decrease photosynthetic processes of the phytoplankton and decrease productivity. Mobile organisms like fishes will likely move out of the site. Fine particulates are irritants to fill gills which will					The safety procedures during unloading, storage and transport of chemicals at the causeway are in place and these facilities should be regularly maintained to ensure that no accidental spills or leakages occur. Bund walls should be checked annually to test integrity. Rainwater accumulated inside the bund walls shall be drained towards the drainage channels only upon testing of water to check for any contamination from spillages or leaks. CBNC should continue to support the protection of the established MPAs. Resilience may be further enhanced with management support to

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-onstruction	Construction	Operation	Abandonment	
sustain damage to the oxygen exchange mechanisms of the gill filaments.					some sites with notable ecosystem features like S7, S8, S9, and especially S10, which is a protected island. Extending protection to the reef will promote the island as an ultimate ecotourist site.

2.3 THE AIR

This section includes baseline and impact assessment for the meteorology, greenhouse gas emission, air quality and noise level. Sampling procedures in the conduct of the baseline data are presented in **Annex 2.1.1**.

2.3.1 Meteorology and Climatology

2.3.1.1 Methodology

Climatological data were obtained from PAGASA. The closest synoptic station of PAGASA relative to the proposed project site is the Puerto Princesa Synoptic Station in Palawan. This station has available record since 1981. Climatologic indicators for the area include mean temperature, rainfall, relative humidity, wind speed, and direction.

Other relevant information gathered from PAGASA is the climate and typhoon frequency maps and the 2020 and 2050 climate projection (Climate Change in the Philippines, 2011).

RTNMC also monitored other weather parameters including daily minimum and maximum temperature starting from 1980. More recently, CBNC installed an automatic weather station in their HPAL plant in Brgy. Rio Tuba in 2004 that likewise monitored maximum, minimum and mean temperature, among other parameters. Wind data was also recorded.

2.3.1.2 Baseline Conditions

Climate

The province of Palawan has two (2) types of climate. The first, which occurs in the northern and southern extremities and the entire western coast, has two (2) distinct seasons – six (6) months dry and six (6) months wet. The other, which prevails in the eastern coast, has a short dry season of one to three (3) months and no pronounced rainy period during the rest of the year. The southern part of the province is virtually free from tropical depressions but northern Palawan experiences torrential rains during the months of July and August. Summer months serve as peak season for Palawan.

Rainfall characteristics indicate that the climate in the project area is of Type III under the Modified Corona Classification of Philippine Climate (**Figure 2.3.1**). This type of climate is relatively dry from January to April and wet throughout the year. The main atmospheric systems controlling rainfall in the area are the southwest monsoon from June to September, northeast monsoon from December to February, and Easterly Waves from March to April. The Intertropical Convergence Zone (ITCZ) also contributes significantly to the rainfall in the area especially during summer.

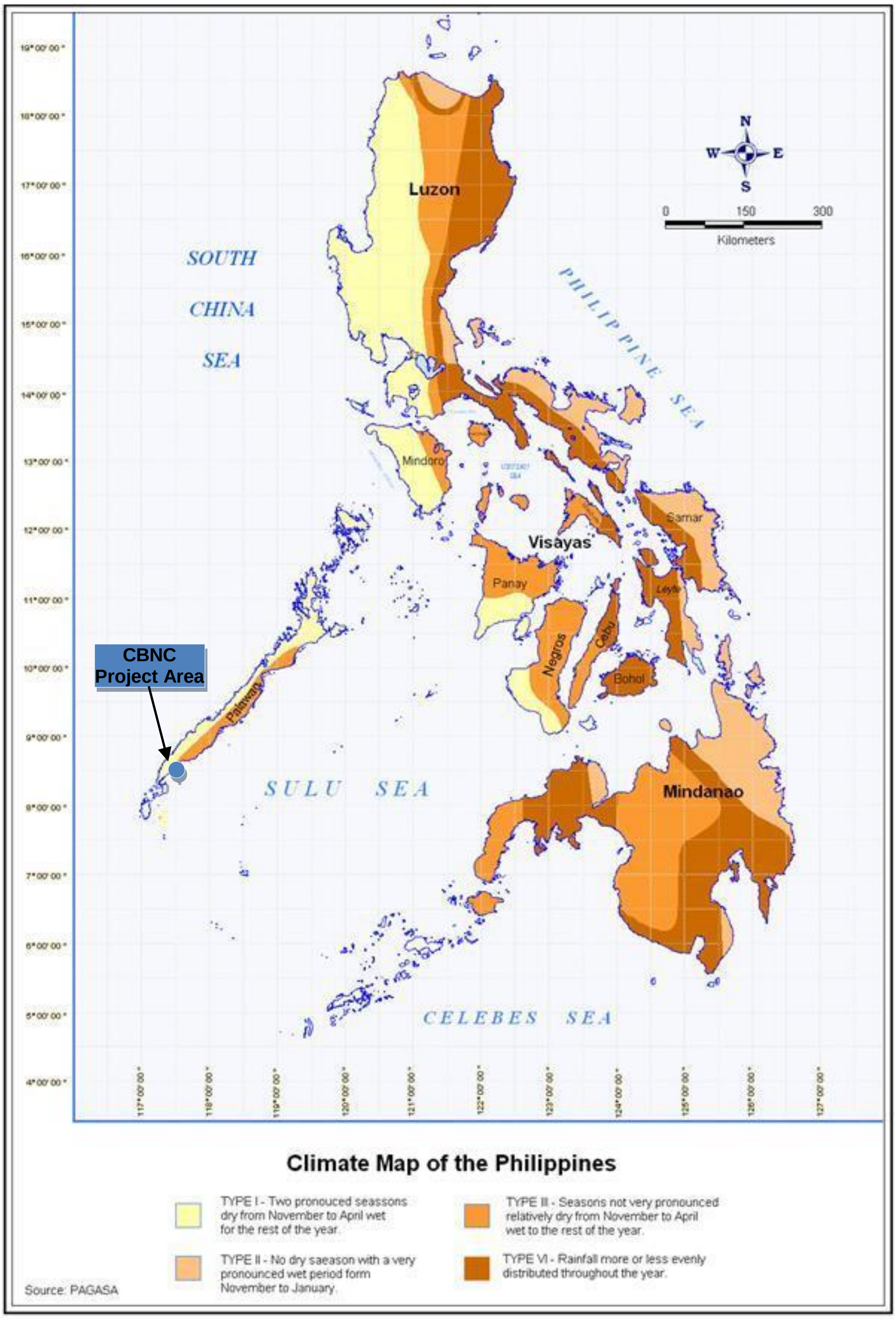


Figure 2.3.1. Climate Map of the Philippines

Tables 2.3.1 and **Table 2.3.2** present the climatological normals and extremes from the Puerto Princesa Synoptic Station.

Table 2.3.1. Climatologicat Normals at Puerto Princesa Synoptic Station

Station Name: PUERTO PRINCESA, PALAWAN Period: 1981 - 2010									Latitude: 09°44'30'' N Longhitude: 118°44'00'' E					Elevation: 16.0m		
Month	Rainfall		Temperature						Vapor Pressure (mbs)	Rel. Hum. %	MSLP (MBS)	Wind		Cloud Amount (okta)	No. Days with Thunderstorm	
	Amount (mm)	No. of RD	Max (°C)	Min (°C)	Mean (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dew Pt. (°C)				DIR (16 pt)	SPD (mps)		TSTM	LTNG
JAN	36.4	5	30.8	23.2	27.0	26.7	24.0	23.0	28.0	80	1010.9	E	3	5	1	2
FEB	23.7	3	31.0	23.1	27.0	26.8	24.0	23.0	27.9	79	1011.1	E	3	4	1	1
MAR	37.3	4	31.7	23.7	27.7	27.5	24.5	23.4	28.7	78	1010.7	E	3	4	2	3
APR	54.2	7	32.7	24.5	28.6	28.4	25.3	24.2	30.1	78	1009.7	E	2	4	7	8
MAY	118.4	12	32.7	24.8	28.8	28.4	25.7	24.8	31.1	81	1008.9	W	2	5	15	18
JUN	171.1	17	31.8	24.2	28.0	27.5	25.3	24.5	30.7	84	1008.8	S	2	6	13	17
JUL	153.5	18	31.4	23.8	27.6	27.1	25.0	24.3	30.2	84	1008.7	W	2	6	11	13
AUG	185.4	18	31.3	23.8	27.5	27.0	25.0	24.3	30.3	85	1008.6	S	2	6	11	12
SEP	170.1	17	31.5	23.7	27.6	27.0	24.9	24.1	30.0	84	1009.1	W	2	6	12	13
OCT	216.1	19	31.4	23.7	27.5	27.0	25.0	24.3	30.3	85	1009.2	W	2	6	13	15
NOV	211.0	15	31.1	23.7	27.4	27.1	25.0	24.3	30.2	84	1009.3	E	2	5	11	13
DEC	150.1	11	30.7	23.5	27.1	26.9	24.5	23.6	29.1	82	1010.1	E	3	5	4	8
ANNUAL	1527.3	146	31.5	23.8	27.7	27.3	24.8	24.0	29.7	82	1009.6	E	2	5	101	123

Table 2.3.2. Climatological Extremes recorded at Puerto Princesa Synoptic Station

MONTH	TEMPERATURE				GREATEST DAILY RAINFALL (MM)		HIGHEST WIND (MPS)			SEA LEVEL PRESSURE (MBS)			
	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	34.4	01-16-1988	18.3	01-20-1961	120.4	01-03-2013	19	E	01-19-1985	1019.4	01-09-2004	1002.2	01-01-1950
FEB	34.6	02-16-2010	18.5	02-02-2002	140.8	02-16-2012	18	E	02-26-1982	1018.8	02-01-1962	1003.8	02-07-1985
MAR	36.4	02-17-2005	19.2	03-15-1967	116.3	03-05-1954	18	SE	03-21-1982	1019.8	03-05-2005	989.1	03-24-1949
APR	36.3	04-03-1996	20.9	04-16-1971	92.7	04-25-1971	16	E	04-04-2005	1017.2	04-08-1969	989.8	04-04-1949
MAY	36.0	05-22-1987	21.3	05-24-1961	121.7	05-08-1954	15	SSE	05-12-2006	1015.8	05-16-1958	1002.7	05-17-1989
JUN	35.6	06-04-1998	16.2	06-17-1988	194.1	06-29-1980	18	SW	06-22-1990	1015.8	06-09-1971	1001.3	06-30-1964
JUL	35.2	07-13-1975	20.6	07-11-1961	106.3	07-28-2012	20	SW	07-04-2001	1014.8	07-07-1953	1001.4	07-04-2001
AUG	35.2	08-30-1996	20.5	08-31-1987	137.5	08-21-1982	18	WSW	08-07-2005	1017.8	08-25-1979	1000.5	08-17-1990
SEP	34.7	09-05-2000	20.6	09-08-1967	226.0	09-30-1983	18	ESE	09-04-1993	1015.4	09-20-1965	1001.8	09-11-1996
OCT	36.0	10-16-1977	20.9	10-02-1967	134.1	10-02-1949	23	W	10-06-1988	1016.4	10-27-1977	999.6	10-14-1970
NOV	34.2	11-20-2004	19.2	11-19-1984	202.4	11-28-1955	49	NW	11-25-1968	1017.5	11-24-1957	989.2	11-25-1968
DEC	34.0	12-04-2002	19.2	12-30-1986	269.3	12-29-1975	31	ENE	12-31-1998	1018.3	12-12-2002	999.2	12-12-1998
ANNUAL	36.4	03-17-2005	16.2	06-17-1988	269.3	12-29-1975	49	NW	11-25-1968	1019.8	03-05-2005	989.1	03-24-1949
Period of Record	1951-2014				1949-2014		1950-2014			1949-2014			

Rainfall

Rainfall has been measured in Palawan as early as 1949 by PAGASA. Several rainfall stations are operating and the station in Brooke's Point is the newest since it only started operation in 1971. Monthly minimum rainfall ranges from zero (as observed in all stations) to 188 mm (as observed in Cuyo), while monthly maximum ranges from 22 (as observed in Coron) to 4,623 mm (as observed in Brooke's Point). On the other hand, mean monthly values vary from 3 mm to 613 mm as recorded in Cuyo and Brooke's Point, respectively. There is abundant rainfall during the months of June to October.

Table 2.3.3. Climatic variables at Puerto Princesa City

Months	Rainfall (mm)	No. of rainy days	Temperature (°C)	Relative Humidity	Evaporation (mm)
January	3.2	1	26.3	78	19.82
February	2.6	2	26.7	78	21.06
March	9.5	3	26.2	82	22.37
April	19.8	3	27.9	79	23.75
May	116.4	16	28.2	82	22.37
June	148.8	12	27.3	82	22.37
July	147.6	16	26.6	87	22.37
August	143.5	17	26.8	86	22.37
September	83	12	27	84	22.37
October	145.9	15	26.5	86	22.37
November	118.1	14	26.4	85	22.37
December	52.7	5	26.6	89	22.75
TOTAL	**991.1**	**116**	**26.9**	**83**	**266.34**

Table 2.3.4. CBNC Weather Station Rainfall Data

Months	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Ave.
Jan	68.0	75.0	35.0	188.0	119.1	106.5	279.2	267.2	176.0	380.0	121.5	**165.0**
Feb	22.0	37.0	11.0	10.0	166.5	131.2	0.0	120.2	259.6	24.8	109.2	**81.0**
Mar	19.0	0.0	117.5	108.0	93.0	60.7	8.2	374.6	154.6	13.2	180.0	**102.6**
Apr	64.0	0.0	51.5	27.0	146.4	425.8	107.4	97.1	99.0	254.6	197.2	**133.6**
May	124.5	110.0	213.5	58.5	732.8	237.0	75.6	263.0	238.8	184.1	142.7	**216.4**
Jun	416.0	293.0	249.0	136.5	307.8	401.6	113.8	320.9	265.6	531.0	455.0	**317.3**
Jul	390.0	737.0	254.0	431.5	249.9	321.9	105.3	222.7	266.6	547.6	544.0	**370.0**
Aug	249.5	283.0	328.5	245.5	131.3	158.8	391.2	386.5	130.4	229.2	155.8	**244.5**
Sep	133.5	272.0	478.0	681.5	281.5	381.0	118.5	538.4	821.9	328.7	584.4	**419.9**
Oct	356.0	406.0	424.0	239.0	229.6	313.6	231.1	302.6	298.4	480.6	418.4	**336.3**
Nov	0.0	233.0	28.0	560.1	292.2	278.5	139.2	337.2	170.0	203.2	143.6	**216.8**
Dec	95.0	415.0	124.0	300.8	233.6	77.3	231.4	266.1	47.8	112.6	119.4	**183.9**
Total	**1,937.5**	**2,861.0**	**2,314.0**	**2,983.7**	**2,893.9**	**2,893.9**	**1,800.9**	**3,495.5**	**2,928.7**	**3,289.6**	**3,171.2**	**2,787.6**

CBNC maintains a meteorological station that measures rainfall, wind direction, velocity and temperature. This facility provides vital information to the operations of the HPP and RTNMC as well. Rainfall data from Coral Bay Weather Station was consolidated from 2004-2014 and presented in **Table 2.3.4** and **Figure 2.3.2**. Annual rainfall was highest in 2011 at 3,497 mm. Average annual rainfall for the period was 2,787 mm and average monthly was 232 mm

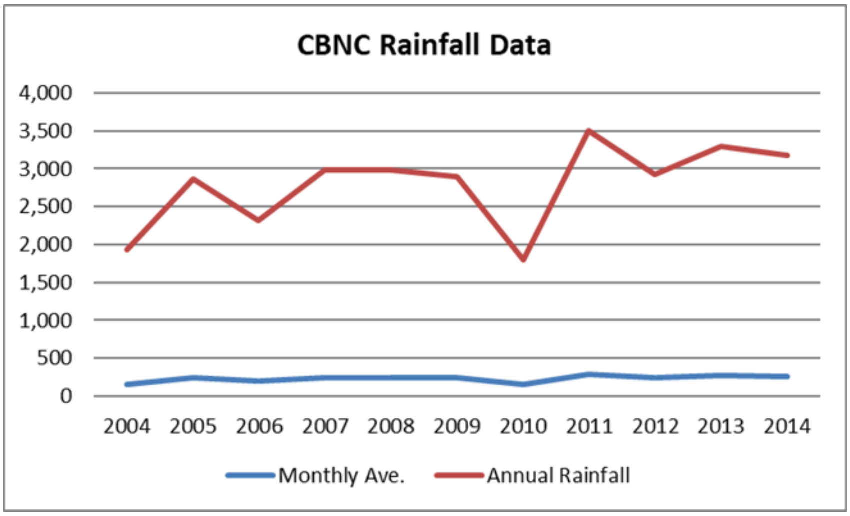


Figure 2.3.2. Annual Rainfall trend for the CBNC station

Temperature

The mean annual temperature in the area is 27.7°C based on Puerto Princesa data. Highest temperature was recorded at 36.4°C on Mar 17, 2005 while lowest temperature was logged at 16.2 °C on June 17, 1988.

RTNMC has monitored the daily minimum and maximum temperature from 1980. For the period 1980-1998, data was consolidated and shown in **Table 2.3.5** which lists the minimum, maximum and mean monthly temperatures computed from the data.

Table 2.3.5. Minimum, maximum, and mean temperature in Rio Tuba mining areas, Municipality of Bataraza, 1980-1998

Month	Minimum Temperature (°C)	Maximum Temperature (°C)	Mean Temperature (°C)
January	22.65	30.09	26.37
February	22.81	31.00	26.91
March	23.24	32.05	27.64
April	24.37	32.42	28.40
May	24.62	32.03	28.32
June	23.72	30.13	26.93
July	23.35	29.58	26.47
August	23.46	29.39	26.43
September	23.28	29.77	26.53
October	23.10	29.84	26.47
November	23.13	30.20	26.67
December	22.77	30.10	26.44

Table 2.3.5 shows that from June to February, the mean temperature is fairly constant at 26.37 to 26.93°C, with January being the coldest month. The mean temperature exceeds 28°C during April and May, which are the warmest months of the year. The annual average temperature in the area is 26.96°C.

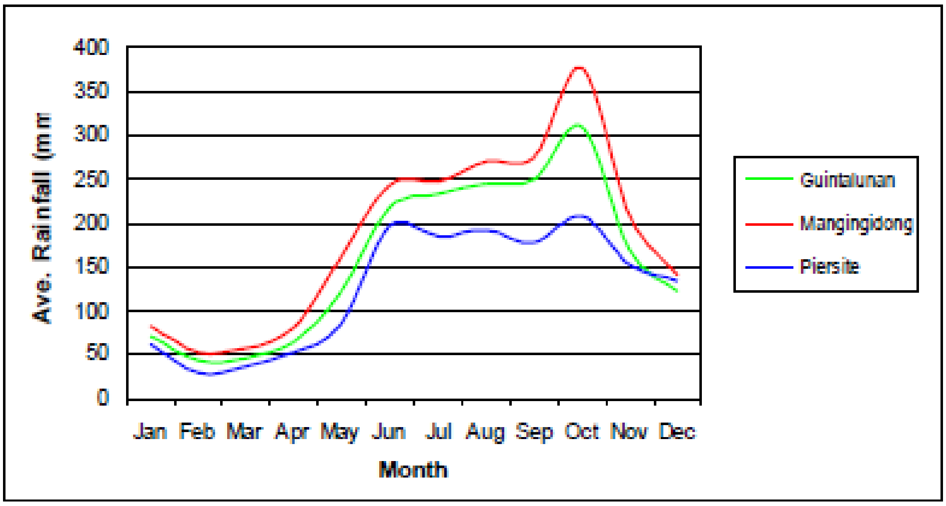


Figure 2.3.3. Monthly Rainfall trend for the three (3) stations

Wind Pattern

There are several types of wind systems that affect the province. Wind speed range from 1.0 m/s during the months of July and August to a maximum of 2.3 m/s in January. Mean annual wind speed is 1.9 m/s on general E direction. The annual wind rose diagram of Palawan is shown in **Figure 2.3.3** while **Figure 2.3.4** shows the annual windrose diagram in Brgy. Rio Tuba, Bataraza, Palawan.

Typhoons

The mean frequency of typhoon passage inside the Philippine Area of Responsibility (PAR) is about 20 typhoons per year. In the Palawan area, the typhoon passage frequency is one (1) cyclone per year mostly in Northern Palawan. This occurs during the last quarter of the year when the tail end of the cold front moves towards the southern part of the country. It is very rare for typhoons to pass in the project area which is located at the southern tip of mainland Palawan. **Figure 2.3.5** presents the cyclone map of the Philippines.

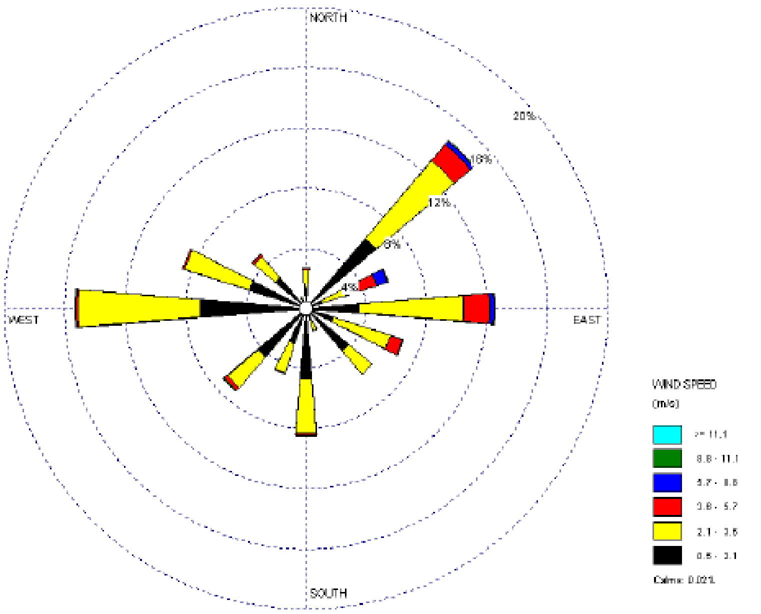


Figure 2.3.4. Annual Windrose diagram, Puerto Princesa (Station 618)

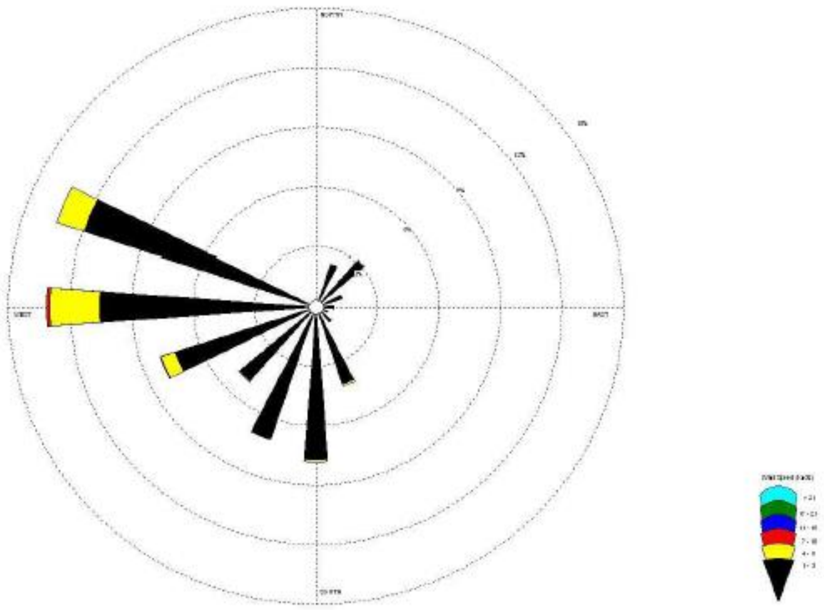


Figure 2.3.5. Annual Windrose Diagram, CBNC, HPP, Bgy. Rio Tuba, Bataraza, Palawan

Cloudiness

Cloudiness is measured in terms of the fraction of the sky covered with clouds. One okta is one-eight sky cover. Cloud observation records in Puerto Princesa show that the mean monthly cloud cover ranges from 4 to 6 oktas. Mean cloud cover is 4 oktas in the dry months of January to April and 5 to 6 oktas in the wet months from May to December. The mean annual cloud cover is 5 oktas.

Mean Sea Level Pressure

The mean sea level pressure in Palawan is 1,009.6 mbs. The extremes recorded over the 1949-2014 period were 1,019.8 and 989.

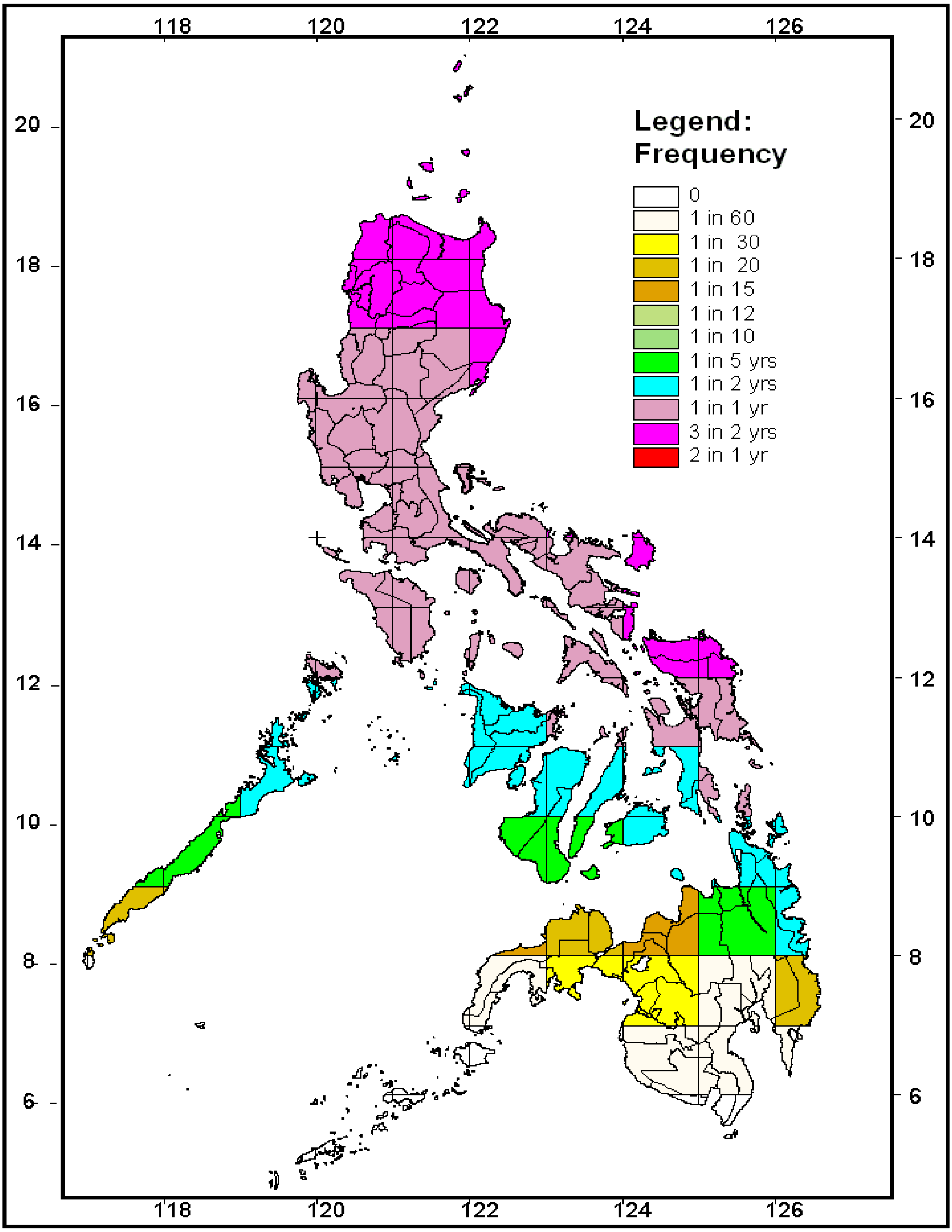


Figure 2.3.6. Cyclone Map of the Philippines

2.3.1.3 Impact Assessment

CBNC maintains a meteorological station that measures rainfall, wind direction, velocity and temperature. This facility provides vital information to the operations of the HPP and RTNMC as well. During periods of abnormal conditions CBNC and RTNMC are provided with actual data to activate Emergency Safety Procedures including well-trained personnel in case disaster/accidents occur. The facility can also be used to support disaster management measures of the LGU.

As mentioned in the Flora Section, CBNC is a recipient of the Presidential Mineral Industry Environmental Award (PMIEA) from 2008 to 2011 and 2014 to 2017 and the Best Mining Forest Award for their efforts to rehabilitate TSF1 and recognition by the DENR in 2012 for their contribution to the National Greening Program (NGP). The rehabilitation program of CBNC provides continued support mechanism to ensure the success of the program, which can contribute to the minimization of green house gas emissions. Support mechanisms include monitoring growth of plants species, maintenance and replacement in case of non-survival of planted seedlings.

Greenhouse Gas (GHG) Emission

The estimated GHG emission for the project's current operation and for the TSF3 construction is derived through the GHG emissions calculation tools (version 4.1 for the Stationary Combustion tool and version 2.6 for the Transport tool) formulated by the Greenhouse Gas Protocol Initiative (http://www.ghgprotocol.org/calculation-tools/all-tools).

GHG estimation for the project is limited to the Scope 1 (all direct emissions) category of Greenhouse Gas Protocol, the default emission factors and the fuel data of the power plant, vehicles and heavy equipment involved during the construction period (from 2016-2023) and during normal operations as provided by the CBNC.

It should be noted that the above ground and below ground biomass from land clearing were not considered in the estimation since most of the CBNC areas subject for expansion were already cleared of vegetation.

The estimated fuel consumption during the construction of TSF3 is placed at 14,100,000 L of diesel. **Table 2.3.6** presents the fuel consumption for TSF3 construction This will be for the use of heavy equipment during construction of the tailings dam. The power consumption will be taken as part of the normal operations.

During operation, the annual fuel consumption is placed at 4,000,000 L of diesel and 213,000 tons of coal. Out of the 4,000,000 L diesel consumption, around 2,500,000 L will be for transport usage while the remaining 1,500,000 L will be for power generation.

Tables 2.3.6 and **2.3.7** summarize the results of the GHG calculation tools. The GHG calculation results are as follows:

- The annual transport GHG for normal operations is 6,690 MT CO2-e;
- For construction of TSF3, the total additional GHG for the 8-year from transport use alone is 44,427 MT CO2-e;
- The annual average GHG from transport alone is 11,408 MT CO2-e; and
- For the operation of the power plant, the estimated annual GHG is 392,611 MT CO2-e.

Annual average GHG over the 8-year period is **404,019 MT CO2-e.**

Table 2.3.6. GHG emissions for construction of TSF3 (transport only) and annual transport GHG (normal operations)

Source Description	Region	Mode of Transport	Scope	Type of Activity Data	Fuel Used	Fuel Amount	Unit of Fuel Amount	GHG Fossil Fuel CO_2 (MT)
2016 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	325,000	Litre	869.81
2017 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	383,000	Litre	1,025.03
2018 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	2,430,000	Litre	6,503.47
2019 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	4,632,000	Litre	12,396.75
2020 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	3,287,000	Litre	8,797.09
2021 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	1,942,000	Litre	5,197.43
2022 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	597,000	Litre	1,597.77
2023 TSF3 construction	Other	Road	1	Fuel Use	On-Road Diesel Fuel	504,000	Litre	1,348.87
Normal Operations	Other	Road	1	Fuel Use	On-Road Diesel Fuel	2,500,000	Litre	6,690.82
MT								44,427.03
Annual Average (MT)								11,407.84

Table 2.3.7. GHG emissions for normal operations (stationary combustion only)

User supplied data					GHG emissions (tonnes)			
Sector	Fuel type (e.g. solid fuel)	Fuel	Amount of fuel	Units (e.g. kg or kWh)	CO_2	CH_4	N_2O	All GHGs (tonnes CO_2-e)
Energy	Solid fossil	Sub bituminous coal	213,000	Metric tonne (t)	386,869.77	4.03	6.04	388,582.71
Energy	Liquid fossil	Gas/Diesel oil	1,500,000	Litres (l)	4,014.74	0.16	0.03	4,027.90
Total GHG emission from fossil fuels (tonnes CO_2-e)								392,610.61
Total CO_2 emissions from biomass (tonnes)								0.00

Table 2.3.8. Predicted impacts on meterology of the proposed

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Discussion
• Change in the local climate		✓	✓		The proposed project will have no impact on the local climate as the amount of emission from the plant even at full operation would be insignificant compared to the current greenhouse gas inventory. The annual GHG is estimated at only **404,019 MT CO2-e** or 0.4 million metric tons per year. The Philippines' GHG average over the past decade was around 140 million metric tons a year. The data on climate change projections study for 2020 and 2050 (PAGASA, 2011) are presented in **Table 2.3.9** to **Table 2.3.11** The study shows that mean temperature rise by 2020 would be 0.98°C and for 2050 it would be 1.9 °C, both compared to baseline of 27.4 °C.
• Contribution in terms of		✓	✓		The construction of a new tailings storage facility will contribute

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
greenhouse gas emissions					additional but minimal greenhouse gases only during the construction stage. Thereafter, operations will be same as the baseline situation. The increase in cobalt production was only an outcome of better input material quality and hence has minimal addition to the current baseline greenhouse gas production.

Table 2.3.9. Seasonal temperature change for 2020 and 2050 in Palawan

Months	OBS (1971-2000)	2020 (2006-2035)		2050 (2036-2065)	
		Change	Projected Value	Change	Projected Value
December-January-February (DJF)	26.9	0.9	27.8	1.8	28.7
March-April-May (MAM)	28.1	1.1	29.2	2.1	30.2
June-July-August (JJA)	27.3	1.0	28.3	2.0	29.3
September-October-November (SON)	27.4	0.9	28.3	1.8	29.2

Table 2.3.10. Seasonal rainfall change for 2020 and 2050 in Palawan

Months	OBS (1971-2000)	2020 (2006-2035)		2050 (2036-2065)	
		Change, Percent	Projected Value	Change, Percent	Projected Value
December-January-February (DJF)	101.8	15.7	117.78	7.3	109.23
March-April-May (MAM)	189.3	-7.2	175.67	-9.0	172.26
June-July-August (JJA)	781.7	-2.6	761.38	1.0	789.52
September-October-November (SON)	640.6	19.6	766.16	6.9	684.80

Table 2.3.11. Seasonal extreme events for 2020 and 2050 in PP, Palawan

Parameters	OBS	2020	2050
No. of days with Temp. max >35°C	29	23	297
No. of Dry Days	8348	6457	6455
No. of days with Rainfall >300 mm	2	7	7

2.3.2 Air Quality and Noise

2.3.2.1 Methodology

Ambient Air Quality Sampling

The ambient air quality at the project site was assessed following the DENR Administrative Order (DAO) 2000-81 (Implementing Rules and Regulations of the Philippine Clean Air Act of 1999). The sampling procedures were based on USEPA, 40 CFR Part 50, (Appendix A, B, and J) and EMB Air Pollution Monitoring Manual (1994). A 24-hour ambient sampling for analysis of particulate matter 10 microns (PM10), total suspended particulate (TSP), gaseous pollutants (NO_2, and SO_2) and heavy metals (As Cd, Pb, Hg, Ni & Cr) was done for each sampling station. Air sampling was conducted and analyzed by Industramach Corporation, a DENR-accredited air quality sampler. The instrument used was a BGI PQ200 PM10 Sampler and a Graseby High Volume Sampler for TSP. For SO_2 and NO_2, a Graseby Gas Bubbler Sampler was used. The SO_2 and NO_2 samples were preserved in an icebox, PM10 and TSP filters were placed inside clean envelop. All samples were submitted to the laboratory for analysis. PM10 filters were analyzed at Industramach gravimetric/balance room. Ambient Sampling Report is provided as **Annex 2.3.1**.

Five (5) sampling stations were established covering the proposed project site and the receptor area (**Table 2.3.12** and **Figure 2.3.6**.). The 24-hour ambient air quality sampling was conducted from August 18 to 27, 2016. The stations were selected based on the areas where the proposed expansion will be established including the main receptor area which may likely be affected once operations commenced. The selection of the sites were also guided by the May 2011 Air Dispersion Modeling Results conducted by Area Quaterra, Inc. for CBNC.

Table 2.3.12. Sampling stations for 2016 CBNC expansion project

Station No.	Description	Coordinates	
AQ1	Lower Togpon; Beside siltation pond (south side; about 800m west of power plant smoke stack and about 500m downwind of P. Princesa South Road (**Plate 2.3.1**)	8°33'24.7"N	117°24'47.4"E
AQ2	Lower Kinurong (near S1 of CBNC); 2km southwest of power plant stack and about 15m from siltation pond (**Plate 2.3.2**)	8°33’12.6”N	117°24’59.6”E
AQ3	Sitio Tagpisa (near A3 of CBNC); about 2 km east of power plant smoke stack (**Plate 2.3.3**)	8°33’46.6"N	117°26’19.09”E
AQ4	BCI Complex; near A4 of CBNC; about 1.4 km southeast of power plan and about 140 m southwest of PPrincesa South Rd (**Plate 2.3.4**)	8°32’59.7"N	117°25’48.1”E
AQ5	Pier Site; 500m Southwest of coal yard and 150m southwest of sulphuric acid depot; about 500m southeast of nickel stockpile and 40m west of Gate 3 of pier site (**Plate 2.3.5**)	8°30'17.8"N	117°26'56.9"E

In compliance with the Environment Monitoring Plan, CBNC conducts monthly ambient air quality monitoring for TSP, NO_x and SO_x. The results are presented in the quarterly Self-Monitoring Report submitted to EMB Region IV-B Office. Eight sampling stations were established covering the project site and the receptor area (**Table 2.3.13** and **Figure 2.3.7**). The stations were selected based on the areas where the project operations generate emissions and included the main receptor area which may likely be affected. For compliance to ambient air quality guidelines, only stations A1 to A4 are outside the plant premises and will be reported here.

Table 2.3.13. Air Quality Sampling Stations for CBNC EMP

Station No.	Description	Coordinates	
A1/Stn 1	DORM D - East of HPP at 60m West of concrete/Macadam Road	N 8°33’21.61"	E 117°25’50.55”
A2/Stn 2	South of HPP RTNMC Magazine	N 8° 33’16.04"	E 117°25’24.75”
A3/Stn 3	South-East of Tagpisa Settling Pond- Community	N 8° 33’46.62"	E 117°26’19.09”
A4/Stn 4	GSSI Compund - South East of HPP - Community	N 8°33’2.37"	E 117°25’50.10”
A8/Stn 5	F-NTRL South of CCD Pond	N 8°33’28.76"	E 117°25’24.65”
A9/Stn 6	Ore Prep Line 2, Below 201BC03A	N 8° 33’21.7"	E 117°25’14.4”
A10/Stn 7	A-10 Utilities Line 2 North Side	N 8°33’32.3"	E 117°25’11.0”
A11/Stn 8	A-11 Utilities Area Line 1 South Side	N 8° 33’27.3"	E 117°25’12.8”

CBNC monitors air quality stations near the HPP area for its total solid particulate levels (TSP) using the Staplex volumetric hourly air samplers. For ambient air monitoring, the regular use of Kimoto gas sampler is not feasible. Based on acceptable sampling practices, the liquid absorbents from the sampler have to be analyzed within a 24-hr period.

Considering the remoteness of the HPP location, this was found to be very difficult and expensive to carry out. The preparation and analysis of the samples (containing these absorbents) are not done in-house (or on-site) by the proponent to avoid possible issues regarding its accuracy and reliability.

Plate 2.3.1. AQ1 - Lower Togpon

Plate 2.3.2. AQ2 - Lower Kinurong (near S1 of CBNC)

Plate 2.3.3. AQ3 - Sitio Tagpisa (near A3 of CBNC)

Plate 2.3.4. AQ4 - BCI Complex

Plate 2.3.5. AQ5 - Pier Site

As a result, an alternative procedure was followed wherein solid absorbents contained in filter badges branded as Advantec and acquired from Toyo Roshi Kaisha, Ltd. were used and its analysis done by the in-house laboratory of CBNC following a standard procedure. These filter badges are recognized under U.S. EPA standards. Samples of these filter badges were also submitted to EMB Region IV last 8 December 2005 for their evaluation on their reliability.

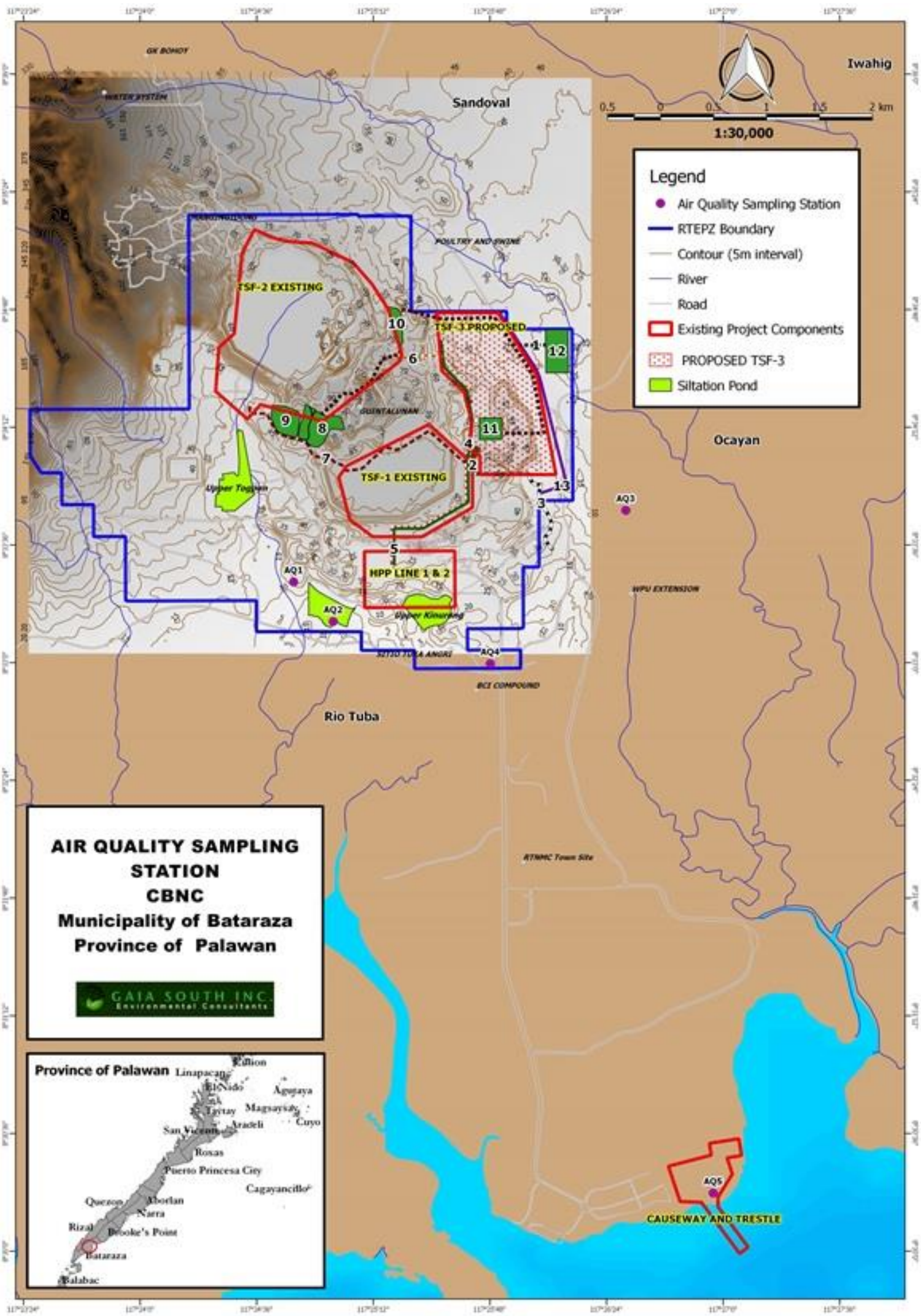
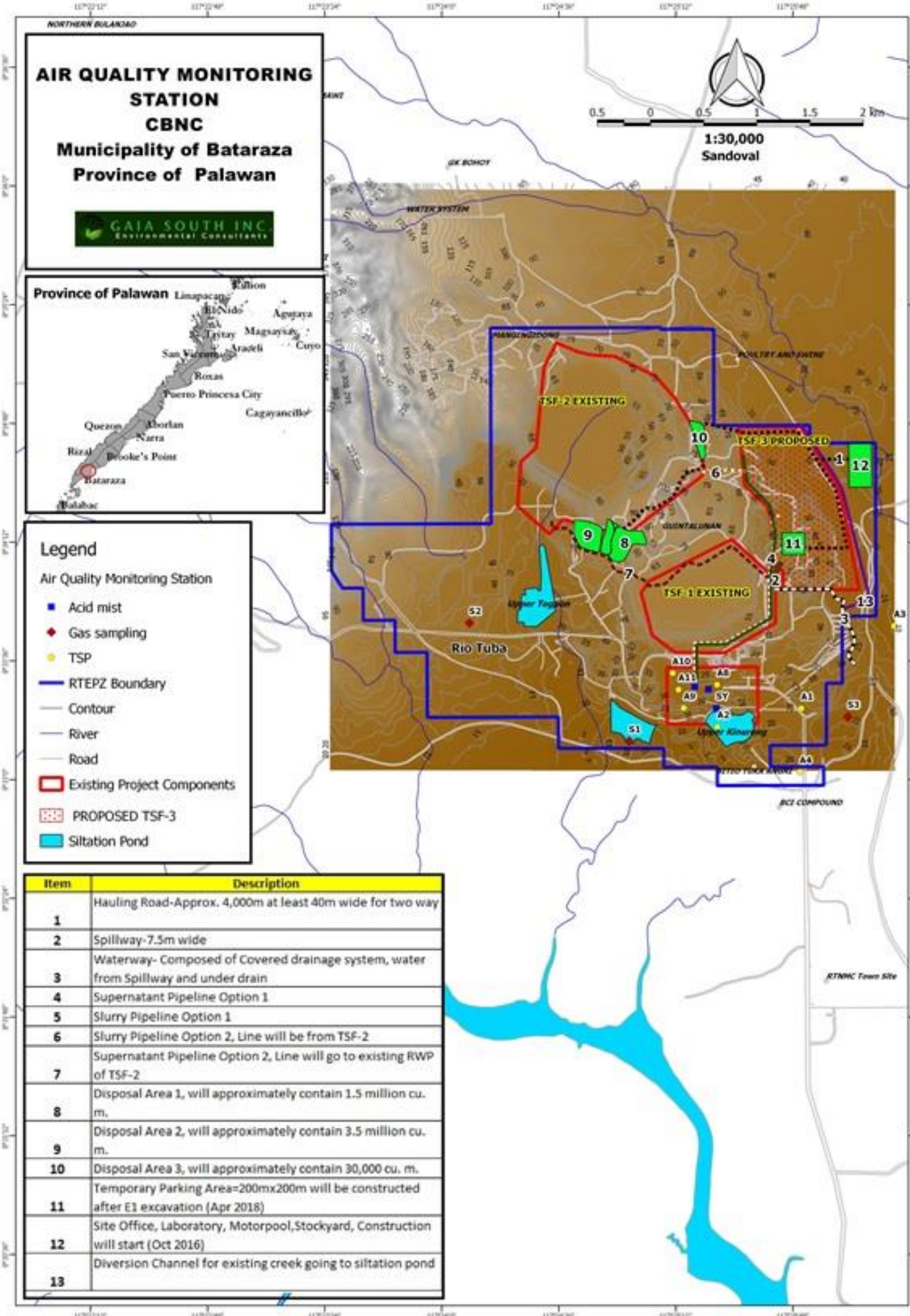


Figure 2.3.7. Sampling map for ambient air quality assessment and noise level sampling station for CBNC expansion project (August 2016)



Item	Description
1	Hauling Road-Approx. 4,000m at least 40m wide for two way
2	Spillway-7.5m wide
3	Waterway- Composed of Covered drainage system, water from Spillway and under drain
4	Supernatant Pipeline Option 1
5	Slurry Pipeline Option 1
6	Slurry Pipeline Option 2, Line will be from TSF-2
7	Supernatant Pipeline Option 2, Line will go to existing RWP of TSF-2
8	Disposal Area 1, will approximately contain 1.5 million cu. m.
9	Disposal Area 2, will approximately contain 3.5 million cu. m.
10	Disposal Area 3, will approximately contain 30,000 cu. m.
11	Temporary Parking Area=200mx200m will be constructed after E1 excavation (Apr 2018)
12	Site Office, Laboratory, Motorpool,Stockyard, Construction will start (Oct 2016)
13	Diversion Channel for existing creek going to siltation pond

Figure 2.3.8. Map of the air quality sampling stations for CBNC EMP

In addition, a Sibata gas sampler for determining acid mists in the atmosphere was acquired for regular monitoring of any fugitive sulfuric acid mists escaping from the HPP operation. Ambient air monitoring using these new instrument and gadgets was carried out at various locations of the HPP complex on a regular basis starting year 2006.

Noise Level Monitoring

The same sampling stations used for the CBNC EMP TSP monitoring were also used for noise level monitoring in compliance with the Environment Monitoring Plan of CBNC. However, in this report, only stations outside the plant will be relevant to the ambient noise standards.

A Digital EXTECH 407764 sound meter that meets the American National Standard Institute (ANSI) standard was used in measuring noise level in the air quality sampling points. The arithmetic median of the readings was taken and compared with the National Pollution Control Commission (NPCC-1981) noise standards.

2.3.2.2 Baseline Conditions

Ambient Air Quality

The results of the 2016 ambient air quality sampling covering expansion areas are presented in **Tables 2.3.14** and **2.3.15**. The measured values for PM10, TSP, SO_2 and NO_2 were all within the ambient air quality guideline values.

Table 2.3.14. Result of 2016 ambient air quality sampling for general parameters

Station	Location	PM-10 Ug/Ncm	TSP ug/Ncm	SO_2 µg/Ncm	NO_2, µg/Ncm
AQ-1	Lower Togpon	34.1	46.4	5.0	2.8
AQ-2	Lower Kinurong	63.8	42.7	5.6	3.1
AQ-3	Sitio Tagpisa	25.4	68.8	8.0	4.0
AQ-4	BCI Complex	25.6	60.5	9.3	4.2
AQ-5	Pier Site	21.2	52.4	11.7	4.9
DENR National Ambient Air Quality Guideline Value (NAAQGV, Table 1)		150	230	180	150

Table 2.3.15. Result of 2016 ambient air quality sampling for heavy metals

Station	Location	As µg/Ncm	Cd µg/Ncm	Pb µg/Ncm	Ni µg/Ncm	Hg µg/Ncm	Cr µg/Ncm
AQ-1	Lower Togpon	3.09	0.06	0.29	0.18	ND	ND
AQ-2	Lower Kinurong	1.33	0.03	0.31	ND	ND	ND
AQ-3	Sitio Tagpisa	ND	ND	0.24	ND	ND	ND
AQ-4	BCI Complex	ND	0.03	0.41	ND	0.1	ND
AQ-5	Pier Site	ND	0.01	0.41	ND	ND	ND
DENR National Ambient Air Quality Guideline Value (NAAQGV)		20	10	20			

The results for PM10 measurement show an average of 34.02 µg/Ncm which is below the guide value of 150 µg/Ncm. The highest value was recorded at AQ-2 or Lower Kinurong.

The results for the five sampling stations show conformity to DAO 2000-81 ambient air quality guideline values for TSP, which is 230 µg/Ncm. Total suspended particulates were below the limit and ranged only between 42.7 and 68.8 µg/Ncm during the time of sampling and averaged only 54.16 µg/Ncm. This was even lower than the measurements taken in the

CBNC 2015 monitoring which ranged between 77.85 and 146.94 µg/Ncm, and averaged 124.3 µg/Ncm.

The SO_2 values for the five stations were also below the 180 ug/Ncm Guide Value, ranging only from 5.0 to 9.3 µg/Ncm and averaged 7.92 µg/Ncm.

The NO_2 values were also below the guide value of 150 µg/Ncm and averaged only 3.8 µg/Ncm, with values falling between 2.8 and 4.9 µg/Ncm.

For the heavy metals arsenic, cadmium, and lead, the values recorded were all within the ambient air quality guide values. The other heavy metals nickel, mercury, and chromium were generally not present in the ambient air except for AQ-1 which showed a Ni value of 0.18 µg/Ncm and AQ-4 which registered a 0.1 µg/Ncm Hg level during the time of sampling.

Noise Level

The noise levels for 2016 are presented in **Table 2.3.16**. The Philippine Ambient Noise Standard for the different DENR class is shown in **Table 2.3.17.** Morning, evening, and night time measurements were averages from previous years which were discontinued upon advise of its MMT.

Table 2.3.16. 2016 Ambient Noise Levels, dBA

Station ID		Morning (dB)	Daytime (dB)	Evening (dB)	Nighttime (dB)
Stn 1	Ave	56	51	53	47
Stn 2	Ave	54	50	60	56
Stn 3	Ave	48	52	53	52
Stn 4	Ave	-	55	62	53
Average for all sites		53	52	57	52
DENR Standard (Class C)		*65*	*70*	*65*	*60*

Table 2.3.17. Philippine Ambient Noise Standards

Category[1]	Maximum Allowable Noise (dBA) by Time Periods[2]		
	Daytime	Morning/Evening	Nighttime
AA	50	45	40
A	55	50	45
B	65	60	55
C	70	65	60
D	75	70	65

Note: [1]**Class AA** - a section of contiguous area, which requires quietness, such as areas within 100 meters from school sites, nursery schools, hospitals and special houses for the aged; **Class A**- a section of contiguous area, which is primarily used for residential areas; **Class B** – a section or contiguous area, which is primarily a commercial area; **Class C** – a section primarily zoned or used as a light industrial area and **Class D** – a section, which is primarily reserved, zoned or used as a heavy industrial area. [2]**Morning** - 5:00 A.M. to 9:00 AM; **Daytime** - 9:00 A.M. to 6:00 P.M; **Evening** - 6:00 P.M. to 10:00 P.M.; **Nighttime** - 10:00 P.M. to 5:00 A.M.

The 2016 ambient noise monitoring data shows that the average for all sites falls within the DENR ambient noise standard. The daytime average for all sites is 52 as against the guide value of 70.

2.3.2.3 Impact Assessment

Air quality monitoring data for the past three (3) years (2015-2017) were plotted and compared to DENR guide values to determine conformity of the plant to the requirements.

The results are plotted in **Figures 2.3.9** for TSP, **Figure 2.3.10** for NO_2, and **Figure 2.3.11** for SO_2.

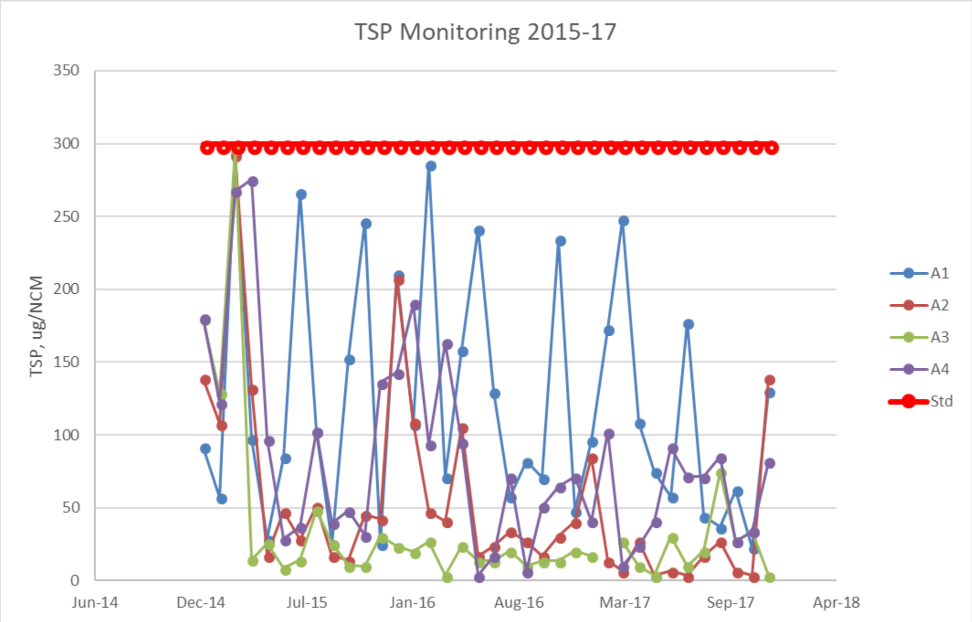


Figure 2.3.9. CBNC TSP Monitoring (2015-2017)

The plot for TSP for the 4 stations (**Figure 2.3.9**) show that values are within the prescribed standard for TSP of 300 µg/NCM (National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations).

Figure 2.3.9 shows that A1 registers the highest TSP readings, averaging 122 µg/NCM for the 3-year period.

For NOx, the reported values were all below 16 µg/NCM (**Figure 2.3.10**). Station A2 has slightly higher NOx readings, averaging 3.02 µg/Ncm for the period. Maximum value reported was 15.48 µg/NCM for A1.

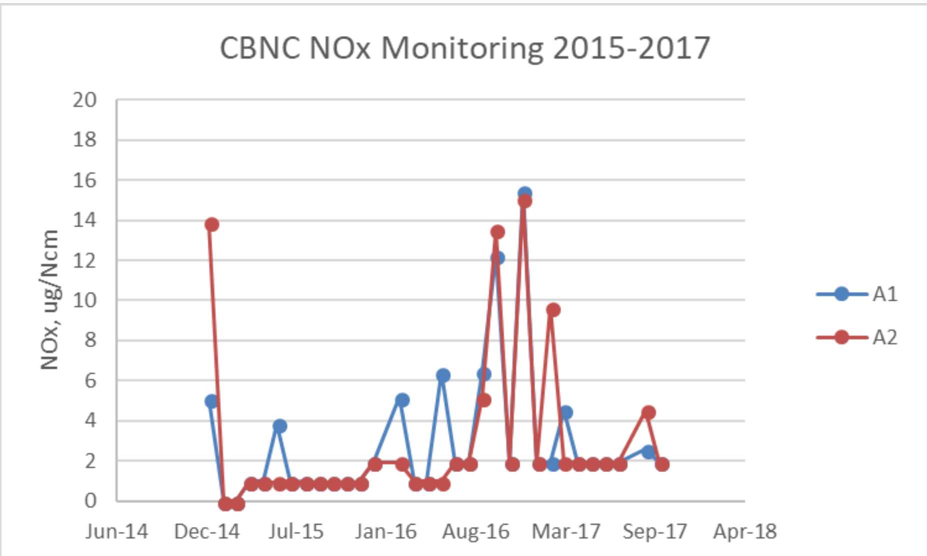


Figure 2.3.10. NO_2 monitoring for 2015-2017. Standard is 260 µg/NCM (60 min averaging time)

Figure 2.3.11 shows the SO_x monitoring for the same period. The Clean Air Act guide value of 340 μg/Ncm SO_2 was not exceeded. The average for the dataset was 9.10 μg/Ncm.

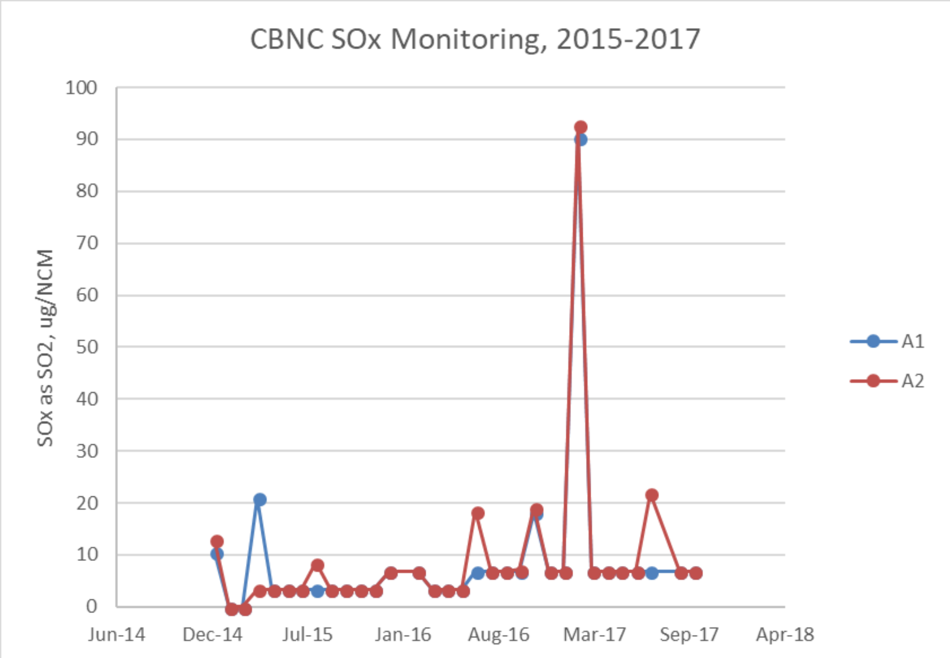


Figure 2.3.11. SO_2 monitoring for 2015-2017. Standard is 340 μg/NCM (60 min averaging time)

The HPP Plant and associated facilities are installed with air pollution control devices that ensures compliance with the emission standards including electrostatic precipitators and gas scrubbers. These facilities are regularly maintained and the results of the CEMS and Stack samplings indicate that the operations comply with the emissions standards. These are regularly reported as seen in **Annex 6.2.1** and **Attachment 5**.

The CBNC Management also ensures that process safety and risk management information are readily available to all personnel to ensure that emergency procedures are met especially if there are gas leakages. This also allow the personnel to have complete and accurate written information on process chemicals, technology, and equipment which is necessesary for the proper operations of all facilities. Other safety features of the HPP to manage gas leakages include:

- Closed-system facilities to prevent gas leakage;
- Distributed control system for equipment and processes;
- Open-structure design of the facility with local ventilation;
- Gas detection system;
- Emergency shutdown system for all critical systems;
- Electrical grounding;
- Good firefighting system; and
- Fire and explosion proofing based on API standard.

The HPP plant is also provided with following equipment that are regularly inspected and maintained:
- Fire extinguishers;
- Gas detectors;
- Smoke detectors;
- Fire alarm system;

- Emergency lighting; and
- Emergency generators.

All employees, including maintenance and contractor employees are required to undergo regular training to fully understand the safety and health hazards of the chemicals and processes they work with. The training cover operating procedures and safety work practices, emergency evacuation and response, safety procedures, routine and nonroutine work authorization activities, and other areas pertinent to process safety and health.

Noise Level

The monitoring results for 2015-2017 were taken from the same stations as above (**Table 2.3.20**). Measurement of noise level was done during daytime as per advice of its MMT.

The monitoring results showed that the average (55 dBA) for all stations is within the daytime standard of 70 dBA. Each station recorded only 1-2 occasions of exceedance to the standard noise level and these were only between 72-75 dBa (**Figure 2.3.12**).

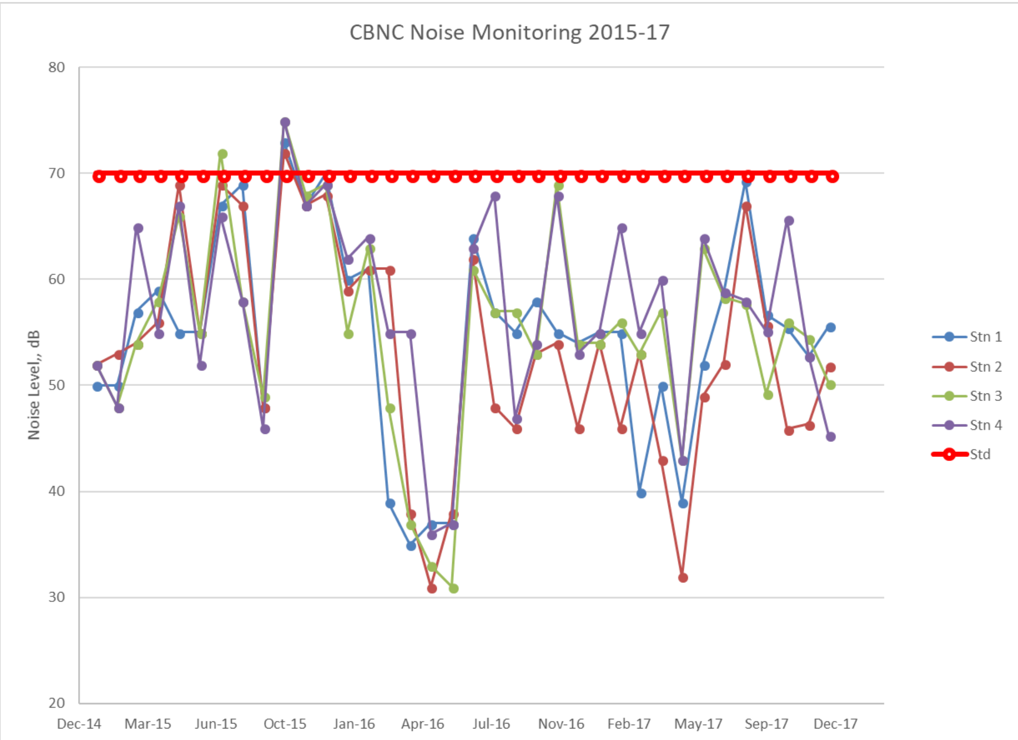


Figure 2.3.12. CBNC noise monitoring results for 2015-2017

Table 2.3.18.Statistical Parameters for Daytime Noise Level, 2015-2017

Parameter	Stn 1	Stn 2	Stn 3	Stn 4
Count	73	72	75	75
Mode	55	53	54	55
Average	55	53	55	57
Maximum	73	72	75	75
# Exceeding std	1	1	2	1
% Exceeding Std	1%	1%	3%	1%

Air Dispersion Modelling

An air dispersion modelling was conducted on July 2016 to assess the impact of point and area sources of emission in the project site on ground level concentration of criteria pollutants in the impact sites. The emission sources, both point and area sources, from CBNC, Rio Tuba Nickel Mining Corporation, and Unichamp Mineral Philippines (limestone source for CBNC) were all considered. The spatial distribution of pollutants was modelled within a computational domain of 12km x 12km with the Project Site approximately at the center.

The air dispersion modelling conducted for this assessment has been based on the modelling approach using AERMET as meteorological pre-processor to the air dispersion model AERMOD. The model is compliant with EMB MC 2008-03 "Guidelines for Air Dispersion Modeling." The Unicorn Installation and Allied Services, Inc. was commissioned to conduct the air dispersion modelling. The full report is included in **Annex 2.3.2**. The summary of the modelling results is presented here in **Table 2.3.19**. Location of the Maximum Ground Level Concentration (MGLC) is presented in **Figures 2.3.13**.

Table 2.3.19. Maximum Ground Level concentration of criteria pollutants based on air dispersion modeling

Reception Group	Averaging Period	Location (m)		Max Modeled Concentration (µg/Ncm)	Background Concentration (µg/Ncm)	Total Concentration (µg/Ncm)	CAA Limit (µg/Ncm)
		x	y				
TSP	1-hour	547034	946014	32.91	10	42.91	300
	24-hour	547034	946014	15.37	-	15.37	230
PM_{10}	1-hour	546134	947414	10.08	0.102	10.18	200
	24-hour	546134	945814	2.08	-	2.08	150
SO_2	1-hour	546134	947414	172.13	28	200.13	340
	24-hour	546134	945714	35.42	-	35.42	180
NO_2	1-hour	546134	947414	183.68	9	192.68	260
	24-hour	546134	945714	47.40	-	47.40	150
CO[a]	1-hour	546134	947414	0.0160	-	0.0160	35
	8-hour	546434	946214	0.0045	-	0.0045	10
H_2S	1-hour	546534	945814	5.08	-	5.08	100@30 min
	8-hour	546534	945814	1.57	-	1.57	100@30 min

Based on the model predictions, maximum ground level concentrations for the criteria pollutants TSP, PM10, SO_2, NO_2, CO and H_2S are below the limits prescribed by the Clean Air Act. No additional mitigation measures for the project's emissions are thus foreseen. The locations cited in **Table 2.3.19** and **Figure 2.3.14** below are recommended for use as sampling stations for the three entities' air quality monitoring program.

The highest GLCs of TSP and PM10 for 1-hour averaging period are 32.91 ug/Ncm and 10.08 ug/Ncm, respectively, which occurred directly east of CBNC or south-southeast of the Unichamp Lime Kiln Smokestack. The TSP and PM10 modelling results are below the CAA limits. The isopleths or concentrations are included in the Unicorn report.

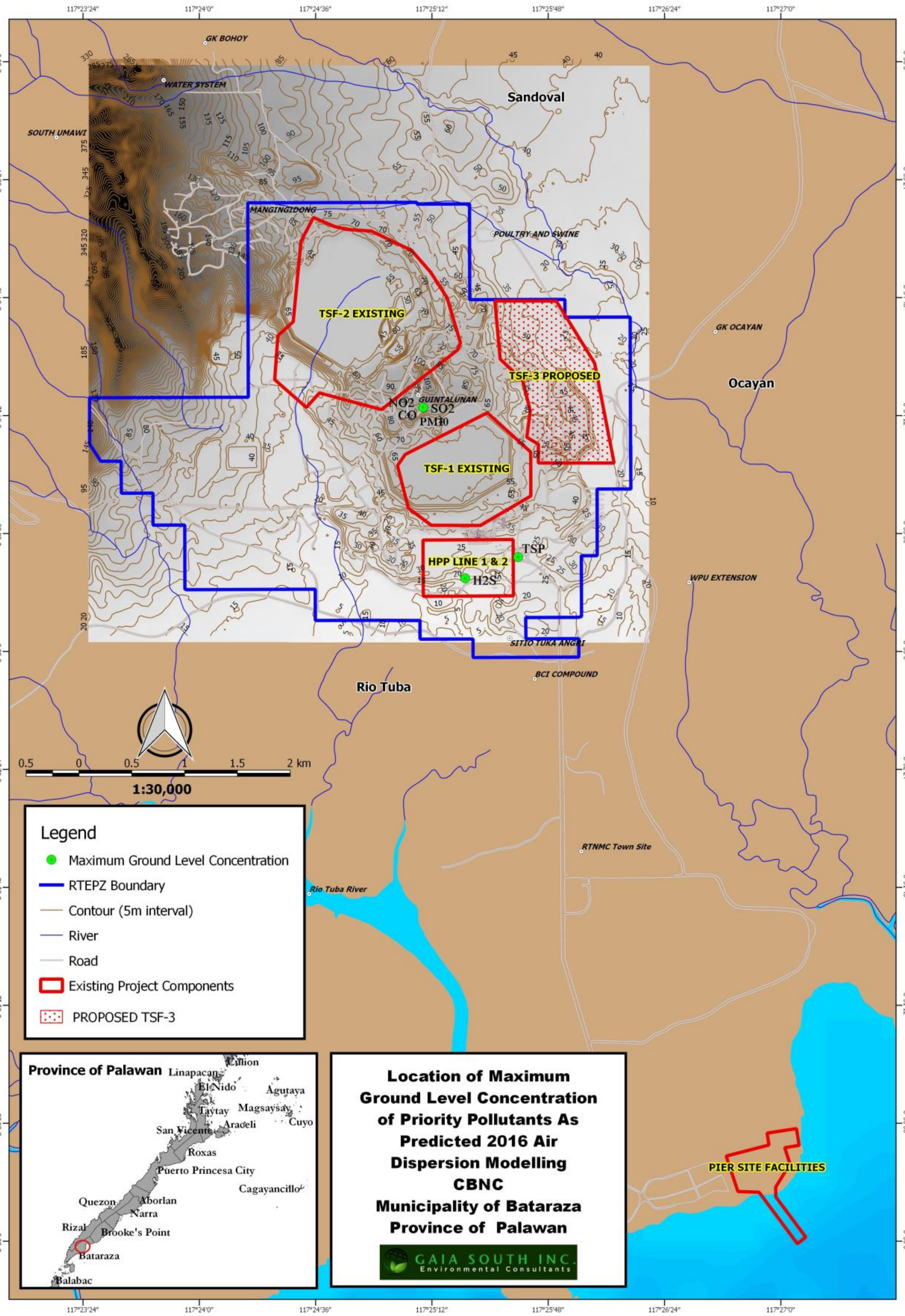


Figure 2.3.13. CBNC 2016 Air Dispersion Modelling results

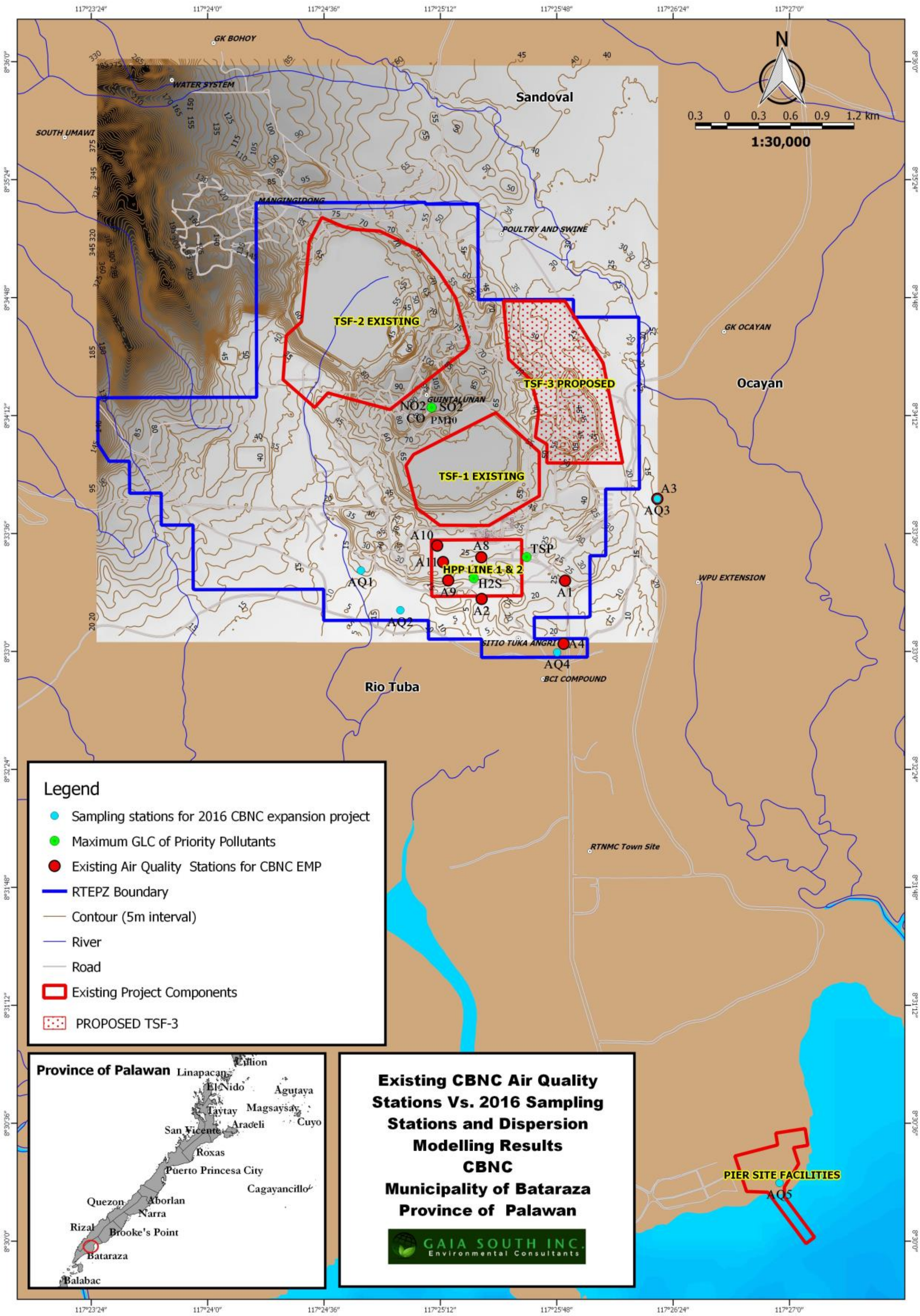


Figure 2.3.14. Location of the existing CBNC Air Quality Stations versus 2016 sampling stations and the dispersion modelling results

Table 2.3.20. Predicted impacts on air quality of the proposed project

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
Degradation of ambient air quality		✓	✓		The project's impact on air quality will mainly be on dust generation and to a lesser extent, an increase in SOx and NOx concentrations resulting from genset operations and increased vehicular activity. During construction, increased dust emission may ensue from frequent vehicle ingress/egress at construction site, from road construction, grading, and demolition activities. This may potentially impact on nearby areas. Loss of vegetation in newly opened sites will contribute to increased dust emission. However, since the site is a mined-out area, this will be insignificant. The stockpiling of soil materials and ores and hauling of these materials will also generate dust. This, however, is confined to already existing ore-preparation areas and existing controls will be sufficient as there is no increase in ore-handling capacity. The following measures are currently being implemented and are expected to continue to reduce dust pollution: • Regular water sprinkling along haul roads; • Concreting of main haul roads (Macadam Road); • Imposing speed limit of vehicles, hauling trucks and other heavy equipment; • Installation of tire-washing platform at entrance of Macadam Road; • Use of tarpaulin covers on hauling trucks; and • Installation of chutes, wind breaker and dust collector boxes for the mining operations. Covering the ore stockpiles also helps minimize dust generation. The installation of accordion chutes in the screening and crushing plant has been performed by CBNC to enclose dust particles that are agitated and dispersed into the air during deposition and stockpiling of the operation. Windbreakers and dust collector boxes are also in place at strategic locations around the crushing plant discharge to prevent any dust from dispersing further. It is expected that this practice will be maintained and improved. Increased vehicle movement may also generate additional SO_x, NO_x, and VOCs from vehicle emissions. Construction activities use a wide range of mobile equipment, such as bulldozers, graders, dump trucks, pavers, excavators, and bobcats. The engine exhaust from these vehicles, especially from those operating on diesel fuel, represent a source of particulate and other emissions (e.g., SO_x, NO_x, VOC, CO) from the construction site. Vehicle and equipment engines should be properly maintained to reduce exhaust emissions of CO, VOCs, and PM. Equipment that is in good condition will also reduce fuel consumption. During operation of the power plant, the potential emissions are NO_x, SO_x and particulate matter. With reasonable fuel quality, NO_x and SO_x would most likely be low. The power plant has so far been monitored

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
					and found in compliance with NESSAP guidelines. Hence, the likelihood for non-attainment in particular emission would only increase during upset conditions and improper maintenance. Preventive maintenance of the power plant will most likely lessen the occurrence of abnormal conditions and thus mitigate the above potential impacts. Regular monitoring of emission will measure the performance of the plant and thus determine if there is need for additional pollution control devices other than that already installed.
Increase in ambient noise level		✓	✓		As a result of vehicle movement and mining operations, ambient noise levels are expected to increase. To date, the noise levels are already that of Class C (light industry). This impact can be minimized by using properly maintained heavy equipment with installed mufflers. Maintaining the vegetation (i.e., 'buffer zones') near the mining areas and along access/haul roads will serve as a noise barrier. Workers exposed to increased noise levels shall use earplugs

2.4 THE PEOPLE

2.4.1 Socioeconomics

2.4.1.1 Methodology

The baseline data was sourced from the barangay profiles provided by each barangay and the profile of Bataraza provided by the Municipal Planning and Development Office (MPDO).

A perception survey, focus group discussions (FGD) and Key Informant Interviews (KIIs) were conducted for the direct impact barangays - Rio Tuba and Ocayan.

FGDs were conducted in Taratak, Sandoval and Iwahig as these had been identified in previous studies as impact areas and the team felt that focus should also be given to them in terms of gathering more information for better planning and recommendation setting. Key informant interviews were conducted with the barangay captains of the other indirect impact barangays - Sumbiling, Igang-igang, Sarong, Culandanum, and Tarusan.

A total of 371 respondents for the perception survey were randomly selected from the two (2) direct impact barangays, 334 for Rio Tuba and 37 for Ocayan (**Table 2.4.1**). **Annex 2.4.1** shows the perception survey form/questionnaire utilized during the assessment.

The sample sizes for the household survey were determined with consideration of the household population size, the level of confidence, that is, 95% and margin of error of + or – 5%.

The total combined sample size of three hundred seventy-one (371) respondents was derived using the Slovin's Formula, which is represented in the following formula:

$$\mathbf{n = N/\ 1+(N \times e^2)}$$

Where: n = sample size
N = Total population
e = margin of error, +/- 5%, confidence level, 95%

Computation:

n = 5052/ 1+ (5052 x .0025)
5052/ 13.63
= **371 total samples**

broken down as: **Ocayan (10%) = 37 samples**
Rio Tuba (90%) = 334 samples

Table 2.4.1 presents the various figures used in the computation and the sample size obtained. The same sample size was used in the Public Health study.

Table 2.4.1. Population, number of households and sample size of Barangays Ocayan and Rio Tuba

Barangay	Population 2015	Household size using the 2010 NEDA estimate of 4.7 persons/household	Percentage	Number of samples
Ocayan	2418	514	10	37
Rio Tuba	21330	4538	90	334
Total		5052	100	371

Spot maps of the impact barangays are attached herein as **Annex 2.4.2.**

2.4.1.2 Baseline Conditions

Profile of the Municipality of Bataraza

History of Bataraza

Sultan Haron Narrazid, the great negotiator and one of the signatories of the Treaty of 1878 pledging peace and loyalty of the Sultanate of Sulu to Spain, left Sulu and settled in Palawan, where the Spanish Government entrusted him the rule of the Muslim population of Balabac, and the neighboring southern islands. This Sultan established the main settlement at Bono-Bono. Several settlements were put up from Abo-Abo, the first barangay of Brooke's Point (now Municipality of Española) from the north, to the west coast up to Alfonso Hill (Quezon). Sultan Haron brought with him his family, his favorite sons, Datu Bataraza and Datu Jolkiple, who were in their teens when they settled in Bono-Bono. Because of his kindness, understanding and sympathy over the welfare of the native *Palawanos*, his rule in a nutshell was very successful one. He died and was buried in Bono-Bono where his tomb serves as a landmark in the said place.

Datu Bataraza Narrazid being the eldest ruled over the area. Like his father, he ruled with prudence and tact and continued the program of government of his great father. When the Americans took over the country, Datu Bataraza's authority over his subjects was fully recognized and respected by the American Government. He became a good and trusted friend of Governor Edward Miller. Because of the great trust and confidence of the Governor, Datu Bataraza was appointed Deputy Governor and given the title Superior Datu of the

Muslim population. The Governor set the boundary of his territory from Barangay Salogon, Brookes Point down south. A monument was erected in Barangay Salogon to serve as landmark of the decree signed by the Governor himself.

Datu Bataraza married Diumatria and was blessed with three sons, Sapiodin, Tahang and Anzaruddin. The sons were still in their teens when their father died in Manila. Datu Jolkiple, brother of Datu Narrazid, became the legal guardian of Sapiodin and his two (2) brothers. He attended to all the educational needs of his nephews. Datu Sapiodin grew to be the most outstanding among the three brothers. Leadership runs in their blood. Datu Sapiodin Narrazid was elected as Mayor of Brooke's Point and served for three consecutive terms.

Until January 1, 1964, by virtue of Republic Act No. 3425 authored by then Congressman Gaudencio Abordo mandating the division of Brooke's Point into two (2) distinct municipalities, the northern portion remained the municipality of Brooke's Point and the southern part was named the Municipality of Bataraza, in honor of the late Datu Bataraza Narrazid. By popular mandate, Datu Sapiodin became the first mayor of Bataraza.

The seat of government was put up in Tarusan, which was at that time strategically located in relation to the center of population, had proved very accessible to the greater bulk of the population. Datu Sapiodin strongly endorsed a resolution that all barangays south of Malis River will comprise the Municipality of Bataraza and that the seat of government shall be at Barangay Tarusan.

In 1967, Datu Jolkiple, the younger brother of Datu Bataraza and Uncle of Mayor Sapiodin was given also the authority to rule the Municipality of Bataraza. Under the administration of Datu Jolkiple, a massive socio-economic program was launched. Education was endorsed and he encouraged all parents to send their children to school.

The 1971 election ended the rule of the Narrazid in Bataraza and Hadjes P. Asgali, Sr. reigned. The major changes that the new mayor instituted was the return of the seat of government to Marangas, which until the present time remain in the Poblacion. He was also remembered for his decisive action in rejecting the Cojuangco estate to occupy Bataraza and for his fearless crusade against military abuses.

Demography

In the 2015 Census of Population and Housing released by NSO, the total population of Bataraza was 75,468. The barangay with the highest population based on the 2008 CBMS survey, results show that the Municipality of Bataraza registered a total population of 41,479 and with a total household population of 7,561. Female population dominated the area with 22,568 while the male population totaled only 18,479. The average family size was 5.4 persons per household.

The barangays with the lowest population size were Barangays Tagnato and Tagolango with 522 and 538, respectively.

Table 2.4.2. Total population by barangay, 2015

Barangay	Total Population
Bono-bono	3,293
Bulalacao	1,940
Buliluyan	1,782

Barangay	Total Population
Culandanum	3,966
Igang-igang	1,542
Inogbong	4,062
Iwahig	2,064
Malihud	2,112
Malitub	701
Marangas(pob)	8,183
Ocayan	2,418
Puring	1,293
Rio tuba	21,330
Sandoval	3,424
Sapa	1,886
Sarong	1,788
Sumbiling	3,609
Tabud	1,161
Tagnato	1,037
Tagolango	943
Taratak	2,008
Tausan	4,926
Total	**75,468**

Source: *NSO Census of Population and Housing, 2015*

Table 2.4.3. Number of Households, Total Population by Barangay, 2008

Barangay	No. of Households	Total Population	Male	Female
Bono-bono	508	2,312	1,164	1,148
Bulalacao	270	1,165	586	579
Buliluyan	241	1,067	531	536
Culandanum	651	2,855	1,448	1,407
Igang-igang	258	1,143	590	553
Inogbong	435	1,966	1,027	939
Iwahig	330	1,542	789	753
Malihud	212	1,352	724	628
Malitub	130	544	286	258
Marangas(pob)	1,086	5,299	2,660	2,639
Ocayan	294	1,252	646	606
Puring	218	1,015	549	466
Rio tuba	826	8,461	1,832	6,629
Sandoval	238	1,183	606	577
Sapa	134	611	309	302
Sarong	416	1,868	979	889
Sumbiling	300	1,361	704	657
Tabud	170	761	372	389
Tagnato	126	522	264	258
Tagolango	124	538	277	261
Taratak	373	1,759	916	843
Tausan	268	2,471	1,220	1,251
Total	7,561	41,047	18,479	22,568

Based on the 2008 CBMS survey results, out of the total 7,561 households only 103 or 35.15% were living in makeshift housing condition.

Income

Households with Income Below Poverty Level

Out of the 7,561 total households, 3,940 or 52.11% were categorized as with income below poverty threshold. This 2008 proportion rate was significantly lower than the 2006 proportion rate of 69.41%.

Households with Income Below Food Threshold
The total number of households with income below food threshold decreased to 39.21% in year 2008 as compared to the 2006 result of 53.34%.

Based on the CBMS survey results, Barangay Malihud posted the biggest number of households below food threshold with 89.15% followed by Barangay Tarusan with 89.04%. With only 1.93%, Barangay Rio Tuba had the lowest proportion rate of households with income below food threshold.

Water and Sanitation
Households with Access to Safe Water
Based on the data gathered during the 2008 CBMS survey 55.92% of the total households in Bataraza have access to safe water supply. This is slightly higher as compared to the 2006 CBMS result of 55.38%.

Households using safe water supply are predominant in the Barangays of Tarusan and Sumbiling with both recorded a 100% proportion rate. Households using unsafe water can be found in the Barangays of Puring and Malitub.

Households with Access to Sanitary Toilets
The data gathered during the 2008 CBMS survey showed that the proportion of households equipped with sanitary toilets decreased to 35.16% as compared to the 2006 rate of 51.54%. The highest numbers of households utilizing sanitary toilets were found in Barangay of Rio Tuba with 73.55% followed by Barangay Marangas with 62.25%, while on the other hand all households in Barangays Buliluyan and Malitub had no access to sanitary toilets.

Education
The 2008 CBMS results showed that the basic literacy rate of persons with ages 10 years old and above in the municipality was 79.34%. This 2008 result was slightly lower than the 2006 basic literacy rate of 82.24%.

At the barangay level, Barangay Marangas recorded the highest number of persons with ages 10 years old and above who were able to read and write with a proportion rate of 94.18% followed by Barangay Buliluyan with 93.77% while Barangay Inogbong posted the lowest literacy rate of 30.57%.

Elementary Education
At the elementary level enrollment participation rate of children with ages 6-12 years old during the 2008-2009 school year was 70.46%. This 2008 participation rate decreased by 3.4% as compared to the 2006 elementary participation rate of 73.50%.

Secondary Education
Out of 3,210 children with ages ranging from 13-16 years old, only 1,767 were enrolled during the school year 2008-2009. This figure (1,767) only constitutes 55.05% secondary school participation rate.

Employment
Employment rate in the municipality stood at 91.69% or 8,419 employed individuals from its labor force population of 9,182. This 2008 proportion rate was slightly lower as compared to the 2006 employment rate of 92.38%.

Infrastructure and Utilities

Roads and Bridges

A national highway connects the Municipality of Bataraza to the Provincial Capital. An all-weather gravel road stretches from Buligay Bridge (Brooke's Point) to Barangay Tagnato, Bataraza.

Transportation

Public utility vehicle (jeeps, buses and shuttle vans) ply the routes of Rio Tuba-Bataraza – Puerto Princesa City and vice-versa daily. Tricycles also serve some barangays while other barangays use pump boats and motor boats as means of transportation.

Power

The Palawan Electric Cooperative (PALECO), operating 24 hours is the major distributor of energy in the area.

Communication Services

Two telecommunication companies provide communication network in Bataraza: the SMART Communication and GLOBE Communication companies.

Tourism

Malihud Falls

Malihud falls is made up of a series of falls emanating from the very source of the Bulalacao River. The main falls is located at the very source of the river that it could not be reached by foot due to some impassable steep ravines and fully forested area.

The most frequented area is the Kapangyan Falls, which could be reached by foot from the national highway traversing Barangays Malihud to Rio Tuba. It will take at least 1.5 hours to reach the Kapangyan Falls through a winding trail of greenery and forest trees.

Gangub Cave

Gangub Cave is located at Barangay Sandoval, 20 km from the Poblacion. It could be reached by bus or jeep. It is accessible by foot from the provincial road traversing Sandoval to Barangay Iwahig for about 15 minutes at a slow pace.

From a distance, the cave resembles a ten–story building with an imposing height of more or less 100 ft from the base. The base is firmly anchored on a rock having an estimated area of at least 50,000 m2. The main entrance has an elevation of at least 39 ft, which requires one climber to ascend with greater effort and stamina. Upon reaching the entrance, one will be awed by its wonderfully and architecturally designed facade resembling that of a stately cathedral in the city. As you enter, you are welcomed by enticing sounds emanating from the multi-colored dome of the cave created by bats that inhabit the cave. One will notice that the floor of the cave is carpeted with *guano* that from time to time is being utilized/excavated for agricultural purposes.

Ursula Island Game Refuge and Bird Sanctuary

Ursula Island was declared as Palawan's Game Refuge and Bird Sanctuary through Presidential Proclamation No. 14 on July 30, 1960. This 17-hectare oval-shaped island is located southwest of Sulu Sea. It is 10 nautical miles southeast of Rio Tuba. On the southern side of the island lies a wide coral reef covering an even larger area than the island itself.

The island is haven to over 1,500 birds that cluster two (2) hours before sunset as they roost back to their places among the island trees. The scenery is a delightful sight for tourists and sports divers enjoying the beautiful coral line and marine vegetation surrounding the island.

Profile of the Direct Impact Barangays

Barangay Rio Tuba

The data provided in this section were sourced from the State of Barangay Governance Report of 2014.

General information

Barangay Rio Tuba is around 39.7 km way from the Central Poblacion of Bataraza. Rio Tuba has a total land area of 16,635.887 ha.

The barangay is basically industrial. Of the total land area, 5,000 ha were classified as industrial of which 100 ha were planted with coconut trees, 80 ha of forest area, and 50 ha were considered as idle land based 2014 barangay profile.

Its development goals had been in recreation, communication, legal, medical, tailoring and dress shop, beauty parlor, barber shops, gasoline stations, restaurants, lodging, etc. Manufacturing establishments found in the barangay like bakeries, hollow block-making, and furniture were found to be thriving.

Demography

Population

The population of Rio Tuba in 2004 was shown to be at 8,695, while 2014 data show that it increased to 20,071. This is higher than the 2013 survey of 17,689. The average percentage increase in household population for 2013 and 2014 is 10.9% and 10.93% while if this is divided for two (2) years, the average yearly percentage is 4.25% and 5.76%, respectively.

Household accounts show that out of 4,544 households in 2013 Household Actual Survey (HHAS) it has increased by 372 with a total of 4,196 in this year 2014 survey. This represents 7.21% increase for one (1) year after census was previously conducted.

Age distribution

Dependency ratio was approximately one (1) worker: 2.01 dependents with about 80% of the labor force being male and 63% of the dependents being female.

Sex Distribution

There were more males than females and the ratio was 51:49.

Religion

The predominant religion was Roman Catholic closely followed by Islam. This is due to the ethnic background of the settlers in the area from Luzon and from the Sulu group of islands. Records showed that 45% of the population in Rio Tuba was Roman Catholic, 23% Islam, 17% Protestants, 10% Iglesia ni Cristo and 5% practicing beliefs of indigenous tribes.

Ethnicity

The predominant ethnicity and dialect spoken by the people in the area was Tagalog with more than half of the population being Tagalog speakers.

Education

Educational facilities for pre-school, elementary and high school were present in the barangay. Tertiary and vocational schools did not exist. The nearest tertiary level school is in Brooke's Point about 70 km away from the barangay.

Preference for enrolment is more for public schools due to the affordability and accessibility of the public schools. This was true for the educational levels for pre-school to age 24.

Non-formal education was also provided to indigenous communities through the Indigenous Learning System (ILS) by the two (2) companies. There was also an ALS in Barangay Rio Tuba that catered to the out of school youth sponsored by the two (2) mining companies.

Housing

Housing was relatively stable in the barangay with about 84% having their own house and lot or having their own house on a free lot with the consent of the owner. The RTNMC has also provided housing for their employees complete with utilities and facilities.

Infrastructure and Utilities

Access to potable water

Water sources tapped were mostly artesian and deep well, which produced reasonably potable water. The level of technology being applied has improved in the recent years, which came with the introduction of commercial water refilling stations and provision of the RTNMC of potable water.

Water services to some sitios of the barangay come from the water services of RTNMC and CBNC, while in the other sitios, the source of water are from deep wells.

Barangay Rio Tuba has relied mainly on surface water (river and lakes) and ground water pumped from wells for drinking water. Drinking water was obtained through Piipinas Water Resources Incorporated (PWRI).

Source of Lighting

Power Source Philippines through the Barangay Power Association (BAPA) primarily supplies the power needs of Brgy. Rio Tuba. The total number of households served by BAPA gradually increased from 2013 to 2014 due to the increase in population according to the latest survey. Households without access to electricity utilized kerosene for lighting and cooking.

Sports and Recreational Facilities

The barangay has a basketball court with a stage used for various purposes. Other sports facilities present are the privately owned billiards hall and the public plaza in front of the barangay hall where games can be played.

Roads and Bridges

There is a 500 m-long concrete road in fair condition while there is an earth surface road maintained by RTNMC.

Means of Transportation

Barangay Rio Tuba is accessible to all kinds of land and sea transportation. There are 14 buses, 25 vans plying to Puerto Princesa City and vice versa. There are also 12 jeepneys and five (5) buses plying everyday from Rio Tuba to Brookes Point and vice versa. The sea port in the barangay accommodates cargo vessels from Japan and other countries.

Means of Communication

The barangay has cellular services from Globe Telecom and Smart Telecom. Both companies have a cell site in the barangay since November 2003. Aside from these, the barangay also operates a post office and has radio communications technology.

The headway Cable station has been the popular source of information and entertainment for the people of Rio Tuba.

The Brigada News FM 94.5 is the radio station in the barangay. It serves as the source of information and news coming from the main radio station in Puerto Princesa City.

Private courier services such as JRS and 2GO with offices deliver domestic and overseas letters, cargoes and packages.

Smart Bro/Globe Tattoo also make internet services possible.

Peace and Order

The peace and order in the barangay is uncontrollable even if there is a Police Station present in the barangay. There still exist criminal cases that remain unsolved.

Cultural Data

Barangay Rio Tuba is said to be a melting pot of different tribes and cultures. Many people coming from other provinces migrate and look for a job in the barangay. The two (2) companies present in the barangay are the reasons why different people tended to congregate in the place.

The ethnicity is diverse in the barangay. The different ethnic groups found to be present in the barangay were *Tagalogs, Cebuano, Tausug, Maranao, Mapun, Ilonggo, Cuyunun, Ilocano, Pangutaran, Bicolano, Palaw'an,* and *Boholano*.

Economic Data

State of Income

Income per capita is high. Poverty incidence is low. Magnitude of families living below poverty threshold is low.

Labor Force/Employment

Age range analysis showed that about 60% of the population was within the working age range of 15 to 64 years old denoting a high level of potential labor force.

Nature of Occupation

The profile of occupation showed a high percentage of permanent employment in the private sector. Owning a business can also be interpreted as self-employed which is applicable to farm owners and other occupations.

The good economic condition in the barangay paved the way for better or improved standard of living in the area. Establishment of livelihood programs created opportunities for economic development. Other forms of business also contributed to the economic growth in the barangay.

Rio Tuba is known for its nickel mineral reserves. Nickel mining is a very important industry in the locality. The RTNMC mine site is located within its jurisdiction. In addition to the mine site, the $180 million mineral processing plant of CBNC is within the barangay. The plant was designed to extract nickel from low grade ore previously considered as waste.

Commercial enterprises are thriving. There are many medium sized stores, mostly located in barangay proper. The service sector is also growing with the rise of many commercial establishments. The barangay produces good quality nickel and cobalt.

Commerce and Industry

Trade and commerce has been gradually escalating around Rio Tuba and the barangay is being considered as an important hub of commercial and other socio-economic activities. Several agricultural trading establishments, financing institutions and motorcycle outlets have been put up in the barangay which has encouraged the growth of small and medium enterprises from a small store beside the house to a mobile food stall installed on a bicycle sidecar.

In the same way, the barangay has become the drop-off point of various fruits and vegetables, livestock, household goods, local handicraft and native delicacies coming from the neighboring barangays during “Tabuan” which is every Saturday in sitio Marabahay and barangay proper on Sunday. Traders would come to the barangay to buy goods and sell these to their barangays. Business is usual during week days. The presence of the different panels loaded by groceries and other products envigors the trading industry more productive of the barangay. The seaport is accessible to all kinds of sea transportation to ship products from Balabac and Mangsee.

The public market is located at Sitio Kayasyasan which is the center of commercial activities in the barangay. Business establishments inside the public market are of different categories like grocery stores, rice stores, and others.

Barangay Ocayan

The data provided in this section were based on the 2007 Barangay Profile of Barangay Ocayan. Note that the latest barangay data available in both the municipal and barangay offices is from 2007.

General Information

Barangay Ocayan is considered a rural barangay with a total land area of 1,803.5 hectares. Its land use is generally agricultural with negligible portions of residential, forest and idle land.

Demography

Population Distribution

Based on the 2007 NSO Census of Population declared in the Barangay Profile of Barangay Ocayan, the total population was 1,780 with 846 males and 936 females. Around 26.23% of the population was classified as adults (ages 18-35 years) followed by children (18.65%) belonging to age class 6-12 years old. A considerable portion, 17.47% accounted for children 0-5 years old while children 13-17 years old made up 11.40% of the populace. Adults 36-50 years old comprised 15.73% of the population while only 6.23% were adults classified under 51-65 years old. Only 3.70% made up the more than 66 years old age group.

In 2007, there were 308 households with an average of six (6) persons per household.

Religious Affiliation

Majority of the residents in Barangay Ocayan were Roman Catholics (52.92%) while 32.47% practiced the Palaw'an religion. Islam was the religion 10.5% believed in. The other religious affiliations for the rest of the members of the community were Iglesia ni Cristo, Seventh Day Adventist, and Christian Fellowship.

Language/Dialects Predominantly Spoken

The prevalent dialect spoken in the barangay as declared in the Barangay Profile was Ilonggo at 38.31%, followed by Palaw'an, 32.46%. There was also 17.21% of the resident who spoke Tagalog while 9.09% communicated in Mapun. Cebuano was spoken by 2.92% of the community.

Education

The barangay has five (5) pre-school/day care centers, five (5) public elementary schools and one (1) private preschool facility.

Educational Background of Residents

The residents of Barangay Ocayan generally were able to attend primary or elementary level. There were also 238 who had pre-school education. There were eight (8) who reached and graduated from college while two (2) were able to pursue post graduate studies.

Housing Materials

Very few of Barangay Ocayan residents occupied houses made of permanent structures (4.87%). On the other hand, majority of its members dwell in temporary abodes made of bamboo, sawali and *nipa/cogon* (82.14%) while 12.98% reside in semi-permanent structures made of wood and GI sheets.

Infrastructure, Transport Facilities and Services

Roads

Roads in the barangay were reported to be either gravel or earth filled. The most common means of transportation was through public utility bus, jeeps, tricycle and skylab.

Access to Potable Water

Potable water from pipes and tubes were limited to only 7.07% of its residents having access. There was 26% that had deep wells as the source of water and 69.77% abstracted from surface waters such as rivers and springs.

Source of Lighting

Lighting source of the barangay came in the form of kerosene for 86.98% of the population. There were 12 residents or 4.04% that used solar power while 10 (78%) utilized generator sets.

Toilet facilities

Most of the residents (40.44%) had pit type toilets while 24.26% utilized water sealed facilities. It is noteworthy to mention that 39.10% had no toilet facilities.

Sports and Recreational Facilities

There were four (4) basketball courts existing in the barangay where residents could hold their sports and recreational facilities.

Peace and Order Situation

The situation in the barangay has been described as generally peaceful.

Presence of Indigenous/Ethnic Groups

There were two (2) ethnic groups – the *Cuyunen* and *Palaw'an* - noted in the barangay. The members of these groups, their capacity as chieftains are involved in the settlement of disputes. The chieftain is likewise involved in the celebration of their traditional wedding practices and burial rites.

Economic Data

Employment

There were a total of 616 employed residents. Of this number, four were employed locally while 612 were self-employed. There were four (4) residents employed as teachers while 28 as skilled workers.

Major Sources of Livelihood

Farming has been ranked as number one major source of income while fishing was ranked second. Business was ranked third as their major source of livelihood.

Establishments Found in the Barangay

There was one (1) poultry/livestock farm reported in the barangay, together with 21 backyard gardens. There were 21 *sari-sari* stores and one rice flour/corn/saw mill. Three mining/quarrying firms had also been indicated.

Household Survey Results

Annex 2.4.3 indicates the tabulated responses discussed under this section.

Respondent's Information

Position of Respondent in the Family

Majority (84.13%) of the respondents from Barangay Rio Tuba were spouses and only 8.38% were heads of the households whom were mostly within the 25 to 44 age bracket. On the other hand, respondents from Ocayan were composed majorly of heads of the family (67.57) followed by the spouses (27.03%) who were mostly from the 20-34 and 40-54 age group.

Gender of Respondents

In terms of gender, there was a slightly higher number of female respondents (58.98%) in Rio Tuba compared to the male interviewees (41.02%). The same trend was observed in Ocayan as there were more female respondents (35 or 94.59%) compared to males (2 respondents or 5.41%).

Marital Status of Respondents

The respondents in Rio Tuba were mostly married, 262 or 78.44%. There were nine (9) or 2.69% who had a live-in arrangement with their partners while 17 or 5.09% were widowed and 14 or 4.19% were single. In Ocayan, 91.89% or 34 of the respondents were married and two (2) were widowed.

Religious Affiliation of Respondents

Majority of the respondents in Brgy. Rio Tuba, 55.39% (185), practiced the Catholic faith while 21.56% (72) belonged to Islam or the Muslim religion. Other respondents were Born Again Christians, members of Iglesia Ni Cristo and members of other religions. Same with Brgy. Rio Tuba, majority of the respondents (56.76% or 21) were Catholics and 13.51% pursued the teachings of Islam. The other less practiced religions in the barangay were Protestantism, Pentecostal and Iglesia Ni Cristo. There were two (2) respondents who reported to be pagans.

Ethic Group

In terms of ethnicity, 81% of the respondents do not belong to any ethnic group. For the 18.26% who do, they belong to the following groups: *Palaw'an, Molbog, Mapun/Muslim, Cuyunen, Cagayanen, Tagbanua, and Igorot*. In Brgy. Ocayan, 23 or 62.16% belonged to an ethnic group while 14 or 37.84% do not. More than one third of the respondents reported to be *Palaw'an* (14 or 37.84%). The other ethnicities reported were *Molbog, Mapun/Muslim, Cuyunen, Ilonggo* and *Tagbanua*.

Residency

Majority (50%) of the respondents of Rio Tuba had resided in the area for more than 10 years while 20.36% had lived there since birth. There were 9.98% who stayed in the locality from only 1-5 years and 18.86%, for 6-10years. For respondents who were not born in the barangay, 15.87% were born in the same municipality but different barangay and 11.68% were from the same region (MIMAROPA) but different municipality. The rest of respondents were born from other regions of the country such as Region 6, Region 7, CALABARZON, Central Luzon, Ilocos Region, Eastern Visayas, Northern Mindanao, and the ARMM.

For the Brgy. Ocayan residents, 17 or 45.95% had been living in the barangay since birth. There were 16 or 43.24% who had resided there for more than 10 years and four (4) respondents who had stayed in the barangay for less than 10 years. For those who were not born in Ocayan, the places of birth reported were in Region 4B, Western Visayas, and Davao region.

Migration

The main reasons for migration to Brgy. Rio Tuba are employment (40.12%), livelihood opportunities (20.68%) and marriage or family matters (14.07%). For Ocayan, 32.42% of the respondents indicated that they migrated for better livelihood chances while 16.22% moved to the barangay due to marriage or due to family concerns.

Educational Attainment

The highest educational attainment reached by the respondents from Brgy. Rio Tuba was graduating from college (29 respondents or 7.49%) while 33 % were able to graduate from high school. Majority of the respondents fell into the category of reaching elementary level, being elementary graduates, high school level, college level and no formal education. There were eight (8) or 2.40% who reported that they had some vocational training. In Barangay Ocayan, 17 respondents (45.95%) reached only elementary level while 11 respondents were able to graduate from high school. For tertiary education, one (1) respondent was able to enter college but was not able to graduate and two (2) who successfully graduated.

Employment

In terms of employment, majority of the respondents in Rio Tuba (58.38%) reported to have jobs/work while majority of the respondents in Ocayan (56.76%) were unemployed.

The Rio Tuba residents who were employed , their sources or income included farming (7 or 2.10%), self-employment from business, buy and sell, piggery, etc. (37 or 11.08%), serving the barangay as *Kapitan, Kagawad, Tanod*, etc. (18 or 5.39%), rendering skilled work as welder, carpenter, crane operator, technician, plumber, mechanic, etc. (29 or 8.68%), employment as teacher, medical assistant, administrative staff, revenue collector, safety engineer, nurse, supervisor, etc. (37 or 11.08%), fishing and fishing-related activities (17 or 5.09%) and as driver (22 or 6.59%). Income sources of the Barangay Ocayan respondents included farming, self-employment, government employee, utility workers, etc. There was one respondent who worked in the religious sector.

A total of 198 respondents (59.28%) from Barangay Rio Tuba indicated that their place of work was also in the barangay. On the other hand, 36 respondents (10.78%) have workplace in other barangays while four (4) or 1.20% of the respondents worked outside of the municipality. For Ocayan, 10 respondents (27.03%) of the respondents have workplaces in the Barangay Ocayan with the same number working outside the barangay. There was only one (1) respondent who reported that his workplace was outside of the municipality.

Household Demographic Information

Household size ranged from one (1) to more than 10 family members. The highest number of household members in Rio Tuba fell in the category of 3 to 6 members at 227 or 67.96%. It is worthy to note that there were single households, (11 or 3.29%), 2-member households (25 of 7.49%), and two (2) or 0.60% with more than 10 members. For Ocayan, the 3 to 6 member households totaled to 20 or 54.05% which comprised majority of the respondents. There were 10 or 27.03% who had only a 2-member household. The highest number of members in a household was nine (9) reported by two (2) or 5.41% of the interviewed residents.

The monthly income of the Barangay Rio Tuba households ranged from less than PhP1,000 to as high as more than Php17,500. There were 231 or 69.16% who had a monthly income PhP2,500-15,000. It must be noted that 63 or 18.86% of the households earned more than PhP17,500 per month.

The dialect spoken in the households of Barangay Rio Tuba was predominantly *Tagalog* (214 or 64.07%). Tagalog was also combined with other dialects such *Hiligaynon, Bicolano, English, Bisaya, Mapun* and *Ilonggo* (76 or 22.76%). Other dialects spoken at home included *Tausog, Islam, Palaw'an, Mapun, Pangutaran, Cuyunin, Ilocano, Cebuano* and *Molbog*. For Barangay Ocayan residents, the predominant dialect spoken was *Tagalog* as reported by 13 or 35.14%. Another dialect spoken by almost one third of the respondents was *Palaw'an* (11 or 29.73%). A combination of *Tagalog-Ilonggo* was also spoken at home by 6 or 16.22%

Two hundred seventy-three or 81.74% of the respondents in Brgy. Rio tuba stated that there was no other income being contributed into their household other than the income earned by the head of family. On the other hand, 61 or 18.26% reported that they have access to other sources of income. For Ocayan respondents, 17 or 45.95% reported to have other sources while 20 or 54.05% had none. Other sources of income came from farming, buy and sell, Conditional Cash Transfer provided by the government and providing services as house help.

The skills present in Brgy. Rio Tuba included singing, dancing, sculpting, crane operation, driving and cooking. It is interesting to note that there were 224 or 67.07 % of respondents who did indicate any skills. There were 16 or 43.24% in Ocayan who possessed skills that they can use in the future to derive or add to their income. These skills include art/sculpting, farming skills, selling and some business acumen.

Two hundred fifteen or 64.37% of the respondents reported that they source and purchase their food and other necessities from the Public market in Brgy. Rio Tuba and 118 or 35.33% got theirs from the *sari-sari* stores, *talipapa, tabuan* and ambulant vendors in the barangay. The respondents from Ocayan had the same response that is, from the public market in Barangay Rio Tuba (33 or 89.19%). There are also markets in Pabo, Bataraza and *sari-sari* stores or ambulant vendors.

It can be seen from the table that out of the 334 respondents, only 23 or 6.89% had family members who worked outside of barangay Rio Tuba. There were 301 or 90.12% who stayed in the barangay for work. The same trend is observed for Brgy. Ocayan. There was 32.43% who went outside of the barangay for work opportunities. No one from Barangay Ocayan reported any family member who worked as an overseas worker. Please see **Annex 2.4.3** for the demographic information of the interviewed households.

Housing Information

House ownership in Barangay Rio Tuba as reported by the respondents was 221 or 63% while 121 or 36% did not own their place of residence.

Eighty-one percent of the respondents in Barangay Ocayan reported that the house they live in is owned by them.

One hundred eleven or 33.23% in Barangay Rio Tuba owned the land where their residences are built while 223 or 66.77% did not. For those who did not own the land, 167 or 50% identified private individuals as the owners. On the other hand, 25 or 7.49% stated ownership by their relatives and 16 or 4.79% mentioned their parents or family members as owners of the land. There were nine (9) respondents who stated that the land where they reside is owned by the government while three (3) people cannot identify the owners. Land ownership in Ocayan was mentioned by 26 or 70.27% of the respondents. For those who did not own the land, it was mentioned that these belonged to relatives and private individuals.

Sources of water, electricity and fuel

Water in Rio Tuba is drawn from various sources. Fifty-two or 15.57% abstracted water from wells, 13 or 3.89% from deep wells, nine (9) or 2.69% from piped faucets, one (1) or .30% from spring and one (1) or .30% from river/stream. There were 269 or 80.54% who got water from a commercial water refilling station or from the water supplied by the barangay. Water in Ocayan was sourced from springs, wells, and from the water supplied by the barangay.

As far as electrical connection is concerned, 268 or 80.24% are connected to a power supplier while 66 or 19.76% have no electrical connection. For those who have no connections, they use kerosene lamps (13 or 3.89%) for lighting purposes. All of the Ocayan respondents had no connection to a power source. They provide their own electricity through kerosene lamps (15 or 40.54%), generator sets (13 or 35.14%), and solar panels (8 or 21.62%).

Respondents from Rio Tuba used charcoal (279 or 83.53%) for fuel. Sixty-three or 18.86% use liquefied petroleum gas while 17 or 5.09% utilized electricity.

Fuel used in Barangay Ocayan is predominantly wood. Other sources include liquefied petroleum gas and charcoal.

The respondents enumerated various appliances they possess in their households. Two hundred forty-two owned television sets while 231 have electric fans. There were also 130 who owned washing machines. Refrigerator is also a common appliance in the barangay as reported by 125 respondents. Other possessions included electric iron, electric stove, VCD player, transistor radio, stereo, rice cooker and others like laptop/computer, air conditioning units, oven, etc. Since there is no electrical connection in Ocayan, the number of appliances in the household was few but not limited since some households have generator sets and solar panels. Appliances reported were transistor radio, television sets, refrigerator, electric fan, VCD player, and washing machine.

House and roof materials

The roof of the houses in Rio Tuba is generally made from galvanized iron sheets. *Nipa* or cogon is also a popular roofing materials as well as bamboo and concrete. The walls of these houses were generally made of bamboo. A considerable number was also reported for wooden and concrete walls. There are also some reports of sawali or bamboo mat board and nipa/cogon being utilized as wall materials for houses in the barangay.

Galvanized iron sheets were popular roofing material for houses in Barangay Ocayan (25 or 67.57%) while nipa /cogon also was used by 14 or 37.84%. The walls of their houses were usually made of bamboo mat board (sawali), wood, concrete, *nipa*/cogon, or bamboo.

Community Information

Membership in local organizations was not an activity pursued by 281 or 84% of the respondents in Barangay Rio Tuba compared to 53 or 15.87% who belonged to an organization. Belonging to a religious organization was the choice of 28 of the respondents while 13 preferred to be part of a civic organization. The other organizations the respondents joined are the economic and political groups. On the one hand, 685 of Barangay Ocayan respondents were members in organizations. These organizations were of economic, civic and religious nature.

The civic organizations to which the Rio Tuba members belonged include Samahan ng mga Kababaihan, Senior Citizen, KALAHI CIDS, RIC and PANTRODA (Tricycle Driver's Association). Only 2 rose to becoming officers of the civic group while 12 were members. On the other hand, Ocayan residents belonged to Samahan ng kababaihan, Farmer's association and PANTRODA. All of the Ocayan residents were members without having any extra responsibility as a leader.

The religious groups mentioned as organizations by the respondents in Barangay Rio Tuba to which they are affiliated are the Couples for Christ and the pastoral council. One of the interviewees mentioned of being the president or leader of the religious group while the others considered themselves as members. In the same light, Barangay Ocayan respondents reported to be members of the pastoral council. One reported to be the president/leader while two were members in the pastoral council.

The only economic group where three of the respondents in Barangay Rio Tuba reported to belong was the four (4) IPs or Conditional Transfer program of the government. The same is true for the interviewees in Barangay Ocayan who mentioned the same government program.

Community Issues

It was reported by 209 of the respondents from Brgy. Rio Tuba that illegal drug trade and use was a community problem besetting the area. Aside from this, limited sources of income, limited access to education, prostitution, dirty and polluted environment and health issues were some of the problems experienced in the barangay. Conversely, Ocayan respondents saw the lack of income opportunities as well as health problems in the locality. The lack of access to education has been forwarded as an issue together with polluted environment, illegal drugs and political conflicts. The unstable peace and order condition was also mentioned as a societal problem.

Positive attributes of the barangay

Even if a dirty and polluted environment was previously reported as one of the community concerns, 108 of the respondents thought otherwise. The same was observed with the limited sources of income because 179 of the respondents reported that the barangay presently has many people employed. Furthermore, the residents stated that their barangay leaders are performing well and trustworthy. One hundred sixty-one forwarded that there are members of the youth that are in school.

The positive attributes of Brgy. Ocayan as seen by some of the respondents include the initiatives of the barangay leaders to provide education to children and education to individuals. Nine people saw a clean environment while 4 stated that their barangay leaders practice good governance.

In cases of problems in their households, the residents in Rio Tuba readily approach the barangay captain. The present and past officials of the barangay were also the go to persons in cases of domestic trouble. There were a couple of instances when relatives are also contacted. Majority of Barangay Ocayan respondents consult their barangay captain while one consulted relatives.

Women Participation

Based on the responses, women in Brgys. Rio Tuba and Ocayan play a very important and participative role in family decision-making. Women helped decide on matters of finances, children's educational plans and concerns, strategies on how to raise them, family purchases, daily chores and social, and wedding activities.

Women in both barangays contribute to family income by engaging in various forms of employment. Three hundred seven engaged in selling while 121 pursued sewing and dressmaking. Other income sources of women were from providing laundry services, domestic help, farming, street sweeping, fishing/livestock-raising.

Respondents reported that some women encounter problems in the community while others do not. For those who are experiencing problems, the lack of employment/livelihood was forwarded. Domestic violence and marital infidelity were also given as problems that beleaguer the women of Rio tuba. The lack of income sources and domestic violence were also the issues faced by women in Barangay Ocayan.

Respondents from Brgy. Rio tuba specified some activities that women can pursue to help the community. These include participation in community activities and livelihood programs. In addition, they can indulge themselves in work or other endeavors. Also, women are seen as participants in organizations and information dissemination efforts. The respondents from Ocayan saw less participation from women to help the community. But the respondents felt that their involvement in social activities, livelihood programs and other work-related endeavors will benefit the community.

Youth participation

The youth in Barangay Rio Tuba were seen as very active in sports as specified by 311 of the respondents. Also, they belong to organizations and training programs to while away their time. Two hundred twenty-three respondents saw the youth as an important factor in the development of the community while 111 responded otherwise. To those who regarded the youth as a significant sector of society, their involvement in barangay activities and participation in sports development projects was emphasized. There were 24 or 64.86% of the respondents in Ocayan who forwarded that the youth can participate in barangay activities as well as actively immersing themselves in sports-related projects.

Resources of historical, cultural or archeological in the community

Two hundred ninety-six or 88.62% of the respondents answered in the negative when asked if there are resources of historical or archeological importance found in their locality. Nevertheless, there were 38 or 11.38% who perceived that there are resources of these kind present in the area. When queried about these, they gave rivers, trees, mountains as the said resources (Please see **Annex 2.4.3** for the tabulated response). For Barangay Ocayan respondents, 12 or 32.43% answered in the positive. These natural resources were caves and mountains of no archeological or historical value.

Environmental Change

There were 262 or 78.44% Rio Tuba residents who have noticed changes occurring in the environment over the past five (5) years while 53 or 5.69% who have observed no change (Please see **Annex 2.4.3** for the tabulated response). The changes reported include construction of industrial plants, conversion of land to subdivisions, changes in farm production, flooding, forest conditions, population, water quality, air quality, traffic conditions and putting up of street lights. The changes were both in terms of increase and decrease of these parameters. Conversely, 32 or 86.49% of Ocayan interviewees reported that they observed changes in the environment too. These changes bordered on the construction and establishment of the CBNC plant site, conversion of land to subdivisions, population increase, water and air pollution, and traffic congestion.

When asked about which of these changes affected their families, Brgy. Rio Tuba respondents stated all the parameters but construction of the industries/plants, conversion of lands to subdivisions, population increase, forest destruction and air pollution were mentioned more than the other changes. The entities mentioned who help in addressing environmental issues was predominantly the barangay officials. The municipal and provincial officers, and non-government organizations were mentioned by fewer respondents. The church, as an assisting organization was seen only by four (4) respondents.

Among these changes, the decrease in farm production affected Barangay Ocayan families together with water and air pollution, flooding and conversion of land to subdivision. Support and assistance to address these problems came from the barangay and municipal government. There were 14 responses mentioning that NGOs and POs helped them. It was also indicated in the 19 responses that RTNMC and CBNC extended assistance to tackle the problems.

The calamities that have affected the households in Barangay Rio Tuba were identified as typhoons, floods and landslides. Although rarely occurring in Palawan, six (6) respondents reported earthquakes to have affected them. With the residents of Barangay Ocayan, the occurrence of typhoons and floods affected the families most. There were other calamities reported such as landslide and earthquake.

Awareness of the proposed project

Three hundred sixteen or 94.61% of respondents from Rio Tuba and 36 or 97.30% from Ocayan were aware and know of the presence of the various inter-related companies existing in their community (Please see **Annex 2.4.3** for the tabulated response). When asked about their knowledge of the planned CBNC Expansion Project for the TSF3 and increase in cobalt annual limit, 211 or 63.17% in Barangay Rio Tuba and 9 or 24.32% from Ocayan responded in affirmation. However, there were 113 or 33.83% in Rio Tuba who had no idea of the proposed project. There were 10 respondents who had no answer. For those in Barangay Rio Tuba who were aware of the proposed project, their sources of information were the barangay officials, employees of CBNC, friends/relatives and neighbors, print and broadcast media, barangay meetings/consultations and other surveys. Those from Barangay Ocayan sourced their information from barangay meetings and consultations, relatives/neighbors and employee of RTN. One respondent also indicated their information source as the socio-economic survey conducted.

The Barangay Rio Tuba respondents mentioned of various projects that they know of that has been implemented by CBNC. These include financial assistance, medical missions, livelihood programs, skills training orientation, sponsored tours/trips and employment assistance programs. Community service such as feeding programs and tree planting were also listed as projects pursued by CBNC. The most mentioned project conducted in Ocayan was the support to infrastructure (schools, water system, health center), educational and health care centers and provision of financial assistance.

Perception towards CBNC
It has been mentioned by the Barangay Rio Tuba respondents that the positive impacts they foresee from the proposed CBNC expansion project are provision of more employment to local residents, increase in business and livelihood, industrialization of the company, increased tax collection and revenue for the barangay and municipality, increased land values, more community projects and better solidarity in the community (Please see **Annex 2.4.3** for the tabulated response). All these responses had likewise been forwarded by the Barangay Ocayan respondents.

The negative effects expected in Barangay Rio Tuba by 194 respondents would be the possible pollution and poisoning of the environment as a result of the proposed project. It was also seen as a negative effect on livelihood and damage to crops. There was likewise a concern on the possibility of more people settling in the community. More flooding/landslides is also projected that will displace families and affect the way of life. Accidents are also seen as a possibility together with an unstable peace and order condition. All these possible negative impacts as a result of the project were given by the people surveyed in Barangay Ocayan.

When asked about their perception of the proposed expansion activities, 263 respondents felt that this will greatly help the community and its residents in Rio Tuba. However, 75 of the interviewees thought that the benefit would just be minimal. There were 4 who perceived that the project will not positively affect the community while 13 felt that negative effects will be encountered as a result of the project. The same trend of responses was obtained from the Ocayan residents.

Aspirations
About 306 or 91.62% of the respondents from Barangay Rio Tuba agreed to pursue the construction of the TSF3 and the increase in annual cobalt production limit. There were only four (4) or 1.2% who did not agree and 24 or 7.19 who had no opinion. On the other hand, 25 or 67.57% agreed that the proposed project will be able to provide more jobs and development to the community. Six or 16.22% had no opinion while five (5) or 13.51% disagreed. There was one (1) respondent who strongly disagreed with the expansion project. Please see **Annex 2.4.3** for the tabulated response.

Willingness to participate
Three hundred thirteen or 93.71% of the Barangay Rio Tuba respondents, if given the opportunity, were willing to work or will allow their family members to work with the company. There were 13 or 3.89% who were not willing. Eight or 2.4% of the respondents were still undecided. The same trend was observed with the Barangay Ocayan responses as 31 or 83.78% were willing to work with the company. Only three or 8.11% were undecided (Please see **Annex 2.4.3** for the tabulated response).

Acceptance of the project
One hundred sixty-five or 49.40% from Barangay Rio Tuba strongly agreed in accepting the project while 150 or 44.91% agreed to the project. There were only two (2) people or 0.60% who strongly disagreed. There were also two (2) or 0.60% who had no opinion. The Ocayan

respondents strongly agreed (14 or 37.84%), agreed (9 or 24.32%), disagreed (5 or 13.51%), strongly disagreed (2 or 5.41%).

Three hundred two or 90.32% of the respondents approved the implementation of the proposed project if mitigating measures to address potential negative impacts, if any, will be addressed. There were only 11 or 3.29% who did not want the project to be carried out. There were 17 or 5.09% who were not sure or undecided. With the same trend as Barangay Rio Tuba, Barangay Ocayan respondents (27 or 72.97%) agreed to pursue the project. There were seven (7) or 18.92% who gave a negative response while three (3) or 8.11% were undecided.

One hundred fifty-nine or 47.60% from Barangay Rio Tuba strongly agreed and 156 or 46.71% agreed to actively participate in monitoring the operation of the CBNC to ensure that the company follows the standards set by the DENR. Only two (2) or 0.50% disagreed. There were six (6) who did not give their answer. As far as Ocayan is concerned, there were 18 or 48.65% who strongly agreed while 15 or 40.54% agreed. Only three (3) or 8.11% gave no opinion. One resident strongly disagreed.

There was an overwhelming positive response at 326 or 97.60% of Rio Tuba residents when asked whether they were willing to attend CBNC meetings and consultations for clearer understanding of the strategies undertaken by the company to protect the environment, livelihood, education, community development and other concerns about the project. Only eight (8) or 2.40% did not want to participate. Barangay Ocayan respondents gave a 100% support to attend meetings and consultations with CBNC to thresh out issues and come up with better approaches so that all stakeholders and the environment are given attention and protection at the same time.

2.4.1.3 Impact Assessment

The CBNC has claimed positive economic impacts of the HPP operations in terms of the direct and/or multiplier effects of taxes, local purchases, imports, gross revenues, employment, the investments for the CRAs and the SDMP to the national and local environment.

To date, the capital investment for the proposed project amounted to USD 146.345 million and a total of USD 605.433 million ($1: PHP 49.8824) for the whole HPP Complex. The summary of the beneficial impacts of the HPP are shown in **Table 2.4.4** which are based on the current operations.

Table 2.4.4. Beneficial impact of CBNC HPP operations (CBNC, 2015)

In the form of	Particulars	Annual Financial Impact in millions PHP
Economic effects	Gross Revenues	1,121.607
Employment or Job Generation	CBNC	535.107
	RTNMC and RTNFI	464.008
	Contractors	667.649
	Multiplier Effect (5)	
	Salaries, wages and other benefits	*as mentioned above for CBNC and RTNMC
	5 % of Gross Revenue	56.080
	Real Property Tax	0.994
	Other Taxes	308.938

In the form of	Particulars	Annual Financial Impact in millions PHP
SDMP or Social Development Projects	1.5% of Direct Operating Costs (2014-2018)	813 for 5 years or 162.6/year
	CRA CSR (Joint CBNC/RTNMC – 2014-2018)	390.000 for 5 years or 78/year

Table 2.4.5 shows a summary listing of the national government and LGU revenues from a mining project in the Philippines. These include corporate income tax, value added tax, various customs and duties on imports, income taxes, real property taxes, among others, as well as various fees.

Table 2.4.6 shows the specific taxes paid by CBNC for 2014 and 1015 which totaled to Php 640,159,071 and Php 309,932,184, respectively.

The payments for real property taxes were only P3.12 million and P0.994 million in 2014 and 2015, respectively. It should be noted that per PEZA law, in lieu of the real property tax, the company was charged 5% of the gross income (3% to the national and 2% to the local government) which was directly remitted to the national and municipal treasurer's office. In 2014, the LGU of Bataraza obtained a share of Php 110,575,718 while Php 22,432,142 was achieved in 2015. (**Table 2.4.7**)

Table 2.4.5. Summary listing of the national government and LGU revenues from a mining project in the Philippines

Payments due to the National Government	Payments due to the Local Government Units
• 35% corporate Income Tax • 2% Excise tax on actual value of minerals produced • Custom duties and fees under the Customs and Tariffs Code • 10% Value Added Tax on imported equipment, goods, and services • 5% of the actual value of the minerals (Produced as royalties, in case of mineral reservations) • Documentary stamp tax depending upon the nature of the transaction • Capital gains tax equivalent to 10-20% of the gain • 15% tax on interest payments to foreign loans • 15% tax on foreign stockholders dividends	• Local business tax (At a maximum of 2% of gross sales) • Real property tax equivalent to 2% of actual market value of properties based on assessment (plus 1% special education levy) • Registration fees • Occupation fees (Php50/ha. per annum) • Community tax (At a maximum of P10,500 per year) • Other local taxes, the rate and type depending on the LGU concerned

Source: Mines and Geosciences Bureau Senate Economic Planning Office 2005

Table 2.4.6. Taxes and fees paid by CBNC, 2015

TAXES AND FEES PAID	PhP million	
	2014	2015
1. National taxes and fees		
- Income tax	276.485	35.871
- Excise tax on minerals	-	-
- Customs, duties fees	7.667	-
- Value added tax	-	-
- Capital gains tax	-	-
- Documentary stamp tax	0.000733	-
- Other income taxes and fees		
2. Local taxes and fees		
- Local business tax	2.178	-
- Real property tax	3.120	.994
- Occupation fees	-	-
- Community tax	0.015	0.015
- Registration fees	0.001	0.001
- Permit fees	-	-

TAXES AND FEES PAID	PhP million	
	2014	2015
- Wharfage fees	20.087	-
- Sand and gravel tax	-	-
- Extraction fees	-	-
- Other local taxes and fees	20.265	-
3. Withheld Taxes		
-Withheld tax on payroll	121.480	76.861
- withheld tax on royalty to claim owner/surface owner	-	-
- Withheld tax on dividends	-	78.861
- Withheld tax on profit remittance to mother company	-	-
- Withheld tax on interest income	108.180	-
- Withheld tax on interest payments	93.277	0.0566
- Withheld tax on royalty for transfer of technology	20.265	12.149
- Other withheld taxes , fringe benefit tax and expanded withholding tax	186.397	117.143
Total taxes paid	**640.159**	**309.932**

Source: CBNC ComRel Office, Power point presentation 2016

Table 2.4.7. CBNC Gross Income Tax share to National and Local government units 2014 and 2015

	2014	2015
LGU BAtaraza share (2%)	110,575,718	22,432,142
National Government Share (3%)	165,863,577	33,648,214
Total	**276,439,295**	**56,080,356**

Source: CBNC ComRel Office Power point presentation 2016

Aside from taxes, CBNC provided direct investments under its Community Relations Assistance (CRA) Program that is over and above the SDMP and is part of CBNC's emerging corporate social responsibility (CSR) program. The Implementation of the SDMP and CRA is a joint program of CBNC and RTNMC however, 75% of the costs are shared by CBNC. From 2004 to 2013, the total CRA/CSR was PHP 627 million. Among the significant expenses of the CRA are:

- Bataraza Water Supply and Distribution System;
- RTNFI Hospital Improvement and Operation;
- Gawad Kalinga Housing Project;
- Hydro power project that provided free electricity 24/7 to households in Bohoy Gawad Kalinga;
- Power generators for the community;
- Walk-in requests during fiestas, weddings, social and athletic activities, assistance to religious groups to name a few;
- Transportation and communication needs of the community; and
- Typhoon calamity fund.

The water supply and distribution system is a project aimed for the barangays that are non-beneficiaries of the SDMP. Initially, these benefited 6 barangays where Php 52 million was allotted and spent. However, the project was expended and has covered adjoining barangays. The total investment cost for the water supply system was PhP140M.

Typical GK House

Water Supply Treatment Facility

Townsite Market

A significant portion of the SDMP resources are allotted for the IP community in the impact barangays. Gaia South, Inc in 2006 reported that “IPs in Bataraza have lost land due to the encroachment of lowland settlers and resource exploitation and are among the most impoverished in the municipality and suffer from lack of basic infrastructure and social services. While RTNMC has had preferential bias to IPs in the impact barangays, the SDMP has enabled CBNC and RTNMC to pour in significant resources to ICCs. This bodes well for the IP. The proposed Gawad Kalinga communities will pilot test whether GK’s model of community development is applicable to the *Palaw’an.* Improvements in the quality of life are discernable in the IPs ranging from free medical services and education to infrastructure projects”. The Gawad Kalinga Project is located in seven areas and benefited around 1,000 families.

Aside from the GK project, all IPs at the impact barangays are provided with their own budget to implement their separate SDMP from the other residents. Based on the data provided from 2004 to 2013, 40% of the SDMP budget is allotted for projects with IP communities.

The SDMP have enabled ICCs to preserve their culture since part of the funds has been used to build tribal halls, acquire indigenous instruments, and initiate cultural activities. These programs are thought to generate social cohesion and community pride. In addition, the Indigenous learning system where IPs who had been early on deprived of access to the regular educational system, are given the chance to be educated.

While the environmental management measures including the implementation of the EPEP and the SDMP are requirements of its ECC, these are also monetarily significant as these include direct investments in manpower/employment, materials purchase and others. The implementation of the SDMP is on its third cycle however on the first 10 years of operations, a total of PhP 656,161,609 was allocated for the implementation of the SDMP from 2004 to 2013. The programs implemented by the SDMP are presented in **Table 2.4.8**.

Table 2.4.8. SDMP for 2004 – 2013

Programs	2004-2008 (PhP)	2009-2013 (PhP)	Accomplishments
Education	21,907,537.39	40,994,733.12	school buildings/literacy buildings/ day care centers constructed and maintained;3106 IP scholars; Average of 1236 students enrolled per year at the LSV Memorial /school
Infrastructures & Facilities	20,387,718.77	32,395,346.72	barangay halls/ multi-purpose pavements/barangay clinics/ senior citizen's hall/sanitary programs (toilet facilties) were constructed; Roads, bridges and other public facilities were constructed and maintained
Livelihood Programs	9,732,761.70	32,276,922.48	fishing boats/hand tractors/ bags of fertilizers/bags of seeds were provided to the residents to serve as inputs to increase their farming and fishing productivity
Social Services/ various social projects	15,824,331.35	50,958,051.76	assistance to BHW; medical and dental missions; ambulance/barangay service vehicles; health clinics
Health and sanitation	-	7,427,465.76	Medical missions; Dengue free campaign
Hospitalization program for IPs and indigents	53,981,221.96	101,503,535.76	The RTNFI has an average of 50,000 patients per year. One half of this are company workers and their dependents while the other half are IPs and indigents.
LSVMS Social subsidy (for non-dependents)	38,551,231.17	4,447,9180.24	2686 non-IP non-dependent scholars
GK Housing for IPs	7,139,115.50	13,091,882.00	1000 GK units were constructed to improve the IPs dwelling places
Indigenous Learning system	6,531,713.50	15,493,260.00	Number of learners who enrolled to the ILS program ranged from 399 in 2006 to 1322 in 2015
Community relations Assistance program	34,439,278.00	54,731,962.00	Water system and power generation facilities provision; Provision of transportation and communication facilities; Respect of local values through cultural participation and support
IEC	13,670,680.00	54,731,962.00	
Sub-total	222,165,589.34	448,084,301.84	
Total		**P670,249,891.18**	

Source: CBNC Social and Development and Management Program (SDMP) and Corporate Social Responsibility (CSR), CBNC ComRel Office power point office report, 2016

The implementation of the EPEP especially the rehabilitation of TSF1 provided CBNC an avenue to develop the rehab site a potential tourism area as well as an on-site laboratory to show farming practices and other livelihood programs including basket weaving, fruit plantation, etc.

Cultivation of herbal plants is also done at the rehab site, which is aimed to provide alternative source of medicine for the indigenous communities. Although all IPs living at the impact areas are provided with free hospitalization and medicines, the use of herbal plants are part of the culture of the IPs and thus, would provide an avenue for learning and practice of their culture.

Table 2.4.9 provides summary of the costs associated with major aspects of its environmental and social development program.

Table 2.4.9. Associated costs of CBNC's major aspects of its environmental and social development program at present (CBNC, 2004 to 2013)

Program	Purpose	Schedule	Total expenses (2004-2013)	Annual Budget million PHP
1.Operation of the HPP's Wastewater Treatment and Air Pollution Control Facilities	Environmental protection	Year round	-	-
2. Monitoring of water, air, flora, fauna, and marine life	Determine efficiency of environmental control measures	As scheduled	-	-
3. Implementation of the Solid Waste Management Program	Maintain good sanitation and health in the community	Year round	-	-
4. Pursue the Social Development and Management Program	Uplift the living standard of the community	Year round	619	61.9
Implementation of CRA	Uplift the living standard of the community	Year round	257	25.7

Source: CBNC, 2016

Comparing the average annual internal revenue allotment (IRA) of the LGU of Bataraza amounting to Php 89.752 million/year from 2004 to 2013, the direct investment of the CRA and SDMP infused an additional average amount of Php 87.60 million which is almost the same average annual IRA of Bataraza.

Table 2.4.10. Impacts assessment and mitigation for soico-economics

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
Displacement of settlers There will be no displacement of settlers as the area is within the RTN mining site.					
In-migration Migration of people into the barangays has been observed in the past years because of the employment opportunities offered by CBNC and RTNMC. However, there will only be an additional 394 contractual workers to be hired as a result of the TSF3 construction. This is not seen as a large number to influence a high rate of migration.		✓			CBNC, LGU and other concerned agencies to continuously work together to contain illegal migrants/settlers
Cultural/lifestyle change (especially on indigenous people, if there is any) The company has already positively influenced changes in the lifestyle of the IPs and non-IPs residing in the direct and indirect impact areas. This was brought about by the SDMP I, II and currently III in addition to the CSR funds allotted to assist the development of the communities.					
Impacts on physical cultural resources There will be no building or structure with cultural or archeological value that will be affected as a result of the expansion project. Gangub cave is located in Brgy. Sandoval but is not					Prior to the construction and operations of HPP Line 1, an Archaological Asessment was conducted along the Gotok Limestone Area and no

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
projected to be affected by the proposed project. The Gangub cave will be developed as a tourist spot in collaboration with the Department of Tourism.					archaeological materials were observed. This was certified by the National Museum. An Archaelogical Impact Assesment study conducted by the Archaelogical, Cultural & Environmental Consultancy Inc. (ACECI) is provided **Annex 2.4.4**.
Threat to delivery of basic services/resource competition *Power* – The proposed expansion project will utilize the existing power source. *Water* - During construction minimal amount of water is required. The volume of water from the Ibelnan river is more than enough to supply the operational water requirements of CBNC. There will be no additional water requirements as a result of the proposed plant.		✓	✓		
Generation of local benefits from the project Enhancement of employment and livelihood opportunities – Generation of more jobs is not expected to increase significantly since only 394 contractual workers are needed during the construction phase.		✓			
Increased business opportunities and associated economic activities – There might be a negligible increase in business opportunities during the construction stage as transient workers will be around for board and lodging needs.		✓	✓		
Increased revenue of LGUs In the past three (3) years, CBNC aside from paying taxes to the national government has paid their share to the local government. In 2013, a payment to the LGU of Php 106,104,927 was remitted. In 2014, Php 27,662,901 was paid while Php 1,005,548 in 2015 was paid in local taxes. Aside from these local taxes, CBNC from their Gross Income Tax gives a share to the LGU in lieu of the real property tax which was affected per PEZA law. Five percent (3% to the national and 2% to the local government) was directly remitted to the national and municipal treasuries. These revenues are expected to be paid to the national and local government units contingent to the gross income obtained by the company.	✓	✓	✓		
Possibility of unsustainable income generating projects				✓	Proper identification of livelihood projects with appropriate support system from CBNC, LGU and other concerned local/national agencies and non-government organizations.

2.4.2 Public Health

2.4.2.1 Methodology

The methodology used under the socio-economic study was adopted in the public health study.

2.4.2.2 Baseline Conditions

Municipal Health Profile

Table 2.4.11 shows the combined vital health statistics of the 11 impact barangays in the Municipality of Bataraza, Palawan. There is a fluctuating trend in the mortality rate across all ages from 2011 to 2015. Infant mortality rate as well as maternal death rate also showed fluctuating trends. The infant mortality rate in 2014 was exceptionally low in 2014 at 0.2 per 1,000 population. Only one (1) case in Brgy. Ocayan was recorded during that period. No maternal deaths were recorded in the years 2011 and 2013 (**Figure 2.4.1**).

Table 2.4.11. Health statistics of the 11 impact barangays in Bataraza Palawan by year, rate per 1,000 populations

Statistics	2011	2012	2013	2014	2015
Morbidity Rate	67.94	81.09	89.70	46.92	43.99
Mortality Rate	2.36	1.74	2.29	1.26	2.34
Maternal Death Rate	0.00	0.05	0.00	0.02	0.06
Infant Mortality Rate	0.14	0.15	0.12	0.02	0.06

Source: Barangay Health Statistic Bataraza, Palawan 2011-2015

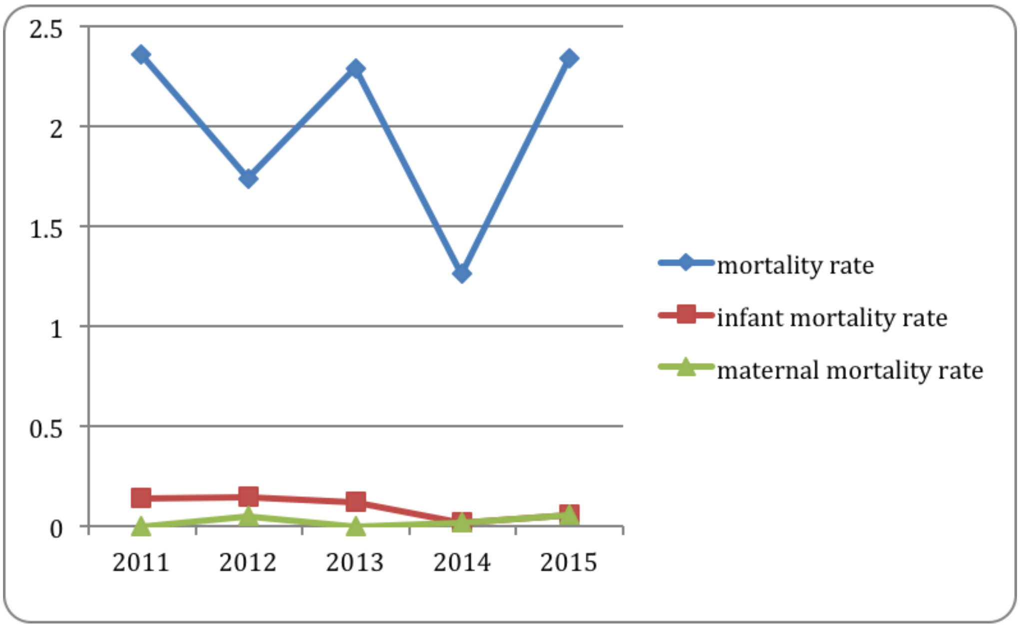


Figure 2.4.1. Mortality rates in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

Morbidity rates increased from 2011 to 2013 then decreased significantly in 2014 (**Figure 2.4.2**).

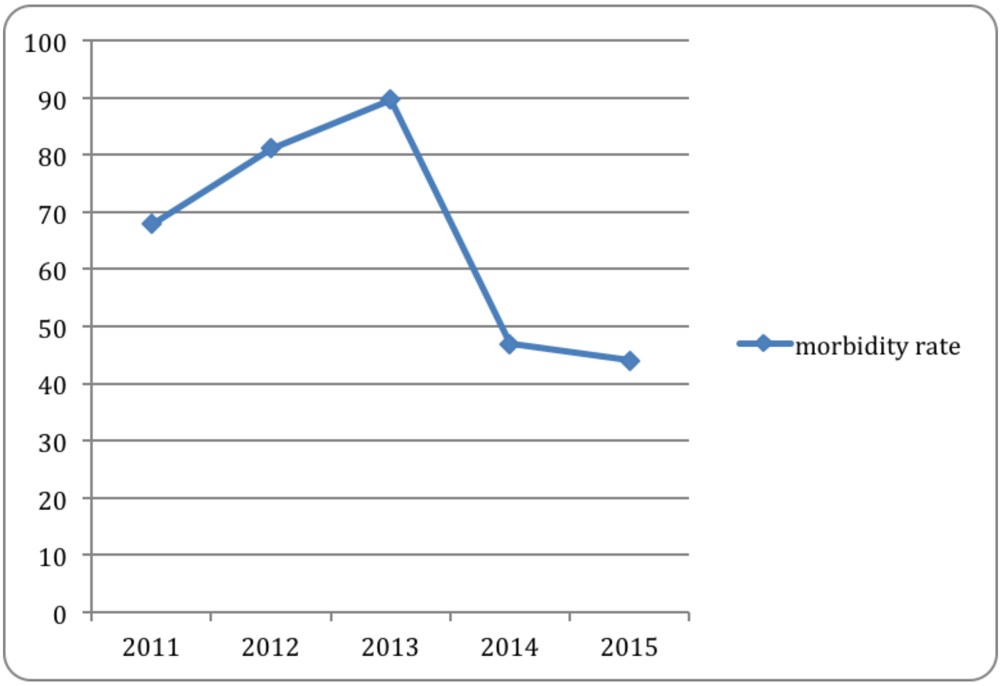


Figure 2.4.2. Morbidity rates in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

Recorded crude birth rate in the Municipality of Bataraza in 2015 was at 24.30, which indicated an increasing trend from 2012, which was at 20.84. The same is true for the crude death (CDR) rate, which increased slightly to 1.73 from the 2011 CDR of 1.12.

The leading cause of diseases in the impact barangays in Bataraza, Palawan is upper respiratory tract infection (URTI) which consistently ranked first from 2011 to 2015. Listed among the leading causes of infectious diseases from the same period are diarrhea, skin diseases, malaria, typhoid fever and pulmonary tuberculosis**.** Among the leading causes of non-infectious diseases are hypertension, urinary tract infection (UTI), bronchial asthma, anemia, animal bite, and age-related illnesses (**Table 2.4.12**)**.**

Table 2.4.12. Leading causes of diseases by year in the 11 impact barangays in Bataraza Palawan

Causes	2011		2012		2013		2014		2015	
	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000
Upper Respiratory Tract Infection (URTI)	1,700	40.96	1,945	48.92	2,322	53.76	1,760	35.29	1,491	31.76
Hypertension (HPN)	206	4.96	239	6.01	233	5.39	111	2.23	109	2.32
Urinary Tract Infection (UTI)	254	6.12	213	5.36	259	6.00	160	3.21	101	2.15
Diarrhea	86	2.07	215	5.41	121	2.80	59	1.18	76	1.62
Asthma	37	0.89	41	1.03	32	0.74	19	0.38	18	0.38
Anemia	78	1.88	51	1.28	26	0.60	18	0.36	7	0.15
Malaria	70	1.69	30	0.75	46	1.06	34	0.68	154	3.28
Age-related illnesses	144	3.47	144	3.62	145	3.36	7	0.14	5	0.11
Animal Bite	6	0.14	15	0.38	18	0.42	39	0.78	32	0.68
Skin Diseases	31	0.75	21	0.53	28	0.65	14	0.28	1	0.02
Typhoid fever	8	0.19	19	0.48	12	0.28	10	0.20	12	0.26
Pulmonary Tuberculosis (PTB)	4	0.10	5	0.13	12	0.28	7	0.14	65	1.38

Source: Barangay Health Statistic Bataraza, Palawan 2011 -2015

All of the leading causes of infection showed fluctuating trends from 2011 to 2015 with URTI being the leading cause of diseases in the 11 impact barangays in Bataraza Palawan during the mentioned period (**Figure 2.4.3**).

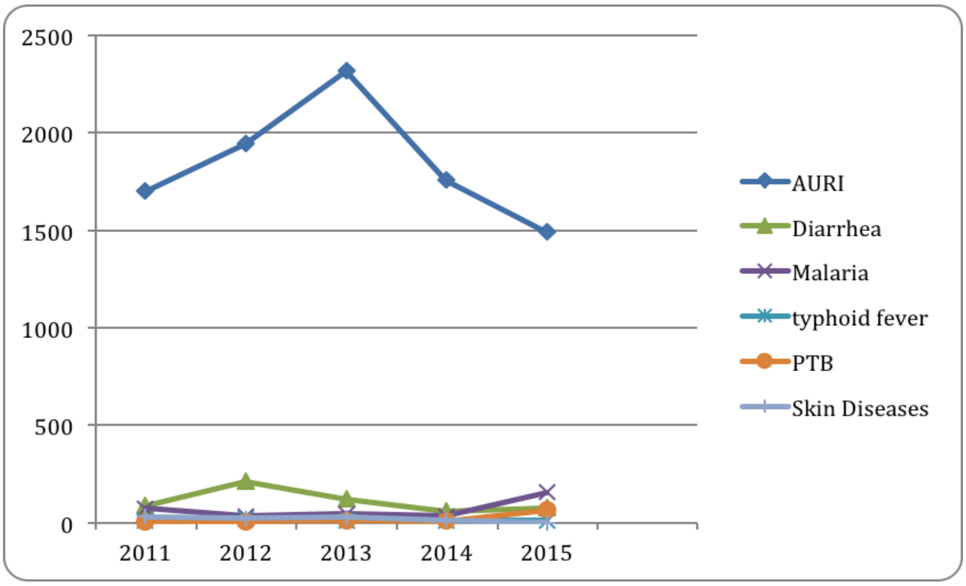


Figure 2.4.3. Leading causes of infectious diseases in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

Hypertension (HPN) and urinary tract infection (HPN) were the leading causes of non-infectious disease from 2011 to 2015. The cases for all causes of the non-infectious diseases except animal bites significantly dropped in the year 2014 (**Figure 2.4.4**).

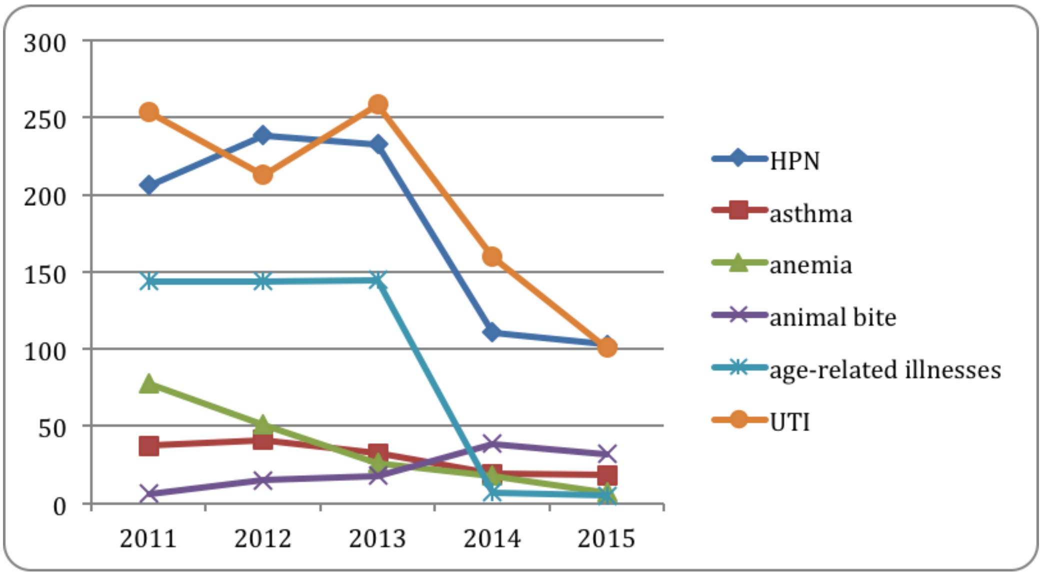


Figure 2.4.4. Leading causes of non- infectious diseases in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

The leading cause of death in the 11 impact barangays in Bataraza, Palawan from years 2011 to 2015 is hypertension (HPN). Most of the leading causes of death for the covered period are not related to communicable diseases with the exception of pulmonary tuberculosis (PTB) (**Table 2.4.13**) and are classified as degenerative (senility), lifestyle (cancer, heart disease, and diabetes), Obygyne-related (still birth), and others**.** In April

2011, the local government officials placed the town under a state of calamity due to a cholera outbreak that killed 21 people in Barangay Culandanum. There were no reported cases of mortality or morbidity relating to the disease in the years after that.

Table 2.4.13. Leading causes of death by year in the 11 impact barangays in Bataraza Palawan

Causes	2011		2012		2013		2014		2015	
	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000	No.	Rate/ 1000
Hypertension	7	0.17	7	0.18	8	0.19	8	0.16	18	0.38
Senility	5	0.12	8	0.20	8	0.19	7	0.14	9	0.19
Cancer	5	0.12	5	0.13	6	0.14	4	0.08	12	0.26
Asthma	5	0.12	3	0.08	2	0.05	4	0.08	3	0.06
Heart Disease	5	0.12	2	0.05	2	0.05	3	0.06	5	0.11
Still Birth	3	0.07	1	0.03	6	0.14	1	0.02	8	0.17
Diabetes	0	------	2	0.05	3	0.07	0	-------	6	0.13
Vehicular Accident	3	0.07	3	0.08	5	0.12	0	-------	3	0.06
PulmonaryTuberculosis	3	0.07	1	0.03	3	0.07	1	0.02	3	0.06
Suicide	4	0.09	1	0.03	2	0.05	3	0.06	0	-------
Cholera	21	0.51	0	------	0	------	0	-------	0	-------

Source: *Barangay Health Statistic Bataraza, Palawan 2011 -2015*

Figure 2.4.5 shows a fluctuating trend for PTB trend as a leading cause of death while **Figure 2.4.6** shows an increasing trend for hypertension as a leading cause of death. The remaining causes of death related to lifestyle diseases exhibited fluctuating trends.

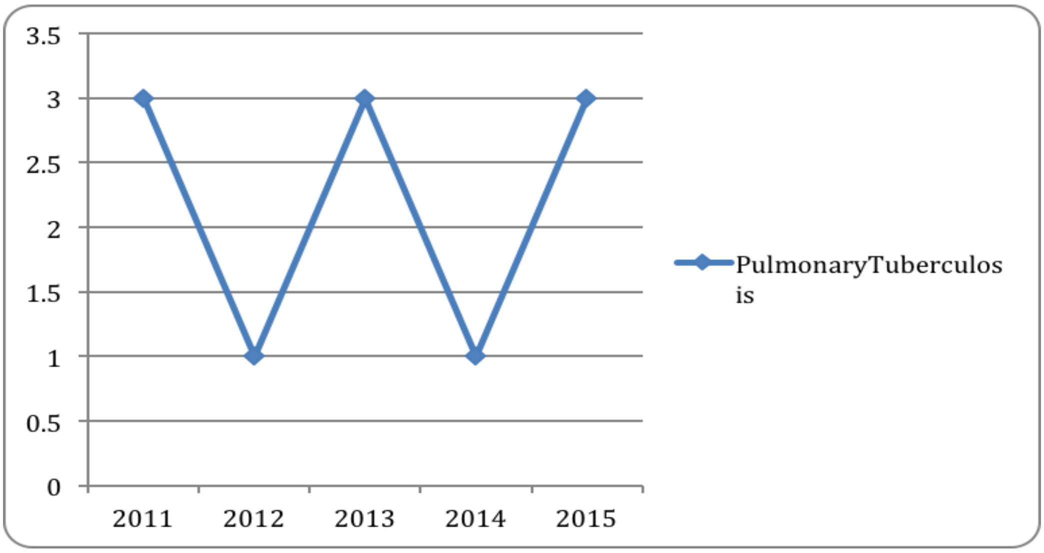


Figure 2.4.5. Leading causes of death by infectious disease in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

Municipal Health System and Facilities

Primary health care delivered by the Municipal Rural Health Unit (RHU), located at the Poblacion, are services limited to preventive and promotive services such as immunization, health and nutrition education, and family planning and routine check-ups.

In 2011, a doctor, a dentist, a medtech, and a sanitary inspector take care of the 63,644 population of Bataraza, Palawan. There is one (1) nurse for every 21,215 resident in the municipality, one (1) midwife for every 4,546 resident, and one (1) active barangay health worker for every 350 resident in the municipality (**Table 2.4.14**).

The impact barangays in Bataraza each has its own health center. A birthing clinic managed by a midwife beside the health center was recently put up in Barangay Taratak. The impact barangays regularly receive assistance from CBNC in the form of medical subsidy.

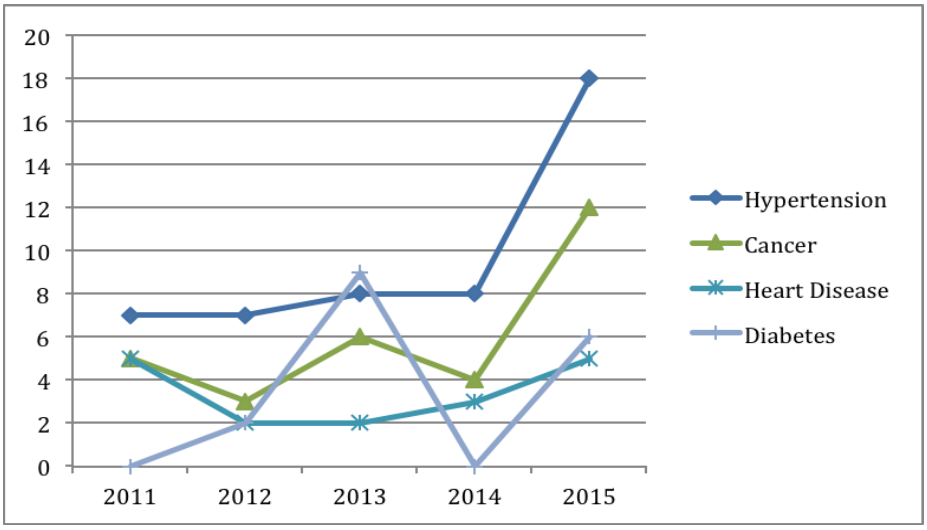


Figure 2.4.6. Leading causes of death by lifestyle diseases in the 11 impact barangays in Bataraza, Palawan from 2011 to 2015

Barangay Rio Tuba listed 19 health related facilities, which included three (3) private medical clinics, one (1) hospital, two (2) maternal and child clinics, a Barangay Health Center, a Family Planning Center, six (6) Day Care Centers, and five (5) drug stores. There is the South Palawan Provincial Hospital located in Brooke's Point, about 32 km from the Poblacion area of Bataraza. Available services include diagnostic, therapeutic and rehabilitative.

Table 2.4.14. Health workers in Bataraza, Palawan, 2011

Health Worker	Number	Ratio of No. to Population
Doctor	1	1:63,644
Nurse	3	1: 21,215
Dentist	1	1:63,6455
Midwives	14	1:4,546
Medtech	1	1:63,644
Sanitary inspectors	1	1:63,644
Active Barangay Health Workers	182	1:350

Source: PPDO-Research, Statistics & Evaluation Division, as of December 2013

RTNFI hospital

Complementing the role of the Municipal RHU in health service delivery is the RTNFI Hospital, which is located within the RTN Townsite about 35 km from the town proper. It has 30 beds and five (5) bassinets. It is a primary hospital with capability for emergency operations. It also provides outpatient services including clinical laboratory, radiological, pharmacy, dietary, dental, and pastoral services. There are nine (9) doctors, 21 nurses and 32 staff that provide medical services to employees of RTNMC and CBNC as well as residents of the nearby barangays. Since 1984, indigent patients particularly members of the indigenous community are treated free. For the period 1990 to 1996, 53% of patients admitted in the hospital and 18% of outpatients are non-employees and dependents. The Community Relations Assistance (CRA) program includes free-hospitalization and medical services for indigent folks at the RTNFI hospital. To date, the hospital serves about 50,000 patients every year. Half of them are the workers and their dependents while the rest are indigenous people (IPs) and poor non IPs. Quarterly medical outreach activities to all impact areas are being conducted and a total of PhP 322 M in 12 years (2004 -2015) has been spent on medical assistance programs.

Environmental Health and Sanitation

A little more than half of the households had access to sanitary toilet facilities. Based on the 2013 records of the Municipal Health Office, only 58% of households had sanitary toilet facilities. 850 households have sanitary solid waste disposal and complete basic sanitation facilities which is only about 7% of the total households. Most households practice open burning or composting to manage their solid wastes. About 7,816 households or 68% of residents have access to safe water (**Table 2.4.15**). Since 2005, CNBC spent a total of PhP 238.99M on water projects on all 22 barangays in the Municipality of Bataraza.

Table 2.4.15. Environmental sanitation program of Bataraza, Palawan, 2013

Activities	Number	Percentage (%)
No. of Households (HH)	11,479	
No. of HH with access to safe water	7,816	68
HH with Sanitary Toilet Facilities	6,615	58

Source: *Municipal Health Office of Bataraza, Palawan*

2.4.2.3 Impact Assessment

The operation of the HPP is hinged on safety. The design of the plant has undergone extensive engineering studies and testing procedures to minimize accidents from failure in process, procedures, or equipment. These will include the following:

- Extensive metallurgical test works were done and the modification of the process was done;
- Engineering studies including process control and hazard and operability (HAZOP) which is a “technique is a step-by-step review of the process design to consider possible malfunctions and failures. The review is designed to verify that sufficient safety and redundancy provisions are included in the design to ensure safe operation and if necessary a safe controlled shut-down from any condition, whether operating or emergency” (HPP ERA 2002);
- Geotechnical studies were conducted for the tailings dam and foundation of structures and including slope stability for the dam embankments; and
- Hydrological studies including collection of meteorological data to project the one in thousand years’ storm in the design considerations. The meteorological station is a vital facility of the HPP operation until this time.

As mentioned in the previous section, the plant has the following safety features:

- All facilities are closed systems to prevent gas leakage;
- Hydrogen sulfide production is discontinued in a moment at the plant by stopping the supply of hydrogen;
- A Distribution Control System (DCS) is installed to eliminate human error except for the sulfur melting process;
- A gas detector is installed within the production area to detect gas leakage;
- Around the dangerous area of the HSF, a hydrant is installed for firefighting;
- Around the HSF, open spaces are provided to give more space for firefighting;

- The open structure of the HSF is adopted to disperse any leakage easily;
- In hazardous areas, electrical equipment and wiring method are installed based on API (American Petroleum Institute) standard;
- The facility has other safety devices against other chemical contingencies;
- HSF is equipped with a gas scrubber; and
- A public address system and emergency alarm system is installed

An ERPP is submiited and approved by the MGB whch outlines the procedures for different emergency situations occurring inside and within the vicinities of the project area. The ERRP is updated as needed.

The HPP is also equipped with an emergency power generating system that allows the plant to operate all pollution control facilities such as the EP and scrubbers in case the power plant breaks down and as well as to shutdown all critical facilities.

An Annual Health and Safety Program (ASHP) is submitted and approved also by the MGB. The ASHP outlines all safety and health requirements of the HPP operations including:

- Annual health examinations;
- Mandatory drug and alcohol testing;
- Strict use of PPE;
- Safety trainings for personnel and safety orientation for visitors;
- Regular walkthroughs and site inspections; and
- Incentives for employees when safety targets are met.

Site Inspections and use of PPEs

Plate 2.3.6. Site Inspections and use of PPEs

The safe operations of CBNC is attested by the various awards and recognitions received by CBNC from the MGB - PMSEA ANMSEC. Among them are:

- Excellent Safety Record during the HPP construction in November 2004;
- Safest Mineral Processing Plant-Extraction Category in November 2007, 2008, 2009;
- Most Improved Safety Performance, November 2009;
- Runner Up for the Safest Mineral Processing Plant-Extraction Category in November 2010, 2011;
- Certificate of Recognition - for 2 Million Man Hours without Lost-Time-Accident in November 2014; and
- Safest Mines Award - Extraction Category in November 2015.

In terms of social development of the impact areas, the operations of CBNC contributed significant investment in the health facilities of the Municipality of Bataraza and the impact barangays. Among the significant contributions of CBNC to the improvement of public health is the improvement of the RTNFI Hospital, which services the residents with the IP Communities in the impact barangays receiving free services. As mentioned in the previous section, the joint SDMP implemented by CBNC and RTNMC provides assistance on the following:

- Conduct of regular medical missions;
- Building of health facilities;
- IEC program for dengue, internal parasites and others;
- Providing support to the BHW including sponsorship of trainings and payment for allowances/honorarium;
- Contribute to sanitation facilities including toilet facilities and water supply system; and
- Ambulances.

Table 2.4.16. Impacts assessment and mitigation for public health

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Discussion
Dust generation Dust control measures are currently implemented by CBNC. The Macadam Road where the major impact of dust generation is felt id paved to limit dust generation from the transport of ores and other materials from the plant site to the pier site. However, the Macadam Road is the major access to the Pier Site and the frequent passage of vehicles generate high concentrations of	✓	✓			• Dust control measures are in place and the frequency of water spraying is intensified during dry days. • Speed limits are imposed along Macadam Road. • Daily clean up of spilled materials are done along Macadam Road.

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Discussion
dust.					
Vehicle combustion emissions (NO_2, PM, CO, CO_2)	✓	✓	✓	✓	• Regular inspection of site vehicles and engines and repair if required • Limit vehicle idling • properly training operators, and employing safe work practices
Suspension of tailings solids/ heavy metals in the air and dust re-suspension from beached tails			✓	✓	• Ensure that tailings material remains moist • Revegetation of area
Entrained liquors, acid-generating compounds and/or mobile metal contaminants in tailings can seep into groundwater or emerge in surface streams			✓	✓	• Design, construct, maintain, and monitor all tailings and waste rock facilities and supporting infrastructure to: a. Ensure structural stability and controlled discharge; b. Protect the surrounding environment and local communities from potential impacts of acidification, metal leaching, loss of containment or contamination, including contamination of groundwater. • Design of dams and storage facilities needs to take into account foreseeable extreme flood events, based on statistics such as the probable maximum flood. • Daily or weekly visual inspections for instability evidence including erosion, corrosion, cracks or loss of containment. – Groundwater monitoring hydraulically located upstream and downstream of the tailings and waste rock facilities that detect potential for seepage and contamination.
accidental discharge as a result of failure of mechanical systems -such as broken pipelines or faulty control devices -or materials			✓		• Appropriate maintenance and replacement schedules for mechanical equipment should be in place. • Tailings pipelines should have control systems designed to shut the supply pump down if a no-flow condition is detected at the discharge end.
Work-related accidents	✓	✓	✓	✓	• Implement project-specific health and safety-related measures as stated in the company's Emergency Response and Preparedness Program (ERPP).
Noise generation	✓	✓			• Reduce noise frequency and impulse noise at the source of generation by: ✓ Replacing back-up beepers on machinery with strobe lights. This eliminates the most annoying impulse beeping; ✓ Using appropriate mufflers to reduce the frequency of sound on machinery that pulses, such as diesel engines and compressed air machinery; and ✓ Modifying machinery to reduce noise by using plastic liners, flexible noise control covers, and dampening plates and pads on large sheet metal surfaces.
Hazards of communicable and infectious diseases	✓	✓			• Medical certificates should be requested to ensure workers are fit to work. • Appropriate sanitary facilities should be provided at all construction sites.

3 Environmental Management Plan

Coral Bay Nickel Corporation

This chapter presents a summary of the mitigating measures for the potential impacts/risks of the proposed Tailings Storage Facility (TSF) No. 3 that were identified in *Chapters 2* and *4*. The mitigating measures being implemented by the current operations of the whole Hydrometallurgical Processing Plant (HPP) Complex and its support facilties are discussed as well.

3.1 PRE-CONSTRUCTION AND CONSTRUCTION PHASE

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Completion of necessary Memorandum of Agreements (MOAs), endorsements and clearances	PEOPLE	• Social acceptance and support for the project • Potential misunderstandings due to insufficient knowledge about the proposed expansion	• Conduct meeting/IEC with the concerned government agencies to secure the necessary MOAs/endorsements/clearances • Conduct regular IEC on all impact barangays to increase awareness on the proposed project and develop continuous acceptability by the stakeholders. • IEC through meetings, distribution of brochures/leaflets, consultations with leaders/key influential persons in the community regarding the potential impacts of the project.	• CBNC Environmental Management and Quality Control Section (EMQCS) • CBNC ComRel	Part of the construction cost	• Construction shall not commence until full compliance and completion of the required documents/ endorsements • IEC Program • SDMP Accomplishment Report
Site clearing and establishment of access road, and temporary site office	LAND	• Vegetation removal due to diversion of existing access road • Threat to existence and/ or loss of important local species	• Conduct 100% tree inventory within the area to be developed and proposed road ways prior to site development. • Prepare checklist and locate endangered and threatened plants. Conduct tree marking of these species during clearing operations. • Balling and transplanting of endangered and threatened plant species of appropriate size	• CBNC EMQCS	Part of the construction cost	• Include in the Annual Environmental Protection and Enhancement Program (AEPEP) • Compliance Monitoring Report

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Site clearing and establishment of access road, and temporary site office *(Continuation)*	LAND		• Continue to support and maintain the nursery where endemic, endangered and threatened plant species are cultivated and propagated • Establish buffer areas and green corridors where endangered and threatened species can be replanted and conserved • Avoid development and cutting of trees within the required legal easements such as the rivers and creeks, riparian zones, and other prohibited areas • Limit clearing to areas only for construction • Vegetation clearing kept to a minimum and what is essential based on existing provisions	• CBNC EMQCS	Part of the construction cost	• Include in the Environmental Protection and Enhancement Program (EPEP) and Annual EPEP • Compliance Monitoring Report (CMR)
		• Loss of topsoil • Change in soil quality/fertility (Contamination due to oil and grease leakage from equipment and vehicles)	• Vegetation clearing kept to a minimum and what is essential based on existing provisions • Overburden with topsoil from the exposed areas will be saved and placed in appropriate stockpile areasRegular maintenance of all vehicles and equipment to be used in construction at a designated motorpool area	• CBNC EMQCS • CBNC Maintenance Support Unit	Part of the constructio n cost	• Include in the EPEP and AEPEP • Compliance Monitoring Report
	WATER	• Degradation of ground and surface water quality from surface run-off that will be generated along exposed areas	• Construction of berms and run-off canals along the edge of access road to divert surface run-off to a silt pond • Establishment of silt fences on erosion prone areas • Regular washing of all hauling trucks along designated areas far from existing creeks/preferably along drainage areas leading to siltation ponds	• CBNC EMQCS • CBNC Engineering Support Unit	Part of the construction cost	• Include in the EPEP and AEPEP • CMR • Include in TOR of the contractor

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Site clearing and establishment of access road, and temporary site office *(Continuation)*	AIR	• Degradation of air quality from dust generation and gaseous emission from the operation of heavy equipment	• Limit clearing to areas only for construction and conduct enrichment planting at the buffer zones • Construction vehicles and equipment shall be regularly maintained and only at a designated motorpool area • Hauling trucks and vehicles leaving the construction site should be washed before passing through residential areas. Wash water should be drained and allowed to settle prior to discharge • Speed should be limited for construction vehicles (20 kph along the plant site; 30 kph along Magam, Cimaron, and Macadam Road; 50 kph less populated area of Macadam Road) • Access roads should be regularly sprayed with water to minimize dust generation	• CBNC EMQCS • CBNC Maintenance Support Unit	Part of the construction cost	• Include in the EPEP and AEPEP • Include in TOR of the contractor • CMR
		• Increase in noise level	• Regular maintenance of heavy equipment and haul trucks at a designated motorpool area • Installation of mufflers • Provision of ear plugs to laborers exposed to high noise levels • Strict implementation of vehicle speed limit (20 kph along the plant site; 30 kph along Magam, Cimaron, and Macadam Road; 50 kph less populated area of Macadam Road) • Conduct of regular IEC and proper notification/installation of signages	• CBNC EMQCS • CBNC Safety Section • CBNC Maintenance Support Unit	Part of the construction cost	• Include in the TOR of the Contractor • Include in the EPEP and AEPEP • CMR
	PEOPLE	• Generation of Employment Opportunities	• Prioritization of qualified residents from impact areas in terms of employment • Conduct of training programs to equip residents with skills to enhance their chances for employment in the mining company	• CBNC ComRel • CBNC Personnel Section	Part of the construction cost	• Include in the TOR of the Contractor • CBNC HR Guidelines

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Site clearing and establishment of access road, and temporary site office *(Continuation)*	PEOPLE	• Threat to public safety (peace and order)	• CBNC and its contractors implement strict policies regarding personnel safety and conduct in their camps and construction sites including non-alcohol consumption and drug use. • CBNC and contractors to coordinate with the barangay and municipal police forces regarding entry of new construction personnel. • Priority should be given to local residents for new construction jobs to minimize in-migration	• CBNC Personnel Section • CBNC ComRel • CBNC Safety	Part of the construction cost	• MOA with the LGU
		• Additional income and benefits to the local government units	• CBNC shall secure all the necessary local permits, licenses and fees prior construction	• CBNC General Affairs Department	Part of the construction cost	• Include in TOR of the Contractor
		• Increase commercial activities in barangays	• CBNC shall patronize local goods and services being provided by local entrepreneurs whenever possible.	• CBNC ComRel • CBNC Procurement Section		• IEC Plan • Corporate Social Responsibility (CSR)
		• Possible adverse effects on health and sanitation	• The workforce shall be provided with clean and potable water, sanitary toilet facilities, and hygienic canteen facilities • Domestic wastes segregation shall be practiced, where recyclable materials shall be collected for re-use or sold to recyclers • Generated spoils during construction will be hauled to the existing waste dump on a regular schedule	• CBNC EMQCS • CBNC Engineering Support Unit	Part of the construction cost	• Include in the TOR of the Contractor • Solid Waste Management Program
		• Occupational hazard/ Occurrence of accidents	• Provision of Personal Protective Equipment (PPEs) • Strict implementation of Safety and Health Program Regular conduct of safety seminars for employees	• CBNC Safety Section	Part of the construction cost	• Include in TOR of the Contractor • Include in the ASHP • Include in the Monthly General Accident Report (MGAR)
Quarrying for embankment materials at	LAND	• Slope failure of dam embankment	• Geotechnical investigation shall be conducted prior to the construction of TSF3	• CBNC Engineering Support Unit	Part of the construction group	• Include as ECC Conditionality • Include in the EPEP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Guintalunan north of CBNC for TSF 3 embankment construction						and AEPEP
	WATER	• Change in drainage morphology/ inducement of flooding/reduction in stream volumetric flow	• Establishment of silt/rock traps and check dams to reduce material transport by surface run-off and allow settlement before water enters the silt ponds • Creation of berms and drainages directly connected to silt ponds	• CBNC EMQCS • CBNC Engineering Support Unit	Part of the construction cost	• Include in the EPEP and AEPEP • CMR • Include in TOR of the Contractor
		• Degradation of surface and groundwater quality • Threat to existence and/or loss of important aquatic local species and habitat • Threat to abundance, frequency and distribution of aquatic species	• Embankments and floodways of silt ponds shall be elevated if necessary to increase settlement • Monitoring of structural integrity of silt pond embankments to check for gullying and avoid collapse resulting to untoward release of water laden with silt • Establishment of additional silt ponds whenever necessary • Creation of silt fences or wattling along steep areas to deter surface run-off laden with silt • Regular maintenance of vehicles and equipment to prevent fuel leaks • Designation of a motorpool area far from existing drainage ways • Collection and proper storage in leak proof containers and disposal of used oil • Proper maintenance of sewage tanks to treat wastewater from offices and camps • Regular inspection of the motorpool, fuel depot and HazWaste area	• CBNC EMQCS • CBNC Engineering Support Unit	Part of the construction cost	• Include in the EPEP and AEPEP • CMR • Include in TOR of the Contractor
	AIR	• Degradation of air quality from dust generation and gaseous emission from the operation of heavy equipment	• Strict implementation of vehicle speed limit (20 kph along the plant site; 30 kph along Magam, Cimaron, and Macadam Road; 50 kph less populated area of Macadam Road) • CBNC shall operate water trucks capable of pneumatic spray/with peacock-type nozzle to remove dust accumulation on the roads	• CBNC EMQCS • CBNC Engineering Support Unit • CBNC Safety Section	Part of the construction cost	• Include in the EPEP • CMR • Include in TOR of the Contractor

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			• Regular road grading • Regular water spraying of access roads • Regular washing of all hauling truck along designated areas with sumps and oil and water separators			
		• Increase in noise level	• Regular maintenance of heavy equipment and haul trucks at a designated motorpool area • Installation of mufflers • Provision of ear plugs to laborers exposed to high noise levels • Strict implementation of vehicle speed limit (20 kph along the plant site; 30 kph along Magam, Cimaron, and Macadam Road; 50 kph less populated area of Macadam Road) • Conduct of regular IEC and proper notification/installation of signages	• CBNC EMQCS • CBNC Safety Section • CBNC Maintenance Group	Part of the construction cost	• Include in the AEPEP • CMR • Include in TOR of the Contractor • ASHP
	PEOPLE	• Occupational hazard/ Occurrence of accidents	• Provision of PPEs • Strict implementation of formulated Safety and Health Program • Regular conduct of safety seminars for employees	• CBNC Safety Section	Part of the construction cost	• Include in TOR of the Contractor • Include in the MGAR

3.2 OPERATIONS PHASE

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Daily operations of the HPP Complex, which includes: • Ore	LAND	• Occurrence of natural hazards that affect the HPP operations	• Implementation of formulated Emergency Response and Preparedness Program (ERPP) • Revise ERPP to include the PAGASA 2020 and 2050 climate change projection	• CBNC Safety Section	Part of the operation cost	• ERPP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
preparation • High pressure acid leach • Neutralization, CCD/ Thickening and Final Neutralization • Zinc removal and sulfurization • H_2S Plant • Office and canteen • Laboratory and workshop • Chemical/ sulfur yard and warehouse • Spare parts storage and MS warehouse		• Generation of solid and hazardous wastes (i.e. caustic soda, halogenated organic solvents, lime slurries, waste oils)	• The solid waste management program shall be implemented continuously. This include: ○ Distribution of color-coded trash bins in strategic location within the HPP Complex for efficient collection of wastes ○ Recycling of solid and industrial wastes shall be practiced ○ Garbage shall be collected regularly by company-hired trucks and disposed to a designated landfill (GP-28) • Hazardous wastes shall be stored in a well-kept temporary storage prior to hauling by a DENR-accredited third party HazWaste hauler/treater • Proper labeling of hazardous waste in accordance with DAO 2004-36 • Hazardous wastes shall be disposed in accordance with DAO 2004-36 • Provision of spill kits within the hazardous waste storage area	• CBNC EMQCS	Part of the operation cost	• Compliance Monitoring Report • AEPEP
	WATER	• Land contamination due to accidental spillage of acid, methanol, and diesel during hauling	• During transport chemicals and materials, agents that will neutralize the spill shall be readily available i.e. soda ash and lime • In the event of accidental spillage, carry out formulated response plan for fuel, oil and chemical spills/leaks • Trucks shall maintain a speed of 30 kph during hauling of chemicals	• CBNC Operations (Hauling) • CBNC EMQCS • CBNC Safety Section	Part of operation cost	• ERPP • MGAR

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Daily operations of the HPP Complex, which includes: • Ore preparation • High pressure acid leach • Neutralization, CCD/ Thickening and Final Neutralization • Zinc removal and sulfurization • H_2S Plant • Office and canteen • Laboratory and workshop • Chemical/ sulfur yard and warehouse • Spare parts storage and MS warehouse *(Continuation)*	WATER	• Degradation of fresh and marine surface water due to release of oils, chemicals, process water or wastewater and domestic wastewater • Degradation of groundwater quality due to seepage of leachate from industrial wastes (i.e. used batteries, and laboratory waste)	• Operation and maintenance of waste water treatment facilities • Regular maintenance of installed stormwater and runoff management system • Regular maintenance of installed septic tanks and absorption fields • Regular maintenance of drainage channels around coal stockyards and sedimentation ponds. • Regular maintenance of installed oil – water separators placed at various locations • Proper containment of hazardous waste in a hazardous waste storage facility prior to disposal	• CBNC EMQCS • CBNC Maintenance Group	Part of the operation cost	• CMR • AEPEP
	AIR	• Degradation of air quality due to fugitive dust • Degradation of air due to emissions (NOx, SOx, CO and H_2S)	• Operation and regular maintenance of installed air pollution control equipment such as venturi-type scrubber and stack and packed-column scrubber/stack. • Regular maintenance of conveyor systems (i.e. side wind guards and covers, belt cleaning) • Regular water spraying of roads and work areas • Cover ore stockpiles to minimize dust generation. • Maintenance of accordion chutes (screening and crushing plant), wind breakers and dust collector boxes that are placed in strategic locations around the crushing plant • Regular maintenance of all vehicles and equipment to be used in construction at a designated motorpool area	• CBNC EMQCS • CBNC Maintenance Group • CBNC Safety Section •	Part of the operation cost	• CMR • AEPEP •
		• Increase in noise level	• Maintenance of the constructed sound barriers • Use of silencers and mufflers	• CBNC Maintenance Group	Part of the operation cost	• CMR

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Daily operations of the HPP Complex, which includes: • Ore preparation • High pressure acid leach • Neutralization, CCD/ Thickening and Final Neutralization • Zinc removal and sulfurization • H_2S Plant • Office and canteen • Laboratory and workshop • Chemical/ sulfur yard and warehouse • Spare parts storage and MS warehouse *(Continuation)*			• Provision of ear plugs to workers exposed to high noise levels	• CBNC Safety Section		
	PEOPLE	• Occupational hazards/ Occurrence of accidents	• Strict implementation of the formulated Safety and Health Program (Annex 4.1.1) • Provision of appropriate PPEs to all employees	• CBNC Safety Section	Part of the operation cost	• ASHP • MGAR
		• In-migration	• Monitoring or population and migration rate in coordination with barangay • To minimize/control in-migration, qualified workers from the impact barangays must be prioritized for hiring	• CBNC Personnel Section • CBNC ComRel	Part of the operation cost	• CMR • CBNC HR Guidelines
		• Cultural/lifestyle change (especially of IPs)	• CBNC shall continue to conduct various activities that enhances the culture of IPs residing in the impact barangays • CBNC shall continue to support the implementation of the Indigenous Learning System (ILS)	• CBNC ComRel • LGUs	Part of the operation cost (SDMP/ CSR funds)	• SDMP Accomplishment Report
		• Generation of Employment Opportunities	• Prioritization of residents from impact areas in terms of employment	• CBNC Personnel Section	Part of the operation cost	• CBNC Hiring Plan
		• Threat to public safety (peace and order)	• CBNC and its contractors implement strict policies regarding personnel safety and conduct in their camps including non-alcohol consumption and drug use. • CBNC in coordination with host LGU should coordinate to monitor migration rate • To minimize/control in-migration, qualified workers from the impact barangays must be prioritized for hiring	• CBNC ComRel • CBNC HR	Part of the operation cost	• MOA with the LGU
Daily operations		• Threat to public safety (hauling of materials)	• CBNC shall regularly conduct an IEC on the appropriate emergency response during chemical spill • As a safety measure, all vehicles traversing along the Macadam Road shall stop while the acid lorry is in transit • CBNC shall continuously conduct specific emergency drills that involve the community	• CBNC Safety Section • CBNC ComRel	Part of the operation cost	• IEC Plan • ASHP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
of the HPP Complex, which includes: • Ore preparation • High pressure acid leach • Neutralization, CCD/ Thickening and Final Neutralization • Zinc removal and sulfurization • H_2S Plant • Office and canteen • Laboratory and workshop • Chemical/ sulfur yard and warehouse • Spare parts storage and MS warehouse *(Continuation)*		• Threat to delivery of basic services/ resource competition	• CBNC shall maintain its own power and water supply sources for its plant operations and for use of their personnel in their different housing units. • CBNC (together with RTNMC) shall continuously operate and maintain the water supply system provide to the residents of Bataraza. • CBNC (together with RTNMC) shall continuously operate various establishments such as the RTNFI Hospital and L.S. Virata Memorial School to provide medical and educational facilities for its personnel.	• CBNC Utilities Department • CBNC EMQCS • CBNC ComRel	Part of the operation cost	• CMR • SDMP Accomplishment Report
		• Generation of local benefits from the project - Enhancement of employment and livelihood opportunities - Increase business opportunities and associated economic activities • Increased revenue of LGUs	• Whenever possible, supplies and services shall be sourced from local suppliers to further boost economic activities and open other job opportunities. • CBNC shall continue to support the programs for Health and Sanitation, Infrastructure, Education, Enterprise/Livelihood in their social development programs • All permits shall be secured and appropriate taxes paid. • Financial literacy seminars for employees and dependents of employees financial literacy seminars for employees and dependents of employees	• CBNC Procurement Section • CBNC ComRel	Part of the operation cost	• SDMP Accomplishment Report
Daily operations of the power plant	LAND	• Generation of solid waste (coal ash)	• Coal ash from the power plant operations shall be disposed in the coal ash pit	• CBNC EMQCS	Part of the operation cost	• CMR • AEPEP
	WATER	• Degradation of groundwater quality due to leachate from coal ash pond.	• Drainage channels around coal stockyards and coal sedimentation ponds are be regularly maintained and spilled coal shall be collected	• CBNC EMQCS	Part of the operation cost	• CMR • AEPEP
	AIR	• Degradation of air quality from gaseous emissions	• Operation and regular maintenance of installed air pollution control equipment such as electrostatic precipitators, smoke	• CBNC EMQCS • CBNC Procurement	Part of the operation cost	• CMR • AEPEP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Daily operations of the power plant (Continuation)		(SOx, NOx, CO and TSP)	stack and Continuous Monitoring and Emissions System (CEMS) • Preventive maintenance of the power plant • The HPP operations shall continue to utilize coal with low sulfur content for the power plant	• CBNC Maintenance Group		
		• Contribution to greenhouse gas (GHG) emissions	• The company shall continue to support reforestation programs aside from the requirements of the EPEP thru the establishment or adoption, protection and maintenance of plantation and forests (i.e. mangrove plantation in Brgy. Sumbiling) • The 40-m wide bio-fence buffer zone around the project area shall be maintained. • Continue to support the rehabilitation and reforestation of open areas such as the TSF1.	• CBNC EMQCS	Part of the operation cost	• CMR • AEPEP
Daily operations of TSF 2 and 3	LAND and WATER	• Inundation of dam impoundment areas • Inundation of area downslope of tailings dam due to tailings overflow or dam break • Degradation of water quality of nearby rivers and creeks such as Pinamasaan Creek, Tuba River and Ocayan River	• The tailings disposal process of the HPP operations ensures that the embankment is strengthened as more tailings are disposed. The effluent discharge facilities (effluent sump, pump and pipe network) shall be continuously monitored and maintained to ensure maximum removal of liquids • Conduct daily inspection of tailings discharge, pipes and valves, inlet, crest, slopes, toe, piezometers, and wall freeboard • In the event of any tailings spillage, conduct immediate containment procedures and clean up as indicated in the ERRP • The emergency spillway shall be closely monitored and regular maintenance should be conducted.	• CBNC EMQCS • CBNC Maintenance Group	Part of the operation cost	• CMR • AEPEP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			• Regular maintenance of the WWTP and the constructed decant tower and Return Water Pond (RWP) shall be done. • Continue to conduct daily water quality sampling to ensure that supernatant solution discharges are within the DENR standards for effluent water			
Daily operations of pier site, causeway and trestle	WATER	• Degradation of groundwater quality due to metal leachate from coal	• Maintenance of coal stockpile within a fully sealed stockyard • Regular maintenance of drainage channels around the coal stockyards and sedimentation ponds. • CBNC shall continue to use coal, which does not contain significant amounts of leachable heavy metal	• CBNC Procurement Group • CBNC Pier site group • CBNC Maintenance Group.	Part of the operation cost	• CMR
		• Degradation of water quality of groundwater and Coral Bay due to accidental chemical spill (e.g. H_2SO_4, CH_3OH, diesel and coal).	• Storage tanks are equipped with bund walls to contain 100% of spills. Spill kits are also in place and emergency procedures are regularly updated. • Regular check-up and maintenance of storage facilities shall be continued as specified in the ASHP. • Safety protocols during re-filling of chemical storage tanks and transferring from storage tanks to lorry shall be maintained and review of protocols and updating should be conducted in case spillage occurs.	• CBNC Safety Section • CBNC Pier site group	Part of the operation cost	• ASHP • MGAR • ERPP • CMR
	AIR	• Degradation of air quality due to generation of odor from spontaneous combustion of stockpiled coal	• Stockyard management to minimize the risks of coal overheating and spontaneous combustion by strictly limiting the time that the coal remains uncompacted.	• CBNC Pier site group	Part of the operation cost	• CMR
		• Degradation of air quality due to dust and increase in noise level from hauling vehicles and	• Use of silencers and mufflers • Regular maintenance of vehicles and equipment used in hauling • Strict implementation of vehicle speed limit (20 kph along the plant site; 30 kph	• CBNC Maintenance Group • CBNC Safety Section	Part of the operation cost	• CMR

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		equipment.	along Magam, Cimaron, and Macadam Road; 50 kph less populated area of Macadam Road)			

3.3 ABANDONMENT PHASE

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
Dismantling of infrastructures and equipment (HPP Complex including power plant)	LAND	• Generation of solid and hazardous waste • Land contamination due to residual chemicals and other raw materials	• Remaining unused oils/fuels, chemicals, laboratory reagents and hazardous wastes shall be collected and hauled out by DENR-accredited third party HazWaste hauler/treater • Materials from decommissioned facilities that have value such as scrap metals shall be sold to recyclers • Remediate any contaminated land	• CBNC EMQCS	Part of rehabilitation cost	• CMR • FMR/DP
	LAND AND WATER	• Accidental oil and/or fuel leakage from the operation of moving/hauling vehicles	• Regular maintenance of hauling vehicles shall be conducted • Carry out emergency response to oil spill/leakage	• CBNC EMQCS	Part of rehabilitation cost	• CMR • FMR/DP
	PEOPLE	• Loss of income/ decreased employment opportunity	• Prior to closure, proper identification of livelihood projects with appropriate support system/mechanism from CBNC, LGU and other concerned local/national agencies and non-governmental organization shall be conducted to assist the community Remuneration package in accordance with DOLE guidelines shall be provided	• CBNC Personnel Section • CBNC ComRel	Part of the SDMP and Abandonment Cost	• SDMP • FMR/DP
Reforestation and remediation of filled-up TSF; Reforestation of open areas	LAND AND AIR	• Establishment of green cover and canopy • Rehabilitation and improvement of habitat • Reduction in the	• Use of soil amelioration technique to improve soil fertility prior to planting of vegetation such as rice hull, chicken dung and vermi-compost • Implementation of Assisted Natural Regeneration (ANR) forestry technique to effectively establish forest cover in the	• CBNC EMQCS	Part of rehabilitation cost	• CMR • FMR/DP

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impacts	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		generation of fugitive dusts	future • Initial use of grasses, herbs and reeds to immediately cover the exposed tailings • Once grass cover is established, fast-growing pioneer species shall be planted to hasten establishment of canopy • Introduction of climax species such as dipterocarps in the undergrowth once canopy was established. • Implementation of formulated FMR/DP			

4 Environmental Risk Assessment (ERA) & Emergency Response Policy and Guidelines

Coral Bay Nickel Corporation

This Environmental Risk Assessment (ERA) was prepared as a component of the Environmental Performance Report and Management Plan (EPRMP) for the Coral Bay Nickel Corporation's (CBNC) proposed Expansion Project in Rio Tuba, Bataraza, Palawan. This project of CBNC involves the establishment of an additional tailings storage facility (TSF No.3) and an increase in cobalt (Co) annual production limit as described in *Chapter 1*. The ERA was undertaken in compliance with the scoping agreement between the EMB and the proponent, which has specified the need to conduct a quantitative assessment of the risks involved. A previous ERA for the Hydrometallurgical Processing Plant (HPP) of CBNC was conducted in July 2001.

4.1 OBJECTIVES OF THE STUDY

This ERA aims to come up with an updated analysis of the hazards associated with the project, characterize the associated risks, and recommend measures to further manage the identified risks. An updated qualitative and quantitative risk assessments are valuable tools for determining the overall, as well as the added environmental risks, that may ensue with the proposed expansion project of CBNC, particularly the establishment of an additional tailings storage facility (TSF No. 3) and an increase in cobalt annual production limit. In particular, it will assess the risks associated with hazardous substances, activities and processes. This study also aims to calculate the associated individual fatality risks and societal risks that may arise due to project operations. Results of the study will be valuable in providing DENR and EMB with relevant information to decide on the acceptability of the proposed project expansion. It will likewise help the CBNC management in reviewing its existing risk management program and in ensuring that significant environmental risks are reduced to acceptable levels or to a level that is as low as reasonably practicable (ALARP). This ERA also aims to review the existing Emergency Response Plan.

4.2 SCOPE AND LIMITATIONS

The various physical and chemical environmental hazards associated with the project were analyzed. The ERA focused on safety risks, which are characterized by low probability, high consequence, accidental nature and acute effects, in compliance with the Procedural Guidelines for Scoping of Environmental Risk Assessment, Annex 2-7e of the Revised Procedural Manual of DAO 03-30) (EMB-EIAMD, 2007). Risks from hazardous substances stored and utilized at the HPP project site and the piers were qualitatively and quantitatively characterized. Hazardous substances were identified as the following: coal, diesel, methanol, sulfuric acid (H_2SO_4), hydrogen gas (H_2), hydrogen sulfide (H_2S) gas, and the heavy metal contents of the nickel ores (nickel, cobalt, iron, chromium, manganese, zinc, magnesium and aluminum). The acute and chronic hazards associated with physical risks, such as structural collapse of the TSF embankments were also assessed. Measurement of physical risks, however, were not undertaken, as these are the domain of geological and geotechnical assessments.

The quantitative risk assessment (QRA) aspect of the ERA focused on investigating the quantitative impacts of hazards associated with loss of containment of hazardous substances from two (2) locations, namely: the pier and the HPP project site. Loss of containment (LOC) event scenarios were postulated based on sizes of hazardous substance release from storage tanks and vessels.

4.3 METHODOLOGY AND CONCEPTUAL FRAMEWORK

This ERA was conducted using the following steps:

1. Identification of hazardous activities, processes and substances that are present at the project site and its ancillary facilities;
2. Risk screening activity that included all identified hazardous substances projected to be used, handled, or stored at the Plant site to determine the type of environmental risk assessment to be conducted and the focus of analysis;
3. Identification of possible event scenarios;
4. Consequence analysis based on postulated event scenarios;
5. Frequency analysis on postulated event scenarios;
6. Calculation of associated risks (Location Specific Individual Fatality Risk and Societal Risks);
7. Characterization of risks as to their acceptability; and
8. Formulation of recommendations to mitigate or control identified risks (including Emergency Response measures).

The conduct of the Quantitative Risk Assessment was generally based on the procedures described in VROM's (2005) Publication Series on Dangerous Substances (PGS 3): Guidelines for quantitative risk assessment (TNO's Purple Book).

4.3.1 The Environmental Risk Assessment Process

Environmental Risk Assessment (ERA), as defined in the Procedural Manual for DAO 2003-30, is "the use of universally accepted and scientific methods to assess the risks associated with a project. It focuses on determining the probability of occurrence of accidents and their magnitude (e.g., failure of containment or exposure to hazardous materials or situations.)". Risk is defined as 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. Risk involves two measurable parameters: consequence and probability. Risk refers to qualitative or quantitative measure of hazards associated with the project. It is the integrated result or product of the calculated consequence of a postulated event scenario and the calculated probability or frequency of occurrence of such event. Two measures of risks were calculated: (1) Location Specific Individual Fatality Risk (LSIFR) and (2) Societal Risks.

4.3.2 The ERA Framework

The general framework of this ERA is illustrated in **Figure 4.3.1.**

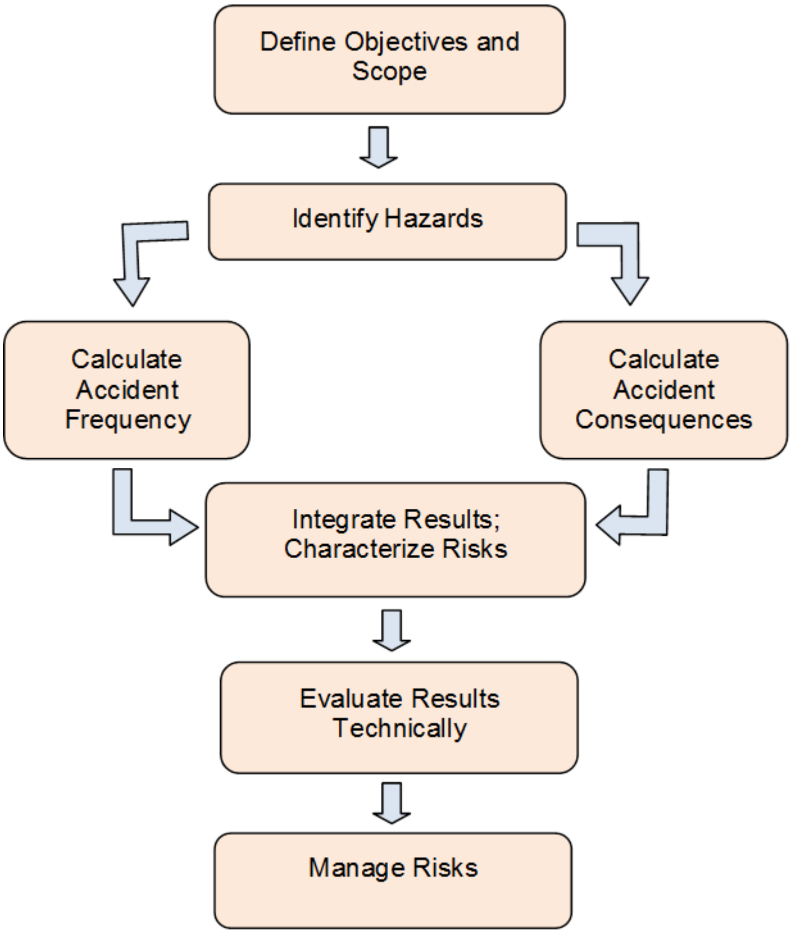


Figure 4.3.1. The risk assessment process

4.3.3 Methodology

4.3.3.1 Hazard Identification

The various hazardous processes, activities and substances associated with the project were identified at this stage. The substances' flammability, explosive potential and potential for toxicity were the focus of hazard identification. Risk screening that included all substances to be used, handled and stored at the project site was conducted. The potential of each substance to pose hazards to the environment, the public and the facility was analyzed based on a thorough review of its intrinsic physical, chemical and hazard characteristics. Risk screening was done according to the process and criteria described in the *Revised Procedural Manual of DAO 2003-30: Guidelines for the Conduct of Environmental Risk Assessment*, particularly *Annex 2-7e*. The risk screening process determines the level of risk assessment that must be conducted.

4.3.3.2 Consequence Analysis

Based on the postulated loss of containment event scenarios, quantitative calculation or estimation of unwanted consequences, effects, impacts or outcomes of potential major hazard incidents in the facility were undertaken. Major hazardous events involve activities or substances that have impacts in terms of death, injury or evacuation of people, damage to property or lasting harm to the environment. The consequence analysis focused on accident scenarios that involved the release of flammable, explosive and/or toxic substances, especially those with quantities that are beyond the threshold limit set by DENR.

Toxic Substances

The consequence analysis for toxic substances focused on loss of containment (LOC) events involving the following potentially toxic substances: hydrogen sulfide (H_2S) gas, H_2SO4 liquid, and methanol. Calculation of consequences was undertaken in several steps. First, distances to specified endpoints or levels of concern of accident impacts were calculated and hazard footprints were generated using a modelling tool, ALOHA®Ver 5.4.7. Secondly, the generated ALOHA® footprints were overlain on Google map using MARPLOT® ver 5.0.3, a mapping software application that was developed by NOAA and USEPA. The affected project facilities and potentially affected communities outside of the project perimeters were visualized using MARPLOT. The size of the total affected area was calculated using MARPLOT®. The size of the populated area was estimated by multiplying the total affected area with the estimated percentage of populated area. The number of potential external fatalities was estimated by multiplying the size of the affected area with the population density, which was calculated by counting the number of houses as shown in the Google Earth® map and multiplying this with six, the average Filipino household size. For potential internal fatalities, the number was derived by multiplying the total area affected by the manpower density, which was assumed to be uniformly distributed throughout the Plant site or Pier site. Manpower density was derived by dividing the total Plant/Pier site area with the maximum number of manpower per shift.

Flammable/Explosive Substances

The consequence analysis for flammable substances focused on loss of containment events arising from the release of flammable/explosive substances from storage vessels, pipe works and process containers. Substances included in the analysis were methanol, hydrogen gas, hydrogen sulfide and diesel. Hazard distances for methanol, hydrogen gas and hydrogen sulfide were estimated using ALOHA® Ver 5.4.7. Estimation of hazard distances for diesel is described below.

Assumptions

Atmospheric Conditions

Four atmospheric conditions (atmospheric stability-wind speed combinations) were factored in. These are D_7 (neutral-high wind speed), D_3 (neutral-medium wind speed), $B_{2.5}$ (unstable-medium wind speed) and F_2 (very stable – low wind speed). Wind direction investigated focused on wind blowing towards populated communities. The number of potential fatalities to people was the endpoint criteria used in the assessment. The weather stability class and wind speed combinations that were used in the study are shown in **Table 4.3.1** below. Data from PAGASA were used in modeling, unless specified otherwise. The wind direction sectors were chosen to correspond to the populated areas around the project facilities. The mean ambient temperature of 30°C was used for modeling purposes.

Table 4.3.1 Atmospheric stability and wind speed conditions used in ALOHA® modeling

Designation/ Code	Pasquill's Atmospheric Stability Class	Wind Speed (mps)	Description
D_7	D	7	Neutral condition-high wind speed
D_3	D	3	Neutral condition- medium wind speed
F_2	F	2	Very stable condition – low wind speed
$B_{2.5}$	B	2.5	Unstable condition – medium wind speed

Consequence Estimation for Diesel Fire

The assessment and calculations focused on the fuel's potential to cause pool fires within bunded premises. It was assumed that the fire will be confined within the bunded area surrounding the fuel tank. The low vapor pressure of the diesel (0.042 psia at 21°C) renders the occurrence of vapor cloud fire or explosion not credible.

The derivation of downwind distances to specific thermal radiation levels were conducted using the pool fire equations (D-22 and D-23) described in USEPA-CEPPO's (1999) *"Risk Management Program Guidance for Offsite Consequence Analysis (RMPGOCA)".* The *Pool Fire Equations* are as follows:

$$q = \frac{f * m * Hc * \tau a}{4 * \pi * x\hat{}2} \qquad \textbf{(D-22)}$$

Where: q = Radiation per unit area received by the receptor (Watts per square meter)
m = Rate of combustion (kilograms per second)
τ_a = Atmospheric transmissivity
H_c = Heat of combustion (Joules per kilogram)
f = Fraction of heat of combustion radiated
x = Distance from point source to receptor (meters)

$$m = \frac{0.0010 * Hc * A}{H\,v + C\,p * (T\,b - T\,a)} \qquad \textbf{(D-23)}$$

Where: m = Rate of combustion (kilograms per second)
H_c = Heat of combustion (Joules per kilogram)
H_v = Heat of vaporization (Joules per kilogram)
C_p = Liquid heat capacity (Joules per kilogram-degree K)
A = Pool area (square meters)
T_b = Boiling temperature (K))
T_a = Ambient temperature (K)
0.0010 = Constant

Table 4.3.2 Variables used in the calculation of hazard distances for diesel

Variable	Value
Heat of Combustion (H_c)	45,000,000 J/kg
Fraction of Hc radiated (f)	0.1
Heat of Vaporization (H_v)	176,000 J/kg
Liquid Heat Capacity (C_p)	1,951.5 J/kg-K
Ambient Temperature (T_a)	303 K
Boiling Temperature (T_b)	583 K
Atmospheric transmissivity (t_a)	1
Constant	0.0010

4.3.3.3 Postulated Credible and Worst-case Event Scenarios

Credible and worst-case event scenarios involving loss of containment of hazardous substances from storage tanks and pipelines/hoses were assessed. Three project facilities were assessed: the Pier site, the Plant site and the Power Plant site. Three event outcomes were assumed to take place for the highly flammable gases and liquids (hydrogen gas, hydrogen sulphide, methanol). These outcomes are vapour cloud fire (VCF) of flashback fire, vapour cloud explosion (VCE) and jet/pool fire. For diesel, a pool fire is assumed to take place.

For the toxic substances (hydrogen sulphide, methanol, and sulphuric acid), toxic vapour cloud (TVC) dispersion is assumed as the final event outcome following the loss of containment event. Worst-case loss of containment scenarios were assumed. That is, loss of containment is assumed to take place instantaneously, from a catastrophic failure of the biggest container or pipeline.

The postulated LOC events were defined by the hole sizes in tanks or vessels, which were based on the guidelines given HSE (2012) in *Failure Rate and Event Data for use within Risk Assessments (28/06/2012)*. Loss of containment events are thus classified as either catastrophic, major or minor. A catastrophic event involves the instantaneous release of the entire contents of a tank or vessel. Major releases results from large holes, which cause the total emptying of a tank or vessel in five (5) minutes. Minor releases results from losses through small holes, which can empty the contents of a tank or vessel in around 30 minutes (HSE, 2012, p.10).

4.3.3.4 Levels of Concern of Event Scenarios

Three (3) outcomes of loss of containment for flammable substances were assessed. These were jet fires or pool fires, vapour cloud fire (VCF) and vapour cloud explosion (VCF). The endpoint of concern used are shown in **Table 4.3.3**.

Table 4.3.3 Levels of concern used for the study of flammable substances

Event Outcome	Level of Concern	Relevance
1. Vapor Cloud Explosion (VCE)	Explosion overpressure (psi)	
	8.0	Destruction of buildings
	3.5	Serious injury to people likely
	1.0	Shatters glass
2. Vapor Cloud Fire (VCF)	% LFL	
	100%LFL (1.0 LFL)	Vapour cloud concentration at 100% LFL; criteria used to account for 100% fatality in persons exposed to the vapour cloud fire envelope
3. Pool fire and Jet fire	Thermal Radiation Dose (kW/m^2)	
	5	People will feel pain after 13 seconds and receive second-degree burns after 40 seconds. Used to define the injury zone.
	12.5	Used to define the 7% fatality zone after 20 seconds of exposure for persons not protected by clothing or shelter
	35	Used to define the 100% fatality zone after 20 seconds of exposure for persons regardless of protection of clothing or shelter;

4.3.3.5 Frequency Analysis

The calculation of the frequency of events as used in the computation of Societal Risks is based on the combination of four factors, which are as follows: frequency of failure (F_f) of equipment (per year), probability of ignition (P_{ig}), probability of weather condition (P_m), and probability of wind direction (P_Ψ). The frequency of event for a given event scenario, Fs,m,Ψ,i, is calculated using the following equation:

$$\mathrm{Fs, m, \Psi, i} = \mathrm{F_f} \times \mathrm{P_m} \times \mathrm{P_\Psi} \times \mathrm{P_{ig}}$$

Frequency of Failure

The frequency of failure of specific equipment and facilities were computed based on peer reviewed generic data on failure rates of equipment. The frequency of failure per year, Ff, was derived using the following formula:

$$F_f = \frac{Failure\ rate}{unit - yr} * No.of\ units$$

Probability of Ignition

The occurrence of the postulated event scenarios depends on the manner of ignition after LOC event. There are three possible outcomes after loss of containment of a highly flammable substance: (1) immediate ignition of the escaping vapours, (2) delayed ignition of the vapour cloud, and (3) no ignition. In the event of immediate or direct ignition of vapours, a pool fire or jet fire may occur. Delayed ignition of a vapour cloud may either result to a vapour cloud fire (VCF) or vapour cloud explosion (VCE). The resulting events following a loss of containment event are shown in **Figure 4.3.2** below.

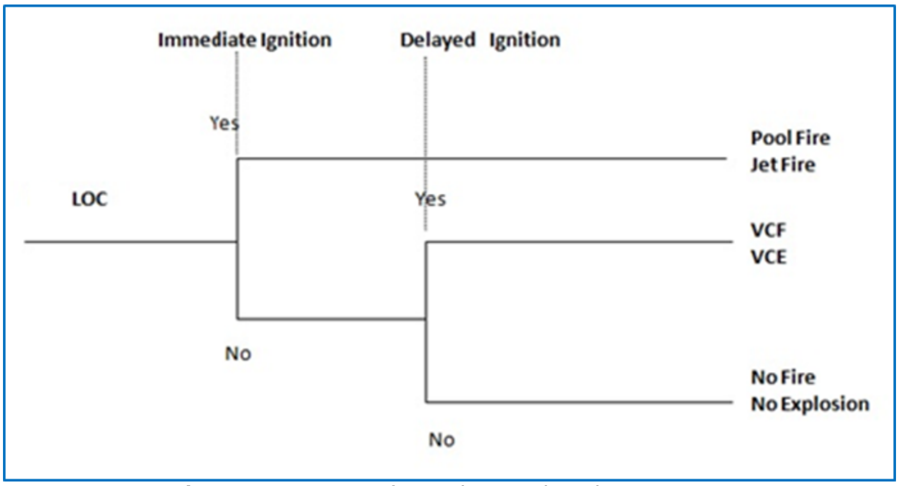


Figure 4.3.2. Loss of containment (LOC) Event Tree

The probabilities of immediate and delayed ignition following an LOC event were based on peer reviewed generic data.

Probability of Wind Direction and Wind Sector

The probability of wind blowing from a certain direction to populated communities was computed based on data derived from *https://meteoblue.com* (Wind rose, Rio Tuba Climate). The frequencies for specific wind direction are expressed in hours per year for each wind speed class. To calculate for the probability of a certain wind direction, the numbers of hours for all wind speed classes for the said direction were summed up and divided by the total number of hours for all wind directions and wind speed classes.

The pertinent wind sectors used were based on the wind direction blowing into populated communities relative to the location of the site of loss of containment (LOC) event.

4.3.3.6 Probability of Weather Stability-Wind Speed Condition, P_{Ψ}

In the absence of available data for the site, PΨ was assumed to be one (1).

4.3.3.7 Location Specific Individual Fatality Risk (LSIFR)

The Location Specific Individual Fatality Risk (LSIFR) for each Event Scenario at a particular location was calculated using the following equation:

$$LSIFR = F_f * P_{ig} * P_m * P_{\varphi} * P_d$$

Where: Ff : Frequency of failure (yr^{-1})
Pig : Probability of ignition
Pm : Probability of weather stability-wind speed condition
Pϕ : Probability of wind direction
Pd : Probability of death

LSIFR for each event scenario was calculated for each LOC event. The sum of all these LSIFR comprises the LSIFR for that particular LOC site.

4.3.3.8 Societal Risks

Societal Risk was calculated by combining the results of the consequence analysis, in terms of number of fatalities, with the event frequency (Fs,m,Ψ,i). Calculation of the potential number of fatalities was earlier described. The Event Frequency was calculated based on the following equation:

$$\mathrm{Fs, m, \Psi, i} = \mathrm{Ff} \times \mathrm{Pm} \times \mathrm{P\Psi} \times \mathrm{Pig}$$

Where: Fs,m,Ψ,I : Event frequency
Ff : Frequency of equipment failure
Pm : Probability of weather stability-wind speed condition
PΨ : Probability of wind direction
Pig : Probability of ignition

4.4 HAZARD IDENTIFICATION

Hazards identified in the previous ERA for the project remain essentially the same. These hazards are attributable to the flammable and toxic characteristics of some of the substances stored, transported, processed and utilized by CBNC. Major physical hazards are presented by the existence and proposed construction of another TSF. Failure of containment of the TSFs could result to flooding and massive release of heavy-metal contaminated water and sediments. The third type of hazard is due to extreme natural events that may cause damage and subsequent release of hazardous substances from the CBNC facilities or directly result to injuries and fatalities to people. Such natural events include earthquakes, tsunamis, storm surges, typhoons and unusually heavy and/or prolonged rains. Risks from explosives are no longer included in this ERA as the facility is already under the Rio Tuba Nickel Mining Corporation (RTNMC).

4.4.1 Flammable and Toxic Substances

Major hazards associated with the CBNC project are its storage, transport, processing and utilization of potentially flammable and toxic substances. The flammable substances were identified as the following: methanol, diesel, coal, hydrogen gas and hydrogen sulphide gas. The toxic substances are methanol, sulphuric acid, hydrogen sulphide, sodium hydroxide and the heavy metal contents of the nickel ores (nickel, cobalt, zinc, iron, chromium, aluminium, magnesium and manganese). This ERA will focus on investigating the hazards associated with these substances. The quantitative risk assessment will focus on the substances that will be proven to significantly affect populated communities and CBNC's manpower, through the extent of their potentially fatal (1% probability of death) hazard distances, as well as the probability of occurrence of the events (frequency of occurrence greater than 10^{-8} events per year).

4.4.2 Failure of Tailings Storage Facilities (TSF)

The expansion project will entail the construction of a third TSP to serve as containment of tailings produced in the process of heavy metal extraction from the nickel ores. The first TSF had already been retired and rehabilitated. Collapse of these structures due to any reason could result to flooding of areas and communities downstream of the site. Impacts from such events carry both physical and health consequences. Immediate impacts results from flooding and landslides, which may cause injuries and fatalities to people caught in the flood path. The heavy metal contents of the sediments and water contained in the TSF can result to heavy metal toxicities to exposed people and animals. It is likewise expected to pollute the soil and water bodies drained by the released water and sediments. The large amount of heavy metal contents, many of which have potential toxicities, of the released water and sediments may contaminate the ground water and possibly find their way in drinking waters of humans. Another impact of the event is the siltation of rivers and surface water bodies with contaminated sediments.

Possible causes of the postulated TSF failure scenario are the following: extreme natural events such as earthquakes, heavy and prolonged rains, and very strong typhoons; engineering design problems; deficient monitoring and maintenance; vandalism; and terrorist attacks.

4.4.3 Risk Screening of Hazardous Substances at the Pier and Plant Sites

A risk screening procedure was undertaken to validate the scoping process undertaken with the EMB, to determine the type of environmental risk assessment to be undertaken and to prioritize the environmental risks presented by the various hazardous substances and activities. The criteria and process used in risk screening was based on *Annex 2-7e (Guidelines for the Conduct of Environmental Risk Assessment)* of *the Revised Procedural Manual of DAO 2003-30*.

According to *Annex 2-7e of the RPM of DAO 2003-30* conduct of an ERA is required if a proposed project will use, handle, transport, or store substances that are explosive, flammable, oxidizing, or toxic. The proposed expansion of the HPP project of Coral Bay Nickel Corporation (CBNC) requires an ERA as it involves the use of toxic, flammable and oxidizing substances. These hazardous substances are listed in **Table 4.4.1**.

The level of ERA coverage is defined by the type of hazardous substance and the expected maximum inventory of this substance to be stored or handled at the project site at any one time. The levels of ERA coverage are as follows (Annex 2-7e of the RPM of DAO 2003-30):

- Level 2 – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 2** threshold inventory shall be required to conduct a Quantitative Risk Assessment (QRA) and prepare an Emergency/Contingency Plan based on the results of the QRA;

- Level 1 – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 1** threshold inventory shall be required to prepare an Emergency/Contingency Plan based on the worst case scenario. The Plan shall be based on a Hazard Analysis study; and

- Risk screening level – specific facilities or the use of certain processes shall require the conduct of a risk screening study even if the projected or estimated inventory does not reach the threshold levels.

Table 4.4.1 shows the maximum amount of the identified hazardous substances that may be stored at the project site at any one time, their hazard classification, the corresponding DENR Threshold Inventory Levels (Level 1 and Level 2) for each of the substance, and the level of ERA preparation required.

As there are more than one hazardous substance involved, the risk screening procedure made use of the Total Indicative Sum (TIS) equation in deciding as to what level of ERA was to be undertaken. Based on the RPM of DAO 2003-30, the computation of the TIS should be based on the following equation:

$$\mathbf{TIS} = \frac{\mathbf{q1}}{\mathbf{Q1}} + \frac{\mathbf{q2}}{\mathbf{Q2}} + \frac{\mathbf{q3}}{\mathbf{Q3}} \ldots + \mathbf{qn/Qn}$$

Where: q = the quantity of hazardous substance
Q_x = the indicative threshold level of the dangerous substance

Based on the TIS computation, both the pier site and the plant site would require the conduct of QRAs as the computed TIS for both sites exceeded the value of "1.0" (139.8 for the pier site and 18.7 for the plant site). **Table 4.4.1** below shows the listing of hazardous substances at the pier and plant sites of CBNC's HPP project.

According to TNO's Purple Book (VROM, 2005, p. 13), "a particular dangerous substance can be excluded in the QRA if at least one of the following generic criteria is fulfilled:

1. *Physical form of the substance*

Substances in solid form, such that, under both normal conditions and any abnormal conditions which can be reasonably foreseen, a release, of matter or of energy, which could create a major-accident hazard, is not possible.

2. Containment and Quantities

Substances packaged or contained in such a fashion and in such quantities that the maximum release possible under any circumstances cannot create a major-accident hazard.

3. Location and Quantities

Substances present in such quantities and at such distances from other dangerous substances (at the establishment or elsewhere) that they can neither create a major-accident hazard by themselves nor initiate a major accident involving other dangerous substances.

4. Classification

Substances which are defined as dangerous substances by virtue of their generic classification in Annex I Part 2 of Council Directive 96/82/EC, but which cannot create a major-accident hazard, and for which therefore the generic classification is inappropriate for this purpose.

Based on #1 and #2 of the above stated criteria, solid forms of sodium hydroxide (NaOH) was not included in the QRA but is nonetheless included in hazard identification. Coal at the Pier and Plant sites was likewise not included in the quantification of risks since the quantity is below DENR's Level 1 Inventory ceiling and was too small to exert any major accident hazard. Risk from an accident is not expected to go beyond the perimeters of the establishment.

The selection of the substances to be included in the QRA was also guided by the criteria set forth by the TNO's *Purple Book* (VROM, 2005, P. 41), which stated that only event scenarios that contribute to the individual and societal risks should be included in the QRA. That is, the loss of containment events should meet both of the following two (2) criteria:

1. The frequency of occurrence is equal to or greater than 10^{-8} per year; and
2. The resulting lethal damage (1% probability) occurs outside the establishment's boundary or the transport route.

Table 4.4.1 Screening and Classification of Potentially Hazardous Substances.

Substance	Max. Inventory of the Substance (MT)	Number of Tanks	Hazard Category	DENR Level 1 Inventory (MT)	DENR Level 2 Inventory (MT)	Remarks
I. At the Pier						
1. Methanol (99.99%)	2,860	2	Highly Flammable	50	200	Above Level 2
2. Sulfuric Acid (98%)	40,000	3	Oxidizing	50	200	Above Level 2
3. Diesel (RTN pier)	903	1	Flammable	5,000	50,000	Below Level 1
4. NaOH (solid)	3,500	3500 bags	Oxidizing	50	200	Above Level 2
II. At the HPP Site						
1. Methanol (99.99%)	28	2	Highly Flammable	50	200	Below Level 1
2. Sulfuric Acid (98%)	3,682	2	Oxidizing	50	200	Above Level 2
3. NaOH (solid, solution)	30.75	2	Oxidizing	50	200	Below Level 1
4. Hydrogen sulfide gas	0.3416	1 gas holder, 2 supply vessels	Highly Toxic	5	20	Below Level 1
5. Hydrogen gas	0.0838	2 gas holders	Extremely Flammable	10	50	Below Level 1
III. At the Power Plant and Steam Generator						
1. Diesel	139.8	2	Flammable	5,000	50,000	Below Level 1
2. Coal	750	2 silos	Flammable	5,000	50,000	Below Level 1

4.4.4 Hazard Analysis Matrix

The acute hazards associated with the various processes and substances at the CBNC project facilities and the corresponding initiating and contributing factors are summarized in the **Hazard Analysis Matrix** (**Table 4.4.2**).

Table 4.4.2. Hazard analysis matrix

Hazard/ Unit Operation	Hazard Outcome	Initiating/ Contributing Factors
A. Hazardous Chemicals at the Pier Site and Plant Site		
1. Methanol (CH_3OH)	• Fire and Explosion; toxicities	• Spills/ leaks from storage vessels and pipelines • Lack of or inadequate bunding system; • Earthquakes; • Severe weather conditions (very strong typhoons, etc.) • Damage to storage tanks, pipeline or accessories
2. Sulfuric Acid (98%)	• Highly corrosive to human tissues and metals; highly reactive to water and other substances; toxic vapors and mists	• Spills/leaks from storage tanks; • Lack of or inadequate bunding system; • Earthquakes; • Severe weather conditions (very strong typhoons, etc.) • Damage to storage tanks, pipeline or accessories
3. Hydrogen sulfide gas	• Fire and explosion; toxic gas dispersion	• Leaks/ releases from storage vessels, flanges and pipeline; • Earthquakes; • Severe weather conditions (very strong typhoons, etc.) • Damage to storage tanks, pipeline or accessories
4. Hydrogen gas	• Fire and Explosion; toxicity through asphyxiation	• Leaks/ releases from storage vessels, flanges and pipeline; • Earthquakes; • Severe weather conditions (very strong typhoons, etc.) • Damage to storage tanks, pipeline or accessories
5. Sodium Hydroxide pellets and solution	• Contact with and inhalation of substance following accidental release; • Corrosive to body tissues and metallic materials; • Causes severe skin burns and eye damage	• Spills/leaks from storage tanks; • Lack of or inadequate bunding system; • Earthquakes; • Severe weather conditions (very strong typhoons, etc.) • Damage to storage tanks, piping or accessories
6. Heavy Metals from feed ores, hydrometallurgical processing, and tailings	• Toxicities to exposed people; • Toxicities to exposed biota; • Contamination of soil, air and water bodies	• TSF failure and subsequent release fo tailings; • Run off from ore piles; • Emission of heavy metal fumes in processing
7. Light Fuel Oil (Diesel)	• Fire/ explosion following major releases/ spills	• Presence of ignition sources in the vicinity of storage tanks; • Lightning strikes; • Breach of containment; • Mechanical impacts; • Exposure to fires and high heat of storage tanks; • Corrosion of tanks and accessories; • Defective or substandard materials; pipeline and/or pump failure • Vandalism

Hazard/ Unit Operation	Hazard Outcome	Initiating/ Contributing Factors
B. Power Plant Facilities		
1. Coal	• Coal dust fire/ explosion	• Spontaneous combustion; • Presence of ignition sources in the vicinity of coal storage; • Activites that create friction in the stockpiles; • Confining conditions; • Too high volatile contents of the coal; • Too high coal fines content; • Poor housekeeping leading to accumulation of coal dusts on walls, floors and crevices; • Frictional sparks created by presence of foreign materials, such as tramp metals and spikes in the coal feed to the crusher; • Poor equipment maintenance; • Failure of or inadequate fire detection and control systems; • Failure to follow proper isolation, clearing, start up or shutdown procedures; • Entry of sparks, flames or smoldering embers from dust production areas; • Failure of explosion venting and/or explosion suppression; • Unplanned of the coal firing system; • Frictional sparks from broken fans, ducting system, etc.; • Defective electrical equipment; • Failure of component parts, lack of maintenance; • Sabotage
2. Lube Oil	• Oil Fire at the turbines, transformers	• Leaks in the lubrication or control oil system; • Malfunctioning bearings; • Poor housekeeping (accumulation of oil leaks on the floor); • Poor equipment maintenance
3. Cable Channels, Room and Galleries	• Electrical Fires	• Overheating due to excess load resulting to short circuits; • Inadequate equipment maintenance
4. Electrical equipment	• Electrical burns from flash arcs and direct contact with electricity • Electrical shocks from direct contact with electricity	• Inherent presence of electrical safety hazards inside the Plant; • Failure of electrical equipment and accessories; • Human error (non-compliance with operation protocols, etc.); • Loitering in off limits areas • Lack of/inadequate PPEs; • Poor or inadequate housekeeping; • Inadequate safety trainings and drills
5. Steam Pipes and Boiler house	• Release of extremely hot steam	• Failure of equipment and pipes; • Failure of pressure detection and control systems; • Uncontrolled pressure elevation due to obstruction and other factors; • Inadequate maintenance and housekeeping; • Earthquakes; • Extreme weather conditions (eg. very strong typhoons, tsunami, etc.)
C. Tailings Storage Facility (TSF) Failure	• Flooding of low lying areas; • Mass movement of sediments; • Contamination of affected soil	• Breach of TSF embankments due to the following: extreme natural events (earthquakes, extreme weather); faulty engineering design; deficient monitoring and

Hazard/ Unit Operation	Hazard Outcome	Initiating/ Contributing Factors
	and water bodies, including ground waters; • Heavy metal toxicities to exposed people, animals and biota	maintenance; vandalism; terroristic acts

4.4.5 Characteristics of Identified Hazardous Substances

4.4.5.1 Sulfuric Acid, 98% (CAS Number 7664-93-9)

Health Hazards

Sulfuric acid (H_2SO4) is also known dihydrogen sulfate, aqeous sulfuric acid, and hydrogen sulfate. A colorless, oily, inorganic acid, sulfuric acid is corrosive to metals and tissue. It is corrosive and highly toxic if inhaled. It may cause severe irritation and burns of the nose, throat and the respiratory tract that could lead to death. Ingestion of the substance can cause serious burns of the mouth or perforation of the esophagus or stomach. Severe skin burns can result from splashes on the skin, which results from the substance's strong exothermic reaction with water. Direct contact of the eyes with the liquid, its mists or vapors may cause stinging, tearing, redness, swelling, corneal damage and irreversible eye damage. Splashes in the eyes will cause severe burns. Overexposure to the mists or vapors of the substance may cause irritation and burns of the mouth, nose, throat, respiratory and digestive tract, coughing, nausea, vomiting, abdominal pain, chest pain, pneumonitis, pulmonary edema and perforation of the stomach (Hill Brothers Chem. Co., 2003).

Fire and Explosion Hazards

Though the substance is not flammable it is highly reactive. It is capable of igniting finely divided combustible materials on contact. When contacted with water and organic materials, it is capable of violent reaction with evolution of heat. It may release hazardous oxides of sulfur if involved in fire. When exposed to extreme heat, tanks containing sulfuric acid may rupture due to pressure buildup. Hydrogen gas, which can form flammable mixture with air, may be evolved when sulfuric acid contacts with common metals.

Delivery, Storage and Use

Sulfuric acid (98%) is transported by carrier ships (usually 12,000 MT capacity) from Japan to the CBNC port in Rio Tuba. Frequency of delivery by carrier ships is about 50 per year. The acid is unloaded from the ship by pumps into the three (3) H_2SO_4 storage tanks at the Pier site through a network of rubber hoses and stainless steel pipeline that is enclosed with a carbon steel material to contain any spill. Maximum capacities of the three tanks are 10,000 MT (6,172 m^3) for the two tanks and 20,000 MT (12,336 m^3) for the biggest tank. The tanks are made of acid-resistant material, carbon steel and are enclosed by a corrosion-resistant bund with capacity to contain 100% of the maximum tank contents. As such, any leak from the tanks will be contained within the bund. Each tank is fitted with a vent and overflow lines fitted with dessicators.

To transport the acid from the Pier site to the Plant site, the acid is pumped from the pier storage tank into a 40 MT ISO-tainer tank lorry, which transport and unloads the acid into carbon steel sulfuric acid tanks at the HPP Line 1 site (one 1640 m^3 or 30,00 MT capacity tank) and at HPP Line 2 site (one 316 m^3 or 578 MT capacity tank). The tanks are fully enclosed by a corrosion-resistant bunds which can accommodate the entire storage capacity. Each tank is likewise provided with a vent and overflow lines fitted with dessicators. The ISO-tainer lorry is impact resistant. Its vessel walls are constructed from 6-mm boiler plate and protected from head-on collision by steel box end frames. No loading or unloading connections are located on the bottom of the vessel for safety reasons.

The major user of sulfuric acid is the autoclave in the high pressure acid leach section. The acid is brought from the tank to the various users in the HPP through the use of pumps and pipelines, which are equipped with appropriate emergency shut-off valves and corrosion-resistant bund to contain any acid spill. To avoid the spread of acid during extreme cases, pressure relief valves are also provided.

Possible causes of sulfuric acid leaks within the HPP include flange leak, mis-operation of isolation valves, or mist from the vent line. Established safeguards within the Plant include adoption of the isolation philosophy, appropriate PPEs, acid proof painting and lining, drainage to sump, safety showers, and placement of vents on tanks and thickeners at safe locations.

4.4.5.2 Methanol (CAS No. 67-56-1)

Methanol or methyl alcohol (chemical formula CH_3OH) is the main ingredient used in the production of hydrogen (H_2) gas at the Hydrogen Sulfide (HS) facility of the HPP. Hydrogen gas, in turn, is combined with sulfur vapor to form hydrogen sulfide (H_2S), which is used to precipitate out the metal sulfides from the leach solution. Methanol is received and stored at the Pier site and Plant site in 99.99% concentration.

Methanol is a colorless, fairly volatile liquid with a faintly sweet pungent odor of ethyl alcohol. It is completely miscible with water. Its hazards arise from being both a flammable and toxic substance.

<u>Fire/ Explosion Hazards</u>

Slightly heavier than air, methanol vapors may travel some distance to a source of ignition and flash back. Its vapors may accumulate in confined spaces, such as buildings or sewers, and may explode if ignited. Its NFPA Hazard rating is as follows: Health = 1 (can cause significant irritation; Flammability = 3 (can be ignited under almost all temperature conditions; Stability = 0 (normally stable even under fire conditions) (CAMEO, 2016). With a flash point of 11.7 °C, methanol is classified as a highly flammable liquid. The lower and upper explosive limits of the substance are 6.0 % and 36.5 % by volume, respectively. If exposed to fire, containers of methanol may explode.

To mitigate the flammable and explosive character of the substance, exposure and/or contact to the following conditions or materials should be avoided: heat, sparks, open flame, strong oxidizing agents, aluminum and zinc, some forms of plastic, rubber, and rubber-based coat. Excessive heating or incomplete combustion will generate Toxic carbon monoxide and other vapors such as formaldehyde may form through excessive heating and incomplete combustion.

Reactivity Hazards

Methanol reacts violently with several substances, including the following: acetyl bromide, concentrated sulfuric acid, and concentrated hydrogen peroxide. Contact with concentrated sulfuric acid and concentrated hydrogen peroxide can cause explosions. Methanol can ignite on contact with a platinum-black catalyst (CAMEO).

Health Hazards

As earlier mentioned, methanol is toxic. Routes of exposure are through inhalation, dermal/mucosal absorption and ingestion. Exposure to excessive vapors of methanol can cause eye irritation, headache, fatigue and drowsiness. In high concentrations, the substance can elicit central nervous system depression and optic nerve damage. An ambient concentration of 50,000 ppm may cause death in 1 to 2 hrs. Ingestion may result to death or eye damage (USCG, 1999). The dose that is Immediately Dangerous to Life and Health (IDLH) 25,000 ppm. Ingestion of 1 to 4 oz of the substance can cause irreversible injury to the nervous system, blindness, and even death.

Delivery, Storage and Use

The Hydrogen Sulfide (HS) facility at the HPP, uses methanol to produce hydrogen (H_2) gas, which in turn is used to produce hydrogen sulfide (H_2S) gas. The HS facility consumes around 7,000 MT of methanol per year. Procured from Indonesia, the substance is shipped to the CBNC port in Rio Tuba on a chemical tanker. Methanol is unloaded from the ship to the Pier site methanol storage tanks (2 tanks) using pumps, hoses and a pipe network, utilizing procedures similar to that for sulfuric acid unloading. There are two (2) methanol storage tanks at the pier site, with 1,000 MT and 1,860 MT weight capacities, respectively. The tanks are made of carbon steel and are enclosed in a bund that can accommodate 100% of the entire tank contents. Portable foam and powder fire extinguishers are provided in the area of storage. The storage area is also provided with four (4) lightning arrestors to protect the facilities from lightning strikes.

Methanol is unloaded from the Pier site storage tanks to the methanol lorry with volume capacity of 10 m^3 (8 MT) to be transported to the HS section of the Plant site. At the Plant site, methanol will be pumped and loaded into a 32 MT capacity (40 m^3 volume) storage tank, which is built of carbon steel and enclosed in bund walls with capacity to contain 100% of the tank's contents. Fire detectors and fire hydrants are provided in the storage area.

To produce hydrogen gas, methanol is pumped from the storage tank to an evaporator where it is vaporized together with pure water. The vaporized methanol and pure water are then brought to a converter where to be reacted with a catalyst to produce hydrogen gas.

Credible release scenario of methanol is through a leak in the flange. Outcome of the release may be fire, explosion or chemical burns. Plant safeguards to mitigate these hazards include provision of fire hydrant, portable fire extinguishers, fire engine, dike, and drainage to the sump. Workers working in the vicinity of the area are provided with the following PPEs: safety glasses, gloves, fire retardant clothes and shoes, showers and eyewash.

4.4.5.3 Hydrogen gas (CAS# 1333-74-0)

Approximately 800 normal cubic meter per hour (Ncm/hr) of hydrogen (H_2) gas with purity of more than 99.9% is produced at the hydrogen generator section of the HS facility at full plant capacity. Impurities such as CO_2, CO, and methanol gases are discharged to the exhaust gas boiler where they are used as fuel gas. The cleaned hydrogen gas is inputted into the H_2S reactor to react with sulfur gas to produce H_2S gas.

Fire and Explosion Hazards

Hydrogen is a colorless, odorless gas that has an NFPA Flammability Rating of “4”, meaning that it is burns readily and rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature. It is classified as an extremely flammable gas. It burns with a pale blue, almost invisible flame once ignited, making hydrogen fires difficult to detect. Alternative methods of detection such thermal camera should be used. Hydrogen gas is lighter than air and would tend to accumulate in the upper section of enclosed spaces. The gas is easily ignited by low-ignition energy, such as static electricity. Heat, sparks and flames can easily ignite it. Fire flashback along vapor trail may occur. If ignited in an enclosed area, hydrogen gas may explode. Hydrogen gas containers when exposed to fire and intense heat may rupture violently and rocket. If provided with pressure relief devices, gas cylinders exposed to fire may vent and release flammable gas. The gas is flammable over a wide range of vapor/air concentrations. Its Lower Explosive Limit (LEL) is 40,000 ppm while its Upper Explosive Limit is 750,000 ppm (CAMEO, 2016).

Health Hazards

Hydrogen is not toxic. Rather, it is a simple asphyxiant by the displacement of oxygen in the air. Suffocating atmosphere due to hydrogen gas is created at gas concentration higher than LEL, such that the atmosphere becomes both oxygen-deficient and explosive. The three tiers of Protective Action Criteria (PAC) of hydrogen gas is as follows (ALOHA ver 5.4.7 Help, 2016):

PAC Tier	Concentration in Air (ppm)	Significance
PAC-1	65,000	Temporary, non-disabling effects threshold
PAC-2	230,000	Disabling (escape impairment) threshold
PAC-3	400,000	Life-threatening effects threshold
LEL	40,000	Concentration equal to or above this supports vapor cloud fire and explosion

Exposure to gas concentration equal to or higher than PAC-1 but lower than PAC-2 may cause temporary effects such as headaches, dizziness and nausea due to deficient oxygen. At PAC-2 or higher, severe dizziness or unconsciousness may occur. At PAC-3 level, dizziness, unconsciousness or asphyxiation and death may occur without warning (CAMEO Chemicals ver 2.7, 2016).

Delivery, Storage and Use

Hydrogen gas is stored in a carbon steel hydrogen gasholder, with volume capacity of 80.3 m^3, after cleaning in the Pressure Swing Adsorption (PSA) unit. HPP Line 1 and HPP Line 2 have one (1) hydrogen gas holder each. From the gas holder, the gas is fed to the H_2S reactor, where it reacts with molten sulfur to produce H_2S gas.

Credible Loss of Containment Scenarios for H_2 Gas

Credible loss of containment scenarios for hydrogen gas are as follows:

1. Undetected flange leak leading to gas accumulation to concentration equal to or greater than LEL, ignition and subsequent flashback fire or explosion;
2. Controlled excessive pressure in the H_2S reactor through reduction of H_2 feed, H_2 release from safety valve and subsequent H_2 purge through the stack with addition of steam.
3. Uncontrolled excessive pressure in the H_2S reactor leading to either explosion of the H_2 gas holder; and
4. Catastrophic release of entire gas contents of the gasholder resulting from large hole due to mechanical impact, metal fatigue or other factors.

The second scenario above assumes that excessive pressure build up in the H_2S reactor is controlled through reduction or stoppage of H_2 feed, which triggers H_2 releases through the safety valves of the hydrogen gasholder and H_2S reactor inlet line. The released H_2 gas is purged through the stack. Steam is added to prevent explosion by electrostatic sparks.

The third scenario, which is a BLEVE or vapor cloud explosion, is a worst-case scenario that affects the full storage of hydrogen gas in the gasholder.

The following are the safety features of the plant to prevent and/or control risks from H_2 releases:

1. Closed system facilities to prevent gas leakage;
2. Installed Distributed Control System (DCS) for all equipment and processes (except for the sulfur melting process) to eliminate human errors;
3. Adoption of Open Structure in the plant to prevent dangerous accumulation of hazardous gases and provision of Local Ventilation systems;
4. Installation of gas detection systems (12 H_2 detector units and 82 H_2S detector units are installed);
5. All critical systems are provided with an emergency shutdown system;
6. Grounding of all electrical systems;
7. Provision and availability of a good fire-fighting system consisting of nitrogen gas purging, portable fire extinguishers, fire hydrant, and fire engine; and
8. Hazardous areas are installed with electrical equipment and wiring that are specifically designed to prevent fire and explosion based on API standard.

4.4.5.4 Hydrogen sulfide (CAS No. 7783-06-04)

Hydrogen sulfide (H_2S) gas is generated at the H_2S reactor of the HS facility through the reaction of hydrogen gas and sulfur vapor. After purification, hydrogen gas is fed to the zinc removal and mixed sulfide (MS) precipitation sections of the HPP.

Colorless with a characteristic rotten egg odor, hydrogen sulfide is both a flammable and highly toxic gas. Boiling point of the substance is -60.2°C.

Fire and Explosion Hazards

Hydrogen sulfide is assigned an NFPA Flammability Rating of “4”, meaning that the gas burns readily and rapidly or completely vaporizes at atmospheric pressure and ambient temperature. It is classified as a very flammable gas. The gas is heavier than air and may travel a considerable distance near the ground to a source of ignition and flash back. Prolonged exposure of closed containers to heat may result in their violent rupturing and rocketing. It forms explosive mixtures with air over a wide range, with lower and upper explosive limits at 40,000 ppm and 440,000 ppm, respectively. It forms highly toxic fumes of sulfur oxides when heated decomposition. In the presence of the gas, the following conditions should be avoided: ignition sources (heat, sparks, open flame, others), storage near nitric acid, strong oxidizing materials, and corrosive liquids or gases (CAMEO Chemicals ver 2.7, 2016).

Health Hazards

Hydrogen sulfide is highly toxic. The NFPA Health Rating of this substance is “4”, meaning that exposure to it can be lethal. The routes of exposure are by inhalation and ingestion. It is very toxic by inhalation. Inhalation of the gas can cause coughing, dizziness, headache, labored breathing, nausea, sore throat, and unconsciousness. At high concentrations, respiratory arrest may ensue. Exposure to greater than 700 ppm ambient concentration may be fatal. The substance may also cause redness, pain, and severe deep burns to the eye. The odor threshold of the substance is 0.1ppm. However, continued exposure to the substance can fatigue the sense of smell, making odor detection for the presence of gas unreliable. Some important public health guidelines for the substance are as follows:

IDLH: 100 ppm (NIOSH, 2016)

AEGLs (Acute Exposure Guideline Levels)			
Exposure Period	**AEGL-1**	**AEGL-2**	**AEGL-3**
10 minutes	0.75 ppm	41 ppm	76 ppm
30 minutes	0.6 ppm	32 ppm	59 ppm
60 minutes	0.51 ppm	27 ppm	50 ppm
4 hours	0.36 ppm	20 ppm	37 ppm
8 hours	0.33 ppm	17 ppm	31 ppm

Source: (NAC/NRC, 2016)

A self-contained breathing apparatus should be available for emergency use or when concentrations exceed the exposure limits. Protective gloves are made of neoprene or butyl rubber; safety goggles or glasses serve as eye protection. Other protective equipment includes poly vinyl chloride, polyethylene, safety shoes, safety shower, and eyewash fountain.

Delivery, Storage and Use

Hydrogen sulfide is produced from the reaction of hydrogen gas and sulfur vapors in the H_2S reactor at the HS Facility. The purity of the product is more than 95% by volume. The output gas from the reactor is fed to a condenser where the gas is cooled down and excess sulfur gas is liquefied. The liquid sulfur is returned to the reactor and recovered.

From the condenser the gas is fed to the water washing tower to remove the fumed sulfur and unreacted sulfur as colloidal sulfur. From the washing tower, the gas output, which has a temperature of approximately 40°C, is fed to the gas cooler to lower its temperature to 10°C. The vapor pressure is reduced and the drain water is returned to the washing tower.

From the gas cooler, the output gas is fed to the dehydrator to completely remove moisture by contacting with pre-cooled calcium chloride ($CaCl_2$) solution with a temperature of –20°C. The gas subsequently cools down to –15°C. The water absorbed $CaCl_2$ solution is fed partially to the concentrator where the absorbed water from the gas is continuously stripped by steam. The dehydrated gas is more than 97 % pure by volume. The 3% by volume impurities is composed of H_2 gas (2%) and H_2O (1%).

The purified H_2S gas is fed to a compressor where it is compressed to 350 kPag. The resulting compressed H_2S gas is then fed to the zinc removal and mixed sulfide (MS) precipitation sections of the HPP.

<u>Credible Loss of Containment Scenarios for H_2S Gas</u>

Credible loss of containment scenarios for H_2S gas are as follows:

1. Undetected flange leak leading to gas accumulation near the ground to concentrations that are toxic and/or flammable/explosive (equal to or greater than LEL). Exposed workers are at risk for H_2S toxicities and from impact of flashback fire and/or vapour cloud explosion;
2. Purging of H_2S gas from the liquid paraffin seal of the H2S gasholder as an emergency measure. The purged gas is channelled to the alkaline scrubber to be broken down into sodium sulfide and water;
3. Fireball or explosion of the H_2S gasholder, which may result from exposure to fire, vapour cloud explosion or mechanical damage from projectiles.
4. Catastrophic release of entire gas contents of the gasholder resulting from a large hole from mechanical impact or metal fatigue and subsequent vapour cloud dispersal for toxic effects; ignition and subsequent flashback fire or vapour cloud explosion for its flammable hazard.

Safety features of the Plant to address risks from toxic cloud exposure, and exposure to fire and/or explosions are similar to those discussed for the hydrogen gas risks mitigation.

4.4.5.5 Sodium Hydroxide (CAS No. 1310-73-2)

Sodium hydroxide or caustic soda is used for pH control/ adjustments. It is stored at the Pier site in solid form in bags (100 kg/bag) at a maximum inventory of 3,500 bags. It is transported in solid form to the plant site for use at the Chemical Preparation Section for the preparation of a 25% NaOH solution, which is stored in a 3.3 m^3 and 17.2 m^3 volume capacity tanks at HPP Line 1 and HPP Line 2, respectively.

<u>Environment and Health Hazards.</u>

The primary hazard associated with the substance is its high corrosive property and reactivity. It is generally corrosive to body tissues and metallic materials. It may cause severe irritation or burns to the eyes, skin, gastrointestinal tract, and respiratory system. Routes of exposure could be through inhalation, skin contact or eye contact. The chemical can aggravate existing skin and lung disorders. Prolonged or repeated exposure may cause lung injury. Prolonged skin contact may defat the skin and produce dermatitis. Being a strong base, it reacts violently with acids. When spilled or disposed into water bodies or soil, it can severely affect the pH condition of the environment and make it more basic. The substance is not flammable or explosive and is not expected to form any hazardous combustion products. It is not suspected or classified as carcinogenic to animals and humans. The pertinent physical, chemical and toxicological properties of caustic soda are listed in **Table 4.4.3**.

Table 4.4.3. Physical, chemical and toxicological properties of NaOH

Properties	Description
Chemical Name	Sodium hydroxide
Physical form	solid
Flammability	Not flammable
Molecular weight	34.01
Toxicological properties	
STEL in air (ACGIH)	2 mg/m^3
TLV-TWA in air (OSHA)	2 mg/m^3
LC50 (Inhalation, rats)	1463 ppm (4 hours)
LC50 (Dermal, rabbit)	1350 mg/kg BW

4.4.5.6 Light Fuel Oil (Diesel)

Diesel is used as fuel for vehicles, emergency generators and as start-up fuel for the CBNC Power Plant. It is stored at the RTN Oil Depot (outside the CBNC Pier Site premises) in a tank with maximum volume capacity of 1,077 m^3, which is secured with bund walls capable of containing the 100% content of the storage tank. Diesel from this site is transported to the Plant site through an eight (8) m^3 capacity diesel lorry, where it is stored in two tanks at the HPP Line 1 (60 m^3 and 17 m^3 tanks) and in one (1) tank (80 m^3 capacity) at HPP Line 2.

Fire Hazards

Diesel is a moderately flammable liquid fuel. The National Fire Protection Agency (NFPA) of the U.S.A. assigns to diesel a Flammability Rating 2 (ignites when moderately heated). Distillation temperature of diesel at 90% point is between 282-338°C. Its minimum flash point temperature is 52°C. Its other physic-chemical and toxicological properties are listed in **Table 4.4.4**.

Table 4.4.4. Physico-chemical and toxicological properties of diesel.

Property	Value/ Description
CAS RN No(s).	68334-30-5; 68476-30-2; 68476-31-3
UN Number	1993
Maximum Inventory at the Site	500 m^3
Flammability Designation/Code	Moderately Flammable
Flash Point, °C	52
Lower flammability limits in air (%)	1.3
Upper flammability limits in Air (%)	6
Autoignition Temperature, °C	254-285
Boiling/Condensation point (°C) at 1 atm	282-338
Specific gravity (liquid)	0.841 at 16°C
Vapor pressure	0.0028 bar at 21°C

Sources: CAMEO Chemical Inventory; NREL Liquid Fuels Database, 2007.

Health Hazards

Diesel is assigned an NFPA Health Hazard Rating of 1, meaning that it is slightly hazardous to health. The slight health hazard associated to the substance is mainly due to its volatile organic compound components (VOCs), which is approximately 1.5% of its total weight. VOCs from diesel may include benzene, toluene, ethylbenzene, xylene and other alkylbenzenes. High level exposure to these substances usually results to disorientation, euphoria, giddiness and confusion, progressing to unconsciousness, paralysis, convulsion, and death from respiratory or cardiovascular arrest. Chronic exposure to levels above the threshold level values may result to specific organ toxicity.

4.4.5.7 Coal

Sub-bituminous coal from Kalimantan, Indonesia is used at the CBNC power plant and steam generator. Coal is transported by ship from its source to the Pier site, where these are stored and subsequently transported to the Plant site by trucks to be used as primary fuel in the CBNC Power Plant and steam generator. Typical characteristics of the said coal are listed in **Table 4.4.5**.

Table 4.4.5. Typical properties of the Kalimantan coal used in the project.

Property	Value/ Description
Type	Sub-Bituminous
Ash, %	2.75 (ADB)
Fixed Carbon, %	40.1
Fines (0-2 mm), %	24
Volatile Combustible Matter, %	42.7
Moisture, %	14.5 (ADB)
Calorific Value, cal/g	4900 (GAR)

Source: CBNC, 2016

<u>**Environment and Health Hazards**</u>

Coal dust explosion and fire are among the major hazards in coal-fired power plants. Though readily combustible, coal is not classified as highly flammable material. It is a complex mixture containing variable amounts of volatile combustible matter, the components of coal (except for moisture) which are released or volatilized at high temperature in the absence of air. The presence of coal dust and the co-presence of methane, a flammable gas, influence the potential of coal for flammability. In coal utilization, it is the process, rather than the coal itself, that may present fire and explosion hazards. Further, the flammability of coal could vary with its origin (geological characteristics), the percentage of volatile matter and the calorific value, factors that influence the ease of combustion (Bingham, 2001). Although it has been demonstrated that methane and other short-chained hydrocarbons (ethane, ethylene, propane, propylene and butane) may be present in coal with no apparent methane emission, the amount of these residual gases is very minimal. Based on the study by Kim and Douglas (1973), the amount of residual gases in coal merely ranges from 0.0007 to 0.524 ft^3/ton of coal (Douglas, 1973).

Coal dust explosion requires the following five necessary elements, referred to as the explosion pentagon, to occur concurrently: fuel, heat, oxygen, suspension, and confinement. It should be noted that the first three elements (fuel, heat and oxygen) compose the so-called fire triangle. Removing any one of the five elements would prevent an explosion from propagating. For the fuel element, there are three prerequisites for coal dust to be explosive: (1) a volatile ratio exceeding 0.12, (2) particle size of 841 microns (0.841 mm) or less, and (3) the quantity of coal dust available at least meet the minimum explosive concentration (MEC), the quantity of dust in suspension that will propagate a coal dust explosion and generate sufficient pressure to cause damage. MEC for bituminous coal is approximately

100 grams per cubic meter. A person cannot breathe in an atmosphere containing dust at MEC. A layer of coal dust on the floor with potential to be at MEC if suspended is around 0.00127-mm thick, enough for footprints to be visible. Also, if coal dust is visible on the walls of a plant, it is considered to be enough to propagate an explosion (Stephan). The Kalimantan coal has volatile ratio of 0.427 and size of coal dust particles could be 0.841 mm or less. As such, dust from this coal can be explosive, if present in sufficient quantity and there are elements of confinement, oxygen, heat and suspension (Stephan).

Coal dust explosion hazard increases with decreasing coal particle sizes. Particle sizes of coal that can propagate a dust explosion may occur within cyclone dust collectors, coal mills, dust collectors/baghouses, and coal feed bunkers (Alameddin and Luzik, 1987). Coal dust explosion may be triggered by spontaneous coal dust combustion or by ignition sources such as sparks. In coal feed bunkers fires may be triggered by unplanned shutdowns and power interruptions. During such events, coal in the bunker may undergo spontaneous combustion because of prolonged residence time. Exothermic reaction is accelerated in the confined space of the bunker, which could lead to uncontrolled heating and eventually to spontaneous combustion (General Electric, 2013).

Electrical or frictional sparks can also provide the heat source to initiate a fire or explosion, even in the absence of methane. All coal dusts are predisposed to ignition when exposed to the frictional sparks of badly maintained machinery or in the presence of contaminating tramp metal (Stephan, n.d.).

Studies on the causes of coal dust explosion accidents on coal-fired power plants show that coal-fired power plant equipment with the highest coal dust explosion potential are the following: coal pulverizer, dust collector, cyclone, electrostatic precipitator, coal storage bins and silos, and transport pipes and ducts connecting the vulnerable equipment. Of these equipments, the dust collectors (bag houses) had the highest frequency of explosion accidents. Causes of and predisposing factors to explosion include the following (Fike Corporation, 2001; FM Global Property, Jan. 2000; General Electric, 2013):

- Unplanned shutdowns and power interruptions leading to prolonged coal residence time in feed bunkers, which could lead to spontaneous combustion, fire and/or explosion;
- Failure of inert gas source in coal pulverizer, introducing air and subsequently igniting collected pyrites below the pulverizing bed;
- Failure to follow inerting procedures;
- Sparks created by foreign objects (eg. tramp metals and spikes) in the coal feed;
- Ignition created by uncontrolled high static electricity in the dust collector due to typically high temperatures and coal dust suspension;
- Entry of sparks, flames or smoldering embers from dust production areas into vulnerable equipment, particularly dust collectors, cyclones or electrostatic precipitators;
- Continuous spark generation and mechanical rapping in electrostatic precipitators serve as inherent sources of ignition;
- Poor equipment maintenance (eg. broken fans can generate frictional sparks); and
- Poor housekeeping can lead to build up of coal dusts in bunkers, crusher house, hidden crevices and others, predisposing to coal fire and explosion.

Coal Fire/Explosion at the Stockyards

Coal dust explosion in open areas where coal is massively stored or handled, as in the stockyard, is highly unlikely due to the absence of the confinement element of the explosion pentagon. The coal stockyard is simply a roofed but open area that is well ventilated and far from combustible structures and populated areas. The worst-case accident scenario that could occur at the stockyard is a flaming fire resulting from uncontrolled/unchecked smoldering of coal. Uncontrolled smoldering/combustion of coal dust below the surface can volatilize flammable gases from the volatile combustible matter of coal to generate flames that may spread rapidly on the surface. The component of coal that will take part in the combustion process will be limited to the volatile combustible matter. The Kalimantan coal has approximately 42% volatile matter.

Severe coal fires are unlikely either at the CBNC Pier Site or Plant Site as the coal stockyards and handling areas are equipped with adequate and appropriate fire detection and control systems.

4.4.5.8 Heavy Metals from Ore Feeds and Tailings

Substances of concern in the ore feeds and tailings are the heavy metal contents of the ore, which are identified as follows: nickel, cobalt, magnesium, manganese, zinc, iron, aluminum and chromium. The tailings materials of the Hydrometallurgical Processing Plant, in particular contain large amounts of heavy metals.

Chromium (7440-47-3)

Sources and background levels

Chromium can be found in all phases of the environment (air, water, soil, biota). In continental crust its average concentration is reported to be 125 mg kg^{-1}, with commonly observed range of 80-200 mg kg^{-1}. The chromium content of soils is mostly dependent on parent materials, with concentration normally ranging from 10 to 150 mg/kg, with average of 40 mg/kg. In soils derived from sependinitic parent materials, however, its level can reach 125,000 mg/kg. Freshwater concentrations generally range from 0.1 to 6.0 ug/L with average of 1.0 ug/L. Values in sea water average 0.3 ug/L and range from 0.2 to 50 ug/L. Freshwater concentrations can be higher depending on the Cr levels in the surrounding watershed. Drainage water in irrigated agriculture areas with elevated amounts of soil Cr can have concentrations as high as 800 ug/L. Chromium concentration in the atmosphere also varies widely. Studies measuring atmospheric background Cr concentration show background levels of 5.0×10^{-6} to 1.2×10^{-3} ug/m^3 in air samples from remote areas such as Antartica, Greenland, and the Norwegian Arctic. These levels could have resulted from natural sources such as windblown dusts and volcanic activity (Losi, 1994).

Environmental Chemistry and Fate

While Cr can exist in oxidation states ranging from 2- to 6+, only oxidation states 3+ and 6+ are normally found within the pH and redox potentials common in environmental systems. Trivalent Cr (Cr^{3+}) is generally considered to be the more stable form. Hexavalent Cr (Cr^{6+}) is a strong oxidizer and is considered as the toxic form. The speciation of Cr(VI) is pH-dependent. In environmental systems, the species of Cr(VI) is largely that of the chromate ion (CrO_4^{2-}).

The trivalent Cr [Cr(III)] is more stable than Cr(VI). At lower pH, Cr(III) precipitation can be prevented by some organics that form complexes with it. The speciation of Cr (VI) and Cr(III) generally depend on various environmental parameters, including pH, concentration, and available ligands. In most natural systems, Cr(VI) will be present as CrO_4^{2-} while major trivalent species may exist as hydroxides and various organic complexes. When considering environmental properties and toxicity of Cr, the behaviour of both Cr(III) and Cr(VI) and the inter-conversion between the two forms must be understood (Losi, 1994).

Toxicity

Chromium in trace amounts is an essential element of human and animal nutrition. It is important in glucose and fat metabolism. Trivalent Cr is the nutritionally useful form while the hexavalent form is toxic and mutagenic. The biotoxicity of chromate is mostly a function of its ability to cross biological membranes and its powerful oxidizing capabilities. Cr(VI) compounds can be absorbed by humans through inhalation, dermal contact, and ingestion. Excessive Cr exposure can result to ulceration and perforation of the nasal septum, respiratory cancer, skin ulceration, contact dermatitis, and in the event of ingestion, kidney damage. It can also cause damage to various proteins and nucleic acids, which can lead to mutation and carcinogenesis (Lewis and Bianchi, 1982).

Nickel

Nickel may be an essential trace metal in mammals, involved in glucose metabolism. Excess nickel, however is toxic to life forms. Nickel is a respiratory tract carcinogen, the incidence of which is significantly higher among workers in the nickel refining industry. Severe acute and sometimes fatal toxicity may follow nickel carbonyl exposure. Nickel may also induce contact dermatitis Goyer, 1996).

Nickel is slightly absorbed through the gastrointestinal tract. It is transported in the plasma bound to serum albumin and a host of other small organic ligands, amino acids or polypeptides. Excretion in the urine is complete in 4 to 5 days. Environmental nickel or nickel concentration in ambient air influences serum nickel concentration. A study of people living near a large nickel mine in Ontario revealed serum nickel levels of 4.6±1.4 ug/L, with range of 2.0 to 7.3 mg/L, and urinary concentrations of 7.9 ± 3.7 ug/day (range 2.3 to 15.7 ug/day). Fecal nickel is generally 100 times the concentration in urine (Goyer,1996).

Toxicity

Occupational exposure to nickel predisposes humans to lung and nasal cancer. There are also evidence of increased risks from laryngeal cancer in nickel refinery workers in Norway and gastric carcinoma and soft tissue sarcomas from the Soviet Union. Increased risks from renal cancer had also been reported among nickel refinery workers in Norway and Canada. Increased risks from respiratory tract cancer had also been detected among nickel refining workers. Studies indicate that the increased risk of cancer among the nickel refining workers could be attributable to nickel subsulfide (Ni_3S_2) and nickel sulphate ($NiSO_4$), substances which are present in the nickel molten ore (Goyer, 1996)

Nickel dermatitis is one of the most common forms of allergic contact dermatitis. Increased ingestion of nickel-containing food increase the probability of external sensitization to nickel and eventually the episodes of acute nickel dermatitis (Goyer, 1996). Nickel is also reported as affecting male and female reproductive capacity (Thomas, 1996).

Cobalt

Like the other heavy metals, cobalt (Co) is known to exert toxic effect on the vascular system through blocking of the calcium channels and through reactions with the sulfhydryl, carbonyl, or phosphate groups (Ramos et al., 1996). It is also known to be toxic to the male and female reproductive capacity. Excess of cobalt have been demonstrated to cause testicular toxicity through inhibition of DNA synthesis (Thomas, 1996).

Manganese

Manganese (Mn) is neurotoxic and could induce Parkinson-like syndromes and degeneration of the caudate nucleus, basal ganglia, and substancia nigra (Chang, 1994).

Iron

Iron (Fe) is a usual component of nickel and chromite laterite deposits. It is an essential element to humans and animal metabolism in trace amounts. In excess, it can exert toxic effects and environmental impacts. The iron compound pyrite (FeS_2) is partly to blame for acid mine drainage, one of the most common and damaging problems in the aquatic environment. Acid mine water is a consequence of the presence of sulfuric acid produced by the oxidation of pyrite, a process that occurs very slowly at low pH conditions. Below pH 3.5, the iron oxidation is catalyzed by the iron bacterium Thiobacillus ferrooxidans, and in the pH range 3.5-4.5 it may be catalyzed by a variety of Metallogenium, a filamentous iron bacteria. The beds of streams afflicted with acid mine drainage are usually covered with “yellowboy”, an unsightly deposit of amorphous, semigelatinous $Fe(OH)_3$. The product, sulfuric acid, is however the most damaging component of acid mine water. It is directly toxic to organisms and plants (Manahan, 1994).

Zinc (CAS# 7440-66-6) and Zinc Sufide(CAS# 1314-98-3)

Zinc sulfide (ZnS) is a waste product of the Hydrometallurgical Processing Plant of CBNC. It is disposed as one of the tailings wastes. A yellowish-white powder in a liquid, ZnS is insoluble in water and denser than water. The substance’s primary hazard is to the environment. Steps should be taken to limit spread to the environment. It easily penetrates the soil to contaminate groundwater and nearby waterways.

Zinc, is a heavy metal component of the ore feed at the HPP. It is one of the most common elements in the earth’s crust and may be found in the air, soil, water, and all food. It may combine with other elements to form zinc compounds such as zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide.

Released to the environment by natural as well as human processes, zinc attaches to soil, sediments, and dust particles. Rain scavenges zinc dust from the air. Zinc compounds can move into the groundwater, lakes, and streams. It bio-accumulates in fish and other organisms, but not in plants.

Modes of exposure to zinc include the following: ingestion of food with small amount of zinc, drinking contaminated water or beverages, taking too many dietary supplements containing zinc, and inhalation of zinc particles at or near manufacturing sites.

An essential element in man's diet, too little or too much of the substance can cause health problems. Harmful effects of Zn are usually manifested at levels from 10 to 15 times the recommended daily allowance (RDA), which is from 100 to 250 mg/day. Too much Zn intake can cause stomach cramps, nausea and vomiting. Chronic effects due to prolonged excessive intake include anemia, pancreatic damage, and lower levels of high-density lipoprotein cholesterol. Inhalation of large amount of zinc dusts or fumes can cause meal fume fever.

Aluminum

Aluminum (Al) is naturally occurring, making up about 8% of the earth's surface. In the natural environment, this metal is mostly combined with other elements as minerals and rocks. Acid rain and acidic environment may leach out Al from soil and rocks. It may eventually dissolve in lakes, streams, and rivers. Aluminum can be taken up into some plants from soil. It may bind with particles in the air when airborne (US-ATSDR, 1997).

The exposure modes to aluminum include the following: ingestion of food containing small quantities of Al; inhalation of Al-contaminated air; drinking Al contaminated water; and ingesting substances with high Al content, such as antacids.

Health hazards

Al is not essential in the human body. Low-level exposure to the metal from food, water, air and skin contact may not be harmful. However, aluminum is not necessary for the body and too much may be harmful and could exert toxicological impacts. People exposed to high aluminum levels in the air may have Respiratory problems such as coughing and asthma may result from inhalation of Al particles in air. The metal is also linked to the development of Alzheimer's disease. It has also been found that Infants and adults who received large doses of aluminum as a treatment for another problem developed bone diseases, suggesting that the metal may cause skeletal problems. Animal studies in mice and rabbits show that the metal may cause delays in skeletal and neurological development.

The U.S.E.P.A. recommends that the concentration of Al in drinking water not exceed 0.2 ppm because of taste and odor problems. The U.S.O.S.H.A. set a maximum concentration limit for aluminum dust in the workplace air of 15 mg/cu m for an 8-hour workday over a 40-hour week. The U.S.N.I.O.S.H. has recommended a limit of 10 mg/cu m in workplace air for up to a 10-hour workday over a 40-hour workweek.

4.5 RESULTS OF CONSEQUENCE ANALYSIS

4.5.1 Maximum distances to levels of concern

Using the ALOHA 5.4.7® software, the outcome of postulated hazardous substance releases were quantified in terms of distances and footprints to specified levels of concern or hazard endpoints. The derived distances and generated footprints were used to plot the fatality zones of postulated event scenarios on Google maps using the mapping application software, MARPLOT®.

Tables 4.5.1 and **4.5.2** below show the calculations for the distances to the various hazard endpoints or levels of concern. The relevance of each hazard endpoint or level of concern is described in **Table 4.5.3** and in *Section 4.3.4*. The longest distance to a particular level of concern represents the worst case event for a particular event scenario. These distances are highlighted in **Tables 4.5.3** and **4.5.4**. It is worth noting that worst case event scenarios mostly occurred during very stable-low wind meteorological condition (F2).

Table 4.5.1. Maximum distances to toxic levels of concern.

Event Scenario Designation/ Stability-wind speed conditions	Hole Diameter (mm)	Scenario Description	Maximum Distance to LOC (m)		
			Toxic Vapor Dose		
			AEGL-2 [1]	AEGL-3	1% Pd
I. At the Pier Site					
1. P-CH_3OH-cat	cat.	Catastrophic release of the entire contents of the biggest tank of methanol into bunded area at the pier site resulting to toxic vapor cloud (VC) dispersion	28	27	ND
a. $B_{2.5}$	cat.		53	28	ND
b. D_3	cat.		50	27	ND
c. D_7	cat.		50	27	ND
d. F_2	cat.		173	76	ND
2. P-H2SO$_4$-cat		Catastrophic release of the entire contents of the largest tank of 98% sulfuric acid into bunded area at the pier site resulting to toxic VC dispersion			
a. B2.5	cat.		55	44	ND
b. D3	cat.		102	44	ND
c. D7	cat.		96	44	ND
d. F2	cat.		229	48	ND
II. At the HPP site					
1. HPP-CH_3OH-cat		Catastrophic release of the entire contents of the largest tank of methanol into bunded area at the HPP site resulting to toxic VC dispersion			
a. $B_{2.5}$	cat.		<10	<10	ND
b. D_3	cat.		<10	<10	ND
c. D_7	cat.		<10	<10	ND
d. F_2	cat.		16	<10	ND
2. HPP-H_2SO_4-cat		Catastrophic release of the entire contents of the largest tank of sulfuric acid (98%) into bunded area at the HPP site resulting to toxic VC dispersion			
a. $B_{2.5}$	cat.		27	20	ND
b. D_3	cat.		50	20	ND
c. D_7	cat.		46	20	ND
d. F_2	cat.		106	23	ND
3. HPP-H_2S-Ho-cat		Catastrophic release of H_2S gas from a 1500 mm diameter round hole in the H_2S holding tank at the HPP site resulting to toxic VC dispersion			
a. $B_{2.5}$	1500		493	358	178
b. D_3	1500		697	512	252
c. D_7	1500		219	160	66
d. F_2	1500		938	718	355
4. HPP-H_2S-Su-cat		Catastrophic release of H_2S gas from the H_2S gas supply vessel from an 800 mm diameter round hole resulting to toxic VC dispersion			
a. $B_{2.5}$	800		308	223	112
b. D_3	800		444	321	156
c. D_7	800		289	209	105
d. F_2	800		345	251	125

Legends: cat. = catastrophic; ND = no data for computational constants; 1%Pd = concentration resulting to 1% probability of death; AEGL-2 =Acute Exposure Guideline Level –Tier 2; AEGL-3 =AEGL-Tier 3

[1] AEGL-2 (Acute Exposure Guideline Level -2) is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or serious, long-lasting adverse health effects or an impaired ability to escape; AEGL-3 is the airborne concentration above which it id predicted that the general population, including susceptible ones, could experience life-threatening health effects or death.

Table 4.5.2. Maximum distances to levels for flammable substances

Event Scenario Designation/ Stability-wind speed conditions	Hole Diameter (mm)	Scenario Description	Maximum distance to levels of concern (m)						
			VC Conc. (LFL)	Thermal Dose (kW/m^2)			Explosion Overpressure (psi)		
			1	5	12.5	35	1	3.5	8
I. At the Pier Site									
1. P-CH_3OH-cat	cat.	Catastrophic release of methanol from the largest tank into bunded area resulting to either of the following: vapor cloud fire (VCF), pool fire or vapor cloud explosion (VCE) at the pier site							
a. $B_{2.5}$	cat.		27	57	39	28	NE	NE	NE
b. D_3	cat.		27	60	43	29	NE	NE	NE
c. D_7	cat.		27	59	47	32	NE	NE	NE
d. F_2	cat.		NE	55	36	28	NE	NE	NE
2. P-Diesel-cat	cat.	Catastrophic release of diesel into bunded area resulting to pool fire at pier site	NE	57	36	21	NE	NE	NE
II. At the HPP site									
1. HPP-CH_3OH-cat		Catastrophic release of methanol into bunded area at plant site resulting to VCF, pool fire or VCE							
a. $B_{2.5}$	cat.		<10	<10	<10	<10	NE	NE	NE
b. D_3	cat.		<10	<10	<10	<10	NE	NE	NE
c. D_7	cat.		<10	<10	<10	<10	NE	NE	NE
d. F_2	cat.		<10	<10	<10	<10	NE	NE	NE
2. HPP-H_2SO_4-cat		Catastrophic release of hydrogen gas through a 2000 mm rounded hole on its storage vessel at the plant site resulting to VCF, jet fire or VCE							
a. $B_{2.5}$	2000		34	30	10	10	100	49	40
b. D_3	2000		59	30	10	10	122	70	63
c. D_7	2000		37	32	10	10	77	44	38
d. F_2	2000		141	30	10	10	207	146	138
3. HPP-H_2S-Ho-cat		Catastrophic release of hydrogen sulfide gas through a 1500 mm rounded hole on its holding tank at the plant site resulting to VCF, jet fire or VCE							
a. $B_{2.5}$	1500		11	10	10	10	25	11	NE
b. D_3	1500		11	10	10	10	24	10	NE
c. D_7	1500		<10	10	10	10	NE	NE	NE
d. F_2	1500		11	10	10	10	25	11	NE
4. HPP-H_2S-Su-cat		Catastrophic release of hydrogen sulfide gas through an 800 mm round hole on its supply vessel at the plant site resulting to VCF, jet fire or VCE							
a. $B_{2.5}$	800		11	10	10	10	24	11	NE
b. D_3	800		11	10	10	10	22	10	NE
c. D_7	800		<10	10	10	10	NE	NE	NE
d. F_2	800		11	10	10	10	25	11	NE
5. HPP-Diesel-cat	cat.	Catastrophic release of diesel into bunded area at the plant site resulting to pool fire	0	17	11	6	NE	NE	NE

Legends: cat. = catastrophic; NE = not exceeded; VC = vapor cloud

4.5.2 Event Scenarios with Significant Hazard Distances

Based on VROM's Purple Book (2005, p. 41), only LOC events that contribute to the individual and/or societal risk should be included in the QRA, meaning that an LOC event of an installation should be included only if the following two conditions are met:

1. The frequency of occurrence is equal to or greater than 10-8 per year, and
2. The lethal damage (1% probability) occurs outside the establishment's boundary or the transport route.

Based on the above guideline, LOC event to be included in the computation of LSIFR were initially selected based on the significance of their hazard distances. That is, only LOC events that have the potential to generate hazard distances corresponding to 1% probability of death (1%Pd) or serious injury (in the absence of data on 1%Pd) were selected from the initial list of LOC events. The events selected for inclusion in the LSIFR computations are shown in **Tables 4.5.3** and **4.5.4**. For a particular event and site, the worst or longest hazard distances were used in the subsequent computations of LSIFR and Societal Risks (highlighted in **Tables 4.5.3** and **4.5.4**).

Table 4.5.3. Significant event scenarios that are included in the LSIFR computations for flammable substances.

Event Scenario Designation	Hole Diameter (m)	Maximum distance to levels of concern (m)						
		VC Conc. (LFL)	Thermal Dose (kW/m2)			Explosion Overpressure (psi)		
		1	5	12.5	35	1	3.5	8
I. At the Pier Site								
1. P-CH_3OH-cat	cat.	27	59	47	32	NI	NI	NI
2. P-Diesel-cat	cat.	NI	57	36	21	NI	NI	NI
II. At the HPP site								
1. HPP-H_2-cat	2000	141	30	10	10	207	146	138

Legends: cat. = catastrophic; NI = not included;

Table 4.5.4. Significant event scenarios that are included in the LSIFR computations for toxic substances.

Event Scenario Designation	Hole Diameter (m)	Maximum Distance to LOC (m)		
		Toxic Vapor Dose (ppm)		
		AEGL-2	AEGL-3	1% Pd
I. At the Pier Site				
1. P-CH_3OH-cat	cat.	173	76	ND
2. P-H_2SO_4-cat	cat.	229	48	ND
II. At the HPP site				
1. HPP-H_2S-Ho-cat	1500	938	718	355
2. HPP-H_2S-Su-cat	800	444	321	156

Legends: cat. = catastrophic; ND = Data on constants needed for computation not available

4.5.3 Probability of Death

4.5.3.1 Exposure to Thermal Radiation from Pool Fires and Jet Fires

Based on the Probit Equation described in the *Section 2.2.4.1*, the probabilities of death, for specific thermal radiation doses were computed and are shown in **Table 4.5.5** below.

Table 4.5.5. Probabilities of death for the various thermal radiation doses

Radiation Dose, Q (KW/m^2)	Time (s)	Computed Probit Value, Pr	Pd
5	20	0.36	0
10	20	2.73	0.02
12.5	20	3.49	0.07
35	20	7.00	0.98

4.5.3.2 Exposure to Vapor Cloud Fires (VCF)

The probability of death from VCF is assumed as one (1) for persons within the vapour cloud envelope with concentration of at least 85% Lower Flammable Limit (LFL) of the flammable vapor cloud, as this is the concentration that is expected to support the propagation of fire in case of ignition.

4.5.3.3 Exposure to Vapor Cloud Explosion (VCE)

The probability of death due to explosion overpressure from vapor cloud explosion is shown in **Table 4.5.6** below. The levels of concern used in the quantitative assessment are highlighted.

Table 4.5.6. Probabilities of death and other impacts due to VCE.

Explosion Overpressure (psi)	Expected Damage/Relevance	Reference
1.0	Shatters glass; Possible serious injury due to flying glass and missiles; Probability of injury is 10%; Fatality not expected.; Partial demolition of houses; Usually used as the threshold overpressure value for regulatory purposes by USEPA.	ALOHA® v.5.4.7 USEPA;
>1.45	Possible serious injuries; 2.5% Probability of death for persons inside buildings; Fatality not expected for person in the open.	VROM, 2005, p.119
3.0	Storage tanks fail; 20% chance of fatality to a person in a building.	Dept. of Planning, Sydney, Australia. “Guidelines for Hazard Analysis”
3.5	Serious injury likely	ALOHA® v.5.4.7
>4.35	100% Probability of death for person inside or outside a building	VROM, 2005, p.119
5.0	Nearly complete destruction of houses; Threshold of eardrum damage; 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open.	Dept. of Planning, Sydney, Australia. “Guidelines for Hazard Analysis”
8	Destructionof buildings	ALOHA® v.5.4.7
10.0	Threshold of lung damage; 100% chance of fatality for a person in a building or in the open; Complete demolition of houses	Dept. of Planning, Sydney, Australia. “Guidelines for Hazard Analysis”

4.5.3.4 Exposure to Toxic Vapor Clouds (TVC)

The probability of death (Pd) due to exposure to a toxic cloud was calculated using a probit function and relation. The probit function for death due to toxic exposure is expressed in the following equation (VROM, 2005):

$$\mathbf{Pr = a+b * \ln(C\hat{\ }n*t)}$$

Where:

Pr : probit corresponding to the probability of death (-)
a, b, n : constants describing the toxicity of a substance (-)
C : Concentration (mg/m3)
T : exposure time (minutes, limited to maximum of 30 minutes)

Of the substances assessed for toxicity, only hydrogen sulfide had given values for the constants “a, b, and n”. Since the *Purple Book* (VROM, 2005) guideline states that quantitative risk calculation should be done up to 1% probability of death, Pd, the concentration of hydrogen gas in air corresponding to a 1%Pd was calculated. Results of the calculation showed that the concentration expected to result to 1% Pd was **285 mg/m^3** or **190 ppm** of H_2S gas.

In the absence of data for constant values for the other toxic substances, the value of AEGL-3 (60 minutes) was instead used. Resulting hazard distances as delineated by AEGL-3 are expected to be overestimated, as deaths resulting from exposure to AEGL-3 concentrations are lower than the 1% Pd. "Acute Exposure Guideline Level 3 (AEGL-3) is the airborne concentration of a substance (expressed in ppm or mg/m^3) above which it is predicted that the general public, including sensitive individuals, could experience life-threatening health effects or death" (ORR, NOAA). AEGL-2, on the other hand, is the airborne concentration of a substance (expressed as ppm or mg/m^3) above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

4.5.3.5 Fraction of Death, Fd

The fraction of death, Fd, is one of the factors considered in the calculation of the expected fatalities from an event scenario. It is used in the calculation of Societal Risk. The fraction of death values were calculated based on assumptions given in VROM (2005, pp. 117-119) that the fraction of population inside of buildings is 93% during daytime and 99% at night time. Computed Fd are shown in **Table 4.5.7**.

Table 4.5.7. Fraction of death, Fd, inside and outside of buildings during daytime and night time.

Time/ Rad. Dose	Fpop,in	FE,in	Fpop,out	FE,out	Fd
'I. Thermal Radiation from Pool/ Jet Fires					
1. Day time					
<35 kW/m^2	0.93	0	0.07	0.14	0.0098
≥35kW/m^2	0.93	1	0.07	1	1
2. Night time					
<35 kW/m^2	0.99	0	0.01	0.14	0.0014
≥35kW/m^2	0.99	1	0.01	1	1
'II. Toxic Vapor Cloud					
1. Day time	0.93	0.1	0.07	1	0.163
2. Night time	0.99	0.1	0.01	1	0.109
'III. Vapor Cloud Explosion					
1. Day time					
>4.35 psi	0.93	1	0.07	1	1
>1.45psi	0.93	0.025	0.07	0	0.02325
<1.45psi	0.93	0	0.07	0	0
2. Night time					
>4.35 psi	0.99	1	0.01	1	1
>1.45psi	0.99	0.025	0.01	0	0.02475
<1.45psi	0.99	0	0.01	0	0

<u>Fraction of Death for Vapor Cloud Fires</u>

The fraction of death in the event of delayed ignition of flammable vapor cloud resulting to vapor cloud fires or flash fires is assumed to be one (1) for persons caught engulfed in the flame envelope (VROM, 2005, p. 117).

4.5.4 Number of Fatalities, Nf

The number of potential fatalities was calculated as input for the calculation of the Societal Risk. The calculation of the number of fatalities for a specific event scenario was based on the following formula:

$$Nf = Ne \times Pd \times Fd$$

Where: Nf : Number of fatalities
Ne : Number of exposed population
Pd : Probability of death
Fd : Fraction of death

Hazard distances corresponding to at least 1% probability of death or serious injuries for all event scenarios modelled did not extend beyond the perimeters of the Plant and project facilities. These did not encroach in any populated communities. As such, external fatalities for all event scenarios are nil (zero) and there is no need to compute for Societal Risks, as far as public exposure is concerned. Potential number of fatalities internal to the project were calculated.

Table 4.5.8 shows the calculated potential number of internal fatalities, as well as the bases of the computations. The effect distances are based on the worst event scenarios that produced the longest maximum effect distance. For toxic cloud events, the longest hazard distances were mostly associated with F2 (very stable weather-low wind speed conditions). The longest hazard distances for vapour cloud fire, vapour cloud explosion and pool/jet fires likewise mostly occurred under F2 conditions.

Table 4.5.8. Potential Number of Internal Fatalities (Nfi) and bases for computation.

Scenario Designation	Hazard dose	Effect Distance (m)	Covered Area (m2)	Max. Number of workers per shift	Pop. Den. (pa/m2)	Exposed Workers, NE-int	Pd	Fraction of Death (Fd)	Internal Fatalities (Nfi)
I. Storage of Hazardous Substances at Pier 1									
A. Storage of Methanol									
1. P-CH3OH-cat-TC	AEGL-3 (7200 ppm)	76	4030	7	0.000229	1	0.005	0.163	0.00
2. P-CH3OH-cat-Pool	12.5 kW/m2	47	5214	7	0.000229	1	0.07	0.0098	0
	35 kW/m2	32	2291	7	0.000229	1	1	1	1
3. P-CH3OH-cat-VCF	1 LFL	27	NS	7	0.000229	NS	1	1	NS
B. Storage of H_2SO_4									
1. P-H2SO4-cat-TC	AEGL-3 (37 ppm)	48	NS	7	0.000229	NS	0.005	0.163	NS
Total									**1**
II. Storage of Diesel at Pier 2									
1. P-Diesel-cat-pool	12.5 kW/m2	36	4072	3	0.00068	3	0.07	0.0098	0
	35 kW/m2	21	1385	3	0.00068	1	1	1	1
Total at Pier 2									**1**
II. At the HPP									
A. Storage of H2 gas									
1. HPP-H2-cat-VCF	1 LFL	141	458	248	0.00165	1	1	1	1
2. HPP-H2-cat-VCE	1.45 psi	172	33407	248	0.00165	55	0.025	0.02325	0
	4.35 psi	138	9125	248	0.00165	15	1	1	15
B. Storage of H2S in gas holder									
1. HPP-H2S-Ho-cat-TC	1%Pd (190 ppm)	355	12067	248	0.00165	20	0.01	0.163	0
C. Storage of H2S in supply vessel									
1. HPP-H2S-Su-cat-TC	1%Pd (190 ppm)	232	5051	248	0.00165	8	0.01	0.163	0
Total at the Plant						**99**			**16**

Legends: NS = not significant

4.6 RESULTS OF FREQUENCY ANALYSIS

4.6.1 Frequency of Failure

The frequencies of failure (Ff) of equipment were based on historical generic data as given in the database of HSE (2012) entitled Failure Rate and Event Data for use within Risk Assessments (28/06/2012). The failure rate data are shown in **Table 4.6.1**. The frequencies of failure for significant event scenarios, as determined by previously computed hazard distances, are highlighted.

Table 4.6.1. Calculations of frequencies of failure (F_f) arising from loss of containment of hazardous substances.

Event Scenario Designation	Tank Volume (m^3)	Hole Size (mm)	Failure Rate/ Unit	Unit	No. of Units	Ff (yr^{-1})	References
I. At the Pier							
A. Storage of Methanol at the Pier, 2 tanks							
1. P-CH_3OH-cat	3,361 (L)	cat.	5.00E-06	per tank/year	2	1.00E-05	HSE, 2012, P. 8
2. P-CH_3OH-maj	3,361 (L)	500	1.00E-04	per tank/year	2	2.00E-04	HSE, 2012, P. 8
3. P-CH_3OH-min	3,361 (L)	150	2.50E-03	per tank/year	2	5.00E-03	HSE, 2012, P. 8
B. Storage of H_2SO_4 at the pier, 3 tanks							
1. P-H_2SO_4-cat	12,336 (L)	cat.	5.00E-06	per tank/year	3	1.50E-05	HSE, 2012, P. 8
2. P-H_2SO_4-maj	12,336 (L)	1000	1.00E-04	per tank/year	3	3.00E-04	HSE, 2012, P. 8
3. P-H_2SO_4-min	12,336 (L)	300	2.50E-03	per tank/year	3	7.50E-03	HSE, 2012, P. 8
C. Storage of Diesel at the Pier, 1 tank							
1. P-Diesel-cat	1072 (L)	cat.	5.00E-06	per tank/year	1	5.00E-06	HSE, 2012, P. 8
II. At the HPP							
A. Storage of Methanol at the HPP Lines 1 and 2							
1. HPP-CH_3OH-cat	40 (S)	cat.	1.60E-05	per tank/year	2	3.20E-05	HSE, 2012, p. 19
2. HPP-CH_3OH-maj	40 (S)	250	1.00E-04	per tank/year	2	2.00E-04	HSE, 2012, p. 19
3. HPP-CH_3OH-min	40 (S)	75	1.00E-03	per tank/year	2	2.00E-03	HSE, 2012, p. 19
B. Storage of H_2SO_4 at the HPP, 1 tank							
1. HPP-H_2SO_4-cat	1640 (L)	cat.	5.00E-06	per tank/year	2	1.00E-05	HSE, 2012, p. 19
2. HPP-H_2SO_4-maj	1640 (L)	500	1.00E-04	per tank/year	2	2.00E-04	HSE, 2012, p. 19
3. HPP-H_2SO_4-min	1640 (L)	150	2.50E-03	per tank/year	2	5.00E-03	HSE, 2012, p. 19
C. Storage of Hydrogen (H_2) gas at HPP, 1 tank							
1. HPP-H_2-cat	80.3 (S)	2000	2.00E-06	per tank/year	2	4.00E-06	HSE, 2012, p. 19
2. HPP-H_2-50	80.3 (S)	50	5.00E-05	per tank/year	2	1.00E-04	HSE, 2012, p. 19
3. HPP-H_2-13	80.3 (S)	13	1.00E-05	per tank/year	2	2.00E-05	HSE, 2012, p. 19
D. H_2S gas supply vessel							
1. HPP-H_2S-cat	2.36	250	4.00E-06	per tank/year	2	8.00E-06	HSE, 2012, p. 19
2. HPP-H_2S-50	2.36	50	5.00E-06	per tank/year	2	1.00E-05	HSE, 2012, p. 19
3. HPP-H_2S-13	2.36	13	1.00E-05	per tank/year	2	2.00E-05	HSE, 2012, p. 19
E. H_2S gas holder							
1. HPP-H_2S-cat	200 (S)	1500	4.00E-06	per tank/year	1	4.00E-06	HSE, 2012, p. 19
2. HPP-H_2S-50	200 (S)	50	5.00E-06	per tank/year	1	5.00E-06	HSE, 2012, p. 19
3. HPP-H_2S-13	200 (S)	13	1.00E-05	per tank/year	1	1.00E-05	HSE, 2012, p. 19
F. Storage of Diesel at the Plant site							
1. HPP-Diesel-cat	80 (S)	cat	4.00E-06	per tank/year	2	8.00E-06	HSE, 2012, p. 19

Legends: cat. = catastrophic release; min= minor; maj = major; L = large tank/vessel; S = small tank/ vessel

4.6.2 Ignition Probabilities

The probabilities of immediate (P_{ig-im}) and delayed (P_{ig-del}) ignition following an LOC event were based on peer reviewed generic data and are shown in **Table 4.6.2** below.

Table 4.6.2. Probability of Ignition for Flammable Substances

Event Scenario Designation	Hole Diameter (m)	Released Amount (kg)	$P_{ig\text{-}im}$	$P_{ig\text{-}del}$	References
A. At the Pier Site					
1. P-CH_3OH-cat	cat.	2,395,000	0.065	0.7	VROM, 2005, p. 76, 81
2. P-Diesel-cat	cat.	903,000	0.065	NA	VROM, 2005, p. 76
II. At the HPP site					
2. HPP-H_2-cat	2000	2,000	0.7	0.9	VROM, 2005, p. 76, 81

Legends: cat. = catastrophic; NA = not applicable; $P_{ig\text{-}im}$ = probability of immediate ignition; $P_{ig\text{-}del}$ = probability of delayed ignition

4.6.3 Probability of Wind Direction and Wind Sector

The probability of wind blowing from a certain direction to populated communities was computed based on meteorological data from https://meteoblue.com (Wind rose, Rio Tuba Climate). The wind direction data, as well as the computed probabilities of wind direction (PΨ) are shown in **Table 4.6.3**. The pertinent wind sectors used were based on the wind direction blowing into populated communities relative to the location of the site of loss of containment (LOC) event.

For LOC resulting to pool or jet fires, the probability of wind direction was assigned a value of one, as thermal radiation effects are minimally affected by wind direction.

Table 4.6.3. Wind sectors used and probability of wind direction

Event Scenario Designation	Hole Diameter (mm)	Pool Fire/Jet Fire		VCF/VCE/Toxic Cloud	
		Wind Sectors	Total P_Ψ	Wind Sectors	Total P_Ψ
I. At the Pier Site					
1. P-CH_3OH-cat	cat.	all	1	NNE to ENE	0.46
2. P-H_2SO_4-cat	cat.	all	1	NNE to ENE	0.46
3. P-Diesel-cat	cat.	all	1	NA	NA
II. At the HPP site					
1. HPP-H_2-cat	2000	all	1	W to NNW	0.089
2. HPP-H_2SO_4-cat	cat.	NA	NA	W to NNW	0.089
3. HPP-H_2S-Ho-cat	1500	NA	NA	W to NNW	0.089
4. HPP-H_2S-Su-cat	800	NA	NA	W to NNW	0.089

Legends: P_Ψ = Probability of wind direction

4.6.4 Probability of Atmospheric Condition, Pm

The probabilities of occurrence of the various atmospheric stability condition-wind speed combinations were not factored in the computations of LSIFR due to non-availability of such data for Rio Tuba. As such, Pm for each event scenario was simply assigned a value of “1”.

4.7 CALCULATION OF LOCATION SPECIFIC INDIVIDUAL FATALITY RISK (LSIFR)

The Location Specific Individual Fatality Risk (LSIFR) for each event scenario at a particular location was calculated using the Equation for LSIFR as provided in the VROM’s Purple Book (2005), which is as follows:

$$LSIFR = F_f * P_{ig} * P_m * P_\varphi * P_d$$

Where: Ff : Frequency of failure of equipment (yr^{-1})
Pig : Probability of ignition
Pm : Probability of weather stability-wind speed condition
P_ϕ : Probability of wind direction
Pd : Probability of death

LSIFR for each event scenario was calculated for each loss of containment (LOC) site. The sum of all these LSIFR comprises the LSIFR for that particular LOC site.

4.7.1 Results of LSIFR Calculations

Results of the calculations and the bases of calculation of the Location Specific Individual Fatality Risk (LSIFR) for each event scenario at a particular location are shown in **Table 4.7.1**.

4.7.2 LSIFR Contours

Based on the calculations of the total LSIFR per event scenario per site, the LSIFR contours lines were derived. **Figure 4.7.1** shows the LSIFR contour lines at the Plant site. The contour lines were primarily derived from the hazard distances and corresponding calculated LSIFRs of the worst event scenarios involving the catastrophic release of hydrogen gas resulting to vapour cloud explosion (HPP-H_2-CAT-F2-VCE) and the catastrophic release of hydrogen sulphide gas from the gas holder resulting to toxic vapour cloud dispersion (HPP-H_2S-HO-CAT-F2-TC). Event Scenario No. HPP-H_2-CAT-F2-VCE generated the longest or worst hazard radii among the flammable substances at the Plant site. Event Scenario No. HPP-H_2S-HO-CAT-F2-TC, on the other hand generated the longest hazard radii among the hazardous toxic substances at the Plant site.

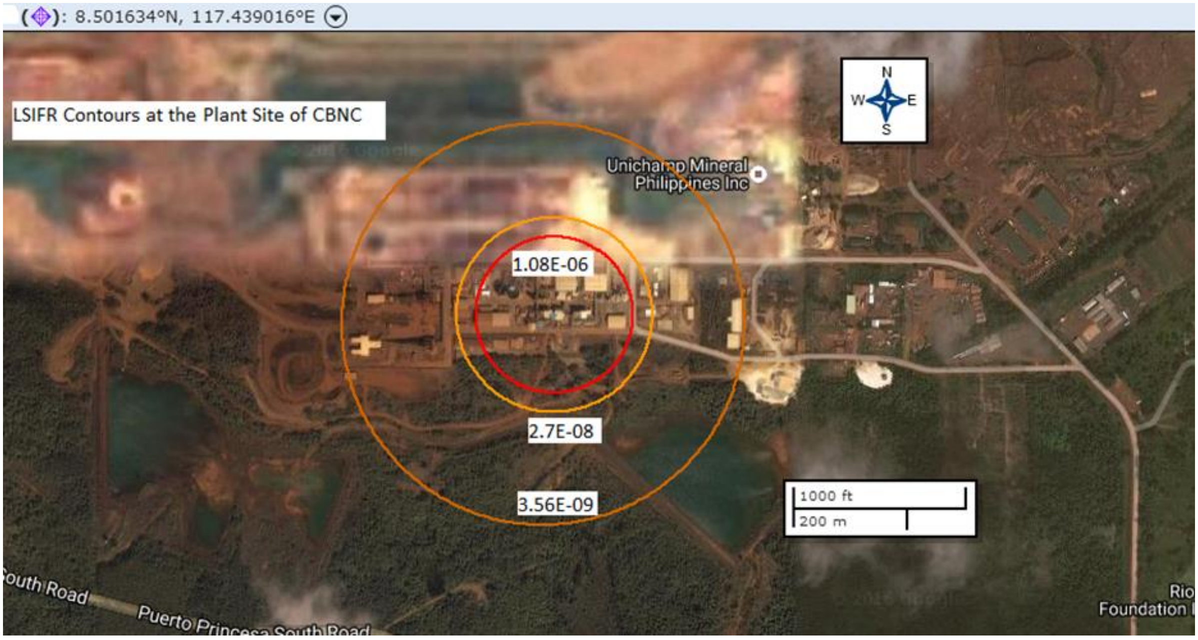


Figure 4.7.1. LSIFR Contours for the LOC event scenarios at the Plant Site of CBNC.

Table 4.7.1. Location Specific Individual Fatality Risks (LSIFR), bases of calculations and corresponding hazard distances for the various Project Facilities of CBNC, 2016.

Scenario Designation	Hazard dose	Ff (yr-1)	Pig	Pm	Pd	PΨ	LSIFR	Hazard radius (m)
I. Storage of Hazardous Substances at Pier 1								
A. Storage of Methanol								
1. P-CH_3OH-cat-TC	AEGL-3 (7200 ppm)	1.00E-05	NA	1	0.005	0.46	2.30E-08	76
2. P-CH_3OH-cat-Pool	12.5 kW/m2	1.00E-05	0.065	1	0.07	0.46	2.09E-08	47
	35 kW/m2	1.00E-05	0.065	1	1	0.46	2.99E-07	32
3. P-CH_3OH-cat-VCF	1 LFL	1.00E-05	0.654	1	1	0.46	3.01E-06	27
B. Storage of H2SO4								
1. P-H_2SO_4-cat-TC	AEGL-3 (37 ppm)	1.50E-05	NA	1	0.005	0.46	3.45E-08	48
Total LSIFR at Pier 1							**3.39E-06**	
II. Storage of Diesel at Pier 2								
1. P-Diesel-cat-pool	12.5 kW/m2	5.00E-06	0.065	1	0.07	1	2.28E-08	36
	35 kW/m2	5.00E-06	0.065	1	1	1	3.25E-07	21
Total LSIFR at Pier 2							**3.48E-07**	
II. At the HPP								
A. Storage of H_2 gas								
1. HPP-H_2-cat-VCF	1 LFL	4.00E-06	0.27	1	1	0.089	9.61E-08	141
2. HPP-H_2-cat-VCE	1.45 psi	4.00E-06	0.27	1	0.025	1	2.70E-08	172
	4.35 psi	4.00E-06	0.27	1	1	1	1.08E-06	138
B. Storage of H_2S in gas holder								
1. HPP-H_2S-Ho-cat-TC	1%Pd (190 ppm)	4.00E-06	NA	1	0.01	0.089	3.56E-09	355
C. Storage of H2S in supply vessel								
1. HPP-H_2S-Su-cat-TC	1%Pd (190 ppm)	8.00E-06	NA	1	0.01	0.089	7.12E-09	232
Total LSIFR at HPP							**1.21E-06**	

Legends: NA = not applicable; Ff = Fequency of Failure, Pig = Probability of Ignition, Fs = Event Frequency; Pm = probability of weather stability; Pd = probability of death at the location; PΨ = probability of wind direction

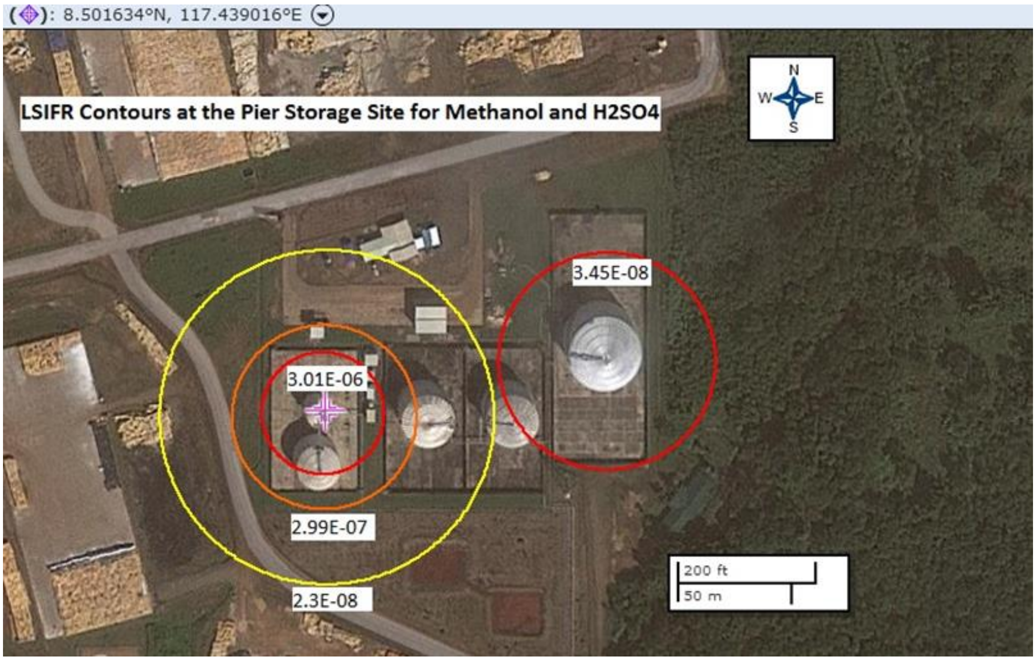


Figure 4.7.2. LSIFR Contours at the Pier Storage Site of Methanol and Sulfuric Acid.

Figure 4.7.3 shows the LSIFR contour lines for LOC event scenarios of diesel in storage at the pier site (RTNMC pier) resulting to pool fire within the bunded area.

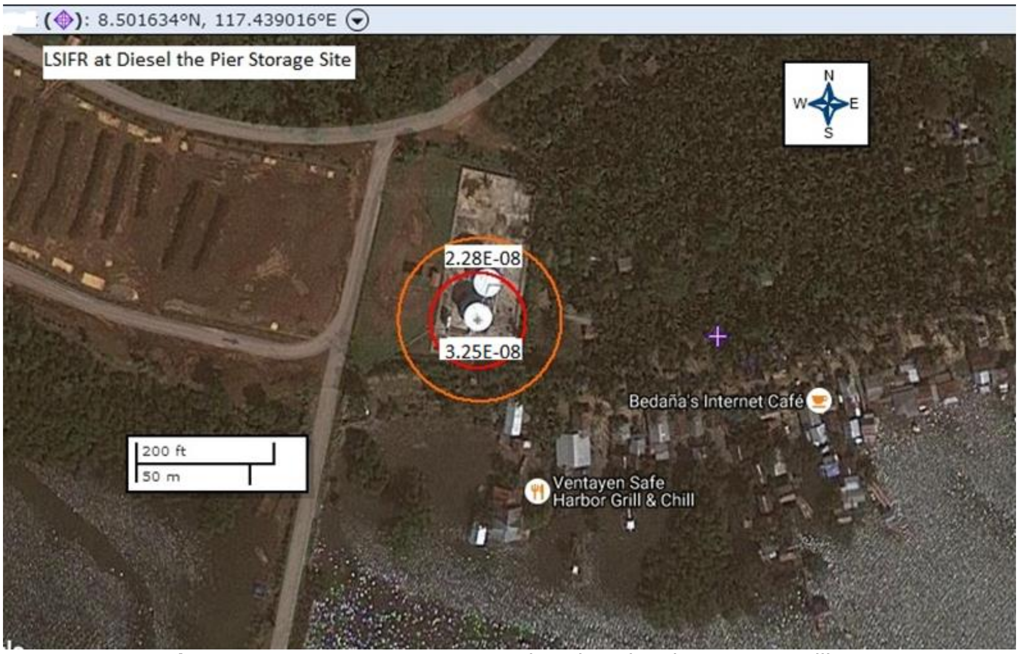


Figure 4.7.3. LSIFR Contours at the Pier Diesel Storage Facility.

4.8 SOCIETAL RISKS

Societal Risk was calculated by combining the results of the consequence analysis, in terms of number of fatalities, with the event frequency (F_s). The potential number of fatalities was earlier calculated in Section 4.5 (**Table 4.5.8**). Calculations of the event frequencies for the various event scenarios are shown in **Table 4.8.1**. The sum of the Event Frequencies for all weather stability-wind speed conditions for each event scenario is shown in **Table 4.8.2**.

4.8.1 Results of Calculation of Event Frequencies (F_s,) for Societal Risks

The results of the calculations of event frequencies and the bases of the computations are shown in **Table 4.8.1**. **Table 4.8.2**, on the other hand, shows a matrix of the derived event frequencies and the corresponding potential fatalities. As significant hazard distances were confined within the limits of the project site's boundaries, all potential fatalities are internal to the project or are project workers. There are no expected fatalities from the surrounding communities.

Table 4.8.1. Event Frequencies (Fs) and bases for computation of Societal Risk.

Scenario Designation	Hazard dose	Ff (yr-1)	Pig	Pm	PΨ	Fs (yr-1)
I. Storage of Hazardous Substances at Pier 1						
A. Storage of Methanol						
1. P-CH_3OH-cat-TC	AEGL-3 (7200 ppm)	1.00E-05	NA	1	0.46	4.60E-06
2. P-CH_3OH-cat-Pool	12.5 kW/m2	1.00E-05	0.065	1	0.46	2.99E-07
	35 kW/m2	1.00E-05	0.065	1	0.46	2.99E-07
3. P-CH_3OH-cat-VCF	1 LFL	1.00E-05	0.654	1	0.46	3.01E-06
B. Storage of H2SO4						
1. P-H_2SO_4-cat-TC	AEGL-3 (37 ppm)	1.50E-05	NA	1	0.46	6.90E-06
Total LSIFR at Pier 1						**1.51E-05**
II. Storage of Diesel at Pier 2						
1. P-Diesel-cat-pool	12.5 kW/m2	5.00E-06	0.065	1	1	3.25E-07
	35 kW/m2	5.00E-06	0.065	1	1	3.25E-07
Total LSIFR at Pier 2						**6.50E-07**
II. At the HPP						
A. Storage of H_2SO_4						
1. HPP-H_2SO_4-cat-TC	AEGL-3 (37 ppm)	1.00E-05	NA	1	0.089	8.90E-07
B. Storage of H_2 gas						
1. HPP-H_2-cat-VCF	1 LFL	4.00E-06	0.27	1	0.089	9.61E-08
2. HPP-H_2-cat-VCE	1.45 psi	4.00E-06	0.27	1	1	1.08E-06
	4.35 psi	4.00E-06	0.27	1	1	1.08E-06
C. Storage of H_2S in gas holder						
1. HPP-H_2S-Ho-cat-TC	1%Pd (190 ppm)	4.00E-06	NA	1	0.089	3.56E-07
	AEGL-3 (50 ppm)	4.00E-06	NA	1	0.089	3.56E-07
D. Storage of H_2S in supply vessel						
1. HPP-H_2S-Su-cat-TC	1%Pd (190 ppm)	8.00E-06	NA	1	0.089	7.12E-07
	AEGL-3 (50 ppm)	8.00E-06	NA	1	0.089	7.12E-07
Total LSIFR at HPP						**5.28E-06**

Table 4.8.2. Matrix of Potential Fatalities and Event Frequencies.

Scenario Designation	Hazard dose	Effect Distance (m)	Potential Fatalities (Nfi)	Event Frequency (Fs)
I. Storage of Hazardous Substances at Pier 1				
A. Storage of Methanol				
1. P-CH_3OH-cat-TC	AEGL-3 (7200 ppm)	76	0	4.60E-06
2. P-CH_3OH-cat-Pool	12.5 kW/m^2	47	0	2.99E-07
	35 kW/m^2	32	1	2.99E-07
3. P-CH_3OH-cat-VCF	1 LFL	27	NS	3.01E-06

Scenario Designation	Hazard dose	Effect Distance (m)	Potential Fatalities (Nfi)	Event Frequency (Fs)
B. Storage of H_2SO_4				
1. P-H_2SO_4-cat-TC	AEGL-3 (37 ppm)	48	NS	6.90E-06
II. Storage of Diesel at Pier 2				
1. P-Diesel-cat-pool	12.5 kW/m^2	36	0	3.25E-07
	35 kW/m^2	21	1	3.25E-07
II. At the Plant Site				
A. Storage of H2 gas				
1. HPP-H_2-cat-VCF	1 LFL	141	1	9.61E-08
2. HPP-H_2-cat-VCE	1.45 psi	172	0	1.08E-06
	4.35 psi	138	15	1.08E-06
B. Storage of H_2S in gas holder				
1. HPP-H_2S-Ho-cat-TC	1%Pd (190 ppm)	355	0	3.56E-07
C. Storage of H_2S in supply vessel				
1. HPP-H_2S-Su-cat-TC	1%Pd (190 ppm)	232	0	7.12E-07

Legends: NS= not significant

4.8.2 Classification of Consequence Classes and Total Event Frequencies

Based on **Table 4.8.2**, event scenarios were classified using a scale of consequence and frequency classes. The consequence classes are shown in **Table 4.8.3** as number of fatality classes. Similar or approximate event frequencies (up to one order of magnitude) of event scenarios that belong to the same consequence class were summed up. The resulting cumulative frequencies (F_{cum}) together with the corresponding number of fatalities (N_f) were plotted on a DENR prescribed FN graph for Societal Risk. The resulting FN Curve is shown in **Figure 4.8.1** and **4.8.2** for the Plant site facilities and the Pier chemical storage facility, respectively.

Table 4.8.3. Matrix of Fatality Classes and Summed Event Frequencies

Fatality Classes	N Value	Summed Fs Value ($year^{-1}$)
I. Storage of CH_3OH and H_2SO_4 at Pier Site		
>0 to <1	<1	2.99E-07
	<1	4.60E-06
1 - 10	1	2.99E-07
	1	1.51E-05
II. Plant Site		
<0 to >1	<1	7.12E-07
	<1	3.56E-07
	<1	1.08E-06
1 - 10	1	9.61E-08
11 - 100	15	1.08E-06

4.8.3 Societal Risk FN Curve

The FN Curves for the CBNC's Plant site and pier site facilities are shown in **Figures 4.8.1** and **4.8.2**, respectively. For the Plant site facilities, all societal risk points, except one, fall well within the Acceptable region of the FN graph. One point fall a little within the ALARP region. This point corresponds mostly to the risk from vapor cloud explosion (VCE) arising from massive loss of confinement of hydrogen gas.

As for the pier facilities, all risk points fall within the acceptable region of the Societal Risk FN graph. This indicates that societal risks presented by storage facilities of methanol and sulfuric acid at the pier site are low and are well within acceptable limits.

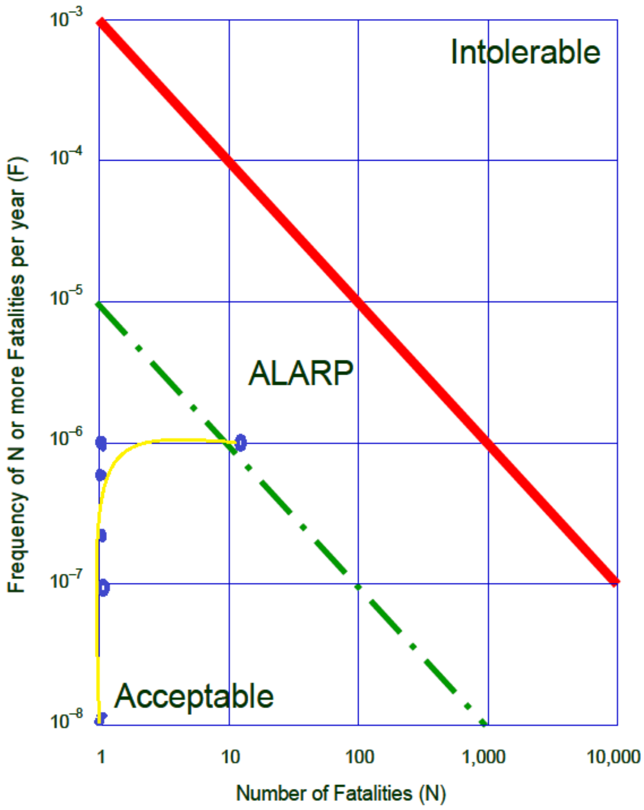


Figure 4.8.1. Societal Risk FN Curve for the Plant Site Facilities

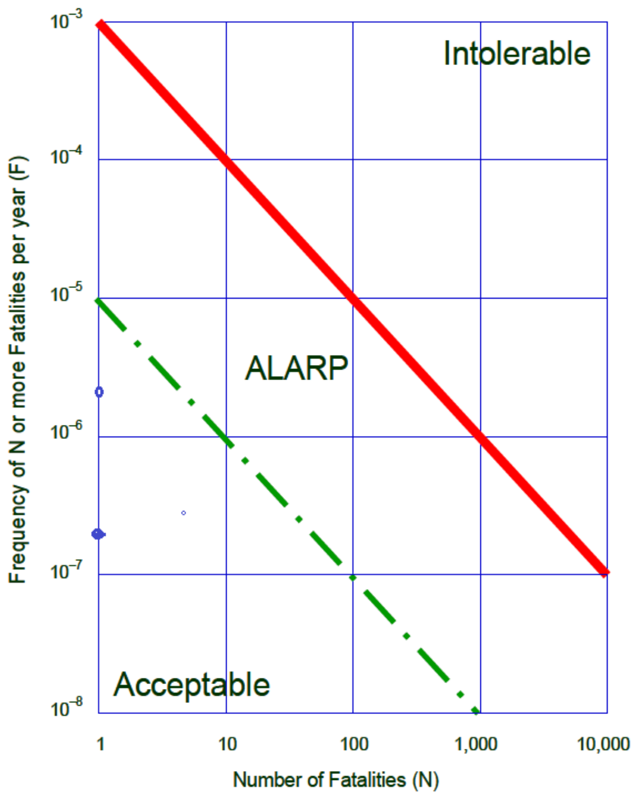


Figure 4.8.2. Societal Risk FN Curve for the Pier Site Storage Facilities

4.9 RISK ACCEPTABILITY

The ERA Guidelines in DAO 2003-30 has set 10^{-6} fatalities per year as the acceptable individual risk criterion, subject to "supplemental guidelines that may be issued by the DENR Secretary". The same DAO set the acceptable societal risk criterion as an "FN curve with slope = -1 and with intercept at N = 1 of 10^{-3}, subject to supplemental guidelines that may be issued by the DENR Secretary (EMB-DENR, 2007).

4.9.1 LSIFR

4.9.1.1 Event Scenarios at the Plant Facilities

The calculated LSIFR of all event scenarios following loss of containment of the various hazardous substances (methanol, sulphuric acid, diesel, hydrogen gas and hydrogen sulphide gas) and using the maximum hazard distance to calculate the event consequences, ranged from 1.08E-09 to 7.12E-06 chance of fatality per year. The total LSIFR for Plant site was calculated at 1.21E-06. The total LSIFR at this site is a little more than the prescribed LSIFR criteria of 10^{-6} fatalities per year. Plots of the LSIFR contour lines (refer to **Figures 4.7**) show that no LSIFR value higher than 10^{-6} chance of fatality per year encroached beyond the boundaries of the project site and no populated communities are affected by such.

4.9.1.2 Event Scenarios at the Chemical Storage Areas at the Pier Site

The calculated LSIFR values at the pier site range from 2.3Ethe LSIFR -08 to 3.01E-06 chance of fatality per year at Pier site with a total of 3.39E-06 chance of fatality per year. Hazardous chemicals that contributed to the risks are methanol and sulphuric acid (98%). The LSIFR contour lines for this site are shown in **Figure 4.7.2**. It is worth noting that no LSIFR lines equivalent to 10^{-6} chance of fatalities per year encroach beyond the boundaries of the project site and no populated communities are affected by such.

4.9.1.3 Event Scenarios at the Pier Diesel Storage Site

The LSIFR values at this project site range from 2.28E-08 to 3.25E-07 chance of fatality per year. Total LSIFR is 3.48E-07 chance of fatality per year. This value is definitely within prescribed LSIFR standard of 10^{-6} chance of fatality per year. No LSIFR contour line greater than 10^{-6} encroach beyond the boundaries of the project site (refer to **Figure 4.7.3**).

4.9.2 Societal Risk

The societal risks associated with the project facilities are illustrated in FN Curve in **Figures 4.8.1** and **4.8.2**. Based on these FN Curves, it could be said that the societal risks associated with the project are all within acceptable limits. For the Plant site, one FN coordinate fell a little way off within the ALARP region. This risk point was attributable to the event scenario of catastrophic release of hydrogen gas from a hydrogen gas holder leading to vapour cloud explosion.

4.9.3 Summary of Risk Acceptability

The results indicate that the societal risks and individual risks associated with the CBNC facilities at the Plant site and at the Pier sites are within acceptable limits based on the set standards of DENR. FN coordinates of the Societal Risk curves mostly fall within the

Acceptable Region, with only one veering a little to the ALARP region. None of the FN coordinates fell within the *Unacceptable Region*. The low risks attributable to the CBNC facilities are confirmed by the LSIFR contour lines. No LSIFR contour lines with equivalent value of greater than 10^{-6} chance of fatality per year encroached beyond the project site boundaries and none of these affected populated communities and public road network in the vicinity.

The ERA and quantitative risk assessment was able to show that both the societal and individual fatality risks from the proposed expansion of the HPP project of CBNC are low and are expected to be within acceptable limits based on DENR Environmental risk criteria. The proposed project expansion involves the establishment of a third Tailings Storage Facility (TSF No. 3), with the closure of TSF No. 1 and an increase in the annual production limit of Cobalt sulfide production. These expansion components will not entail any increase in the amount of hazardous materials/substances stored at the project facilities at the Plant site or at the pier site. It will not involve any increase in the size or number of storage facilities for hazardous substances. Neither will it involve a change in the process employed at the HPP. The increase in the production limit of cobalt sulfides being sought is mostly attributable to higher cobalt contents of nickel ores than was originally expected. As such, it can only be expected that individual and societal risks arising from the project with expansion will not significantly vary from that of the existing project. The assessment done was able to confirm that both individual and societal risks are within acceptable limits, with some areas that need stricter mitigation to keep safety risks to as low as reasonably practicable.

4.10 ENVIRONMENTAL RISK MANAGEMENT OF THE COMPANY

CBNC, aside from its commitment to comply with all regulatory requirements, is committed to promote and develop a safe working environment for its workforce and to ensure that project risks are properly managed so as not to negatively affect the safety and health of the surrounding communities and environment. In compliance with *Section 144* of DENR Administrative Order 2010 – 21 (DAO 2010 – 21), CBNC implements a Safety and Health Program which includes an Emergency Response and Prevention Program. Said document is annually updated and submitted to Mines and Geosciences Bureau Regional Office No. IVB. Policies, guidelines and procedures contained in the said programs are being implemented strictly, such that based on the safety statistics of the Company from 2013-2015, there is no record of any major accident occurrence.

4.10.1 Safety and Health Program (SHP) of CBNC

The Annual Safety and Health Program of CBNC serves as the blue print for ensuring the safety of the workforce and the surrounding communities from the safety and health risks presented by the project. Establishment of an ERPP is part of the SHP. These documents were created based on DAO 2000 – 98 (Mine Safety and Health Standards).

The 2017 Annual SHP is attached as **Annex 4.10.1**. It describes and sets policies, guidelines and procedures on the following aspects, among others:

- Safety and Health Organization of CBNC;
- Organizational Rules and Procedures;
- Safety and Health Meetings;
- Risk Assessment and Management;

- Planned Inspections,
- Safety Trainings;
- Personnel Safety Development;
- Accident/Incident Analysis Investigation, Analysis and Reporting;
- Health Control and Services;
- Emergency Response Program;
- Globalized Harmonized System (GHS) Safety Program;
- Personnel Protective Equipment;
- Safety and Health Incentives;
- Safety Promotion; and
- Community Consultation and Information Campaign

Personnel Protective Equipment.

To implement the SHP, CBNC allocates a sizable budget for the Program. In the aspect of Personnel Protective Equipment, for example, it had allocated budget for the procurement of the following PPEs for a manpower of 1,000 to 1,500:

- Head protection (safety helmet and accessories);
- Foot protection (safety shoes, rain shoes, etc.);
- Hand protection (various types gloves appropriate for various uses);
- Eye protection (goggles, face shield, safety glass, etc.);
- Hearing protection (ear plugs, ear muffs);
- Respiratory protection (various types of respirators, cartridges, etc.); and
- Protective clothing (chemical suit, dust suit, raincoats, full body harness with safety belt, reflectorized vests, bonnets, umbrellas, etc.).

Manpower Safety Trainings

SHP regularly planned and conducted or sponsored safety trainings for its manpower and contractors. The following trainings were regularly and recently conducted:

- First Aid and Basic Life Support Training;
- Fire Fighting Training;
- Training/Seminar for Assistant Radiological Health and Safety Officer;
- Basic Occupational Safety and Health Seminar (BOSH); and
- Disaster Management Training.

Other safety trainings that are conducted and sponsored by CBNC for its manpower and contractors are the following:

- Safety Orientation;
- Safety Cards;
- Radiation Training;
- Defensive Driving Course;
- Safety Proficiency/ Knowledge Test;
- Lifting Equipment and Overhead Safety Training; and
- Boom Truck Operator Training.

4.10.2 Safety Statistics for the Period 2013-2015

Tables 4.10.1 below shows the annual safety statistics for the CBNC HPP project for the period 2013-2015. For the said period, there is only one non-fatal loss time accident (NF-LTA), which occurred in the year 2013, incurring a total of 11 days lost. A lost time accident is an accident occurring at the workplace that results in at least one full day away from work due to sustained injury. A Fatal Lost Time Accident (FLTA), on the other hand, is an accident occurring at the workplace that results to the death of a worker or workers. A death at the workplace is equivalent to 6,000 days lost.

It is worth noting that no fatal lost time accident (FLTA) occurred in the three-year period, indicating that no major accident happened in the said period. For the said period, a total of thirty two (32) No Lost Time Accident (NLTA) were recorded, majority (17) of which occurred in 2013. CBNC was able to reduce the NLTA in the next two years. Total man-hours worked in the three year span of 2013-2015 was 21,615,670 hours. At the close of 2015, total man-hours worked to date was 46,898,119. Based on the safety statistics, it could be said that the safety performance of CBNC for the period was good.

Table 4.10.1. Annual safety statistics for the CBNC Project Operations, 2013-2015

Year	Type of Accident			Total	Days Lost	Manhours Worked		Freq. Rate	Severity Rate
	NLTA	Lost Time Accident							
		NF	Fatal			This Year	To Date		
2013	17	1	0	18	0	7,131,194	32,398,497	0.03087	0
2014	8	0	0	8	0	7,356,987	39,770,630	0.00000	0
2015	7	0	0	7	0	7,127,489	46,898,119	0.00000	0
Total	32	1	0	33	0	21,615,670	46,898,119		

Legends: NLTA = No Lost Time Accident; NF =Non-Fatal

4.10.3 Emergency Response and Preparedness Program (ERPP)

CBNC has already established a system of preparation and implementation of an ERPP (**Annex 4.10.2**). The Safety and Health Committee reviews the ERPP once a year, every time an emergency occurs or whenever there is a new/revised legislation. Additional information, revisions and modifications proposed by the said committee shall be incorporated in the plan while the dissemination of these changes shall be the responsibility of the plant manager in collaboration with the Central Safety and Health Committee. The ERPP prepared and implemented by CBNC is based on the Awareness and Preparedness for Emergencies at Local Level (APELL) which has the following requirements:

- **Step 1** Identify the emergency response participants and establish their roles, resources and concerns.
- **Step 2** Evaluate the risks and hazards that may result in emergency situations in the community and define options for risk reduction.
- **Step 3** Have participants review their own emergency plan for adequacy relative to a coordinated response, including the adequacy of communication plans.
- **Step 4** Identify the required response tasks not covered by the existing plans.
- **Step 5** Match these tasks to the resources available from the identified participants.
- **Step 6** Make the changes necessary to improve existing plans, integrate them into an overall emergency response and communication plan and gain agreement.

- **Step 7** Commit the integrated plan to writing and obtain approvals from local governments.
- **Step 8** Communicate the integrated plan to participating groups and ensure that all emergency responders are trained.
- **Step 9** Establish procedures for periodic testing, review and updating of the plan.
- **Step 10** Communicate the integrated plan to the general community.

The 2017 Annual ERPP describes in detail the responsibility of various Emergency Response Team (ERTs), which is headed by the Plant Manager (**Table 4.10.2** and **Figure 4.10.1**). Furthermore, it contains the Emergency Management Plan with primary details on the communication routes, handling the public, and communication contacts, among others. It covers emergency procedures for incidents listed in **Table 4.10.3**. The ERPP is approved by MGB.

Table 4.10.2. Composition of the Emergency Response Team (ERT)

Incident	Responsible Person/s
Plant Manager	Head, ERT
Manager, Production Dept.	Head, Production Operation Team at Plant Site (Production)
Manager, Technical Dept.	Sub-head, Production Operation Team at Plant Site (Production) Sub-head ERT
Manager, General Affairs Dept.	Head, Guidance and Public Relations Team
Manager, Personnel Section	Sub-head, Guidance and Public Relations Team (Calamity)
Manager, Community Relation Section	Sub-head, Guidance and Public Relations Team
Manager, Maintenance Dept.	Head, Fire Fighting and Maintenance Operation Team Sub-head ERT
Manager, Purchasing and Logistics Dept.	Head, Pier Site Operation
Manager, Utilities Dept.	Head, Utilities Operation Team

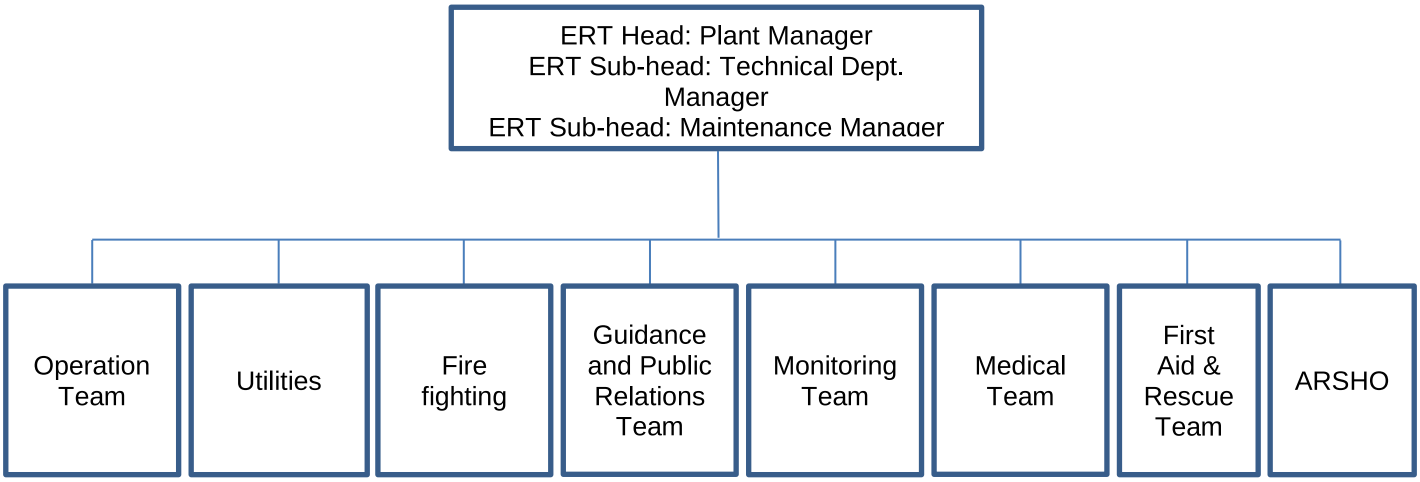


Figure 4.10.1. Organizational chart of the Emergency Response Team (ERT)

Table 4.10.3. Incident covered by CBNC's ERPP

Incident	Responsible Person/s	Details
H_2S gas leak	• Production Manager • General Affairs Manager • Plant Manager • ERT • Maintenance Manager	Refer to *Section 3.1* of Chapter 3; pp. 20 - 29
Acid leak/Autoclave Emergency - Pipeline (Plant Site)	• Plant Manager (ERT Head) • Production Manager • Acid Leak Response Team Members	Refer to *Section 3.2.1* of Chapter 3; pp. 32 - 34
- Pipeline (Pier Site)	• Plant Manager (ERT Head) • Purchasing and Logistics Manager (Acid Leak Pier Site Team Head) • Pier Site Shift Supervisor (Acid Leak Team Sub-Leader) • Acid Leak Response Team Members	Refer to *Section 3.2.2* of Chapter 3; pp. 34- 36
- Lorry (Plant Site)	• Plant Manager (ERT Head) • Production Manager (Operation Team Head) • Acid Leak Response Team Members	Refer to *Section 3.2.3* of Chapter 3; pp. 36- 39
- Lorry (Pier Site)	• Plant Manager (ERT Head) • Pier Site Shift Supervisor (Acid Leak Team Sub-Leader) • Acid Leak Response Team Members	Refer to *Section 3.2.4* of Chapter 3; pp. 39- 40
- Lorry (Macadam Road)	• Plant Manager (ERT Head) • Pier Site Shift Supervisor (Acid Leak Team Sub-Leader) • Acid Leak Response Team Members	Refer to *Section 3.2.6* of Chapter 3; pp. 41- 44
Power failure/Boiler/Steam turbine generator emergency	• Production Manager/Utility Manager • Production Chief Supervisor and Shift Leaders • Field Operators	Refer to *Section 3.3* of Chapter 3; pp. 44- 48
Fire - Coal Fire (Stockyard)	• Plant Manager (ERT Head) • Pier Site Shift Supervisor (Pier Site Fire Fighting Team Leader) • Pier Site Fire Fighting Team Members	Refer to *Section 3.4.1* of Chapter 3; pp. 50- 52
- Methanol Fire (Pier Site)	• Plant Manager (ERT Head) • Pier Site Shift Supervisor (Pier Site Fire Fighting Team Leader) • Pier Site Fire Fighting Team Members	Refer to *Section 3.4.3*of Chapter 3; pp. 52- 54
- Methanol Fire (Plant Site) -	• Plant Manager (ERT Head) • Production Manager (Fire Fighting Team Leader of MS) • MS Process (Fire Fighting Team Members)	Refer to *Section 3.4.4* of Chapter 3; pp. 54- 56
- Sulfur Fire (Pier Site) -	• Plant Manager (ERT Head) • Pier Site Shift Supervisor (Pier Site Fire Fighting Team Leader) • Pier Site Fire Fighting Team Members	Refer to *Section 3.4.5* of Chapter 3; pp. 56 - 57
- Sulfur Fire (Plant Site)	• Plant Manager (ERT Head) • Production Manager (Fire Fighting Team Leader of MS)	Refer to *Section 3.4.6* of Chapter 3; pp. 57 - 59

Incident	Responsible Person/s	Details
	• MS Process (Fire Fighting Team Members)	
Traffic Accidents - Fuel, Oil and Chemical Spills/Leaks Oil Spills	• EMQCS Coordinator • Emergency Response Team •	Refer to *Section 3.5* of Chapter 3; pp. 59 - 61
Chemical Leaks	• Plant Manager (ERT Head) • Logistics	Refer to *Section 3.6* of Chapter 3; pp. 61- 70
Typhoon, Flood, Heavy Rain and Landslides	• Plant Manager (ERT Head) • Production Manager • General Affairs Manager	Refer to *Section 3.7* of Chapter 3; pp. 70 - 77
Accidents at CBNC Complex	• General Affairs Manager • Supervisor • First Aiders/Rescuers	Refer to *Section 3.8* of Chapter 3; pp. 77 - 80
Tailings Dam Emergency	• Plant Manager (ERT Head) • Production Manager	Refer to *Section 3.9* of Chapter 3; pp. 80- 86
Emergency on Nuclear Equipment and Devices	• Shift Superintendent	Refer to *Section 3.10* of Chapter 3; pp. 86 - 96
Earthquake	• Plant Manager (ERT Head) • Production Manager • Purchasing and Logistics Manager	Refer to *Section 3.11* of Chapter 3; pp. 96 - 104
Medical Outbreak	• RTNFI Hospital Director	Refer to *Section 3.12* of Chapter 3; pp. 104 - 107

Emergency Information, Posters and Signage

The following information, which are important in averting and/or responding to specific emergency situations are posted in strategic locations and from as part of CBNC manpower orientation:

- Location of H_2S detectors;
- Emergency Response Team chart;
- Evacuation Route Plan for H_2S Gas Leak
- Emergency Plan for GOB and PSO;
- Emergency Route Plan During an Earthquake;
- CBNC Emergency Flow Chart;
- Emergency Muster Areas;
- Emergency Evacuation Areas;
- CBNC Plant Site Restricted Areas;
- CBNC Pier Site Restricted Areas;
- CBNC Plant Site Fire Hazard Areas;
- CBNC Plant Site Smoking Area;
- Locations of Fire Equipment;
- Locations of pH Monitoring System;
- Location of Plant site Paging System;
- Required Personnel Protective Equipment; and
- Provision of MSDS for hazardous chemicals in strategic and easily accessible locations.

Emergency Drills

Emergency drills for specific events such as fire, earthquake and toxic chemical spills are regularly conducted. The following emergency drills were recently conducted:

- Earthquake and Tailings Dam Failure Emergency Drill;
- Fire Drill;
- Emergency Acid Leak Drill (Plant Site);
- Macadam Road Emergency Acid Leak Drill;
- H_2S Leak Emergency Drill; and
- Fire Truck and Fire Hydrant Utilization;

4.11 CONCLUSION AND RECOMMENDATIONS

Results of the ERA and the quantitative risk assessment show that environmental risks from the proposed project expansion of CBNC will not significantly differ from that of the existing project. Societal risks, as well as individual risks are all within acceptable limits based on the standards of DENR. A review of the existing Safety and Health Program (SHP) and Emergency Response and Prevention Program (ERPP) of the Company, as well as a walk through conducted, showed that the existing policies, strategies, procedures and facilities to manage environmental, safety and health risks from the project are adequate. A walk through of the project facilities and interview of key personnel showed that the approved SHP and ERPP are being implemented as planned. The good safety statistics for the past three-year period for the Company would tend to support the ERA and QRA findings. It is recommended that the Company continue with the strict implementation of their MGB-approved annual SHP and ERPP. The continued monitoring of heavy metal concentration in the impacted surface waters and ground waters will help confirm the impact of increased Cobalt production, as well as the impact of a new TSF.

5 Social Development Plan/Framework (SDP) and IEC Framework

Coral Bay Nickel Corporation

This chapter presents the Social Development Plan (SDP) of Coral Bay Nickel Corporation (CBNC) which continuously serves as basis in enhancing the on-going social projects of the company which benefit the local stakeholders. Moreover, under Republic Act No. 7942 (Philippine Mining Act of 1992), the Social Development and Management Program (SDMP) provides that the contractors shall assist in the development of the affected communities, promote the general welfare of the communities' inhabitants and develop geoscience and mining technology. Thus this SDP shall provide understanding of the current status of the SDMP implementation and other projects that may be enhanced in coordination with the communities and authorities. The Information, Education, and Communication (IEC) framework on the other hand shall serve as a guide to properly develop a strategy that will enrich the current IEC activities of the company.

5.1 SOCIAL DEVELOPMENT AND MANAGEMENT PLAN (SDMP)

Since 2004 upon the operation of Line 1 Hydrometallurgical Processing Plant (HPP), a combined fund for the implementation of the SDMP between CBNC and Rio Tuba Nickel Mining Corporation (RTNMC) has been established and now on its third SDMP covering years 2014 to 2018.

Identification and Prioritization of Projects

To carry out the plan, a Community Relations Office (CRO or ComRel) was established by both CBNC and RTNMC. Its office is respectively headed by a Community Relations Officer who is ably supported by a set of qualified staff.

The ComRel, aside from being the spokesperson of the company, interacts with the host communities and local government officials. Concerns about employment, medical missions, education, trainings, livelihood, and other community needs have been the primary focus of the ComRel. Up until SDMP II, the CRO has been responsible in highlighting the needs of the community and approval and/or endorsement of these necessities to the proper corporate authorities. CRO also leads in assisting in the development of the affected communities.

During the last quarter of the last year of implementation of SDMP II, a Technical Working Group (TWG) was organized to prepare for the implementation of SDMP III. This group was composed of representatives from the 10 affected barangays plus one (1) adopted barangay, RTNMC/CBNC ComRel, Department of Education, DENR-MGB IVB, Rural Health Unit, RTN Foundation, Inc., Haribon, Palawan Council for Sustainable Development (PCSD), Community Environment and Natural Resources Office (CENRO), Municipal Planning and Development Coordinator (MPDC), Bureau of Fisheries and Aquatic Resources (BFAR), Municipal Agricultural Office (MAO), and Provincial Planning and Development Office (PPDO). Subsequently, activities on barangay development planning were held in the 11 barangays. The barangay development planning sessions focused on four (4) sectors or areas of development. These were Enterprise Development, Health, Land-use, and Human Resource.

Then, by the middle of 2013, together with the National Commission on Indigenous Peoples (NCIP), Indigenous Peoples' Development Office (IPDO), and the Indigenous Cultural Communities (ICCs), an SDMP III wish list of IPs and ICCs was drawn. Subsequently, the SDMP III budget was presented among the RTNMC/CBNC Management representatives, Multi-partite Monitoring Team (MMT), Mines and Geosciences Bureau (MGB) representatives, TWG, RTNMC/CBNC Comrel, RTNFI, and heads of Barangays/Tribal chieftains. There were also planning conferences/meetings held among the barangay captains of the other 11 non-impact barangays as these have already been included to benefit from the implementation of the social development projects. Towards the end of the third quarter of 2013, a validation of SDMP III allocation for IPs and ICCs was held.

Table 5.1.1 shows the combined SDMP and Corporate Social Responsibility (CSR) funds for the three (3) periods: SDMP I (2004-2008), SDMP II (2009-2013), and SDMP III (2014-2018). The total amounts increased through the years from PhP 356,004,517.00 during SDMP I, PhP 565,132,967.00 (approximately 62% increase from SDMP I) in SDMP II to PhP 991,202,133.29 in SDMP III (approximately 57% increase from SDMP II).

Table 5.1.1. CBNC and RTNMC combined funds for SDMP and CSR

Mandates	DENR DAO 2004-51		DENR DAO 2010-13	Joint CSR
Mandated obligation	1% of direct milling cost	1% of direct milling cost	1.5% of operating cost	-
	PhP238,165,600	PhP332,479,794	PhP991,202,133 (projected)	-
	SDMP I	SDMP II	SDMP III	Corporate funds
	2004-2008	2009-2013	2014-2018	2014-2018
Community Development Programs				
Community-based (Community Development Programs)				
1. Infrastructure and Human Resources development	30,429,431.00	36,812,894.00	57,746,030.00	-
2. Health and sanitation	-	8,440,302.00	74,379,374.00	-
3. Education	32,697,817.00	46,584,924.00	97,453,361.00	-
4. Livelihood	14,526,510.00	36,678,321.00	94,315,003.00	-
5. Various Social Projects	23,618,405.00	57,906,877.00	-	-
6. Land-use and environment	-	-	39,651,558.00	-
7.SDMP for IPs	-	-	131,966,807.00	-
A. Hospitalization program for IPs and Indigents	80,568,988.00	116,344,927.00	250,000,000.00	-
B. LSVMS School subsidy (for non-dependents)	57,539,161.00	50,544,523.00	-	50,000,000.00
C. GK Housing for IPs	14,278,231.00	26,183,764.00	-	50,000,000.00
D. Indigenous Learning system	13,063,427.00	30,986,520.00	-	60,000,000.00
E. Community Relations Assistance	68,878,567.00	109,463,924.00	-	100,000,000.00
IEC	20,404,000.00	46,186,000.00	147,420,000.00	-
Development of mining technologies and geosciences	Combined with IEC	Combined with IEC	98,270,000.00	-
TOTAL	**356,004,517.00**	**565,132,976.00**	**991,202,133.29**	**260,000,000.00**

Source: CBNC ComRel Report, 2016

Table 5.1.2 shows that CBNC, all throughout SDMP I, II, and III allotted a higher percentage contribution compared to RTNMC. With SDMP I, CBNC's contribution was 67% compared to RTNMC's 33%. When SDMP II was implemented, CBNC shared 88% while only 12% was given by RTNMC. With the ongoing SDMP III, CBNC contributes 82.78% in relation to RTNMC's 17.22%. The difference in percentage contribution is attributed to the source of funds and the coverage of the impact areas of CBNC (11 barangays) and RTNMC (6 barangays). SDMP funds are sourced from the direct milling and operating costs of the respective organizations and these change based on the different factors affecting expenditure. On the other hand, there was a 50:50 sharing in allocating funds for projects under the CSR of the companies.

Table 5.1.2. Percentage Sharing Scheme of RTN and CBNC

Companies	Period 2004-2008		Period 2009-2013		Period 2014-2018	
	SDMP I	CSR	SDMP II	CSR	SDMP III	CSR
CBNC	67%	50%	88%	50%	82.78%	50%
RTN	33%	50%	12%	50%	17.22%	50%

CBNC ComRel Report, 2016

CBNC SDMP and CSR Budget Allocation for Various Projects

Table 5.1.3 shows that 30% or PhP 67,852,349.20 of the total SDMP I financial resources amounting to PhP 222,165,589.84 sourced from CBNC was spent for community-based development projects that include infrastructure and human resource development (9.18%), education (9.86%), livelihood (4.38%), and various social projects (7.12%). On the other hand, 24.30% was allotted for the hospitalization program of indigenous people (IPs) and indigents, 17.35% for the Leonides S. Virata Memorial School (LSVMS) subsidy, 15.5% for community relations assistance (CRA) program, 3.21% for *Gawad Kalinga* (GK) housing for the IPs, and 2.94% for Indigenous Learning System (ILS). Furthermore, about 6% was spent for the IEC program.

For SDMP II, funds allocation differed from the previous SDMP efforts. Aside from an increase in a total budget of PhP 433,996.019.84, funds appropriated for the community-based projects increased to 37.80% from 30.54%. However, the other programs on hospitalization, LSVMS subsidy, GK housing for IPs, and CRA decreased in percentage allocation. The proportion of funds allocated for IEC nevertheless increased to 9.36% from 6.15%.

As SDMP III rolled out for implementation, the funds allotted to community-based projects increased to almost 50% of the total appropriation of PhP 820,517,125.94. It should be noted that there was an increase in monies assigned to carry out SDMP III activities as a result of increasing the base source from 1% of milling costs to 1.5% of operating costs. Basis of change was DENR DAO 2010-13.

There were two (2) additional community-based projects in SDMP III. These were land-use and environment, and SDMP projects for IPs. The SDMP funds allocated to projects for IPs comprised the highest percentage among the community-based projects at 13.32%, followed by education (9.83%), and livelihood (9.51%). The sector that got the lowest percentage share was land-use and environment (4.00%). Furthermore, about 14.87% was allotted for IEC, and 9.91% for development of mining technologies and geosciences.

The other projects that had been supported in SDMP I and II and not integrated in SDMP III were the subsidy to the LSVMS, GK Housing for IPs, and CRA. Nonetheless, these were continued and supported under the CSR funds of the company which totaled to PhP 130,000,000.

Table 5.1.3. Social Development Management Program and Corporate Social Responsibility of CBNC, 2004-2018

Mandates	DENR DAO 2004-51	%	DENR DAO 2004-51	%	DENR DAO 2010-13	%	CSR	%
Mandated Obligation	1% of Direct milling cost	-	1% of Direct Milling cost	-	1.5% of Operating cost	-		-
	SDMP I (2004-2008)	-	SDMP II (2009-2013)	-	SDMP II (2014-2018)	-	Corporate funds 2014-2018	-
Community-based Programs								
A. Community based CDP 1. Infrastructure and Human Resource Development	20,387,718.77	9.18	32,395,346.72	7.46	47,802,163.63	5.82	-	-
2. Health and Sanitation	-	-	7,427,465.76	1.71	61,571,245.80	7.50	-	-
3. Education	21,907,537.39	9.86	40,994,733.12	9.44	80,671,892.24	9.83	-	-
4. Livelihood	9,732,761.70	4.38	32,276,922.48	7.44	78,073,959.48	9.51	-	-
5. Various Social Projects	15,824,331.35	7.12	50,958,051.76	11.74	-	-		
6. Land-use and	-		-	-	32,823,559.71	4.00		
7. Environment							-	-
8. SDMP for IPs	-	-	-	-	109,242,123.07	13.32	-	-
Subtotal	*67,852,349.20*	*30.54*	*164,052,520.00*	*37.80*	*410,184,944.00*	*49.99*	-	-
B. Hospitalization Program for IPs and Indigents	53,981,221.96	24.30	101,503,535.76	23.39	206,950,000.00	25.22	-	
C. LSVMS School subsidy (non-dependents)	38,551,231.17	17.35	44,479.180.24	10.25	-	-	25,000,000.00	19.23
D. GK Housing for IPs	7,139,115.50	3.21	13,091,882.00	3.01	-	-	25,000,000.00	19.23
E. Indigenous Learning System	6,531,713.50	2.94	15,493,260.00	3.56	-	-	30,000,000.00	23.10
F. Community Relations Assistance Program (CRA)	34,439,278.50	15.50	54,731,962.00	12.61	-	-	50,000,000.00	38.46
IEC	13,670,680.00	6.15	40,643,680.00	9.36	122,034,276.00	14.87	-	-
Development of Mining Technology and Geosciences	-	-	-	-	81,347,906.00	9.91	-	-
Subtotal	*154,313,241*	*69.45*	*269,943,500*	*62.20*	*410,332,182*	*50,00*	*130,000,000.00*	*100.00*
Total	**222,165,589.84**	**100.00**	**433,996,019.84**	**100.00**	**820,517,125.94**	**100.00**	**130,000,000.00**	**100.00**

CBNC ComRel Report, 2016

Assessment of the SDMP Implementation

The SDMP projects implemented by CBNC/RTNMC are seen as an avenue to improve the lives of the residents of the direct and indirect impact barangays together with the IPs. From years 2004 to the present, hundreds of millions in Philippine peso have been allocated and disbursed to address the plight of the communities.

All through these years, several completed projects focused on different sectors. There are several points that need to be given a closer look when one goes through the list of SDMP accomplishments.

1. The number of beneficiaries mentioned is not categorized as to whether these are direct or indirect. For example, a completed project on the provision of hand tractors, listed that there were 2,000 beneficiaries when this was completed in 2010. It is not clear if this was the number of farmers who were granted the tractors or if this

included the family members or residents in the community that gained directly or indirectly from the program.

A misconception on the total number of affected people is implied if proper categorization of project beneficiaries is not done. As the report is presented, it seems that a big number of beneficiaries gained through the completed SDMP projects but a closer inspection on site suggests otherwise.

2. Appropriate identification of livelihood options must be prioritized as well as proper coordination among sectors before implementation by the community members is pursued.

   The list of projects done in the first phase of SDMP which were stated as failure such as animal dispersal has been repeatedly reported in 2014 and 2015 as one of the livelihood projects implemented. *If these were seen as failures, why were projects still repeated?* The implementers should have taken down notes and lessons learned from the previous years of project implementation so that the mistakes done and more funds wasted could have been avoided.

   While the creation of the sectoral committees for the implementation of SDMP III seemed to be the right approach to address the community's needs and concerns, it was somehow perceived by the participants in the FGDs and KIIs as compartmentalized rather than holistic. Accordingly, sectoral committees meet, discuss and approve plans, programs and budget allocation without consultation with the other committees. There are instances when the person assigned to a specific committee has limited knowledge about the issues raised and discussed within that committee. By the time the plans and programs of the other groups are presented during the budget validation and meetings, very little can be done to influence a major change to address the over-all implementation based on the inter-related sectoral issues.

   The barangay leaders/representatives felt they cannot pursue their arguments about some issues, especially on the more technical ones, because they are less educated than the other representatives from the NGOs, LGUs and national agencies. They deemed that some of the members from the MGB, Haribon and PCSD are "all knowing" about their situation at the barangay level but in reality are not. One even stated that "no one actually knows what is happening and how one feels except the one who is actually in the situation and encounters all the trials and challenges."

   It is recommended that prior to approval of projects and corresponding budget, there should be another round of validation possibly in smaller groups where the less learned are not intimidated by the more educated ones.

3. Appropriate preparation of local communities prior to enterprise development must be suitably carried out.

   In the conduct of the coffee plantation project for example, the members of the community learned many lessons the hard way. It was found that if the seedlings are planted during summer months, survival rate is low because of the limited water supply and extreme heat conditions. Likewise, the chance of survival is also low if seedlings are over-mature and have overstayed in the nursery before they are transplanted out in the field. These situations were experienced because of the delay in the release of funds. It also seemed that some of the participants of the project were not too interested in pursuing the project because it takes a long period of time (about 3-5 years depending on the factors of production) before they can harvest the beans and recover their inputs.

It is thus recommended that while the local communities are "given a relatively free hand in mapping their future by choosing the projects they want to embark in", the approaches should be perceived in the most objective manner. There are barangays that are fortunate to have leaders who are knowledgeable and can lead them to implement successful projects. They may also have residents who are very familiar on the various practices and strategies in executing specific project activities. However, there are barangays that tend to lag behind and should be given more time or more technical assistance/skills training to prepare them in decision-making and project implementation. A standard and general approach in implementing livelihood projects cannot be adopted for all participating barangays if the community participants are not embarking at the same level of preparedness.

It should also be noted that a specific project should not be recommended for implementation just because this has been successfully put into action in other communities. It is worthy to state that there are various factors which influence the success of a project. These include the willingness and interest to participate, availability of skills/capabilities, raw materials, institutional and political support, market and financial assistance and state of the art technology and best practices.

4. The communities' present dependence on mining firms for employment must be transformed to a desire to implement technically, socially and economically sustainable livelihood projects for them to be empowered.

   The results of the FGD substantiated that one of the primary positive impacts of the project is gaining employment from the company although some barangay representatives ventilated that they do not benefit enough on this aspect. Only few members of the community are directly employed either as regular or contractual employees. The residents also obtain employment from contractors who transact with the company on infrastructure projects such as the construction or repair of roads, bridges, schools, and other buildings.

   It has been mentioned in the past EIA efforts about the responsibility of the company to provide employment to the residents of the affected barangays. However, employing people comes with the requirement of basic education, skills and experience of the applicant. Most often than not, these are lacking from them.

   There have been success stories about individuals who have been given scholarships or trainings by the company and have landed in regular jobs either with the firm or in other local and foreign offices, thus improving their lives. It was gathered in some of the FGDs and KIIs conducted that the residents should at times be blamed for their present plight. They often rely on dole outs and assistance from the company. It was mentioned by some of the participants that there are residents in their community who are just too lazy to improve on their situation. They are complacent to face the challenges in life and be better off from their present predicament.

The members of the community therefore must be continuously and properly informed through IEC and other information extension strategies, that the company also has limitations in accepting applicants to work for them. Limitations in the number of positions, requirements for higher education and skills and extensive experience which local residents most often do not possess, constrain the company to hire more from the affected barangays. The members of the communities should not look at the company as a “milking cow” from which they extract benefits but rather a partner in improving their lives.

The residents, with the help of the company and suitable livelihood options to be implemented, must be trained and be prepared on how to properly implement these livelihood options as a source of a continuous stream of income and benefits. They must be sent to successful projects so they may observe and witness the real situation and ask questions on how achievement came about. This will hopefully, through example, inspire them to pursue the same path.

About 9.5% of the total SDMP III funds have been allotted for enterprise development and almost 6% for human resource development. With this, the members of these sectoral committees must work hand in hand to be able to identify the suitable livelihood options and the proper trainings to be able to arrive at a sustainable livelihood project.

5. SDMP III has allotted some funds specifically for IPs. The IPs of Palawan, based on previous studies, plant crops such as bamboo, pineapple and gather rattan poles which they use to weave mats and baskets. They also tap resin from Almaciga trees and gather wild honey. They rarely use sea salt in their diet and thrive on bananas, cassava, bread fruit, wild pigs, freshwater fish and wild chicken. Given this information, it is recommended that financial and market support system be extended to them with the products that they gather from the wild such as honey, rattan and resin. Since they are already knowledgeable on the sustainable gathering of these resources, the support they need would focus on financial and marketing/pricing assistance. They might have the knowledge as to where to gather these but where to market their products at a reasonable price is a confusion for them. Most of the time, they are taken advantage of by the “smart” business people they negotiate with.

Annex 5.2.1 presents the list implemented projects under the Social Development Management Program from 2004- to 2016.

Table 5.1.4 shows a summary of the various projects undertaken during SDMP I, II and III, the number of beneficiaries and planned and actual budgets.

During SDMP I (2004-2008), the total combined budget of CBNC and RTN for SDMP projects was PhP356,004,517. At this period, PPAs on Health were subsumed in the various social projects and did not have a specific budget for its sole purpose. The total CBNC planned and actual contribution for PPAs alone on this era amounted to PhP212,383,934.17. The table also shows that at this time, most of the funds were channelled to the hospital program for IPs and indigents (PhP53,981,221.96), the LSVMS school subsidy for non-dependents, and community and relations assistance (CRA) at PhP34,439,278.50. A total of eleven (11) barangays with 24,726 beneficiaries were supported by the SDMP PPAs.

For SDMP II (2009-2013), there was a fifty-fifty funds contribution by CBNC and RTN to carry out and continue the implementation of the LSVMS school subsidy, GK housing projects for IPs, Indigenous Learning System and CRA. For CBNC, this amounted to PhP109,589,366 which was charged to SDMP funds. The budget for Education (PhP83,005,604.88), Health (PhP13,36a1,260), Livelihood (PhP41,404,248.16), Human Resources and infrastructure (PhP44,769,542.40) and various social projects (PhP68,184,826.12) both planned and actual amounted to PhP250,725,482. The total planned and actual budget for the second cycle SDMP was PhP501,462,062.82. SDMP II covered eleven barangays and a total of 31,642 beneficiaries.

SDMP III (2014-2018) covered a total of twenty-two (22) barangays of Bataraza plus one barangay from Rizal town for a total of 63,644 beneficiaries. There was a total planned budget of P869,497,018.73 while the actual funds utilization as of March 2018 was P736,688,723.95. In this third cycle of SDMP, the expenses for the LSVMS school subsidy, GK Housing project for the IPs, Indigenous Learning System and the CRA were all activities charged under the Corporate Social Responsibility (CSR) funds.

Overall, there was an increase in the funds allotted and spent for SDMP PPAs in SDMP I at PhP212,383,934.17 to PhP501,462,062.82 in SDMP II. There was a further increase to PhP869,497,018.73 (planned) and PhP736,688,723.95 (actual as of March 2018) for SDMP III. There was also an increase in area coverage from 11 barangays to 22 barangays in Bataraza and one (1) barangay in the municipality of Rizal. This increase in the number of barangays was due to the decision made by the direct and indirect impact barangays to spread the benefits and provide funds of PhP100,000 each to the other 11 barangays of Bataraza. As a consequence, more people were benefitted.

SDMP I had 24,726 beneficiaries while SDMP II supported 31,642 people from the host and neighboring barangays. SDMP III more than doubled (63,644) the number of people who gained from the PPAs implemented in their respective communities.

The PPAs in SDMP I were all completed as indicated in **Annex 5.2.1**. However, there were PPAs in SDMP II which were planned but not implemented, thus reprogramming was requested. But as seen from the table, majority of the projects were completed. As far as SDMP III is concerned, majority of the PPAs were completed but there was a few that were not implemented and reprogramming was initiated. On the other hand, there is also a small number of still on-going projects. Some of the continuing ones include the Marine Protected area and the coffee cooperative fund under the livelihood projects, improvement of the flea market, concreting of the tribal stage, CBCRM program, CADT application, mapping, delineation, barangay site development planning and land titling, watershed protection and management and Level III water system project.

Table 5.1.4. Summary of the Financial Accomplishment of SDMP I, II and III

#SDMP	SDMP Category	No. of Beneficiaries	Planned Budget (CBNC & RTN Combined)	Planned Budget (CBNC)	Actual Cost, PhP	Remarks
SDMP I (2004-2008)	A. Development of Host & Neighboring Community (DHNC)	11 impact barangays Beneficiaries = 24,726				
	Education		32,697,817.00	21,907,537.39	21,907,537.39	Non-IP = PhP 36,180,000.00 IP = PhP 28,334,300.00 (actual cost)
	*Health**			-	-	
	P3Livelihood		14,526,510.00	9,732,761.70	9,732,761.70	
	Human Resources & Infrastructures		30,429,431.00	20,387,718.77	20,387,718.77	
	Various Social Projects		23,618,405.00	15,824,331.35	15,824,331.35	
	Hospital Program for IPs & Indigents		80,568,988.00	53,981,221.96	53,981,221.96	
	B. Information, Education & Communication (IEC)		20,404,000.00	13,670,680.00	13,670,680.00	Combined budget w/ DMTG
	C. Dev't of Mining Technology & Geoscience (DMTG)				-	Budgetted under IEC
	D. LSVMS School Subsidy (for non-dependents)		57,539,151.00	28,769,575.50	28,769,575.50	Charge to SDMP
	E. GK Housing Projects for IP		14,278,231.00	7,139,115.50	7,139,115.50	Charge to SDMP
	F. Indigenous Learning System (ALS Accresited)		13,063,427.00	6,531,713.50	6,531,713.50	Charge to SDMP
	G. Community & Relations Assistance (CRA)		68,878,557.00	34,439,278.50	34,439,278.50	Charge to SDMP
	Sub-total		**356,004,517.00**	**212,383,934.17**	**212,383,934.17**	
SDMP II (2009-2013)	A. Development of Host & Neighboring Community (DHNC)	11 impact barangays Beneficiaries = 31,642				
	Education			83,005,604.88	83,005,604.88	Non-IP = Php 142,750,556.75 IP = Php 109,481,081.56 (actual cost)
	Health			13,361,260.00	13,361,260.00	
	Livelihood			41,404,248.16	41,404,248.16	
	Human Resources & Infrastructures			44,769,542.40	44,769,542.40	
	Various Social Projects			68,184,826.12	68,184,826.12	
	Hospital Program for IPs & Indigents			101,503,535.76	101,503,535.76	
	B. Information, Education & Communication (IEC)			40,643,680.00	40,643,680.00	Combined budget w/ DMTG

#SDMP	SDMP Category	No. of Beneficiaries	Planned Budget (CBNC & RTN Combined)	Planned Budget (CBNC)	Actual Cost, PhP	Remarks
	C. Dev't of Mining Technology & Geoscience (DMTG)					Budgetted under IEC
	D. LSVMS School Subsidy (for non-dependents)		50,544,523.00	25,272,261.50	25,272,261.50	Charge to SDMP
	E. GK Housing Projects for IP		26,183,764.00	13,091,882.00	13,091,882.00	Charge to SDMP
	F. Indigenous Learning System (ALS Accresited)		30,986,520.00	15,493,260.00	15,493,260.00	Charge to SDMP
	G. Community & Relations Assistance (CRA)		109,463,924.00	54,731,962.00	54,731,962.00	Charge to SDMP
	Sub-total		**217,178,731.00**	**501,462,062.82**	**501,462,062.82**	
SDMP III (2014-2018)	A. Development of Host & Neighboring Community (DHNC)	22 barangays of Bataraza + 1 barangay from Rizal Town Beneficiaries = 63,644				
	Education			153,668,688.86	116,432,799.79	Planned budget as of March 2018 Non-IP = Php 333,054,402.56 IP = Php 115,312,119.68
	Health			59,721,228.37	49,133,093.91	
	Livelihood			84,463,321.12	60,427,229.00	
	Human Resources & Infrastructures			63,424,811.08	45,653,979.52	
	Various Social Projects			31,786,142.30	31,786,142.30	
	Land Use & Environment			66,100,645.00	66,100,645.00	
	Hospital Program for IPs & Indigents		250,000,000.00	206,950,000.00	214,985,810.98	As of March 2018
	B. Information, Education & Communication (IEC)		147,420,000.00	122,034,276.00	90,583,173.76	As of March 2018
	C. Dev't of Mining Technology & Geoscience (DMTG)		98,270,000.00	81,347,906.00	61,585,849.68	As of March 2018
	D. LSVMS School Subsidy (for non-dependents)		50,000,000.00			Now under CSR
	E. GK Housing Projects for IP		50,000,000.00			Now under CSR
	F. Indigenous Learning System (ALS Accresited)		60,000,000.00			Now under CSR
	G. Community & Relations Assistance (CRA)		100,000,000.00			Now under CSR
	Sub-total		**755,690,000.00**	**869,497,018.73**	**736,688,723.95**	
	GRAND TOTAL		**1,328,873,248.00**	**1,583,343,015.72**	**1,450,534,720.94**	

*Note: *Health is integrated in the budget of Various Social Projects for SDMP 1 only*

5.2 SOCIAL DEVELOPMENT PLAN

The SDP integrates interventions to instill improvements on the well-being of the various participants of a project. With the participation in these programs, productive potentials are tapped and targeted to be maximized if not optimized. The SDP further aims to emancipate the affected communities from the clutches of poverty resulting to self-reliance, self-respect, and empowerment.

Human Resource/ Infrastructure Development

To promote the intellectual and physical well-being of the community, CBNC shall continue to provide adequate educational and necessary facilities to continuously develop the human resource sector. This is in the form of skills development trainings to support the needs of the other sectors of enterprise development, health and land use. To be able to pursue the activities and skills needed to successfully attain the objectives of the other sectors, the residents who will manage and implement these should be properly prepared with the necessary skills. In addition, the people who will work to keep the other sectors' operational requirements must also come prepared with the appropriate capabilities.

Prior to mining, majority of the people of Bataraza focused on farming and fishing. With the coming of mining and processing firms, the emphasis shifted to mining-related activities. Given this situation, trainings on the best practices in agriculture and fishing are deemed vital to be imparted to the members of the community. The best practices, state of the art technologies, appropriate tools, facilities, infrastructure, market mechanisms and an encouraging political environment must prevail to assist the communities in moving to a better way of life.

To back up the program of CBNC on LSVMS subsidies, training teachers on innovative ventures can also be considered as another undertaking as this is perceived to further improve the quality of education of the local students.

CBNC shall continue to provide educational assistance to the host barangays through additional school rooms and other educational facilities, donations of educational equipment including computer and reference books. The provision of scholarship grants to deserving children of affected barangays shall also be continued by the proponent.

Health Sector

CBNC aims to assist in improving the general health situation and nutrition of residents in the municipality by enhancing the delivery of basic health and nutritional services to the affected communities and affiliating with the local nutritional programs. This can be accomplished through the continuation of medical, dental and other health-related missions. Furthermore, regular monitoring of health conditions of the surrounding communities through the existing RHU and/or barangay health stations is done. The RTN hospital provides medical assistance and answers the medical needs of the IPs and indigent members of the community. Contribution to the improvement of health services and facilities is being implemented through the SDMP funds. Getting the support of the Barangay Health Workers or BHWs on a regular basis to keep an eye on the health conditions of the community not only helps in the financial condition of the workers (through honoraria) but likewise assures a continuous monitoring and compilation of information regarding the health status of the community.

The implementation of ILS improved the health condition of the IPs as they were made aware of the importance of proper nutrition and sanitation. As this will remain to be one of the projects implemented by CBNC through its CSR funds, a further improvement on the health situation of the IPs is expected.

Enterprise Development Sector

With a relatively bigger portion of the SDMP III funds allocated for the development of livelihood and other income generating projects, the success of the project is likely to happen provided the other factors affecting profitability are considered. A priority activity that is vital to be initially conducted is the identification of the appropriate livelihood option for the community. For a successful endeavor to ensue, the necessary support mechanisms must be present. These include the presence of native or homegrown raw materials, manpower/skills, management capabilities, suitable infrastructure, financial, marketing, technical, and institutional backing. The interest and willingness of the community to participate is also a factor that drives the success of a livelihood option. Another important element which is often overlooked is the presence of a stable political environment. With the interplay of all these influences, the success of the enterprise cannot be far behind.

Therefore, more trainings and capability building preparations should be conducted in relation to the identified alternative livelihood.

Land-use Sector

CBNC is resolute in the conservation and protection of our natural resources. Projects under this program will be continued to address not only the potential effects of the proposed project but also adverse effects produced by humans.

Projects worth mentioning under this sector include waste management, construction of Materials Recovery Facilities (MRF), tree planting, assisting IPs in CADT application, mapping and delineation, provision of trash bins in public markets, land acquisition for worthwhile uses such as day care center, and recreational areas like basketball courts.

SDMP for IPs

IPs have often been shortchanged by educated and influential entities due to their lack of market and financial know-how. They possess the skills to produce an agriculture/forest-based product but they lack the complicated knowledge of pricing and marketing their produce. Therefore, one of the projects that can be geared towards the enhancement of the business skills of the IPs is to train them on how they can provide for themselves by raising/collecting, pricing and marketing sustainably managed resources and establishing linkages so that the middleman who usually does the selling and marketing for them, is eliminated. Thus, they get the bigger bulk of the profit.

Disaster Preparedness Program to include trainings

Man-made or natural disasters can happen anytime and anywhere, more so in areas where industrial activities are carried out. Even if the government has put in efforts relative to disaster preparedness, not everyone has been fully prepared. In this regard, trainings must be conducted for the different sectors of the community so that should a catastrophe strike, they are prepared. Even at a relatively young age, elementary and high school students, should be periodically taught so that they will be equipped with the proper understanding of what is taking place and what should be done during adversities. Even housewives, who are the first responders at home, must undergo trainings on disaster preparedness. Trainings and seminars must be done in coordination and collaboration among the company, local government and national agencies.

5.3 INFORMATION, EDUCATION AND COMMUNICATION

The CBNC together with RTNMC believe that IEC program is a valuable tool in building good relationship with its partner barangays. The dissemination of information about the company and the project, EIA findings, project benefits and unfavorable impacts, mitigating measures, monitoring guidelines, company procedures and regulations had been and is being done by CBNC. This is pursued with the use of radio broadcast, print ads, newsletter and flyers. Meetings and consultations are also regularly being done. The continuation of this approaches keep the community abreast of the present situation and updates about the company/ies. The cost of carrying out these activities are based on the cost of air time, cost of IEC materials, number of participants to meetings/consultations, venue where the meetings are held, cost of meals and snacks and other incidental expenses in the implementation of the activity.

A recommendation forwarded is for the CBNC/RTNMC ComRel, IEC team, representatives from schools/students, LGU, POs, NGOs and other concerned sectors to convene in a workshop to identify the Strengths, Weaknesses, Opportunities and Threats (SWOT) of the extension strategies already being implemented by the said companies and assess these and forward improvements on the present situation, if need be. Results of the analysis will serve as inputs in determining the most effective and efficient strategies that can be adopted to disseminate updates on the activities and programs undertaken. Furthermore, management will have a basis on how future actions shall be tackled.

Disaster preparedness should be an important piece of information disseminated by the company as disaster can potentially affect everybody. A wider base can be reached through broadcast and print media. Newsletters and flyers shall also be one of the means by which target audience is reached. The youth, which comprise a larger portion of the population can be taught and influenced on disaster preparedness through school activities and competitions in arts and sports. A disaster preparedness themed contest (declamation, oration, song, dance, painting, school plays) in relation to school celebrations or barangay/municipal celebrations can be launched to encourage the participation of the students/youth. Prizes, medals, trophies, cash prizes shall be charged to company funds.

Annex 5.3.1 shows the list of IEC implemented programs by CBNC/RTNMC from years 2006-2016.

Table 5.2.1. Social Development Plan Framework

Concerned entities/Program	Responsible community member/beneficiary	Partner Institutions/ Government agency/non-government agency and services	Proponent	Indicative timeline	Source of Fund
Community Relations Office/ TWG/People's Management Council	All stakeholders		Community Relations office/ TWG/People's Management council	Pre-construction to operation	Corporate funds
Community Development Programs 1. Infrastructure and Human Resource Development 2. Health and Sanitation 3. Education 4. Livelihood ○ trainings and seminars on the identification of appropriate livelihood options and provision by the company of support mechanisms to ensure the sustainability of the livelihood project 5. Land-use and environment 6. SDMP for IPs ○ project on developing market and financial linkages for IPs ○ capability building of IPs on marketing, pricing and distribution of their products from sustainably managed sources	All stakeholders	DPWH, TESDA, DOH, DENR, BFAR, LGU, DA, PCSD, Haribon, RTNFI, IPDO, NCIP, ICCs, DepEd, DTI	Community Relations Office/People's Management Council/TWG	On-going	SDMP III
Hospitalization program	IPs and indigent residents in the affected communities	DOH, LGU	Community Relations Office/ People's Management Council/TWG	On-going	SDMP III
LSVMS subsidy for non-dependents	School children (non-dependents)	DepEd, LGU, ngos	Community Relations Office	On-going	CSR
GK Housing for IPs	IPs	LGU, ngos	Community Relations Office	On-going	CSR
Indigenous Learning System (ILS)	IPs	LGU, IPDO, NCIP, ngos	Community Relations Office	On-going	CSR
Community Relations Assistance (CRA) Program	All stakeholders	LGU, DSWD, DOH, BFAR, DA, DENR, PCSD, Haribon, NCIP, DTI	Community Relations Office	On-going	CSR
Information, Education and Communication (IEC)	All stakeholders	Multimedia, LGU, TESDA, DTI, DPWH, DENR, DA, BFAR,	Community Relations Office/ People's Management council/TWG	On-going	SDMP III
Development of Mining Technology and Geosciences	Concerned stakeholders	Research sectors, academe, ngos, MGB-DENR	Community Relations Office/ People's Management Council/TWG	On-going	SDMP III
Peace and order	All stakeholders	LGU, barangay tanods, police	CBNC Security group	On-going	CSR
Spiritual	Concerned Stakeholder	LGU, religious groups	Community Relations Office	Ongoing	CSR/SDMP
Disaster Preparedness Program to include trainings and drills	All stakeholders	LGU, DENR, NDRRMC, DA, DOST, DPWH, DSWD, DOH	Community Relations Office	Quarterly	CSR-SDMP

Table 5.3.1. CBNC Information, Education, and Communication Plan

Target sector	Major Topics of concern in relation to project	IEC Scheme/ Strategy/ Methods	Information Medium	Indicative timelines and frequency	Indicative cost
Households and LGU officials of Direct and indirect impact barangays Students POs NGOs	- Project description - EIA findings - actual impacts/ measures/ monitoring guidelines - company procedures with regards to requests from community members	Individual and group methods Multi-media	flyers, FGD, radio broadcast, KII, consultations meetings, hand-outs, site tours	Continuing	Based on cost of radio broadcast time cost of flyers/IEC materials, number of participants, venue
RTNMC ComRel, IEC team Representatives from school, affected communities, LGU, NGOs, POs	Conduct of SWOT analysis for the various extension strategies adopted by the company should be conducted to serve as inputs in management decision-making	Group method	FGD, KII, consultation meetings,	Continuing	PhP 30,000/ quarter
LGUs, affected communities, NGOs, academe, POs	- Quarterly reports of On-going and planned/ upcoming projects to include budget allocation - News on environmental enhancement programs	Group method	Reports, consultation meetings	Quarterly	PhP 10,000 per meeting
All stakeholders	Report on SDMP accomplishment	Individual and/or group method	Reports, fliers, meetings	Bi-annual	PhP 50,000
All stakeholders	Report on current activities with the government/local authorities	Group method	FGD, general assembly meetings	Annual	PhP 50,000
CBNC/RTNMC Comrel, LGU, local communities	Disaster Preparedness Program	Group method	Fliers/newsletters	Monthly	PhP 2,000 per meeting
All stakeholders		Group method	FGD, general assembly meetings fliers	Quarterly	P15,000/quarter

6 Environmental Compliance Monitoring

Coral Bay Nickel Corporation

Chapter 2 discussed the environmental impacts of both CBNC's current operations and proposed expansion – Tailings Storage Facilities No.3 (TSF No.3) and increase in Co production. Such environmental impacts are measured by monitoring environmental parameters that are presented in this chapter. The current operation is covered by the Environmental Compliance Monitoring (ECM) program being implemented CBNC. Revision of the ECM shall be made to include the proposed expansion. The ECM shall also serve as a tool in assessing the effectiveness of the management measures stated in the Environmental Management Plan in *Chapter 3*.

6.1 ENVIRONMENTAL COMPLIANCE FRAMEWORK

As part of its quality policy, CBNC strictly complies with all environmental regulatory requirements being imposed by the government for a processing plant. Listed in **Table 6.1.1** are the permits/licenses/clearances/certificates acquired from various government agencies, namely: Department of Environment and Natural Resources (DENR), Philippine Drug Enforcement Agency (PDEA), Philippine National Police (PNP) and Philippine Nuclear Research Institute (PNRI).

Table 6.1.1. DENR Environmental laws/permit/licenses/certificates of CBNC

Environmental Laws	Permits		Date of Issue	Expiry Date
R.A. 9275 Philippine Clean Water Act of 2004	Discharge Permit No.	2013-DP-PAL-02-012	June 5, 2013	June 4, 2018
PD 1586 Environmental Impact Statement System	ECC 1	0201-021-313	July 10, 2002	ECC 2 supersedes pertinent provisions of ECC 1
	ECC 2	0701-002-3721	February 1, 2007	Until project's end
	ECC 2 Amendment on production capacity	0701-002-3721	February 15, 2008	Until project's end
RA 6969 Toxic Substances and Hazardous and Nuclear Control Act of 1990	Hazardous Waste Generator DENR ID	*On-line registration No.;* GR-4B-53-00043	May 24, 2016	None
	CCO Registry	CCO – PCB : Exempted	Nov. 10, 2004	None
	Importer/Purchaser Clearance No	P5IM 064 R532-40108-40509 P6 029 R531-40108-40509 (for H_2SO_4 &HCl issued by PDEA)	March 4, 2016	April 15, 2017
RA 2067 as amended by RA 3589 & RA 5207 Science Act of 1958	Radioactive Material License	No. Y04.04071.16	August 1, 2017	Jan. 31, 2018
RA 8749 Philippine	Permit to Operate APSCI, Line 1	2004-POA-D-0453-175	Dec 15, 2014	Dec 14, 2019

Environmental Laws	Permits		Date of Issue	Expiry Date
Clean Air Act of 1999	Permit to Operate APSCI, Line 2	2004-POA-D-0453-175	Dec 15, 2014	Dec 14, 2019
RA 7942 Philippine Mining Act of 1995	Mineral Processing Permit (2nd Renewal)	No. 006-2004-IVB	Apr 26, 2015	Apr 25, 2020

Source: Self-Monitoring Report of CBNC, 4th Quarter of 2017

In compliance with these regulatory requirements, CBNC submits the following reports on regular basis:

- Self-Monitoring Report (SMR) on a quarterly basis (every 15th day after the end of the said quarter) to Environmental Management Bureau Regional Office No. IVB (EMB Region IVB); and
- Compliance Monitoring Report (CMR) on a semi-annual basis (every 15th day after the end of the 6thmonth of the covered period and after the end of the covered year) to EMB Region IVB.

6.2 SELF-MONITORING FRAMEWORK

In compliance with *Section 173* of DENR Administrative Order (DAO) 2010 – 21, CBNC created the Environmental Management and Quality Control Section (EMQCS) which is equivalent to the Mine Environmental Protection and Enhancement Office (MEPEO). As stated in *Condition No.5c* of ECC No. 0701-002-3721, the EMQCS shall monitor the impacts of the project and the corresponding management measures listed in the EIS and EPRMP. These monitoring activities are documented in the SMR, which is submitted to EMB Region IVB by the Pollution Control Officer (PCO) in compliance with DAO 2003 – 27. Aside from the SMR, CMR is also being submitted to the same office. Presented as **Annex 6.2.1** is the 2017 4th Quarter SMR with 2nd Semester CMR.

Table 6.2.1 presents the summary of CBNC's monitoring activities while **Table 6.2.2** shows the detailed Environmental Monitoring Plan (EMoP) that includes the indicator parameters for every monitoring activity with the corresponding Environmental Quality Performance Level (EQPL).

Also included in **Table 6.2.2** are the recommended appropriate and effective remedial actions to be undertaken in case of exceedances. Specific actions are given for every impact identified at every level (Alert, Action, Limit).

Table 6.2.1. The self-monitoring activity of CBNC

Aspect	Parameters	Stations
HPP Plant Operation	• Production capacity - Average daily production output (Mixed sulfide product, DMT)	-
Hazardous Materials	• Solid and liquid wastes generated • Waste storage, treatment and disposal	HPP Complex
Water	• Wastewater generated, m^3/day - Domestic wastewater - Process wastewater - Cooling water - Wash water of equipment - Wash water of floor	-

Aspect	Parameters	Stations
	• Wastewater Treatment Plant Discharge, m^3/day • Wastewater from the spillway of coal settling pond, , m^3/day	
	• Wastewater characteristics of primary pollutants: - pH - Dissolved Oxygen (DO), mg/L - Temperature, °C - BOD5 (for freshwater bodies only) - Total Suspended Solids (TSS), mg/L - Oil and Grease (O&G), mg/L*	• SW1 – Ibelnan Intake Dam • S4 – Lower Kinurong Siltation Pond Discharge • S5 – Lower Togpon Siltation Pond Discharge • S6 – Confluence of Togpon&Kinurong Siltation Pond Discharge • S7 – Downstream of Confluence • DC – HPP canal discharge to Upper Kinurong Siltation Pond • W5 – Groundwater at Well No. 5 • S20 – Upstream of Ocayan River • S21 – Downstream of Ocayan River • CP – Coal Pond • S17 – Estuarine Water at Rio Tuba River • S18 – Ameril Island (Control Station) • S19 – Barangkas (Control Station) • RW1 – Raw Water Intake (from Ibelnan/Reservoir/Upper Togpon) • S11 – Marine Water at 375m NE of Supernatant Water discharge point • S12 – Marine Water at 375m NW of Supernatant Water discharge point • S13 – Marine Water at 375m SW of Supernatant Water discharge point • S14 – Marine Water at 375m SE of Supernatant Water discharge point • TS – Marine Water at Tagdalungon shoreline • E – Supernatant water sampling port at causeway • L – Categorized sanitary landfill at GP-28 discharge water
	• Wastewater characteristics of secondary pollutants: - hexavalent chromium (Cr^{6+})*, mg/L - lead (Pb), mg/L - zinc (Zn), mg/L - copper (Cu), mg/L - nickel (Ni), mg/L - cobalt (Co),mg/L - iron (Fe), mg/L - manganese (Mn), mg/L - chromium total (Cr), mg/L - calcium (Ca), mg/L - silicon (Si), g/L - aluminum (Al), mg/L - magnesium (Mg), g/L - arsenic (As), mg/L* - mercury (Hg), mg/L* - cadmium (Cd), mg/L* *additional parameters - Conductivity, mS/cm - Turbidity, NTU - Salinity, ppt	
Air	• Fuel - No. of hours of operation of process equipment, fuel burning equipment and pollution control facility - Fuel used and quantity consumed (liters for diesel oil; MT for coal)	-
	• Power plant Emissions - CO, ppm - NOx, ppm - SOx, ppm - Opacity, % - Temperature, °C • HPAL Scrubber	-

Aspect	Parameters	Stations
	- Temperature, °C - pH (alkalinity) • MS Area Scrubber - H_2S, ppm - Temperature, °C	
	• Ambient Air Quality - TSP, µg/Sm^3 - PM10, ug/Sm^3 - NO_2, µg/Sm^3 - SO_2,µg/Sm^3	TSP • Stn1 – East of HPP at Dorm D Compound • Stn2 – South of HPP near RTNMC Magazine • Stn3 – SitioTagpisa, Ocayan • Stn4 – GSSI Compound • Stn5 – F-NTRL Line 1, South of CCD Pond • Stn6 – Ore Prep Line 2, below 201BC03-A • Stn7 – Utilities Area Line 2, North Side • Stn8 – Utilities Area Line 1, South Side NO_2 and SO_2 • S – 1 – Lower Kinurong • S – 2 – Water Reservoir
Noise	• Noise level, dB	• Stn1 – East of HPP at Dorm D • Stn2- South of HPP near magazine • Stn3 – East of HPP at SitioTagpisa • Stn4 – South of HPP at GSSI Compound • Stn5 – F-NTRL Line 1, South of CCD Pond • Stn6 – Ore Prep Line 2, below 201BC)3-A • Stn7 – Utilities Area Line 2, North Side • Stn8 – Utilities Area Line 1, South Side
ECC Conditions	• Status of Compliance • Action/s Taken	Quarterly
Environmental Management Plan/ Program	• Enhancement/Mitigation Measures • Status of Implementation • Actions Taken	Quarterly
Solid Waste Characterization/ Information	• Average quantity of solid wastes collected per month, m^3 • Total Quantity of solid wastes collected per quarter, m^3	Quarterly
Accidents and Emergency Records	• Area/Location • Findings and Observations • Actions/s Taken	Quarterly
Personnel/Staff Training	• Date Conducted • Course/Training Description • No. of personnel trained	Quarterly

Source: 4th Quarter Self-Monitoring Report with 2nd Sem Compliance Monitoring Report, 2017

Table 6.2.2. CBNC Environmental Monitoring Plan with EQPL

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
I. Construction Phase													
➢ Site Clearing and Establishment of Access Road ➢ Temporary TSF 3 Site Office Construction and motorpool ➢ Quarrying of Embankment Materials ➢ TSF 3 Embankment Construction	• Vegetation Removal and loss of Habitat • Threat to existence and loss of important local species • Threat to abundance, frequency and distribution of important species	Diversity and Species Richness (Abundance and Frequency)	Quadrat Sampling for Flora and Transect Monitoring for Fauna	Semi Annual	Adjacent areas to the proposed TSF3 and along the embankment	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget		It is projected that the existing flora and associated vegetation located inward of the embankment of TSF3 will perish during pre-construction phase.			Prior to construction phase, CBNC will secure tree-cutting permit from the DENR. A 100% tree inventory will be conducted and as indicated in EO23, CBNC is compelled to replace all the flora individuals (with ≥15 cm dbh) that will be affected with the establishment and operation of TSF5 • For naturally growing species – 100 seedlings for every individual • For planted species – 50 seedlings for every individual CBNC commits to establish a buffer zone (*please see proposed location*) where the seedlings will be planted. CBNC will also tie-up with the DENR for its flagship project - the National Greening Program (NGP). The company shall also implement the Biodiversity Action Plan, among the main projects. Details of the action plan are presented in **Annex 2.1.11**. Growth and performance of CBNC will be monitored (*please see proposed location of the monitoring stations*) as part of the proposed Environmental Monitoring Plan	
	• Soil Erosion, Loss of topsoil/	Volume of top soil conserved	➢ Record keeping of soil volume	Semi Annual	Within and adjacent to construction	CBNC EMQCS / PCO	Include in EMQCS Budget	Volume of soil conserved is less than 70%	Volume of soil conserved is less than 60%	Volume of soil conserved is less than 50% of	Notify heavy equipment operator to set aside top soil	Implement volume quota to heavy equipment operator	Future acquisition of top soil from

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
	overburden	along storage sites	conserved and mapping of storage sites		sites in the TSF 3			of the estimated top soil needed for future rehabilitation	of the estimated top soil needed for future rehabilitation	the estimated top soil needed for future rehabilitation	and identify additional storage area for top soil	to set aside top soil and maximize additional storage area for top soil	adjoining areas to be used for rehabilitation
	• Generation of Solid and Hazardous Waste	Volume of solid and hazardous waste generated	➢ Record keeping of generated solid and hazwaste, mode of disposal and volume disposed or recycled	Monthly	Within construction site	CBNC EMQCS / PCO DENR-accredited HazWaste Transporter	Include in EMQCS Budget	Foul odor from waste disposal site	Sighting of pest such as rats and roaches	Spread of disease to surrounding areas	Review of housekeeping practices when pests are present at the holding areas Continuous collection, treatment and disposal by DENR-accredited HazWastetreater	Pest eradication Immediate clean-up of the temporary storage site and disposal of accumulated wastes Immediate disposal or treatment of hazardous wastes	All waste from the kitchen should be contained. Compost pit should be covered Use of environment friendly materials
	• Degradation of Air Quality	Ambient PM10, TSP, SO_2 and NO_x	1-hour ambient air monitoring for PM10, TSP, SO_x and NO_x	Quarterly	• Within construction site, • Sitio Bohoy, Brgy. Rio Tuba, • GK Village Ocayan • Ocayan community approx. 1km from RTNMC airport	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget	➢ SOx-144.5 µ/Ncm ➢ NOx-120.5 µ/Ncm ➢ TSP – 184.5 µ/Ncm ➢ PM_{10} - 120.5 µ/Ncm	➢ SOx-162.5 µ/Ncm ➢ NOx-135.5 µ/Ncm ➢ TSP – 207.5 µ/Ncm ➢ PM_{10} - 135.5 µ/Ncm	DENR Standard Limits as stipulated in the IRR of Clean Air Act • SO_x-180µg/ Ncm • NO_x-150µg/ Ncm • TSP-230µg/ Ncm • PM_{10}- 150µg/ Ncm	Identification of possible source of pollutant	Temporarily halt operation and do corrective measures. Conduct of maintenance of the equipment/ machinery identified as the source of pollution	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel.
➢ Site Clearing and Establishment of Access Road ➢ Temporary TSF 3 Site Office Construction and motorpool ➢ Quarrying of Embankment Materials ➢ TSF 3 Embankment Construction	• Increase in Ambient Noise Level	Noise level (dB)	Noise meter	Monthly	• Within construction site, • SitioBohoy, Brgy. Rio Tuba, • GK Village Ocayan • Ocayan community approx. 1km from RTNMC airport	CBNC EMQCS / PCO	Include in EMQCS Budget	61dB	68dB	DENR Standard Limits for noise 75dB	Identification of possible source of noise Issuance of ear plugs	Maintenance, adjustment, or replacement of mufflers and installation of noise reduction apparatus	Change equipment or noise minimization device Limit operations during daytime hours
	• Threat to Workers/ Public Health and Safety	Safety record, Accident/fatality incidence/occurrence	Record keeping	Daily	Whole TSF 3 construction area	CBNC Safety Officer	Minimal cost	Lost time due to minor injury	Occurrence of major injury due to accident	Occurrence of fatality due to accident	Conduct quarterly safety briefing and orientation to laborers and workers Installation of safety signages along accident prone areas within the construction site	Conduct daily inspection of construction area Conduct daily briefing on safety program	Work stoppage along accident area and identify the proper safety measures and implement specific safety procedures and protocols
	• Social Impacts	Number of jobs generated for locals; training programs; and other social dev't. programs	Record keeping;	Monthly	CBNC host community and impact areas	CBNC ComRel	Minimal cost	Number of locally hired employees fall down to less than 40% of the total workforce SDMP accomplishment	Number of locally hired employees fall down to less than 20% of the total workforce SDMP	No locals are employed by the company in the last six months SDMP accomplishment falls below 40% of target	Review hiring policies Review SDMP programs and determine reasons for the poor implementation of the program	Implement more skills training program to empower residents Identify alternatives for the SDMP program to improve accomplishment	Conduct a third-party assessment of the SDMP

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
								falls below 80% of targets	accomplishment falls below 60% of target				implementation
	• Complaints Management	No. of valid complaints	Record keeping	Daily	CBNC host community and impact areas	CBNC ComRel	Minimal cost for record keeping	Submission of formal complaint at the ComRel Officers	Submission of formal complaint the need response/ action or intervention from the upper management	Media intervention causing local/regional/ national issues	Institution of grievance system Conduct regular IEC to inform and justify the activities being undertaken by CBNC during construction	Notify CBNC Admin for complaint and take remedial measures to address complaints Investigate all complaints, conduct dialogue with communities and implement mitigating measures Compensate affected communities	Conduct in depth investigation and identify root cause for all valid complaints Institute measures to avoid occurrence of similar problems
II. Operation Phase													
➢ Hydrometallurgical Processing Plant Operation ➢ High Pressure Acid Leaching Plant Operation ➢ Mixed Sulfide Plant Operation ➢ Power Plant Operation ➢ Tailings Neutralization and disposal to Tailings Storage Facilities ➢ Administrative and Maintenance Operation ➢ Logistics Operation at the Trestle and Causeway including loading of Mixed Sulfide Product and Coal and H_2SO_4 unloading and transport to the plant site	• Vegetation Removal and loss of Habitat • Threat to existence and loss of important local species • Threat to abundance, frequency and distribution of important species	Diversity and species Richness	Quadrat Sampling for Flora and Transect Monitoring for Fauna	Semi Annual	Terrestrial Flora Monitoring • Site 1A – Ibelnan Intake Dam • Site 1B – Ibelnan Resort Area • Site 2 – Lower and Upper Kinurong • Site 3 – Nagoya Beach • Site 4 –Magas-magas/ Mangingidong • Site 5 – Mt. Bulanjao Forest • Site 6 – Rehabilitated Tailings Dam • Site 7 – Ursula Island Terrestrial Fauna Monitoring • Nagoya Beach • Lower Bulanjao • Ibelnan • Tailings Dam 1 • Upper to Lower Kinurong • Ursula Island	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget	85% total cover and frequency reduction*	80% total cover and frequency reduction*	75% total cover or 5% vegetation loss and frequency reduction*	Assess extent of vegetation clearing and identify areas within the impact area for reforestation Use indigenous and native species as well as fruiting trees as reforestation species	Establish green corridors and shelterbelts Conduct immediate rehabilitation once TSF reached its maximum storage capacity	Assess areas prone to soil creep or landslide and stabilize slope area and rehabilitate. Institute biodiversity offset areas
	• Rehabilitation and Reforestation program	Survival rate of seedlings	Survey and performance monitoring	Semi Annual	Within CBNC reforestation/ rehabilitation area	CBNC EMQCS / PCO Third party	Include in EMQCS Budget	If survival rate is 80%	If survival rate is 70%	If survival rate is only 50% or below	Assessment of planting area condition to include possible infestation/ ascertain debilitating	Restocking or replanting of seedlings	Immediate assessment of soil viability and if necessary soil amelioration

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
➢ Hydrometallurgical Processing Plant Operation ➢ High Pressure Acid Leaching Plant Operation ➢ Mixed Sulfide Plant Operation ➢ Power Plant Operation ➢ Tailings Neutralization and disposal to Tailings Storage Facilities ➢ Administrative and Maintenance Operation ➢ Logistics Operation at the Trestle and Causeway including loading of Mixed Sulfide Product and Coal and H_2SO_4 unloading and transport to the plant site						consultant					factors		should be done prior to replanting
	• Generation of Solid Waste	Volume of solid waste generated including volume recycled and disposed to the landfill	Estimation of volume generated	Weekly	Within CBNC Processing Plant and support facilities	CBNC EMQCS / PCO	Include in EMQCS Budget	Foul odor from waste disposal site	Sighting of pest such as rats and roaches	-	Review of housekeeping practices when pests are present at the holding areas Spread of disease to surrounding areas	Pest eradication Immediate clean-up of the temporary storage site and disposal of accumulated wastes	All waste from the kitchen should be contained. Compost pit should be covered
	• Degradation of Surface Water Quality to include siltation of coal settling pond discharge	Visual inspection, photo documentation, manual and mechanical desilting	Weekly for inspection of siltation and quarterly or semi-annual for desilting of coal settling pond	Quarterly	Ocayan River, Coal Settling Pond	CBNC EMQCS / PCO	Include in EMQCS Budget	Accumulation of silt and powdery coal along discharge point	Shallow depths along portions of the waterbody previously characterized as deep	Heavy flooding and siltation of waterbody despite occurrence of only light precipitation	Assess if coal settling pond holding capacity is sufficient Identify sources of siltation	Re-evaluate the efficiency of control measures and implement improvement measures e.g. increase capacity of settling ponds, installation of additional silt traps, check dams, etc.	Install additional settling ponds, silt traps and check dams along the drainage areas
	• Impact on freshwater and marine biology	Species richness of freshwater and marine organisms -Fish macro vertebrates -Plankton -Benthos -Corals -Seagrass	Limnological and marine biology assessment and plankton sampling using plankton net	Semi Annual	Ocayan River, MagasMagas Creek, Nagoya Beach, Coral Bay near mooring dolphin, trestle and causeway	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget	High BOD levels along monitoring stations 30% abundance and frequency reduction of freshwater and marine organisms as based on the baseline studies	Increased number of pollution indicators 40% abundance and frequency reduction of freshwater and marine organisms as based on the baseline studies	Prevalence of pollution indicators such as nematodes 50% abundance and frequency reduction of freshwater and marine organisms as based on the baseline studies	Observation of frequency and extent of siltation and identify sources of silt Improve efficiency of coal settling pond by conducting maintenance or construction of additional chamber for the pond	Temporarily stop effluent discharge and install additional silt pond chambers and increase the holding capacity of coal settling pond by raising embankment and elevating the spillway	Install additional coal settling pond and check dams to manage siltation of river and coastal beach. Intensify reforestation activities and rehabilitation
	• Groundwater contamination due to possible seepage • Reduction of groundwater recharge	Color, pH, conductivity TDS, DO, Salinity Hardness, Turbidity and Heavy Metals such as Cr^{+6}, Pb, Ni, Co, Zn, Mn and Cd Groundwater Recharge	Grab sampling and laboratory analysis Manual measurement of groundwater level	Monthly	• GW 2 • GW 3 • GW 4	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget	➢ 4.0 TCU Color ➢ pH 7.5 – 8.0 ➢ 401mg/L TDS ➢ 241 (as $CaCO_3$) Hardness ➢ 0.008mg/L As ➢ 0.0024mg/L Cd ➢ 0.04mg/L Cr^{+6} ➢ 0.008mg/L Pb Groundwater level reduced by 10% from normal trend	➢ 4.5 TCU Color ➢ pH 8.0 – 8.2 ➢ 451mg/L TDS ➢ 271 (as $CaCO_3$) Hardness ➢ 0.009mg/L As ➢ 0.0027mg/LCd ➢ 0.045mg/L Cr^{+6} ➢ 0.009mg/L Pb Groundwater level reduced by 20% from normal trend	DENR Standard Limits as stipulated in PNSDW •5.0 TCU Color •pH 6.5 – 8.5 •500 mg/L TDS •300 (as $CaCO_3$) Hardness •0.003mg/LCd •0.05mg/L Cr^{+6} •0.01mg/L Pb Groundwater level reduced by 30% from normal trend level	Map out location of contaminated or depleting groundwater sources and observed for one quarter Determine possible sources of contamination or reduction of volume	Prohibit use of groundwater for water spraying and domestic use Promote groundwater recharge along affected areas by installing engineering measures	Provide alternative source of water to impacted communities
	• Degradation of Surface Water Quality due to	Temp., Color, Turbidity, TSS, pH,	In-situ sampling, Grab sampling and laboratory analysis	Monthly	• SW 1 - Ibelnan Dam • SW 2 - Togpon Pond	CBNC EMQCS / PCO	Include in EMQCS Budget	➢ pH 7.5 – 8.0 ➢ 6.0 mg/L (Min) DO ➢ TSS - not	➢ pH 8.0 – 8.2 ➢ 5.5 mg/L (Min) DO ➢ TSS - not	DENR Standard Limits as stipulated in DAO 90-34	Ascertain the run-off flow rate, rate of settlement and observe the	Addition of embankment and control measures	Immediate de-silting of settling ponds

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
➢ Hydrometallurgical Processing Plant Operation ➢ High Pressure Acid Leaching Plant Operation ➢ Mixed Sulfide Plant Operation ➢ Power Plant Operation ➢ Tailings Neutralization and disposal to Tailings Storage Facilities ➢ Administrative and Maintenance Operation ➢ Logistics Operation at the Trestle and Causeway including loading of Mixed Sulfide Product and Coal and H_2SO_4 unloading and transport to the plant site	possible above embankment spillage, emergency release of water	DO, BOD, Oil & Grease, and Heavy Metals (As, Hg, Cr^{+6}, Pb, and Cd)			• SW2A - Upper Togpon Pond • SW3 - Lower Kinurong Pond • SW4 - Upper Kinurong Pond – CBNC Drainage Canal • Additional monitoring station at Ocayan River • MW near CBNC Causeway	Third party consultant		more than 24 % increase ➢ 5.6 mg/L BOD ➢ 1.6 mg/L O&G ➢ 0.04 mg/L As ➢ 0.0008 mg/L Cd ➢ 0.04 mg/L Cr^{+6} ➢ 0.04 mg/L Pb ➢ 0.0016 mg/L Total Hg	more 27 % increase ➢ 6.3 mg/L BOD ➢ 1.8 mg/L O&G ➢ 0.045 mg/L As ➢ 0.0009 mg/L Cd ➢ 0.045 mg/L Cr^{+6} ➢ 0.045 mg/L Pb ➢ 0.0018 mg/L Total Hg	• pH 6.0 – 8.5 • 5.0 mg/L (Min) DO • TSS – not more than 30% increase • 7 (10) mg/L BOD • 2.0 mg/L O&G • 0.05 mg/L As • 0.01 mg/L Cd • 0.05 mg/L Cr^{+6} • 0.05 mg/L Pb • 0.002 mg/L Total Hg	effectiveness of particle settlement within the TSF and settling pond		Establishment of additional settling ponds
	• Degradation of Surface Water Quality due to disposal of supernatant water	pH, Conductivity, Turbidity, DO, temp., Salinity, TSS, Cr^{+6}, Pb, Zn, Cu, Ni, Co, Fe, Mn, Total Cr, Ca, Si, Al, Mg, As, Hg, Cd, Oil & Grease	In-situ sampling, Grab sampling and laboratory analysis	Daily Sampling	• Supernatant Pipe Sampling Port at Causeway • Tailings Dam 1 • Tailings Dam 2 • Tailings Dam 3	CBNC EMQCS / PCO	Include in EMQCS Budget	➢ pH 7.5 – 8.0 ➢ 6.0 mg/L (Min) DO ➢ TSS - not more than 24 % increase ➢ 5.6 mg/L BOD ➢ 1.6 mg/L O&G ➢ 0.04 mg/L As ➢ 0.0008 mg/L Cd ➢ 0.04 mg/L Cr^{+6} ➢ 0.04 mg/L Pb ➢ 0.0016 mg/L Total Hg	➢ pH 8.0 – 8.2 ➢ 5.5 mg/L (Min) DO ➢ TSS - not more 27 % increase ➢ 6.3 mg/L BOD ➢ 1.8 mg/L O&G ➢ 0.045 mg/L As ➢ 0.0009 mg/L Cd ➢ 0.045 mg/L Cr^{+6} ➢ 0.045 mg/L Pb ➢ 0.0018 mg/L Total Hg	DENR Standard Limits as stipulated in DAO 90-34 • pH 6.0 – 8.5 • 5.0 mg/L (Min) DO • TSS – not more than 30% increase • 7 (10) mg/L BOD • 2.0 mg/L O&G • 0.05 mg/L As • 0.01 mg/L Cd • 0.05 mg/L Cr^{+6} • 0.05 mg/L Pb • 0.002 mg/L Total Hg *Note: No DENR Standard for other parameters being monitored.*	Identification of possible source of pollutant Conduct of maintenance of the equipment/ machinery identified as the source of pollution	Temporarily halt operation and do corrective measures.	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel.
	• Degradation of Surface Water Quality due to disposal of effluent water from coal settling pond	pH, Conductivity, Turbidity, DO, temp., Salinity, TSS, Cr+6, Pb, Zn, Cu, Ni, Co, Fe, Mn, Total Cr, Ca, Si, Al, and Mg Water Discharge Volume	In-situ sampling, Grab sampling and laboratory analysis	Monthly	• Pier Site Coal Settling Pond Discharge	CBNC EMQCS / PCO	Include in EMQCS Budget	➢ pH 7.5 – 8.0 ➢ 6.0 mg/L (Min) DO ➢ TSS - not more than 24 % increase ➢ 5.6 mg/L BOD ➢ 1.6 mg/L O&G ➢ 0.04 mg/L As ➢ 0.0008 mg/L Cd ➢ 0.04 mg/L Cr^{+6} ➢ 0.04 mg/L Pb ➢ 0.0016 mg/L Total Hg	➢ pH 8.0 – 8.2 ➢ 5.5 mg/L (Min) DO ➢ TSS - not more 27 % increase ➢ 6.3 mg/L BOD ➢ 1.8 mg/L O&G ➢ 0.045 mg/L As ➢ 0.0009 mg/L Cd ➢ 0.045 mg/L Cr^{+6} ➢ 0.045 mg/L Pb ➢ 0.0018 mg/L Total Hg	DENR Standard Limits as stipulated in DAO 90-34 • pH 6.0 – 8.5 • 5.0 mg/L (Min) DO • TSS – not more than 30% increase • 7 (10) mg/L BOD • 2.0 mg/L O&G • 0.05 mg/L As • 0.01 mg/L Cd • 0.05 mg/L Cr^{+6} • 0.05 mg/L Pb • 0.002 mg/L	Identification of possible source of pollutant Conduct of maintenance of the equipment/ machinery identified as the source of pollution	Temporarily halt operation and do corrective measures.	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel.

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
➢ Hydrometallurgical Processing Plant Operation ➢ High Pressure Acid Leaching Plant Operation ➢ Mixed Sulfide Plant Operation ➢ Power Plant Operation ➢ Tailings Neutralization and disposal to Tailings Storage Facilities ➢ Administrative and Maintenance Operation ➢ Logistics Operation at the Trestle and Causeway including loading of Mixed Sulfide Product and Coal and H_2SO_4 unloading and transport to the plant site										Total Hg *Note: No DENR Standard for other parameters being monitored.*			
	• Generation of Hazardous Waste	Volume of oil sludge and hazardous waste generated including types of waste generated	Estimation and record keeping	Monthly	Hazardous waste storage facility	CBNC EMQCS / PCO DENR-accredited HazWaste Transporter	Include in EMQCS Budget	Accumulation of hazardous wastes	Evidence of leakage, spillage or signs of damage of hazardous waste containers	Complaints from workers and laborers	Continuous collection, treatment and disposal by DENR-accredited HazWastetreater	Reduction on the use of raw materials which are potential source of hazardous wastes Immediate disposal or treatment of hazardous wastes	Use of alternative materials which are more environment friendly
	• Degradation of Air Quality	Ambient PM10, TSP, SO_2, NO_x and H_2SO_4	24-hour ambient air monitoring for PM10, TSP, SO_x and NO_x	Monthly	For TSP and PM10 • S-6 – Ore Prep Line 2 • S-7 Utilities Area Line 2 • S-8 Utilities Area Line 1 For gaseous emission • S-1 Lower Kinurong • S-2 Water Reservoir For H_2SO_4 • S-Yard • F-NTRL • CCD-1 • CCD-7	CBNC EMQCS / PCO Third party consultant	Include in EMQCS Budget	➢ SO_x-272 µg/Ncm ➢ NO_x-208 µg/Ncm ➢ TSP-240 µg/Ncm ➢ PM_{10}-160 µg/Ncm	➢ SO_x-306 µg/Ncm ➢ NO_x-234 µg/Ncm ➢ TSP-270 µg/Ncm ➢ PM_{10}-180 µg/Ncm	DENR Standard Limits as stipulated in the IRR of Clean Air Act • SO_x-340 µg/Ncm • NO_x-260 µg/Ncm • TSP-300 µg/Ncm • PM_{10}-200µg/Ncm	Identification of possible source of pollutant Conduct of maintenance of the equipment/ machinery identified as the source of pollution	Temporarily halt operation and do corrective measures.	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel.
	• Degradation of Air Quality	Source Emission	CO, Opacity, SO_x and NO_x H_2S	Daily	• CEMS Boiler 1 • CEMS Boiler 2 • H_2S Scrubber	CBNC EMQCS / PCO	Include in EMQCS Budget				Identification of possible source of pollutant	Temporarily halt operation and do corrective measures.	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants
	• Increase in Ambient Noise Level	Noise level (dB)	Noise meter	Monthly	• Stn 1 – East of HPP at Dorm D • Stn2 – South of HPP near magazine • Stn3 – East of HPP Tagpisa • Stn4 – South of HPP at GSSI • F-NTRL Line 1 • Ore Prep Line 2 • Utilities Area Line 2 • Utilities Area	CBNC EMQCS / PCO	Include in EMQCS Budget	61dB	68dB	DENR Standard Limits for noise 75dB	Identification of possible source of noise and Issuance of ear plugs	Maintenance, adjustment, or replacement of mufflers and installation of noise reduction apparatus	Change equipment or noise minimization device Limit operations during daytime hours

Key Environmental Aspects per Project Phase	Potential Impacts per Envt'l. Sector	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
➢ Hydrometallurgical Processing Plant Operation ➢ High Pressure Acid Leaching Plant Operation ➢ Mixed Sulfide Plant Operation ➢ Power Plant Operation ➢ Tailings Neutralization and disposal to Tailings Storage Facilities ➢ Administrative and Maintenance Operation ➢ Logistics Operation at the Trestle and Causeway including loading of Mixed Sulfide Product and Coal and H_2SO_4 unloading and transport to the plant site					Line 1								
	Safety Record and Construction Hazards	Safety record, Accident/fatality incidence/occurrence	Record keeping	Daily	Whole CBNC operation area	Safety officer	Minimal cost	Lost time due to minor injury	Occurrence of major injury due to accident	Occurrence of fatality due to accident	Conduct quarterly safety briefing and orientation to laborers and workers Installation of safety signages along accident prone areas within the construction site	Conduct daily inspection of construction area Conduct daily briefing on safety program	Work stoppage along accident area and identify the proper safety measures and implement specific safety procedures and protocols
	Social Impacts	Number of jobs generated for locals; training programs; and other social dev't. programs	Record keeping; Social Impact Assessment (SIA)	Monthly Every five years for SIA	CBNC host community and impact areas	CBNCComRel SIA Third Party Consultant	Minimal cost	Number of locally hired employees fall down to less than 40% of the total workforce SDMP accomplishment falls below 80% of targets	Number of locally hired employees fall down to less than 20% of the total workforce SDMP accomplishment falls below 60% of target	No locals are employed by the company in the last six months SDMP accomplishment falls below 40% of target	Review hiring policies Review SDMP programs and determine reasons for the poor implementation of the program	Implement more skills training program to empower residents Identify alternatives for the SDMP program to improve accomplishment	
	Complaints Management	No. of valid complaints	Record keeping	Daily	Whole CBNC operation area	CBNC ComRel	Minimal cost for record keeping	Submission of formal complaint at the ComRel Officers	Submission of formal complaint the need response/action or intervention from the upper management	Media intervention causing local/regional/ national issues	Institution of grievance system Conduct regular IEC to inform and justify the activities being undertaken by CBNC during construction	Notify CBNC Admin for complaint and take remedial measures to address complaints Investigate all complaints, conduct dialogue with communities and implement mitigating measures as needed Compensate affected communities	Conduct in depth investigation and identify root cause for all valid complaints Institute measures to avoid occurrence of similar problems

As indicated in **Table 6.2.1,** CBNC's self-monitoring program includes the monitoring of the water quality and air quality parameters and noise level. The results of CBNC's monitoring from 2011 to 2016 are presented in the Environmental Performance Section of the Water and Air Quality Modules in Chapter 2.

6.3 MULTI-SECTORAL MONITORING FRAMEWORK

In accordance with DENR Administrative Order 2003 – 30 (DAO 2003 – 30), a Multi-Partite Monitoring Team (MMT) was formed. The MMT ensures that CBNC complies with all environmental regulatory requirements and addresses all conditionalities listed in the ECC.

The MMT of CBNC is composed of various representatives from the following groups/ offices/ organizations:

- Mines and Geosciences Bureau (MGB) IVB;
- DENR-EMB Region IVB;
- Palawan Council for Sustainable Development (PCSD);
- Provincial Environment and Natural Resources Office (PENRO);
- Community Environment and Natural Resources Office (CENRO) Brooke's Point;
- Department of Health (DOH);
- LGU-Bataraza;
- LGU-Rio Tuba;
- Bureau of Fisheries and Aquatic Resources (BFAR);
- Philippine Economic Zone Authority (PEZA);
- Apostolic Vicariate of Puerto Princesa;
- HARIBON-Palawan;
- Indigenous People;
- RTNMC;
- Provincial Government of Palawan; and
- NCIP Region IVB or Provincial Health Office.

Despite the proposed TSF No.3 and increase in Co production, no modification will be done on the current MMT set-up. **Table 6.3.1** details the environmental monitoring program of the MMT of CBNC.

Table 6.3.1.The CBNC's MMT Monitoring Program

Aspect	Parameters	Frequency
Compliance with the ECC conditions and other commitments	• 33 ECC Conditions stipulated in ECC No. 0201-021-313 issued last July 10, 2002 • 10 ECC Conditions stipulated in the ECC No. 0701-002-3721 issued last February 1, 2007	Quarterly
Compliance with the Environmental Protection and Enhancement Program (EPEP) commitments	• Status of compliance with the submitted AEPEP	Quarterly
Compliance with the Social Development and Management Program (SDMP) commitments	• Status of compliance with the submitted SDMP	Quarterly
Compliance with the DENR Permit's condition	• Status of compliance	Quarterly
Compliance with the SEP Clearance	• Status of compliance	Quarterly

Source: 2nd Semester Compliance Monitoring and Validation Report (CMVR) for CBNC Line 1 & 2 HPP Project, 2017

Table 6.3.2 presents the status of compliance of CBNC to the Impact Management

Commitments in the EIA and EPRMP reports and EPEP as observed by the MMT and reported in the 2nd Semester of 2017 CMVR (**Annex 6.3.1**). This covers the MMT monitoring period from October to December 2017 for the Hydrometallurgical Processing Plant (HPP) of CBNC.

Table 6.3.2.Status of compliance of CBNC based on the MMT's evaluation

Requirements		Complied		Remarks/ECC or EPEP Condition
		Yes	No	
Compliance with ECC Conditions/Commitments	Validity	✓		ECC 0701-002-3721 issued February 1, 2007 and amended on Feb. 15, 2008
	Project coverage/limits/ components	✓		Total production limit per year for Line 1 & 2 plants as per ECC Amendment on Production Capacity on Feb. 15, 2008: 25,000 DMT Nickel/year and 1,875 DMT Cob
	EMP and updates deemed as necessary	✓		Same as approved AEPEP
	Regular reporting of Self-monitoring results by the proponent	✓		Submitted SMR/CMR on January 2018
	Other sectoral requirements mandated by other agencies to be complied with	✓		
Compliance with EPEP commitments	Implementation of Environmental Impact Control Strategies	✓		See attached Impact Management Commitments in EIA Report & EPEP
	Safety	✓		With approved ASHP CY 2017
	Rehabilitation	✓		Included in the 2017 AEPEP
Compliance with SDMP Commitments		✓		
Complaints Management	Complaint receiving set-up	✓		
	Case investigation	✓		No case investigation for the semester under review
	Implementation of control measures	✓		
	Communication with complainant/public	✓		No complainant for the semester
	Complaint documentation	✓		No complainant for the semester under review
Accountability- qualified personnel are charged with the routine monitoring of the project activities in terms of education, training, knowledge and experience of environmental team		✓		PCO/MEPEO is a Chemical Engineer with more than ten (10) years' experience in environmental works, Excellent in his craft

Source: 2nd Semester Compliance Monitoring and Validation Report (CMVR) for the CBNC Line 1 & 2 HPP Project, 2017

6.4 ECC COMPLIANCE

On July 10, 2002, ECC No.0201-021-313 was granted by EMB to Rio Tuba Nickel Mining Corporation (RTNMC) for the Hydrometallurgical Plant Complex and its support facilities. A Memorandum of Agreement (MOA) was then executed on November 8, 2002 between RTNMC and CBNC on the delineation of responsibilities in complying with the conditionalities listed in the said ECC (**Annex 1.1.5**).

In 2007, CBNC applied for the expansion of its operation (Line 2) thus a new ECC (ECC No. 0701-002-3721) was issued by EMB on February 1, 2007 superseding ECC No. 0201-021-313. However, the mitigating measures included in the EIS of Line 1 should still be implemented. Thus, the conditionalities of both ECC shall be discussed (**Tables 6.4.1** and **6.4.2**).

Table 6.4.1. CBNC Status of ECC No. 0201-201-313 conditionalities compliance as reported in the 2017 2nd Semester Compliance Monitoring Report (CMR)

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
1	This certificate covers the establishment of a Hydrometallurgical Processing Plant Complex that includes the following: Hydrogen Sulfide Plant, Limestone Quarry, Water Supply and Drainage System, Two (2) Tailings Dam, Nine point Nine (9.9) MW Coal-Fired Plant, Port Facilities and other Support Facilities			
	1.1. The plant complex shall have the capacity to produce 10,000 dry metric tonnes (DMT) of nickel and a maximum of 750 DMT of cobalt per year as mixed sulfide at the final stage, through high pressure acid leaching using low-grade ore and laterite as raw materials;	✓		In compliance with the capacity as stated in the new ECC that includes HPP Line 2 expansion was issued by DENR-EMB (ECC-0701-002-3721)
	1.2. The hydrogen sulfide plant shall be initially designed to meet daily consumption of 21.7 metric tonnes per day (MTPD), expandable as the plant increases production;	✓		In compliance with the new ECC.
	1.3. The limestone quarry shall employ open cast mining method using conventional drilling and blasting technique. It shall be limited the 13 hectares in Sitio Gotok, Brgy. Iwahig, Bataraza, Palawan within the geographic coordinates of 8°35'50" to 8°36'20" North Latitude and 117°27'45" to 117°28'15" East Longitude; The proponent shall conduct a thorough study of the limestone quarry area underground system, including flora and fauna and groundwater resource potential and shall provide complete mitigation plan for submission to EMB within 90 days upon approval of this certificate, to serve as basis for the development of the quarry area and/or commencement of limestone quarry activities;			RTNMC's commitment.* Quarrying in progress. All permits acquired.
	1.4. The main source of water supply shall be a from 300 m^3 capacity dam that will be constructed at the intake point of the East Ibelnan River. Other sources shall be from the Togpon, Magas-Magas and Tagpisa siltation ponds;	✓		RTNMC's commitment.* Operation in progress. All permits acquired.
	1.5. Two (2) tailings dam shall be constructed north and northeast of the HPP to collect and impound materials generated from the process. The first shall be similar to the second here it is limited to a height of 33m. Design of the dams shall be in accordance with DENR Memorandum Order No.	✓		Discharge permit was renewed last June 5, 2013 (2013-DP-PAL-02-012), valid until June 2018.

No.	ECC Conditions	Complied Yes	Complied No	Proof of Compliance/Remarks
	99-32 on Policy Guidelines and Standards for Min Waste and Mine Tailings Management dated November 24, 1999 and that in case of deviations, justifications shall be provided;			
	1.6. Power distribution shall be from a coal-fired boiler and turbine not exceeding 9.9 MW;	✓		Renewed Certificate of Compliance of HPP1 Power Plant as Self-Generation Facility from ERC (16-12-S15927L) on December 3, 2016. Renewed Certificate of Compliance for HPP 2 as Self-Generation Facility from ERC (13-06-GXT 16224 – 16468) was likewise renewed last June 25, 2013.
	1.7. A 380 meter long causeway shall be constructed using boulders and gravel and connected to 1,080 m long southwest trending trestle that is mounted on steel pipes. The trestle shall be 5m high from sea level and no more than 30 m wide; The modeling shall further seriously consider the sediment discharge from the nearby Ocayan River, the results of which shall be submitted to EMB within ninety (90) days upon approval of this certificate;	✓		RTNMC's commitment.* CBNC requested for an amendment of the ECC prior modification of the causeway. Amended ECC was received on October 26, 2006. Permit to Operate was issued by the Philippine Ports Authority (PPA) on November 4, 2004 (Good for five years) while Authority to Construct was received from PPA on December 13, 2006. Approval of request from EMB-IVB to construct temporary jetty was received on August 21, 2007 while request for a permanent jetty was granted on September 15, 2008.
	1.8. The borrow areas for sand and gravel shall be a part of Malatgao River located in Sitio Pasi-Pasi-, Brgy. Sandoval, Municipality of Bataraza, Palawan. It shall be limited to a total of 1.98 hectares with dimensions of 276 m long and 72 m wide;	✓		RTNMC's commitment.* Complied.
2	The proponent shall provide quality assurance program for the construction materials to be used for the causeway and tailings dam.	✓		Complied.
3	Details of air and water pollution sources (power plant, sulfide processing and other facilities shall be submitted for review by EMB within ninety (90) days upon approval of this Certificate as basis for the endorsement for the issuance of the Authority to Construct for the air and water pollution/control facilities based on the guaranteed operating guaranteed operating emissions/effluent and ambient limits of these facilities;	✓		Submitted.
4	Forty (40) meters wide buffer zones measured landward along the river/streams bank's high water line and along the entire periphery of the project site shall be established. Fast growing vegetation, indigenous where possible, shall be planted and maintained in these zones.	✓		Slopes around plant and reservoirs stabilized with vegetation
5	The proponent shall ensure that its contractors and sub-contractors properly comply with the relevant	✓		Complied

No.	ECC Conditions	Complied Yes	Complied No	Proof of Compliance/Remarks
	conditions of this certificate.			
6	Noise levels, emissions and effluents generated from project activities shall conform with the prescribed DENR Standards	✓		Results of monitoring regularly submitted to EMB in Quarterly Self Monitoring Reports *Monitoring results from 2011 to 2016 are discussed in **Chapter 2**.*
7	The proponent shall provide adequate safety gadgets to protect its employees/workers from health and occupational hazards posed by project implementation.	✓		Complied. Required reports submitted to MGB & DOLE-BWC
8	Qualified local residents and women shall be given priority in employment. Adequate public information shall be provided for jobs available to local residents in the affected areas as the as part of its livelihood support, the proponent shall undertake appropriate skills training and job preparation. A report on the hiring activities shall be submitted to the Department of Labor and Employment (DOLE) Regional Unit.	✓		Complied. CBNC is giving priority to qualified local residents. *Of the 568 CBNC employees, 57% are residents of the Municipality of Bataraza. Another 26% are from the other municipalities of Palawan.* *CBNC also encourages its contractors and sub-contractors to employ qualified local residents if feasible.*
9	The proponent shall undertake an effective and continuing Information, Education and Communication (IEC) Program to explain publicly its EIS mitigating measures for negative impacts as well as conditions of ECC for a greater awareness, understanding and acceptance of the project among the local residents. It shall open opportunities to educate the workers, contractors, sub-contractors and affected communities through sectoral and small group consultations on environmental and human safety measures in quarrying. The IEC activities shall be funded by the proponent but implemented in coordination with the MGB Region IV-B and EMB Region IV-B,	✓		Complied. Continuing activity. Aside from barangays, other attendees during technical seminar include schools and social/religious group. *Joint responsibility of CBNC and RTNMC.*
10	The proponent shall coordinate with the DENR Coastal Environment Program (CEP) and the Bureau of Fisheries and Aquatic Resources (BFAR) in the rehabilitation of mangroves and sea grasses found affected by the project operations in and around the HPP	✓		Latest Coastal Resource Assessment was conducted by the Palawan Fisherfolk Alliance last May 17 to 20, 2016. Report submitted last August 8, 2017.
11	List of all the stations to be monitored for barren areas with discharge from the mine tailings ponds shall likewise be submitted to EMB Region IV-B prior to project implementation;	✓		RTNMC's commitment.* An additional sampling point was established after the new pond was constructed in upper Togpon.
12	All other permits and requirements of concerned government agencies shall be secured prior to operations	✓		Permits acquired. *CBNC complies with all permitting requirements relative to the operations of HPP Lines 1 & 2 and other support facilities as listed in **Table 6.1.1**.*
13	This Certificate shall be considered automatically revoked if the project has not commenced, i.e. horizontal development, within five (5) years from the date of issuance.			Complied. The project started immediately after the ECC issuance.
14	Any expansion and/or modification of the currently approved mining and processing operations shall be subject to new EIA requirements	✓		ECC No. 0701-002-3721 was secured from EMB last February 1, 2007 covering the HPP expansion.

No.	ECC Conditions	Complied Yes	Complied No	Proof of Compliance/Remarks
				Current ECC application is in progress for the proposed construction of TSF No.3 and increase in Cobalt (Co) production limit.
15	Transfer of ownership of the Project carries the same conditions in this ECC for which written notification shall be made by herein grantee to the EMB and MGB within fifteen (15) days from such transfer.	✓		CBNC shall comply with this if there will be transfer of ownership.
16	The proponent shall submit to EMB a detailed vegetation analysis of the limestone area for quantitative and qualitative analysis for endemic/indigenous plants	✓		RTNMC's commitment.* Already submitted. One of the requirements prior to granting of MPSA.
17	The proponent shall establish a clonal laboratory and nursery for the multiplication and maintenance of endemic/indigenous plants that will be used for the rehabilitation and restoration of damaged areas and those that shall be subjected for mining. All wildings of the endemic plants shall be uprooted/earthballed accordingly. A tri-partite Memorandum of Agreement shall be established among the PENRO/CENRO, community or NGO and the proponent for proper monitoring	✓		RTNMC's commitment.* The Clonal Lab was established at RTNMC townsite. MOA with LGU, PENRO and Proponent finalized.
18	A stormwater/runoff management plan shall be submitted to the EMB for approval prior to project implementation. It shall include the provision for effective drainage system through construction of silt traps/siltation ponds and establishment of vegetative buffers to filter sediments and sediment bound pollutants.	✓		In place. Regular inspection is being undertaken.
19	A community assistance program for livelihood and skills training shall be submitted to the EMB Region IV-B prior to project implementation. The program shall also include assistance in the construction of shallow and deep wells for potable drinking water and other domestic uses, establishment of credit facilities/cooperatives and improvement of the fishing system in and around the Municipality of Bataraza.	✓		The first MOA between CBNC and the IPs was approved by NCIP on September 21, 2004. The second MOA between CBNC and ICCs for 2009-2003 was signed in November 2008. The third SDMP for 2014-2018 including assistance to ICCs was approved on January 7, 2014. *CBNC and RNTMC are jointly implementing the SDMP which includes the said projects. Status of the SDMP implementation is presented in Chapter 5.*
20	The proponent shall implement a Social Development Program and shall assist the local government units in the provision of health, education and welfare services to the residents of the impact areas and vicinities in coordination with the Department of Health, the Department of Education, Culture and Sports and the Department of Social Welfare and Development. The proponent shall undertake special consideration of the growing Muslim community dependent on trade and commerce indirectly resulting from activities of project.	✓		*Joint responsibility of RTNMC and CBNC.* First SDMP (SDMP No. 028-2005-01) was approved by MGB Central Office on January 27, 2005. Second SDMP covering 2009 - 2013 was submitted to MGB IVB on November 28, 2008. MGB IVB approved the said SDMP on September 24, 2009 (SDMP No.01 – 2009IVB – 2[nd]).

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
				Third SDMP covering 2014-2018 including assistance to ICCs was approved on January 7, 2014 (SDMP No. MGBIVB-2013-003-III).
21	All environmental hazards and risks (i.e., reagent as well as radioactive contamination, if any, slope failure, explosive hazards) identified in the revised Environmental Risk Assessment (ERA) which will include a Disaster-Preparedness Program and flood routing studies shall be conducted in order to assess and mitigate the possibility and risk of storm surges.	✓		Regularly inspected and monitored by the MMT. *All environmental hazards and risks in relation to HPP Line 1 & 2 were carefully assessed and mitigating measures were implemented to minimize if not eliminate the hazards/risks.* *To address the work- related hazards, CBNC formulates an Annual Safety and Health Program (SHP), which includes an Emergency Response and Preparedness Program (ERPP) is submitted annually to MGB-IVB for evaluation. After approval, the ASHP is implemented by CBNC and monitored by the MGB Regional Office. The 2016 ASHP was approved on 2 February 2016 under Certificate of Approval No. ASHP/ERPP_MGBIVB_2016-05.* *Strict implementation of these programs is being observed by CBNC.*
22	The proponent must implement environmental management and protection requirements of the pertinent provisions of the Philippine Mining Act of 1995 (RA 7942) and its Implementing Rules and Regulations (DAO 96-40), as well as the Memorandum of Agreement (MOA) between the EMB and MGB executed on April 16, 1998. It must establish a Contingent Liability and Rehabilitation Fund (CLRF) to cover expenses of multi-sectoral monitoring activities, short- and long-term rehabilitation programs and/or indemnification of damages to life and property that should include an Environmental Trust Fund (ETF) to cover payment. The absence of the CLRF shall cause the cancellation of this ECC.	✓		*Joint responsibility of RTNMC and CBNC* EPEP for HPP Line 1 (EPEP 063 2004 – 04) was approved on September 21, 2004. The CLRF trust fund is intact. EPEP for HPP Line 1 and 2 was submitted to MGB-IVB on March 23, 2007. Certificate of Approval for the EPEP and FMR/DP was released on December 14, 2009.
23	A Solid Waste Management Program acceptable to the LGU leadership to include specific disposal of waste must be developed and submitted to EMB prior to project implementation.	✓		Sanitary Landfill was constructed in compliance with the submitted proposed SWMP. The sanitary landfill is covered by ECC-4B-079-PA-9200-2007, which was granted by EMB-IVB on August 15, 2007.
24	Slope stabilization and erosion control of the tailings dam, as well as the affected side slopes if the nearby gullies/creeks/rivers within the project site, shall be strictlyeffected throughout project implementation;	✓		CBNC conducts dam integrity monitoring (*i.e.* piezometer, extensometer and visual inspection). Monitoring results are included in SMRs.
25	An Environmental Audit must be submitted to EMB after one (1) year of operation and every three (3) years thereafter;	✓		CBNC commissioned BMP Environment and Community Care, Inc. to conduct

No.	ECC Conditions	Complied Yes	Complied No	Proof of Compliance/Remarks
				environmental audit. The 3rd environmental audit was conducted on January 28 – 31, 2015. Final Report was submitted to EMB, MGB-IVB and EMB-IVB on November 9, 2016.
26	The proponent shall design and construct roads with minimal land and ecological disturbance and with adequate drainage. It shall likewise maintain access roads and other public/private roads within the quarry site	✓		RTNMC's commitment. Complied.
27	Detailed safety management plans and programs focusing on high risk areas shall be submitted to MGB and DOLE thirty (30) days upon the issuance of the certificate.	✓		Closely related to Condition No. 21 *SHP with ERPP is annually submitted to MGB-IVB while Monthly General Accident Report (MGAR) is submitted monthly to DOLE.*
28	Any infrastructure development relative to the port facilities shall be conducted with minimal disturbance to the mangrove ecosystem	✓		Complied.
29	The proponent shall conduct quarterly monitoring of air/water quality and emissions/effluent generated from the operations as well as the bioassay of fish in terms of heavy metals, the result of which shall be submitted to the EMB Region IV-B and the EMB. Should monitoring results indicate that there is exceedance of DENR Standards, the proponent shall immediately cease its operation and institute remedial measures until such time that the monitoring results conform with the DENR Standards.	✓		Complied through the MMT. *CBNC conducts regular monitoring of air quality, water quality and noise level quarterly. Results of which are included in the SMRs submitted to EMB-IVB and MGB.* *Fish tissue and Sediment Analysis reports submitted annually to EMB, EMB-IVB, MGB-IVB and BFAR-IVB.*
30	The proponent shall observe good vegetative practices, proper land use, and sound soil management. All used/open areas in the site shall be planted with appropriate species. Direct use of the recovered topsoil for re-soiling or as soil cover on waste dumps and for camp beautification in general shall be undertaken. Stockpiling on designated suitable areas shall be done and maintained at not more than one (1) meter in height and temporarily vegetated to protect the soil from erosion.	✓		Complied. *TSF 1 was decommissioned on July 1, 2010 and the trial plantations established were multi-species and multi-cropping. To prevent erosion and for visual aesthetics, grass was planted on the embankment slopes.* *To improve the soil media for nursery seedling stock production and plantation, the company employs vermicomposting of organic materials.*
31	The proponent shall undertake the following:			
	31.1. Period inspection of the stability of all earthworks such as silt dams, waste dumps, stockpiles, tailing pond embankments, road cuts, airport, pier and open pits;	✓		*CBNC conducts regular inspection of tailings pond embankments.*
	31.2. Periodic inspection of the capacities and stability of the drainage canals, culverts, stormwater pond and sedimentation ponds;	✓		Being undertaken
	31.3. Continuous de-silting of drainage canals and sedimentation ponds;	✓		RTNMC's commitment.* Being undertaken.
	31.4. Clearing of rocks and boulders along slopes, especially in road cuts;	✓		RTNMC's commitment.* Being undertaken.

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
	31.5. Periodic testing of the chemical and physical characteristics of decant water from tailings pond being discharge to the sea; and	✓		Complied. Presently, about 2/3 of supernatant is recycled to the plant.
	31.6. Annual monitoring of faunal diversity	✓		2017 Flora and Fauna Monitoring Reports was conducted last June 6 to 11, 2017. Report preparation is on-going
32	An abandonment plan shall be submitted to the EMB, copy furnished EMB Region IV-B and MGB, after a year of the project's operations. Alternatives shall be presented and the same shall be consistent with the long term zoning and land use development plan for the local and provincial government	✓		FMR/DP for HPP 1 & 2 was submitted on August 27, 2009. A Certificate of Approval was granted by MGB on December 14, 2009.
33	Relevant provisions of the revised EPEP on abandonment shall be strictly implemented	✓		CBNC shall comply upon abandonment.

Source: 4th Quarter Self-Monitoring and 2nd Sem Compliance Monitoring Report, 2017

*Note:*Responsibility of RTNMC based in MOA on the Delineation of Responsibilities of CBNC and RTNMC dated November 8, 2002*

Table 6.4.2. CBNC Status of ECC No. 0701-002-3721 conditionalities compliance as reported in the 2017 2nd Semester Compliance Monitoring Report (CMR)

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
I.	**ENVIRONMENTAL MANAGEMENT** The proponent shall strictly implement the mitigating measures contained in the Environmental Management Plan, EPRMP and EIS for Line 1 & 2, including the following:			
1	Management of all external, chemical and processes and health hazards identified in the Environmental Risk Assessment of its EPRMP and in case of emergency, address immediately for the protection of the workers, nearby residents, and sensitive ecosystem.	✓		Latest revision of ERPP was submitted to MGB-IVB on November 28, 2016. Awaiting Approval from MGB IVB.
2	Undertake an effective and continuing Information, Education and Communication (IEC) Program to inform and educate all stakeholders, especially its local residents, on the project's mitigating measures embodied in the EPRMP, as well as the conditions stipulated in this Certificate, the greater awareness, understanding and continued acceptance of the project.	✓		Regular IECs are conducted in Barangays and ICCs. IECs are also conducted for other groups such as schools, LGUs and other government officials.
3	Observe good vegetative practices, proper land use and sound soil management. All used/open areas in the sites shall be planted with appropriate species. Direct use of the recovered top soil for re-soiling or as soil cover on waste dumps and for camp beautification in general shall be undertaken. Stockpiling on designated suitable areas shall be done and temporarily vegetated to protect the soil from erosion.	✓		Reforestation is a combined effort of CBNC and RTNMC. Activities related to reforestation are regularly monitored by the MMT. Separately, CBNC also operates a plant nursery and conducts reforestation and planting activities in the HPP buffer zones and within the plant site. Mangrove planting at the causeway area at Nagoya Beach is also being conducted.
4	**GENERAL CONDITIONS** The plant operations shall conform with the provisions of RA 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990), RA 9003 (Act Providing for an Ecological Solid Waste Management Program), RA 9275 (Philippine Clean Water Act of 2004), and RA 8749 (Philippine Clean Air Act of 1999)	✓		Quarterly monitoring conducted by MMT. Regular Self-Monitoring is being conducted as specified in the approved EPEP. Quarterly Self-Monitoring Reports (SMR) submitted to EMB-IVB and MGB.

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
				Sanitary landfill was issued an ECC (ECC-4B-079-PA-9200-2007) last 15 August 2007.
5	The proponent shall strictly comply with the environmental management and protection provision of the Philippine Mining Act of 1995 (RA 7942) and its revised implementing rules and regulations (DAO 9640), as amended, as well as the pertinent provisions of the Memorandum of Agreement (MOA) between EMB and MGB executed on April 16, 1998, such as, but not limited to the following:	✓		CBNC is committed to comply with all regulatory requirements as required by law. Required reports as specified by DAO 96-40 are submitted to MGB and MGB-IVB: - Monthly Report on Production Sales, Inventory of Metallic Minerals and Employment Data for Nickel (MGB Form 29-5) - Monthly General Accident Report (MGB Form 15 – 5) - Quarterly Energy Consumption Report (MGB From 29 – 18) - Semi-annual Report on Mine Waste and Tailings Generated - Integrated Annual Report (MGB Form 29-16) - Annual EPEP and Annual SDMP Other reports as requested b MGB also submitted such as: - Revitalization of the Minerals Industry Program Quarterly Monitoring Report - Survey Form on Taxes, Fees and Royalties Paid/Withheld by Mining Operators/Companies - Quarterly EPEP Expenditure Report - Required permits such as Ore Transport Permit, Permit to Operate or Certificate of Electrical Inspection are obtained upon need from MGB IVB
a.	Submission of a revised Environmental Protection and Enhancement Program (EPEP), including Final Mine Rehabilitation/Decommissioning Plan (FMR/DP) to reflect the inclusion og Line 2 of the HPP with thirty (3) calendar days from receipt of this Certificate to the MGB/EMB Offices, for approval.	✓		EPEP for combined HPP 1 & 2 was submitted to MGB-IVB last March 23, 2007. Presented to CLRF-SC last February 12, 2009. Final draft of the EPEP was submitted to MGB May 8, 2009. FMRDP submitted last August 27, 2009. Certificate of Approval received December 14, 2009.
b.	Submission of a revised Social Development and Management Program (SDMP) within thirty (30) calendar days prior to the expiration of the existing SDMP to the MGB Regional Office No. IVB, which shall include appropriate skills training and job preparation projects as part of its livelihood support program, for approval; and,	✓		SDMP for 2014 – 2018 was submitted to MGB-IVB last November 27, 2013. Approval (SDMP No. MGB-IVB-2013-003-III) given January 7, 2014.
c.	The Mine Environmental Protection and Enhancement Office (MEPEO) shall submit to EMB and the EMB Region IVB monitoring reports on environmental compliance of the proponents as well as with the EMMoPs. The MEPEO shall also	✓		Quarterly Self-Monitoring Reports submitted to EMB IVB. Copies also submitted to MGB and MGB-IVB.

No.	ECC Conditions	Complied		Proof of Compliance/Remarks
		Yes	No	
	monitor the actual project impacts vis–a –vis the predicted impacts and management measures in the EIS and EPRMP, including monitoring of flora and fauna diversity;			2017 Flora and fauna monitoring activity was conducted last June 6 to 11, 2017. Report preparation is on-going. Fish tissue and sediment analysis reports submitted annually to EMB, EMB-IVB and MGB-IVB. Coastal Resource Assessment reports submitted annually to EMB, EMB-IVB, MGB-IVB and BFAR-IVB. 2017 CRA was conducted last May 17 to 20, 2017. Report submitted last August 8, 2017.
6	The proponent shall provide a high resolution imagery of the project and impact areas within one year after the approval of this Certificate and every five (5) years thereafter to show the impacts of the project on the physical, social and economic environment.			Photomosaic of HPP area was submitted to EMB last January 30, 2008. CBNC submitted last photograph to EMB last July 30, 2010. Satellite image obtained last February 2015 and was submitted to EMB on June 18, 2015
7	**RESTRICTIONS** 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 as regards to transfer of ownership.			Company shall comply in the event of transfer of ownership.

Source: 4thQuarter Self-Monitoring and 2ndSem Compliance Monitoring Report, 2017

6.5 CONTINGENT, LIABILITY AND REHABILITATION FUND

A Memorandum of Agreement (MOA) was executed on July 28, 2003 among RTNMC, CBNC, MGB-IVB, Provincial Government of Palawan, Municipal Government of Bataraza, PCSD, residents of Brgy. Rio Tuba, residents of Brgy. Ocayan;*Katutubong Palawan*, HARIBON Foundation, and Bataraza Christian Muslim PalawanoAsso., Inc. (BACHRISMUPAL).*Section 1* of the MOA states that RTNMC/CBNC shall establish a Mine Rehabilitation Fund (MRF), which is in compliance with *Section 181* of DENR Administrative Order 2010 – 21. The current MRF of RTNMC/CBNC is in two (2) forms: Monitoring Trust Fund (MTF) and Rehabilitation Cash Fund (RCF). The MTF committed as per MOA to cover the expenses of the monitoring activities is PhP50,000.00 and the current amount deposited in the Development Bank of the Philippines (DBP) is PhP64,430.02. On the other hand, the RCF committed as per MOA to ensure compliance with the approved rehabilitation activities is PhP5,000.000.00 and the current amount deposited is PhP5,240,034.90. In addition, an Environmental Trust Fund (ETF) was established by CBNC. The current amount of ETF as deposited in DBP is PhP287, 949.85.

Annex 6.5.1 shows the signed MOA while **Annex 6.5.2** is the Statement of Account from the DBP indicating the available funds as of December 31, 2015.

6.6 COMPLAINTS MANAGEMENT SYSTEM

CBNC follows a procedure in handling external complaints from interested party. This procedure is under the Internal and External Communication Procedure provided as **Annex 6.6.1**.

In case of complaint related to environmental issues/concerns, the PCO or the ComRel shall register the information and fill-up Form 03 QC 2007 rev.00 as instructed in *Section 7.2.5.2* of the Internal and External Communication Procedure (**Annex 6.6.1**). Succeeding actions are presented on the workflow provided as **Figure 6.6.1**.

Responsibility	Work flow	Interface
	START	
Procurement and Logistics Department (PLD), ComRel, PCOs	Receive information/ complaints from external interested party	Form 03 QC-2007 rev.00
(1) PCO(s) (2) PLD Manager (3) ComRel Supervisor	Accomplished Information Report (1) Environmental related Issues/ Concern (2) Costumer Complaints/Concern	Form 06 QC-2007 rev.00
(1) PCO(s) (2) PLD Manager (3) GAD Manager	Conduct verification on the information received as basis of judgment and action	Form 06 QC-2007 rev.00
(1) PCO(s) (2) PLD Manager	Report to Plant Manager	
(1) PCO(s) (2) PLD Manager	Issue Corrective/ Preventive Action Report (CPAR)	Form 1 QC-2005 rev.00
Concerned Department Manager	Apply Corrective &/ or Preventive Action	Form 1 QC-2005 rev.00
(1) PCO(s) (2) PLD Manager	Reply to interested party (if necessary)	
(1) PCO(s) (2) PLD Manager	Settle the issue	
	END	

Figure 6.6.1. CBNC's Procedure in handling of complaints

7 Abandonment/Decommissioning/ Rehabilitation Policy

Coral Bay Nickel Corporation

The Hydrometallurgical Processing Plant (HPP) operations of Coral Bay Nickel Corporation (CBNC) is projected to end by 2022. This chapter gives an overview of the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP) of CBNC submitted in August 27, 2009 and approved by the Mines and Geosciences Bureau (MGB) last December 14, 2009.

7.1 INTRODUCTION

Pursuant to Section 187 of DENR Administrative Order (DAO) 2010-21, an integrated Environmental Protection and Enhancement Program (EPEP) and Final Mine Rehabilitation and/or Decommissioning (FMR/DP) shall be submitted by the Contractor/Permit Holder to the Mine Rehabilitation Fund (MRF) Committee and Contingent Liability Rehabilitation Fund (CLRF) Steering Committee, through the Regional Office concerned and the MGB Central Office, respectively. In formulating the FMR/DP, risk-based methodologies must be used and all closure scenarios must be considered. Furthermore, the document must contain cost estimates for the implementation of the FMR/DP.

As suggested by the MGB guideline released last June 2006, an FMR/DP shall contain the following:

- Company Information;
- Executive Summary;
- Background Information
- Stakeholder Involvement;
- Risk Assessment;
- FMR/DP or Closure Plan;
- Schedule of Operations and Costs;
- Plan Showing Proposals; and
- Technical Appendices.

However, the company information and executive summary sections may be omitted since the FMR/DP is integrated in the EPEP.

CBNC has an approved FMR/DP which covers the existing facilities. With the proposed Tailings Storage Facility No. 3 (TSF3), CBNC shall revise its existing FMR/DP to incorporate the proposed TSF 3. The following discussion is culled from the 2009 FMR/DP of CBNC.

7.2 FINAL MINE REHABILITATION AND/OR DECOMMISSIONING PLAN (FMR/DP)

7.2.1 Objectives

The FMR/DP of CBNC is formulated to address biophysical, chemical, and social issues related to closure.

Biophysical Issues

- Physical stability and bare surfaces of the embankments and impounded tailings of TSF 1 and 2;
- Voids in the borrow areas of TSF 2;
- Physical stability, bare surfaces, and impounded sediments of the water reservoirs;
- Physical stability and control of nuisance problems such as dust, odor, and vermin of the sanitary landfill;
- Other built-up areas such as the sites of the HPP and personnel accommodations that has impact on visual aesthetics and prevent the productive use of the land;
- Soil provision or conditioning to support the re-establishment of robust endemic vegetation; and
- Selection of indigenous floral species such as shrubs, vines, grasses and trees appropriate to the contemplated post-mining land use.

Chemical Issues

- Heavy metals associated with the ore at the TSFs such as Fe (iron), Cr (chromium) and Al (aluminum);
- Chemicals such as H_2SO_4 (sulfuric acid), Ch_3OH (methanol), H_2S (hydrogen sulfide), NaOH (caustic soda), and diesel stored in the reagents are of the process plant, workshops, and storage facilities;
- Industrial wastes such as coal ash, used oil, and grease and batteries;
- Leachates from the sanitary landfill, which contains elevated levels of BOD_5, COD, SO_4, NH_4, N, metals and methane gas; and
- Domestic solid waste which needs collection and proper disposal.

Social Issues

- Sustainability of the host and impact communities after the depletion of the low-grade ore feed to HPP.

7.2.2 Closure Plan

Plant closure activities are summarized in **Table 7.2.1**.

7.2.2.1 Decommissioning

CBNC shall adopt the following basic approaches during decommissioning (Queensland Department of Environment and Heritage, 1995 and Australian Mining Council, 1990):

- Materials, equipment or structures that have residual value and any existing or potentially hazardous substance, equipment or structures shall be removed from the site;
- Existing or potentially hazardous materials, equipment or structures shall be treated at site by various methods such as chemical treatment, fixing in solids (cementation or backfilling) or burial (whichever is applicable); and
- Existing or potentially hazardous materials, equipment or structures shall be collected and contained within the smallest area possible through encapsulation, capping, submersion, burial, etc.

7.2.2.2 Plant Rehabilitation

The rehabilitation goals of CBNC is similar to MGB's closure criteria which requires the disturbed land to be physically and chemically stable, visually acceptable and productive or self-sustaining condition.

- Physical Stability – the plan addresses both short-duration extreme events (*i.e.* floods, fires, tropical cycles and earthquakes) and slow but perpetual forces (*i.e.* water and wind erosion).
- Chemical Stability – relevant to TSF tailings, sedimentation pond and sanitary landfill. Similar measures indicated for physical stability.
- Visual Acceptability – for this criterion, natural streams and slopes of the area are adopted as model landforms while floral species present in the area are used for plantation works.
- Productivity – Tree species that are recommended for rehabilitation works (i.e. Palawan agoho, Batino, *Trema* sp., Narra.. etc.) were selected based on ecological, economic and social considerations.
- Self-sustaining Condition – Ecosystem Function Analysis (EFA) by the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) shall be adopted in assessing the rehabilitation of disturbed sites.

7.2.2.3 Maintenance and Monitoring

Majority of maintenance activities shall focus on all plantations. CBNC shall initially carry out these activities prior to handing it over to a cooperative or individual caretaker. Other maintenance works relative to slopes along the walls, berms and embankments of TSFs, sedimentation pond, water storage and sanitary landfill may be conducted as needed.

Monitoring activities shall cover not only the project facility but also adjacent and downstream areas. Majority of which shall be conducted by an FMRD Team (**Figure 7.2.1**) without external laboratory analyses. A detailed monitoring plan is included in *pages 6-44 to 46* of **Annex 7.2.1**.

Table 7.2.1 Closure activities

Activities	Coverage	Details
Plant decommissioning - Removal of materials, equipment and structures - Treatment of hazardous materials	HPP Complex • Ore preparation, chemical/ sulphur yard and warehouse, and spare parts storage and MS warehouse • High pressure acid leach, neutralization, CCD/thickening, and final neutralization (includes limestone storage), zinc removal and sulfurizatioin, H_2S plant, laboratory and workshop • Power plant • Office, canteen and accommodations • Port area including causeway	Refer to *Section* 6 *pp. 6-10 to 6-17* of **Annex 7.2.1**
Rehabilitation	• HPP Complex (components of which are same as listed above) • TSF 1 and 2 • Water storage • Sanitary landfill • Port area	Refer to *Section 6 pp. 6-26 to 6-39* of **Annex 7.2.1**
Maintenance and monitoring	All	Refer to *Section 6 pp. 6-42 to 6-46* of **Annex 7.2.1**

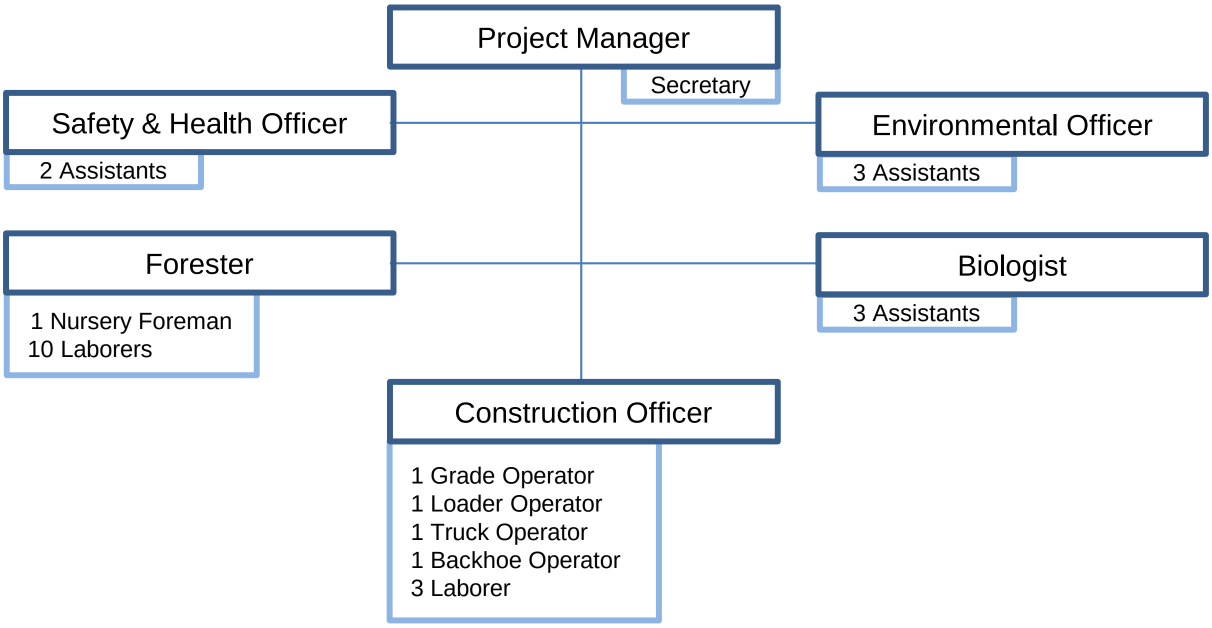


Figure 7.2.1. FMRD Team Organizational Structure

7.2.4 Final Land-use

In establishing the final land use of CBNC Project Site *Section 167* of DAO 1996-40 was taken into consideration, which states that:

"Minesite decommissioning and rehabilitation shall aim to establish a land use capability that is functional and proximate to the land use prior to the disturbance of the mine area, unless other more beneficial land uses are predetermine and agreed in partnership with local communities and Local Government."

The specific land-use per project component is listed in **Table 7.2.2** along with the activities that shall be undertaken.

Table 7.2.2 Land use per project component

Project Component	Specific post-mining land use	Required Works
HPP Complex		
Ore preparation, chemical/ sulphur yard and warehouse, and spare parts storage, and MS warehouse	Forestland	• Haul out unused ore, chemicals, spare parts, sulfur stockpiles, and wastes • Remove conveyor belt, crushers, cables, pipes, concrete, roof, walls and racks • Decontaminate and remove oil and chemical spills • Fix drainage • Deep rip hardstands • Condition the soil • Plant endemic species
High pressure acid leach, neutralization, CCD/thickening, and final neutralization (includes limestone storage), Zinc removal and sulfurizatioin, H_2S plant, Laboratory and workshop	Forestland	• Haul out unused chemicals, limestone, and wastes • Remove autoclave, tanks, thickeners, equipment, cables, pipes, concrete, roof, walls and racks • Decontaminate and remove oil and chemical spills • Fix drainage • Deep rip hardstands • Condition the soil • Plant endemic species

Table 7.2.2 Continuation…

Project Component	Specific post-mining land use	Required Works
Power plant	Forestland	• Haul out unused coal, petrochemicals, sludge and wastes • Remove boilers, generators, electrostatic precipitators, ash handling system, storage tanks, cables, pipes, concrete, roof, walls and racks • Seal the ash pond • Decontaminate and remove oil and chemical spills • Fix drainage • Deep rip hardstands • Condition the soil • Plant endemic species
Office, canteen and accommodations	Forestland	• Haul out unused cleaning and cooking materials, office supplies and wastes • Remove equipment, furniture, cables, pipes, concrete, roof and walls • Decontaminate and remove oil and chemical spills • Fix drainage • Deep rip hardstands • Condition the soil • Plant endemic species
TSF 1 and 2		
Embankments	Shrubland	• Rehabilitate downslope batters and crests of the embankments • Provide permanent diversion drainage systems, erosion and sediment control protection including strip planting north of TSF1 • Return tailings delivery and decant return pipe work • Decommission decant tower • Finalize and implement of design of closure outlet conduit complete with erosion protection and trash traps • Condition the soil • Plant vines and grasses
Impoundment area	Industrial tree plantation	• Pump out and treat tailings supernatant • Dry tailings aided by sprinkling and wicks and grading of surface • Condition the soil • Plant industrial tree species
Others		
Water storage (Upper Togpon Pond; Water reservoir; Borrow areas for TSF 2 and East Ibelnan and Togpon Intake Dams)	Aquaculture	• Strengthen slopes and embankments • Fix drainage for long-term stability by side slope flattening, widening, re-grading, rock armoring, and revegetation • Plant endemic species along pond perimeter • Provide fencing, bunding and appropriate safety signage around the pond • Conduct fish trial propagation for heavy metal tissue analysis • Stock fish full-scale if heavy metal tissue is favorable
Sanitary Landfill	Sports ground or public open space	• Develop and implement field trials of alternative capping designs for the filled cells • Finalize and implement capping design • Fix drainage for long-term utility by side slope flattening, widening, regarding, rock armoring and revegetation • Condition the soil • Plant endemic species

Table 7.2.2 Continuation…

Project Component	Specific post-mining land use	Required Works
Port area including causeway	Port and Coconut land	• Haul out concrete, walls, and roof of Materials Recovery Facility • Provide fencing, bunding and signage around landfill to prevent access to dangerous places • Haul out unused oil, coal and reagents and wastes • Remove trestle, tanks, pipes, pumps, concrete, walls, roofs and racks • Decontaminate and remove oil and chemical spills • Fix drainage • Deep rip hardstands • Plant coconuts • Turnover causeway to the local government

Source: FMRDP for the HPP Project Lines 1 & 2, July 2009.

7.2.5 Schedule of Operations and Costs

7.2.5.1 Schedule of Activities

The projected end of operations of the HPP Complex was based on the availability of low grade ore. Most project facilities are to be decommissioned by 2022 to 2024 except for TSF 1, which was decommissioned earlier than planned as it already reached its maximum tailings storage capacity last 2010 (**Table 7.2.3**).

Note that the schedule shall be revised to include the decommissioning and rehabilitation activities for TSF 3.

Table 7.2.3 Schedule of decommissioning and rehabilitation works for the HPP Project

Project Facility	Component	Decommissioning	Rehabilitation and Monitoring	
			Start	End
HPP Complex	Various	2022 – 2023	2023	2032
TSF 1	Embankment	2013 – 2014	2014	2024
	Impoundment	2013 – 2015	2015	2025
TSF 2	Embankment	2022 – 2023	2023	2033
	Impoundment	2022 – 2024	2024	2033
Water Storage	Buffer zone for TSF 1 borrow areas Buffer zone for TSF 2 borrow areas	2022	2022	2032
Sanitary Landfill	Various	2024	2024	2034
Port Area	Port Excluding Causeway	2022	2022	2032
	Causeway	22	2022	2023

Source: FMRDP for the HPP Project Lines 1 & 2, July 2009.

7.2.5.2 Total Cost of FMR/DP

Excluding the rehabilitation of TSF 3, the total estimated FMR/DP cost of the HPP Complex along with its auxiliary facilities is PhP 105,929,000. The summary of cost per activity is presented in **Table 7.2.4**. Please refer to *pages 7-4 to 7-13* of **Annex 7.2.1** for the detailed breakdown of cost per activity annually from 2014 to 2034.

Table 7.2.4 Total cost of FMR/DP activities

FMRDP Activity	Cost (Php)
Decommissioning	**7,350,000**
• Removal of materials, equipment and structures	7,250,000
• Treatment of hazardous materials	100,000
Rehabilitation	**48,185,000**
• Hydrometallurgical Processing Plant	7,035,000
• TSF 1	5,808,000
• TSF 2	23,150,000
• Water storage	5,460,000
• Sanitary landfill	3,213,000
• Port area	3,519,000
Maintenance and monitoring expenses	**40,764,000**
TOTAL	**96,299,000**
Contingency (at 10%)	**9,629,000**
GRAND TOTAL	**105,929,000**

Source: FMRDP for the HPP Project Lines 1 & 2, July 2009.

The schedule of deposits of this amount is in accordance with *Table 1* of DAO 2005-07. The FMRD Fund for Line 1 is spread over 15 years while 10 years for Line 2 (**Table 7.2.5**).

Table 7.2.5 Schedule of FMRD Fund deposits

FMRD Cost/Fund (in PhP'000)	Year														
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Line 1 (Based on 15 years)	10,964	9,534	7,945	6,885	5,296	4,237	3,337	2,648	1,059	530	530				52,965
Line 2 (Based on 10 years)				10,964	9,534	7,945	6,885	5,296	4,237	3,338	2,648	1,059	530	530	52,965
Total FMRDP Fund Desposit				17,849	14,830	12,182	10,222	7,945	5,296	3,866	3,178	1,059	530	530	105,930

Source: FMRDP for the HPP Project Lines 1 & 2, July 2009.

8 Institutional Plan for EMP Implementation

Coral Bay Nickel Corporation

In accordance with DENR Administrative Order No. 2010 – 21 known as *Providing for a Consolidated Department of Environment and Natural Resources Administrative Order for the Implementing Rules and Regulations of Republic Act No. 7942 otherwise known as the Philippine Mining Act of 1995*, various offices were established by Coral Bay Nickel Corporation (CBNC) such as the Environmental Management and Quality Control Section (EMQCS), Community Relations (ComRel) Office, and Safety Section to ensure that the Environmental Management Plan (EMP) stated in *Chapter 4* are implemented properly. A Multipartite Monitoring Team (MMT) is formed to monitor and evaluate the compliance of CBNC.

8.1 POLICY STATEMENT

CBNC is committed to be the world's leading producer of Nickel and Cobalt Mixed Sulfides that meets customer expectations. This is achieved by applying High Pressure Acid Leach (HPAL) Technology and establishing, implementing, maintaining and improving an Integrated Management System (ISO 9001:2008 and ISO 14001:2004) granted by Certification International last November 20, 2015. The ISO certification is valid until September 14, 2018 (**Annex 8.1.1**).

As a company, CBNC has been carrying out the following for the advancement of its operations:

- Comply with all statutory and regulatory equipment and regulatory requirements related to production activities and environmental aspects;
- Entrust protecting the environment;
- Supply products that meet customer satisfaction;
- Periodically review the effectiveness of our quality and environmental management systems;
- Establish annual objectives, targets and programs geared towards the improvement of all processes within the organization;
- Exert strong influence to our suppliers and contractors to adhere to this policy; and
- Ensure that all stakeholders are aware of this policy.

8.2 ENVIRONMENTAL MANAGEMENT AND QUALITY CONTROL SECTION (EMQCS)

CBNC established EMQCS which is equivalent to the Mine Environmental Protection and Enhancement Office (MEPEO). The EMQCS is headed by the Section Manager who directly reports to the EVP and Plant Manager and Vice-president for the Environment and External Affairs. The group is composed of a Senior Supervisor, Junior Supervisor, one (1) Assistant II, four (4) Assistant I, three (3) operators, three (3) coordinators, three (3) research assistants and an assistant operator (**Figure 8.2.1** and **Figure 8.2.2**). Its duties and responsibilities as stated in the latest IMS Manual (**Annex 8.2.1**) are as follows:

- Establish and implement the Integrated Management System;
- Implement the Environmental Protection and Enhancement Program (EPEP);
- Implement the Final Mine Rehabilitation and Decommissioning Plan (FMR/DP);
- Manage the company's compliance to legal and other statutory requirement; and
- Manage tailings and effluent.

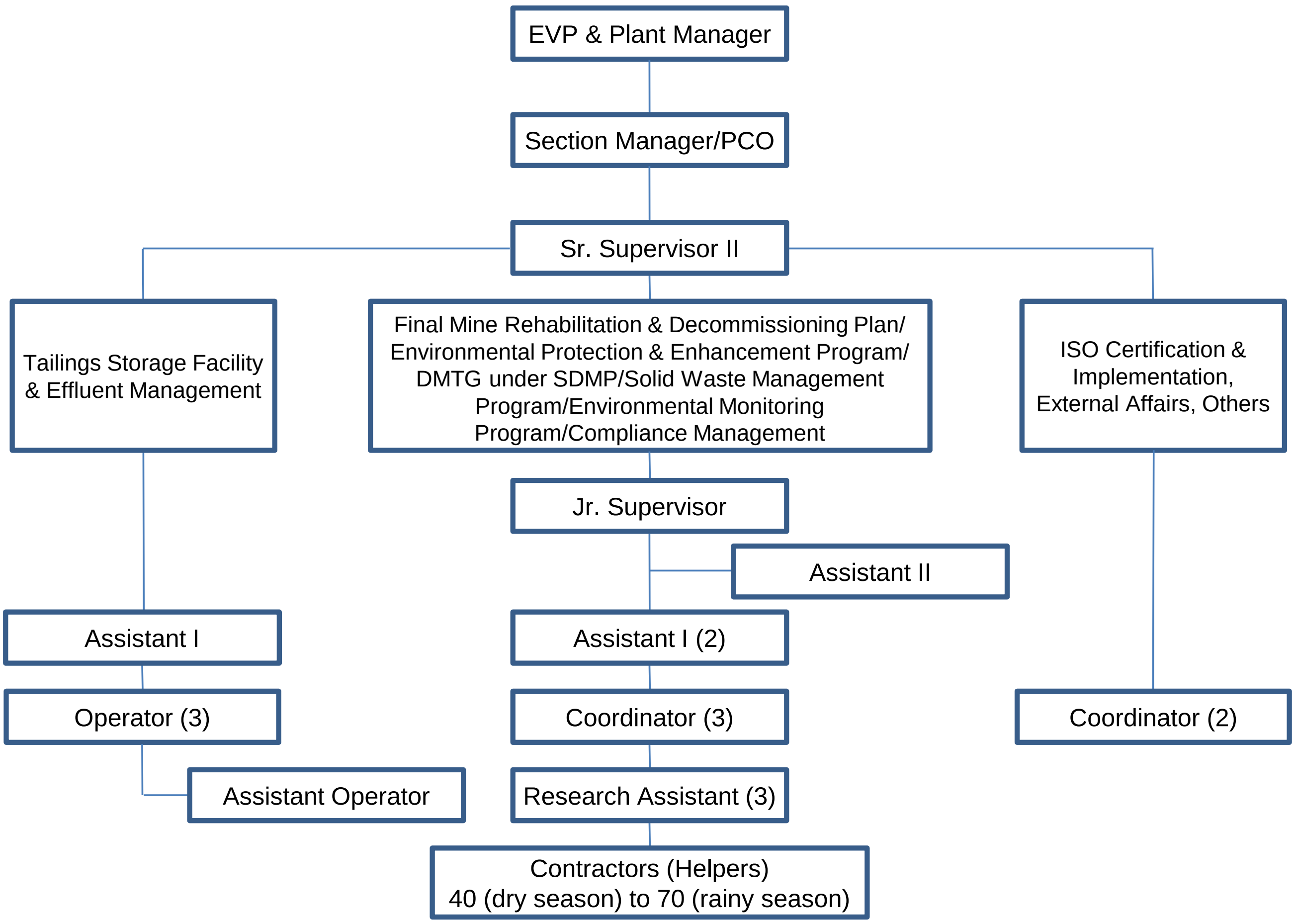


Figure 8.2.1 EMQCS organizational structure

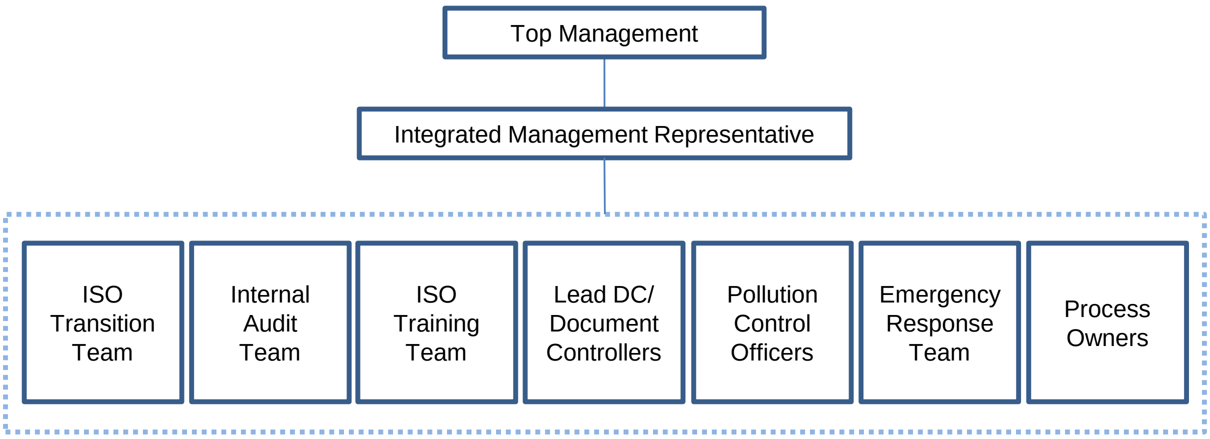


Figure 8.2.2 IMS organizational structure

8.3 COMMUNITY RELATIONS (COMREL) OFFICE

CBNC created a COMREL office, which is under the General Affairs Department (**Figure 8.3.1**). Headed by COMREL General Supervisor, it is composed of three (3) assistants, five (5) coordinators and a service attendant. It acts as the center for empowering the commitment of CBNC in the development of the community in the Barangays of Rio Tuba, Taratak, Sumbiling, Sapa, Ocayan, Sandoval, Iwahig, Igang – Igang, Sarong, Culandanum, Tarusan, and the Indigenous Cultural Communities (ICCs) in these areas. With a vision of creating an *"organized, conscious, empowered, self-reliant, just and humane entity and community*" (CBNC COMREL, 2005), its mission is to:

- Bring a systematic, planned, and liberating change process of community transformation;
- Awaken the mind of every human on the benefits of mining and to make them a partner for development; and
- Teach the community to comprehend their situation and be motivated to act and change oppressive conditions.

ComRel has recognized five (5) broad functions for itself, namely:

- Community developer of long term development based on livelihood programs, healthy environment, and an educated populace;
- Information, Education, and Communication (IEC) Campaign organizer – focused of CBNC's responsible mining activities;
- Project Monitoring and Evaluation Committee on the SDMP and out-of-pocket community relations assistance;
- Community relations in all aspects; and
- Administrative responsibilities including office capability through staff development and equipment acquisition and upgrading.

The CBNC ComRel communicates thoroughly with Rio Tuba Nickel Mining Corporation (RTNMC) and Rio Tuba Nickel Foundation, Inc. (RTNFI).

Aside from the Social Development and Management Plan (SDMP), CBNC and RTNMC implements the Community Relations Assistance (CRA) program, which is an unrestricted assistance to the stakeholders. CRAs commonly cover the health welfare, social services, sponsorships, donations, and general assistance requested by the recipients which are subject to approval by CBNC/RTNMC. The CBNC COMREL sees the reduction of CRAs as evidence of gaining capabilities of the locals and communities, which is one of their goals.

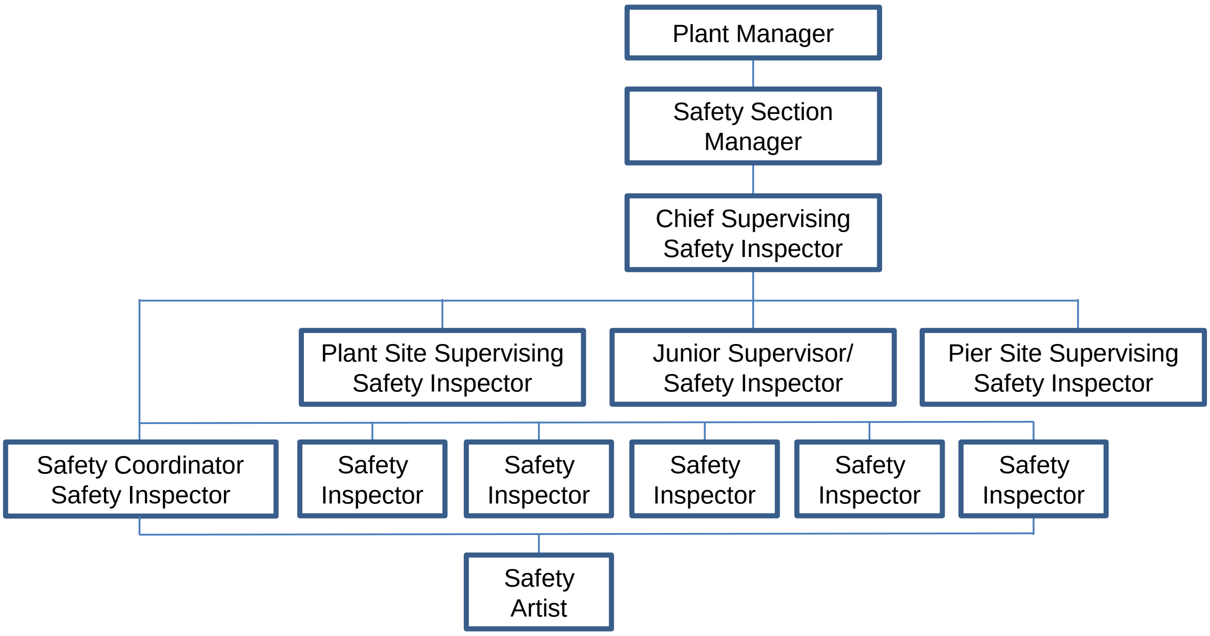
8.4 SAFETY SECTION

CBNC operates with due regard to the safety and health of the workers, contractors and community while taking into consideration the protection of the environment.

The safety rules and regulations likewise the standard operating procedures of CBNC are formulated in accordance with DAO 2000 – 98 (Mine Safety and Health Standards) and RA 7942 (Philippine Mining Act of 1995). To implement these, a Safety Section is in place composed of one (1) Chief Supervising Safety Inspector, two (2) Supervising Safety Inspectors, and seven (7) Safety Inspectors who are registered under the Mines and

Geosciences Bureau (MGB) Regional Office No. IVB (MIMAROPA). It is headed by a Section Manager that directly reports to the Plant Manager (**Figure 8.4.1**).

Furthermore, a safety secretariat is formed to monitor and report the safety performance, accidents, near misses and immediate counter measures that are implemented and health situation of all CBNC employees and contractors. The group is composed of a Safety Manager, Safety Coordinator, and Company Nurse.



Source: ASHP, 2015.

Figure 8.4.1 Safety office organizational structure

8.5 MULTI-PARTITE MONITORING TEAM (MMT)

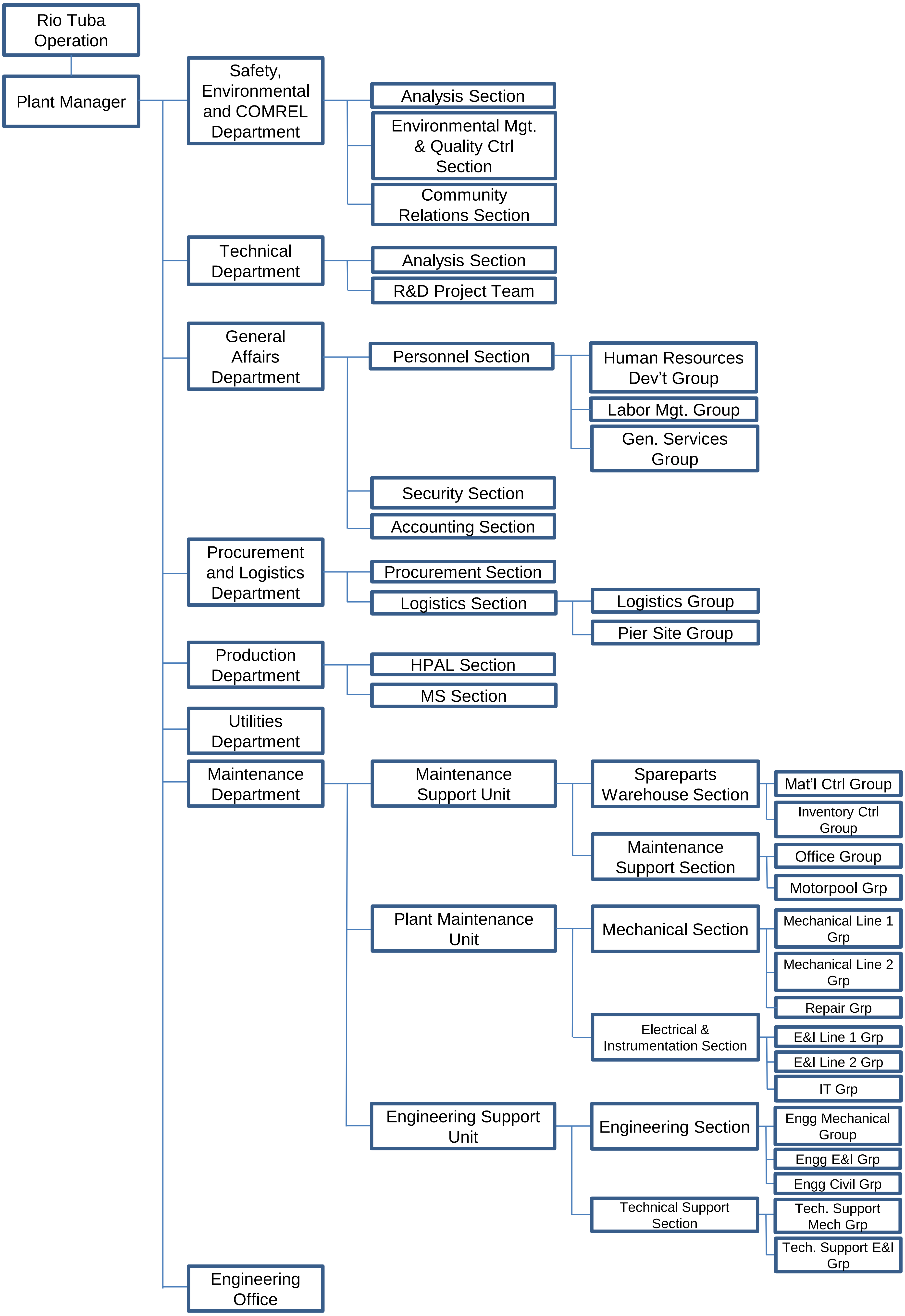
A Multi-partite Monitoring Team (MMT) is formed in accordance with DAO 2003 – 30 otherwise known as *Implementing Rules and Regulations (IRR) for the Philippine Environmental Impact Statement (EIS) Statement*. The MMT is composed of representatives from various sectors enumerated as follows:

- Mines and Geosciences Bureau (MGB) IVB;
- DENR-EMB Region IVB;
- Palawan Council for Sustainable Development (PCSD);
- Provincial Environment and Natural Resources Office (PENRO);
- Community Environment and Natural Resources Office (CENRO) Brooke's Point;
- Department of Health (DOH);
- LGU-Bataraza;
- LGU-Rio Tuba;
- Bureau of Fisheries and Aquatic Resources (BFAR);
- Philippine Economic Zone Authority (PEZA);
- Apostolic Vicariate of Puerto Princesa;
- HARIBON-Palawan;
- Indigenous People; and
- RTNMC.

Among the responsibilities of the MMT are as follows:

- Monitor CBNC's compliance to ECC conditionalities and EMP;
- Validate CBNC's conduct of self-monitoring;
- Gather relevant information and decide on the merits of complaints filed against CBNC and recommend measure to address the complaint;
- Prepare and disseminate simplified monitoring reports to community stakeholders;
- Prepare annual work and financial plan; and
- Regular and timely submission of MMT Report based on the EMB-prescribed format.

As stipulated in the Memorandum of Agreement (MOA) executed last July 28,2003 (**Annex 6.5.1**), in lieu of the Environmental Management Fund (EMF) and Environmental Guarantee Fund (EGF), CBNC set aside funds under the Contingent Liability and Rehabilitation Fund (CLRF) that enables the MMT to conduct their activities and perform their functions on a regular basis.



Source: CBNC IMS Manual, 2016.

Figure 8.3.1 CBNC Plant Site Organizational Chart