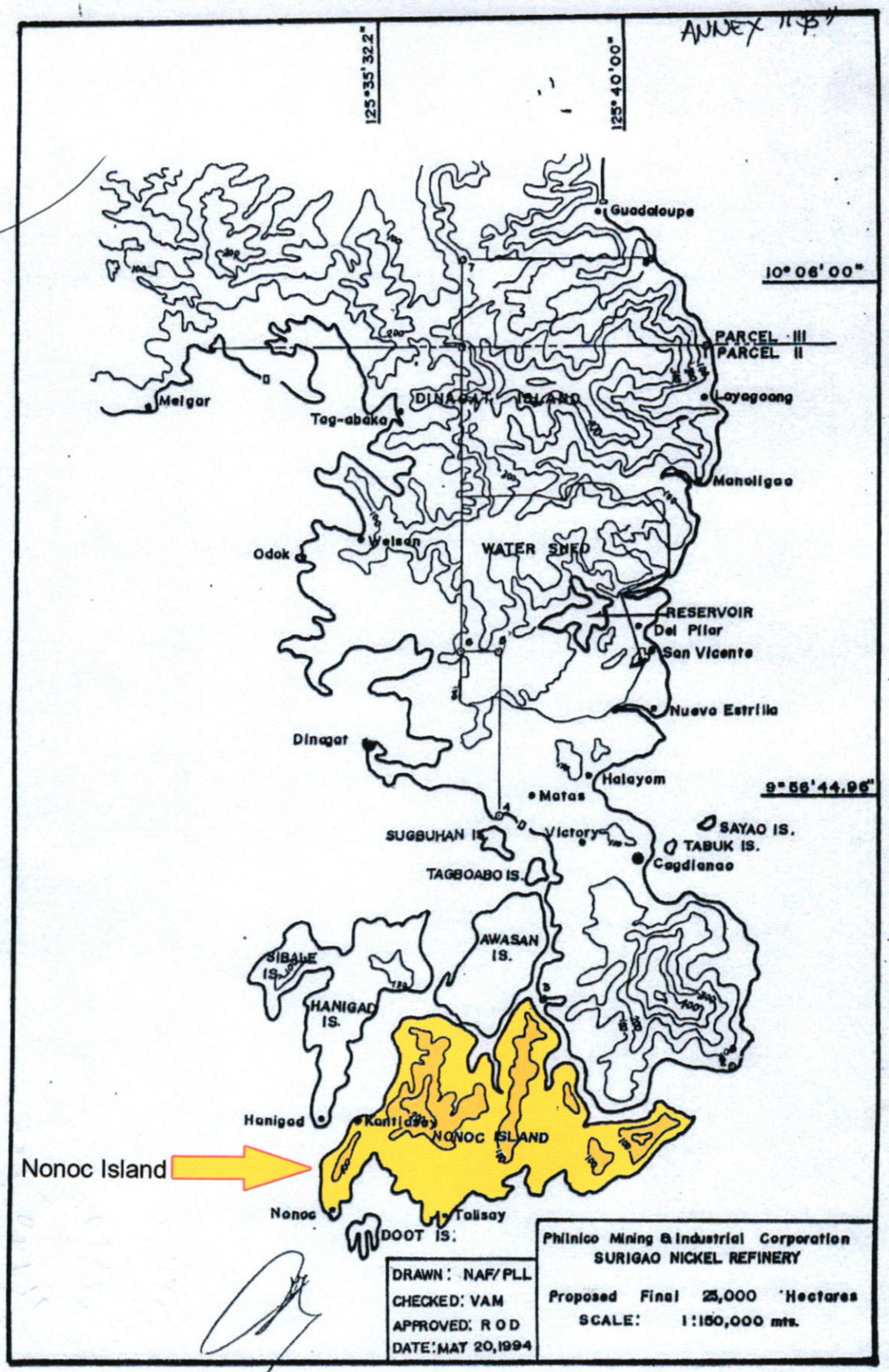
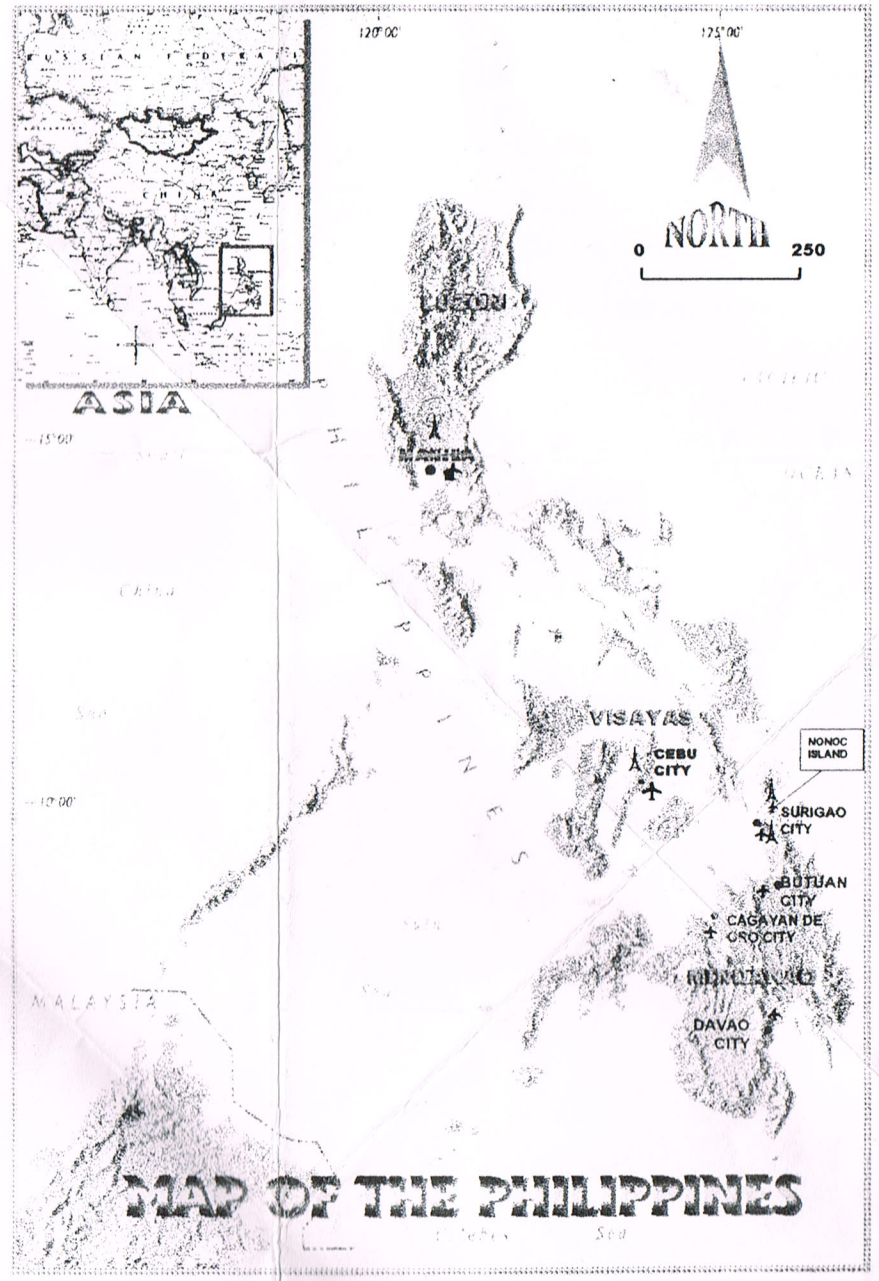
ANNEX "B"


ANNEX "B"
125°35'32.2"
125°40'00"
10°06'00"
9°56'44.96"
Guadaloupe
PARCEL III
PARCEL II
Layagoong
Manoligao
Melgar
Tag-abaka
DINAGAT ISLAND
Odok
Weisan
WATER SHED
RESERVOIR
Del Pilar
San Vicente
Nueva Estrilla
Dinagat
Halayom
Matas
SUGBUHAN IS.
Victory
SAYAO IS.
TABUK IS.
Cagdianao
TAGBOABO IS.
AWASAN IS.
SIBALE IS.
HANIGAD IS.
Hanigad
Kantiasay
NONOC ISLAND
Nonoc Island
Nonoc
Tolisay
DOOT IS.
Philnico Mining & Industrial Corporation
SURIGAO NICKEL REFINERY
Proposed Final 25,000 Hectares
SCALE: 1:150,000 mts.
DRAWN: NAF/PLL
CHECKED: VAM
APPROVED: ROD
DATE: MAY 20,1994

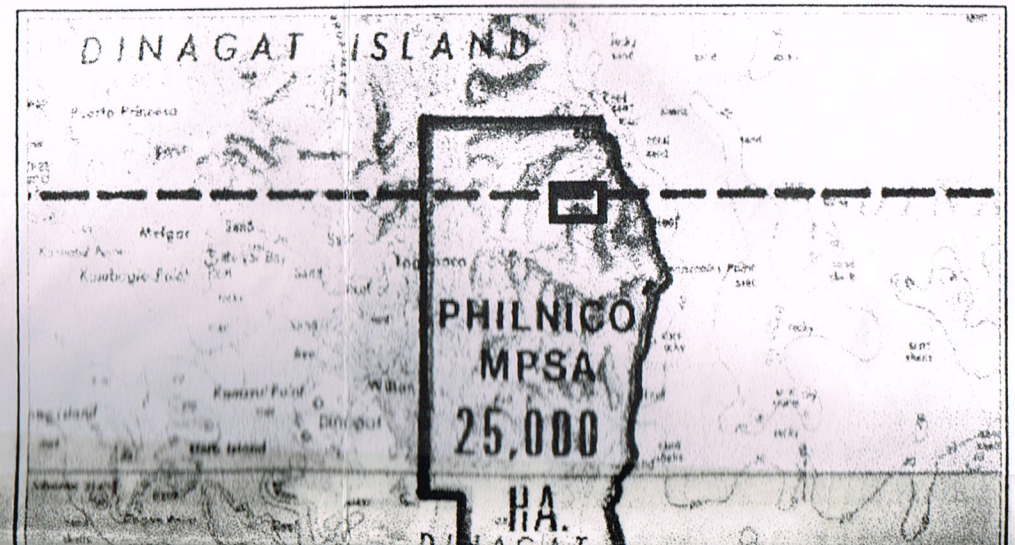
OFFSHORE DETAIL IS PLOTTED FROM PHOTOGRAPHY
NOT BASED ON THE HYDROGRAPHIC DATUM AND E

AREA - E

10°05'



MAP OF THE PHILIPPINES



DINAGAT ISLAND

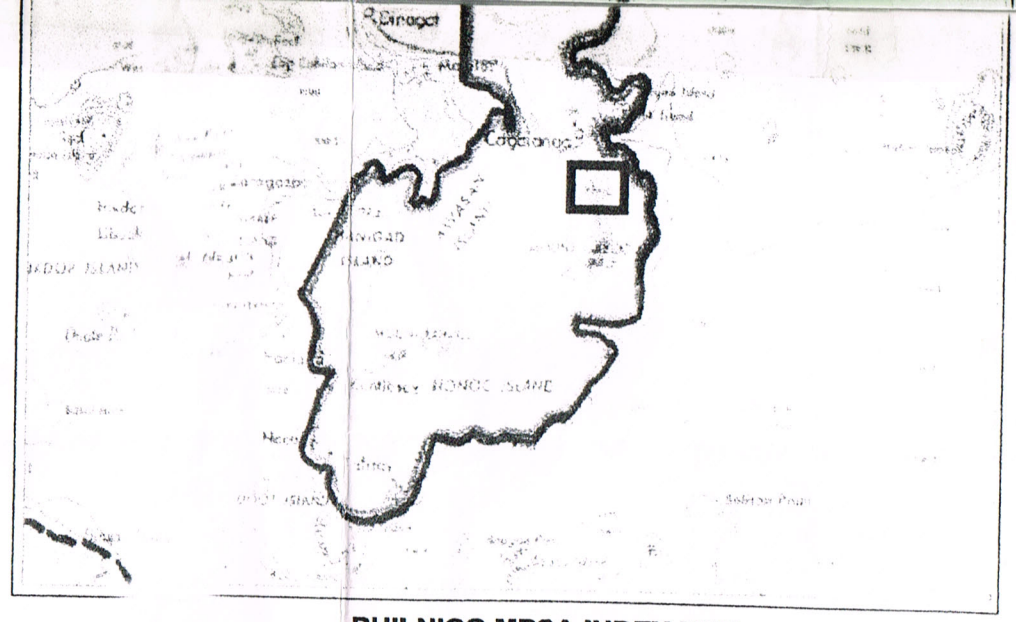
AREA - B

9°55'

125°40'

125°42'

Province; Ch
Municipality
A. Province



PHILNICO MPSA INDEX MAP

NTS

LEGEND:

EXPLORATION AREA

NO.	DATE	REVISIONS	BY	CHKD	-SUPV	SUPT	MGR.
P	1/19/02	FOR COMMENT & APPROVAL	MOR	BGN	BGN	-	VCN

PACIFIC NICKEL PHILIPPINES INC.
SURIGAO NICKEL REFINERY
NONOC IS., SURIGAO CITY

SCALE:	1: 50,000 M
DRAWN	MOR
SURVEYED	-
DESIGNED	BGN
CHECKED	BGN/VCN
APPROVED	VCN
DATE	

PROJECT TITLE:
PROPOSED TWO YEARS EXPLORATION AREA

SHEET CONTENT:
LOCATION PLAN

FIGURE NUMBER	SHEET No.:	REV.
FIGURE - 5.2	1 OF 1	P

PACIFIC NICKEL PHILIPPINES INC.

ENVIRONMENTAL WORK PROGRAM

FOR THE

APPLICATION FOR TWO (2) YEAR EXTENSION

OF

EXPLORATION PERMIT

TABLE OF CONTENTS

ATTACHMENTS

		Description
1.0	Matrix 7.1	Environmental Management Plan
2.0	Fig. 2.1	2-Yr. Exploration Bar Graph Schedule
3.0	Fig. 2.2	2-Yr. Exploration Program (No. of holes and meterage requirements)
5.0	Fig. 5 2	MPSA Map showing the location of the proposed 2-yr. Exploration Areas – South Dinagat, Area – B and E

1.0 NAME AND ADDRESS OF PROJECT

1.1 Project Name

NONOC NICKEL PROJECT

1.2 Company Name and Address

Pacific Nickel Philippines, Inc.
6th Floor, Front Wing, JAKA 6780
Ayala Avenue, Makati City 1200

Telephone: 867-4334
Facsimile: 816-7039

2.0 TYPE AND NATURE OF PROJECT

2.1 Project Description

The main objective of the project is to conduct exploration work in the 460 hectares of the project site. The two-year exploration period will cover mostly the portion of South Dinagat Island. The MPSA covers 25,000 hectares with the following geographical coordinates :

Area		Latitude	Longitude
Nonoc Island, Hanigad Island, & Awasan Island		Bounded by (9^0.48' 37" to 9^0 55' 00"	125^0 34' 25" to 125^0 42' 24"
South Dinagat	Point 1	10^0 04' 51.76"	125^0 41' 26.60"
	Point 2	9^0 51' 57.89"	125^0 42' 01.06"
	Point 3	9^0 53' 07.87"	125^0 38' 28.56"
	Point 4	9^0 56' 25.61"	125^0 37' 36.86"
	Point 5	9^0 59' 19.75"	125^0 37' 36.86"
	Point 6	9^0 59'19.75"	125^0 37' 02.55"
	Point 7	10^0 06' 24.69"	125^0 37' 02.55"
	Point 8	10^0 06' 24.69"	125^0 40' 30.81"

The schedule of activities in the two-year exploration period is shown in **Figure 2.1**.

The estimated cost for the two-year exploration period is about P 8,362,981.00 or US$ 167,259.62 at a forex rate of US$ 1 = P 50.

2.2 Minerals

Nickeliferous iron laterite is a weathering product of mafic and ultramafic rocks. Wright, et al. (1958) cited the following conditions favorable to the formation of laterite ore: distinct wet and dry season; flat or nearly flat topography for greater

infiltration and retarded movement of groundwater; intense fracturing of parent rock to allow easy penetration and circulation of groundwater; and sufficient time of exposure to weathering process. Slow but progressive uplift is also considered to be important in the development of thick laterite mantles.
In addition, Santos Yñigo and Esguerra (1961) also cited sufficient elevation above sea level to insure adequate drainage.

In Nonoc and surrounding areas, parent rocks of the laterite deposit are dunite, pyroxene peridotite, clastic sediments derived from serpentinites and clastic sediments from schists (Wright, et al., 1958).

Reports of the detailed exploration and test pitting done by the Philippine Bureau of Mines (PBM) in 1953 to 1957, indicated the absence of ore in the western side of Nonoc, the Nonoc Ridge and in the part of the Conico Basin.. At the southern slopes of Mt. Tinago it was shown that ore containing 1.0 % nickel and above has been blocked by the PBM. Other mineralized areas are located in the southern half of the Maribojoc-Lutawon Ridge, Banlot Ridge and along most part of Sigbanog Ridge.

In South Dinagat, nickel laterite deposit has been identified west and southwest of Mt. Gaboc. Blocked reserve in South Dinagat is considerably less than the reserve identified in Nonoc Island. Minimal nickel laterite ore has been partially identified in Awasan and Hanigad Islands where small patches have been identified. This requires further drilling to delineate the laterite mineralization.

In 1981, Marinduque Mining and Industrial Corporation (MMIC) reported a reserve of more than 54,300,000 tonnes with a grade of 1.22% for nickel, 0.101% for cobalt and 38.8% iron. The lowering of the the cut-off grade to 0.9% nickel due to improved recovery method will substantially increase Philnico's mineable reserve.

A stylized laterite profile showing major units is shown in **Figure 2.7** of the EPEP.

3.0 PROJECT LOCATION

3.1 Project Location and Accessibility

Location

The Project is located in Parcel II and portion of Parcel III of the Surigao Mineral Reservation on Nonoc Island, Surigao del Norte, Republic of the Philippines, at approximately 125°30'E and 9°50'N. The main facilities of the refinery are concentrated on a sixty (60) hectare refinery site in the southwest corner of the island.

Nonoc Island is located approximately 15 km northeast of Surigao City, and is separated from mainland Mindanao by the Hinatuan Passage. The island is composed of three barangays: Nonoc, Cantiasay, and Talisay. Prior to the refinery activities, only one barangay existed within Nonoc Island. The inhabitants of Barangay Nonoc, then with a population of eighty (80) families, were mostly engaged in fishing for livelihood. The construction of the refinery spawned two other barangays, Talisay

and Cantiasay, and the total island population reached 12,758 in 1985, a year before shutdown.

Other islands surround Nonoc Island. These are:

- Dinagat Island (to the north of Nonoc Island);
- Hanigad Island (to the northwest);
- Awasan Island (to the north);
- Bayagnan Island (to the south).

Except for Bayagnan Island, these islands are separated from Nonoc Island by narrow channels.

Access and Transportation

From Manila, Nonoc Island is accessible either by air transport or by sea. At present, no flights are available at Surigao City, so one has to take the plane to Butuan City and tehn by land transport from Butuan City to Surigao City. From Surigao City, there is a regular ferry going to Nonoc Island every day. For transport by sea, one can take a plane going to Cebu, then ferry from Cebu to Surigao City. Both Nonoc, South Dinagat, Awasan and Hanigad Islands are accessible by sea.

Road

The existing road network established on Nonoc Island will be adequate for the on-going operation of the mine and refinery. If additional access roads are required, they will be constructed within the appropriate guidelines established for the City of Surigao. The roads at Nonoc will be repaired and maintained to provide all-weather access where practicable, and may be upgraded to minimize dust in dry weather and siltation runoff and minor roadside flooding in the wet season. No road network at North Dinagat, Awasan and Hanigad.

Air

Nonoc Island is unusual as it has a fully serviceable airport with a concrete runway 1,300 meters long and 30 meters wide. The hangar and terminal buildings will be repaired on an appropriate standard. As there is no runway lighting system, the airport is limited to daylight operations.

Sea

Existing wharves on Nonoc Island will be repaired and upgraded to manage vessels up to 110 meters in length and a draught of 12 meters. Smaller wharves will be repaired to facilitate general small craft operations including passenger ferries and commercial operations. The Port of Surigao will serve the maritime requirements for general cargo for the project.

3.2 Total Project Area

The Surigao Mineral Reservation comprises 250,000 hectares (ha) and covers resources located at Surigao Del Norte, Awasan, South Dinagat, Hinatuan, Nonoc, Siargao, Hinatuan, Masapelid Islands, and a portion of Eastern Mindanao. It has an overall resource of over 667,000,000 tonnes of nickeliferous laterite and is divided into four parcels **(Figure 2.3, EPEP).** Parcel II comprises Nonoc Island and a number of small islands, and has an estimated total resource in excess of 135.8 million tonnes averaging 1.12% nickel.

The MPSA covers 25,000 hectares comprising Nonoc (4,372 ha.), Awasan (916 ha.), Hanigad (976 ha.) and Dinagat Island (18,736 ha.). The 2-yr. Exploration Program will cover 1,384 hectares mostly the northern part of MPSA (Parcel II & III of Mineral Reservation), Awasan and Hanigad and portion of South Dinagat.

4.0 BASELINE ENVIRONMENTAL CONDITIONS

4.1 Land Environment

4.1.1 Topography/Physiography

Nonoc Island

Nonoc Island has a low to moderate relief (**Figure 3.1, EIS**), with the highest peak elevation of 335 meters ASL represented by the peak of Mt. Conico. The other subordinate peaks in Nonoc are Mt. Tinago (180 meters ASL), Mt. Sigbanog (220 meters ASL). The terrain generally varies from rolling to rugged with the tops of ridges and spurs generally wide and commonly rounded, which is an indication of a mature stage in landform development. Among the gentler terrains in Nonoc, are located on the plant site in the southern portion of the island and Lutawon Basin at the northern part of Nonoc Island.

Previous mining activity has altered the topography in parts of the island. These areas are highly visible due to the deep red color of the bare soil. The mined out areas have been flattened with the removal of the laterite cover. However, the past mining activity has not significantly altered the general topographic characteristic of Nonoc Island.

As identified by previous workers. (Santos-Yñigo, 1961 and Wright, 1958) the dominant topographic features of the island are the north to northeasterly trending ridges. These ridges, from west to east, are:

- Nonoc Ridge
- Conico Ridge
- Tinago Ridge
- Maribojoc-Lutawon Ridge
- Banlot Ridge

- Sigbanog Ridge, the only northeasterly trending ridge in the island.

The two major basins recognized in the island are the Lutawon Basin, located between the Maribojoc-Lutawon Ridge and Banlot Ridge, and the Conico Basin, juxtaposed at the southern part of the Conico Ridge and Tinago Ridge. **Figure 3.2** of the EIS shows the geomorphic features of Nonoc Island.

Dinagat, Awasan and Hanigad Islands

The topography of South Dinagat (**Figure 3.3, EIS**) is dependent upon Mt. Gaboc. It is the highest elevation in the Project site with a peak elevation of 549 masl. The slope of Mount Gaboc is mostly steep to very steep. Towards Cagdianao to the north, terrain varies to low elevation and a less rugged topography.

The northern part of Dinagat Island exhibits generally rugged topography, with a maximum elevation of just over 600 m above mean sea level (a.m.s.l.). Several lower, north-east and north-west trending ridges traverse Awasan and Hanigad Islands, with elevations typically between 110 m to 160 m.

Sabang River Watershed Site/Reservoir

Being of the same geology, the topography of the watershed is identical to the rest of South Dinagat and Nonoc Islands. Topography varies from moderately rugged to rolling. The watershed has a low elevation with more than 90% of the land area below 300 masl (**Table 3.1, EIS**). The highest peak in the drainage divide is 323 masl (**Figure 3.4, EIS**).

Slope Distribution

The slope distribution in the project site is listed in **Table 3.2** and is shown in **Figure 3.5** of the EIS.

4.1.2 Land Use/Capability

Methods and Procedures

Land uses in the study site were determined from vertical aerial photographs, oblique aerial photographs, terrestrial photographs and field observation. The 1968 CERTEZA vertical aerial photo mosaic was used to determine historical land use and the limit of land uses that are observed to have persisted up to the present time. The oblique photos were taken from MMIC's Annual Reports. Terrestrial photographs were taken during the 15 to 19 July 1998 fieldwork. Base map for the study site was prepared using the NAMRIA topographic map. Subsequently, the GIS format base map prepared by Dames and Moore was adopted.

Historical land use pattern in the Project site was established from various literatures. Among the references used were the soil and land use map prepared by the Bureau of Soils and Water Management and the 1958 report on the Philippine Bureau of Mines'

(PBM) geological exploration of Nonoc Island and South Dinagat by Wright and Salazar (1955). The PBM report contained a short account of the previous exploitative activities in the islands prior to the large-scale mining project that started in 1971.

The coverage of the land use component included Nonoc Island, South Dinagat Island up to the northern limit of the coverage of Philnico's MPSA and the Sabang Watershed, the source of the Project's water supply.

It should be noted at this point that updating of the land use of the Project site was confined to Nonoc Island, Sabang Watershed and the eastern seaboard of South Dinagat due to time constraint. Further updating will be done after the aerial photography, contracted to CERTEZA, is completed.

Generally acceptable land use classifications have been adopted for this study. The land uses in the study area can be classified into two major classifications, natural and man-made or modified land use. Land use categories under this classification are as follows:

1. Natural Land Uses

- Dense Scrubs
- Open Scrub
- Grassland
- Mangrove

2. Man-made or modified land use

- Built-up and settlements
- Tailings pond
- Agriculture - coconut plantation
- Bare and mined-out areas.

Historical Patterns of Land and Resource Use

The Project area is a special use area being declared as part of the Surigao Mineral Reservation in 1939 through Proclamation No. 391. Presidential Proclamation 391 encompassed the islands of Nonoc, Dinagat, Siargao, Bucas Grande and the smaller surrounding islands.

No important mining activity was reported in the study site even after the discovery of the laterite deposit of the Surigao Mineral Reservation. In 1936, the Japanese showed interest in the Surigao Laterite and was allowed to collect samples for analysis. Results of the analysis however were unfavorable.

Subsequently, the Philippine Bureau of Mines started an exploration program in 1937 until 1938. In 1940 to 1941, another Japanese group explored the laterite reserve of Nonoc. With the outbreak of World War II, the Japanese abandoned the work and left with no record of the work done.

Even after the islands have been declared as a mineral reservation, logging was carried out in the island. It was reported that a lumber firm from Surigao City conducted logging in Nonoc sometime before World War II. When the Philippine Bureau of Mines resumed exploration in 1955, Nonoc Island may have been logged over. Wright and Salazar (1955) reported the ubiquitous presence of small trees, barren areas, many scattered dead trees and charred logs.

The inherent impoverish condition of the lateritic soils of Nonoc and Dinagat must have prevented cultivation by kaingin method and the establishment of settlements in the logged areas. As observed by earlier workers, settlements in the islands are confined to the meager areas that are not underlain by laterite. Without any large-scale activities after the logging, land cover of Nonoc Island may have improved or at the very least maintained.

The vertical aerial photo mosaic of Nonoc Island taken in 1968 showed the presence of dense vegetation in a number of areas in the island. Dense vegetation was noted in Sigbanog Ridge, northern portion of the Maribojoc-Lutawon Ridge, northern slope of Mt. Tinago and nothern part of Mt. Conico. Large tracts of open areas were noted on the southern part of Nonoc Island. Settlements occupied a very limited land area of the island.

The development of the Nonoc Nickel Refinery and eventual operation introduced changes in the land cover and general land use of the island. It is estimated that the entire project affected about 500 to 600 hectares in Nonoc Island. The refinery and mining project involved the construction of the refinery, dock facilities, power plants, tank farms, housing, storage areas, and road networks. The construction of the tailings pond and the airstrip extended the impact of the project to the adjoining island of Doot. These facilities converted approximately 160 hectares of mangrove in both islands of Nonoc and Doot. Another mangrove area affected by development is the location of the tank farm. Based on the existing open and mined out areas, MMIC's mining activity affected about 300 hectares.

South Dinagat likewise experienced changes but not as extensive as Nonoc Island. Project facilities located in Dinagat Island are the Sabang Dam and a 27-km pipeline. As a water source, the 1,700 ha catchment of Sabang River was put under protection and declared as a watershed reservation. Damming of Sabang River submerged about 235 hecaters of land. From Sabang, water is piped to Talisay, in Nonoc Island. Running parallel to the pipeline is a power line supplying power to the pumps along the pipe route. For safety purposes, the alignment of the powerline and pipeline is regularly maintained. A strip of about 10 meters is regularly cleared of vegetation.

It was reported that the settlements of Nonoc, Talisay and Cantiasay occupied twice the present land area at the peak of the previous nickel-mining project. This dwindled to the present size after the project ceased to operate. The cessation of the mining operation in 1986 left the project site unmaintained. Mine pits were left unrehabilitated and barren. Due to very poor soil conditions, colonization of the mined out areas by vegetation is very slow.

Present Land Use

Consequently, the present land use pattern of Nonoc, South and North Dinagat, Awasan and Hanigad Islands is largely dictated by the past mining and exploration activities. The facilities of the previous mining and exploration project continue to exist and are therefore considered in the classification of the land cover and land use.

- Open and Dense Scrubs

Despite the past exploitation activities of logging and mining and presently charcoal making, a substantial portion of the study area is still covered by natural vegetation. The scrubs classification was adopted since it accurately describes the type of vegetation cover in the islands. The scrubs area are further classified as open and dense. Scrub land with open canopy containing up to a maximum of 40 percent open area is classified as open scrub. On the other hand, closed scrub canopy is classifed as dense scrubs. Despite the previous exploitation activities, substantial land area is still covered by dense scrub vegetation. About 50 percent of Nonoc Island is still densely vegetated. The same condition is observed in South Dinagat, especially the Sabang Watershed Reservation, Awasan and Hanigad Islands that has been effectively protected during the last 27 years or so.

Land use map of the Bureau of Soils as well as the 1968 aerial photomosaic show dense vegetation in the slopes of Mt. Gaboc. However, only the eastern slope was verified during the field visit on 15 to 19 July 1998.

An example of the areas classified as open scrub is shown in **Plate 3.12** while a typical example of a dense scrub is shown in **Plate 3.13** of the EIS.

- Grassland

Grassland formation is not common in the study area unlike other parts of the country where disturbed areas are dominated by grasslands This is attributed to the type of substrate present in the study site. Grass (commonly *Saccharum*) in the study site grows only in non-lateritic soils. Hence, grassland are only present in disturbed areas in the western side of Nonoc Island, where the country rock is non-ultramafic (the parent material of laterite). Grassland constitutes at most 3 percent of the land area of Nonoc Island and South Dinagat. One of the few grassland in the study site is shown in **Plate 3.14 (EIS)**.

- Mangrove

The coastline of the study area is lined by mangrove. Large mangrove areas are found around Doot Island and Nonoc Bay while strips of mangrove stand line the coast of Gaboc Channel on both sites of Nonoc Island, Dinagat, Awasan and Hanigad Islands. About 900 hectares of mangrove have been mapped in the study site, 477 hectares in Nonoc Island and about 417 hectares in South Dinagat.

- Built Up Areas

Built up areas constitute less than 500 hectares in Nonoc Island and these are mostly associated with the previous mining project. The built up area includes the industrial complex, airstrip, mined out areas, road networks and tailings pond. Built-up areas at Dinagat, Awasan and Hanigad Islands include the municipality of Cagdianao and its surrounding barangays.

- Settlements

This category refers to settlements outside the mine area. These are the settlements of Barangay Talisay, Barangay Nonoc and Barangay Cantiasay in Nonoc and other barangays at Dinagat, Awasan and Hanigad Islands It is estimated that settlements occupy only an area of 88 ha in Nonoc Island and 212 ha. in South Dinagat. The absence of flat lands along the coast, the restricted access to Nonoc Island and the lack of other economic activities aside from employment are the major limiting factors in the growth of the settlements in the island. It was reported that the present barangay poblacions were twice larger than today. At the height of the previous mining project, the poblacions expanded towards the sea to accommodate the increasing population. Sign of attempts to reclaim as well as remnants of houses on stilts can still be observed in Talisay and Cantiasay. Typical settlement in the area is shown in **Plate 3.15 (EIS)**.

- Cultivation

Cultivation is very limited in Nonoc, Dinagat, Awasan and Hanigad Islands. Cultivation is only possible in non-lateritic areas. In Nonoc Island, this is confined along the western side, in the vicinity of Barangay Cantiasay and Barangay Nonoc. Crops are commonly coconut and banana. Small patches of "kamoteng kahoy" (cassava) and pineapple are scattered in the non-lateritic areas. Cultivated land accounts for only 5 percent and 9.2 percent in Nonoc Island and South Dinagat, respectively. **Plate 3.16 (EIS)** shows one of the cultivated areas in the study area.

- Fishpond

A small part of the mangrove of Nonoc Island has been converted to aquaculture use. About 7 ha of fishpond is present in Nonoc Bay. Fishpond in the islands of Hanigad, Awasan and Dinagat do not exist.

The distribution of land use in Nonoc and South Dinagat Island is summarized in **Table 3.8**. The land use map is attached as **Figure 3.12 (EIS)**.

4.1.3 Pedology and Soil Characteristics

Nonoc Island

Three soil types/mapping units were identified and characterized in the island of Nonoc. The three soil types are Kabatohan clay loam, San Manuel sandy clay loam

and the Hydrosol (**Figure 3.11, EIS**). Three miscellaneous land types were also identified in the island, namely, the mined-out area/quarry, tailing pond and the built-up areas. The quarry/mined-out area and tailing pond were also characterized. Kabatohan clay loam is the biggest mapping unit, with an aggregate area of 2,587 hectares or 52.31percent of the total area of the island. The second largest unit is the quarry or mined-out area (which is also a Kabatohan clay loam, if not disturbed) and has an area of 1,496 hectares or 30.27% of the land area. The third largest unit is the Hydrosol with an aggregate area of 477 hectares or 9.66% of the land area. The fourth largest unit is the built-up areas with an area of 229 hectares or 4.64% of the land area of the island. The fifth largest unit is the tailings pond which with an area of 128 hectares or 2.60% of the land area. The smallest unit is the San Manuel sandy clay loam with an area of 25 hectares or 0.52% of the land area.

Kabatohan clay loam, the most extensive unit in the island, has two mapping units. One is located in the eastern part in the hilly areas where the South Dinagat conveyor system is located. The other one is in the western part specifically in Barangay Talisay, Nonoc, and in Cantiasay. This has a dominant slope range of 30-50% (**Table 3.5, EIS**) but in some areas, particularly in the plant site, the slope is more gentle at 3 to 8%. This lateritic soil is dark reddish brown to dark red, well drained, moderately deep (50-100 cm, at Barangay Nonoc, **Plate 3.1, EIS**) to very deep (> 200 cm. deep, Area II and IV – **Plates 3.2 to 3.4, EIS**) and composed of clay loam developed from serpentenitic or ultrabasic rocks. This soil has a good penetrability with a bulk density of 0.67 gram per cm^3 (g/cc). Hydraulic conductivity is very fast at 2.67×10^{-2} cm/sec. This soil is strongly acidic (pH 5.2) with moderate content of organic matter at 2.32%, very low phosphorus at 1.73 mg/kg and low potassium at 0.1 cmol/l and cation exchange capacity at 4.60 cmol/l. Base saturation percentage is high at 76.87%. Extractable aluminum of 0.38 cmol/l is below the critical limit of 0.5 cmol/l. Zinc content is moderate at 0.89 mg/kg while copper and iron contents are high at 0.56 mg/kg and 8.9 mg/kg, respectively. Manganese content is very high at 43 mg/kg. Nickel, silicon, cadmium, cobalt and chromium are all above the critical values of 50, 3, 100, and 100 mg/kg, respectively. This soil has low natural fertility.

The soil of the quarry/mined out areas is similar to the Kabatohan soil type, except for the penetrability which is relatively more compact at 1.08 g/cc. However, below the bulk density limit of 1.30 g/cc, hydraulic conductivity is slower and is of medium speed at 9.04×10^{-4} cm/sec. This soil type is moderately acidic with pH equal to 5.6. Like the Kabatohan soil type, contents of all major elements are low to very low, with most of the heavy metals above the critical values. Natural fertility of this soil is low.

The Hydrosol is the poorly drained silty clay loam on the tidal flats with flat to almost flat terrain (0-3% slope). Soils are deep (greater than 150 cm deep), ultra-acidic (pH 3.4) and have a very high organic matter content (15.77%). Phosphorus content is very low at 2.6 mg/kg. The cation exchange capacity and base saturation percentage are high at 101.8 cmol/l, and 58% respectively which may be due to the sodium content of the brackish water. This soil may turn to acid sulfate soils upon drying which are then considered to be a problem soil.

The existing tailing pond has a flat terrain (0 to 3% slope – **Plates 3.5 & 3.6, EIS**). It has a moderately well-drained loamy sand materials which is deep (> 100 cm deep). It has a moderate alkaline reaction (pH 8.2) and has low organic matter content at 1.30 mg/kg. Potassium content is low at 0.13 cmol/l. Both the cation exchange capacity and base saturation percentage are high with 20.85 cmol/l and 62.06 %, respectively. Zinc content is low at 0.26 mg/kg while copper content is high at 0.82 mg/kg. Both the iron and manganese contents are very high at 136 mg/kg and 3.4 mg/kg, respectively. Silicon, cadmium, cobalt, chromium and nickel are all above the critical values of 214, 3, 100, 100, and 50 ppm, respectively. Lead with the amount of 16.4 mg/kg is still within the normal value. The natural fertility of this material is low.

San Manuel sandy clay loam occurs on the localized valleys/coastal-alluvial plains with a slope range of 3-8%. This is a well-drained sandy clay loam with a deep solum (thick soil). This soil is slightly acidic (pH 6.4) with moderate amount of organic matter (3.35%). Phosphorus is very low (1.69 mg/kg), but potassium cation exchange capacity and base saturation percentage are both high. Zinc and copper contents are high at 1.0 and 0.9 mg/kg, respectively, while iron and manganese are very high at 24 mg/kg and 80 mg/kg, respectively. The natural fertility of this soil is moderate.

Sabang River Watershed and South Dinagat Island

Four soil types/mapping units were identified and characterized in Dinagat island, namely: Kabatohan clay loam, Anao-aon clay loam, San Manuel sandy clay loam, and Hydrosol. The Kabatohan clay loam is the biggest mapping unit and has an area of 12,985 ha or 79.05% of the total area of South Dinagat.

The second largest unit is the Anao-aon clay loam with an area of 1,828 ha or 11.13% of the mining claim in South Dinagat. The third largest unit is the San Manuel sandy clay loam with an area of 987 ha or 6.01 percent of the mining claim in the island. The smallest soil-mapping unit is the Hydrosol with an area of 417 ha or 2.53% of the mining claim in the island.

Kabatohan clay loam has two smaller mapping units. One is located at the southern part of Dinagat island, specifically in Mt. Gaboc. The other one is located in the northern part of the mining claim, from the Sabang reservoir to the northern Project boundary in Barangay Layagaan. The physico-chemical properties of these mapping units are similar to the Kabatohan clay loam of Nonoc island (see Kabatohan in Nonoc Island).

Anao-aon clay loam is the mapping unit at the neck of the Dinagat Island from Barangay Cagdianao in the south to Barangay Del Pilar in the north. This brown soil developed from metamorphosed shale. The dominant slope range is 18-30%. This soil is well drained and moderately deep (< 100 cm) and composed of clay loam. Root penetrability is good with bulk density of 1.0 g/cc. Hydraulic conductivity is very fast at 1.63×10^{2} cm/sec. Soil reaction is moderately acidic (pH 5.7) with medium content of organic matter (3.8%).

Phosphorus is very low at 1.38 mg/kg while potassium is low at 0.23 cmol/). Cation exchange capacity and the base saturation percentage are both high at 21.1 cmol/l and 44.9%, respectively. Zinc content is high at 4.14 mg/kg while copper, iron and manganese contents are all very high at 2.4 mg/kg, 72 mg/kg, and 180 mg/kg, respectively. The natural fertility of this soil is low to medium.

San Manuel sandy clay loam occurs on localized valleys/coastal alluvial plains. They are scattered in the whole Dinagat mining claim along the coast. The physico-chemical properties of this mapping unit are similar to the San Manuel sandy clay loam of Nonoc Island. Refer to section 2.1.2.1, Nonoc Island for details of characteristics.

Hydrosols occur on tidal flats around Dinagat Island. The physico-chemical properties of this mapping unit are similar to hydrosol of Nonoc Island.

- Revegetation and Soil Suitability Classification

Qualitative soil suitability classification was prepared by comparing the plant's environmental requirements with the physico-chemical properties of the soil mapping units **(Tables 3.6 and 3.7, EIS).**

Results showed that the selected plants are suitable in the soils of the Project area except for pH as limitation, particularly in the mined out area and the tailings pond. Coconut shows soil reaction (pH) as the limitation for Kabatohan clay loam. Bakauan and pagatpat are suited in the Hydrosol, and not in the terrestrial (upiand).

The plants, that are not included in the suitability classification but are found adaptably growing in abundance in the Sabang Watershed, particularly on Kabatohan clay loam, are the Iron tree, Magkono (*Xanthosthemon verdugonianus*), Paguspus (*Leptospermum flavescens*), Salago (*Wikstroemia meyeniana*), **(Plates 3.7 to 3.10,** EIS), Coarse fern/scrambling fern (*Dicranopteris linearis*), and a sedge (*Machaerina glomerata*) (similar to lemon grass in appearance , **Plate 3.11, EIS**).

4.2 Water Environment

4.2.1 Water Quality

4.2.1.1 Freshwater and Sediment

Physical Paramaters

Table 3.39 of the EIS shows the physical characteristics of the water considering abiotic factors such as temperature, pH, conductivity, salinity, dissolved oxygen and total dissolved solids during the sampling in the month of July 1998. Although the water was on the basic side, the pH still fell within the range set by the DENR standard, which is 6.5 to 8.5. The rest of the parameters were also within the standards for Class A water.

Tables 3.40 and 3.41 (EIS) show on the other hand the results of the water analysis done during the months of September, November 1997 and February and April 1998 from various ground water sources and from the three sampling stations in the Sabang reservoir. Although some of the stations were not reflected in the July sampling, the results are still within the DENR standards except for a relatively high total hardness (439-488 mg/l) in the Talisay Deepwell during the four sampling months considering the DENR standard which is 300 mg/l. Magnesium hardness in the same sampling area during the months of September and November 1997 were 473 mg/l and 246 mg/l respectively in comparison with the DENR standard which is 50-150 mg/l. In the same sampling area, total dissolved solids with a range of 551-603 mg/l also exceeded the DENR standard which is 36, 4851-39,810 mg/l during the sampling regimes.

There was a slight deviation from the DENR standard (6.0-8.5) for pH by 0.2-0.25 units in the three stations in the Sabang reservoir during the sampling regimes

Chemical parameters:

Table 3.42 (EIS)shows the heavy metal analysis of the water from the designated sampling points during the month of July. The five creeks in Mining areas (Mining area V, between Mining area IV & III, Mining area III -1 and Mining area III-2) exceeded the DENR standard (0.05 mg/l) for the chromium level which ranged from 0.15 to 1.50 mg/l. Iron content of the water in the two creeks of Mining area 3-1 and Mining area 3-2 (2.2 and 5.8 mg/l respectively) was high in consideration of the DENR standard which is 1.0 mg/l. Such phenomenon is normal since the areas have been explored by the previous mining company that occupied Nonoc island leaving mounds ot materials that contaminated the nearby creeks. The area is also characterized by the laterite type of soil which are sources of chromium and nickel.

Table 3.43 and **44 (EIS)** show the results of the water analysis based on its heavy metal content from nine stations during the months of September 1997 and February and April 1998. Chromium was high in all the designated stations with a range of 0.38 to 0.07 mg/l during the sampling regime way beyond the standard set by the DENR which is 0.05 mg/l. There was a slight increase in the iron content of the water samples from Talisay deepwell, Cantiasay springs 1 and 2, VIP and Nonoc spring relative to the DENR standard which is set at 1.0 mg/l. Cadmium was also high at the TR-3 spring BSQ-1 sampling point. The rest of the parameters that were considered for analysis such as copper, lead, zinc, nickel, mercury, manganese and cyanide were within the standards set by the DENR. **Table 3.45** and **3.46 (EIS)** show the freshwater analytical results for bacteriological parameters.

4.2.1.2 Marine Water and Sediment

Spatial Distribution

- Salinity

The trend in surface salinity at the 18 stations is given in the EIS as **Table 3.52 (Figure 3.22).** Results show a narrow range in salinity from 35.3 ppt to 36.3 ppt with

an average value of 35.3 ppt. The uniform surface salinity values among all the stations imply absence of any freshwater input from the island.

- Temperature

Surface temperature values ranged from 29.4° to 30.6°C. Temperatures were vertically uniform throughout the water column with an average surface value of 29.8°C and an average bottom temperature of 29.6°C. This indicates a well-mixed water column.

- Transparency

Transparency (or Secchi depth) of the water column at the different sites ranged from 25-100% of the water depth. The lowest transparency readings were at Stns. 12 (Nonoc Pier) and 7 (Pipe trestle) while highest were at the shallow stations (<10 m depth). For the deeper stations, compensation depth or the depth at which 1% of incident light penetrates through the water column was calculated using the following formulas:

$k = 1.7/D$ where D is the Secchi depth
k is the light attenuation coefficient

$z = \ln 0.01/k$ where z is the compenstion depth

Results show that the compensation depths are beyond the water column depth. This implies high transparency even at deeper depths thus favoring the occurrence of primary production all the way to the bottom of the water column. The DENR criteria for Class SC waters is a minimum Secchi depth value of 1 m.

- Total Suspended Solids

The TSS in the water column around Nonoc Island ranged from 0-11 mg/L with an average value of 3.5 mg/L. The highest TSS values were determined at Stns. 7 (Pipe trestle), 11 (Nonoc Pier), 12 (Townsite waste outpost), and 13 (Jetty 3). Activities in the pier, sewage inputs, and the occurrence of circulation cells along the channel thereby resuspending sediment material may be the reasons for higher TSS concentrations at these stations. Both surface and bottom TSS values were high at the sewage outfall (Stn. 12). The lowest TSS value was at Stn. 6 or the entrance to Gaboc Channel.

- Chlorophyll-a

Chlorophyll-a values at all the stations ranged from 0.2-2.8 µg/L with an average chlorophyll concentration of 0.8 µg/L. The highest values were found at Stns. 12 (Townsite waste outpost) and 13 (Jetty 3). These two stations are adjacent to each other and both may be affected by sewage inputs from the outfall. High chlorophyll-a concentrations were also found in bottom waters (9 m) of Stn. 11 (Nonoc Pier). Transparency in the water column is determined by the presence of suspended (living and non-living) materials. Chlorophyll-a is used as the indicator of algal biomass or

the living part. By assuming that chlorophyll-a contributes, on the average, 1.5% of the dry weight organic matter of the algae, estimates of the algal biomass may be obtained by multiplying the chlorophyll-a content by a factor of 67 (Standard Methods, 14th edition). Based on this approximation, the living part can comprise up to 10% of the TSS in the waters around the Island.

- Dissolved Oxygen

Dissolved oxygen (DO) concentrations around the Island ranged from 5.6 to 8.3 mg/. The lowest DO value was found in the vicinity of the sewage outfall (Stns. 12 and 13B). This value however is still above the minimum allowable level set by DENR for Class SC waters (5 mg/L).

- Nutrients

Nutrient concentrations for all the 15 stations are given in **Table 3.52 (EIS).** Among the nitrogen species, ammonia was predominant (66-99% of total inorganic nitrogen = nitrate + nitrite + ammonia) followed by nitrate (0-33%) and nitrite (0-7%). The ranges of concentration are 1.4-2.8 μM for ammonia, 0-0.7 μM for nitrate, and 0-0.2 μM for nitrite. Average values are 2.1 μM for ammonia, 0.2 μM for nitrate, and 0.03 μM for nitrite. High nitrate and nitrite concentrations were determined at Stns. 12, 13, and 13B in the sewage outfall area. Phosphate concentration was also high in the bottom waters of Stn. 12. The range of phosphate values is 0.05-0.2 μM with an average concentration of 0.1 μM. These concentrations are characteristic of open ocean surface waters where a minimum nitrate value of 0.3 μM was determined for the South China Sea (studies of McGlone et al., 1998). Nitrite in the South China Sea was mostly non-detectable but ammonia concentration was 0.8 μM.

- Production Estimates

Primary production is the rate of formation of energy-rich organic compounds from inorganic materials (CO_2, H_2O, N, P). These organic compounds would be food for the higher members of the food chain that include plankton and fishes. Hence the amount of available food (nutrients) can theoretically be used to predict potential production of higher members of the food chain. The equation for this is as follows:

> Primary pdn ($gC/m^2/yr$) = N conc x depth of 1% light x 106C/16N x 70/yr x 12 gC/mole

Assuming a 10% transfer efficiency between trophic levels:

> Secondary pdn ($gC/m^2/yr$) = 1% primary pdn
> Fish pdn ($gC/m^2/yr$) = 1% secondary pdn

Assume C is 38% of the dry weight (DW) of the fish and the dry weight is 14% of fish wet weight (WW). Hence:

> DW = FISH PDN/0.38

$$WW = DW/0.14$$

In the above formulations, nitrogen is assumed to be limiting as the case for marine waters (Chester, 1990), 1% depths used were 3 m for shallow areas (<10 m) and 24 m for deeper areas (>10 m), 106/16 is the Redfield ratio for C:N (Redfield, 1958), 70/yr is the P/B (production to biomass) ratio (Polovina, 1984). Total inorganic nitrogen was used in the estimation. Calculations show that fish production is approximately 8 $gC/m^2/yr$ (= 8 mt fish/km^2/yr) in shallow waters and 60 mt fish/km^2/yr in deeper areas.

Production rates may also be derived from chlorophyll-a data. The equation involved is as follows:

$$Pdn\ (gC/m^2/yr) = \text{chl-a} \times 3.15\ mgC/mgChl\text{-}a/hr \times 12\ hr/day \times 365\ d/yr \times \text{depth of 1\% light}$$

where 3.15 is Pmax for tropical nitrogen-limited waters (Parsons et al., 1984). Secondary production and fish production are estimated following the same procedure above. Calculations show that in shallow areas fish production is approximately 6 mt fish/km^2/yr, while for deeper areas production is 50 mt fish/km^2/yr. These estimates are comparable to those derived from nutrient information thereby adding confidence to the approximations.

- Heavy Metals

The spatial distribution of heavy metals in the sediments is given in the EIS as **Table 3.53** and shown in **Figure 3.23**. The range of concentrations around the island are: <0.004- 7.5 mg/kg for Cd, <0.02–105 mg/kg for Cu, <0.05-10.7 mg/kg for Pb, 257-5588 mg/kg for Zn, <0.0005-0.06 mg/kg for Hg, <0.001-0.005 mg/kg for Cr, 11-4840 mg/kg for Ni, 0.001-0.08 mg/kg for As, 1780-114,119 mg/kg for Fe, 16-4497 mg/kg for Mn, and <0.001-0.024 mg/kg for Co. Talisay Pier (Stn. 1) and the tailings outfall (Stn. 14) had the highest concentrations of Cd in the sediments. These values are above the reported background level of <1 mg/kg Cd for relatively pristine marine sediments (Sadiq, 1992). Cu and Pb values were highest at the Jetty 3 (Stn. 13) and tailings outfall (Stn. 15). These concentrations are also above the reported background level of <10 mg/kg for Cu and <5 mg/kg for Pb in pristine areas (Sadiq, 1992). Although elevated Hg concentrations were found at Banlot Bay (Stn. 4) and mining area V (Stn. 5), these values are still within the reported background level of <1 mg/kg for Hg (Sadiq, 1992). The concentrations of As and Cr found in the sediments around Nonoc Island were below the reported background level of <10 mg/kg for As and <20 mg/kg for Cr (Sadiq, 1992). Cu, Zn, Ni, Fe, Mn, and Co concentrations were highest in the sediments of mining area 1 (Stn. 8) and the tailing outfall (Stn. 15). Cr and As were high at mining area 1 (Stn. 8). Concentrations of Cd, Pb, Fe, Mn, and Co were elevated in mining area V (Stn. 5). As would be expected, the highest concentration in heavy metals occurred in sediments found in the mining area and tailing outfall.

The behavior of heavy metals in the water column is discussed under Temporal Distribution.

Temporal Distribution

- pH

The pH values at all the monitoring stations for the different sampling months are given in **Table 3.54 (EIS)**. Results show that the range of pH values in Nov 97 (pH 7.6-8.3), Feb 98 (pH 7.6-8), and Apr 98 (pH 7.9-8.4) did not vary much. These values fall within the typical range of 7.5 to 8.4 for seawater due to the buffering of the carbonate system (Riley and Chester, 1971). The DENR criteria is for pH to be not less than 6.5 nor more than 8.5, and for any change to be less than 1.0 unit outside the estimated natural seasonal maximum and minimum for Class SC waters.

- Total Solids (TS), Total Dissolved Solids (TDS), and Total Suspended Solids (TSS)

The variability in TS, TDS, and TSS concentrations with time for all the stations are given in **Table 3.54 (EIS).** The average monthly TS values ranged from 37.2-42.5 g/L with a mean of 38.9 ± 2.4 g/L. The range of the average TDS monthly concentrations is 37.5-41.9 g/L with a mean value of 39.1 g/L ± 2.5 g/L. There has been a small variability in TS and TDS concentrations within the monitoring period.

- Heavy Metals

Water column concentrations of the heavy metals Cd, Cu, Pb, Zn, mercury (Hg), Cr, and of CN were determined at all the monitoring stations for different sampling months. Results are given in **Table 3.55 (EIS)**. Since data prior to July 1998 were for total metal concentrations, this information cannot be compared with the dissolved metal values reported for July 1998. The average Cd concentration for April 98 (0.09 mg/L) and July 97 (0.08 mg/L) exceeded the allowable level of 0.01 mg/L for Cd in Class SC waters. Cadmium levels in July 98 were below the allowable value. The Nov 97, April 98 and July 98 values for Cu were within the allowable limit of 0.02 mg/L for Class SC waters. Average Pb concentrations for July 97 and April 98 were 0.47 mg/L and 0.26 mg/L, respectively. These levels of Pb around the Nonoc Island are above the minimum allowable level of 0.05 mg/L for Class SC waters. On the other hand, the concentrations of Pb determined in July 98 (<0.1 mg/L) were below the allowable level. Zinc concentrations varied from an average of 0.05 mg/L in July 97 to 0.11 mg/L in Nov 97 and April 98 to <0.02 mg/L in July 98. No criteria have been set for Zn in marine waters. The average Hg levels of <0.0002 mg/L in July 98 to 0.002 mg/L in July 97 were within the allowable limit of 0.002 mg/L for Class SC waters. All the Cr concentrations for the sampling months were either <0.02 mg/L (Nov 97 and April 98) or <0.05 mg/L (July 98). The criteria for Cr in Class SC waters is 0.05 mg/L which is satisfied by levels found around Nonoc Island. The levels of CN detected in July 97 were below the allowable 0.05 mg/L for Class SC waters.

4.2.2 Hydrology and Hydrogeology

4.2.2.1 Hydrologic Setting

Surface Water

The Project area includes Nonoc Island, North and Dinagat Island, Awasan and Hanigad Islands that are separated by the Gaboc Channel. Dinagat Island includes the area from the catchment of the Sabang Dam in the north and the proposed mining areas on its southern tip. These islands are underlain by an impervious rock suite of ultramafic rocks and partly by sedimentary and volcanic rocks. The ultramafic component of this suite is mantled by a thick lateritic residual soil ranging from one to three m in thickness to as much as 15 m in certain places.

The imperviousness of the catchment materials favors runoff with very limited groundwater retention. This accounts for the predominance of intermittent creeks in th islands. The creeks with reported perennial flow correspond to those with relatively large catchments that can store more groundwater into the underlying fractured rocks and the overlying weathered section.

Nonoc Island is drained predominantly by short perennial streams characterized by small catchment areas and moderate to steep gradients. These streams display a dendritic pattern with a general orientation towards the north and northeast suggestive of structural control. A watershed study conducted by Philnico listed 35 catchments within Nonoc Island with a total drainage area of 3,938 ha. The four biggest catchments correspond to the creeks with the reported perennial flows. These are the East Lutawon, Conico, Duyangan and South Tinago Creeks.

Records of the discharges of the creeks with reported perennial discharges have not been made. Accordingly, flow duration and rating curves cannot be prepared (**Table 3.10, EIS**). Peak flows at the mouth of the 4 creeks in Nonoc Island with a reported perennial flow were estimated using the Rational Method and presented in **Table 3.11 (EIS).**

A series of small brackish water ponds are found along the southwestern end of Nonoc Island with an estimated total area of about 5 ha. These ponds are found immediately north of the mine road bounding the present tailings pond and fish pond. These were artificially formed when the mine road blocked the flow of water from the intermittent creeks that drain southward into the bay. (**Plate 3.17, EIS**)

The entire Nonoc Island has an indicative annual runoff of 82,300,000 m^3. The fraction which flows over the built-up and mined out areas corresponds to about 17,900,000 million m^3. North and South Dinagat is composed of drained streams whose main channels are oriented along the east west in apparent response to structural control. These streams have a collective drainage area of 14,050 ha with an indicative annual runoff of 269,000,000 m^3. As in Nonoc, the tributaries display a

dendritic pattern. Perennial flow is reported at Nueva Estrella, Sabang, and Layagoang Creeks.

Groundwater

Groundwater in the relatively impervious rock suite of both Nonoc and Dinagat Islands occur within the interconnected fractures of the rocks and the interstices of the overlying residual soil. Consequently, groundwater storage is insignificant and only adequate to feed the reported springs and some perennial streaks.

Reported groundwater occurrences are limited to Nonoc and the southern tip of Dinagat Island. The springs are characterized by low discharges that decline during the relatively dry months of the year. Discharge comes from fractures traversing the peridotite mass or from the contact of the overburden and the peridotite.

Limited groundwater is also found in the thin deposit of alluvial sediments at the mouths of the creeks and the narrow beaches at selected sections of the Project area. These are tapped by the shallow tube wells in Talisay and Nonoc.

A map of hydrogeologic units is attached as **Figure 3.13, EIS.**

Water Point Inventory

A water point inventory was conducted to determine the present use and condition of the water resources in Nonoc Island and the proposed mining area in South Dinagat Island. Water from the inventoried springs complement the supply of treated water from Philnico. **Table 3.12 (EIS)** presents the summary of the data regarding the inventoried springs.

Discharge measurements were made at the accessible perennial creeks in Nonoc Island. The results of the measurements are presented in **Table 3.13.**

A gravity dam has been constructed across Sabang Creek in 1974 to store water for the mining operations at Nonoc Island.

The creeks at the southern section of Dinagat Island where the mining will be made are short with moderate to steep gradients. A watershed study conducted by Philnico listed 27 catchments with a combined drainage area of 3,641 ha and an indicative annual runoff of 70,000,000 m^3.

Demand -Supply Projections

Existing Water Sources

The main source of water for Nonoc Island is the Sabang Reservoir. This was constructed in 1974 and has a reported storage capacity of 22,000,000 m^3. Water comes from a catchment of 1,572 ha which has an indicative annual yield of 36,700,000 m^3. This is equivalent to a flow rate of 1.16 m^3/s

Water from the reservoir is pumped to a water treatment plant in Nonoc through a 27-kilometer long pipeline with a diameter of 30 inches. The treated water is distributed to the main mine facilities as well as to the townsite through a network of pipes.

Additional drinking water for the local residents comes from the small discharge springs within Nonoc Island and from the reservoir.

Water used for washing by the barangay residents comes from individually- owned or community-built shallow tube wells.

Current Consumption

Current water production from Sabang Reservoir is estimated to be 108 l/s (0.108 m^3/s). This amount is used by the resident mine staff for the maintenance of the Philnico facilities and exploration purposes. The domestic consumption of local residents and mine staff are also included in this figure.

Projected Water Demand

The projections are based on the following assumptions:

1). The three barangays have a total population of 1,200 prior to start of mining operations.
2). The annual population growth rate is 1.5 percent.
3). The per capita water consumption of the barangay residents is 55 lpcd.
4). The average number of mine personnel for the 20-year period is 1,158 with a per capita consumption of 155 lpcd.
5). The average water consumption for the mine operation is 6,000 gallons per minute (0.380 m^3/s).

Table 3.14 of the EIS presents the population and water demand projection for the barangays in Nonoc Island.

The average number of mine personnel will consume an average of 1.3 liters per second (0.001 m^3/s) of water daily with a peak of 2 liters per second (0.002 cms).

The estimated combined peak domestic consumption of the 3 barangays and the mine personnel is about 0.026 m^3/s(26 lps). This amount is conservative when compared to the PHINICO allocation of about 0.09 m^3/s(1500 gpm) for the domestic consumption. The amount of 0.09 m^3/s is included in the total estimated water consumption for the mining operation of 0.708 m^3/s. This is 6.5 times the estimated current Sabang Reservoir production of 0.108 m^3/s and represents 61 percent of the indicative water yield of the Sabang catchment.

The relationship between the available water resource and the estimated mining and domestic demand is presented in **Figure 3.14 (EIS)**.

4.3 Meteorology/Air Quality and Noise

4.3.1 Climate

The climate in Surigao Province belongs to Type 2 of the Modified Coronas Classification (**Figure 3.39, EIS**). This type of climate has no dry season with very pronounced wet period from November to January.

The synoptic meteorological station of Philippine Atmospheric, Geophysical and Astronomical Administration (PAGASA) nearest to the project site is located in Surigao City Airport. The climatological normals for this station recorded from 1961 to 1995 (35 years) are shown in **Table 3.81, EIS**. The climatological extremes are given in **Table 3.82, EIS**.

The total number of 850 tropical cyclones passed the Philippine Area of Responsibility from 1948 to 1990, giving an average of 20 cyclones per year. Several of these affected Surigao province. The usual path of typhoons over the Philippines is shown in **Figure 3.40, EIS**.

4.3.2 Temperature

The annual average temperature at the project site is 27.3°C. The mean monthly temperature in the area ranges from a minimum of 22.6°C in the months of January and February to a maximum of 32.5°C in the month of June. The highest ambient temperature recorded in the area is 37.5°C on June 15, 1987. The lowest ambient temperature level occurred last January 24, 1905 at 18.2°C.

4.3.3 Rainfall

The annual distribution of mean monthly rainfall shown in **Table 3.82** of the EIS indicates a more wet period from November to March with monthly averages ranging from 455.6 to 337.2 mm. The months of April to October have mean monthly rainfall ranging from 249.4 to 258.3 mm. The highest rainfall that occurred in the area is 564.7 mm as recorded last November 18, 1968. The mean annual rainfall recorded in 35 years is 3639 mm.

The mean annual number of rainy days in the area is 216. The minimum average number of rainy days per month is 12 days occurring in August. The rainiest month is December with an average of 25 days.

4.3.4 Relative Humidity

The mean monthly relative humidity in the site range from 80 to 88%. Its variation is mainly associated with the moisture characteristics of prevailing air mass that passes over the site. During the peak of the southwest monsoon season the air masses that passes over the area are relatively drier than during the northeast monsoon and the easterlies. The mean annual relative humidity is 84%.

4.3.5 Wind

The climatological normals show that the frequent wind directions in the area are northeast from December to February, southwest from June to September, and east for the rest of the months. The southwest and east winds are relatively stronger with mean surface speed of 3 m/s. The northeast monsoon winds are weakened as they pass over land giving mean surface speeds of only 2 m/s.

The daily wind rose (Jan. 1996 to Dec. 1997) at the project site is shown in **Figure 3.41, EIS**.

4.3.6 Air Quality

The air quality in Nonoc Island is affected by the past and existing activities in the project site. Roads and mined areas in the island are the major sources of suspended particulate matters. The volume of vehicles plying the existing roads are minimal.

The ambient ground level concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), hydrogen sulfide (H_2S) and total suspended particulate (TSP) measured from May 1997 to July 1998 in Nonoc Island are shown in the EIS as **Tables 3.83, 3.84,** and **3.85**. Thirty- minute, hourly and 24-hour samples of ambient gas concentrations were taken from eleven (11) air quality sampling stations as shown in **Figure 3.42, EIS**.

As shown in **Table 3.83**, the ambient hourly concentrations of SO_2 in the area ranged from not detectable (ND) to 31.2 ug/Ncm. These are below the National Ambient Standard for SO_2 from industrial sources of 340 ug/Ncm (hourly). Likewise, these values are typical for clean atmospheric air which range from 2 to 50 ug/Ncm. The 24-hour averages measured in five stations (**Table 3.84**) were also within the National Ambient Air Quality Guideline for SO_2 of 180 ug/Ncm.

Ambient ground level concentrations of NO_2 measured from May 1997 to July 1998 were also below the prescribed National Ambient Standards. The National Ambient Standards NO_2 from industrial sources are 260 ug/Ncm and 375 ug/Ncm for hourly and 30-minute samples, respectively. The National Ambient Air Quality Guideline requires maximum short-term NO_2 concentration of 150 ug/Ncm for the 24-hour period. Thirty (30) minute samples collected from 10 sampling stations indicated concentrations ranging from ND to 7.69 ug/Ncm. Hourly ambient concentrations ranged from 3.27 to 29.48 ug/Ncm. For 24-hour samples, ambient concentrations ranging from 2.82 to 50.05 were measured.

Measurements of hourly H_2S concentrations conducted last July 1998 indicated that H_2S is not detectable. The National Ambient Standard for H_2S from industrial sources is 100 ug/Ncm.

Total suspended particulate (TSP) matters in air are generated by vehicles plying the unpaved roads around Nonoc Island. Measurements conducted showed that hourly

TSP concentrations range from 3.18 to 262.1 ug/Ncm. Twenty-four (24) hour average concentrations ranged from 20.11 to 53.3 ug/Ncm. Higher TSP levels were collected near the residential areas and roads where anthropogenic activities are higher. It was observed that resuspension of dust is high on unpaved roads. At the mine site, TSP level was relatively low.

4.3.7 Noise

Noise levels were also measured at 12 stations around Nonoc Island during morning, daytime, evening, and nighttime (**Figure 3.42, EIS**). **Table 3.86** of the EIS shows that noise levels ranged from as low as 30.5 to 65 dB(A). As expected, noise levels during evening, nighttime, and morning, are relatively lower than during daytime. Very low noise levels below 35dB(A) were observed in Nonoc Mining Area V.

4.4 Geology and Geomorphology

Interest in the laterite-rich areas of Surigao can be traced back to the early part of the century. The mineral resource of Surigao was first recognized in 1912 when H.P. Cameron, the Chief Engineer for the Department of Mindanao and Sulu, took interest in the laterite deposit (Wright, et. al., 1958). Sampling and laboratory analyses of laterite samples confirmed the presence of iron in the laterite deposit.

The first detailed exploration of Nonoc Island and Dinagat, collectively known as Parcel II of the Surigao Mineral Reservation, was conducted in 1956. The Philippine Bureau of Mines, in cooperation with the National Economic Council of the Philippines and the United States International Cooperation Administration, conducted exploration activities. The Philippine Bureau of Mines conducted a parallel study on the geology and geochemistry of Parcel II, and the result of such study was published in 1961.

The published reports of these various exploration works are extensively used as reference in establishing the geologic and physiographic condition of the MPSA area of the Project. Primary data collection is limited to the fieldwork, which was done on 15 to 19 July 1998. Inspected during this period were the mining areas in Nonoc Island and the Sabang River Watershed.

As part of the baseline characterization, geology and landforms of Nonoc Island and South Dinagat are evaluated according to their importance as geomorphic (landform) resources. Very limited work has been done on this aspect of Philippine geomorphology. The only attempt in the country to evaluate landform as geomorphologic resources is the work done by the Ministry of Human Settlements in 1973. The system of classification presented by the authors in the said reference is adopted for this study.

4.4.1 Study Area Boundary

The study area for geology and the other terrestrial components is the MPSA area. This MPSA has a total land area of 25,000 hectares and it covers the southern half of

Dinagat Island, Nonoc Island, Awasan and Hanigad Island. These islands belong to the north-south trending cluster of islands at the northeastern tip of Mindanao. Based on the Project development plan, there are three primary impact areas within the MPSA and these are:

- Nonoc Island, where mining and processing will take place.
- South Dinagat Island where mining and other ancillary facilities will be located.
- Sabang River Watershed in central Dinagat, which is the Project's water source.

Consequently, geology and the other terrestrial components focused on these primary impact areas.

Geology strongly suggests that the islands of Nonoc, Dinagat, Awasan and Hanigad are formerly, part of one landmass. Tectonic activities and sea level adjustment during the Pleistocene most likely drowned the main island, giving rise to channels and bays producing the various islands. Being of the same geology, these islands display identical landforms.

The largest of the islands is Dinagat with a total land area of 18,736 ha, next is Nonoc with a land area of 4,372 ha, while Hanigad and Awasan Islands have land areas of 976 ha and 916 ha, respectively.

Typical of the islands in this region, Nonoc and Dinagat Islands have very irregular shoreline, resulting to channels, coves, bays and other embayments. The irregular shoreline, the presence of very steep bathymetric profiles and the absence of coastal plains are geomorphologic evidences of submerged shorelines.

4.5 Biological Environment

4.5.1 Terrestrial Flora and Fauna

- Terrestrial Flora (Vegetation)

The site observation maps for Nonoc and South Dinagat Islands are given in the EIS as **Figure 3.15** and **3.16** respectively.

Ecological (Habitat) Diversity

In the past, the ecological (habitat) diversity types of Nonoc Island, was described by Wright and Salazar (1955) and Santos-Ynigo and Esguerra (1961). These investigators identified five (5) ecological (habitat) diversity types, namely: 1) lowland dipterocarpforest, 2) magkono-dominated second-growth formation (scrub), 3) grassland formation, 4) mangrove formation, and 5) cultivated vegetation. The salient features of these diversity types are summarized in **Table 3.15, EIS.**

Wright and Salazar (1955) and Santos-Ynigo and Esguerrz (1961) reported that the respective ecological (habitat) diversity types are characterized by particular lifeforms. These are presented in **Table 3.15**.

Field surveys conducted on 15-19 July 1998 confirmed the occurrence of the foregoing ecological (habitat) diversity types and the respective dominant species. An additional type was recognized, namely the freshwater wetlands. These are apparently depressions due to previous mining operations in the island that accumulated some amount of water over time. Several of these occur in various parts of the island. The edges of these water bodies are lined with a coarse fern *(Acrostichum aureum)* and "talahib" (*Saccharun spontaneum*).

The six (6) ecological (habitat) diversity types in Nonoc Island are presented in diagrammatic format in **Figure 3.6, EIS**.

The present disturbed state of the terrestrial environment in Nonoc, is the result of a series of unsustainable development or events that started in 1939 onwards. These include: (1) large-scale logging; (2) forest fire; (3) wood-gathering for charcoal-making; and (4) large scale nickel and cobalt open pit mining during the period 1974-1986. Most of the original forest cover (low-land dipterocarp formation) were generally re-planted or revegetated by: (1) low-statured magkono-dominated ultrabasic formation in the lateritic areas: (2) talahib (*Saccharum*), cogon (*Imperata*) grassland formation, broken here and there by pools of freshwater wetlands and bare mined-out trees; and (3) cultivated and built-up areas in the non-lateritic areas. **Table 3.16 (EIS)** summarizes the chronology of events relative to the deforestation of Nonoc Island from 1939 to the present.

The large-scale or commercial logging extracted red and white lauans and perhaps other dipterocarp species (**Table 3.17, EIS**). coastal communities extracted magkono from the old-growth forests for charcoal-making, while non-lateritic areas were converted into cultivated areas (coconut, bananas and other sonomic and ornamental plants) and human habitations.

The Sabang Watershed is in excellent condition due to the strict protection measures being applied by the Philnico security unit. It is characterized by a closed canopy old-growth low-land dipterocarp forest, closed canopy old-growth mangkono-dominated forest and very dense formation of mixed coconut-second growth formation.

Field survey of the 4,000 ha Sabang River Watershed Site (Reservoir) on 18 July 1998 indicated two ecological diversity types, namely the terrestrial type whaich can be subdivided into three sub-types: 1) the lowland dipterocarp forest, 2) the magkono-dominated forest, and 3) the mised-cocnut second growth formation , and secondly, the aquatic (wetland) type represented by the lake (reservoir) itself (**Figure 3.18, EIS**).

The lowland dipterocarp forest is one of the major forest types in the hills. It is dense and of the closed canopy type. It May be considered old growth. A local informant has indicated that the forest harbors species of lauan. A published account on

Philippine dipterocarps (Rojo, 1979) reported 19 dipterocarpaceous species from Surigao and it is possible that some of these may be present in the Sabang as may be discerned from **Table 3.18, EIS**.

The magkono-dominated forest is the other major forest type in the Sabang River Watershed. Like the lowland dipterocarp forest, it is dense and of the closed canopy type. Likewsie, it is here considered old growth. This forest type is distinctive due to the presence of numerous remains of dead standing magkono trees that overtower the whole forest landscape predominantly populated by younger magkono trees. A local informant indicated to us that the dead trees are part of an overmature population.

The third forest type in the Sabang River Watershed id the mixed-coconut-second-growth forest formation. It occupies the area from the water's edge from 10 to 30 m up the slopes. Close to the water's edge to about 5 m up the slopes is a community made up of herbs, vines, shrubs and small trees dominated by the scrambling fern (*Dicranopteris*), talahib (*Saccharum spontaneum)*, pitcher plants (*Nepenthes mirabilis), Sararanga philippinensis, Trema orientalis,* and *Homalanthus.*

Species Diversity

Baseline data (secondary) on the flora accumulated and compiled in 1923-1926 by Merrill indicated the presence in Surigao in general and Dinagat Island, Siargao Island and Bucas Grande Island of numerous flowering lifeforms (**Tables 3.19** to **3.21, EIS**). Many of these may occur also in Nonoc Island because of the geographiical proximity to these islands and Nonoc Island share similar environmental conditions with the said islands.

Field surveys conducted on 15 – 19 July 1998 yielded 21 species of pteridophytic liefforms (ferns) and 20 species of cultivated flowering lifeforms. These are listed in the EIS as **Tables 3.22, 3.23** and **3.24**, respectively.

The existing habitat types are species-poor but with local floral endemism. The low-statured nature of the magkono-dominated formation and the low-statured bakauan lalake-dominated mangrove formation are very characteristic.

A review of available data on the botany of the Dinagat Island forest landscape has indicated the presence of numerous endemic species. It is entirely possible that many of these species are still in the undisturbed portions of the Dinagat Island forest, especially in the Sabang River Watershed.

Endemicity

Secondary data (Merrill) showed 74 species of the flowering plants (**Table 3.25, EIS**) from the Project sites. Of these 74 species that belong to 54 genera (**Table 3.26, EIS**), 51 are endemic. This represents 69% of the total number of species listed (**Table 3.27, EIS**). Of the 54 genera of flowering plants to which the 74 species belong, 2 genera (representing 4 % of the total number of genera listed) are endemic (**Table 3.28, EIS**),

namely Greeniopsis (with 1 species) and Villaria (with 1 species), both of the coffee family (**Table 3.24, EIS**).

Based on the foregoing record, it appears that the project exhibits a rather high flowering plant species endemicity. While only 2 genera of the total number of genera listed for the Project site are endemic, there are only 23 endemic genera (with only 37 species) for the entire country. Thus, the presence of only 2 endemic genera of flowering plants in the Project site may be considered quite high.

Abundance, Frequency and Distribution

Information on the relative abundance, relative frequency and distribution of 79 species of vascular plants (ferns, flowering plants) encountered in various ecological (habitat) types in Nonoc Island (4,372 ha) are presented in **Table 3.28 (EIS)**. Of the 79 species encountered, 8 herbaceous and srubby lifeforms appear as the most abundant (also the most frequently encountered) species which are likewise the most widespread in distribution in the locality, namely:

Dicranopteris linearis (agsam, a coarse scrambling fern)
Leptospermum flavescens (malasulasi, a myrtaceous shrub)
Leptospermum sp (sagasa, another myrtaceous shrub)
Imperata cylindrica (cogon grass with extensive subsurface rhizome system)
Pteridium aquilinum (another coarse fern with rhizomes to about 0.5 m below the surface of the ground)
Saccharum spontaneum (talahib, another coarse grass)
Trema orientalis (anabiong, a small "weed" tree or secondary growth vegetation)
Xanthosthemon verdugonianus (magkono, another myrtaceous shrub)

Photos of terrestrial vegetation are given as **Plates 3.18 to 3.25, EIS**

Magkono is said to have reached its most successful development in the northeastern part of Mindanao and the adjacent islands (including Nonoc Island).

As is characteristic of ultrabasic habitat types, tall trees are conspicuous by the almost total absence.

- Terrestrial Fauna (Wildlife)

Baseline data were collected over the years by Zoologists like Alcala (1986), Dickinson, et al. (1991), Heaney and Morgan (1982), Heaney and Rabor (1982), Haney and Utzurrum (1991), Heaney et al. (1987), and the Wildlife Conservation Society (1997). Data gathered indicated the presence of numerous unique and endemic faunal lifeforms (birds, mammals, reptiles, amphibians) in Dinagat Island (**Tables 3.29, 3.30, 3.31, and 3.32, EIS**). Several of these lifeforms are now listed as endangered (Red Data Book of the Philippines, 1997) including a species of an endemic butterfly (**Table 3.33, EIS**).

Animal Diversity

The presence of wildlife fauna in a particular area can be used as an indicator of the environmental health of the said area. The location of the wildlife transect survey stations in Nonoc is given in **Figure 3.19** while that in the Sabang Watershed is given in **Figure 3.20** of the EIS. The following baseline data would be useful as a basis for future assessment of the state of the health of the Project site (that is, Nonoc Island and South Dinagat Islands).

Table 3.34 (EIS) enumerates the various species of birds encountered in various parts of Nonoc Island such as in the vicinities of the staff houses, coal park, nursery, tailings pond, Mining Areas I, IV, and V, Cantiasay and Hanigad Island during the field survey on 18-19 July 1998. As shown in **Table 3.34 (EIS)**, the 33 species were noted during the survey period. The number of species found in the corresponding areas are: 10 species near the staff houses, 11 species in the coal park, nine species near the tailings pond, 7 species in the Mining Area V, 3 species in the Mining Area IV and 9 species in the Mining Area I, 20 species in the nursery, 7 species in Cantiasay, and 4 species in Hanigad Island.

In Nonoc Island, the dominant species are the Chestnut Munia (*Loncura malacca),* Large-billed Crow (*Corvus macrorhynchus)* and Eurasian Tree Sparrow (*Passer montanus).* In one instance, more than 200 individuals of the rare and migratory Pink-headed Duck (*Rhodonessa caryophyllacea)* were encountered. Another migratory species, the Brown Shrike (*Lanuis cristatus)* was seen in the coal park and in the vicinities of the staff houses. Still another migratory species, Oriental Great Reed Warbler (*Acrocephalus orientalis)* was seen in Mining Area I. Plates show some of the wildlife observation areas in Nonoc and Dinagat Islands.

Faunal species diversity is represented by various species of birds, amphibians, reptiles and mammals, not a few of which are local endemics.

The Sabang Watershed is presumably rich in endemic lifeforms, both plants and animals. This feature of the watershed may be confirmed through future biodiversity field surveys of the area if this is made part of the watershed management plan.

Tables 3.35, 3.36, 3.37, and **3.38** of the EIS list the various species of fauna encountered in the habitat types in the Sabang River Watershed during the field survey on 24-25 July 1998. Listed in **Table 3.38** (EIS) are the eight species of terrestrial reptiles, in **Table 3.37** the two species of amphibians, and in **Table 3.35** the 29 species of birds.

Most of the birds were encountered in the primal forest zone. Of these, the most dominant are the sunbirds. Seven migratory birds were seen in the area. These are the Plumed Egret (*Egretta intermedia),* Grey Plover (*Pluvialis squatarola*), Brown Shrike (*Lanius cristatus).* Whimbrel (*Numenius phaepus*), Black capped Kingfisher (*Halcyon pileata*) and common Kingfisher (*Alcedo atthis).*

Seven of the faunal lifeforms are considered as source of food by the local residents. These are the *Python reticulata, Varanus salvator, Sus barbatus,* Megapode (*Megapodius freycinet),* White-breasted Sea Eagle (*Haliaetus leucogaster),* Philippine Mallard (*Anas luzonica*) and the Calao (*Bucerus hydrocorax).*

Considered nuisance lifeforms by the local residents are three species, namely, rat (*Rattus sp.)* , mice (*Mus musculus)* and the Chestnut Munia *(Lonchura malacca).*

On the whole, the Project site can be said to support a very rich fauna, particularly the Sabang River Watershed because the extant habitat types are in excellent condition. Here many species can maintain healthy populations. Wildlife is not at present heavily hunted because the watershed is under strict protection by Philnico security unit.

Due to time constraint, the survey made is not very exhaustive. Various aspects of the local wildlife will remain unknown particularly the seasonal movements and distribution of rare and secretive birds.

Endemicity

The following are the endemic bird species in the study area of Nonoc Island: *Collocalia troglodytes, Halcyon chloris collaris, Corvus macrorhynchos, Lalage nigra, Nectarinia jugularis, Nectarinia sperata, Pycnonotus goiavier, Pycnonotus plumosus, Eudynamis scolopacea, Rhipidura javanica, Copsychus saularis, Oriolus chinensis, Anthreptes malacensis,*and *Pycnonotus urostictus.*

In Sabang Watershed, an amphibian species (*Platymantis dorsalis),* four species of mammals (*Acerodon jubatus, Cynocephalus volans, Ptenochirus minor, Rattus everetti)* are endemic.

The following bird species found in Sabang Watershed are endemic.

Anas luzonica,Anthus novaeseelandiae, Buceros hydrocorax, Corvus macrorhyncus, Collocalia troglodytes, Eudynamis scolopacea, Eurostopodus macrotis, Gallirallus torquatus, Halcyon chloris collaris, Halcyon smyrnensis, Harpactes ardens, Hypsipetes everetti, Lalage nigra, Nectarinia jugularis, Nectarinia sperata, Oriolus chinensis, Penelopides panini, Phapitreron leucotis, Phapitreron amethystina, Ptililopus lechancheri, Pycnonotus goiavier, Pycnonotus urostictus, Rhipidura javanica, Sarcops calvus, and *Treron pompadora.*

Abundance, Frequency and Distribution

In Nonoc Island, the most abundant species are *Lonchura malacca, Paser montanus* and *Corvus macrorhynchus.*

For frequency and distribution of species, please refer to **Table 3.36, EIS.**

The most abundant avian species in Sabang Watershed were the sunbirds, *Anthreptes malacensis, Aethopyga siparaja, nectarinia jugularis* and *Nectarina sperata.* Except

for *Anas luzonica, Corvus macrorhynchos, Halcyon chloris collaris, Lonchura malacca* and the bulbuls, all of the species were only seen once or twice.

Eudynamis scolopacea and *Harpactes ardens* were only listed because of sound identification.

4.5.2 Freshwater Flora and Fauna

Table 3.56, EIS shows the phytoplankton composition of the different sampling points during the month of July 1998. The phytoplankton collected from Nonoc and Dinagat islands belonged to Divisions Cyanophyta with 7 species, Chlorophyta with 5 species, Chrysophyta. with 7 species and Division Euglenophyta with one species. **Plates 3.41** to **3.56** of the EIS shows some of the collected microalgae from the different sampling stations.

There was the abundance of different species of diatoms such as *Synedra, Cymbella. Navicula, Pinularia, Frustulia, Acanthes* and *Nitzschia* in the creeks of Weir, Duyangan, Panadtaran (reservoir), Mabini and Hercon. The creek in Mabini had the species of *Lyngbya* and *Scytonema* while Panadtaran has species of *Oscillatoria, Chroococcus, Rivularia* and *Gloeocapsa* which are cyanophytes or blue green algae.

Mougeotia , a filamentous green algae, was observed to occur in most of the sampling stations. It is possible that this is an indicator species considering the influence of the laterite type of soil on surface waters. *Staurastrum* , a green desmid, was abundant in Weir and Hercon creek which is a possible indicator species too. There was abundance of *Oedogonium* , a filamentous green algae in the Talipapa spring and *Spirogyra* in Duyangan creek (nursery) which are both filamentous green algae. *Cosmarium*, a green algal desmid, was collected in Hercon creek.

The reservoir with the Panadtaran and Maraging stations had an abundance of diatoms together with a few *Oscillatoria* and *Calothrix*, both filamentous type of blue green algae. A unicellular green algae was also found in Cantiasay and Duyangan creeks but identification has to be verified since this particular species has not been encountered in most of the literature used. In general the phytoplankton composition of the different sites is indicative of a Class A water. There was also the presence of a desmid, *Penium*, which is not normally observed in other freahswater ecosystem and has not been reported in local literature.

Aquatic insects under twelve families, seven gastropods and three crustaceans were collected from the different sampling points during the month of July 1998 as shown in **Table 3.57** and **Plates 3.57** to **3.66, EIS**. The insects were collected using nets while the gastropods were collected using the spade and passed through a series of sieves. Due to time constraint, sampling for these organisms was not standardized.

There was an abundance of aquatic insects belonging to twelve families collected from Duyawan, Maraging , Talipapa and Weir creeks. *Macrobrachium* sp., a freshwater shrimp, was collected from Herkon, Mabini and Maraging creeks. Maraging and Duyawan creeks had the most diverse macroinvertebrates.

Three species of gastropods under the genus *Melanoides* which might have been moderately abundant were scarce because these are being eaten by the Philippine mallard. The presence of *Stenothyra* sp.collected from Duyangan creek is a new record in the area and is possibly a new species.

Three species of crustaceans considered as zooplankton were collected using the plankton net. Considering the abundance of diatoms and some filamentous algae that can be possible sources of food for these organisms, their scarcity is quite surprising. This is due to the pesticidal effect of nickel on these crustaceans. Nickel before is one of the elements incorporated in insecticides and molluscicides but is now banned.

4.5.3 Marine Flora and Fauna

4.5.3.1 Corals and Associated Reef Fish

Rapid Resource Assessment

A total of 104 spot inspections were made around the island **(Figure 3.26, EIS).** Live hard coral cover ranged from 'good' to 'excellent categories' in nearly 60% of the total spot inspections. Nearly 35% of these spot inspections were under the 'very good cover category' (=4), a little over 19% under the 'good category' (=3) and nearly 5% under the 'excellent category' (=5). Strong water current along channels and areas characterized areas with hard coral cover of ranging the good to excellent categories. These areas are located at:

- exposed side of Doot Island
- in front of the Tailings Pond
- fringe reef of Barangay Talisay
- a short stretch in front of Mine Area III
- a short stretch in front of Mine Area IV
- southeastern section of Mine Area V
- most of Gaboc channel.

Many of these areas stretch from 200 to 500 m. Many of the hard corals observed at these areas were branching and large tabulate *Acropora* (>1.5m in maximum diameter) and other species, notably *Porites*, of the massive and branching growth forms. In front of the Tailings Pond, large foliose forms of *Turbinaria* were dominant.

The 'fair' category (=2) of hard coral cover was observed in a little more than 22% of the spots inspected while a little less than 20% were considered under the 'poor' category. Most of these spots were located in areas of high embayment (sheltered).

Dead coral cover ranged from <10 to 30% in more than 90% of the spots inspected and was 31-50% in the remaining spots. None of the spots inspected had more than 50% dead coral cover. Areas of 31-50% dead coral cover were confined and non-continuous. For example, this was observed near Banlot at Mine Area IV and near the

foundations of the water pipe running between Dinagat and Nonoc Islands along Gaboc Channel.

Similarly, soft coral cover ranged from <10 to 30% in nearly 90% of the spots inspected. None of the spots had more than 50% soft coral cover. Areas with fair amounts of soft coral cover were those relatively silty. For example the area near Banlot silt dam and east of the pier at Talisay.

Areas largely devoid of biotic benthic cover comprised a small portion of the coastal perimeter (little over 7% of the total spot inspected). Most of these were in front of the beach areas of the exposed side of Barangay Nonoc promontory. Less than 14% of the spots inspected comprising inner portions of the coves located around the island had silt/sand cover estimated at 51-75%. A large majority of the spots inspected (nearly 80%) had a silt/sand cover estimated at less than 50%. More than half of these had silt/sand cover of less than 30%.

Benthic Lifeforms

- Generic Composition of Coral Communities

A total of 35 genera of scleractinian corals were observed collectively in all 8 stations **(Table 3.59).** The number of genera observed for each station ranged from 17 to 24 with the highest obtained at stations Tailings Pond and Talisay. Overall, individual colonies of *Porites* and *Acropora* were the most common comprising nearly 40% of the total occurrences. Seven genera, *Porites*, *Acropora*, *Fungia*, *Galaxea*, *Favites*, *Turbinaria* and *Goniopora*, were common to all 8 stations.

- Coral Cover

The percentage cover of various reef components varied between stations. Of the five major benthic reef categories, the most important were cover of live corals, dead corals and abiotic components for all stations surveyed. Percentage cover of the various reef components are detailed in **Table 3.60** to **3.66, EIS.**

Live coral cover ranged from 21% to 75 % (**Figure 3.27, EIS**) with the highest occurring at the station in front of Mine Area V. The station at Gaboc channel had the second highest percentage cover of live corals at nearly 64%. This was followed closely by stations in front of the Tailings Pond and Barangay Talisay at nearly 60% (for both). Two stations, Nonoc and Cantiasay, had live coral covers of a little less than 40% while another 2, Mine Areas II/III and III/IV, had coral covers of a little over 20%.

Tabulate and branching *Acropora* (ACTs and ACBs, respectively) together comprised more than 90% of the live hard corals at the station in front of Mine Area V. Foliose corals (CFs), predominantly *Turbinaria*, and ACBs were the most important corals at the stations in Gaboc channel and in front of the Tailings Pond comprising more than 85 and 75%, respectively. The percentage cover of corals at the station in Talisay were almost equally distributed to 5 growth types. In decreasing order, these were

ACTs, encrusting corals (CEs), ACBs, massive corals (CMs) and CFs. In Cantiasay, the common corals were CMs, branching corals (CBs) and CFs. In Nonoc, ACBs, CMs and CFs were the more common type of coral growth forms. The percentage cover of CMs at the station in front of Mine Area II/III comprised more than 2/3 of the total hard corals while CBs, CMs and ACTs were common at the station in front of Mine Area III/IV.

The percentage cover of soft corals were quite substantial in stations between Mine Areas III/IV and II/III, Talisay and Tailings Pond. Algal cover were fairly ample in stations between Mine Areas II/III and III/IV and Talisay. The most common algae was *Caulerpa* spp. Additionally, moderate numbers of the stinging cnidarian *Aglaophenia* sp. was present at these 3 stations.

- Cover of Dead Corals and Other Abiotic Reef Components

The percentage cover of dead corals ranged from 4% to 52% (**Figure 3.28, EIS**). The highest percentage cover of dead corals occurred at Cantiasay (52%) and Nonoc (49%). This was followed by stations at Mine Area III/IV (30%), Talisay (23%) and Gaboc (21%), then stations at Mine Areas V and II/III (both at 11%). The station with the least percentage of dead coral cover was in front of the Tailings Pond (4%). Most of dead corals accounted were covered with algae.

The percentage cover of abiotic reef components ranged from 1% to 38% (**Figure 3.29, EIS**). The highest percentage cover of abiotic reef components was recorded for stations in Mine Area II//III (38%) and Tailings Pond (28%). This was followed by stations in Mine Area III/IV (15%), Nonoc (14.6%), Mine Area V (10%), Cantiasay (9.6%) and Talisay (8%). The station in Gaboc had the least cover of abiotic components. In stations Mine Area II/III, Tailings Pond, Cantiasay and Nonoc, silt accounted for a large proportion of the abiotic component. Rubble was a major abiotic component in Talisay while sand composed most of the abiotic factors at Mine Areas III/IV and V.

Associated Reef Fish

- Species Composition of Reef Fish Assemblages

A total of 164 species distributed to 31 families were observed in all 8 stations combined (**Table 3.66, EIS**). Target species comprised 26% of the total number of species while indicator species (Chaetodontidae) accounted about 9% of the total number of species. About 45% of the species belong to 2 families alone (Pomacentridae (24%) and Labridae (21%)). The rest of the species (20%) were distributed to 15 other families (**Figure 3.30, EIS**).

Forty-three species from 13 families were considered target fish with varying commercial values. All of these except 11 species from Serranidae have medium to low market value when sold locally. Serranids (groupers and trouts (lapu-lapu)) are a highly sought after fish and command a higher market value particularly when sold live than the rest.

Fourteen species of Chaetodontidae (butterflyfishes) were recorded in all stations combined. These species are important because they are indicators of the general status of coral reefs (*sensu* Carpenter *et al.* 1981, McManus *et al.* 1981, Gomez *et al.* 1988). Most members of this family are corallivores (i.e. eat coral polyps) (Hiatt and Strassburg 1960, Hobson 1974, Sano *et al.* 1987, Randall *et al.* 1990), hence a preponderance of butterflyfishes may indicate good live coral cover. *Chaetodon octofasciatus* was common to all stations while *C. trifasciatus* and *Chelmon rostratus* were observed in at least half of the stations.

A total of 40 and 34 species belonged to Pomacentridae and Labridae, respectively (**Figure 3.31, EIS**). These 2 families were consistently dominant in all the stations surveyed. Many of the Pomacentridae (damselfishes) are planktivorous herbivores, detritivores and grazers while majority of the Labridae (wrasses) are benthic predators and scavengers.

The number of species observed for each station ranged from 32 to 65. Three stations recorded the highest number of species. These were the Tailings Pond, Mine Area II/III and Mine Area V. Slightly less than 60 species were noted in stations in Talisay (n=59), Nonoc (n=58) and Mine Area III/IV. Stations in Gaboc (n=38) and Cantiasay (n=32) were the most depauperate.

The species composition for each of the station varied little from the overall species composition. In each station, Pomacentridae and Labridae consistently dominated the fish assemblages. The number of indicator species (Chaetodontidae) was high in stations at Mine Area V, Gaboc and Talisay. Ample number of target fish was present in all stations.

- Individual Abundances of Reef Fishes

A total of 16,200 individuals of fish was estimated in all 8 stations combined. Of these, only 21 species accounted 90% of the total abundance (**Figure 3.32, EIS**). Four species accounted more than 52% of the total abundance. The most abundant species in the area include the damselfish *Chromis caeruleus*, *C. ternatensis* and *Pomacentrus alexanderae*, and the wrasse *Cirrhilabrus cyanopleura*. Several schooling fish species were observed around the area. The more common species were the fusiliers (*Caesio* spp.), anchovies (engraulids), rainbow runners (*Elegatis bipinnulata*) and the black-spot snapper (*Lutjanus fulviflamma*).

The mean number of individuals ranged from 21 to 510 individuals $50m^{-2}$ (**Figure 3.33, EIS**). The highest mean number of individuals was recorded in Talisay (±127 (SE)) and the lowest at Gaboc and Cantiasay (both 21 ±9). Moderate densities of fish were observed at stations in Mine Areas V, III/IV and II/III with 320 (±80), 300 (±154) and 220 (±30) individuals $50m^{-2}$, respectively. Fair densities of fish were observed at stations in Nonoc and Tailings Pond with 140 (±41) and 82 (±26) individuals $50m^{-2}$, respectively.

- Reef Fish Biomass

The mean biomass of fish ranged from 105 to 3800 g $50m^{-2}$. The highest mean biomass was recorded at Talisay (±1630 (SE)) and the lowest at Cantiasay (±35). Estimates of fish biomass in stations at Mine Areas II/III, V and III/IV and Tailings Pond were moderate. The mean biomass at these stations was 851 (±265), 645 (±120), 564 (±297) and 528 (±100) g $50m^{-2}$, respectively. Estimates of fish biomass in stations at Nonoc and Gaboc were fair with 310 (±139) and 257 (±100) g $50m^{-2}$, respectively.

A summary of the contributions of the top 5 species and the top 5 families to the cumulative estimated biomass of fish for each station is presented in **Tables 3.67** and **3.68**, respectively (**Figure 3.34, EIS**). Species with cumulative biomass contributions exceeding 1500 g $500m^{-2}$ included the black spot snapper *Lutjanus fulviflamma*, the fusiliers *Caesio caerulaureus*, *C. cuning* and *Pterocaesio tile*, the coral trout *Plectropomus leopardus* and the rainbow runner *Elegatis bipinnulata*. Reef fish families with cumulative biomass contributions exceeding 1500 g $500m^{-2}$ include Pomacentridae (damselfishes) Labridae (wrasses), Lutjanidae (snappers), Caesionidae (fusiliers) and Serranidae (groupers).

4.5.3.2 Seagrass and Seaweed Communities

Percentage Cover and Frequency of Seagrass and Seaweed Species

A total of 8 sampling stations were surveyed during the study. Seven (7) seagrass species, namely, *Enhalus acoroides*, *Cymodocea rotundata*, *C. serrulata*, *Thalassia hemprichii*, *Syringodium isoeetifolium*, *Halodule pinifolia* and *Halophila decipiens*, and 6 seaweed species, *Halimeda macroloba*, *Halimeda* sp., *Padina minor*, *Hypnea* sp., *Acantophora* sp. and *Caulerpa racemosa*, were identified in all stations combined. Species composition, density, frequency and percentage cover of seagrasses and presence of seaweed species in the 8 stations are presented in **Tables 3.70** and **3.71, EIS.**

The total percentage cover of seagrass species ranged from 5 to 68% with mean of nearly 36%. The lowest percentage cover of seagrass was observed in Station 6 (S of Doot Island) while the highest at Station 2 (SW of Cantiasay). Except at Station 7, the most important species of seagrass were *Cymodocea rotundata* and *Enhalus acoroides* and *Thalassia hemprichii*. These 3 species were the major components of seagrass beds surveyed on the island. In Station 7, four species almost evenly comprised the seagrass community.

Except for Stations 7 (Gaboc channel) and 8 (Talisay), the abundance of seaweed species was not remarkable though they were noted. *Halimeda macroloba* constituted 13% of the cover in Station 7 while *Sargassum polycystum* was the single vegetation observed at Station 8. Numerous patches of *Caulerpa racemosa* were observed occasionally in some stations.

A detailed description of seagrass and seaweed communities are given below for each station.

- Station 1 (near Barangay Cantiasay)

Several small beds of seagrass were observed on the northern portions of the bay but the most extensive beds were observed towards the south. The seagrass bed in front of Cantiasay was among the more extensive beds. The seagrass community in this station was moderately deep (1-3 m) and extends from the pier of Barangay to about a kilometer inwards to the bay. The substratum was muddy. A total of 4 seagrass and 2 seaweed species were present in this station. The most dominant seagrass species was *Enhalus acoroides* with a percentage cover of 38.0%, followed by *Cymodocea rotundata* with 8.0%, then *Cymodocea serrulata* (4.98 %) and *Thalassia hemprichii* (2.0%). Similarly, *E. acoroides* was the most frequent species encountered (20%), followed by *Cymodocea rotundata* (10.4 %), *Thalassia hemprichii (4.0%) and Cymodocea serrulata* (1.6 %). The seaweed species observed in this station comprised of *Halimeda macroloba* and *Padina minor*. The former was interspersed on the substratum while the latter was more dominant on the rocky shores. The cover of these species was unremarkable.

- Station 2 (2 km. southwest of Barangay Cantiasay)

The seagrass bed in this station extends southwards about half a kilometer. The bed was shallow (1-2 m) and the substratum was sandy. The seagrass bed was a monostand of *Cymodocea rotundata* while the genera *Halimeda*, *Hypnea* and *Acantophora* comprised the seaweed community for this station. The percentage cover and frequency of C. rotundata were 68.0 and 80.0%, respectively. The seaweed species were sparse.

- Station 3 (entrance of channel across Barangay Nonoc)

The seagrass bed in this station was shallow (1-2 m) and small with the widest breadth estimated at 250 m. The substratum was characterized as silty to muddy type. A total of three (3) seagrass and three (3) seaweed species were recorded. The seagrass species *Cymodocea rotundata* had the highest percentage cover (20.71%), followed by *Thalassia hemprichii* (6.82 %) and *Enhalus acoroides* (3.0 %). *C. rotundata* was the most frequently encountered species (57%) followed by *T. hemprichii* (25%) and *E. acoroides* (10%). The 3 seaweed species were *Padina minor, Neomeris* sp. and *Halimeda* sp. The abundance of these species was not remarkable.

- Station 4 (southwest of Jetty 3)

The seagrass bed in this station was relatively shallow (0.5-2 m) and relatively small which extends seawards to only about 150 m. The substratum was characterized as of the silty-muddy type the resuspension of which makes water visibility almost zero. Three seagrass and a seaweed species were noted in this station. Of the four species, only one species of seaweed is identified. The bed was mainly inhabited by *Enhalus acoroides, Halodule pinifolia and Halophila decipiens,* with a percentage cover of

15.0%, 8.0% and 5.4%, respectively. The relative frequencies of *E. acoroides, H. pinifolia and H. decipiens* were 25.0%, 12.0% and 3.0%, respectively. The single seaweed species noted in this station was *Padina minor*. The abundance of this species was low.

- Station 5 (northeast of Jetty 3)

The seagrass community in this station was composed of several small beds on shallow substratum (1-3 m) of the silty-muddy type. The water visibility was reduced to almost nil during sampling due to the resuspension of sediments. The largest breadth of the bed sampled in this station was about 50 m only. Only 2 seagrass (*Enhalus acoroides* and *Thalassia hemprichii*) and none of the seaweed species were recorded. *E. acoroides* dominated this station with a percentage cover of 12.8% and a relative frequency of 16.0 %. *T. hemprichii* recorded a percentage cover of 5.6% and a relative frequency of 6.0%.

- Station 6 (south of Doot Island)

Seagrass in this station occupy subtidal zones of a shallow but extensive reef flat. Seagrass was found to be relatively sparse and occurrence was limited to a span of about 50 m. at the middle of the flat. The substratum was sandy and the area has good water visibility owing to strong water currents that flush fine sediments. Single species of seagrass (*Enhalus acoroides*) and seaweed (*Caulerpa racemosa*) were observed in this station. The percentage cover of *E. acoroides* was a low 5.0% and with a relative frequency of 13.6%. Several small patches of *C. racemosa* were observed in the area.

- Station 7 (along Gaboc channel facing Awasan Island)

The seagrass beds in Gaboc channel are limited to the inner portions of small coves and embayments. The bed sampled along the channel was relatively small (a breadth of about 50 m) and shallow (1-2 m). The substratum was sandy. Five seagrass and 2 seaweed species occurred in this station. *Cymodocea rotundata* was the most dominant seagrass with a percentage cover of 15% and a relative frequency of 14.5%. *Syringodium isoetifolium* was the second most dominant seagrass with a percentage cover of 14% and a relative frequency of 12.6%. *Enhalus acoroides* and *Thalassia hemprichii* followed next with a percentage cover of 10% for both and a relative frequency of 4.7 and 10.8%, respectively. The occurrence of another seagrass species, *Halophila decepiens*, was noted but its abundance was not detectable. The percentage cover and relative frequency of a seaweed species, *Halimeda* sp., was estimated at 13 and 15.6% respecitively, while these were not detectable for the 2 other species, *Padina minor* and *Neomeris* sp.

- Station 8 (in front of Barangay Talisay)

No seagrass bed was observed around this station but the vegetation present was monospecific stand of *Sargassum polycystum*. The percentage cover and relative frequency of S. polycystum was estimated at 68 and 83%, respectively. This seaweed

community was relatively large extending about 50-70 m seawards from the subtidal zone. The depth varied from 1-4 m. The substratum was composed chiefly of small to large boulders of limestones and interspersed by sand.

Density and Biomass of Seagrass Species

The density and biomass of seagrass species are presented in **Table 3.71, EIS.** Both parameters varied within and between species across stations. The density and biomass of seagrass species ranged from 9 to 972 shoots m^{-2} and from 0.56 to 178.6 g dry wt. m^{-2}, respectively. The highest density was recorded in Station 2 for *Cymodocea rotundata* and the lowest observed in Station 3 for *Enhalus acoroides* (Table 2.x). The highest biomass was observed in Station 1 for *E. acoroides* and the lowest in Station 4 for *Halophila decipiens*.

Mean density and mean biomass were available only for species that occurred in at least 4 stations. These are presented in **Table 3.71 (EIS)** for *E. acoroides*, *C. rotundata* and *Thalassia hemprichii*. The mean density of *C. rotundata* (466.5 shoots m^{-2}) was nearly 5 times that of *T. hemprichii* (96.5 shoots m^{-2}) and nearly 19 times that of *E. acoroides* (24.8 shoots m^{-2}). Conversely, the mean biomass of *E. acoroides* (98.13 g dry wt. m-2) was about twice that of *C. rotundata* (49.4 g dry wt. m^{-2}) and 3.6 times that of *T. hemprichii* (27.4 g dry wt. m^{-2}).

The total density and total biomass of seagrass species varied between stations. The total density and total biomass of seagrass species in a station ranged from 18 to 972 shoots m^{-2} with a mean of 412 shoots m^{-2} and 89 to 233.6 g dry wt m^{-2} with a mean of 130.5 g dry wt m^{-2}, respectively. The highest mean total density was recorded in Station 2 and the lowest in Station 6. The highest mean total biomass occurred in Station 1 and the lowest at Station 6.

The results of this investigation were consistent with those found by Nienhius *et al.* (1989). They reported that the number of shoots per surface area was species dependent and density was relatively wide in "supply place". Fortes (1990) observed that, extremely prolific seagrass beds at Bolinao Bay (northwestern Luzon) ranged from less than 400 shoots/m^2 (less dense beds) to more than 400 shoots/m^2 (truly dense seagrass). Although the densities of seagrass beds in Nonoc Island widely varied between stations, the total mean density was a little over that of the truly dense seagrass bed (*sensu* Fortes 1990).

Rollon and Fortes (1989) reported a range of 8 to 132 g dry wt m^{-2} for total biomass of selected seagrass communities in the Philippines. A recent work estimated seagrass biomass in Dampalitan, Tayabas Bay showed an annual range of 90.28 to 227.94 dry wt g/m^2 (DA-FSP, 1996). The biomass obtained in the present study was generally consistent with results of earlier studies. *Enhalus acoroides* contributed largest to the total biomass of seagrass beds than any other species in Nonoc Island despite a fairly low mean density. The more massive and heavier rhizomes of this species than that of *C. rotundata* and T. *hemprichii* explain the larger contribution of *E. acoroides* to the total biomass.

4.5.3.3 Plankton

Composition, Density and Abundance of Plankton Communities

- Introduction

The density and abundance of taxonomic groups comprising plankton communities for each station are presented in **Table 3.72** and **3.73, EIS.** A total of 17,254 plankton was estimated in all stations combined. More than 65% of this were phytoplankton while zooplankton comprised the rest. A total of 21 genera constituted the phytoplankton group while the zooplankton group consisted of 8 taxonomic groups. The classes Cyanophyta (blue green algae), Bacillariophyta (diatoms) and Pyrrophyta (red algae) comprised the phytoplankton.

- Mean Density Between Plankton Groups

The density varied widely between plankton groups and between stations. The mean density among the genera of phytoplankton ranged from 1 to 131 individuals m^{-3}. The highest mean density was observed for the diatom *Thalassiothrix* and the lowest for another diatom *Bacillaria*. The most abundantly important genera of phytoplankton include *Thalassiothrix*, *Chaetoceros*, *Synedra*, *Coscinodiscus*, *Skeletonema*, *Trichodesmium*, *Ceratium* and *Polykrikos*. All were recorded in at least 8 of the total 15 sampling stations with *Thalassiothrix* being present in all stations. All except the last 3 genera are diatoms.

The mean density among taxonomic groups of zooplankton ranged from 15 to 196 individuals m^{-3}. The highest was recorded for nauplii (a larval form of crustaceans) and the lowest for the cyclopoid copepod. Nauplii and calanoid copepods were the most abundant zooplankton. The former was recorded in all stations while the latter was present in all but one station.

- Composition and total density of plankton between stations

The number of occurrences of plankton groups in a station ranged from 10 to 18 groups m^{-3} with a mean of 14 groups m^{-3}. The highest was observed in Stations 2 and 10 and the lowest at Stations 1 and 9. Stations 2, 4, 6, 10 and 11 had a higher number of groups of plankton m^{-3} than the mean. On the average, 60% of the plankton groups in a sample for each station was phytoplankton and 40% zooplankton.

The total density of plankton ranged from 543 to 2431 individuals m^{-3} with a mean of 1158 individuals m^{-3}. The highest total density was observed in Station 11 and the lowest at Station 3. Nearly half of the stations had total densities of plankton in excess of 1000 individuals m^{-3}.

4.5.3.4 Soft Bottom Fauna

Composition of Soft Bottom Fauna

A total of 919 benthic organisms were counted from 15 stations combined **(Table 3.74, EIS)**. These organisms represented 37 families under 4 major classes as well as from 8 other large group/phyla. The largest class was Polychaeta with 23 families, followed by Crustacea with 10, Pelecypoda with 3 and Gastropoda with 1. The 8 other large group/phyla were Chaetognatha, Chiton, Nematoda, Ophiuroidea, Rynchocoela, Sipunculida, Turbellaria and Foraminiferans.

The composition of soft bottom fauna was largely dominated by only 3 groups, namely, the polychaetes (marine segmented worms) (46%), the small crustaceans (23%) and the nematodes (round worms) (22%). Together they comprised 91% of the total organisms counted. The rest were distributed to 2 other classes and 7 phyla. The polychaetes were present in all stations with high abundances recorded in Stations 2, 11 and 1. Among the polychaetes, the 5 most abundant were Cirratulidae, Spionidae, Capitellidae Nareidae and Syllidae. Crustaceans were represented in all but 3 stations with the highest abundance noted in Station 6. Tanaidae, Gammaridae and isopods were the most dominant crustaceans. Similarly, nematodes were present in all but 3 stations with high abundances observed at Stations 1, 2 and 6.

Density and Diversity of Soft Bottom Fauna

The total density of soft bottom fauna for each station 6 to 196 individuals m^{-2} with a mean of 61 individuals m-2 **(Table 3.75, EIS)** ranged from an individual per sq. m. to 74 indv/sq.m. It was observed in the study that faunal abundance increased with depth. Station 6 recorded the highest total density of 196 indv/sq.m, mainly dominated by crustaceans. This was sampled at 4 meter depth in the sandy area of Port Gaboc (entrance) where Tanaidae predominated. Species of Tanaidacea (tiny crustaceans) are filter feeders, detrital feeders and sometimes predators but mostly detrital feeders (Mc Laughlin, 1980). The high density of tanadacea is due to the available food. It is at the eastern entrance to Port Gaboc where a small community is primarily fishing. However, interview with fisherfolks revealed that production in fish traps has been reduced greatly at the entrance of the Channel. This may be due to dynamite fishing practice that is very common in the area as noted during the time of sampling. This may be also be due to slash and burn techniques practiced by the community for firewood gathering and regeneration as described in the environmental assessment of the area conducted last August 1996. To lessen negative impacts appropriate and sufficient setbacks for mine sites and mining areas near coastlines should be established. Without these, mining in or near steep slopes adjacent to coastal areas should not proceed. Only the establishment of setbacks will prevent the input of sediment in coastal waters and benthic habitats.

The second densest station was Station 2 with a value of 154 indv/sq.m., being polychaetes as the most dominant organisms followed by nematodes. Stations 3 and 8 recorded the least number of individual organisms sampled with a density of 7 and 6 per sq.m, respectively.

Based on the total number of identified taxa in different sampling sites, Stations 2 and 9 showed to compose the most diverse benthic species followed by Stations 11 and 6. Among the benthic fauna, the polychaetes were well represented at all stations. The greatest number of polychaetes was collected at Station 11 at 71 indv/sq.m. followed by Stations 2 and 3 with 69 and 62 individuals per sq. m, respectively. Various families of polychaete, which includes Nereidae, cirratulidae, Spionidae and Syllidae, were found most common in nearly all stations compared with other families. Their wide distribution suggests a high adaptability to any kind of marine soft bottom community. The least represented among polychaete families were Cossuridae, Lacydniidae and Sternospidae, which shows its restricted distribution. Sternospidae was found only at Station 27, Lacydoniidae at Station 4 and Cossuridae at Station 6 – 111 occurred once per sq. m of sediment samples. Members of family Amphinomidae occurred twice per sq. m. in Station 2 only.

Among crustaceans, Station 6 presents the highest number of individuals at 97 per sq. m. while none were found in Stations 7, 13 and 14.

Both Chaetognaths and Rynchocoelas occurred once per sq. m. in Station 2 only. Chitons appeared twice from the samples per sq. m. in Station 9 while foraminiferans appeared in Station 10 only at 15 indv/sq.m.

It must be noted that very productive communities can have either very high or very low species diversity. Stability seems more directly correlated with diversity than does productivity.

4.5.3.5 Description of the Fisheries

The number of fishers in Barangays Nonoc, Cantiasay and Talisay constitute less than 10% of the total population (**Table 3.76** and **3.77, EIS**). In terms of the number of households however, it is estimated that 1 in 5 households has a fisher for Nonoc and 3 in 10 for Cantiasay. This parameter was unavailable for Talisay. The number of motorized boats was less than that of non-motorized boats. This suggests that majority were subsistence fishers. These results are fairly consistent to an earlier study conducted by GAIA South, Inc.

The fishers in the area are engaged in 4 types of fishery, namely, hook and line, seine nets, spear and fish corrals. Of these, hook and line was the most dominant type of fishery in all barangays. The effort spent by fishers for hook and line varied between barangays and ranged from 2-5 to 3-6 hours representing a range in catch sizes <1-6 to 1-15 kg. On average, hook and line fishers spends about 3-3.5 hrs day^{-1} fishing and capture 2.0-2.5 kg of fish. A total of 15 species belonging to Serranidae (groupers), Lethrinidae (emperors), Lutjanidae (snappers) and Nemipteridae (breams) were targeted by this fishery. These species are carnivorous fishes and have high market value.

The spear fishery in the area targets a suite of species with high to moderate market values. These species are listed in **Table 3.78.** All species except the *Plectropomus*

spp., *Epinephelus* spp. and *Cephalopholis* spp., are moderately valued fish. Fishers engaged in this fishery require a level of skill. The time they spend hunting fish vary from 2-4 to 2-6 hrs with catches ranging from 1-10 to 1-15 kg. On average, a spear fisher hunts for about 3 hrs day-1 and collect between 1.5 to 4 kg of fish day^{-1} in the 3 barangays.

The seine net fishery in the area is seasonal although some practice this fishery all year round. This fishery is relatively active during the rainy season targeting pelagic fishes around Hinatuan Passage. These species are listed in **Table 3.78.** Catch sizes in this fishery is highly variable. Catches vary between 1 to 30 kg for a 2-6 hrs work. On average, seine fishers spend about 3 hrs day-1 and capture about 1.5 kg day^{-1}. A related type of fishery exists in Barangay Talisay. This is the bag net fishery that is aided by lights to lure pelagic fishes such as *Decapterus*, clupeids and sardines. This fishery is more time consuming (8-18 hrs) and the catch varies widely between 1-150 kg. Most of the respondents stick to this fishery because of the chance of large catch sizes.

Fish corrals are a passive type of fishery. Designs and sizes vary depending on the resources of a fisher. On average, fish corrals in the area occupy about 300 m^2 on a reef flat with openings facing a mangrove patch. This is designed to trap fish moving from a mangrove area to seagrass or coralline areas during tidal ebbs. On average, fishers spend 2-3 hrs day^{-1} to check and collect trapped fish with an average catch size of 1.5 kg day^{-1}. During the period between November to early January, this fishery potentially traps 30-50 kg of fish on few occasions. Fish collected from this fishery include 4 species of rabbitfishes and surgeonfishes.

4.6 Socio-economic Environment

4.6.1 General Characteristic of Nonoc Island

Barangays in the project area have been identified as direct impact areas. These are Barangays Cantiasay, Nonoc and Talisay, which occur on Nonoc Island. Barangays Boa and Del Pilar at North Dinagat, Barangay Mabini at South Dinagat and Barangays Aurora and San Pedro in Awasan and Hanigad Islands. The proposed project is located within the political boundaries of these identified impact areas.

Nonoc Island has a population of 7,749 as of 1995 and the population grows at an average rate of 2.023%. Its residents derive income from employment, fishing and business. Each barangay has its own elementary school and in June this year Talisay opened its first public high school offering first and second year. The Jesus Cabarrus Catholic School also provides elementary and high school education, and is being subsidized by the project proponent. The proponent provides social services such as electricity, water and transportation.

Life in the community is generally peaceful if not uneventful. People are generally conscious about health, environment and sanitation. Many women are members of Primary Health Care (PHC) while many men are members of BESIG. They have undertaken projects related to herbal medicine *(Botica Binhi)*, family planning, etc.

The proponent also provides services and facilities to the islanders. It provides the only means of land transportation in the island. It has constructed roads to connect the three barangays and the townsite. While the barangays have their own roads in the poblacion area, access to the different parts of the island is made possible through the road network constructed by the proponent. Children who go to school are picked up by company trucks to bring them to school. The proponent supplies power and street lighting to the three barangays. Barangay Nonoc borrowed from the company a generator set to provide electricity during the night. It has also private generators to provide electricity at certain times of the day. Barangay Cantiasay and Talisay have also passed resolutions to borrow a generatmg set for the company to provide electricity for the barangays. The company has its own water system while most of the residents who live outside the refinery compound make use of natural resources like springs. The proponent is providing Barangay Talisay with a potable drinking water. Communication lines through the telephone system. PLDT lines are available in the island.

There is also a community broadcast television transmitter for the whole island. The proponent maintains a clinic. Some company employees are provided free board and lodging while others have access to free housing and free use of utilities. The company security guards also maintain peace and order within the refinery compound. They are backed-up by a Philippine Constabulary (PC) detachment in Talisay which intervenes only when requested to do so.

The proponent is perceived not only as an employment provider but also as provider of basic social services to the residents of the island. They are dependent on the company for some of their basic needs. Many compare their lives before and after the company shutdown. One of the basic reasons why there is a one hundred percent approval rating for the re~operation of the refinery. They eagerly await the rehabilitation and re-operation of the mining and refinery activities in anticipation of brighter future for themselves and their community.

4.6.2 Demography

4.6.2.1 Population: Size, Growth and Density

Table 3.87 (EIS) presents some of the most important characteristics of the inhabitants of Nonoc Island, specifically of the population of the three identified direct impact areas, (Cantiasay, Nonoc and Talisay). Data on the population of Surigao City are included for comparative purposes.

The population of the barangays at Nonoc, Dinagat, Awasan and Hanigad Islands and Surigao City had been decreasing for the last three census years. Except for Barangay Cantiasay, the decrease had been at an increasing rate. Barangay Cantiasay had the highest increase in population from 1980-1985. This can be explained by the fact that it was during this period that the mining area became fully operational. However, when its operation ceased in 1986 due to the strike of its employees, the population started to decline as families left the island and looked for employment in other areas.

The decline continued as the families and their members got better opportunities in other areas. According to the individual accounts of some members of the communities, most of those who migrated to other areas went to work in mining areas in other provinces or other countries. During the past 10 years (1985-1995), 1,545 families have left Nonoc Island and the number of inhabitants has decreased by a total of 8,984.

Nonoc Island and Surigao City had low density in terms of population. Barangay Cantiasay had the highest density with three people per square km.

In 1995, the combined population of the three barangays at Nonoc Island was only 3.6% of the total population of Surigao City. Barangay Talisay had the highest number of residents, as this was where the housing units for Philnico's junior staff were located. More than half of the household population of the three barangays had six members **(Table 3.88, EIS).**

The 1998 survey conducted by Philnico yielded that there was at least one adult who was able and willing to work (144 or 52.93%) for every dependent (119 or 43.74%) in Barangay Cantiasay. For Barangay Talisay the ratio was better with 365 adults or 57.66% able and willing to work for 253 dependents or 39.96%. For Barangay Nonoc, the number of dependents (82 or 51.90%) was more than the number of adults able and willing to work to support them (75 or 47.47%).

For the whole Nonoc Island, there was at least one adult able and willing to work and provide support (584 or 54.94%) for every dependent (454 or 42.71%) **(Table 3.89, EIS).**

4.6.2.2 Population: Literacy Rate and Educational Attainment

In 1990, approximately 70% of the population of Surigao City were literate **(Table 3.90, EIS).** In terms of gender distribution, the female population had a slightly higher level of literacy (51%) than the male population (49%). There is a big disparity between the number of literate individuals who came from the urban barangays (67.6%) than those who came from the rural barangays (32.3%).

In 1990-1995, only three additional schools were constructed in Surigao City. During the same period, the number of elementary schoolchildren who enrolled declined every year. For the secondary schools, the number of enrollees fluctuated every year. The number of enrollees in tertiary schools also declined sharply, from a high of 12,946 students for the school year 1991-1992 to only 5,042 students in school year 1994-1995 **(Table 3.91, EIS).**

For schoolyear 1994-1995, the number of students who were able to finish their elementary education was low compared to the previous schoolyear (1990-1991) and the succeeding schoolyear (1995-1996).

On the average, the teacher-student ratio within the period 1990-1996 for the elementary schools in Surigao City was 1 teacher for every 31 students. For the secondary schools, the average was 1 teacher for every 44 students.

There was a 92.5% increase in the cost of each elementary student enrolled between the schoolyear 1991 and 1993. For the secondary students, the cost had increased by 62.4% between the schoolyear 1993 and 1994.

Within the Nonoc Island, there were three elementary and secondary schools operating. Of these, the company has been subsidizing the Jesus Cabarrus Catholic School, which offers elementary and secondary education. This school has been open to all dependents of employees of Philnico at half tuition.

The results of both surveys are almost similar. The results of the 1997 survey indicates that the majority of the respondents graduated from elementary school while the 1998 survey indicates that the majority of the respondents graduated from high school. Both surveys show that a small percentage of enrollees? (22.0% and 21.6%) graduated from college. Only eight respondents graduated from vocational school **(Table 3.92, EIS).**

4.6.2.3 Population: Ethnic Groups and Culture

The data on ethno-linguistic groupings was limited to the sum for the three barangays as there was no data available for each barangay. The majority of the inhabitants of Nonoc Island spoke Surigaonon (64.9%), followed by Cebuano (24.4%). Most of these were from Barangay Nonoc, which was the original barangay of the island. This is understandable since Surigao City is just four hours away from Cebu and Samar, both of which are Cebuano- speaking provinces. Also, most of the families who migrated to the island when Philnico started the mining operations came from these nearby provinces **(Table 3.93, EIS).**

The Majority of the inhabitants of Nonoc Island and its neighboring islands speak Surigaonon (64.9%), followed by Cebuano (24.4%). Most of these are from Barangay Nonoc, which is the original barangay of the island. This is understandable since Surigao City is just four hours away from Cebu and Samar, both of which are Cebuano- speaking provinces. Also, most of the families who migrated to the island when Philnico started the mining operations come from these nearby provinces.

There is no reported Mamanwa, the tribal group originally inhabiting the city and its island barangays, still living on the island. As of 1996 (Office of the Southern Cultural Minorities, Surigao City), the only remaining Mamanwa live on Mat-I and numbers only 59.

4.6.2.4 Population: Religious Affiliation

Based on Table 3.94 of the EIS, majority of the respondents in both surveys was Roman Catholic (60.6%). The rest was Aglipay (32.3%). UCCP members (3.5%) and other religious organization (2.2%).

4.6.3 Housing

4.6.3.1 Housing Structure

No data was available on the housing structures for the barangays. In lieu of this, the data for the Surigao City is presented. Of the 18,683 household families living in Surigao City in 1990, 18,000 families or 96.34% occupied their own housing unit. The rest lived with their first-degree families and relatives.

Most of the houses were of the single detached type (92.04%). The rest lived in duplex units (4.5%), multi-unit residential (3.2%), commercial/industrial/agricultural (0.11%), institutional living quarters (0.06%), and other housing units (0.06%).

The ratio of households to occupied housing units indicated that for each housing unit only one family resides. The ratio of household population to occupied housing units confirmed the earlier data that the population density for the island was low.

Philnico had its own housing units inside the refinery for its permanent employees. The proponent has provided 343 housing units that can house a total of *576* families and 816 employees on bachelor status. Those occupying managerial positions were provided with single-detached concrete bungalows with three bedrooms while those in lower supervisory positions live in more simple dwelling quarters. Many houses, which had been vacated after the shutdown, are in a state of disrepair after being damaged by strong typhoons.

4.6.3.2 Housing Materials

Based on **Table 3.94 (EIS)**, GI roof and concrete was the housing materials used by at least 36.34% of the respondents to the surveys, 35.59% used GI roof and wood while 26.06% used nipa and wood. The majority of the respondents from Barangay Cantiasay used nipa and wood (54.05%). For the majority of the respondents of Barangay Nonoc, they used both nipa and GI roof and wood. For the majority of the respondents coming from Barangay Talisay, GI roof and concerete and wood were the housing materials used. This was so because the housing units of Philnico can be found in Barangay Talisay.

4.6.4 Sanitation

4.6.4.1 Water

Based on **Table 3.96 (EIS)**, the majority of families in Barangay Cantiasay get their water from dug wells (40.6%), deep well (35.4%) and spring (40.0%). For Barangay Nonoc, the majority gets their water from dug wells (79.3%), springs (50.0%) and deep wells (50.0%). For Barangay Talisay, the majority has a water line connection to the company that supplies them with water at least every other day. Families without water line connection get water from dug wells (74.8%) and water pumps (21.9%).

4.6.5.2 Lighting Materials

Kerosene is the lighting material used by majority of the respondents (170 respondents or 42.6%). There is no electrical connection in the three barangays. Barangay Cantiasay uses only kerosene and battery for lighting. The electricity used by Barangays Nonoc and Talisay comes from the generator set owned by the barangay officials **(Table 3.101, EIS).**

4.6.6 Livelihood and Income

4.6.6.1 Sources of Livelihood

The majority of the respondents in the 1997 and the 1998 survey were employed by private organizations (146 respondents or 36.6%). Fishing is the source of livelihood of 70 respondents (17.5%). A good number of respondents in the 1998 survey are employee of Philnico (49 respondents or 25.3%). The occupations listed in "Others" include fish vendor, driver, midwife, barangay captain, and pensionado. Those who did not give any answer (6.11%) are presumably jobless. The nickel mining and refinery operations still constitute the major means of employment on the island **(Table 3.102, EIS).**

After the shutdown of the refinery in 1992, some members of the community have begun to work in the city or elsewhere including overseas, while their families have remained in Nonoc Island. They reported that the shutdown of the refinery operations has resulted in tremendous loss of income on their part. Majority (57.26%) of the respondents has stated that a member of their family had worked with the former Marinduque Mines in various capacities as laborers or supervisors. Many are waiting for operations to resume to enable them to get jobs or make use of other income generating opportunities. This is especially true of many residents from Talisay (refinery site) and Cantiasay. While there are considerable number of former Marinduque employees in Barangay Nonoc, it is least dependent on the refinery, when compared to the other two barangays. Many residents have thrived on subsistence fishing and the people have reported that their average catch amounts to P50 a day. The respondents identified the three main occupations in the island as follows: fishing, private employment and business.

As the land is not suitable for agriculture, subsistence farming is a popular activity among the residents and they plant vegetables, rootcrops, fruits, *ipil-ipil* and herbal medicine. Some raise farm animals such as the goat, chicken and cow.

4.6.6.2 Estimated Monthly Income

The majority of the respondents has been receiving a monthly income between 1,000 to 3,000 Pesos (201 respondents). This is below the poverty level of 6,000 Pesos for a rural family. A total of 101 respondents have been receiving 3,001 to 6,000 Pesos while 44 respondents have been receiving between 15,000 Pesos and above **(Table 3.103, EIS).**

4.6.7 Fishing Operations

Each of the 530 respondents in the two surveys that have been conducted uses fishing tools associated with subsistence fishing. 224 or 44.5% are using lambat, 132 fishers or 24.9% are using arrow and 92 fishers or 17.35% are using fishpen **(Table 3.104, EIS).**

5.0 DESCRIPTION OF EXPLORATION WORK

5.1 Description of Exploration Method(s) and equipment to be used

5.1.1 Geological Mapping

Exploration in the MPSA area involves mapping of laterite areas and identification of rock types as well as to check previous workings test pits. Brunton compass, 50-m tape, sample pick and other geologist's tools will be used in mapping.

5.1.2 Geophysical Methods

No plan for geophysical exploration works will be applied since drilling and test pitting are the suited methods in identifying the nickel mineralization.

5.1.3 Geochemical Methods

The geochemical methods applied in nickel laterite exploration will include sampling on 50-meter grid in-fill drilling and 100-meter grid drilling. Sampling will be done per meter of the drill core and channel sampling will also be done on test pits.

With the assay results of the above samples, geochemical maps will be produced through computers.

5.1.4 Drilling Method

Three (3) units Yoshida Boring machine (YBM) drill rigs, using diamond and tungsten carbide bits with core diameter of 2 inches , will be utilized to drill down to the bedrock. The YBM drill is light weight and easy to transport even on a highly rugged terrain requiring small farm tractors to mobilize the rig on the most remote locations. Approximately 750 holes are scheduled to be drilled by YBM drill.
(refer to attachment "A" for the details).

Construction of limited access road for the drills is necessary for easy maneuverabilty of farm tractors pulling the rig in most difficult terrain.

5.1.5 Test Pitting

Test pitting, 1m x 1m, will be undertaken in the strategic drill sites. The primary objective of test pitting is to obtain bulk samples by channel sampling at every 1

meter interval for density measurement, moisture content and metal analysis. Mapping of the test pits is also conducted to delineate the contacts of the limonite, transition and saprolite zones and the bedrock.

5.1.6 Others

The construction of limited access road for the easy and efficient mobilization and transfer of the drills from the different drill sites is necessary particularly along difficult and remote drill hole location during the two-year exploration period.

5.2 Preliminary processing of samples

In YBM drilling,core logging will be conducted by samplers with supervision of geologists and/or mining engineers. The data includes material type (limonite, transition or saprolite), material color, core recovery and other important information regarding the samples. Channel samples from test pits will be analyzed for density measurement, metal and moisture content analysis. The drill core and channel samples collected in the field will be placed in labeled plastic bags, recorded and submitted to Philnico laboratory for analysis.

5.3 Map showing the location of the proposed work area in relation to readily identified geographic and environmental features (refer to Figure 5.1 & 5.2)

5.4 Estimated exploration costs

The estimated cost for the two-year exploration period is about P 8,357,933.85 or US$ 167,158.68 at a forex rate of US$ 1 = P 50.

6.0 IDENTIFICATION OF POTENTIAL ENVIRONMENTAL EFFECTS

6.1 On Land

6.1.1 Impacts of exploration drilling are qualitatively rated very low. YBM drill rigs will be used in the exploration drilling and these will require the construction of limited access roads for mobilization and transferring of drill rigs from the different drilling sites.

6.1.2 Impacts on changes of land forms due to test pitting and installation of campsites are rated very low. Digging of test pits will be restricted only at two (2) test pits per exploration sites or a total of four (4) test pits for the whole 2-year exploration period. Likewise, no permanent and concrete structures for exploration camps will be erected. The exploration camps will be temporary in nature and made of tents and canvass.

Since site preparation for exploration camps and excavation of test pits will be limited, changes in erosion rate is predicted very minimal.

6.2 On Hydrology and Water Quality

6.2.1 The areas subjected to exploration are laterite formation and underlain by an ultrabasic rock. It is expected that no potential generation of acid mine drainage.

6.2.2 Siltation and pollution of surface waters due to surface run-off, erosion and dust are rated very low. This project considers no major excavations to be undertaken. This entails limited excavations such as digging of two(2) test pits (1m x 1m) per exploration sites.

6.2.3 Hard drilling will result to increase of water consumption for the YBM drilling operation. Water for the drilling operations will be sourced from the creek. An average of 900 li/day of water will be required for the three (3) YBM drills. This impact will be considered low to moderate depending on the extent of drilling in the hard ground formation.

6.3 On the Ecology

The effects on ecosystems are rated very low. Campsite preparation, exploration drilling and test pitting would entail minimal production of small particles of soil that may eventually find its way into the nearby creeks. The expected noise sources during the 2-Yr. Exploration Program are the drilling equipment operations. The project will not result to drastic changes in the ethnic composition of the population no matter where they get the workers. This is due to the fact that most of the residents of the communities are also migrant to the islands.

6.4 On Socio-Economic Effects

Surigao City has identified the development of mineral resources as a major development prospect for the city since they have comparative advantage in mineral deposits. The PNPI's Exploration project will help realize this development goal, as the resumption of the 2-Yr. Exploration drilling operations will create job opportunities to Nonoc and its neighboring Islands

7.0 ENVIRONMENTAL MANAGEMENT MEASURES

7.1 Restoration of drilling sites is minimal and this is closely integrated with the duration of the drilling operations. If and when applicable, revegetation of the disturbed drilling, access roads and test pit sites will be undertaken to prevent possible erosion.

7.2 All core samples will be brought to Philnico laboratory for analysis with duplicates to be stored in PNPI Sample/Corehouse at Nonoc Island for future use. Excavated samples from test pits will be properly enclosed with GI sheets or canvass. These samples will be preserved and, if and when necessary, will be brought and stored at Nonoc for future use.

7.3 In this exploration work program, limited access road will be constructed.

7.4 No toxic chemicals and hazardous materials to be handled during the project.

7.5 There will be no major accommodation of other economic activities in the area during the project.

7.6 Habitat of flora and fauna will not be adversely affected during the project.

7.7 Hiring of workers will be thru barangay cooperatives. PNPI officials have already committed themselves to giving priority to local residents who are qualified for the positions to be filled up. The proponent should develop comprehensive guidelines and programs of action for safety at all stages of the project to be implemented by the supervisors. Standard operating procedures of the exploration works should be strictly followed.

7.8 Considering that this project entails no major destruction of the environment, it is assumed that the working areas have been restored at the end of the project's life as previously discussed.

The Environmental Management Plan is presented in **Matrix 7.1**.

8.0 NAME AND SIGNATURE OF PERSONS PREPARING THE EWP

VICTORIANO C. NUÑEZ
PPC / PNPI OIC Plantsite and Minesite
Registered Mining Engineer
PRC License NO. 1216
PTR No. 0513526X
Date of Issue: 1 – 18 - 02

MATRIX 7.1 – ENVIRONMENTAL MANAGEMENT PLAN

Project Activities	Impact Description Per Parameter	Mitigation/Enhancement plan	Cost (PhP)	Schedule
1.0 Establishment of grid lines & layout of boreholes	local loss of vegetative cover	minimize cutting of trees, avoid uprooting of trees and revegetating the affected areas if and when necessary	P 5,000	before and during operation
2.0 Campsite preparation	local loss of vegetative cover	revegetating the affected areas	P 2,000	before and during operation
3.0 Excavation of sump (water reservoir) for drilling operations	local ponding and alteration of topography	restoration of surface to its appropriate configuration	P 1,000	during operation
4.0 Survey, drilling and test pitting	local ponding & erosion of stockpiles	provisions of test pit cover, peripheral drainage canal and sample enclosures	P 5,000	during operation
	increase in accidents/health hazards	provision of safety gadgets and free medical supplies for all workers	P 164,000 P 92,000	during operation
	increase in employment opportunities	hiring of local skilled and non-skilled workers by the barangay coop are given priority	P 9.878 million	during operation
5.0 Construction of limited access roads	Local loss of vegetative cover	Revegetating the affected areas, restoration of surface to its appropriate configuration	P 50,000	During and after operation

PACIFIC NICKEL PHILIPPINES, INC.

Figure 2.2

2 YEAR EXPLORATION WORK PROGRAM
South Dinagat Area
(No. of Drill Holes and Depth)

Exploration Area	Activity	No. of Units	Resouce Classification	Area Covered	Drill Interval	Target Drill Holes	Target Meterage	No. of samples	Average Drilling	Projected Completion
									Adv/day / unit	(Months)
Area - B South Dinagat	YBM Drilling	3	Measured Resource	160	50 m. x 50 m.	500	10,000	10,000	8.0 meters	16
Area - E South Dinagat	YBM Drilling	3	Indicated Resource	300	100 m. x 100 m.	250	50,000	50,000	8.0 meters	8
TOTAL		3		460		750	60,000	60,000		24

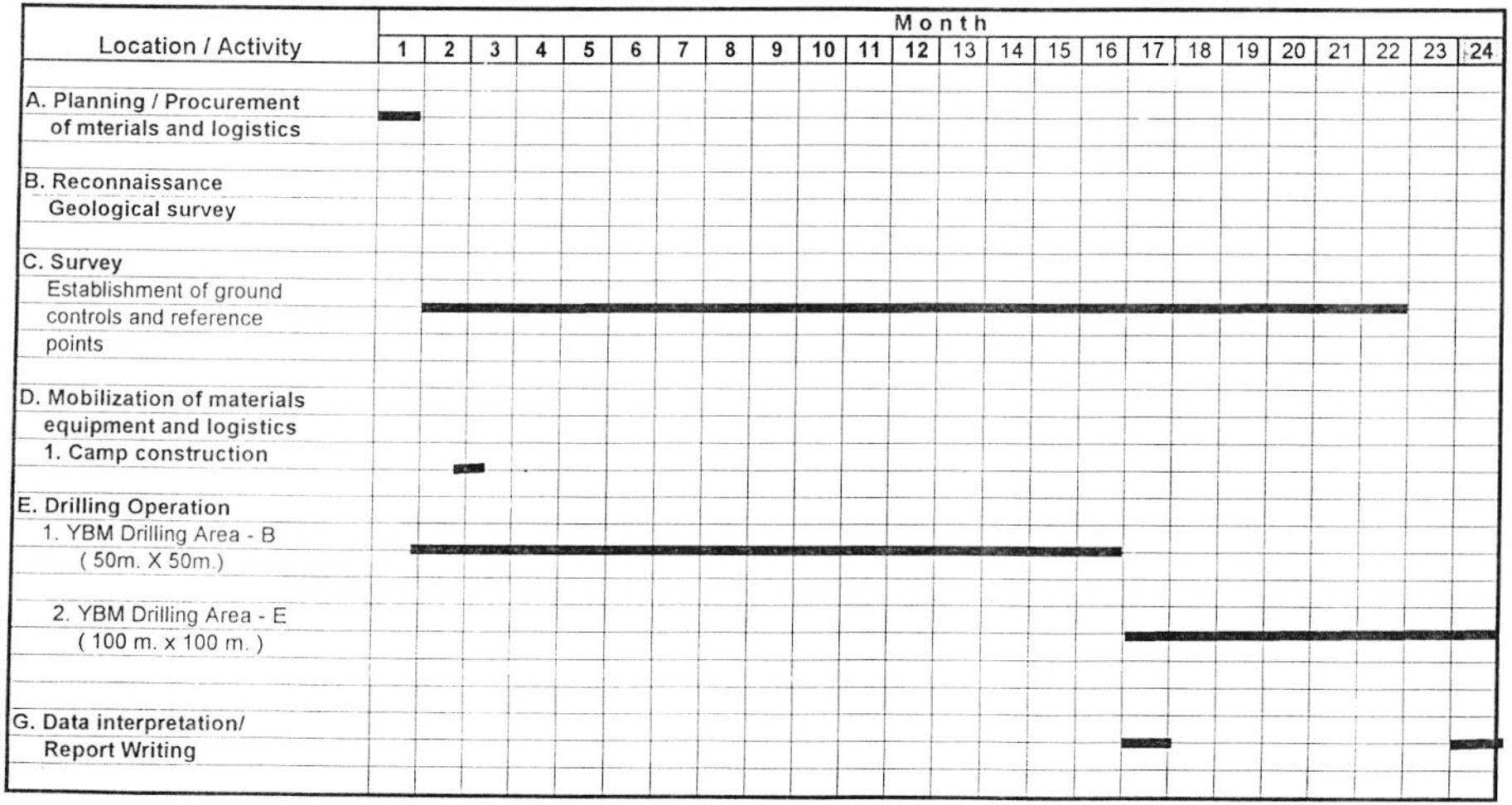
CONSIDERATIONS :

1. Drill holes are selected based on topograpy (flat to moderate slopes)
2. Average 20 meter / drill hole
3. Hectarage based on 0.9 % Ni cut off

PACIFIC NICKEL PHILIPPINES, INC.

Figure 2.1

2 YEARS EXPLORATION WORK SCHEDULE



PACIFIC NICKEL PHILIPPINES INC.

EXPLORATION WORK PROGRAM

FOR THE

APPLICATION FOR TWO (2) YEAR EXTENSION

OF

EXPLORATION PERMIT

Republic of the Philippines
Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
North Avenue, Diliman, Quezon City

EXPLORATION WORK PROGRAM

1.0 Name and Address of Company/Proponent

Pacific Nickel Philippines, Inc.
11th Floor, Manila Bank Building
6772 Ayala Avenue
Makati City

2.0 Location of Project

The MPSA area applied for covers the whole of Nonoc Island, Awasan Island, Hanigad Island and the South Dinagat Island. The table below shows the geographical coordinates of the tenement area.

AREA	LATITUDE	LONGITUDE
Nonoc Island, Hanigad Island & Awasan Island	Bounded by 9° 48' 37'' to 9° 55' 00''	 125° 34' 25'' to 125° 42' 24''
South Dinagat Point 1	10° 04' 51.76''	125° 41' 26.60''
Point 2	9° 51' 57.89''	125° 42' 01.06''
Point 3	9° 53' 07.87''	125° 38' 28.56''
Point 4	9° 56' 25.61''	125° 37' 36.86''
Point 5	9° 59' 19.75''	125° 37' 36.86''
Point 6	9° 59' 19.75''	125° 37' 02.55''
Point 7	10° 06' 24.69''	125° 37' 02.55''
Point 8	10° 06' 24.69''	125° 40' 30.81''

Nonoc Island is located approximately 15 km northeast of Surigao City, and is separated from mainland Mindanao by the Hinatuan passage. Dinagat Island is located north of Nonoc, Awasan Island to the north and Hanigad Island to the northwest.

3.0 Area or size of coverage

The MPSA covers 25,000 hectares. The two-year extension for exploration will cover Area – B South Dinagat and Area – C South Dinagat and portions of Parcel – II area..

4.0 Project Area Description

4.1 Terrain/Physiography

The northern part of the tenement area is characterized by moderate to rugged topography with some flat portions on top of the hills. East of the northern area is the Pacific Ocean. The highest elevation is 600 meters which is part of NW-SE trending ridge. Major rivers drain to the east of the area and unloading its waters to the Pacific side.

Awasan and Hanigad Islands have a dimension of 4 km and 7 km., respectively, in their longest dimensions trending in NE-SW direction. They are both characterized by moderate topography. The highest elevation of Awasan is about 160m. while Hanigad is 163m. Hanigad is located west of Awasan. Landforms in Nonoc Islands are classified as ridges, basins, beaches, mangrove swamps and embayments. Nonoc Island, Awasan Island and adjacent South Dinagat Island seem to be parts of a jigsaw puzzle separated by the Gaboc Channel.

4.2 Accessibility

Surigao City, which is the nearest commercial district near the project area, can be reached from Manila by boat or commercial and private aircraft. From Surigao City, Nonoc Island can be reached by ferry or small boats. An accredited and registered airstrip at the island can accommodate private or chartered aircraft. North and South Dinagat, Awasan and Hanigad Islands can be reached by ferry or small boats. Hanigad Island is connected by a 504-meter wooden footbridge to Nonoc Island.

4.3 Drainage Systems

The natural drainage systems in Dinagat Islands are characterized by intermittent flow for the short creeks together with moderate to steep creeks with small catchment areas and by low but perennial flow for the relatively large catchments drained by creeks with moderate gradients. The impervious character of the rocks making up the catchment favor large runoff with limited retention of groundwater storage. Accordingly, reported groundwater occurrences are limited to small discharge springs emanating from fractures traversing the peridotite mass and the boundary between overburden and the peridotite.

The big river systems are located at North Dinagat (north of MPSA), one is the Sabang River system, where Nonoc Island gets its water to supply the company and including the adjacent community. Sabang dam is connected by 30-km. pipeline to Nonoc Island. The other big river system is the Manoligao River located north of Sabang. At Nonoc Island, smaller systems are present such as the Duyangan Creek, Tinago Creek and Lutawon Creek.

Only small creeks are present at Awasan and Hanigad Islands. All are flowing radial to the islands.

4.4 Land Use

In North Dinagat, only the portion of coastal areas are planted with coconuts but the upper portions are partly denuded or scarce of vegetation. However. remnant forest cover still persists at the upper mountains.

Land uses in Awasan, Hanigad and South Dinagat Islands are classified as built-up, bare and cultivated, open shrubs, grassland, mangrove and some settlements. Cultivated areas

constitute 9.2 percent of Dinagat Island's area. The coastline of Awasan-Hanigad and South Dinagat is lined by extensive mangroves, characterized by low-statured trees.

5.0 Description of Exploration Program

5.1 Research Work

5.1.1 Survey of Previous Work/s on the Area

a. Previous exploration works and studies within the Surigao Mineral Reservation began in the 1940's up to 1960's by the Philippine Bureau of Mines (PBM) and the United States-International Cooperation Administration (US-ICA).

A 1958 report on the "Fe-Ni-Co Resources of Nonoc, Awasan, & Southern Dinagat Islands in Parcel II of the Surigao Mineral Reservation, Surigao, Mindanao" was made by W.S.Wright, US-ICA and L.Santos-Ynigo, et.al., PBM.

The "Geology and Geochemistry of the Nickeliferous Laterites of Nonoc and Adjacent Islands, Surigao Province, Philippines" was a research made by L.Santos-Ynigo and F.B.Esguerra of PBM in 1961.

b. Marinduque Mining and Industrial Corporation (MMIC), which was a domestic mining corporation had entered into a memorandum of agreement (MOA) with the government on July 3, 1968 to explore, develop, exploit, utilize and process the nickel ores within the Parcel II of the Surigao Mineral Reservation.

5.1.1.1 Nature or Type of Study or Undertaking

a. In October 1953, the PBM in cooperation with US-ICA undertook a project to determine the amount, grade, and amenability to economic processing of the nickel-iron reserves in a representative part of Surigao Mineral Reservation (SMR). The incentive for the investigation of this lateritic area was aroused by the successful exploitation of nearly identical deposits in Cuba and New Caledonia, and by the world shortage of nickel that existed at that time.

The exploration of the nickel deposits in the islands includes test pitting and auger drilling maintained at 100m x 100m grid interval.

b. MMIC had conducted test pitting on a 100m x 100m grid within the Parcel II of the SMR and conducted detailed drilling exploration at 25m x 25m in Nonoc Island prior to mining in 1973.

5.1.1.2 Duration

a. The exploration and research studies made by PBM & US-ICA of the part of Surigao Mineral Reservation (Parcel II) was conducted in October 1953 to December 1957.

b. MMIC conducted detailed subsurface exploration in Parcel II of the SMR in 1969 and 1970. Plant operations started in 1974. Nonoc

Mining & Industrial Corporation (NMIC) which was formed by Development Bank of the Philippines (DBP) & Philippine National Bank (PNB) after foreclosing on MMIC in 1984 took over management of the mining and refinery operation in September of that year. In 1986, there was a mass action of the employees due to the delayed salaries which forced the shutdown up to the present.

5.1.1.3 Coverage

a. The study by PBM and US-ICA of the Parcel II of the Surigao Mineral Reservation included 4500 hectares of land which is blanketed by 1-18 meters of Ni-bearing ferruginous laterite. Test pitting and auger drilling at 100-meter interval was done over 2500-hectare portion of this area, embracing the laterites of Nonoc, Awasan and Southern Dinagat Islands.

b. MMIC covered Nonoc Island and completed test pits in Awasan, Hanigad and part of North Dinagat Islands.

5.1.1.4 Proponent

a. Philippine Bureau of Mines and United States–International Cooperation Administration.

b. Marinduque Mining and Industrial Corporation.

5.1.1.5 Results or Conclusions Arrived At

a. Nonoc Island was selected as a desirable field of investigation by PBM &US-ICA for the reason that it was considered a definite lateritic area large enough to afford sufficient ore for a long-term mining operation in the event profitable exploitation should be indicated, and assuming also that the negotiations for development could be consummated.

With the favorable results of the Nonoc field investigation and preliminary metallurgical tests , it was decided to extend the project to include the laterite area in Southern Dinagat Island and Awasan Island.

b. The detailed subsurface exploration of MMIC had delineated several nickel ore bodies in Nonoc Island and the nickel plant operation started 1973 to 1986.

5.1.2 Data Compilation/Collation

5.1.2.1 Geochemical/Geophysical Data

The available geochemical/assay data were based on the test pits and drill holes made by MMIC.

No geophysical data is available for the applied MPSA area.

5.1.2.2 Lithological Data

The available lithological/geological data used by MMIC/Nonoc Mining & Industrial Corporation (NMIC) was that of the one produced by the Bureau of Mines. Detailed mapping and checking of the lithology will still be conducted during the 2-year extension of exploration program.

5.1.2.3 Mineralization/Alteration Studies

The data on the chemistry and mineralogy (particularly XRD analysis) of composite samples were gathered from South Dinagat and part of Nonoc. However, no detailed petrographic and ore microscopic/mineragraphic studies was conducted by the company in the area except those of the Bureau of Mines.

5.1.2.4 Various Thematic Maps covering the Target Area

Land use map
Geomorphologic features
Hydrogeologic map
Slope map
Predicted Erosion map
Historical tsunami events

5.1.2.5 Estimated Cost

The cost for conducting laboratory analyses (petrographic and mineragraphic) for 30 samples will be about P 30,000.00.

5.2 Reconnaissance/Regional Survey or Studies

Reconnaissance mapping will be conducted in South Dinagat and portions of Parcel – II . Since limited information on the mineralization is available within this area, a reconnaissance mapping and sampling will be conducted to define the economic potential of the area.

5.3 Semi-detailed Survey or Follow-Up Studies

Right after the reconnaissance survey is conducted, when potential mineralization is identified, a follow-up survey will be undertaken. This includes a 100-m to 50 m. grid drilling.

5.4 Topographic Survey

5.4.1 Coverage

The survey will cover South Dinagat areas and portions of Parcel - II.

5.4.1 Scale and contour intervals

The scale of the maps that will be produced is 1:5,000 and with contour interval of 5 meters.

5.4.2 **Manpower complements**

Manpower will be provided by PNPI survey team.

5.4.3 **Output**

Tidal computations, leveling computations and maps with CD ROM.

5.5 **Detailed Survey**

The in-fill drilling of 50m x 50m and 100 m. x 100 m. grid survey will be conducted in Area – B South Dinagat and Area – E, South Dinagat respectively where potential economic mineralization was already identified by previous test pitting program.

5.5.1 **Subsurface Investigation**

5.5.1.1 **Drilling and Test Pitting**

5.5.1.1.1 Type

Drilling by Yoshida Boring Machine (YBM) with diamond and tungsten carbide bits with a core diameter of 2 inches will be used during this detailed stage.

Test pitting will be conducted in selected drill stations. The objective for the test pit is to get the bulk density/moisture content per cubic meter aside from getting its assay values through channel samples. Mapping of the test pit is important in getting the composition of the underlying laterite materials as well as to get the true contacts of the limonite, transition and saprolite zones and the bedrock.

5.5.1.1.2 **Number and depth (Attachment "A")**

5.5.1.1.3 **Estimated number of samples (Attachment "A")**

5.5.1.1.4 **Mode of analysis/target elements**

Atomic Absorption Spectrophotometry (AAS)
Elements : Ni, Co, Fe, Mg

5.5.1.1.5 **Costs (Attachment "B")**

5.5.1.2 **Tunneling or Aditting**

Not applicable

6 **Total Exploration Cost (Attachment "B')**

7 **Schedule of Activities (Attachment "C")**

8 **Map Attachments**

Topographic map showing exploration areas

9 **Signature of proponent or person preparing the exploration work program, please specify PRC License and PTR numbers.**

VICTORIANO C. NUÑEZ
PPC / PNPI OIC Plantsite and Minesite
Registered Mining Engineer
PRC No.: 1216
PTR No. 0513526X
Date Issued : 1 – 18 - 02
Place Issued : Surigao City

PACIFIC NICKEL PHILIPPINES, INC.

ATTACHMENT " A "

2 YEAR EXPLORATION WORK PROGRAM
South Dinagat Area
(No. of Drill Holes and Depth)

Exploration Area	Activity	No. of Units	Resouce Classification	Area Covered	Drill Interval	Target Drill Holes	Target Meterage	No. of samples	Average Drilling	Projected Completion
									Adv/day / unit	(Months)
Area - B South Dinagat	YBM Drilling	3	Measured Resource	160	50 m. x 50 m.	500	10,000	10,000	8.0 meters	16
Area - E South Dinagat	YBM Drilling	3	Indicated Resource	300	100 m. x 100 m.	250	50,000	50,000	8.0 meters	8
TOTAL		3		460		750	60,000	60,000		24

CONSIDERATIONS :
1. Drill holes are selected based on topograpy (flat to moderate slopes)
2. Average 20 meter / drill hole
3. Hectarage based on 0.9 % Ni cut off

PACIFIC NICKEL PHILIPPINES, INC.

2 YEAR EXPLORATION BUDGET

ATTACHMENT " B "

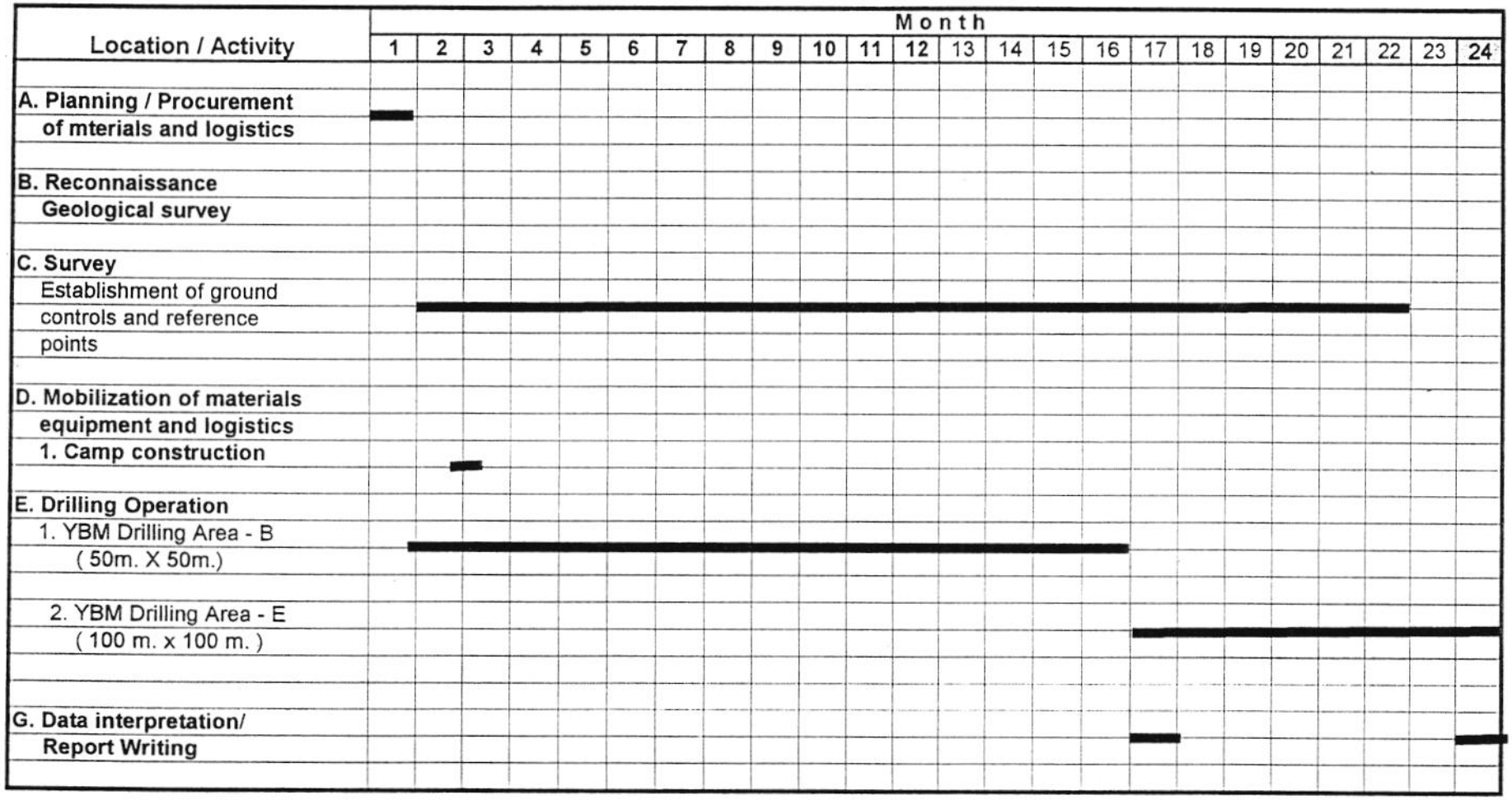
North Dinagat Mining Area- Parcel - III

COST CENTERS	Project Area	Year - 1	Year - 2	TOTAL
A. DRILLING OPERATION				
1. Salaries and Wages	**Area - B and E,**			
1.1 Basic Salaries	**South Dinagat**	1,237,560.00	1,237,560.00	2,475,120.00
1.2 Direct Wage Related Costs		222,761.00	222,761.00	445,522.00
1.3 13th Month Pay		103,130.00	103,130.00	206,260.00
Sub - Total		**1,563,451.00**	**1,563,451.00**	**3,126,902.00**
2. Materials and Supplies				
2.1 Fuel and Lubricants		922,331.00	922,331.00	1,844,662.00
2.2 Supplies and Materials / Medicines		129,648.00	96,698.00	226,346.00
2.3 Drilling Equipment Maintenance parts		180,000.00	180,000.00	360,000.00
Sub - Total		**1,231,979.00**	**1,199,029.00**	**2,431,008.00**
3. Services				
3.1 Assaying Charges		842,400.00	842,400.00	1,684,800.00
3.2 Transport and Travel (staff)		100,000.00	100,000.00	200,000.00
3.3 Bulldozer Access Road Piloting Cost		80,000.00	80,000.00	160,000.00
Sub - Total		**1,022,400.00**	**1,022,400.00**	**2,044,800.00**
4. Total		**3,817,830.00**	**3,784,880.00**	**7,602,710.00**
Add: 10% Contingency		**381,783.00**	**378,488.00**	**760,271.00**
Total PhP		**4,199,613.00**	**4,163,368.00**	**8,362,981.00**
Total USD (1USD = 50 Php)		**83,992.26**	**83,267.36**	**167,259.62**

PACIFIC NICKEL PHILIPPINES, INC.

ATTACHMENT " C "

2 YEARS EXPLORATION WORK SCHEDULE



PACIFIC NICKEL PHILIPPINES, INC.

SOUTH DINAGAT AREA

Position	Rate	MONTH																								Sub Total
			1		2		3		4		5		6		7		8		9		10		11		12	
Salaries and Wages																										
Drilling																										
Driling Foreman	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	97,200
Dril Operators	5,200	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	187,200
Driler Aide	4,290	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	154,440
Samplers	4,290	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	154,440
Dril Mechanics	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Driver Tractor Operator	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Warehouseman	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Camp Guard	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Cook	4,290	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	102,960
Radio Operator	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Instrumentman	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Survey Aides	4,290	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	102,960
Bulldozer Operator	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	78,000
Carpenter	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Sub-Total			**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	1,237,560
Direct Wage Related Cost			18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563	222,761
13th Month Pay																									103,130	103,130
TOTAL			**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**224,823**	1,563,451

Position	Rate	MONTH																								Sub Total
			13		14		15		16		17		18		19		20		21		22		23		24	
Salaries and Wages																										
Drilling																										
Driling Foremen	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	1	8,100	97,200
Dril Operators	5,200	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	3	15,600	187,200
Driler Aide	4,290	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	154,440
Samplers	4,290	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	3	12,870	154,440
Dril Mechanics	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Driver Tractor Operator	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Warehouseman	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Camp Guard	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Cook	4,290	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	102,960
Radio Operator	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Instrumentman	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Survey Aides	4,290	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	2	8,580	102,960
Bulldozer Operator	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	1	6,500	78,000
Carpenter	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	1	4,290	51,480
Sub-Total			**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	**22**	**103,130**	1,237,560
Direct Wage Related Cost			18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563		18,563	222,761
13th Month Pay																									103,130	103,130
SUB TOTAL			**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**121,693**		**224,823**	1,563,451
TOTAL Php			243,387		243,387		243,387		243,387		243,387		243,387		243,387		243,387		243,387		243,387		243,387		449,647	3,126,902
USD (1USD = 50 Php)			**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**4,868**		**8,993**	62,538

PACIFIC NICKEL PHILIPPINES, INC.

PNPI-EXPLORATION BUDGET
(Detailed costs for drilling supplies)

MATERIAL DESCRIPTION	UNIT	QTY	U/COST	Month												
				1	2	3	4	5	6	7	8	9	10	11	12	Sub Total
Drilling & Sampling Supplies/Food Allow.																
Pentel pen	pc.	120	28	280	280	280	280	280	280	280	280	280	280	280	280	3,360
Engineer's field book	pc.	12	25	150						150						300
Folder ordinary, long	pc.	20	7	70						70						140
Folder ordinary, short	pc.	20	7	70						70						140
Log book	pc.	4	80	160						160						320
Rain coats(jacket and Pant)	pc.	50	350	8,750						8,750						17,500
Rubber boots	pr.	50	250	6,250						6,250						12,500
Skull guards	pc.	21	200	4,200												4,200
Flashlights	pc.	5	50	250												250
Tarpaulin	m.	225	25	5,625												5,625
Water container	pc.	12	100	1,200												1,200
210 l. Empty Drums	pc.	6	500	1,500						1,500						3,000
Gas lantern (Petromax)	pc.	2	1500	3,000												3,000
Safety shoes (staff)	pr.	5	2500	12,500												12,500
Sleeping bag (staff)	pc.	5	1500	7,500												7,500
Plugging tape/ribbon	roll	4	200	400						400						800
Field shoulder bag	pc.	2	200	300												300
Bolo	pc.	10	120	1,200												1,200
Japsaw	pc.	3	150	450												450
Pencil pen and refill lead	pc.	10	120	1,200												1,200
Ball pen	pc.	50	5	125												125
Sample bags	pc.	7800	1	650	650	650	650	650	650	650	650	650	650	650	650	7,800
Hand gloves	pr.	108	15	135	135	135	135	135	135	135	135	135	135	135	135	1,620
Bond Paper A4	reams	12	130	390			390			390			390			1,560
Yellow ruled pad	pad	24	16	96			96			96			96			384
Masking tape	roll	72	24	432			432			432			432			1,728
Packing straw	roll	4	30	60						60						120
Batteries size D	pc.	144	9	108	108	108	108	108	108	108	108	108	108	108	108	1,296
Assorted CW nails	kgs.	20	30	300						300						600
Empty sacks		50	5	25	25	25	25	25	25	25	25	25	25	25	25	300
Medicines, assorted				1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	18,000
Plywood	pc.	20	500	5,000						5,000						10,000
SUB - TOTAL				63,876	2,698	2,698	3,616	2,698	2,698	26,326	2,698	2,698	3,616	2,698	2,698	119,018

PACIFIC NICKEL PHILIPPINES, INC.

MATERIAL DESCRIPTION	UNIT	QTY	U/COST	Month												Sub Total
				1	2	3	4	5	6	7	8	9	10	11	12	
FUEL AND LUBRICANTS																
1. ADF	LITERS	4992	14	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	209,664
2. GASOLINE	LITERS	29952	17.96	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	537,936
3. LUBRICANTS	LITERS	1600	61.20	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
4. KEROSENE	LITERS	1640	13.45	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	30,731
Sub-total				**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**922,331**
SURVEY SUPPLIES																
1. Bob	pc.	5	150	1,000												1,000
3. Hand gloves	pc.	11	15	165					165							330
4. Nails	kg	1	37	1,000					1,000							2,000
5. Bob sharpener	pc	6	350	1,050					1,050							2,100
6. Survey umbrella	pc	2	300	600												600
7. Fiber Glass Mrasuring Tape (100 m.)	pc	2	2300	4,600												4,600
Sub-total				**8,415**	**-**	**-**	**-**	**-**	**2,215**	**-**	**-**	**-**	**-**	**-**	**-**	**10,630**
ASSAYING CHARGES																
Ni, Co, Mg and Fe elements		7906	90	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	842,400
Sub Total				**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**842,400**
DRILL PARTS / SUPPLIES																
				15,000	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**180,000**
BULLDOZER OPERATION FOR ACCESS ROAD PILOTING																
				10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	120,000
TOTAL				**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**120,000**

PACIFIC NICKEL PHILIPPINES, INC.

SUMMARY OF EXPLORATION BUDGET

PARTICULARS	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	
1. Salaries and Wages	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	1,237,560
2. Direct wage Related Cost	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	222,761
3. 13th Month Pay												103,130	103,130
Sub - Total	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	224,823	1,563,451
4. Drilling and Sampling Supplies	63,876	2,698	2,698	3,616	2,698	2,698	26,326	2,698	2,698	3,616	2,698	2,698	119,018
5. Fuel and Lubricants	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	922,331
6.Survey Supplies	8,415	-	-	-	-	2,215	-	-	-	-	-	-	10,630
7. Assaying Charges	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	842,400
8. Drilling Maintenance Supplies	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
Bulldozer Road Piloting Cost	10,000	10,000		10,000	10,000		10,000	10,000		10,000	10,000		80,000
Sub - Total	244,352	174,759	164,759	175,677	174,759	166,974	198,387	174,759	164,759	175,677	174,759	164,759	2,154,379
TOTAL	366,045	296,452	286,452	297,370	296,452	288,667	320,080	296,452	286,452	297,370	296,452	389,582	3,717,829

PACIFIC NICKEL PHILIPPINES, INC.

PNPI-EXPLORATION BUDGET
(Detailed costs for drilling supplies)

MATERIAL DESCRIPTION	UNIT	QTY	U/COST	Month												Sub Total
				13	14	15	16	17	18	19	20	21	22	23	24	
Drilling & Sampling Supplies																
Pentel pen	pc.	120	28	280	280	280	280	280	280	280	280	280	280	280	280	3,360
Engineer's field book	pc.	12	25	150						150						300
Folder ordinary, long	pc.	20	7	70						70						140
Folder ordinary, short	pc.	20	7	70						70						140
Log book	pc.	4	80	160						160						320
Rain coats(jacket and Pant)	pc.	50	350	8,750						8,750						17,500
Rubber boots	pr.	50	250	6,250						6,250						12,500
Tarpaulin	m.	225	25	5,625												5,625
Water container	pc.	12	100	1,200												1,200
210 l. Empty Drums	pc.	6	500	1,500						1,500						3,000
Plugging tape/ribbon	roll	4	200	400						400						800
Bolo	pc.	10	120	1,200												1,200
Japsaw	pc.	3	150	450												450
Pencil pen and refill lead	pc.	10	120	1,200												1,200
Ball pen	pc.	50	5	125												125
Sample bags	pc.	7800	1	650	650	650	650	650	650	650	650	650	650	650	650	7,800
Hand gloves	pr.	108	15	135	135	135	135	135	135	135	135	135	135	135	135	1,620
Bond Paper A4	reams	12	130	390		135	390			390			390			1,560
Yellow ruled pad	pad	24	16	96			96			96			96			384
Masking tape	roll	72	24	432			432			432			432			1,728
Packing straw	roll	4	30	60						60						120
Batteries size D	pc.	144	9	108	108	108	108	108	108	108	108	108	108	108	108	1,296
Assorted CW nails	kgs.	20	30	300						300						600
Empty sacks		50	5	25	25	25	25	25	25	25	25	25	25	25	25	300
Medicines, assorted				1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	18,000
Plywood	pc.	20	500	5,000						5,000						10,000
SUB - TOTAL				**36,126**	**2,698**	**2,698**	**3,616**	**2,698**	**2,698**	**26,326**	**2,698**	**2,698**	**3,616**	**2,698**	**2,698**	**91,268**

PACIFIC NICKEL PHILIPPINES, INC.

MATERIAL DESCRIPTION	UNIT	QTY	U/COST	Month												Sub Total
				13	14	15	16	17	18	19	20	21	22	23	24	
FUEL AND LUBRICANTS																
1. ADF	LITERS	4992	14	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	17,472	209,664
2. GASOLINE	LITERS	29952	17.96	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	44,828	537,936
3. LUBRICANTS	LITERS	1600	61.20	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
4. KEROSENE	LITERS	1640	13.45	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	2,561	30,731
Sub-total				**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**76,861**	**922,331**
SURVEY SUPPLIES																
1. Bolo	pc.	5	150	1,000												1,000
3. Hand gloves	pc.	11	15	165					165							330
4. Nails	kg	1	37	1,000					1,000							2,000
5. Bolo sharpener	pc	6	350	1,050					1,050							2,100
Sub-total				**3,215**	-	-	-	-	**2,215**	-	-	-	-	-	-	**5,430**
ASSAYING CHARGES																
Ni, Co, Mg and Fe elements		7906	90	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	842,400
Sub Total				**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**70,200**	**842,400**
DRILL PARTS / SUPPLIES																
				15,000	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**180,000**
BULLDOZER OPERATION FOR ACCESS ROAD PILOTING																
				10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	120,000
TOTAL COST, PhP				**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**120,000**
																-

PACIFIC NICKEL PHILIPPINES, INC.

SUMMARY OF EXPLORATION BUDGET

PARTICULARS	Month												
	13	14	15	16	17	18	19	20	21	22	23	24	Sub Total
1. Salaries and Wages	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	103,130	1,237,560
2. Direct wage Related Cost	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	18,563	222,761
3. 13th Month Pay												103,130	103,130
Sub - Total	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	121,693	224,823	1,563,451
4. Drilling and Sampling Supplies	36,126	2,698	2,698	3,616	2,698	2,698	26,326	2,698	2,698	3,616	2,698	2,698	91,268
5. Fuel and Lubricants	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	76,861	922,331
6.Survey Supplies	3,215	-	-	-	-	2,215	-	-	-	-	-	-	5,430
7. Assaying Charges	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	70,200	842,400
8. Drilling Maintenance Supplies	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
Bulldozer Road Piloting Cost	10,000	10,000		10,000	10,000		10,000	10,000		10,000	10,000		80,000
Sub - Total	211,402	174,759	164,759	175,677	174,759	166,974	198,387	174,759	164,759	175,677	174,759	164,759	2,121,429
TOTAL	333,095	296,452	286,452	297,370	296,452	288,667	320,080	296,452	286,452	297,370	296,452	389,582	3,684,879
TOTAL (Mos. 1 - 24)	699,141	592,905	572,905	594,741	592,905	577,335	640,161	592,905	572,905	594,741	592,905	779,165	7,402,709
Add : 10% Contingency	69,914	59,290	57,290	59,474	59,290	57,733	64,016	59,290	57,290	59,474	59,290	77,916	740,271
TOTAL Php	769,055	652,195	630,195	654,215	652,195	635,068	704,177	652,195	630,195	654,215	652,195	857,081	8,142,980
TOTAL USD (1 USD = Pnp 50)	15,381	13,044	12,604	13,084	13,044	12,701	14,084	13,044	12,604	13,084	13,044	17,142	162,860