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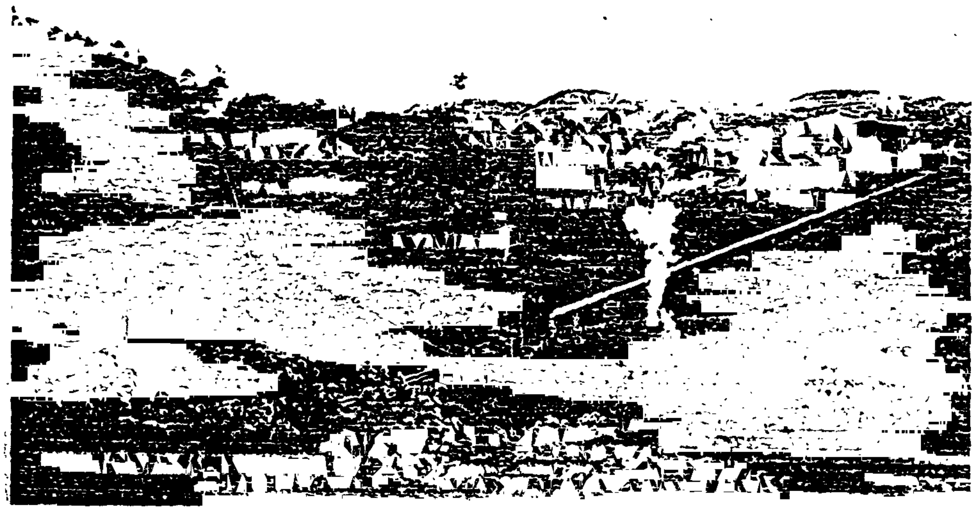
VOL. 3

NORTHERN NEGROS GEOTHERMAL DEVELOPMENT PROJECT

ENVIRONMENTAL IMPACT STATEMENT (VOLUMEII)



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CHAPTER 3.0

BASELINE ENVIRONMENTAL CONDITIONS

3.1 THE LAND

3.1.1 GEOLOGY

3.1.1.1 STRATIGRAPHY

Five (5) stratigraphic units were identified in the areas surrounding Canlaon volcano, based on pertinent geologic information obtained from the Philippine National Oil Company- Energy Development Corporation (PNOC-EDC), the Mines and Geosciences Bureau (MGB) and the Philippine Institute of Volcanology and Seismology (PHIVOCS). These ranged in age from Cretaceous to Recent. **Figs. 3.1.1 and 3.1.2** show the composite stratigraphic columns, including their distribution and relative age.

Only the volcanic rocks are exposed in the immediate area of the proposed geothermal development project. However, older sedimentary rocks have been encountered during the drilling of test wells MC-1 and MC-2 by PNOC in 1978 and 1979. The test wells reached depths of 1,220 meters (m) and 1433.4 m, respectively. These formations are correlative to the rock formations exposed in northeastern Negros.

A. Basalt Formation (Bf)

This rock formation lies in the eastern portion of Northern Negros. It consists of thick, interbedded sequences of basalt and clastic sedimentary rocks. The sedimentary rocks are composed of mudstones, claystones and fine conglomerate. Pillow lava structures, columnar joints and layering are common in this volcanic section. The clastic rocks are highly indurated.

B. Hagdan-Mainit Block

This block includes the Hagdan Hardin sang Balo crater and the Mainit hot springs to the east. It has a width of 2.0 to 3.0 km. Three (3) long E-W lineaments, spaced at less than two (2) km. characterize this block. The Initihan fault is one of the more prominent lineaments.

C. Hardin-Saray Block

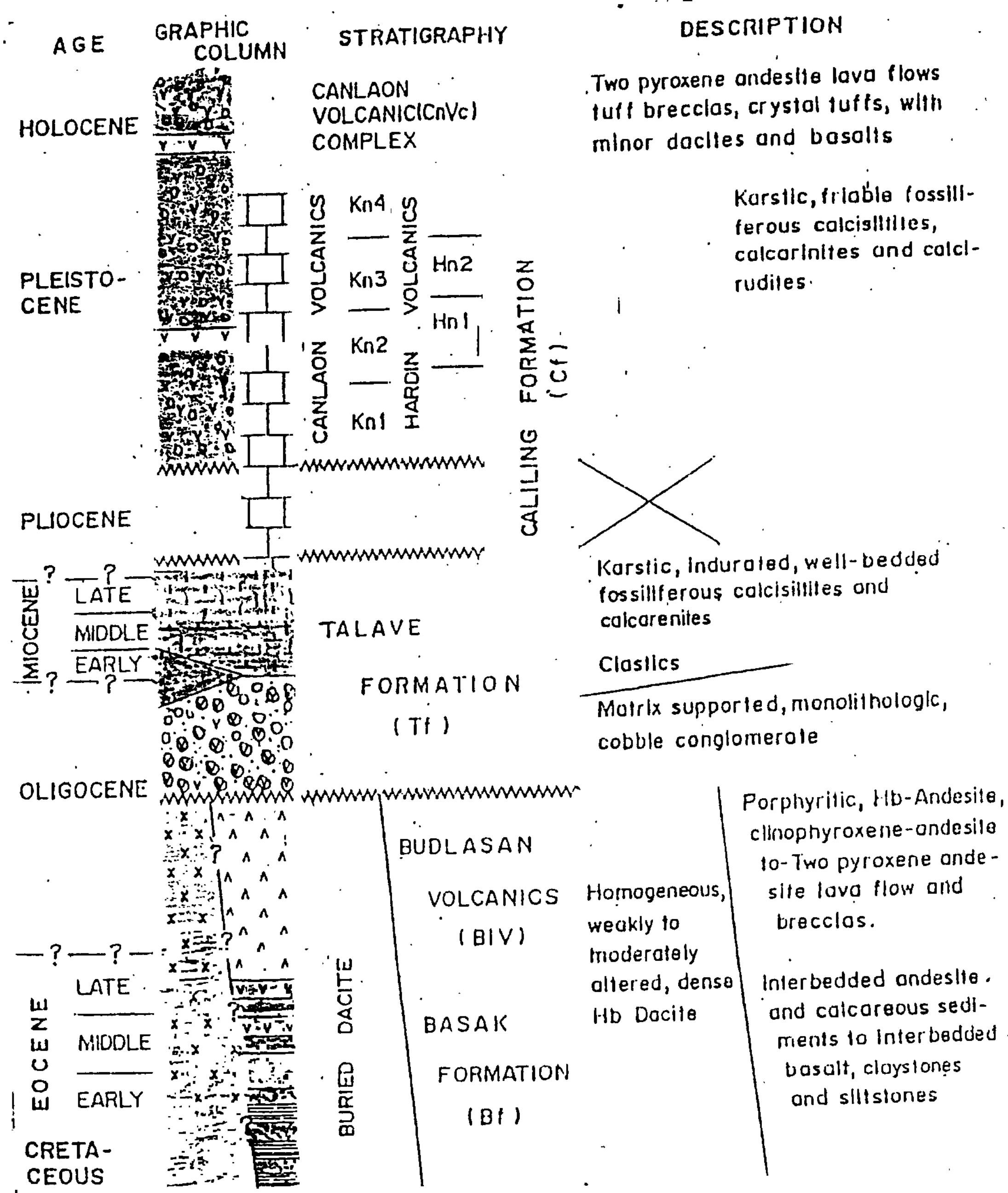
This block is not as well-defined as the other two (2). In fact, it apparently terminates at the Hagdan-Mainit block. From this point, the block extends toward the north to Bago River.

While this lineament block may seem minor compared with the other two (2), a PNOC geologist has suggested that the crater distribution of Canlaon volcano may have been controlled by N-S/NNE lineaments and that these lineaments may be older and more deeply seated than the other sets.

3.1.1.3 HYDROLOGY OF GEOTHERMAL AREAS

The hydrology of the geothermal system is strongly influenced by the existing lineament blocks and their stratigraphy. Ground water of meteoric origin percolate to greater depths through the fracture openings around the lineaments. In addition, part of the water flowing through the porous and permeable sedimentary rocks of the Talave formation join the percolating water from the fractures. These waters are heated beneath Mt. Canlaon and flow upward along the NW/NNW lineaments towards Mambucal, Kinabkaban and Hagdan (Fig. 3.1.5).

Analyses of the drilling results of MC-1 and MC-2 suggest that the heat source is located beneath the craters of Hardin sang Balo, Makawili, Margaha and the active Canlaon



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

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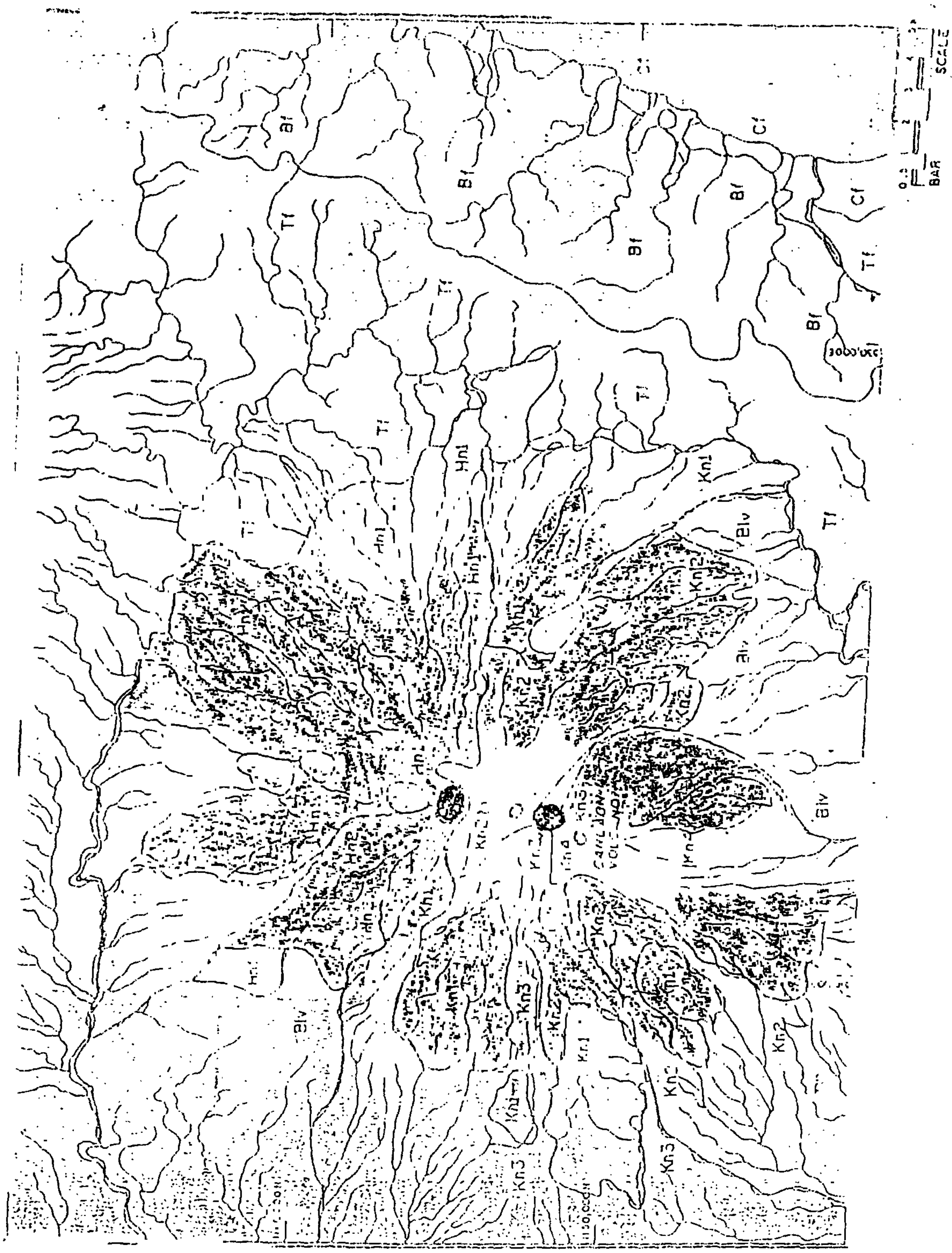
TITLE:
Local Stratigraphy Beneath
Mt. Canlaon Volcano.

FIG. 3.1.1



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
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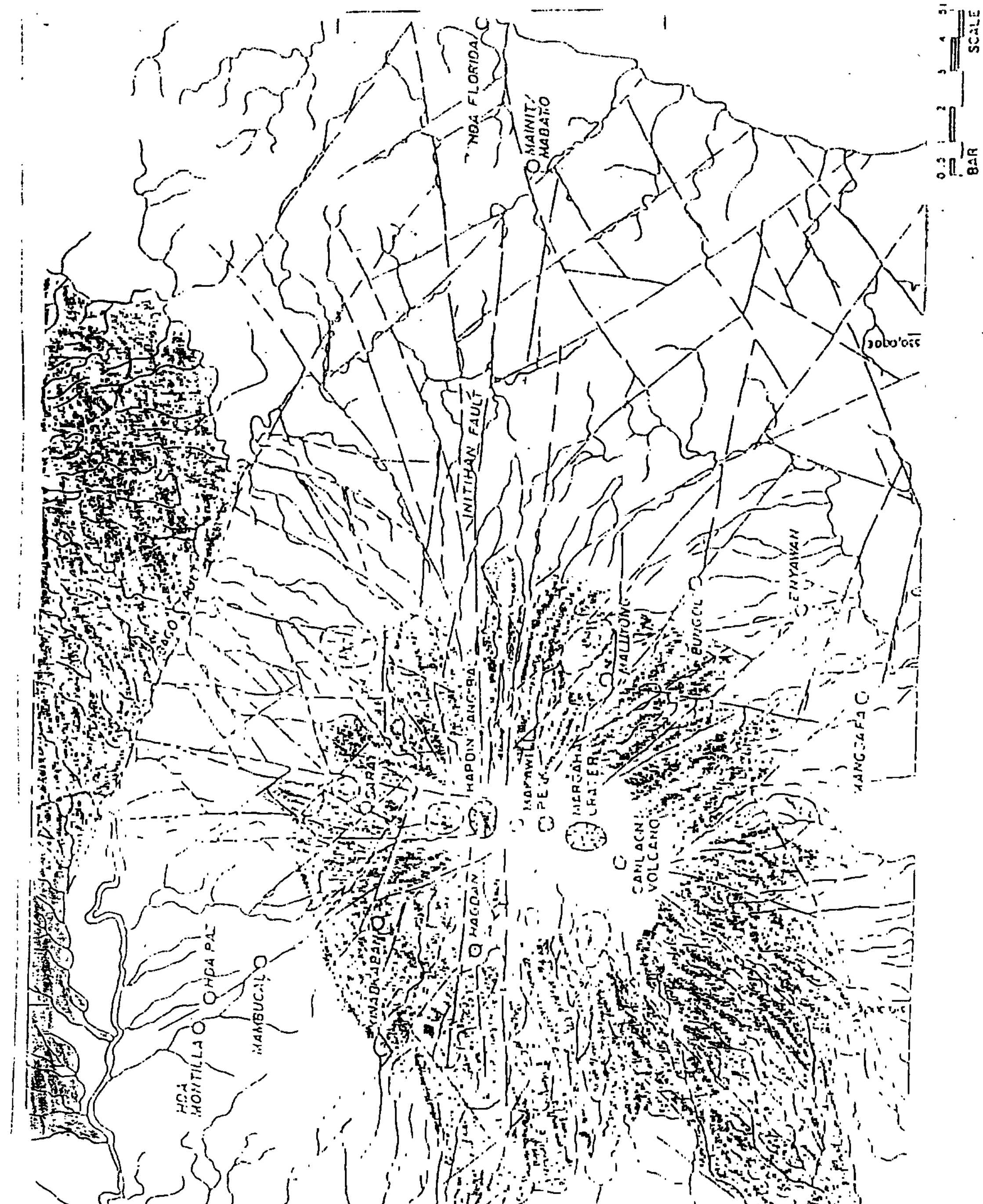
TITLE:
Surface Distribution of Rock Units Around Canlaon Volcano

FIG. 3.1.2

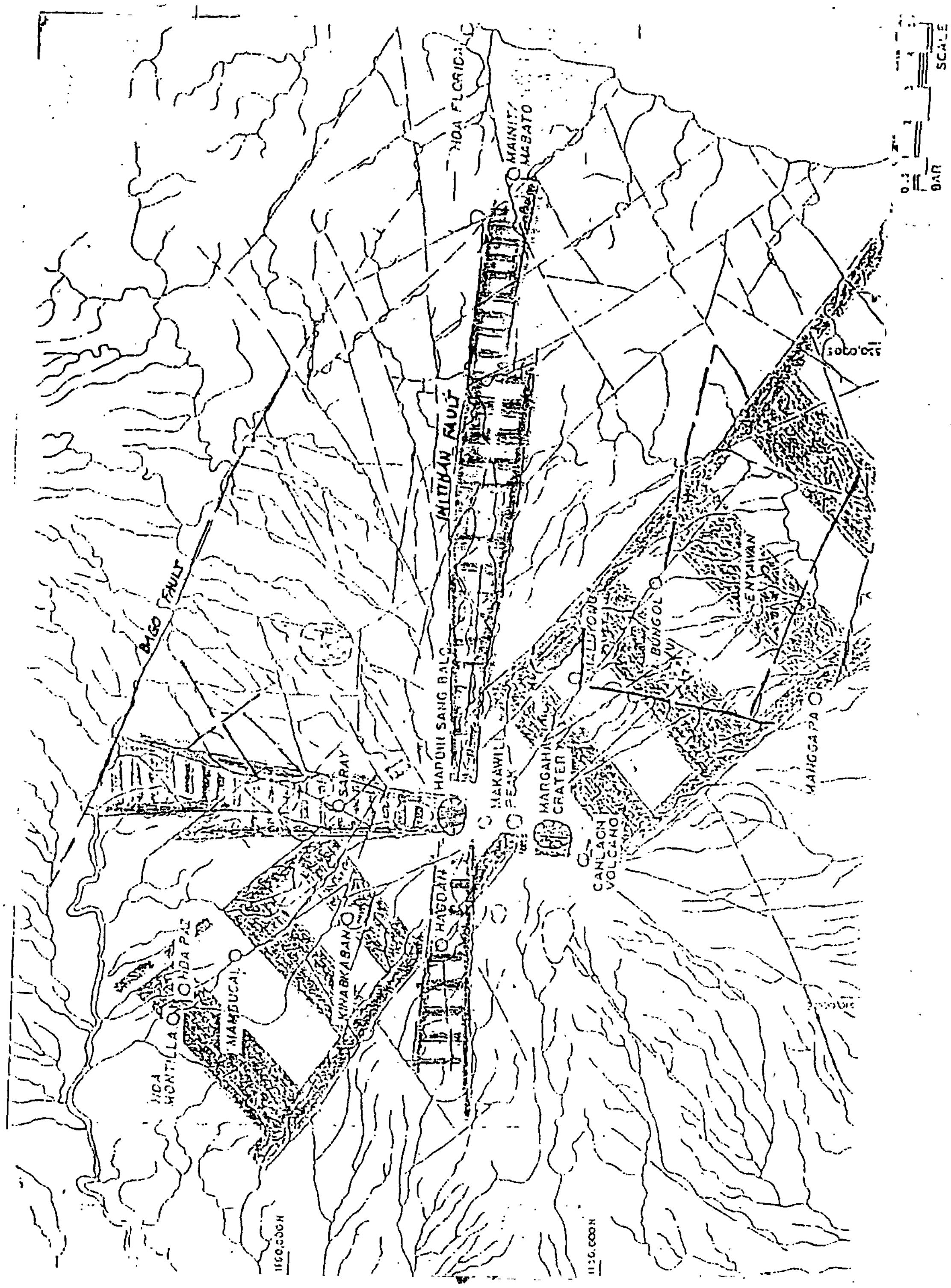


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Distribution of Lineaments, Craters, Springs and Domes Around Canlaon Volcano

FIG. 3.1.3



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Blocks Defined by Lineaments
At Canlaon Volcano

FIG. 3.1.4

A 108-m section of the Basak formation was drilled for MC-1 at a depth interval of -610 to -718 MSL. This section consisted of andesitic rocks and some calcareous sedimentary rocks. The slight difference in composition between this section and the exposed rocks in the type locality may be attributed to a shift in volcanic activity from basaltic to andesitic and to the shoaling of the basin of deposition.

The MGB has dated the Basak formation as belonging to the Cretaceous to Paleocene age. Recent studies by PNOC suggest that this rock formation may span even up to the Late Eocene age.

B. Budlasan Volcanics (Blv)

The Budlasan volcanics is found in a plateau southeast of Mt. Canlaon. It ranges in composition from hornblende andesite to pyroxene andesite. It also exhibits well developed columnar jointing.

Rocks showing similar characteristics have been encountered during the drilling for MC-1 at a depth interval of -406 to -610 MSL. This section consists of porphyritic pyroxene andesite with some intercalated volcanic breccia.

No conclusive dating of this rock type has been done. However, based on its relative position with respect to the Basak formation, the Budlasan volcanics may belong to the Oligocene age.

C. Dacite Dome

A light green dacitic unit has been found at a depth of 650 m in MC-2 and this persists up to the end of the test well. There being no apparent intrusive contact with the overlying volcanic rocks, this unit may be considered as a buried dome.

D. Talave Formation (Tf)

The Talave formation is composed of three (3) lithologic members. The basal portion consists of massively bedded cobble conglomerate. The coarse fragments are similar to the Budlasan volcanics and are embedded in a tuffaceous silty and sandy matrix. The age of the basal portion is uncertain.

The upper limestone member consists of well-bedded and indurated calcareous siltstone and sandstone. They form karst topography with low knobby hills.

The middle member, which was identified by the MGB, has not been observed in the area immediately surrounding Mt. Canlaon.

The calcareous clastics and limestone in MC-1 and the volcaniclastic conglomerate and limestone in MC-2 are highly similar to the Talave formation and therefore can be assumed to be part of the same formation. Paleontologic analyses of the rock samples suggest that the limestone member may belong to the Early Miocene to Pliocene era.

Thus, based on various paleontologic analyses, the Talave formation has been estimated to be of the late Eocene to Pliocene age.

E. Canlaon Volcanic Complex

This formation includes all the extrusive rocks derived from the volcanoes of Cuernos de Negros, Silay, Mandalagan and Canlaon.

The deposits belonging to the Canlaon volcanic complex generally consist of pyroxene andesite lava flows and tuffs, with occasional basalt and dacite. PNOC has created a further subdivision of the volcanic complex according to the vent areas of the deposits. These cover the ancient Canlaon crater, Makawili peak, Hardin sang Balo crater and the Margaha crater.

Based on their studies, PNOC has concluded that the development of the Canlaon volcan involved a generally southward trend of volcanic activity.

F. Alluvium

Weathering and erosion of the exposed rock formations permitted the deposition of clay, silt, sand and gravel along the major river channels and at the coastal areas of Negros island. The loosely meshed sediments cover the pyroclastic rocks at lower elevations.

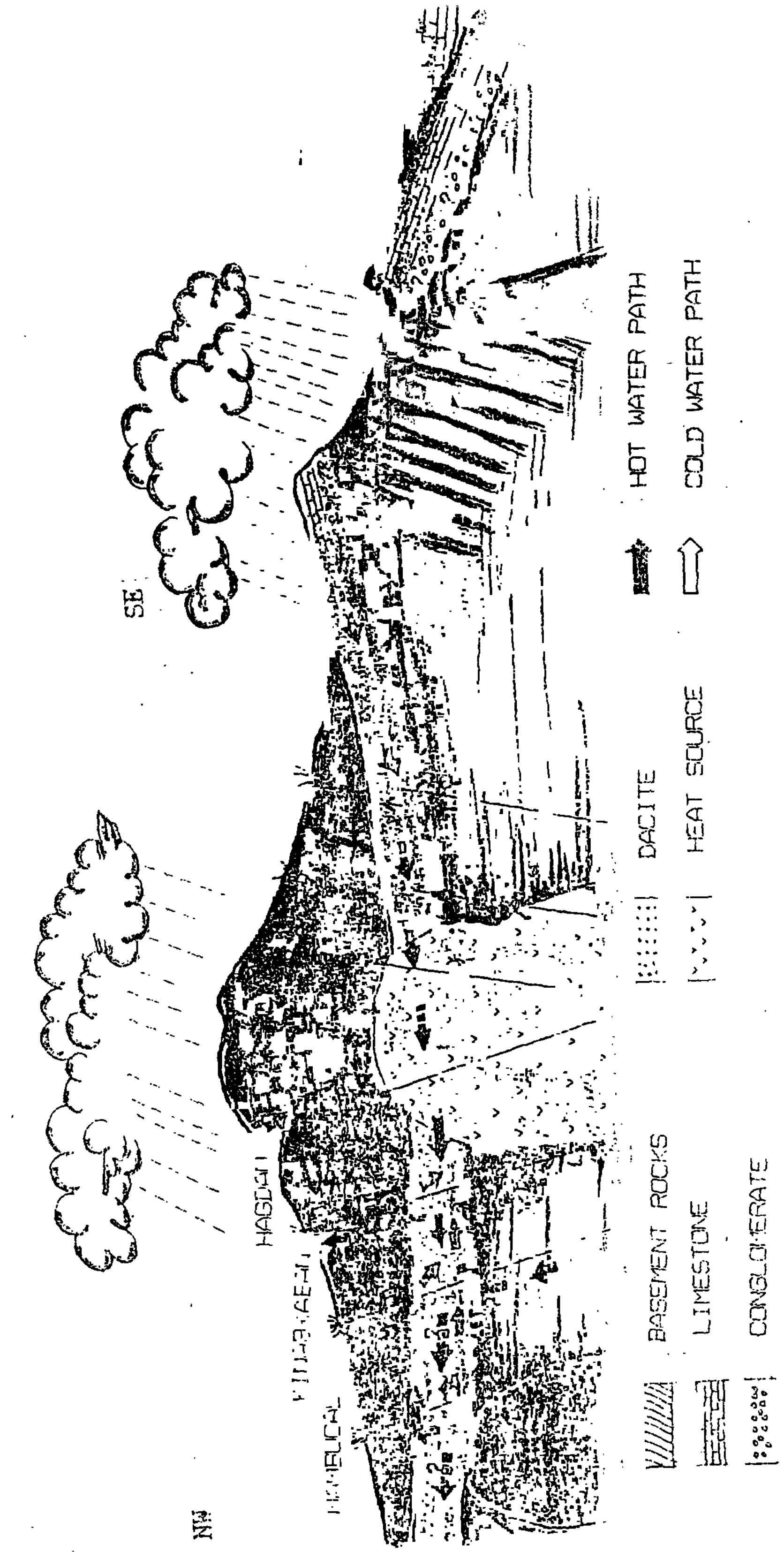
3.1.1.2 GEOLOGIC STRUCTURES

Aerial photoanalysis revealed numerous lineaments around Mt Canlaon, which initially appear as fractures radiating from the Canlaon crater. A closer examination indicated that the lineaments emanated from four (4) distinct trends, namely, the northwest/north northwest (NW/NNW), east-west (E-W), north-south/north northeast (N-S/NNE) and NE lineaments (**Fig. 3.1.3**). The first three (3) define the blocks which significantly influenced the development of geothermal areas around Canlaon volcano.

PNOC has suggested three (3) lineament blocks, designated as the Mambucal-Bucalan, Hagdan-Mainit and Hardin-Saray blocks (**Fig. 3.1.4**).

A. Mambucal-Bucalan Block

This block, which has a width of 4.0 to 6.0 kilometers (km.), is highly relevant in the geological discussion since two (2) of the proposed exploration wells are situated within this block. The northwesterly lineaments within the block are closely spaced and appear to be continuous laterally, even truncating some of the N-E and N-S lineaments These extend from Bago River, northwest of Mambucal, to Bucalan in a southeasterly direction.



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC

TITLE:

Geological, Hydrological Model of Mt. Canlaon

FIG. 3.1.5

crater. PNOC and KRTA geologists have speculated that the heat source of the geothermal system is related to the Canlaon volcano, but not necessarily beneath it.

3.1.1.4 SEISMIC AND VOLCANIC HAZARDS

A. Earthquakes

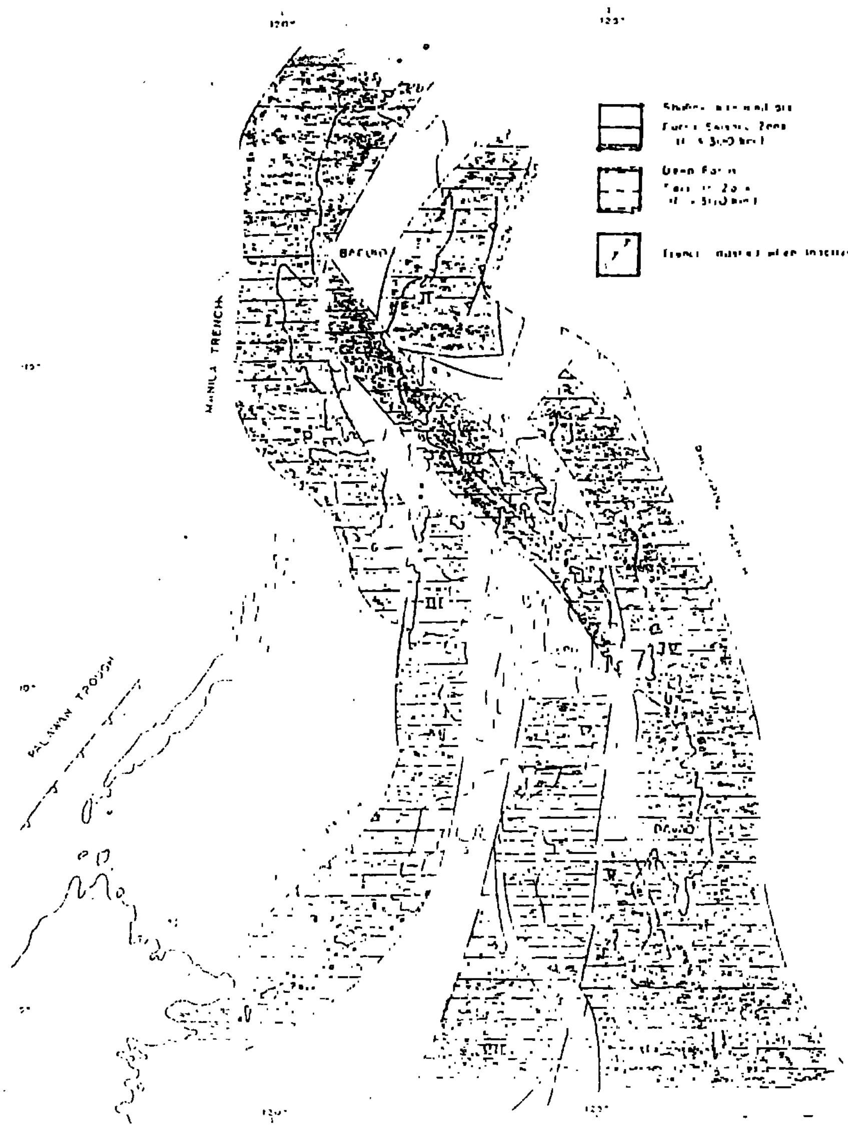
The Philippines is situated along the Circum-Pacific Seismic belt where more than 80% of earthquakes occur and where the more active volcanoes are located. Thus, the development of geothermal areas - which are generally located near active seismic or volcanic zones - may cause concern among the proponents of such projects and the people residing in the immediate vicinity, in case volcanic activity or earthquakes damage the geothermal facilities

It can be observed from **Fig. 3.1.6**, which delineates the seismic zones in the Philippines, that northern Negros is not within any active zone. The nearest seismic zone, Zone III, is viewed as related to the subduction along the Sulu Sea trench and the Antique trough. It can be said that northern Negros is located in a comparatively quiet area.

The same conclusion may be derived from **Figs. 3.1.7** and **3.1.8**. These figures show the distribution of shallow and deep focus earthquakes in the Philippines. Shallow focus earthquakes have occurred only in the sea southwest of Negros island. Only one (1) deep focus earthquake has been recorded near Canlaon volcano. However, the epicenter of that earthquake was determined to be in Guimaras Strait. Not one (1) epicenter has been identified in the entire island of Negros.

B. Volcanic Hazards

Plinian and phreatic type eruptions of the Canlaon volcanoes produced thick deposits of pyroclastic rocks, volcanic ash, lahars and lava flows in northern Negros Island. The



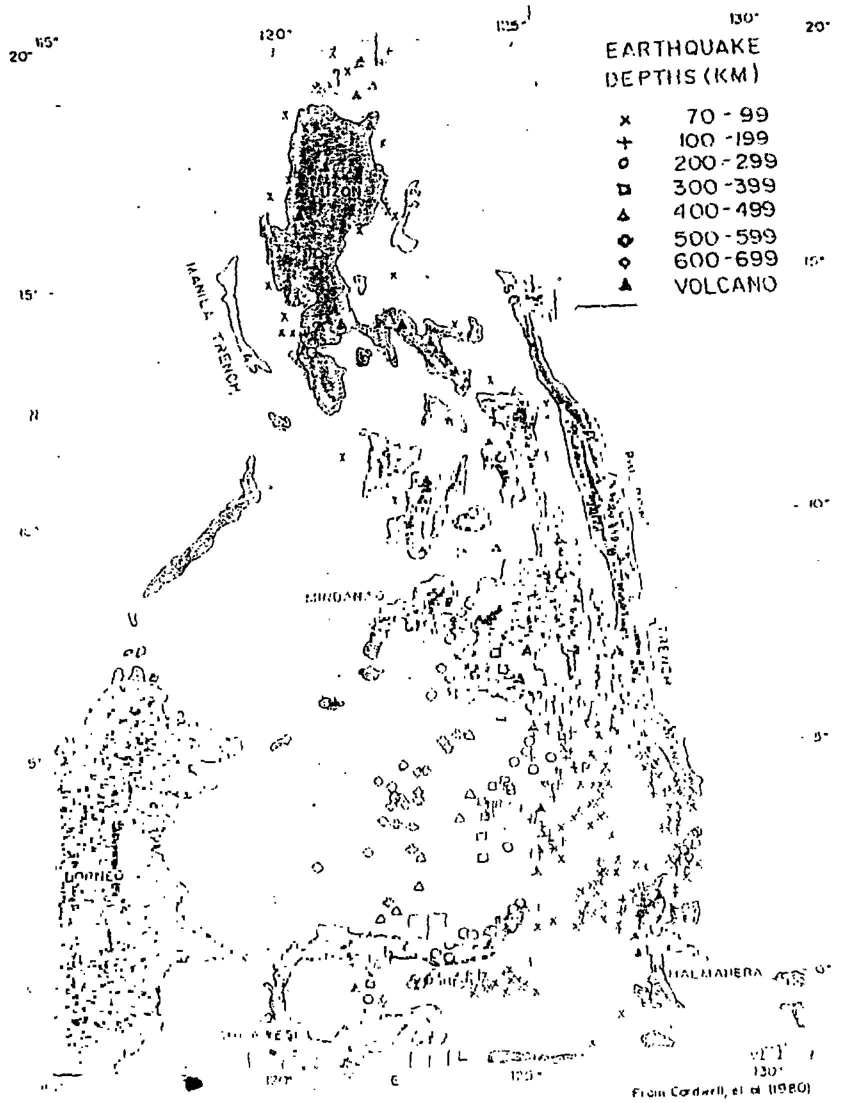
SOUTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Seismic Zones in the Philippine Archipelago

FIG. 3.1.6

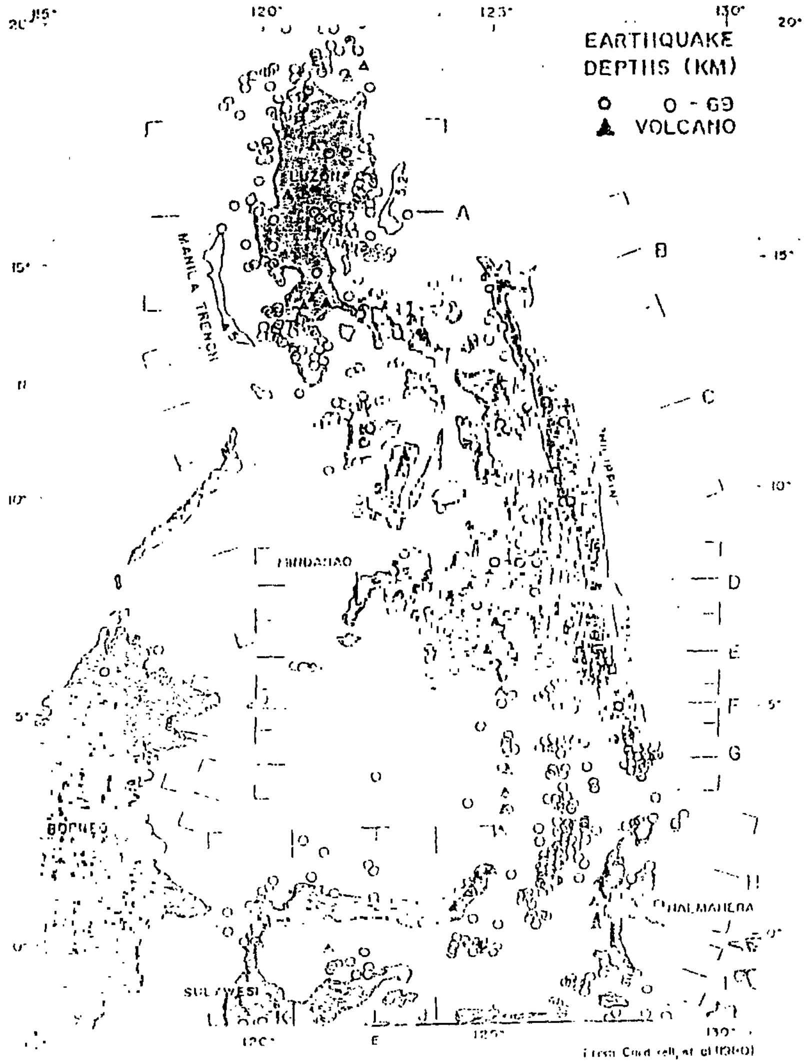


NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
DEVELOPMENT INC.

TITLE:
Map Showing Distribution of Intermediate and Deep Focus Earthquakes

FIG. 3.1.8



NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Map Showing Distribution
of Shallow Focus Earthquakes

FIG. 3.1.7

recorded eruptions since 1866 have been described as mild, protracted, low volume ash ejections except for the 1902 eruption when lava was possibly discharged.

Based on their studies, Punongbayan and Tilling (1989) established the areas around Canlaon volcano that may be affected by lava and pyroclastic flows, ash clouds, ballistic bombs and lahars during intense volcanic activities. These areas are shown in **Figs. 3.1.9, 3.1.10** and **3.1.11a** and **b.**

C. Airfall Tephra

Ash ejections from Canlaon volcano will generally affect the northeastern and southeastern slopes of Canlaon volcano, depending on the prevailing wind direction. However, the northwestern and western slopes where the proposed geothermal projects are located may be affected if the eruption occurs during the months of February to April when the east and southeast trade winds prevail. Other sectors may also be slightly affected by ash ejections regardless of the prevailing wind direction.

D. Ballistic Projectiles

Areas within a six (6)-km. radius from the active crater are considered as high risk areas for ballistic projectiles. Mambucal and Kinabkaban are relatively safe from these projectiles since they are located about 12 km. and eight (8) km., respectively, from the crater. However, the Hagdan area, being only seven (7) km. away, may probably be affected by such eruptions (**Fig. 3.1.9**)

E. Lava Flows

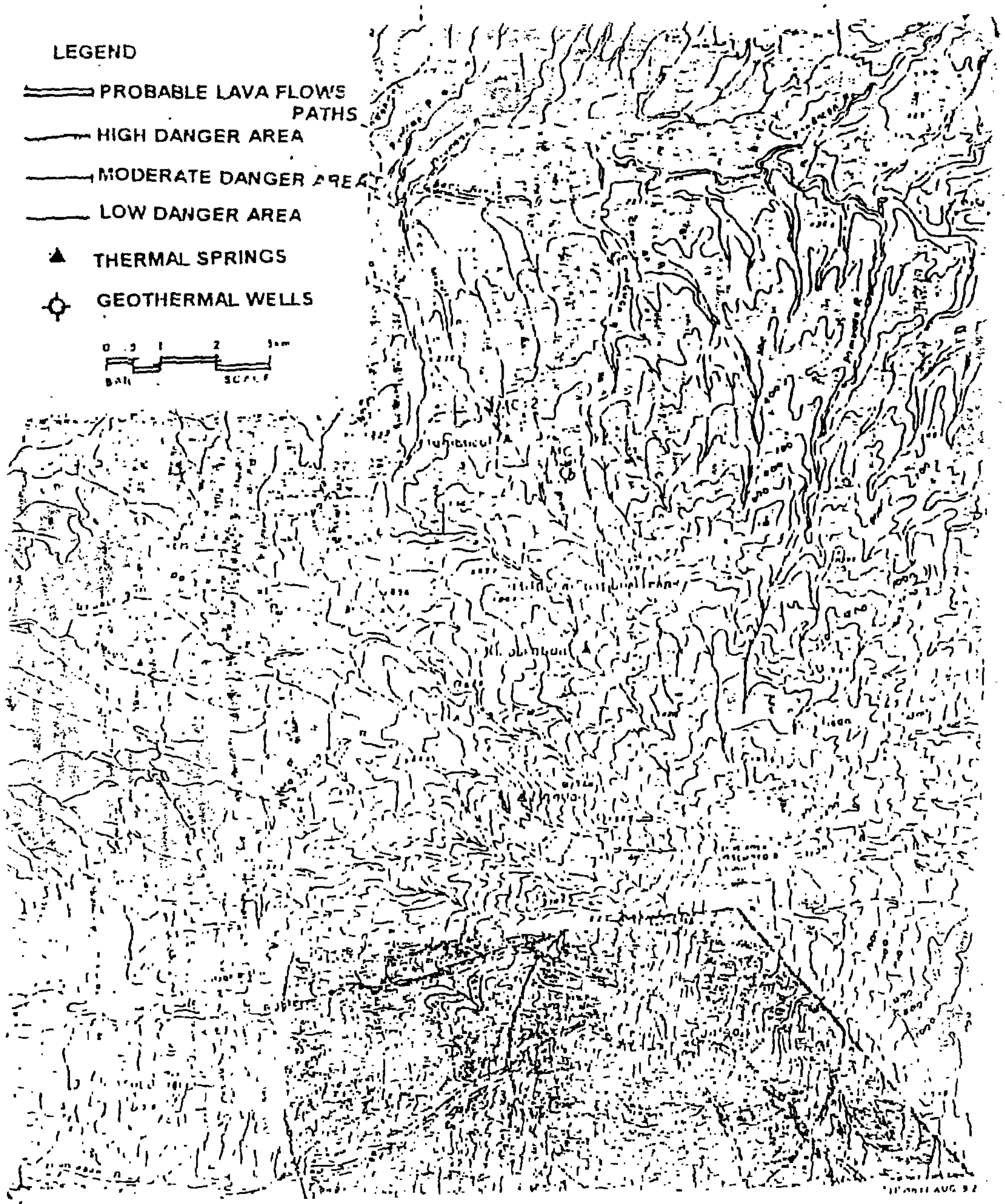
Lava flows will be confined mostly to the drainage channels along the western, southern and southeastern slopes of the active crater. The geothermal areas in the Mambucal, Pataan and Hagdan areas are outside the defined danger areas for lava flows (**Fig. 3.1.10**).

F. Pyroclastic Flows, Surges, and Ash Clouds

The drainage lines on the western, southern and southeastern slopes of the crater will be susceptible to damage by pyroclastic flows and surges. The Pataan and Hagdan areas may be shielded by the Tubidiao mountain range from pyroclastic flows, but they can still be affected by surges and ash clouds. Mambucal lies outside of the probable areas which may experience surges and ash clouds (**Fig. 3.1.11a**)

G. Lahars and Floods

All the drainage systems originating from Mt. Canlaon may suffer from lahar flows. Damage may occur whenever a large volume of loose pyroclastic materials from a major eruption accumulates near the summit. Maximum lahar activity may occur during the months of May to November, which correspond to the rainy season (**Fig. 3.1.11b**).

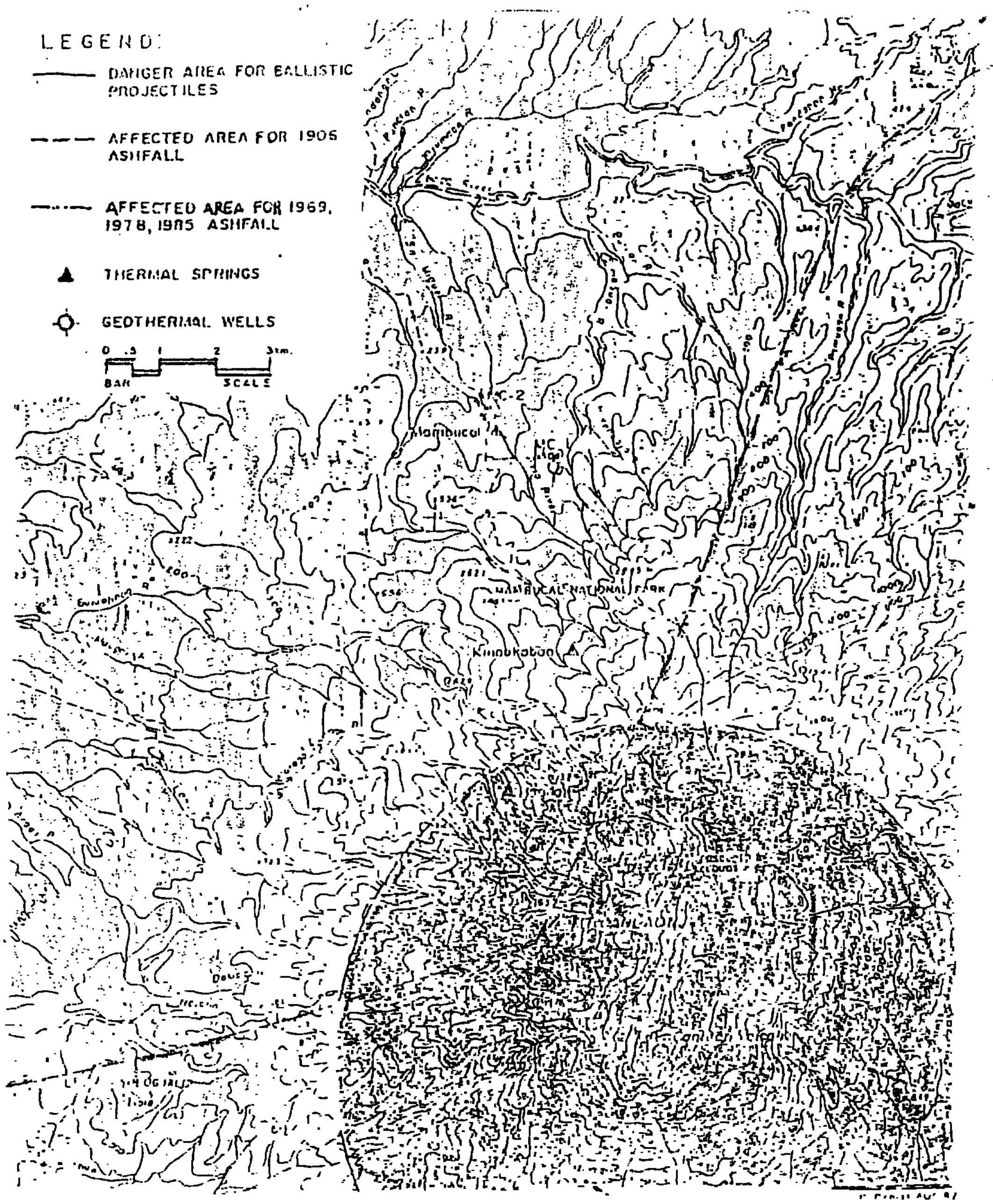


NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY
UNITED ASIAN
DEVELOPMENT INC.

TITLE:

Hazard Map for Lava Flows

FIG. 3.1.10



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...DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Danger Areas for Ballistic
Projectiles and Airfall Ash

FIG. 3.1.9

3.1.2 PEDOLOGY AND LAND USE

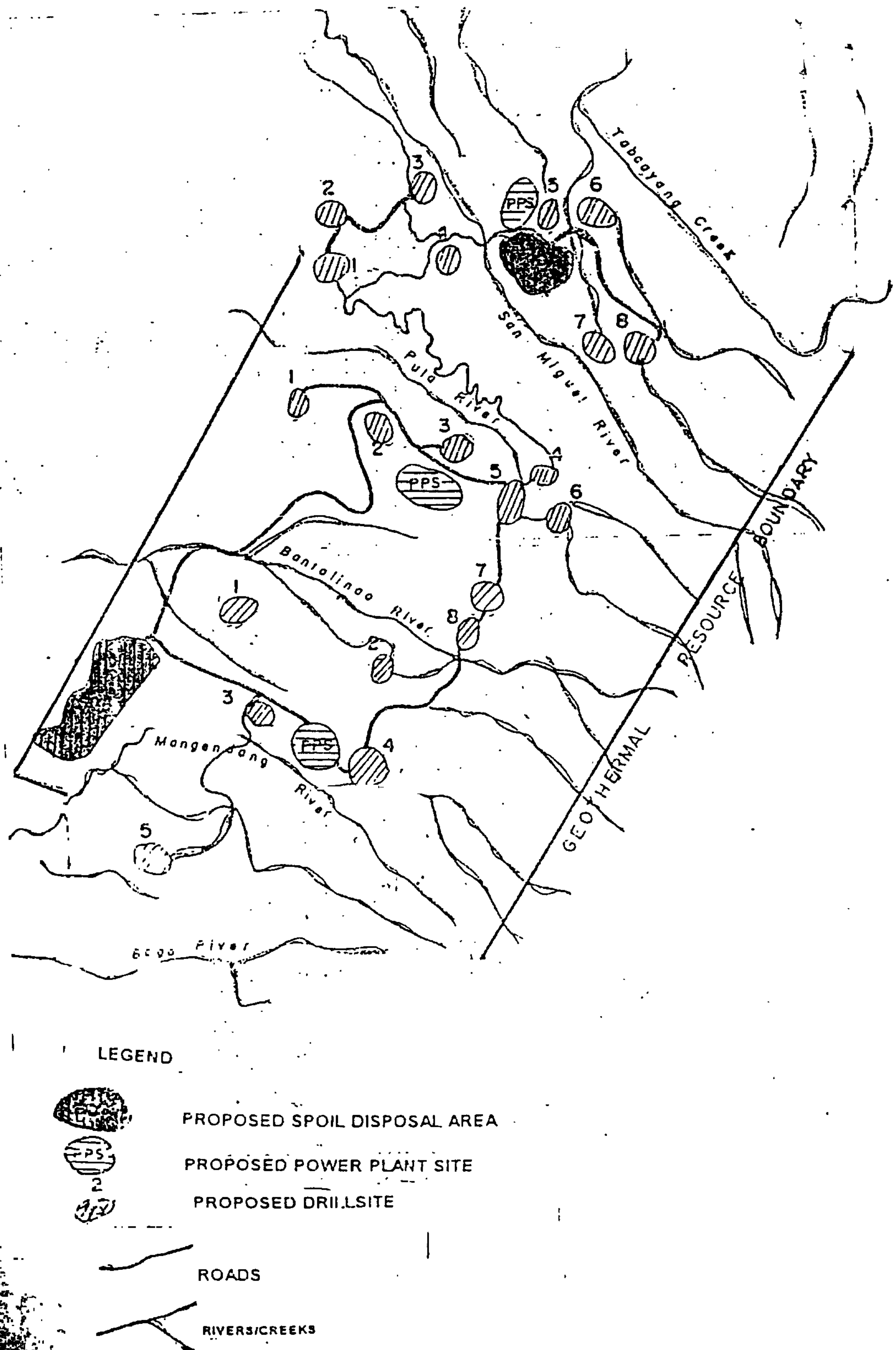
3.1.2.1 METHODOLOGY

A. Delineation of Bago River Sub-Watershed and its tributary watersheds corresponding to the different development areas for each site.

In order to determine the importance of pedology and land use, a well defined sub-watershed and its tributary watershed was segregated and delineated based on the natural boundaries of each drainage area (**Fig. 3.1.12**). The tributaries on drainage areas that may be affected by construction works were classified as direct, through bulldozing, and indirect, by erosion overburden or silt deposition and land use changes. Direct impact areas refer to tributary watersheds whose physical and geological setting will be significantly influenced by the development of the geothermal areas. The indirect impact areas are tributary watersheds closely adjacent to the lower portion of the primary impact zones and connected to all creeks and rivers where runoff water from the development areas are drained. The impact area for pedology is presented in **Fig. 3.1.13**.

B. Assigning number to individual drill site

To facilitate location-specific discussions, each probable drill site was assigned a number to be used as reference in characterizing the different environmental conditions in areas where the drill sites are located. The assigned number for each drill site was further based on the location and arrangement in each development site and was not necessarily given or made by PNOC. The reference number for each drill site is presented in **Fig 3.1.14**.



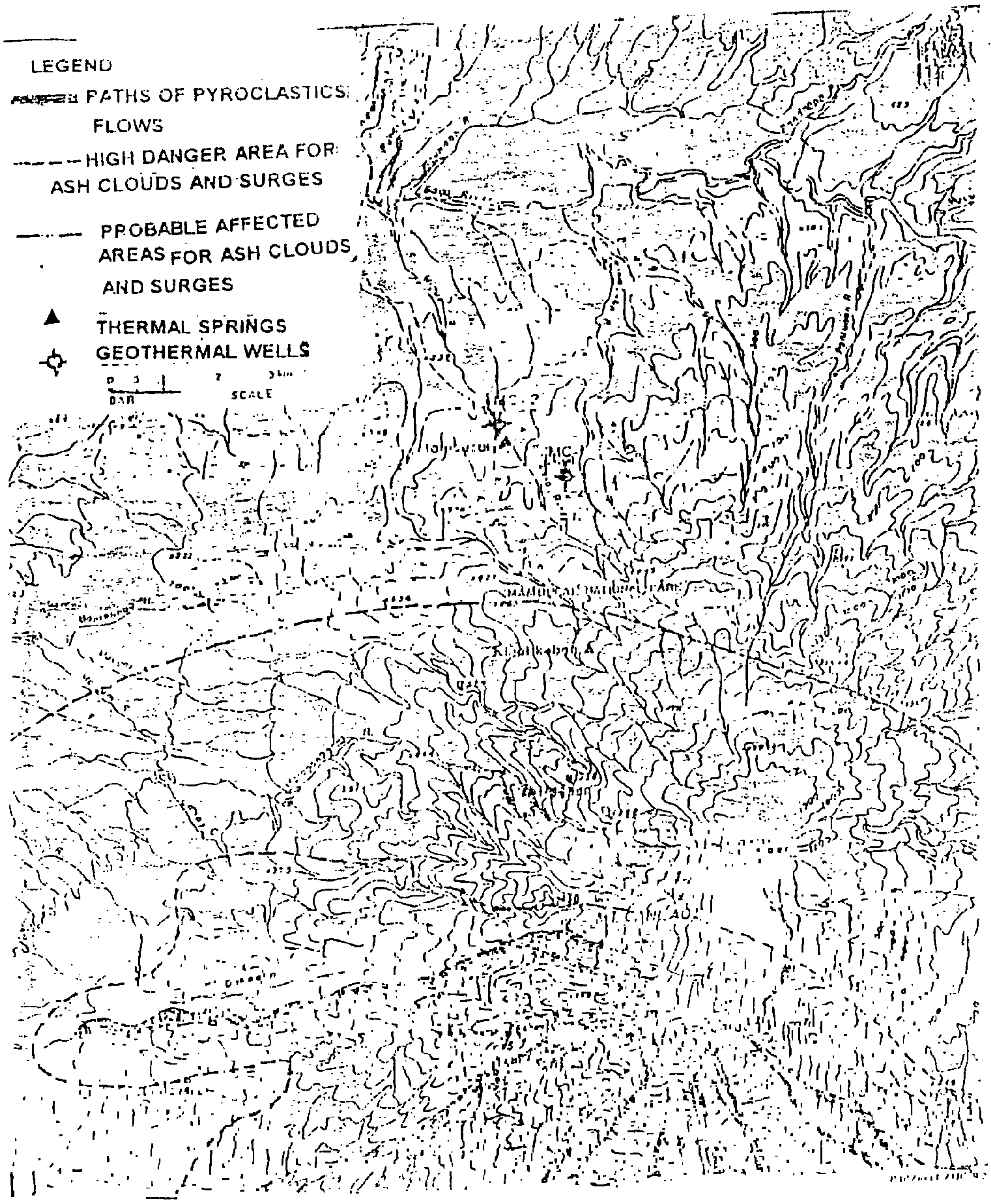
SOUTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Individual drill site map

FIG. 3.1.14



NEGROS GEOTHERMAL POWER
VELOPMENT PROJECT
EIA STUDY

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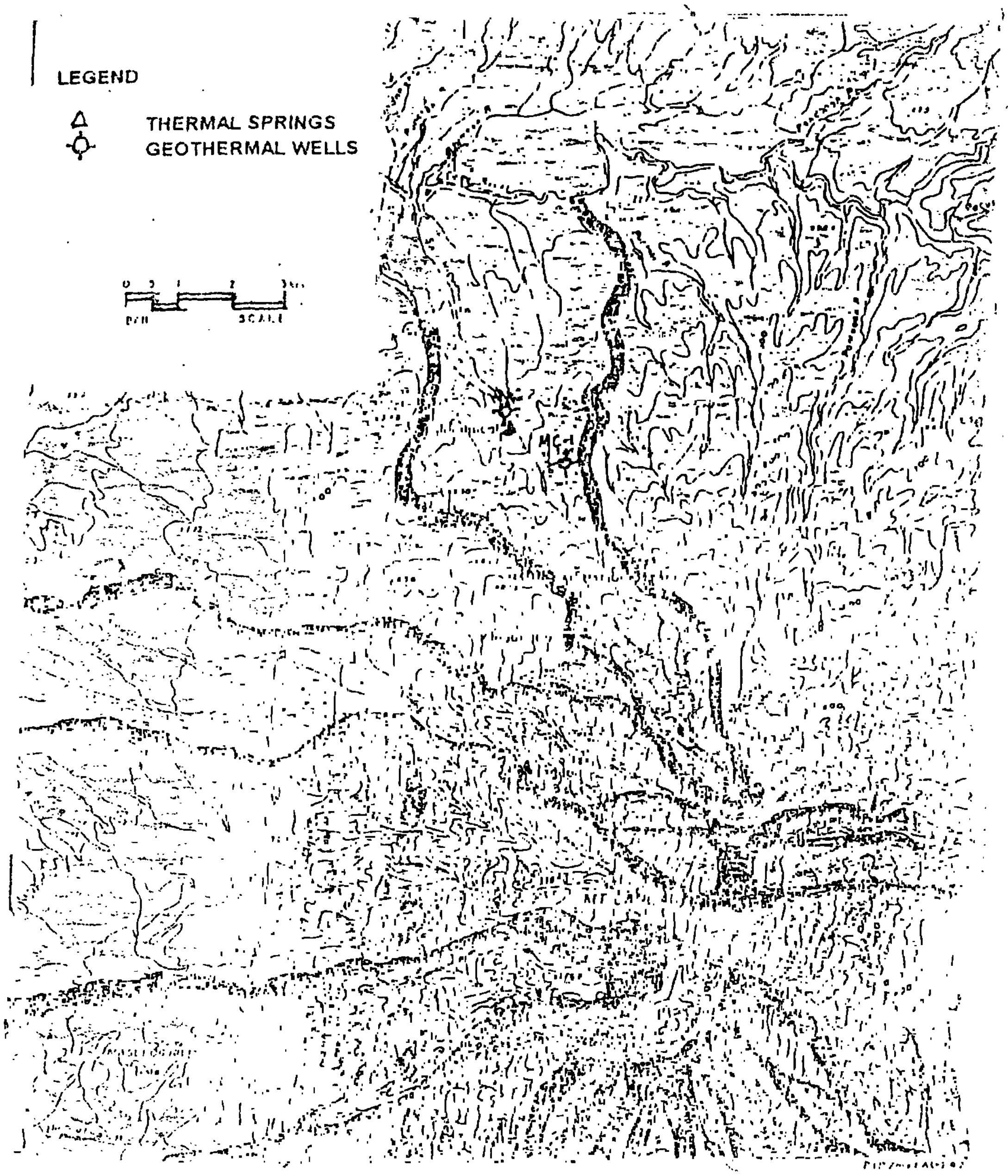
DEVELOPMENT Inc.

TITLE:
Danger Areas for Pyroclastic Flows, Surges and ash Clouds

FIG. 3.1.11a



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Pathways for Lahars and Floods FIG. 3.1.11b

C. Collection of soil samples, analyses and soil characterization

To determine the soil qualities in various environmental gradients along the primary and secondary impact zones, the landscape-ecology transact method was employed. This method basically examines the landscape, topography, elevation, the general soil types, and general land use and vegetation of the area.

Soil site observation/investigation was done in the various environmental gradients within the tributary watershed directly and indirectly affected by any development activities. Each soil site was studied in terms of soil profile condition, present land use, extent of soil erosion, degree of land slope, geomorphology and other observable soil related ecological properties. The soil samples collected from each of the observation site (see sampling site map, **Fig. 3.1.15**) were submitted and analyzed at the PNOC Laboratory. The chemical properties considered were:

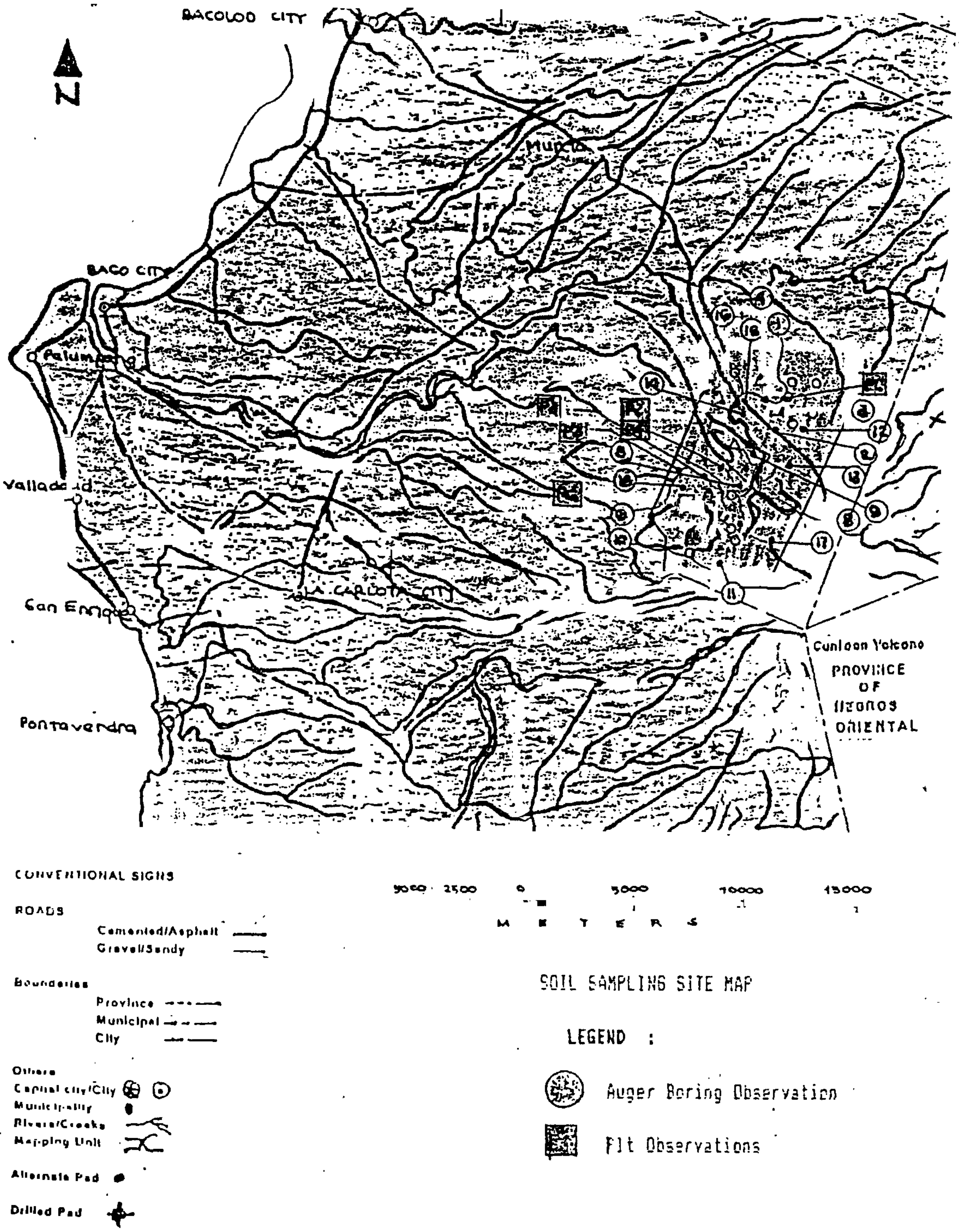
a) Soil pH - to determine nutrient availability;

b) Soil N, P, and K - to determine soil fertility levels and their corresponding amounts and grade of fertilizer requirements.

c) To determine the special nutrients and the status of the soils in the area, their chemical properties were analyzed. Elements studied included : As, H, Fe, C, Cu, Mn, Zn, P, Cd, Ca, Mg, Na, B and Al.

D. Evaluation of Soils, Land Use, Erosion, Slope and Permeability Maps.

Land Resources Maps covering the project area were collected and evaluated prior to the commencement of the field activities. These maps, produced by the Bureau of Soils and Water Management (BSWM), provided preliminary information which subsequently served as the basis for defining additional data requirements to be obtained from the project site. The importance and specific function of these maps to environmental studies are as follows:



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TITLE:

Soil Sampling Site Map

FIG. 3.1.15

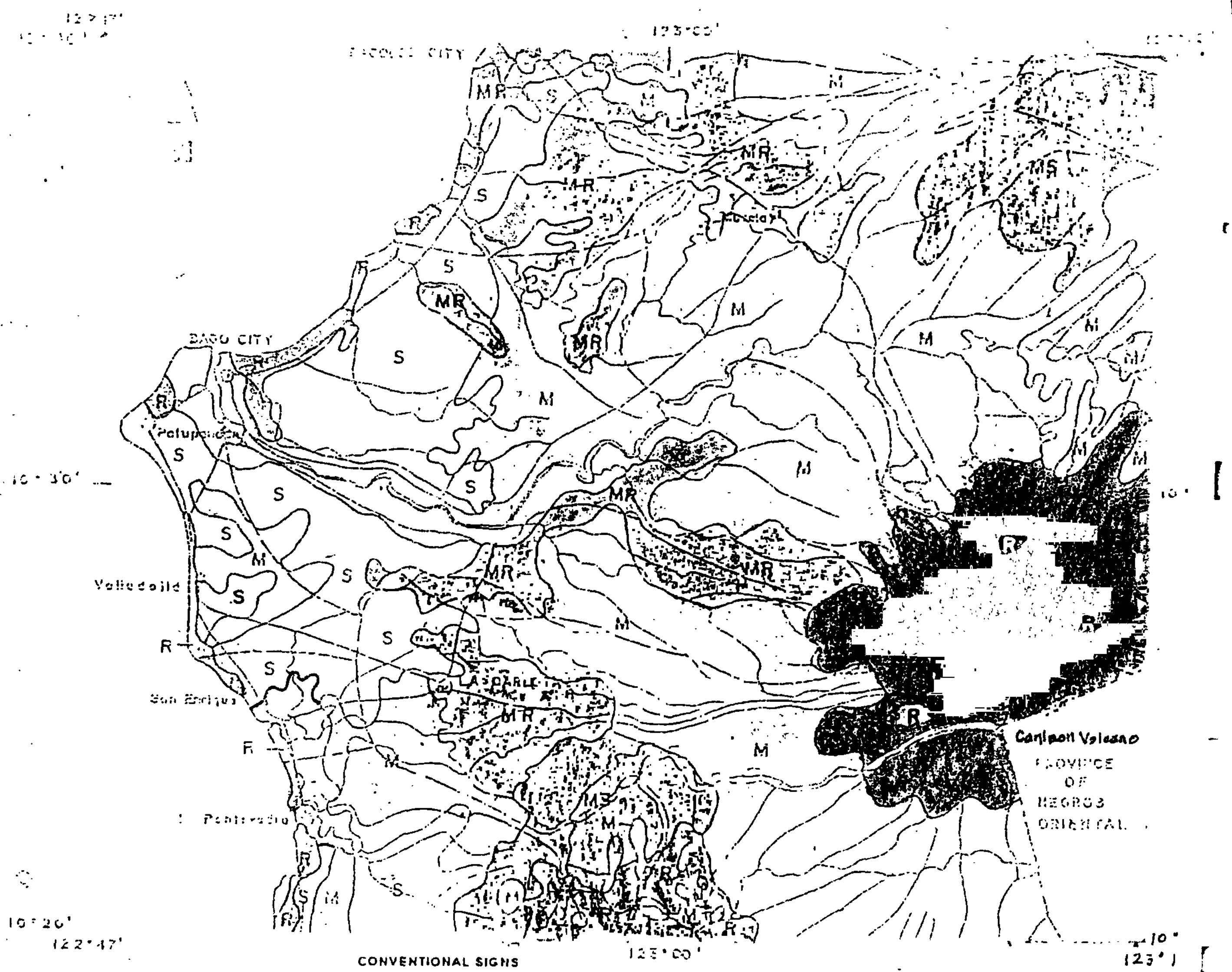
1) The Soil Map (**Fig. 3.1.16**) provides the inventory of soils in the project area, their characteristics/properties and position in the landscape. Basic soil properties like erodibility, inherent fertility, permeability, and soil moisture retention capacity are included, which can be used for the ecological and land productivity assessment of the project site and its environment.

2) The existing (1994) Land Use and Vegetation Map (**Fig. 3.1.17**) provides the social, economic and physical conditions of the project area. Some crops are regarded as indicative of the general topography as well as the state of soil erosion and degradation within the area. With the projected development of the site some land use changes may occur.

3) The Slope Map (**Fig.3.1.18**) provides information on the selection and positioning of agriculture and forestry in order to maintain the ecological balance of the area. The slope is a major erosion-inducing factor.

4) Erosion Map (**Fig.3.1.19**) indicates the extent and degree of erosion in the project area. It also helps pinpoint areas where landslides can occur. Associated with erosion is the loss of soil nutrients, which decreases soil fertility, and subsequently the deposition of sediments in the steam channel, which reduces the latter's capacity to carry floodwaters. This map is very beneficial in the formulation of soil conservation measures.

5) Permeability Maps (Fig. 3.1.20) indicate the soils' drainability in the project area. Permeability refers to the hydraulic conductivity of the soil and is measured in meter per day, which is apparently related to size, total volume and size distribution of soil pores. These maps can show if the development areas have moderate to rapid permeability which indicates good drainability.



LEGEND:

S	Slow
MS	Moderately Slow
M	Moderate
MR	Moderately Rapid
	Rapid

CONVENTIONAL SIGNS

ROADS
Cemented/Asphalt
Gravel/Sandy

Boundaries
Province
Municipal
City

Others
Capital city/City
Municipality
Rivers/Creeks
Mapping Unit
Alternate Pad
Drilled Pad

PNOC NORTHERN NEGROS
GEOTHERMAL PROJECT

5000 2500 0 5000 10000 15000
METERS

PERMEABILITY MAP

AVERAGE PERMEABILITY (HYDRAULIC CONDUCTIVIT
RATES AND CLASSES

CLASS	RATE (m/day)
SLOW	0.15
MODERATELY SLOW	0.15-0.5
MODERATE	0.5-1.5
MODERATELY RAPID	1.5-3.0
RAPID	> 5.0

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Permeability Map

FIG. 3.1.20

Land Use and Vegetation, Erosion and Slope Maps provide information on the state of lan productivity, as well as the degree of land degradation in the project area. The integration o these map information with soil types will provide sufficient basis for the analysis of the effect of other land uses, as well as the formulation of appropriate and location specific mitigatio measures for the project.

E. Consultation with other experts

To speed-up the work of the different disciplines/sectors, a series of consultations and dialogue between and among consultants was conducted. This facilitated data generation, helped avoi duplication of work and enhanced the working relationship among the various sectors involve in the project.

3.1.2.2 BASELINE ENVIRONMENTAL PROFILE

A. THE BAGO RIVER WATERSHED

The Project Development Areas: UPPER Minuyan (Catugasan), Pataan and Hagdan are locate in the six (6) sub-watersheds of the Bago River. Based on the BSWM study, of the total lan area of 75,900 hectares of the Bago River Watershed, approximately 30 percent suffers fron moderate to severe erosion (**Table 3.1.1**). Most of the eroded areas are within the project site is located.

The present watershed condition obviously emphasizes the need for a watershed managemen policy in order to sustain the future economic use of the area

TABLE 3.1.1 BASELINE CONDITIONS OF THE BAGO RIVER WATERSHED

Total Area (ha.)	75,900
Eroded Area (%)	29.64
Area (sq. km)	759
Annual Rainfall (mm)	2,400
Run-off (mcm)*	1,822
Area by Agro-climatic Zone (ha)**	
Wet Area	29,100
Moist Area	46,800
Area by General Utilization and by Erosion Condition	
Non-Agricultural	28,250
Eroded	9,400
Non-Eroded	18,850
Agricultural	47,650
Eroded	13,100
Non-Eroded	34,550

* mcm - million cubic meter
**Wet - Annual rainfall is greater than 2,500 mm. with slight moisture deficit during dry season

Temperature ranges from 17.5 C - 25 C with a growing period of 270 - 320 days.

Moist - Annual rainfall ranges from 1,500 - 2,500 mm with moderate moisture deficit during dry season. Has a growing period of 210 - 270 days.

Source : BSWM Land and Soil Management ATLAS for Western Visayas, 1992

B. THE SPECIFIC DEVELOPMENT SITES OR THE DIRECT IMPACT AREAS (DIA)

The general conditions of the three (3) options for development are presented in **Table 3.1.2**.

1. Hagdan Development Area

The power plant site is located in undulating to rolling alienable and disposable lands. The soils in the area are generally deep, well-drained, clay textured and subject to slight erosion. The area is predominantly filled with shrubs and grasses and a few forest trees, with small patches of agricultural and fiber crops. **Fig. 3.1.21 to 22** are representative photographs of this site.

The spoil disposal area is situated in undulating to rolling topography and suffers from slight erosion. The soils are deep, well drained, made of very fine clay and acidic. Grasses abound in this area, interspersed with relatively large plots planted with various agricultural crops and patches of shrubs and abaca and few forest trees. Representative photographs of patches of agricultural crops are shown in **Figs. 3.1.23 to 24**.

- **The Drilling Sites**
  - Drill site 1 is also located in undulating to rolling land and experience slight erosion. Soils and land use are similar with that of Spoil Disposal Area. (see **Fig. 3.1. 25** for photograph of the site)

  - Drill site 2 and 3 are located in relatively steep slopes and subject to moderate erosion. The soils in the area are composed of closely associated volcanic soils, with varying deposits of unweathered volcanic ash and allophane glasses. Vegetation cover consists mostly of shrubs, with remnants of forest and

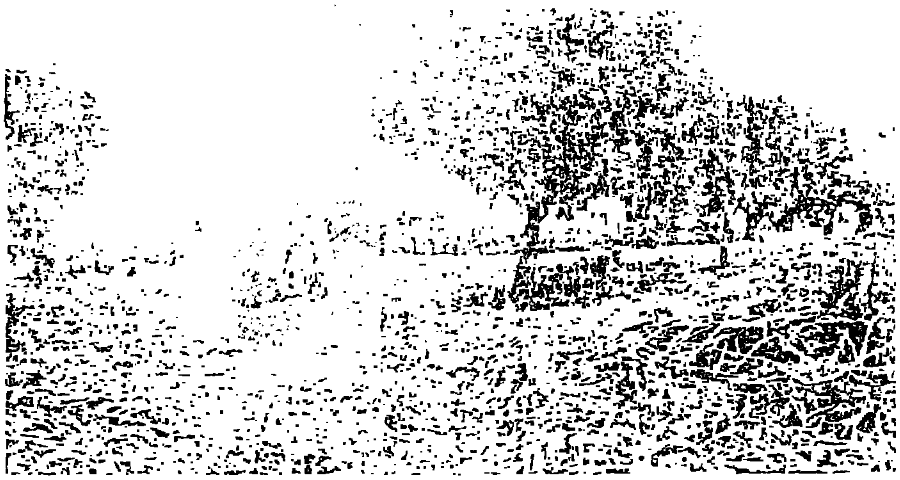
TABLE 3.1.2 SOIL AND ENVIRONMENTAL CONDITIONS OF THE DIFFERENT DEVELOPMENT AREA PER SITE

1. MINOYAN SITE

DEVELOPMENT AREA	SOILS	PRESENT LAND USE / VEGETATION	SLOPE	EROSION
Power Plant Site **Spoil Disposal Area** **Drill Site No. 1** **Drill Site No. 2** **Drill Site No. 3** **Drill Site No. 4** **Drill Site No. 5**	Deep, well drained very fine clayey acid soils (Very fine clayey Typic Kandindults)	Dominantly grasses and shrubs with patches of agricultural and fiber crop and forest trees	Rolling to steep (18-30%)	Moderately eroded
Drill Site No. 6 **Drill Site No. 7** **Drill Site No. 8**		Dominantly shrubs mixed with grasses and patches of agri-cultural crops, fiber and forest trees		

2. PATAAN SITE

DEVELOPMENT AREA	SOILS	PRESENT LAND USE / VEGETATION	SLOPE	EROSION
Power Plant Site	Deep, well drained, claye soils (soil association of kandindults and hemitropepts)	Dominantly shrubs with remnants of forest trees invaded colories by grasses with small patches of agricultural and fiber crops	Steep (30-50%)	Moderately eroded
Drill Site No. 1	Deep, well drained, very fine clayey acid soils (very fine clayey, typic kandindults	Dominantly grasses and shrubs with small patches of agricultural and fiber crops and forest crops	Rolling to steep (15-30%)	Moderately eroded
Drill Site No. 2 to 8	Deep, well drained clayey soils (soil association of kandindults)	Dominantly shrubs with remnants of forest trees invaded by colories of grasses	Steep (30-50%)	Moderately



...RN NEGROS GEOTHERMAL POWER
...DEVELOPMENT PROJECT
EIA STUDY

...ONSOLIDATED ASIAN
...YSTEMS DEVELOPMENT INC.

TITLE:

Photos of Hagdan Development area (Agricultural Farms)

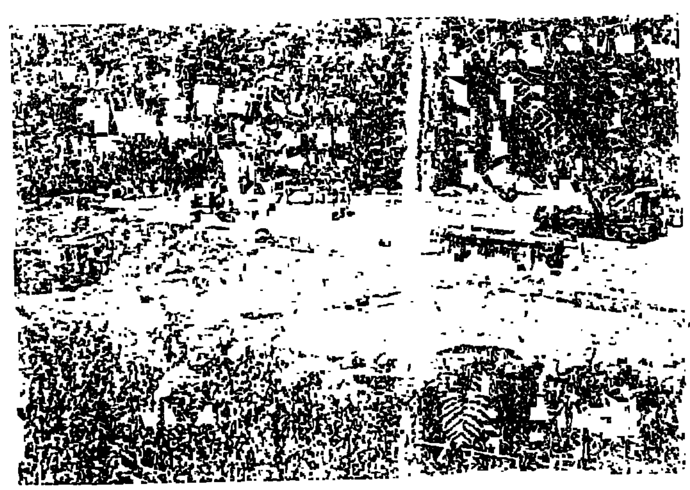
FIG. 3.1.21 and 3.1.22

...THERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT	TITLE: Photos of the Hagdan Spoil	FIG. 3.1.23

TABLE 3.1.2 Continuation...

3.HAGDAN

DEVELOPMENT AREA	SOILS	PRESENT LAND USE / VEGETATION	SLOPE	EROSION
Power Plant Site	Deep well drained very fine clayey acid soils (very fine clayey typic kandindults)	Dominantly grasses and shrubs with remnants of forest trees and with small patches of agricultural and fiber crops.	Undulating to rolling (8-18%)	Slightly eroded
Spoil Disposal Area	Deep well drained,very fine clayey acid soils (very fine clayey, typic Hapludults)	Dominantly grasses with relatively large areas cultivated to various agricultural crops with patches and shrubs and abaca and few forest trees	Undulating to rolling (8-18%)	Sligthly eroded
Drill Site No. 1	Deep, well drained very fine clayey acid soils (very fine clayey typic kandindults)		Undulating to rolling (8-18%)	Slightly eroded
Drill Site No. 2 and 3	Deep, well drained clayey soils. (soil association of kandindults and hermitropepts	Dominantly shrubs with remnants of forest trees invaded by colories of grasses with small patches of agricultural and fiber crops	Steep slopes (30-50%)	Moderately eroded
Drill Site No. 4	Deep, well drained clayey soils (soil association of kandindults and hermitropepts	Dominant grasses with relatively large areas cultivated to agricultural crops with patches of shrubs abaca and few forest	Steep slopes (30-50%)	Severely eroded/ landslide prone areas
Drill Site No. 5	Deep, well drained clayey soils. (soil association of kandindults and hermitropepts	Dominantly grasses with patches of shrubs and few cultivated areas for agricultural crops and abaca forest trees	Steep slopes (30-50%)	Severely eroded/ landslide prone areas



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Photos of the Hagdan Spoil Disposal Area

FIG. 3.1.23 and 3.1.24

NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT

TITLE:

colonies of grasses with small patches of agricultural crops. Representative photographs of the vegetation cover are shown in Figs. 3.1.26 to 27.

- Drill sites 4 and 5 are located in steep slopes that are prone to landslides. The soils are generally deep, well-drained, clay-textured and developed from associations of closely related volcanic materials. The area is now almost devoid of forest and is covered with grasses, some shrubs and a few patches of agricultural crops. (see Figs. **3.1.28 to 29**)

The Land Classification Map (**Fig. 3.1.30**) shows that all the planned development areas, i.e., power plant site, drilling pads, etc. are located on alienable and disposable land. However, about sixty percent (60%) of the total land area of the development block is public land and only forty percent (40%) is classified as alienable and disposable land.

2 **Pataan Development Areas**

The Power Plant site is located in alienable and disposable land with steep slopes. The soils in the area are composed of associated volcanic soils, with varying deposits of unweathered volcanic ash and allophane glasses. The soils are deep, well-drained and clay-textured and generally suffer from moderate erosion. The dominant land use is for shrubs, with remnants of some forest trees and colonies of grasses and a few patches of agricultural and fiber crops. (**Figs. 3.1.31 to 32**)

- **The Drilling Sites**
  - Drill site 1 is on rolling to steep slopes, with generally deep, well drained, clay textured soils and subject to moderate erosion. The area is covered by grasses and shrubs with small patches of cultivated areas. (**Figs. 3.1.33 to 34**)

NORTHERN NEGROS GEOTHERMAL POWER
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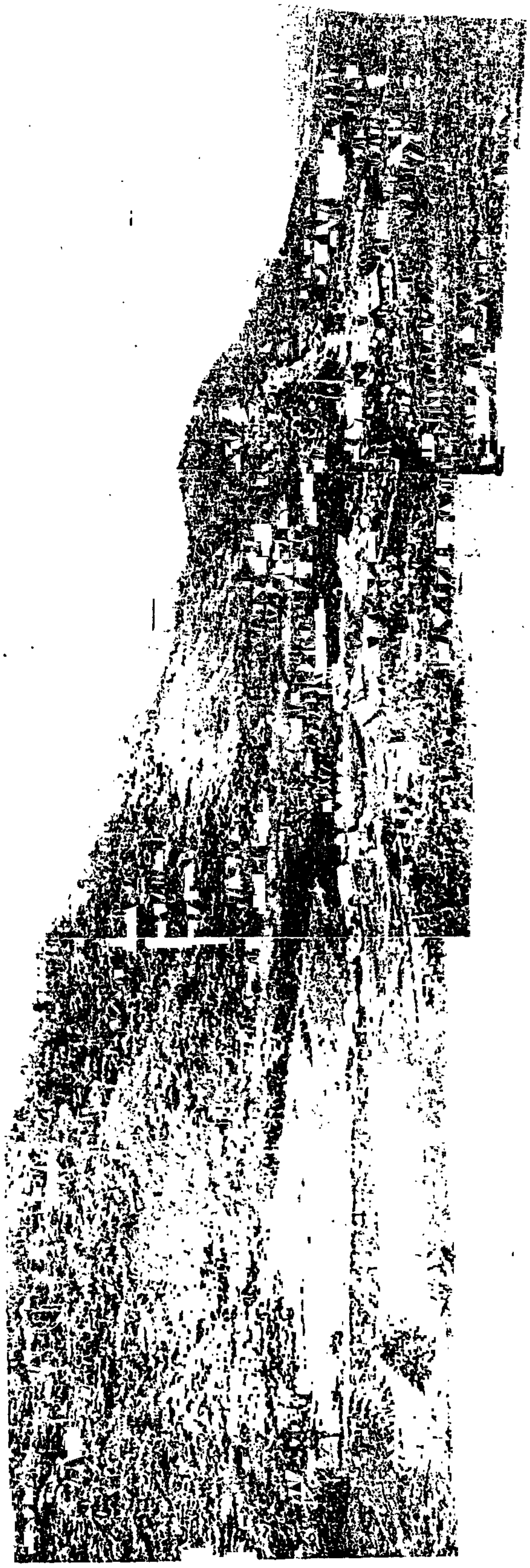
TITLE:

Photos of Vegetation cover of Drill Sites 2 and 3

FIG. 3.1.26 and 3.1.27



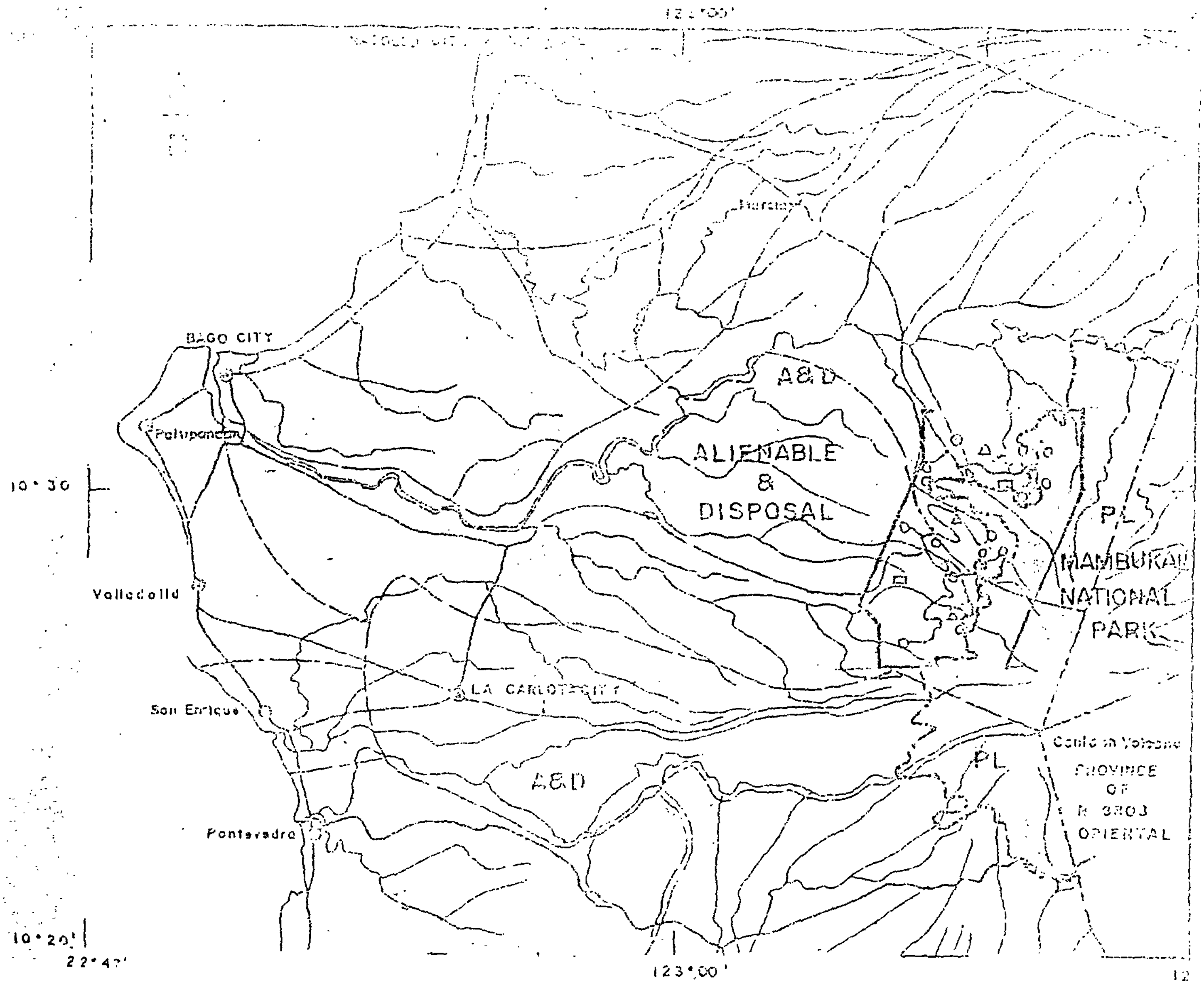
...THERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Photos of Drill Sites 4 and 5

FIG. 3.1.28 and 3.1.29



PNOC NORTHERN NEGROS GEOTHERMAL PROJECT
LAND CLASSIFICATION MAP

5000 2500 0 5000 10000
M E T E R S

SYMBOL DESCRIPTION	AREA (Ha.)	(%
ALIENABLE & DISPOSABLE	10260	40
PUBLIC LAND (Mambukal National Park)	14600	60
	24,860	10

Note: Area measurements is based only on the Geothermal Resource E

CONVENTIONAL SIGNS

ROADS
Cemented Asphalt
Gravel/Sandy

Boundaries
Province
Municipal
City

Capital city/City
Municipality
Rivers/Creeks
Mapping Unit

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

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TITLE:

Land Classification Map

FIG. 3.1.30

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
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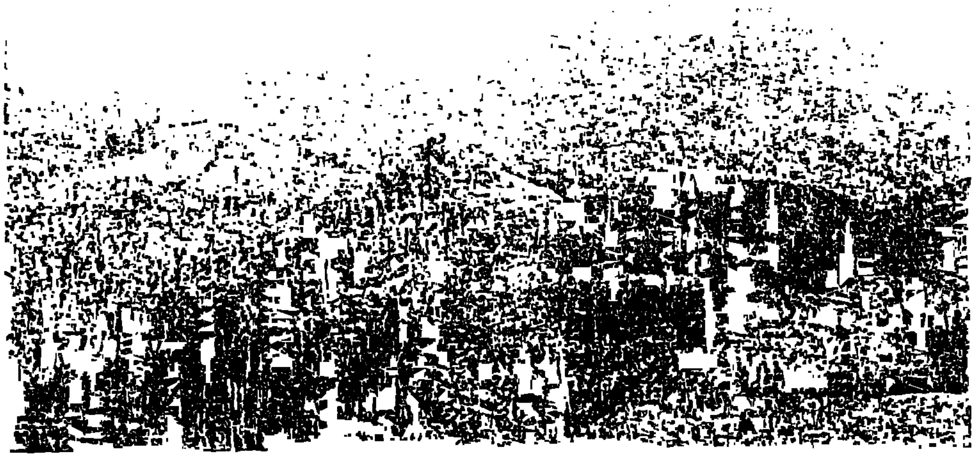
SYSTEMS DEVELOPMENT INC.

TITLE:

Pataan Drill Site No.1

FIG. 3.1.33 and 34



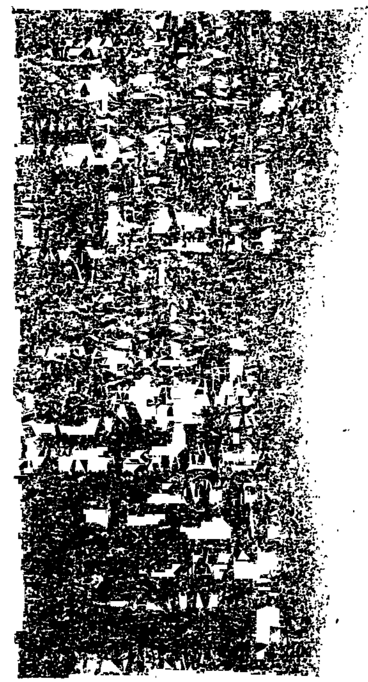
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Photos of Pataan Development area

FIG. 3.1.31
and 32



Drill sites 2 to 8 are located on steep slopes and predominantly grown to shrubs. Forest vegetation has been replaced by grasses and shrubs and a few patches of agricultural crops. The oils are generally deep, well-drained, heavy textured and subject to moderate erosion (**Figs. 3.1.35 to 36**).

3. **Minoyan Development Areas**

A power plant facility, a spoil disposal area as well as eight (8) drill sites are slated for development in the Minuyan area. All development sites are located in alienable and disposable land, with rolling to steep topography (**Fig. 3.1.37**) and subject to moderate erosion. The soils in the area are acidic, slightly weathered and have a deep, well drained clay texture. The general area is mostly covered by grasses and shrubs. A small portion, usually in patches, is utilized for various agricultural crops. The steep slopes are planted with abaca as well as a few remnants of forest trees (see **Fig. 3.1.38**). The presence of rock outcrops is common in the sloping lands, which serve as natural protection against soil erosion. In the absence of dense vegetation cover, rock outcrops, stones and boulders act as natural protection against ecological degradation by improving the natural capacity of the soils to capture and store rain water (see **Fig. 3.1.39**).

The Minoyan area is more populated compared with the Hagdan and Pataan sites. The increased migration may be attributed to economic difficulties and land use pressures in the lowlands, coupled with the unstable peace and order situation in the adjoining vicinities of the area. The relatively cool temperature favors the rearing of fighting cocks, which could have a direct effect on the future development of the area.

Carabao logging and **fuelwood** gathering appear to be major factors that cause soil erosion in many parts of the project.

NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
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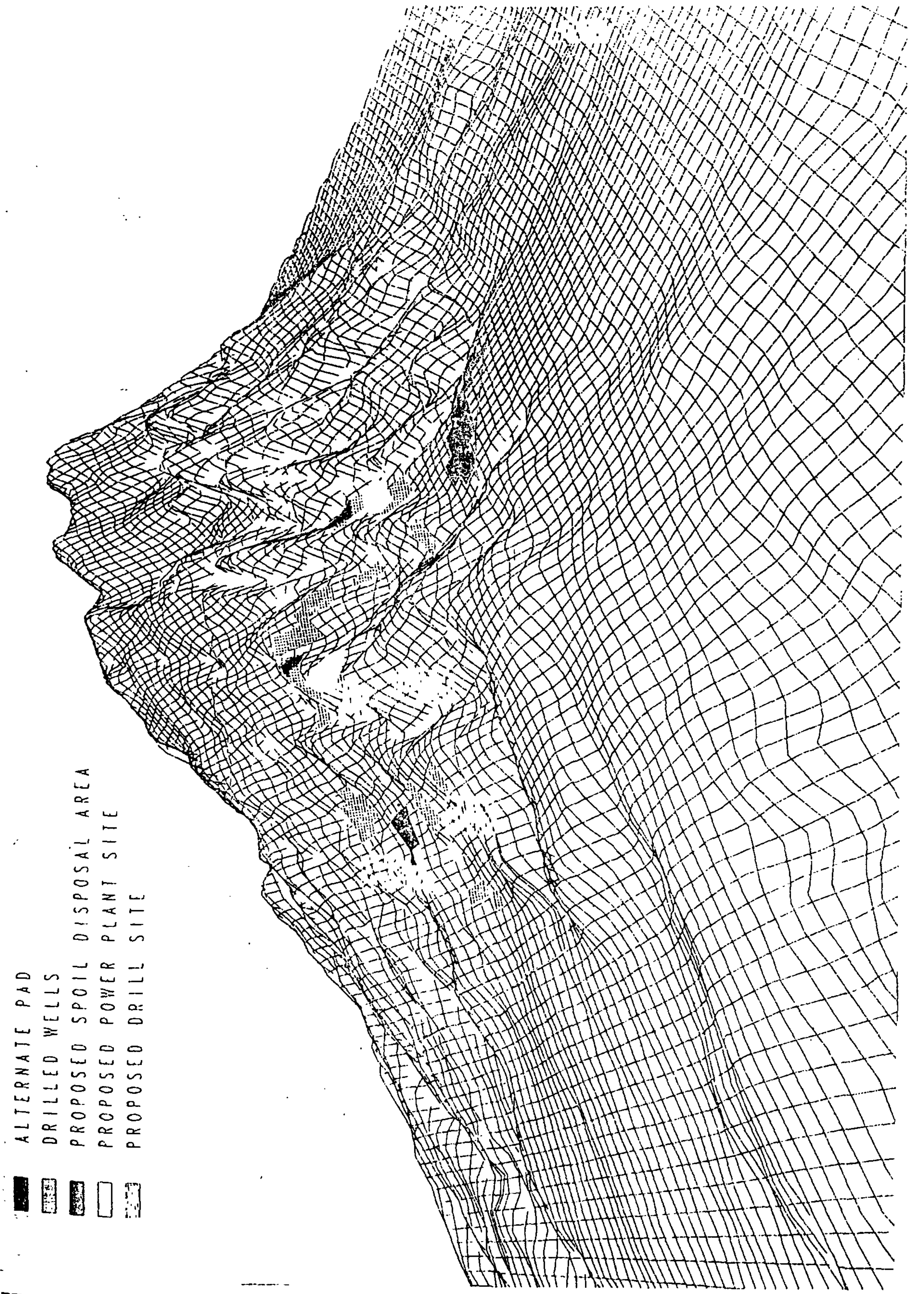
SYSTEMS DEVEL...

TITLE:

Photos of Drill Sites 2 and 3

FIG. 3.1.35
and 3.1.36



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Three Dimensional Representation of the Proposed Northern Negros Geothermal

FIG. 3.1.37

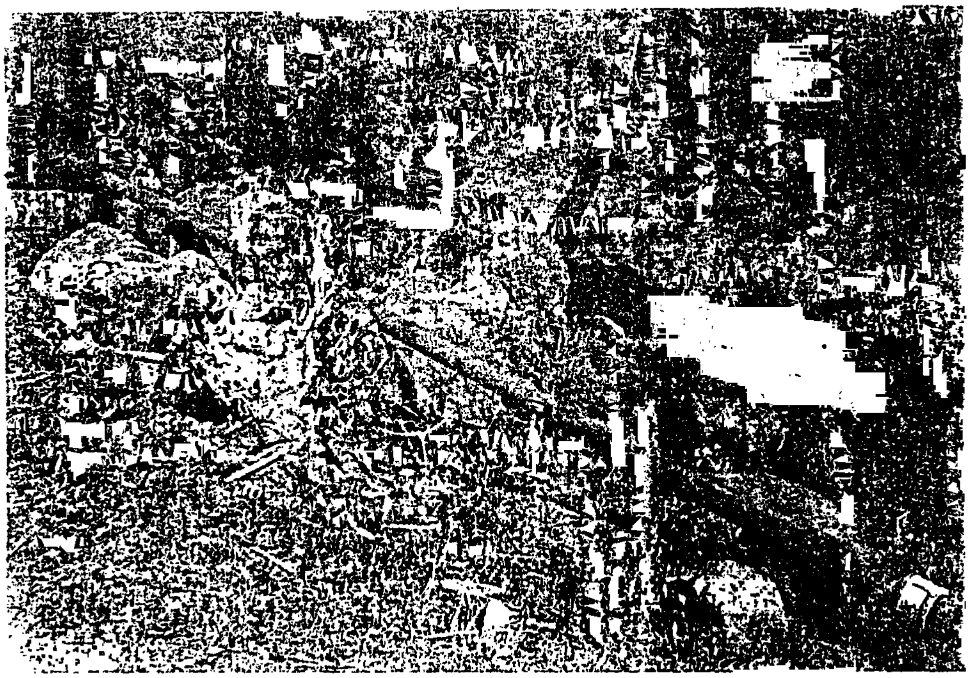
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Minoyan Development area

FIG. 3.1.38



THERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Photos of rock outcrop

FIG. 3.1.39

C. THE IMPACT AREAS

1. *The Direct Impact Areas (DIA) - 6186 hectares*

Soils, Land Use and Vegetation

The soils in the Direct Impact Areas (DIA) consist of deep, well drained, brown to yellowish brown, fine clay and acidic soils, which can be found in the rolling to steep slopes of the volcanic landscape. Basaltic lava flows and partly reworked and levelled pyroclastics from the soil parent materials are also present. Boulders and rock outcrops are common in sloping to moderately steep areas.

The general areas of the DIA (**Table 3.1.3**) are filled with grasses and shrubs (49.7%), with a relatively large area allocated for agricultural crops (31.8%) and forest trees (18.5%)

Slope

Table 3.1.4 shows that majority of the DIA (62.1%) have a slope greater than 18 percent (%), with small patches of plain (4.9%) and relatively large areas of undulating to rolling lands (33%).

Erosion

The DIAs are generally affected by various degrees of erosion (**Table 3.1.5**). Slightly eroded areas cover some 3201 ha. Moderately eroded and severely eroded account for 2279 and 404 ha., respectively and the remaining 302 has no apparent erosion. Four hundred sixty eight (468) has. are considered as landslide prone areas. **Figs. 3.1.40 to 41** show photographs of the different degrees of erosion in the project site.

EXTENT AND DISTRIBUTION OF LAND USE AND VEGETATION BY SITE AND IMPACT AREAS

LAND USE/ VEGETATION	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
	MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%
Agricultural	708	36.0	644	32.7	616	31.3	1968	31.8	521	53.7	116	11.9	334	34.4	971	28.8
	(36.6		(35.5		(26.5				(15.8		(52.0					
Grassland	686	30.8	668	30.0	872	39.2	2226	36.0	309	53.4	28	4.8	242	41.8	579	17.2
	(35.4		(36.8		(37.0				(19.4		(12.1					
Shrubland	257	30.4	286	33.8	302	35.7	845	13.7	291	61.1	26	5.5	159	33.4	476	[illegible]
	(13.3		(15.8		(13.0				(18.3		(11.7					
Woodland	385	33.6	212	18.5	550	48.0	1147	18.5	741	55.2	56	4.2	545	40.6	1342	39.8
	(18.7		(11.9		(23.5				(46.5		(24.2					
Total	2,036	32.9	1,810	29.3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38.0	3,368	
Percent	(100		(100		(100			100	(100		(100					(100

Note : Number in close parenthesis refers to the percentage within the site

TABLE 3.1.4 EXTENT AND DISTRIBUTION OF SLOPE BY SITE AND IMPACT AREAS

SLOPE	SLOPE CLASS	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
		MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
		AREA	%	AREA	%	AREA	%	AREA	%	AREA	%	AREA	%	AREA	%	AREA	%
M	0 - 3%	-		84 (4.6	27 8	218 (9.3	72 2	302	4 9	10 (0 5	10.6	26 (11.5	27.7	58 (4.5	61.7	94	2.8
O	8 - 18%	762 (37.4	37.3	576 (31.8	28 2	706 (30 2	34.5	2044	33.0	286 (15 4	42.3	118 (52.2	17.5	272 (21.3	40.2	676	20 0
P	18 -.30%	786 (38.6	49.5	638 (35.3	40.2	164 (7.0	10.3	1588	25.7	44 (2 4	37.9	-	-	72 (5.6	62.1	116	3 4
Q	30 - 50%	488 (2 4	21.7	512 (28.3	22.7	1,252 (53.5	55 6	2252	36 4	1522 (81.7	61.3	82 (36.3	3.3	878 (68.6	35.4	2482	73.7
Total		2.036	32.9	1,810	29 3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38 0	3.368	
Percent		(100		(100		(100			(100	(100		(100		(100			(100

Note Number in close parenthesis refers to the percentage within the site

TABLE 3.1.5 EXTENT AND DISTRIBUTION OF EROSION BY SITE AND IMPACT AREAS

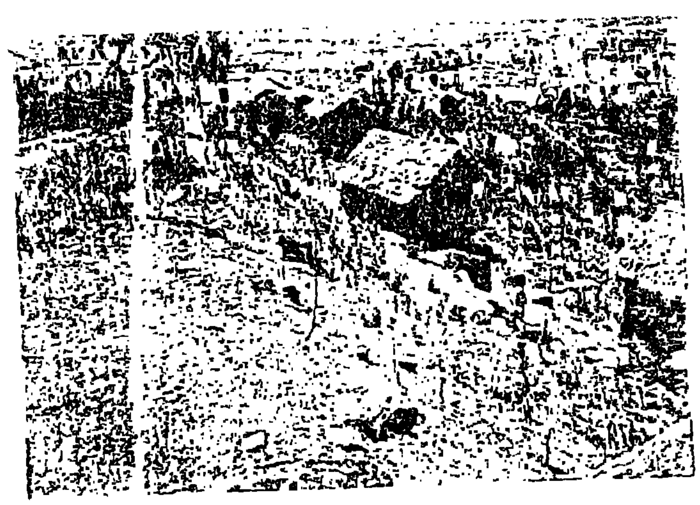
DIRECT IMPACT AREAS

SYMBOL/EROSION CLASS	MINOYAN AREA (has.)	MINOYAN %	PATAAN AREA (has.)	PATAAN %	HAGDAN AREA (has.)	HAGDAN %	TOTAL AREA (has.)	TOTAL %
EO No apparent erosion			84 4.6	27.8	218 9.3 26.9	72.2	302	4.9
E1 Slightly eroded	1145 (56 2	35 8	792 (43.8	24 7	1264 (54 0	39.5	3201	51 7
E2 Moderately eroded	891 (43 8	39 1	934 (51 6	41.0	454 (19.4	19.9	2279	36.8
E3 Severely eroded	-		-		404 (17.3	100 0	404	6.5
TOTAL	2.036	32.9	1,810	29.3	2,340	37.8	6.186	
PERCENT	(100		(100		(100			(100)

INDIRECT IMPACT AREAS

SYMBOL/EROSION CLASS	MINOYAN AREA	MINOYAN %	PATAAN AREA	PATAAN %	HAGDAN AREA	HAGDAN %	TOTAL AREA	TOTAL %
EO No apparent erosion	10 (0.5)	10.6	24 10.6 52	25.5	60 (4.7	63.8	94	2.8
E1 Slightly eroded	1027 (55.2)	50.9	174 (7.7	8 6	~~815~~ (63.7	40.4	2016	[illegible]
E2 Moderately eroded	825 (44.3)	73.5	28 (12.4	2.5	269 (21.0	24.0	1122	[illegible]
E3 Severely eroded	-	-	-		136 (10.6	100.0	136	[illegible]
TOTAL	1,862	55.3	226	6.7	1.280	38.0	3,368	
PERCENT	(100)		(100		(100			[illegible]

Note : Number in close parenthesis refers to the percentage within the site



...HERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN

TITLE:

Eroded areas in the IIA Minoyan area

FIG. 3.1.40 and 3.1.41

Drill sites 2 to 8 are located on steep slopes and predominantly grown to shrubs. Forest vegetation has been replaced by grasses and shrubs and a few patches of agricultural crops. The oils are generally deep, well-drained, heavy textured and subject to moderate erosion (Figs. 3.1.35 to 36).

3. Minoyan Development Areas

A power plant facility, a spoil disposal area as well as eight (8) drill sites are slated for development in the Minuyan area. All development sites are located in alienable and disposable land, with rolling to steep topography **(Fig. 3.1.37)** and subject to moderate erosion. The soils in the area are acidic, slightly weathered and have a deep, well drained clay texture. The general area is mostly covered by grasses and shrubs. A small portion usually in patches, is utilized for various agricultural crops. The steep slopes are planted with abaca as well as a few remnants of forest trees (see **Fig. 3.1.38**) The presence of rock outcrops is common in the sloping lands, which serve as natural protection against soil erosion. In the absence of dense vegetation cover, rock outcrops, stones and boulders act as natural protection against ecological degradation by improving the natural capacity of the soils to capture and store rain water (see **Fig. 3.1.39**).

The Minoyan area is more populated compared with the Hagdan and Pataan sites. The increased migration may be attributed to economic difficulties and land use pressures in the lowlands, coupled with the unstable peace and order situation in the adjoining vicinities of the area. The relatively cool temperature favors the rearing of fighting cocks which could have a direct effect on the future development of the area.

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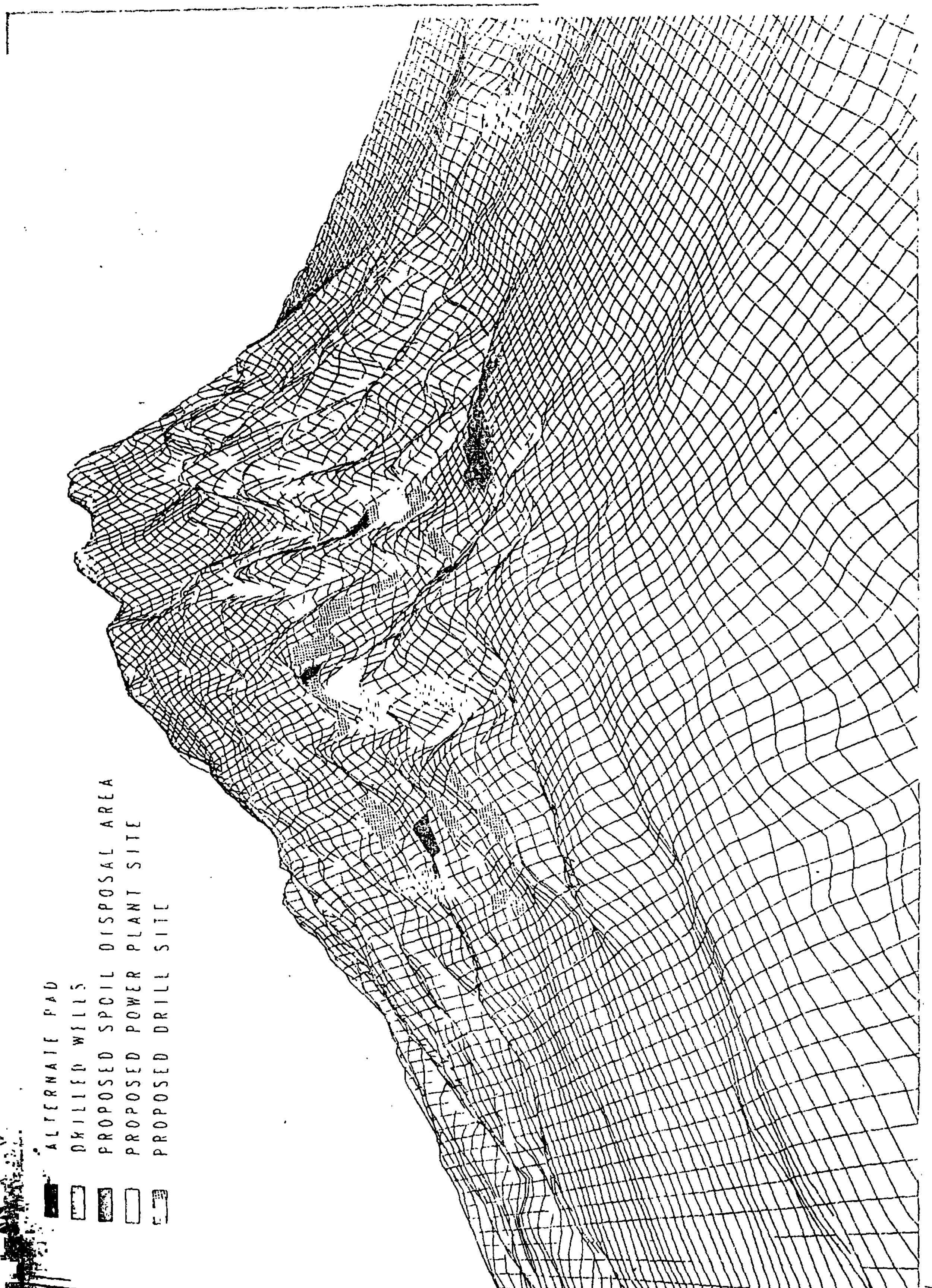
...HERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC

TITLE:

Photos of Drill Sites 2 and 3

FIG. 3.1.35 and 3.1.36

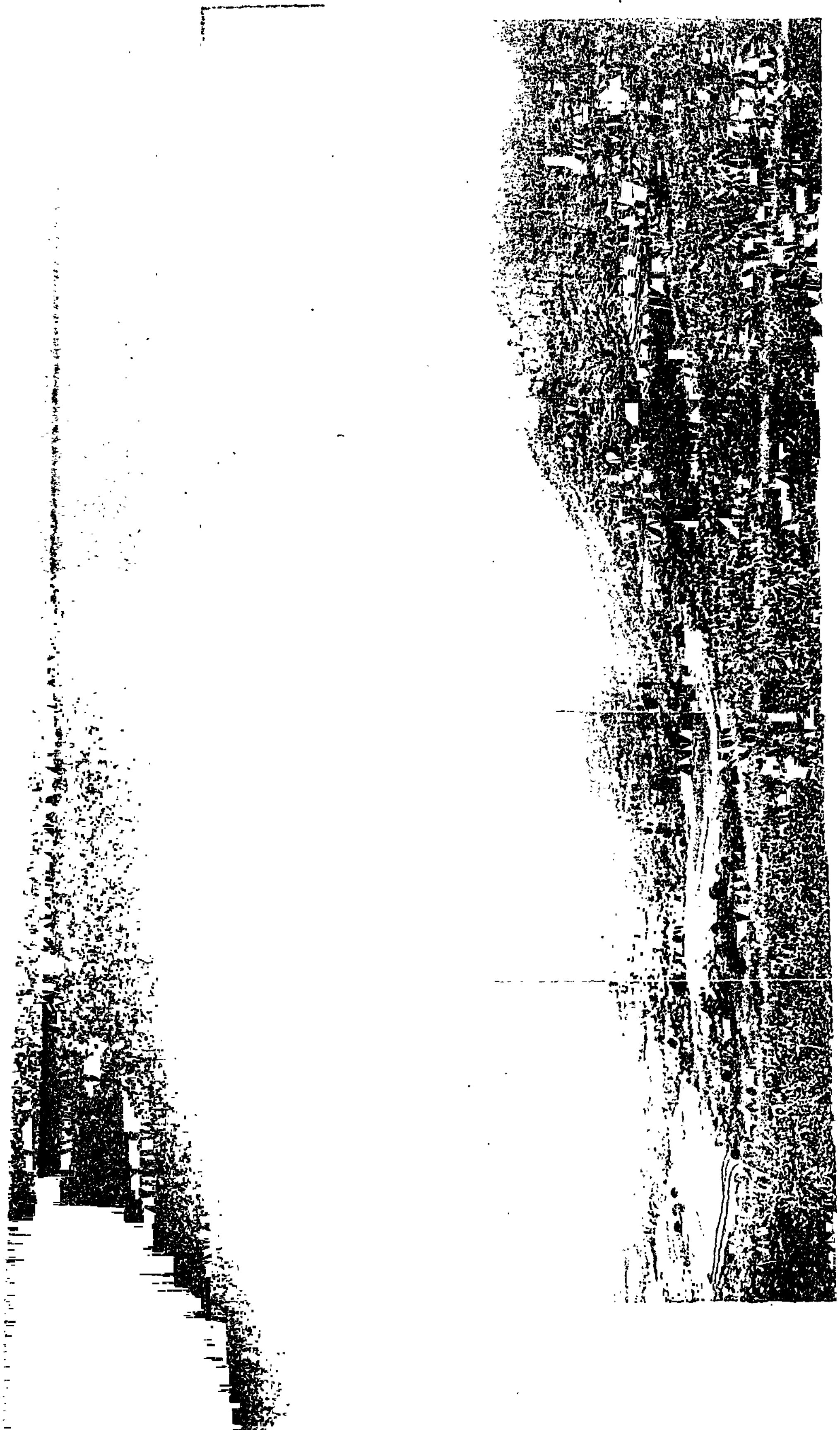


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Three Dimensional Representation of the Proposed Northern Negros Geothermal

FIG. 3.1.37



ERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Minoyan Development area

FIG. 3.1.38

[illegible]THERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Photos of rock outcrop

FIG. 3.1.39

C. THE IMPACT AREAS

1. *The Direct Impact Areas (DIA) - 6186 hectares*

Soils, Land Use and Vegetation

The soils in the Direct Impact Areas (DIA) consist of deep, well drained, brown to yellowish brown, fine clay and acidic soils, which can be found in the rolling to steep slopes of the volcanic landscape. Basaltic lava flows and partly reworked and levelled pyroclastics from the soil parent materials are also present. Boulders and rock outcrops are common in sloping to moderately steep areas.

The general areas of the DIA (**Table 3.1.3**) are filled with grasses and shrubs (49.7%), with a relatively large area allocated for agricultural crops (31.8%) and forest trees (18.5%).

Slope

Table 3.1.4 shows that majority of the DIA (62.1%) have a slope greater than 18 percent (%), with small patches of plain (4.9%) and relatively large areas of undulating to rolling lands (33%).

Erosion

The DIA's are generally affected by various degrees of erosion (**Table 3.1.5**). Slightly eroded areas cover some 3201 ha. Moderately eroded and severely eroded account for 2279 and 404 ha., respectively and the remaining 302 has no apparent erosion. Four hundred sixty eight (468) has. are considered as landslide prone areas. **Figs. 3.1.40 to 41** show photographs of the different degrees of erosion in the project site.

TABLE 3.1.3 EXTENT AND DISTRIBUTION OF LAND USE AND VEGETATION BY SITE AND IMPACT AREAS

LAND USE/ VEGETATION	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
	MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%
Agricultural	708	36.0	644	32.7	616	31.3	1968	31.8	521	53.7	116	11.9	334	34.4	971	28.8
	(36 6		(35 5		(26.5				(15.8		(52.0					
Grassland	686	30 8	668	30.0	872	39.2	2226	36 0	309	53.4	28	4.8	242	41.8	579	17.2
	(35.4		(36.8		(37.0				(19.4		(12.1					
Shrubland	257	30.4	286	33 8	302	35 7	845	13.7	291	61.1	26	5.5	159	33.4	476	14.2
	(13.3		(15.8		(13 0				(18.3		(11.7					
Woodland	385	33.6	212	18.5	550	48.0	1147	18.5	741	55.2	56	4.2	545	40.6	1342	39.8
	(18.7		(11.9		(23.5				(46.5		(24.2					
Total	2,036	32.9	1,810	29.3	2.340	37.8	6,186		1.862	55.3	226	6.7	1,280	38.0	3,368	
Percent	(100		(100		(100			100	(100		(100					(100

Note : Number in close parenthesis refers to the percentage within the site

TABLE 3.1.4 EXTENT AND DISTRIBUTION OF SLOPE BY SITE AND IMPACT AREAS

SLOPE	SLOPE CLASS	DIRECT IMPACT AREAS MINOYAN AREA	%	PATAAN AREA	%	HAGDAN AREA	%	TOTAL AREA	%	INDIRECT IMPACT AREAS MINOYAN AREA	%	PATAAN AREA	%	HAGDAN AREA	%	TOTAL AREA	%
M	0 - 3%	-		84	27.8	218	72.2	302	4.9	10	10.6	26	27.7	58	61.7	94	2.8
				(4.6		(9.3				(0.5		(11.5		(4.5			
O	8 - 18%	762	37.3	576	28.2	706	34.5	2044	33.0	286	42.3	118	17.5	272	40.2	676	20.0
		(37.4		(31.8		(30.2				(15.4		(52.2		(21.3			
P	18 - 30%	786	49.5	638	40.2	164	10.3	1588	25.7	44	37.9	-	-	72	62.1	116	3.4
		(38.6		(35.3		(7.0				(2.4				(5.6			
Q	30 - 50%	488	21.7	512	22.7	1,252	55.6	2252	36.4	1522	61.3	82	3.3	878	35.4	2482	73.7
		(24		(28.3		(53.5				(81.7		(36.3		(68.6			
Total		2,036	32.9	1,810	29.3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38.0	3,368	
Percent		(100		(100		(100			(100	(100		(100		(100			(100)

Note : Number in close parenthesis refers to the percentage within the site

TABLE 3.1.5 EXTENT AND DISTRIBUTION OF EROSION BY SITE AND IMPACT AREAS

SYMBOL/EROSION CLASS	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
	MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA (has.)	%	AREA	%	AREA	%	AREA	%	AREA	%
EO No apparent erosion			84	27.8	218	72.2	302	4.9	10	10.6	24	25.5	60	63.8	94	2.8
			4.6		9.3				(0.5)		10.6		(4.7			
					26.9						52		--			
E1 Slightly eroded	1145	35.8	792	24.7	1264	39.5	3201	51.7	1027	50.9	174	8.6	815	40.4	2016	59.[illegible]
	(56.2		(43.8		(54.0				(55.2)		(7.7		(63.7			
E2 Moderately eroded	891	39.1	934	41.0	454	19.9	2279	36.8	825	73.5	28	2.5	269	24.0	1122	33.[illegible]
	(43.8		(51.6		(19.4				(44.3)		(12.4		(21.0			
E3 Severely eroded	-		-		404	100.0	404	6.5	-	-	-		136	100.0	136	4.[illegible]
					(17.3				–				(10.6			
TOTAL	2,036	32.9	1,810	29.3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38.0	3,368	
PERCENT	(100		(100		(100			(100)	(100)		(100		(100			(100)

Note : Number in close parenthesis refers to the percentage within the site

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Eroded areas in the IIA
Minoyan area

FIG. 3.1.40
and 3.1.41

TABLE 3.1.6 EXTENT AND DISTRIBUTION OF SOIL TYPE BY SITE AND IMPACT AREAS

SYMBOL	SOIL TYPE	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
		MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
		AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%
8	Very fine clayey, typic hapludults	-		340	29.2	824	70.8	1164	18.8	-		66	29.7	156	70.3	222	6.[illegible]
				(18.8		(35.2						(29.5		(12.2			
12	Very fine clayey, typic kendkidults	862	45.3	760	39.9	282	14.8	1904	30.8	1056	88.0	20	1.7	124	10.3	1200	35.6
		(42.3		(2.0		(12.1				56.7		(8.9		(9.7			
13	Fine clayey, typic hapludults	720	73.6	218	22.3	40	4.1	978	15.8	394	67.9	58	10.0	128	22.1	580	17.2
		(35.4		(12.0		(1.7				(21.2		(25.0		(10.0			
17	Kendidults-himetropepts	454	21.2	492	23.0	1,194	55.8	2140	34.6	412	36.1	82	7.2	646	56.7	1,140	33.8
		(22.3		(27.2		(51.0				(22.1		(36.6		(50.5			
18	Canyon and gorges			-		-				-		-		226	100.0	226	6.7
														(17.6			
	Total	2,036	32.9	1,810	29.3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38.0	3,368	
	Percent	(100		(100		(100			(100	(100		(100		(100			(100

Note : Number in close parenthesis refers to the percentage within the site

2. *The Indirect Impact Areas (IIA) - 3368 hectares*

Soils, Land Use and Vegetation

The soils in the IIA are similar to the DIA, comprising of deep, well- drained, brown to yellowish brown, acid clay soils (**Table 3.1.6**).

The IIAs are dominantly covered by forest trees, comprising 1340 ha. or about 40% of the total land area. Underutilized grasses and shrubland represent 31.4% (957 ha.) of the aggregate land area. Agricultural land use covers about 29%, or 971 ha. **Fig. 3.1.42** shows a typical area still with good forest cover.

Slope

Majority of the IIA have steep slopes (73.7%). Undulating to rolling (8-18%) lands represent 20% of the total land area. Plain areas and rolling to undulating lands are estimated at 2.8% and 3.5%, respectively.

Erosion

Approximately 97% of the IIA (**Table 3.1.5**) have been subjected to various degrees of soil erosion. Slightly eroded and moderately eroded land account for 2016 and 1122 ha. respectively Severely eroded and no apparent erosion represent about 4% and 3% of the total land area. Photographs of the different eroded areas within the IIA are shown i **Figs. 3.1.43**.

D. SPECIFIC SOIL TYPE IN THE GEOTHERMAL DEVELOPMENT AREAS

Four (4) major soil types are classified within the Northern Negros Geothermal Development Block (**Table 3.1.7**). These are: fine clay, typic hapludults; very fine clay typic kandiudults; very fine clay, typic dadiudults; and'kandiudults-humitropepts. These soils are developed from pyroclastic materials and their distribution is strongly related t their positions within the landscape.

EXTENT AND DISTRIBUTION OF SOIL TYPE BY SITE AND IMPACT AREAS

SOIL TYPE	DIRECT IMPACT AREAS								INDIRECT IMPACT AREAS							
	MINOYAN		PATAAN		HAGDAN		TOTAL		MINOYAN		PATAAN		HAGDAN		TOTAL	
	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%	AREA (has)	%
Very fine clayey, typic hapludults	-		340	29.2	824	70.8	1164	18.8	-		66	29.7	156	70.3	222	6.6
			(18.8		(35.2						(29.5		(12.2			
Very fine clayey, typic kendkidults	862	45.3	760	39.9	282	14.8	1904	30.8	1056	88.0	20	1.7	124	10.3	1200	35.6
	(42.3		(2.0		(12.1				56.7		(8.9		(9.7			
Fine clayey, typic hapludults	720	73.6	218	22.3	40	4.1	978	15.8	394	67.9	58	10.0	128	22.1	586	17.2
	(35.4		(12.0		(1.7				(21.2		(25.0		(10.0			
Kendidults-himetropepts	454	21.2	492	23.0	1,194	55.8	2140	34.6	412	36.1	82	7.2	646	56.7	1140	33.8
	(22.3		(27.2		(51.0				(22.1		(36.6		(50.5			
Canyon and gorges			-		-				-		-		226	100.0	226	6.7
													(17.6			
Total	2,036	32.9	1,810	29.3	2,340	37.8	6,186		1,862	55.3	226	6.7	1,280	38.0	3,368	
Percent	(100		(100		(100			(100	(100		(100		(100			(100

.ber in close parenthesis refers to the percentage within the site

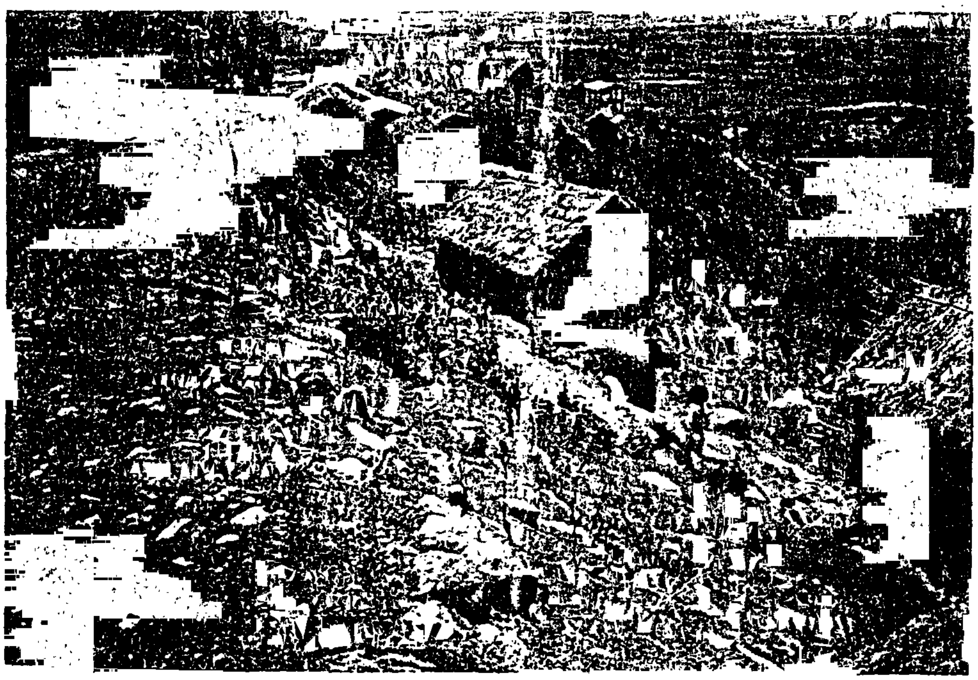
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Photo of Area with Good Forest Cover

FIG. 3.1.42



...OLOGICAL ATTRIBUTES OF THE VARIOUS SOIL TYPES AND THEIR IMPLICATIONS TO SOME ENVIRONMENTAL PROBLEMS

CODE NO./SOIL TYPES	TEXTURE (120-300 CM)	SOIL DRAINAGE	ESTIMATED PERMEABILITY	EROSION POTENTIAL	LANDSLIDE POTENTIAL	LIQUID/SOID WASTE DISPOSAL	CROP PRODUCTIVITY	GROUND WATER POLLUTION
Hilly and Sloping Up-lands								
1.a) Agricultural Areas								
8) Typic Hapludults	Fine clay	Good	Slow-moderate	Moderate	Low	Moderate	Medium	Low
1.b) Grasslands								
12) Typic Kandiudults	Clay over Fine clay	Good	Moderate	High	Low	Moderate	Low	Low
Steep mountains (Acid, Volcanic, Forest Soils)								
13) Typic Hapludults	Clay over Fine clay	Good	Moderate	High	Low	Moderate	Low	Low
17) Umbric Vitrandepts	Silt loam over Sandy loam sand	Good	Moderate-rapid	Low	Low	Low-moderate	Medium	Low-moderate
17) Andic Humitropepts	Sandy loam over gravelly sandy loam	Good	Moderate-rapid	Low	Low	Low-moderate	Medium	Low-moderate

meability is classified as :

slow	: <0.15 m/day
moderate slow	: 0.15 - 0.5 m/day
moderate	: 0.5 - 1.5 m/day
moderately rapid	: 1.5 - 3.0 m/day
rapid	: >3.0 m/day

The kandiudults-humitropepts soils are found on the highest position of the landscape (volcanic cone). Very fine clay, topic dadiudults are extensive in the rolling to moderately steep, moderately dissected upper slopes. The strongly sloping, severely dissected upper slopes are occupied by fine clay, topic hapludults. Pyroclastic terrace areas are generally overlain by very fine clay, topic hapludults. Their distribution is shown in the soil map of the Northern Negros Geothermal Project (Map Scale 1:50,000).

The specific soil type descriptions, their main differentiating characteristics, extent in the project areas and other information are as follows:

1. Soil Unit 8, classified as very fine clay, topic hapludults under the United States Department of Agriculture (USDA) Soil Taxonomy Classification System, are soils derived from weathered pyroclastic materials occurring on the undulating to rolling, slight to severely dissected pyroclastic terraces. They are deep, well drained with a clay texture and acidic. The soil profile is usually moist during the growing period of the various crops. Surface boulders and rock outcrops are common. Hydraulic conductivity (permeability) range from slow to moderate (**Table 3.1.8**). These soils are usually covered by grasses. Small areas are used for agricultural crops Forest trees and shrubs occupy most of the moderately steep phases of these soils.
2. Soil Unit 12, classified as very fine clay, topic kandiudults under the USDA Soil Taxonomy classification system, are acidic soils with relatively thick clay (greater than 120 centimeters). These soils contain very fine clay, more than 59% in the argillic horizon. The soil profile is moist during the growing period of crops and other vegetation. Boulders and rock outcrops are common. The hydraulic conductivity is moderate. This soil unit represents approximately 31% of the total land area covered by DIA and about 36% of the IIA. These soils are underutilized (grasses), often with scattered shrubs, abaca and small trees, corn and

TABLE 3.1.8 ESTIMATED PERMEABILITY OF SOIL TYPES

CODE NO./SOIL TYPES	ESTIMATED* PERMEABILITY	VOLUME PER DAY
(1) Hilly and Sloping Up-lands		
(1.a) Agricultural Areas		
(8) Typic Hapludults	Slow-moderate	0.15 - 0.5 m/day
(1.b) Grasslands		
(12) Typic Kandiudults	Moderate	>3.0 m/day
(2) Steep mountains (Acid, Volcanic, Forest Soils)		
(13) Typic Hapludults	Moderate	>3.0 m/day
(17) Umbric Vitrandepts	Moderate-rapid	<0.15 m/day
(17) Andic Humitropepts	Moderate-rapid	<0.15 m/day

sugarcane. Patches of wetland rice and mulberry are grown in association with grasses.

3. Soil Unit 13, classified as fine clay, topic hapludults under the USDA Soil Taxonomy system, are deep well-drained, generally non-acid soils derived from highly weathered pyroclastic materials. Surface boulders and rock outcrops are common. These soils are slightly to moderately affected by erosion. Their hydraulic conductivity is moderate (see **Table 3.1.8**) and the natural vegetation of these soils are grasses and shrubs. Some areas are used for agricultural crops. This soil unit represents approximately 16% of the total land area of DIA and about 17% of the IIA.

4. Soil Unit 17, classified as associations of kandiudults and humitropepts under the USDA Soil Taxonomy System, consists of deep, well-drained, generally clay soils. They are also derived from volcanic materials on the slightly rolling to steep volcanic cone. This soil type has many volcanic rocks or rock fragments with a depth below 40 to 100 centimeters (cms.). Surface boulders and rock outcrops are common. These soils are underlain by unweathered volcanic materials. In areas dominated by grasses with patches of cultivation, the soils are moderately to severely affected by erosion. These soil associations are generally located in the upper volcanic slopes. Their hydraulic conductivity is moderate to rapid. The lower slopes of these soil units are dominated by grasses and shrubs while the upper slopes are still covered by forest trees. Smaller areas are utilized for shifting cultivation and abaca. This soil unit occupies approximately 34% of the total land area of DIA and about 33% of IIA.

3.1.3 TERRESTRIAL ECOLOGY - FLORAL COMPONENT

3.1.3.1 INTRODUCTION

The terrestrial flora research team was composed of a forester/botanist, research assistant, research aide and field guides (Fig. 3.1.44). The field guides came from the *sitios* where the geothermal plant will likely be constructed. They served as resource persons for the local flora community and assisted in the conduct of survey. They were also the direct users of most forest resources as they earn their livelihood through *kaingin* and forest products gathering.

The survey of the floral component was conducted from February 12-16, 1994. In addition to the surveyed area during the exploratory phase and in consideration of the proposed drilling wells, new sampling sites were established at *Sitios* PNOC and Gayas of Baranggay (Bgy.) Upper Minoyan in Murcia and *Sitios* Hagdan and Pataan of Bgy. Mailum in Bago City, Negros Occidental. These additional sampling sites were located within a five (5)-km radial influence of the drilling and plant sites. Whenever possible, the location of the road network was considered. Greater attention was focused on the vegetation cover directed towards the Mt. Canlaon National Park. Thus, most area samplings were near the foot of the park. These new sampling areas were entirely independent of the previously covered sites during the exploratory phase. The data gathered here, however, were added to the past vegetation analysis.

3.1.3.2 METHODOLOGY

In addition to the previous sampling points/sites used during EIA for the exploration phase, new sampling sites were situated away from past sampling points. **Fig. 3.1.45** indicates the additional sampling sites for all the *sitios*. **Tab. 3.1.9** provides the list and descriptions of sampling stations. The concentration of the survey was focused on the vegetation cover on the slopes of Mt. Canlaon. In *Sitio* Catugasan, the team sampled the vegetation through the line-intercept method. Generally, the sampled areas were abandoned *kaingin* and secondary forests. One

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CONSOLIDATED ASIAN
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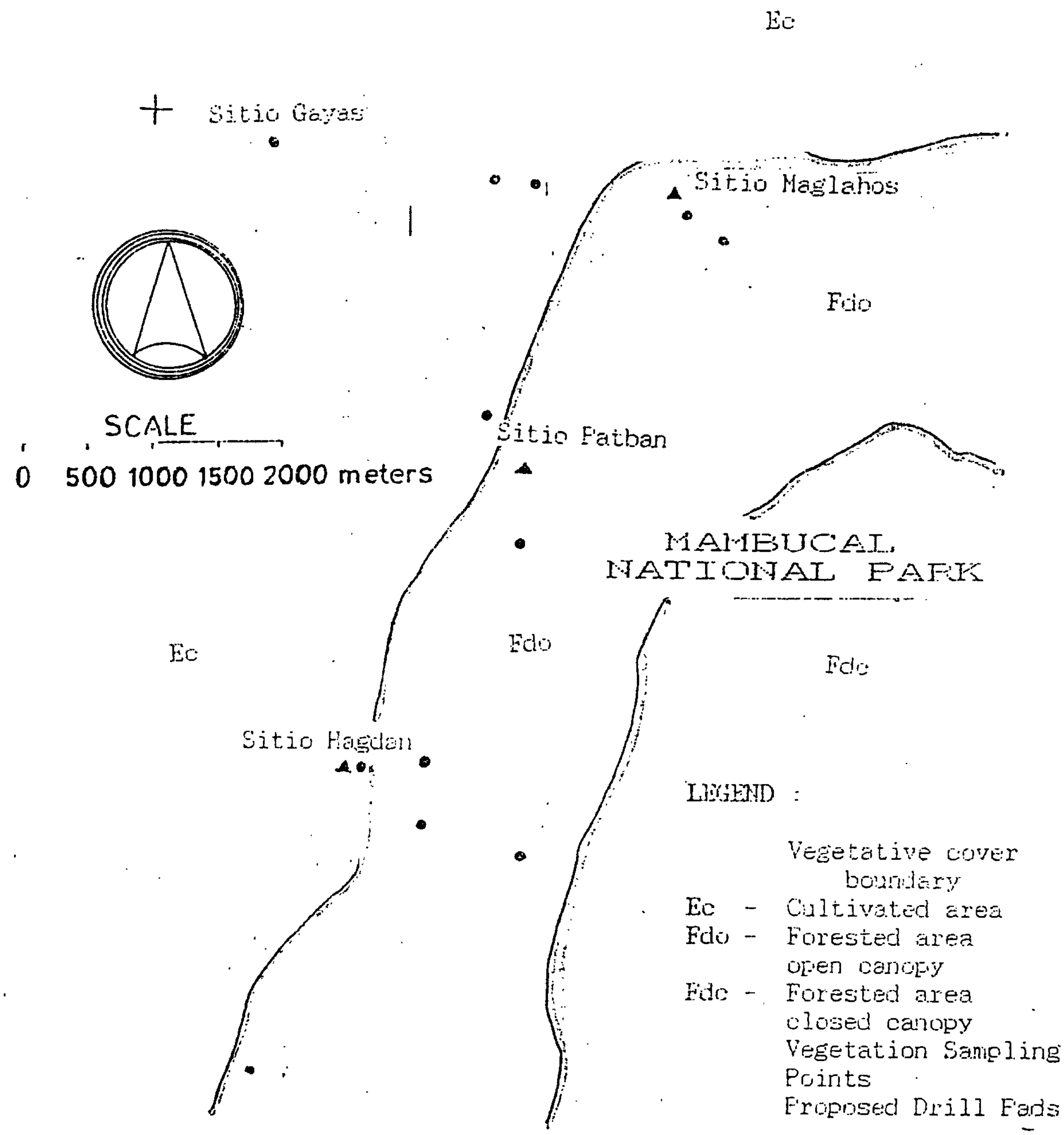
TITLE:

Photo of Terrestrial Ecology Survey Team

FIG. 3.1.44



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Terrestrial Ecology-Floral Sampling Sites

FIG. 3.1.45

Table 3.1.9 LIST AND DESCRIPTIONS OF FLORAL SAMPLING STATIONS

SECTOR/SAMPLING STATION	TYPE OF VEG	METHOD OF ANALYSIS	ELEVATION (asl) m	SLOPE %	ASPECT
Hagdan	1 Open disturbed area	Line intercept method	700	20	SW
	2 Logged over/open canopy	Line intercept method	814	15	NE
	3 Logged over abandoned kaingin	Line intercept method	722	47	NE
	4 Open canopy	Line intercept method	777	50	NE
Katugasan	5 Open canopy/mixed dipterocarp forest	Point centered quarter method	804	33	SE
	6 Open disturbed area	Line intercept method	677	10	SE
	7 Disturbed pasture	Line intercept method	485	30	NE
	8 Logged-over-open canopy forest and abandoned kaingin	Line intercept method	552	70	DN
	9 Pine-Mahogany old plantation	Belt transect method	556	44	NE
Pataan	10 Open canopy secondary forest pine plantation	Point centered quarter method	609	30	NW
	11 second growth forest	Line intercept method	672	33	SE
	12 Logged-over forest/abandoned kaingin	Line intercept method	304	15	SW
	13 Logged-over and abandoned kaingin	Line intercept method	676	10	NW

(1) transect line was established over a proposed road along the Asia River.

The line intercept method was used to obtain the species composition, number, linear and vertical extent and frequency of occurrence of individuals intercepted by the line transect. The procedure adopted was detailed in the exploratory phase report (1993) and reproduced in **Appendix 3.1.A**. A diagram of the line intercept method is shown in **Fig. 3.1.46**.

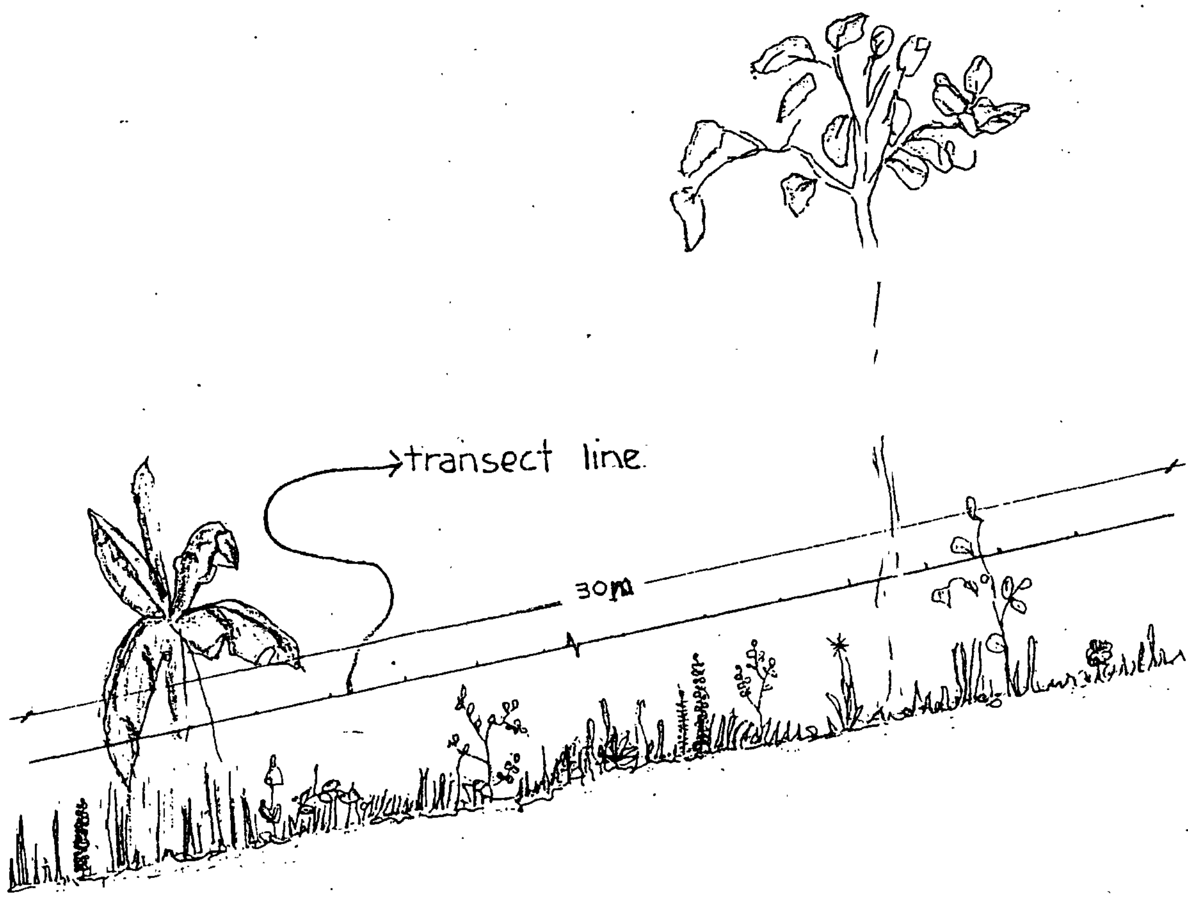
The forested area was analyzed using the point-centered-quarter method (**Fig. 3.1.47**) whenever feasible. The method used was adopted from Nisperos (1987) and further described in the 1993 EIA report. The line intercept method was applied for the forested areas at Hagdan and Pataan. The belt transect method, however, was also employed for the construction of a profile diagram for an old pine plantation.

Along the survey routes, the various plant species encountered were recorded. Samples of plants were collected for identification. The plants were pressed in the field and processed using the standard herbarium techniques. The identification of plants was done using taxonomic literature and with the advise of experts. The 42 specimens collected were numbered from Baja-Lapis 311-352 and were deposited at the DENR-Ecosystems Research Development Bureau (ERDB) Botany Laboratory in Los Banos, Laguna.

3.1.3.3 RESULTS AND DISCUSSION

A. Vegetation Cover - Directly Impacted Areas

The vegetation cover within the DIA consists of mixed dipterocarp and miscellaneous forest tree species, secondary forest (as a result of past logging activity), grassland pasture formations, bare/open and cultivated areas for rice, banana, sugar cane, abaca, paper mulberry and small patches of other agricultural crops.

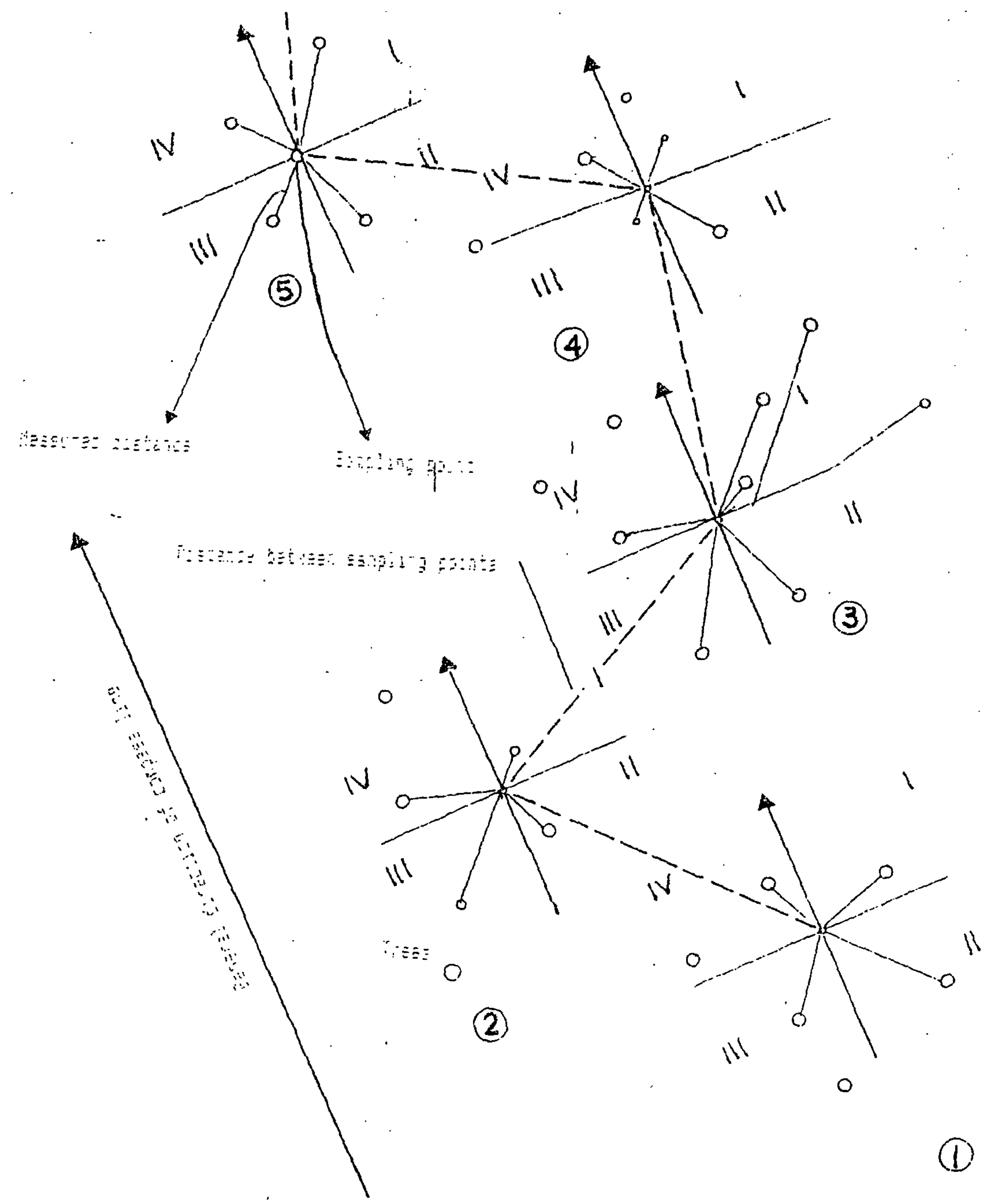


NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN

TITLE:
Diagram of a line- intercept method of vegetation analysis in the grassland-open areas of

FIG. 3.1.46



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN

TITLE:
Diagram of Point-Centered Quarter Method for vegetation sampling in a strip of forest

FIG. 3.1.47

As expected, the results of the vegetation analysis conducted during the exploration EIA in 1993 are still applicable and are thus included in this study. For this development phase EIA, a total of 13 new vegetation sampling studies has been conducted within the development block The development block was divided into three (3) sectors, namely: Hagdan, Pataan and Catugasan.

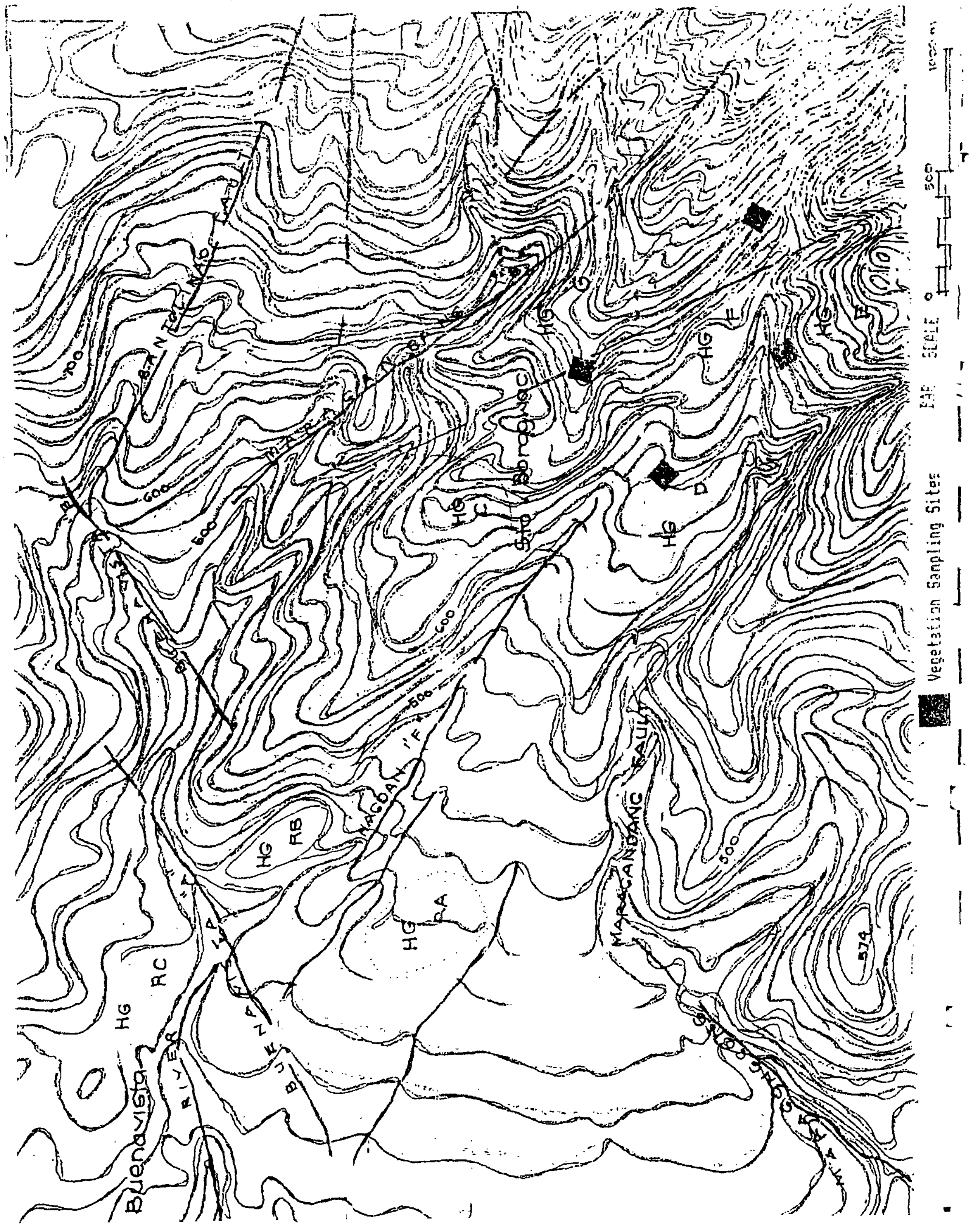
Hagdan Sector

In *Sitio* Hagdan, Bgy. Mailum in Bago City, the exploratory drilling of the geothermal wells were being undertaken when the field work was conducted. The installation of the rig was situated about 10 meters (m) from the sampling site covered during the exploratory phase. The civil works and hauling of heavy equipment were also being undertaken. The construction of the twin sumps was nearly finished. **Fig. 3.1.48** shows the vegetation sampling map.

The proposed drilling site is located in the open disturbed grassland area (see **Fig. 3.1.49**) dominated by *malagabuyo, baho-baho, lambunao and pako-pako*. Other species of grasses and weeds (**Table 3.1.10**), such as *sentimiento, mongo-mongo, lipa* and Imelda vine are also present. They are presented in the table according to their dominance ratio (DR), with the grass or the weed with the highest DR ranking first.

Table 3.1.11 shows the vegetation composition of a logged-over area with open canopy forest (see **Fig 3.1.50**). This forest is located at 814 meters above sea level (masl) and has a 15% slope. The dominant species, based on the computed DR, are *malabuyo, abaca, lipa, cogon,* Imelda vine and *Kalus*. They constitute the first five (5) ranking species.

A sampling site (station 3) was established facing the Mt. Canlaon National Park at an elevation of 722 masl with a 47% slope. The selected site is a logged-over, open canopy area (**Fig. 3.1.51**). Results of the vegetation analysis are presented in **Table 3.1.12**. Litter occupies the highest relative cover and ranks first according to dominance ratio. *Abaca* has a dominance ratio of 9.6 and ranks second. The other dominant plant species encountered in the area



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:
Map of survey areas and sampling stations in Pataan, Mailum, Bago city

FIG. 3.1.48

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:
Vegetation Composition: Disturbed grassland area in Hagdan

FIG. 3.1.49

Table 3.1.10 VEGETATION COMPOSITION OF OPEN DISTRIBUTED AREA IN HAGDAN, MAILUM, BAGO CITY AT 700M ABOVE SEA LEVEL (asl), 20% slope, SW aspect
SAMPLING STATION NO. 1

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Malabuyo	19.10	26.10	8.00	15.10	18.00	1.00
Baho-baho	22.30	22.00	8.00	18.00	17.40	2.00
Lambuno	10.40	22.00	8.00	8.20	14.00	3.00
Pako-pako	8.00	8.40	22.70	19.00	13.00	4.00
Sentimiento	9.30	11.00	8.00	7.30	9.40	5.00
Mongo-mongo	10.00	6.00	8.00	8.00	8.00	6.00
Lipa	3.00	4.40	8.00	2.00	5.10	7.00
Uoko/Imelda vine	5.00	1.40	8.00	4.00	5.00	10.00

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Vegetation Composition: Background-Forested Area; Foreground-Grassland, Cultivated Area

FIG. 3.1.50

TABLE 3.1.11 VEGETATION COMPOSITION OF LOGGED-OVER OPEN CANOPY FOREST AREA IN HAGDAN, MAILUM, BAGO CITY AT 814M FT ABOVE SEA LEVEL (asl), 15% SLOPE, NE ASPECT
SAMPLING STATION NO. 2

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Malabuyo	27.7	12.5	4.4	15.1	15.0	1
Abaca	13.5	13.9	4.4	10.0	11.0	2
Lipa	9.5	4.9	16.1	14.1	10.2	3
Cogon	4.7	8.9	4.0	13.9	10.0	4
Uoko/Imelda vine	13.3	8.6	4.0	9.9	7.0	5
Kalus-kalus	9.1	5.8	12 0	6.7	6.4	6
Tubu-tubu	2.9	4.3	4.4	6.5	6.4	7
Bulubituon	6.8	7.5	8.0	5.1	6.2	8
Paku-pako	2.9	7.3	4.0	4.3	6.1	9
Carabao grass	6.6	5.7	8.0	4.9	5.4	10
Bulo-bulo	2.2	2 5	4.4	3.3	4.2	11
Haras	2.7	2.9	4.4	2.0	3.3	12
Tungao-tungao	2.5	2.5	4.4	1.9	3.1	13
Selaginella	2.9	1.8	4.4	2.1	3.0	14

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DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC

TITLE:
Photo of logged-over open canopy area in sampling station no. 3

FIG. 3.1.51

Table 3.1.12 VEGETATION COMPOSITION OF LOGGED-OVER FOREST AREA AND ABANDONED KAINGIN, SITIO HAGDAN AT 722 (masl) 47% SLOPE, NE ASPECT

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE DENSITY RD	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
litter	36.6	0.1	36.8	24.0	24.5	1
abaca	6.6	15.6	6.6	20.8	9.6	2
bulao-bulao	3.3	19.9	3.3	3.4	8.9	3
hungut-hungutan	6.6	9.0	6.6	11.1	7.4	4
tagpo	3.3	11.3	3.3	6.9	6.0	5
bulubitoon	3.3	11.3	3.3	5.2	6.0	6
talos	6.6	2.9	6.6	4.5	5.4	7
pako	6.6	2.8	6.6	4.2	5.3	8
tagbak	3.3	8.5	3.3	3.4	5.0	9
sangkilan	3.3	8.5	3.3	3.4	5.0	10
bamban	3.3	4.1	3.3	2.8	3.7	11
bare	3.3	-	3.3	3.2	3.3	12
law-at	3.3	2.1	3.3	2.2	2.1	13
pantog-pusa	3.3	1.7	3.3	1.7	2.8	14
bagilumboy	3.3	1.4	3.3	1.0	2.7	15
selagenella	3.3	0.1	3.3	1.3	2.2	16

are *bulao-bulao* (*Palaguim luzoniense*), *hungut-hunguțan* (*Quercus ovalis*), *tagpo* (*Ardisia squamulosa*), *bulubitoon* and *talos* (*Schismatoglottis calyptrata*), ranking from 2-5 in terms of importance value. Litter has a high rank particularly because it occupies a high relative cover, indicating the relatively good formation of organic matter in the forest.

This litter accumulation enhances the improvement of soil physical properties, which eventually will be favorable to the growth of plants/trees.

Another sampling site was established in *Sitio* Hagdan, which falls inside the national park. The species of plants found in the area include *pakol*, *buyo-dalo* (*Piper abbreviatum*), *bagokon* (*Grewia multiflora*), *bayanti* (*Homalathus populneus*), *balokanag* (*Chisocheton cumingianus*), *tugis* (*Languas brevilabris*) *and pako*. They ranked among the top eight (8), including litter which is ranked number 4 (**Table 3.1.13**).

Pataan Sector

In *Sitio* Pataan, the vegetation is mostly open-canopy secondary forest and pine plantation, second growth forest and logged-over abandoned *kaingin*. There were four (4) sampling areas established. The point-centered-quarter and line intercept methods were utilized in these vegetation covers.

In this same *sitio*, the road system was already bulldozed and established. The old trail used to reach the proposed drilling pad over a year ago is now a 6-m-wide road. Before reaching the sampling site, it was observed that the road system followed an old road and trail. It was also noted that portions of cultivated coffee and banana were severely affected, photos of which are shown in **Figs. 3.1.52 to 3.1.53**. See **Fig. 3.1.54** for map of sampling sites for the Pataan sector.

Vegetation analysis was also done in the open-canopy secondary forest at the northwestern part of Canlaon Park at *Sitio* Pagba in Pataan. It lies at 609 masl and has a 30% slope. The data

Table 3.1.13 VEGETATION COMPOSITION OF OPEN CANOPY FOREST IN SITIO HAGDAN AT 777M ELEVATION (asl), 50% SLOPE, NE ASPECT SAMPLING STATION NO. 4

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Pakol	3.3	39.6	4.1	6.8	15.7	1
Bayuhalo	13.3	5.5	16.7	16.7	11.7	2
Bagokon	3.3	26.4	4.1	20.6	11.8	3
Litter	2	0.5	25.1	24.7	11.3	4
Bayanti	1	0.6	12.6	0.5	9.2	5
Balokanag	3.3	7	4.1	6.9	4.8	6
Tugis	3.3	6.6	4.1	5.5	4.7	7
Pako-pako	3.3	5.7	4.1	6.9	4.4	8
Tulotabako	3.3	5.7	4.1	1.6	4.4	9
Bare	3.3		4.1	6.8	3.7	10
Ragiwriw	3.3	2.2	4.1	1.7	3.2	11
Uding	3.3	0.1	4.1	0.0	2.5	12
Aslumaslum	3.3	0.1	4.1	0.0	2.5	13
Hinlalaway	3.3	0.1	4.1	0.0	2.5	14

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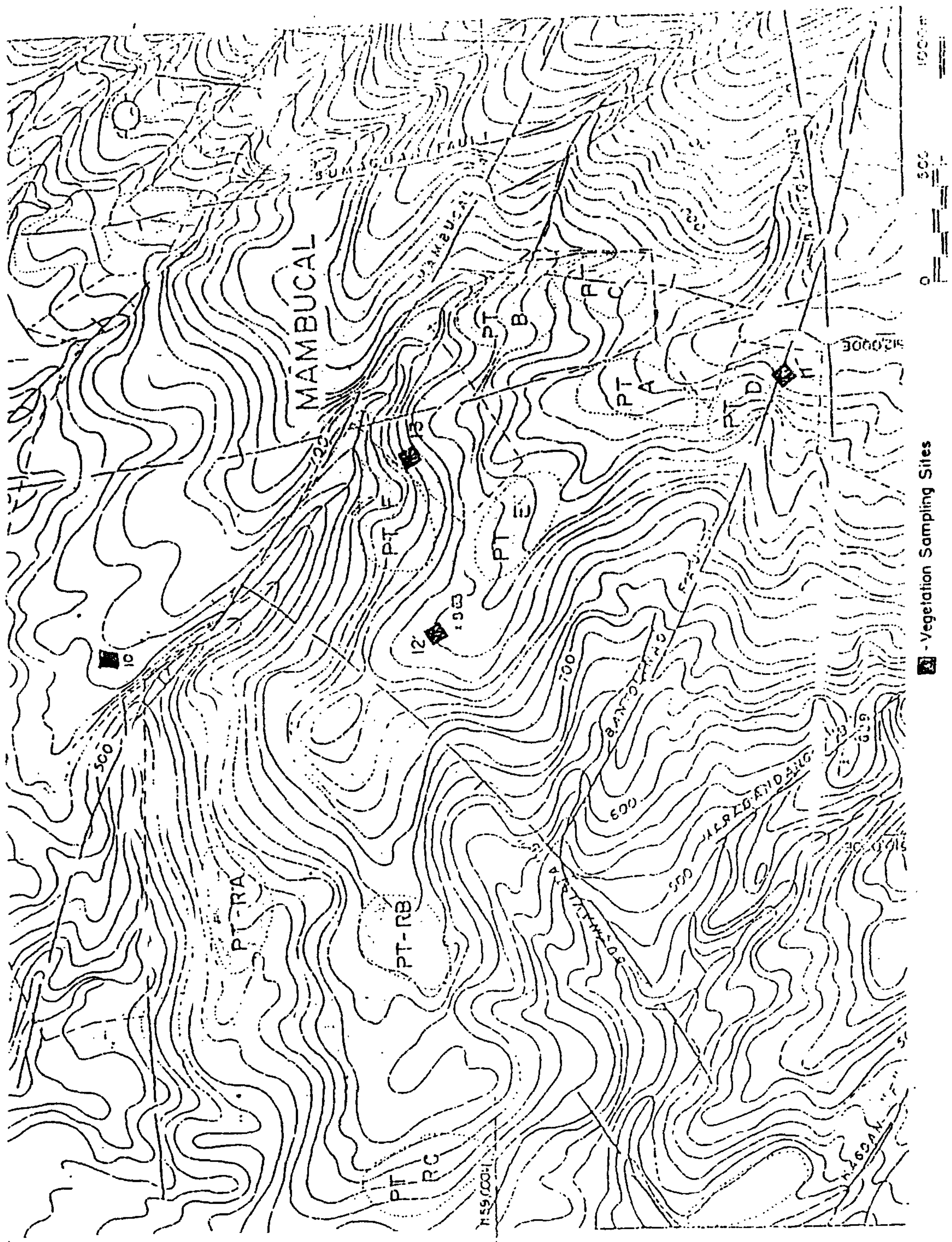
TITLE:

Portions of cultivated coffee and banana

FIG. 3.1.5 and 3.1.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Map of Sampling Sites for the Pataan Sector

FIG. 3.1.54

is presented in **Table 3.1.14**. The area is dominated by Benguet pine (*Pinus kesiya*), planted some 40 years ago. The pine plantation occupies about 20 ha. and is interplanted with mahogany (*Swietenia macrophylla*).

Approaching the pine plantation, other tree species found include narra (*Pterocarpus indicus*), *Eucalyptus, and Wrigthia* among others. The vegetation was analyzed using the point-centered quarter method. This yielded ten (10) species. Based on their importance value, the dominant trees are pine (*Pinus kesiya*), mahogany (*Swietenia macrophylla*), *pipi* (*Actinodaphine dulichophylla*), *amorogna* and *anabiong* (*Trema orientalis*). Benguet pine ranked first, with an importance value of 249.56. The total basal area for pine is 17.195 square meters (m^2) while the average number of trees per hectare is 330.

Sampling station 11 was established and the vegetation composition of the second growth forest in Subang Pula, *Sitio* Pagba, Bgy. Pataan, with an elevation of 672 masl and a slope of 33% is presented in **Table 3.1.15**. The secondary forest is characterized by wide portions of litter and bare area with dominance ratios of 22.5 and 12.4, respectively. These occupy 36.6% and 13.3%, respectively, of the relative cover for the area sampled. Ranking 3rd to 5th based on the dominance ratio are *tagbak, Kowloratia elegans, baligbagan* (unidentified species), *dalakit* (*Ficus mindanaensis*) *bungalon* and *talos*, respectively.

As can be seen in the table, the second growth forest has bare areas and the plant varieties present are of minor value as timber resource, but important as soil cover. The high accumulation of litter is significant for the turn-over and formation of organic matter.

In the same area, a wide portion of the mountain slopes consists of abandoned *kaingin*. A sampling site (station 12) was established at 304 m asl with a 15% slope along its southwestern aspect (**Tab. 3.1.16**). This area is dominated by *paku-pako, payhod, lagasi, uoko*/Imelda vine and *cogon* with dominance ratios of 20.9, 19.50, 16.60, 1570 and 15.30, respectively. Many of the plant varieties identified are weed species and grasses.

Table 3.1.14 VEGETATION COMPOSITION OF OPEN CANOPY SECONDARY FOREST AND PINE PLANTATION IN SUBANG PULA IN SITIO PAGBA, PATAAN, MAAO, BAGO CITY AT 609M (asl), 30% SLOPE AND NW ASPECT USING THE POINT CENTERED METHOD SAMPLING STATION NO. 10

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Pine	76.2	97.4	76.2	6.8	249.6	1
Mahogany	10	0.9	10	16.7	20.9	2
Pipi	10	0.2	10	20.6	20.2	3
Amorogna	10	0.1	10	24.7	20.1	4
Anabiong	10	0.1	10	0.5	20.1	5
Ambot	10	0	10	6 9	20	6
Kobe	2	0.5	2 5	5.5	5.5	7
Binunga	2	0.1	2.5	6.9	5.1	8
Tipolo	1.3	0 9	1.3	1 6	3.4	9
Kakawate	1.3	0.4	1 3	0 0	2.9	10

Table 3.1.15 VEGETATION OF SECONDARY FOREST AREA IN SUBANG PULA, SITIO PAGBA, PATAAN AT 672M (asl), 33% SLOPE AND SE ASPECT SAMPLING STATION NO. 11

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Litter	36.6	0.2	30.6	29.5	22.5	1
Bare	13.3		11.1	9	12.4	2
Tagbak	6.6	12.4	5.5	12.4	8.2	3
Baligbagan	3.3	17.4	2.7	14.2	7.8	4
Dalakit	3.3	6.6	2.7	5.3	7.5	5
Bungalon	6.6	9	5.5	3.1	7.3	6
Talos	10	1.7	8.3	7.1	6.7	7
Kobe	3.3	12.8	2.7	3.5	6.3	8
Kalas-kalas	6.6	3.1	5.5	3.4	5.1	9
Tabong	3.3	8.3	2.7	3.5	4.8	10
Kagay	3.3	7.2	2.7	1	4.4	11
Kamangkilan	6.6	1.1	5.5	3	4.4	12
Pare-pare	3.3	4.2	2.7	0.4	3.4	13
Haras	3.3	1.6	2.7	2.2	2.5	14
Kabungyan	3.3	1.1	2.7	0.4	2.4	15
Buyo-linti	3.3	1.2	2.7	0.6	2.4	16
Turog-turog	3.3	0.7	2.7	0.5	2.2	17

Table 3.1.16 VEGETATION COMPOSITION OF LOGGED OVER FOREST/ABANDONED KAINGIN AREA IN SITIO PATAAN, MAILUM, BAGO CITY AT 304M (asl), 15% SLOPE AND SW ASPECT
SAMPLING STATION NO. 12

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Paku-pako	8.2	5.7	21.0	22.9	20.9	1
Payhod	25.4	27.9	5.3	14	19.5	2
Lagasi	21.4	23.1	5.3	12.0	16.6	3
Uoko	6 1	4.3	15.8	17.2	15.7	4
Cogon	19.1	7.5	15.8	22.7	15.3	5
Agosahis	3.6	4	5.3	2.0	8.9	6
Labnog	8	12.8	5 3	4.7	8.8	7
Mongo-mongo	1.7	4.6	5.3	0.9	8.1	8
Tulotabaco	1.4	3.5	5 3	0.8	6.7	9
Dalupang	1.3	3 4	5 3	0.7	6.4	10
Abaca	2.1	1.7	5.3	1.2	5.6	11
Tungao	1.3	1.8	5 3	0.7	4.7	12

A vegetation sampling (station 13) was conducted in an abandoned *kaingin* which lies within a five (5)-km. radius where the geothermal plant may be located. The area is 676 m asl with a 15% slope. The dominant species are *cogon, hagonoy, toog, tungao* and *sentimiento.*

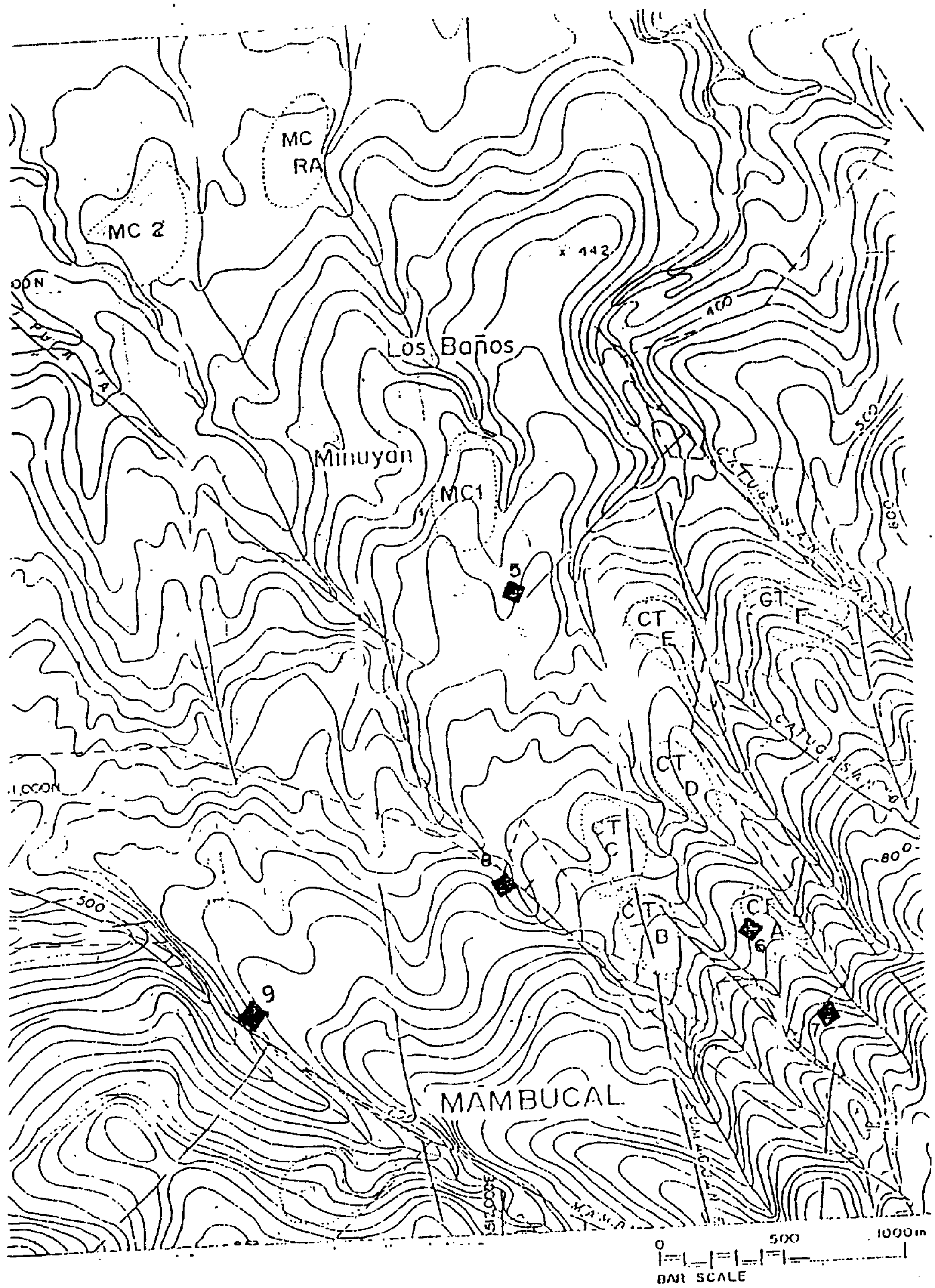
These species encountered in the traverse line are classified as weeds except *toog.*

Catugasan Sector

At *Sitio* Catugasan, vegetation analysis was conducted employing the line-intercept method, point-quarter-centered method and the belt-transect. Five (5) sampling areas were established in the sector, including one at *Sitio* PNOC. A map of the sampling area is enclosed (**Fig. 3.1.55**). Photos of these sites are shown in **Figs. 3.1.56 to 3.1.57**.

Table 3.1.17 shows the vegetation composition of an open-canopy mixed-dipterocarp forest at 804 m asl with a 33% slope (sampling station 5). The vegetation was analyzed using the point-centered quarter-method. There were 26 tree species identified, classified as commercial and non-commercial varieties. Based on their importance values, the dominant species are white *lauan* (*Shorea contorta*), *bagtikan* (*Parashorea malaanonan*), *Kaldemon* (*Atalantia distichia*), and *tangile* (*Shorea polyperma*), with values of 73.6, 47.8, 26.15 and 15 05 respectively. Other miscellaneous trees found are also listed in the table. They are mostly of low economic value. *Apitong* (*Dipterocarpus grandiflora*) is also found in the area, but in very low density and with a frequency of 1 and 1.25, respectively. Another valuable species for commerce present is *kaningag* (*Cinnamomum mercadoi*), though this is of low importance value.

The open disturbed area of *Sitio* Catugasan, Upper Minoyan, Murcia, situated at 677 m asl with a 10% slope and Southeastern aspect, studied a year ago is still in the same condition. Sampling station 6 is dominated by *cogon* (*Imperata cylindrica*), *silhogon* (*Sida acuta*), *amorseco* (*Chrysopogon aciculatus*) and carabao grass (*Paspalum cojugatum*). **Table 3.1.18** presents the vegetation composition. *Cogon* has the largest relative cover, followed by *amorseco* and carabao



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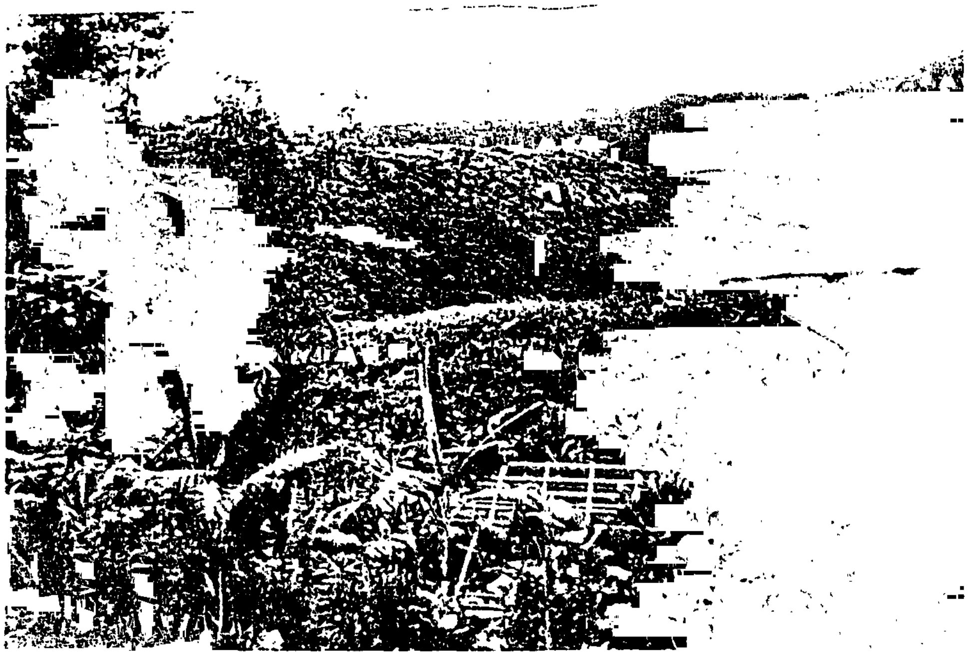
TITLE:
Map of Sampling Sites in Catugasan Area

FIG. 3.1.55



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TITLE:

Photos of the sites at Catugasan

FIG. 3.1.56 and 3.1.57

Table 3.1.17 VEGETATION COMPOSITION OF OPEN CANOPY OF MIXED DIPTEROCARP FOREST IN SITIO KATUGUSAN, UPPER MINOYAN, MURCIA (asl), 33% SLOPE AND SE ASPECT USING THE POINT CENTERED QUARTER METHOD SAMPLING STATION NO. 5

SPECIES	RELATIVE DENSITY RD	RELATIVE DOMINANCE RD	RELATIVE FEQUENT. RF	RELATIVE VALUE RV	RANK
White lauan	17.5	38.6	17.5	73.6	1
Bagtikan	10	27.8	10	48	2
Kaldemon	8	9.4	8.7	26.1	3
Udling	7	2.4	7.5	16.9	4
Tangile	3	8.3	3.7	15	5
Biri	6	0.7	6.2	12.9	6
Miyao	2	8.2	2.5	12.7	7
Bakan/murang	5	1.5	5	11.5	8
Durar-og	2	6.2	2.5	10.7	9
Kape-kape	5	0.4	5	10.4	10
Laku-laku	3	0.5	3.7	7.3	11
Toog	3	0	3.7	6.9	12
Balokanag	2	0.3	2.5	4.8	13
Wild Santol	2	0.3	2.5	4.8	14
Kandalamay	2	0.1	2.5	4.8	15
Tabuyog	2	0.1	2.5	4.6	16
Hamil-ig	2	0.8	1.2	4.6	17
Apitong	1	0.3	1.2	3.7	18
Kaningag	1	0.3	1.2	3	19
Langka-langaka	1	0.1	1.2	2.5	20
Bagolangka	1	0	1.2	2.3	21
Taluto	1		1.2	2.3	22
Tagpo	1		1.2	2.3	23
Taguhangin	1		1.2	2.3	24
Itlog Usa	1		1.2	2.3	25
Yasi	1		1.2	2.3	26

Table 3.1.18 VEGETATION COMPOSITION OF OPEN DISTRIBUTED AREA IN SITIO KATUGUSAN, UPPER MINOYAN, MURCIA, 677M (asl), 10% SLOPE AND SE ASPECT SAMPLING STATION NO. 6

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Cogon	33.1	13.0	17.3	34.0	21.1	1
Silhigon	5.0	17.1	23.4	10.1	15.2	2
Sentimiento	7.0	19.2	6.0	3.3	11.0	3
Carabao grass	7.4	3.0	17.3	15.3	9.2	4
Kalom-kalom	4.0	15.0	6.0	2.0	9.0	5
Amorseco	12.0	6.0	6.0	6.1	8.0	6
Dila-dila	2.3	8.2	12.0	4.0	8.0	7
Homay-homay	5.2	11.0	6.0	3.0	7.4	8
Palagtiki	2.0	7.3	6.0	2.1	3.1	9

grass. The plant varieties identified are indicative of the present environmental condition of the area. The presence of *cogon* may indicate poor soil, while that of *amorseco* may suggest that the area is overgrazed. This information may help in the determination of the appropriate land use for the area.

Another vegetation cover examined in *Sitio* Catugasan is a disturbed pasture area located at 485 m asl, with a 30% slope (sampling station 7). Transect lines on this area were laid to determine its vegetation characteristic. *Lantana camara* ranked first in the list, followed by *bahu-baho*, carabao grass, *dalupang*, *iniam* and *bolo-bolo*. The area is already dominated by weeds. The presence of *iniam* indicates that the area is colonized by pioneering weed varieties. Its growth appeared to be slow because this species is preferred by grazing animals. However, *iniam* could later produce numerous sprouts (**Tab. 3.1.19**).

Further away from the drilling pad at *Sitio* PNOC and traversing the proposed road network of the project, the vegetation composition of an abandoned *kaingin* area along the Asia River was determined. The sampled site (station 8) is at 552 masl with a 70% slope. The area is rocky and previous agricultural activities are still evident as manifest by the sporadic presence of coffee and nangka trees, though growing poorly. Some portions of this area were recently reforested with mahogany provided under the Integrated Protected Areas System (IPAS) program of the Department of Environment and Natural Resources (DENR), Bacolod.

The result of the vegetation analysis is presented in **Tab. 3.1.20**. The dominant species is Imelda vine (*Mikania scandens*), which covers about 23.3% of the sampled area. It ranks number 1 with a dominance ratio of 18.8. Another well distributed plant in the area is *hagonoy* (*Chromolaena odorata*), a noxious weed that efficiently disperses its seeds through the wind. The rest of the vegetation are broad leaf dicots occupying the abandoned *kaingin*.

Along the slopes of Mt. Halcon towards the Mambucal Resort, sampling station 9, which is a mahogany/pine plantation forest occupies at least a 20 ha. area. It is situated at about 556

Table 3.1.19 VEGETATION COMPOSITION OF DISTRIBUTED PASTURE AREA IN SITIO PNOC, UPPER MINOYAN, MURCIA AT ELEVATION OF 485M (asl), 30% SLOPE AND NE ASPECT

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Lantana	20.8	23.3	17.3	19.3	17.6	1
Bahu-baho	11.9	10.5	8.7	16.6	11.8	2
Carabao grass	4.2	5.2	26.1	13.4	11.8	3
Dalupang	11.8	14.5	8 7	10.9	11.7	4
Iniam	13.2	17.4	8.7	12.1	8.9	5
Bolo-bolo	7.2	4.1	13.0	9.9	8.1	6
Mongo-mongo	7.6	9 3	4.3	3.5	7.1	7
Gilon	11.3	3.5	4 3	5.2	6.4	8
Cogon	7.5	2.9	8.7	6.9	6.4	9
Akneb	4 5	9.3	4.3	2.1	6.0	10

Table 3.1.20 VEGETATION COMPOSITION OF LOGGED-OVER OPEN CANOPY FOREST AND ABANDONED KAINGIN ALONG ASIA RIVER IN SITIO PNOC, KATAGUSAN AT 552M (asl), 70% SLOPE AND DN ASPECT
SAMPLING STATION NO. 8

SPECIES	RELATIVE COVER RC	RELATIVE HEIGHT RH	RELATIVE FEQUENT. RF	RELATIVE DOMINANCE RD	DOMINANCE RATIO DR	RANK
Imelda vine	23.3	4.9	26	32.1	18.8	1
Hagunoy	10	10.2	11.1	13.5	10.4	2
Agusais	10	8.3	11.1	10.6	9.8	3
Kanding-kanding	6.6	11.1	7.4	10.1	8.4	4
Tabuyog	3.3	3.9	3.6	9.2	6.9	5
Abungyan	3.3	11.1	3.6	0.5	6	6
Tabong	3.3	8.5	3.6	4.3	5.1	7
Haras	6.6	0.6	7.4	3.1	4.9	8
Talos	3.3	7.3	3.6	7.4	4.7	9
Ipil-ipil	3.3	9.8	3.6	2.9	4.5	10
Bungalon	3.3	3.3	3.6	1.8	3.6	11
Bayanti	3.3	3.1	3.6	1.6	3.3	12
Juamay	3.3	2.7	3.6	0.6	3.2	13
Banana	3.3	2.3	3.6	0.6	3.1	14
Pakol	3.3	1.6	3.6	0.8	2.8	15

asl and has a 44% slope. The vegetation analysis was conducted using the belt-transect metho (Tab. 3.1.21). Mahogany ranks first in the list of 23 species identified and has a DR value o 87.07. Although mahogany does not dominate in terms of height and basal area, it still came ou first due to its high frequency and density. These mahogany trees are expected to dominate i all aspects as they grow. Benguet pine ranked second, with an importance value of 23.90. Thi pine species has the highest average height, average canopy and relative dominance. The othe species in descending order are *pipi*, *bangloy*, *kapi-kapi*, *malapahu*, *kabunyan* and *taluto*. A profile diagram of Pine/Mahogany plantation forest is shown in **Fig. 3.1.58**.

In this plantation, some pine trees are being destroyed through the rampant collection of "sahing" The tree trunk, about 2-3 feet above the ground, are boxed-cut to almost 50% of the tree' circumference. Some wounded trees show severe defoliation and an advanced stage of dryin branches and needles. Other wounded trees are cut and salvaged by other people. Besides pin trees, many mahogany trees and saplings have been cut, leaving stumps of large diameter an mahogany saplings with sprouts. This was also observed among narrow trees with sapling siz of less than 10 cms. in diameter, and the stumps left behind have a number of sprouts. Thes observations suggest that an active destruction of the forest is taking place in the area, eve though it is supposedly a protected national park.

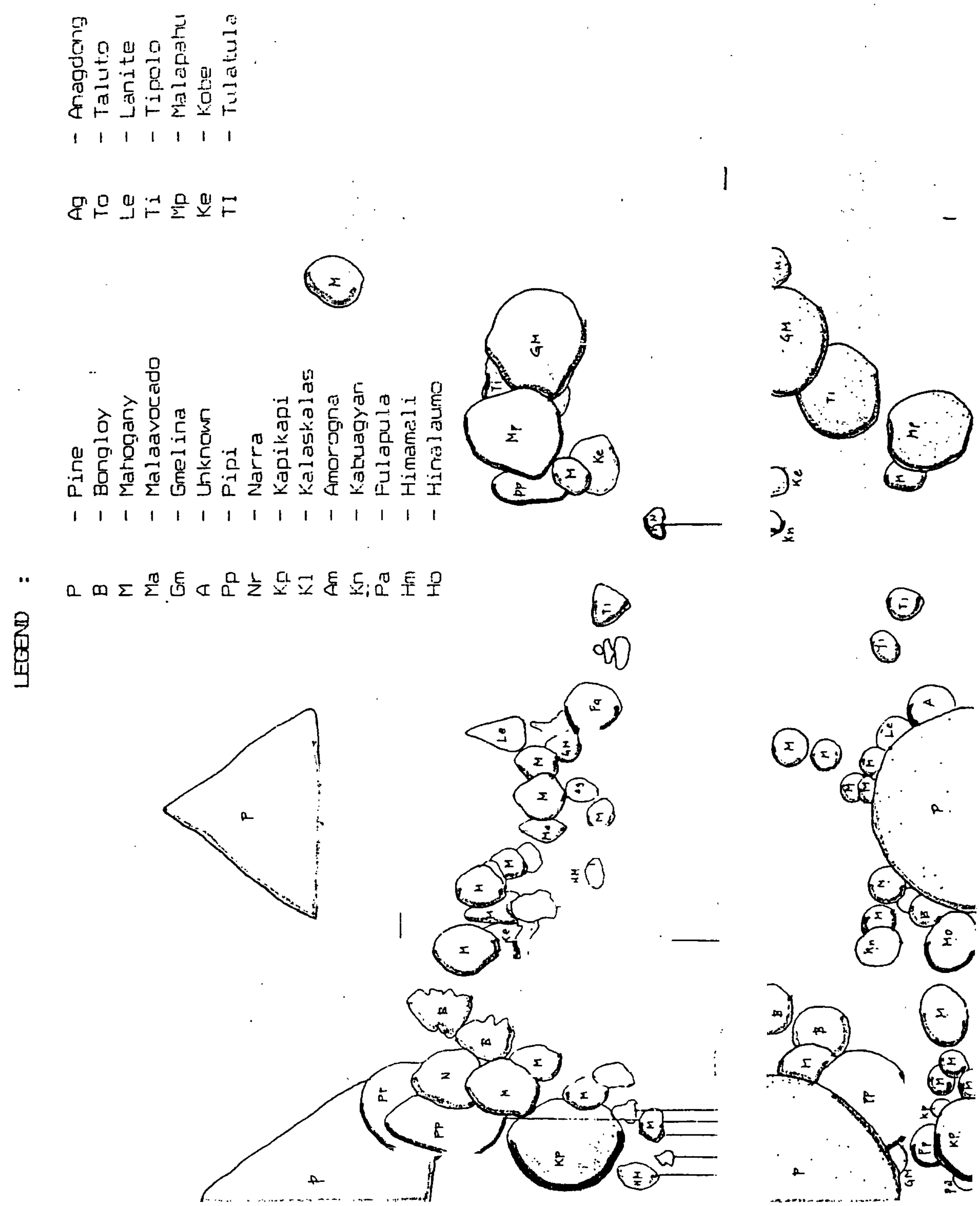
B. VEGETATION ANALYSIS - INDIRECTLY IMPACTED AREAS

The area covered by the environmental impact assessment extends beyond the geothermal bloc and reaches the forested portion of the lower middle mountain slopes of Mt. Canlaon.

Three (3) major plant communities are found in the site, namely: disturbed grass/weed; secon growth forest; and open canopy forest. The disturbed grass/weed community is dominated b grasses namely: *cogon*, *Themada* and *amorseco*. Broad leaf weeds belonging to familie *Compositae*, *Papilionaceae*, *Verbenaceae*, *Tiliaceae* and *Malvaceae*, among others, have als been found. Many of the weed species were seen in abandoned *kaingin* and cultivate

Table 3.1.21 VEGETATION COMPOSITION OF MAHOGANY/PINE PLANTATION IN KATUGASAN, UPPER MINOYAN 556M (asl) 44% SLOPE AND NE ASPECT USING THE BELT TRANSECT METHOD SAMPLING STATION NO. 9

SPECIES	OCCURENCE	AVE. DIA.	AVE. HT.	AVE. CANOPY	RELATIVE DOMINANCE	RELATIVE FREQUENCY	RELATIVE DENSITY	IMPORTANCE VALUE	RANKING
Mahogany	21	0.05	9.76	1.81	5.78	38.18	43.11	87.07	1
Pine	2	0.73	20.00	16.00	11.85	3.64	8.41	23.90	2
Pipi	4	0.07	10.50	3.00	6.22	7.27	8.83	22.32	3
Bongloy	4	0.07	9.25	5.82	5.48	7.27	7.78	20.53	4
Kapi-kapi	2	0.02	7.50	1.90	4.44	3.64	3.15	11.23	5
Malapahu	2	0.31	6.50	1.25	3.85	3.64	2.73	10.22	6
Kabunyan	2	0.07	6.50	1.50	3.85	3.64	2.73	10.22	6
Taluto	1	0.09	10.00	2.00	5.92	1.82	2.10	9.84	7
Kalas-kalas	2	0.02	6.00	1.75	3.55	3.64	2.52	9.71	8
Yemane	2	0.04	5.75	3.00	3.41	3.64	2.42	9.46	9
Tula-tula	1	0.08	9.00	3.00	5.33	1.82	1.89	9.04	10
Malavocado	1	0.02	8.00	2.00	4.74	1.82	1.68	8.24	11
Anagdong	1	0.01	8.00	2.00	4.74	1.82	1.68	8.24	11
Lanite	1	0.01	8.00	3.00	4.74	1.82	1.68	8.24	11
Lauan	1	0.19	6.00	1.00	3.55	1.82	1.26	6.63	12
Hinalaumo	1	0.02	6.00	2.00	3.55	1.82	1.26	6.63	12
Ambot-ambot	1	0.29	6.00	2.00	3.55	1.82	1.26	6.63	12
Kobe	1	0.02	6.00	2.00	3.55	1.82	1.26	6.63	12
Tipolo	1	0.03	5.00	1.00	2.96	1.82	1.05	5.83	13
Amorogna	1	0.02	4.00	2.00	2.37	1.82	0.84	5.03	14
Pula-pula	1	0.09	4.00	1.00	2.37	1.82	0.84	5.03	14
Narra	1	0.01	4.00	1.00	2.37	1.82	0.84	5.03	14
Ambot	1	0.01	3.00	0.80	1.78	1.82	0.63	4.29	15



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Profile diagram of Pine/Mahogany plantation forest in Sitio Gayas, Upper ιminoyan, Murcia at elevation 556m ASL, 44% slope NE aspect

FIG. 3.1.58

areas undergoing a fallow period. The woody species include *Terma orientalis*, *Antidisma fructescent* and *Mallothus sp.*

The species sampled in the disturbed open grassland areas are secondary succession species **(Fig. 3.1.59)**. They occupy the areas opened up during the timber extraction and after the second growth forest was converted into *kaingin*. Because most of the plant families mentioned possess an efficient mechanism of seed dispersal (e.g. *Compositae, Caesalpiniaceae, Graminae*) their colonization of open disturbed space is enhanced.

From a distance, the second growth forest appears to be thickly vegetated, because of overlapping crown. But on a closer look, the forest is nearly bare and has a littered forest floor **(Fig. 3.1.60)**, that provides high relative cover. The vegetation is dominated by the following trees: *Araceae, Aralliaceae, Boraginaceae, Dioscoreaceae, Euphorbiaceae, Zingiberaceae, Malastomataceae, Moraceae, Musaceae, Pandanaceae and Ulmaceae*. Many tree species have colonized the forest when the primary/climax forest was opened up during logging operations. Even though most representative trees in the second growth forest are considered softwood, there is still a danger of destroying the forest's diversity because of the demand for wood for domestic use and trade. It is common to see huts with posts and wall frames made of wood of second growth trees found in the area. There are also some huts which have walls made of Benguet pine slabs.

The forest community is composed of dipterocraps, pines and non-dipterocarp species. Among the dipterocarps, three (3) genera are represented in the area. The pine forest is dominated by *Pinus kesiya*, which was introduced in the area during the early reforestation programs of the government. The non-dipterocarp species are: *Lauraceae, Euphorbiaceae, Moraceae, Meliaceae, Rutaceae, Lecythidaceae, Sterculiaceae and Ulmaceae*.

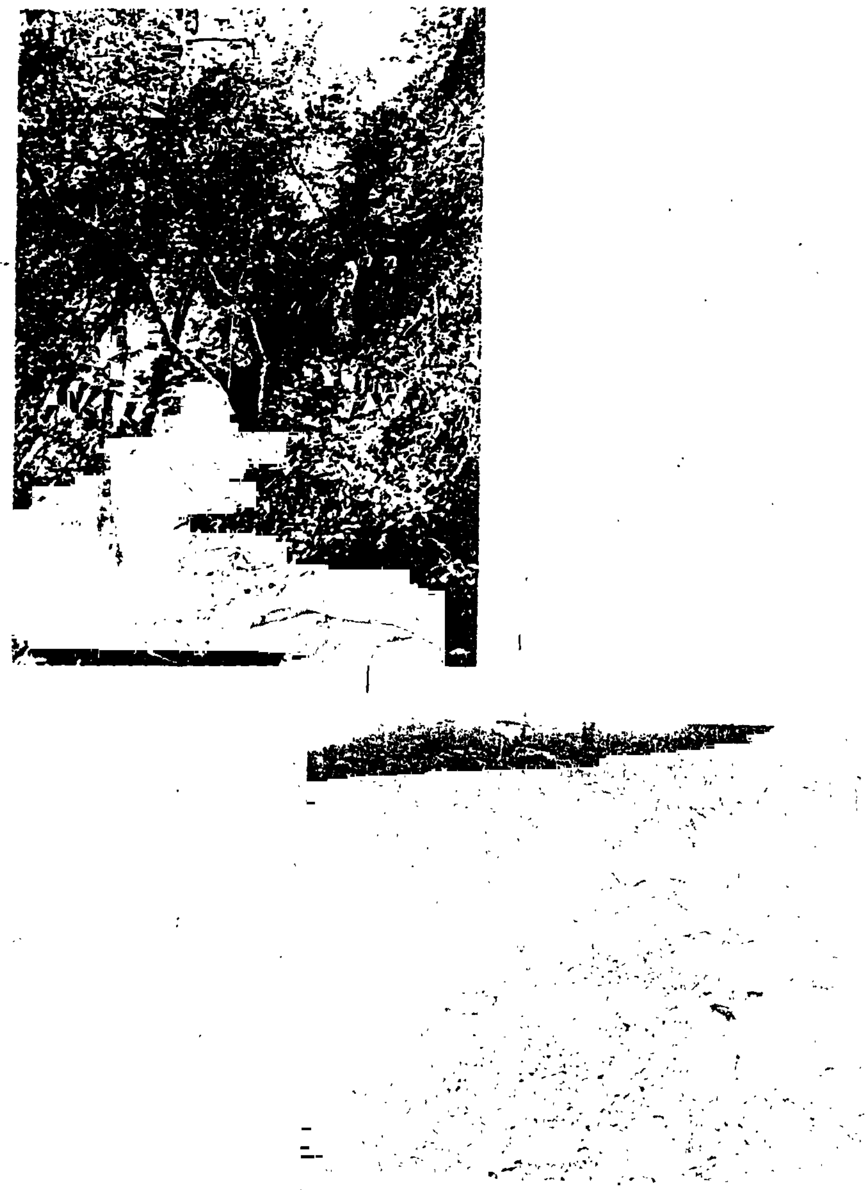
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Disturbed open grassland area and secondary succession species

FIG. 3.1.59



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Photo of forest which looks thickly vegetated but is actually nearly bare

FIG. 3.1.60

In the overstory vegetation, together with the dipterocarp species, *taluto* (*Pterocymbium tinctorium*) and *toog* (*Petersianthus guadrialatus*) also dominated.

The ground communities of the forest are occupied by pteridophytes, climbing bamboos, aroids selaginella and regenerants of the overstory vegetation (**Fig. 3.1.61**). Two 13 x 13 m blocks were established under the forest stand and the wildings of overstory tree species were counted. Wildings of red *lauan, bacan,* white *lauan, pagsahingin, hagakhak, magabuyo* and *tanghay* were mostly found. This suggests that if the forest is left undisturbed, natural regeneration will occur. However, if adequacy of density is desired in an area, the replenishment of artificially raised seedlings can improve forest cover through enrichment planting and assisted natural regeneration scheme.

There are also tree species introduced through reforestation activities. The lower mountain slopes were recently reforested by the DENR-CENRO Bacolod. Tree species found include *Gmelina arborea, Swietenia macrophylla, Pterocarpus inndicus, Cassia spectabilis, Acacia mangium Cacia aurciculiformis* and *Eucalyptus spp.* However, the trees exhibited poor growth probably because of competition with *cogon*. The *acacias* planted within the perimeter of the Don Bosco Parish, on the other hand, showed good growth. This implies that the latter species is tolerant to drought and could thrive on marginal conditions of an open disturbed area. They can serve as good soil cover, which eventually will enhance soil enrichment.

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

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SYSTEMS DEVELOPMENT INC.

TITLE:

Photos of forest vegetation

FIG. 3.1.61

plants present in the area, preliminary information was gathered through on-the-spot interviews with people from the community. The guides who accompanied the team claimed that they are highly dependent on many forest plants for domestic use **(Tab. 3.1.24)**.

The field information was further verified by referring to various botanical books by Brown (1941), Merrill (1923), Quisumbing (1951) and to the **Guide to Philippine Flora and Fauna (1986), Volumes II-IV** by various authors and contributors.

Aside from the domestic use of plants and trees for light construction and furniture, farming implements, basketry, food, and medical purposes, the local people depend on the forest as a source of additional income. Orchid collection, climbing bamboos and rattan gathering, fern trunk harvesting, charcoal-making and tree-cutting are some of the activities undertaken at the periphery and even within the National Park.

E. ENDANGERED, RARE AND ENDEMIC SPECIES FOUND IN THE DEVELOPMENT BLOCK

The category of endemic plants applied in this report is not limited to plant species found only in Negros Occidental, but includes those found in the entire country. Plants in the endemic listing are mostly based on the published account of Merrill (1922-23) and of several authors of the **"Guide to Philippine Flora and Fauna": Vol. II-IV (1986).** The category of endangered species covers those plant varieties whose population have been so reduced that they are in imminent danger of becoming extinct. This reduction in population may have resulted from heavy extraction of forest trees by logging.

Table 3.1.25 enumerates the endemic plants found in the geothermal project site and its immediate vicinities. These species are considered endangered species as listed in **Tab. 3.1.26**. The list is important in the formulation of conservation measures for the included species.

C. TEN (10) MOST IMPORTANT FOREST SPECIES

Based on their ranking in the vegetation analysis of the sampled areas as presented earlier, the ten (10) most important tree species are:

1.	White *Lauan*	-	*Shorea contorta*
2.	*Bagtikan*	-	*Parashoorea malaanonan*
3.	*Kaldemon*	-	*Atalantia disticha*
4.	*Tangile*	-	*Shorea polysperma*
5.	Benguet pine	-	*Pinus kesiya*
6.	Mahogany	-	*Swietenia macrophylla*
7.	*Biri*	-	*Ficus tinctoria*
8.	*Miyao*	-	*Vavaea amicarum*
9.	*Bakan/Marang*	-	*Litsea philippinensis*
10.	*Durar-og*	-	*Ficus pedunculata Miq. imberbis*

Among the tree varieties listed above, the dipterocarps, Benguet pine and mahogany are the most important species because of their high commercial value. The rest are categorized as hardwood of low wood quality.

D. TAXONOMIC ENUMERATION

A list of vascular plant species, found and encountered in the sampling points and survey routes is presented in **Table 3.1.22**. This list does not include plants in pots and those used as ornaments seen along the route.

The vegetation survey (earlier done) and the additional survey of sampling sites yielded 23 species under 189 genera belonging to 66 families. The pteridophytes and mosses observed to be present in **Table 3.1.23**. To have an idea on the number and kind of economically valuabl

Table 3.1.22 TAXONOMIC LIST OF PLANTS FOUND IN THE SAMPLING POINTS AND ALONG SURVEY TRAILS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Acanthaceae	bunlaw	*Justica gendarussa Burm.*
Actinidiaceae	kulalabang	*Saurauia latibractea Choicy*
Asclepiadaceae	ligurias / bukikit	*Asclepis curassivia L.*
Anacardiaceae	kasoy	*Anacardium occidentale L.*
	lamio	*Dracontomelon edule (Bl).) Skeels*
	lako-lako / amugis	*Koordersiodendron pinnatum (Bl.) Merr.*
	bongkoy / pahutan	*Mangifera altissima Bl.*
	manga	*Mangifera indica L.*
	anagas	*Semecarpus elmerianus Perk.*
Annocaceace	guyabano	*Annona muricata L.*
	ilang-ilang	*Cananga odorata (Lam.) Hook. f.*
	talong-gubat, lanutan	*Phaenthus ebacteolatus (Presl.) Merr.*
Apocynaceae	alibutbut / pandakaki	*Tabemaemontana pandacaqui Poir.*
	itlog-usa	*Voacanga globosa (Blanco) Merr.*
	lanite	*Wrightia pubescens R. Br.*
Araceae	gabi	*Aglaonema desinewium Engl.*
	palawan	*Alocacua macrorrhiza (L.) Scholl)*
	Tiger gabi	*Alocasia zebrina C, Koch. & Veitch*
	ando / pongapong	*Amorphopallus campanulatus (Roxb.) Bl.*
	bagak / amlong	*Raphidophora merrillii Engl.*
	lukmoi	*Scindapsus curranii Engl. and Krause*
	alopaye / talos	*Schismatoglottis calyptrata (Roxb.)*
Araliaceae	lunok / oktopos	*Brassaia actinophylla Endl.*
	malapapaya	*Polyscias nodosa Blume.*
	kamang-kamang	*Schefflera clementis Merr.*
	kalang-kalang	*Schefflera insularum (Seem.) Harms*
	galamay-amo	*Schefflera odorata (blanco) Merr & Rolfe*
Auraucariaceae	almaciga	*Agathis philippinensis Warb.*
Bambusaceae	kauayan tinik	*Bambusa blumeana Schultz*
	botong	*Dendrocalamus latiflorus*
	bolo	*Gigantochloa levis (Blanco Merr.)*
	bikal	*Schizostachyum diffusum (Blanco) Merr.*
	pawa	*Schizostachyum fenixii Gamble*
Begoniaceae	aslom	*Begonia everettii Merr.*
Bombacaceae	duldul / kapok	*Ceiba pentandra (L.) Gaertn.*
Boraginaceae	balabaga / halimumog	*Ehretia philippinensis a DC.*
Burseraceae	pagsahingin	*Canarium asperum Benth.*
Caesalpiniaceae	anthoan-dilaw	*Cassia spectabilis L.*
	mongo-mongo	*Cassia timoriensis DC. Prodr.*
	dila-dila	*Cyanometra ineuifolia A. Gray*
	Tubli / Tibangaln	*Derris elliptica (Roxb.)*
Combretaceae	manog talisay/talisay gubat	*Terminalia foetidissima Griff*

Table 3.1.22 TAXONOMIC LIST OF PLANTS FOUND IN THE SAMPLING POINTS AND ALONG SURVEY TRAILS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Compositae	bahu-bahu	*Ageratum conyzoides Linn.*
	hagonoy	*Chromolaena odorata (Linn.) R.M. King and Robinson*
	malasambong	*Crassocephalumcrepedioides (Benth.) Moore*
	malatabako	*Elephantophus tomentosus Kurz.*
	sun-flower	*Helianthephanuus Linn.*
	uuko	*Mikania scandens (L.) Willd.*
	dilang-aso	*Pseudoelepanthopus spiculatus (Juss.) Gleason*
	---	*Spilanthes paniculata*
	wild sunflower	*Tithonia diversifolia A. Gray*
	malasambong	*Vernonia vidalii Merr.*
Crypteroniaceae	bungalon	*Sonneratia caseolaris (Linn.) Engl.*
Cucurbitaceae	melon melon	*Trichosanthes cucumerina Linn.*
	tambo	*Arundo donax L.*
	haras	*Cyperus diffusus Vahl.*
	ragiwriw	*Scirpus grossus Linn. f.*
	---	*Scleria laevis Refz.*
	payongpayong	*Thoracostachyum lucbanense (Elm.) Kerkenth ex Deu.*
Dioscoraceae	kayos	*Dioscorea hispida Dennst. Schlussel*
	pari	*Dioscorea cumingii Orain & Burkill*
Dipterocarpaceae	apitong	*Dipterocarpus grandiflorus Blanco*
	hagakhak	*Dipterocarpus warburgii Brandis*
	bagtikan	*Parashorea malaanonan (Blanco) Merr.*
	red lauan	*Shorea negrosensis Foxw.*
	white lauan	*Shorea contorda Vid.*
	tangile	*Shorea polysperma (Blanco) Merr.*
Ebenaceae	talang-gubat	*Diospyros ahemii Merr.*
Euphorbiaceae	iniam / binayuyo	*Antidesma frutescent Jack*
	bignay-pugo	*Antidesma pentadrum (L.) Blm.*
	dangkalang	*Bredelia stipularis (Henn.) Blume*
	turogturog	*Breynia cimua (Doir.) Muell Arg.*
	bangkuling	*Cicca acida (Linn) Merr.*
	katap	*Croton leiophyllus Muell. Arg.*
	---	*Eucalyptus camaldulenis*
	---	*Euchalyptus saligna*
	pobreng kahoy	*Euphorbia tirucalli Linn.*
	kayong	*Glochidion littorale Blume. Bjdn.*
	matanghipon	*Glochidion philippicum (Cav.) C.B. Rob.*
	balanti	*Homalathus populneus Geisel.) Pax*
	hamil-ig	*Macaranga bicolor Muell. -Arg.*
	binunga	*Macaranga tanarius (L.) Muell.-Arg.*
	tula-tula	*Mallotus florinbundus (Blume) Muell.-Arg.*
	hinlaomo laparan	*Mallotus confusus Merr.*
	hinlaomo	*Mallotus ricinoides (Pers.) Muell. Arg.*
	tabunghian	*Neotremea cumingii (Muell.-Arg.) Pax & Hoffm.*

Table 3.1.22 TAXONOMIC LIST OF PLANTS FOUND IN THE SAMPLING POINTS AND ALONG SURVEY TRAILS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Flagellariaceae	balingway	*Flagellaria indica Linn.*
Fagaceae	hungut-hungutan	*Quercus ovalis Blanco*
	---	*Aliteropsis sp.*
Graminae	amorseco	*Chrysopogon aciculatus (Retz.) Trin.*
	cogon	*Imperata cylindrica (Linn.) Beauv.*
	palagtiki	*Eleusine indica (Linn.) Gaertn.*
	carabao grass	*Paspalum conjugatum Berg.*
	red natal grass	*Pinnesetum polystachyum (Linn) Schutt CE Hubb.*
	---	*Rhynchelytrum repens (Willd.) C.E. Hubb.*
	gilon-gilon	*Rottboellia conchichinensis*
	tambo	*Phragmites karka (Retz) Trin..*
	malatangkad	*Themeda arundinaceae (Rozb.) A. Camus*
Gentianaceae	tulo-tabaco / malasambong	*Budaleia asiatica (Lour.)*
Guttifeae	palomaria / bitaog	*Calophyllum inophyllium L.*
	batuan / binukao	*Garcinia binucao (Blanco) Choisy*
Hippocrateceae	anunggo	*Turpinia pomifera (Roxb.)*
Juglandaceae	bagna	*Engelhardtia parviflora C. DC.*
Labiatae	palapasagi / kambali	*Hyptis capitata Jacq.*
Lauraceae	pipi	*Actinodaphne dulechophylla (Merr.)*
	kaningag / kalingag	*Cinnamomum mercadoi Vid.*
	lau-at / sablot	*Litsea glutinosa (lour.) C.B. Rob.*
	bakan / marang	*Litsea philippinensis Merr.*
	avocado	*Persea americana Mill.*
Lecythidaceae	balubituon	*Barringtonia asiatica (Linn.) Kurz.*
	toog	*Petersianthus quandrialatus Merr.*
Malvaceae	silhigon	*Sida acuta Burm. f.*
	dalupang	*Abutilon indicum (Linn.) Sweet*
	labog-labog / lapnis	*Malchra capitata Linn.*
Marantaceae	higit-hit / kamangkilan	*Phacelophrynium interruptum (Warb.)*
	mangkit	*Urena lobata Linn*
	banban	*Donax canneformis (Forst. f.) K. Schum.*
Melastomataceae	badlin	*Astronia cumingiana Vidal*
	tungao-tungao	*Everettia octodonta Merr.*
	pulo-pinakas	*Medinilla sp.*
	boslog	*Melastoma affine D Don.*
Meliaceae	lumbanao	*Aglaia everettii Merr.*
	balokanag	*Chisocheton cremingianus (C. de Candolli) Harms.*
	malatumbaga	*Chisocheton pentandrus (Blanco) Merr.*
	bagolangka	*Dysoxylum leytense Merr.*
	mountain lanzones	*Lansium domesticum Correa*
	santol	*Sandoricum koetjape (Burm. f.) Merr*
	mahogany	*Swietenia macrophyllia King.*
	Miao	*Vavaea amicorum Benth.*
Menispermaceae	haluot / ambal	*Pycnarrhena maniflensis Vidal*
	kureng	*Stephania japonica (Thunb.) Miers.*

Table 3.1.22 TAXONOMIC LIST OF PLANTS FOUND IN THE SAMPLING POINTS AND ALONG SURVEY TRAILS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Mimosaceae	acacia	*Acacia mangium Willd.*
	auri	*Acacia auriculiformis A. Dunn.*
	payhod / akleng parang	*Albizzia procera (Roxb.) Benth*
	ipil-ipil	*Leucaena leucocephala (Lam.) de Wit*
	giant mimosa	*Mimosa invisa Mart. ex. Colla*
	tuya-tuya / makahiya	*Mimosa pudica Linn.*
	camachile	*Pittecelobium dulce (Roxb.) Benth.*
	bugas	*Pittecelobium ellipticum (Blume) Hasak*
	acacia / raintree	*Samanea saman (Jacq.) Merr.*
Moraceae	antipolo	*Artocarpus blancoi (Elm.) Merr.*
	tipolo, rimas	*Artocarpus communia J.R. & G. Foxw.*
	langka	*Artocarpus heterophyllus Lann.*
	kobe	*Artocarpus nitidus spp. nitidus Trecul*
	marang-banguhan	*Artocarpus odoratissimus Blanco*
	paper mulberry	*Morus alba L.*
	lunok / balite	*Ficus balete Merr.*
	agosahis	*Ficus cumingii Miq.*
	labnog	*Ficus hauili Blanco*
	dalakit	*Ficus mindanaensis Warb.*
	tabong	*Ficus integrifolia Elm. Leafl.*
	tibig	*Ficus nota (Blanco) Merr.*
	pakiling	*Ficus odorata (Blanco) Merr.*
	duraog	*Ficus pedunculosa Miq. imberbis (Elm.)*
	niog-niogan	*Ficus pseudopalma Blanco*
	tabuyog /hawili	*Ficus septica Burm. f.*
	biri	*Ficus tinctoria Forst.*
	takinis / inis	*Ficus ulmifolia Lam.*
	kuyus-kuyus	*Taxotrophis macrophylla (Blume) Boerl.*
Musaceae	saging matsing	*Musa errans (Blanco) Teodoro*
	butulan	*Musa errans (Bl.) teodoro var. Botoan T.*
	abaca	*Musa textiles Mie*
	pula-pula	*Musa sapientum var. humilis*
Myristicaceae	tangkas	*Myristica elliptica var. simiarum (A. de Candolle) sindaer*
	duguan	*Myristica philippinensis Lam.*
Myrsinaceae	tagpo	*Ardisia squamulosa Presl. Re. Haenk.*
Myrtaceae	taguhangin	*Eugenia Clausa C.B. Rob.*
	guava	*Psidium guajava L. (Peri.)*
Orchidaceae	pajarito	*Dendrobium equitans Kranzl*
	sanggumay	*Dendrobium anosmun Lindl.*
	moth butterfly	*Phaleanopsis sp.*
	pink butterfly	*Phaleanopsis equestris*
	ground orchid	*Spathoglottis sp.*
Palmae	bunga	*Areca cetachu L.*
	kaong	*Arenga pinnata (Wurmb.) Merr.*
	palasan	*Calamus merrillii Becc.*
	uay	*Calamus microcarpus*
	botongan	*Calamus filispadix Becc*
	limuran	*Calamus ornatus var. philippinensis Becc.*
	tagiti	*Calamus vidalianus Becc.*
	gatasan	*Daemonorops mollis (Blanco) Merr.*
	bugtong	*Daemonorops ochrolepis Becc.*
	bilis	*Heterospathe sibuyanensis Elm.*

Table 3.1.22 TAXONOMIC LIST OF PLANTS FOUND IN THE SAMPLING POINTS AND ALONG SURVEY TRAILS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Papilionaceae	kadyos / pigeon pea	*Cajanus cajan (Linn.) Millsp.*
	centro	*Centrosema pubescens*
	balog-balog / pukingan	*Clitoria ternatea Linn.*
	---	*Crotolaria mucronata*
	dikit-dikit	*Desmodium gasgeticum (Linn.) DC.*
	dapdap	*Erythrina orientalis (L.) Murr.*
	madre de caco / kakawate	*Gliricidia sepium (Jacq.) Walp.*
	narra	*Pterocarpus indicus Willdenow*
	basingkaran	*Uraria logopodioides (Linn.) Deov. ex DC.*
	kagai	*Whitfordiodendron scandens Elm. ex. Dunn*
Passifloraceae	taungon	*Pasiflora foetida Linn.*
Pandanaceae	pandan	*Pandanus exaltatus Blanco*
Pinaceae	benguet pine	*Pinus kesiya Royle ex Gordon*
Piperaceae	buyo-halo	*Piper abbreviatum Opiz*
	kalaskas	*Piper interruptum var. subarborescens C. DC.*
Rhizophoraceae	bakauan-gubat	*Carallia brachiata (Lour.) Merr.*
Rosaceae	pantog-usa	*Parinarium glabberrium Hassk*
	sampinit	*Rubus fraxinifolius Poir.*
Rubiaceae	kafe	*Coffea spp.*
	kape-kape	*Rondia racemosa (Cav.) F. Viel.*
	---	*Borreria laevis (Lom.) Griseb.*
Rutaceae	kaldemon	*Atalanta disticha (Blanco) Merr.*
	lukban	*Citrus maxima (Burm.) Merr.*
Sapindaceae	tubo-tubo	*Dodonaea viscosa (Linn.) Jacq.*
	alupay-bundok	*Euphoria gr4acilis (Ralk.)*
	hasan, lulatan	*Nephelium mutabile Blume*
Sapotaceae	kaimito	*Chrysophyllum caimito L.*
	nato / bulao-bulao	*Palaquium luzoniense (F. Villar) Vidal*
	tiesa	*Pouteria macranatha (Merr.) Baekni*
Sterculiaceae	taluto	*Pterocymbium tinctorium (Blanco) Merr.*
	duldul / ilahas / kalumpang	*Sterculia foetida L.*
	bulobulo	*Commersonia bartramia (Linn.) Merr.*
	kanding-kanding	*Waltheria americana Linn.*
Tiliaceae	manabo / balobo	*Diplodiscus paniculatus Turez.*
	bagokon	*Gresvia multiflora Juss.*
	datiles	*Muntingia calabura L.*
	kolot-kolotan	*Triumfetta rhomboides Jacq*
Thymelacaceae	salago	*Phaleria perrottetiana (Decne)*
Ulmaceae	mala-ikmo	*Celtis luzonica Warb.*
	malagabuyo	*Celtis philippensis (Blanco)*
	anabiong	*Trema orientales (L.) Blume*
Umbelliferae	yahong-yahong	*Centella asiatica (Linn.) Burban*
Urticaceae	langala / lipang aso	*Fleurya interrupta (Linn.) Gaudich*
	lipa	*Laportea luzonensis (Wedd.) Warb.*
	lipang kalabao	*Lapportea meyeniana (Walp.) Warb*
	lagasi	*Leucosyke capitellata (Poir.) Wedd.*
	nalau	*Piptturus dentatus C.B. Rob*
	handalamai	*Pipturus arborescens (Link.) C.B. Rob.*
Verbenaceae	yemane	*Gmelina arborea Roxb.*
	lantana	*Lantana camara Linn.*
	sentimiento	*Starchytarpeta jamaicensis (L.)*
Vitaceae	ayo, alampirang	*Tetrastigma harmandii Planch.*
	himamali	*Leea indica (Burm. f.) Merr.*
Zingiberaceae	tagbak / wild ginger	*Kolowratia elegans Presl.*
	tugis	*Languas brevilabris (Presl.)*
	torch ginger	*Zingiber negrosense Elm*

TABLE 3.1.23 LIST OF FERN, MOSSES AND OTHERS

Family	Common name	Scientific name
Aspleniaceae	pakpak-lawin	*Asplenium nidus* Linn.
	bird-nest	*Asplenium* sp.
	pako	*Athyrium esculentum* Copel
Cyatheaceae	tree fern	*Cyathea contaminans* (Wall.) Copel.
	salagisog	*Cibotium barometz* (Linn.) J. Sm.
Gleicheniaceae	pakong kalabaw/lalob	*Dicranopteris linearis* (Brum.) Under.
Polypodiaceae	pakong kalabaw	*Angiopteris paemiformis* (Cav.) Cm.
	pako-pako	*Nephrolepis* sp.
Schizaceae	nito	*Lygodium circinnatum* (Burm.) Sw.
	nitong-puti	*Lygodium flexuosum* (Linn.) Sw.
Lycopodiaceae	buntot-pusa	*Lycopodium* sp. L.
	-	*Lycopodium cernuum* L.
Selaginellaceae	-	*Selaginella* sp.
Musci	Spagnum moss	*Sphagnum* sp.

TABLE 3.1.24 LIST OF SOME USEFUL PLANTS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME	USED
Anacardiaceae	kasoy	Anacardium occidentale	food, medicinal
	manga	Mangifera indica	food
	pahutan	Mangifera altissima	food
Annocaceace	guyabano	Annona muricata	food
	ilang-ilang	Cananga odorata	essential oil for perfumery
Apocynaceae	alibutbut / pandakaki	Tabernaemontana pandacaqui	medicine for toothache
Araceae	palawan	Alocacua macrorrhiza	animal feed
	pongapong	Amorphopallus campanulatus	animal feed
	bagak / amlong	Raphidophora merrillii	basketry
	alopaye / talos	Schismatoglottis calyptrata	medicinal
Araliaceae	lunok / oktopus tree	Brassaia actinophylla	ornamental
	galamay-amo	Schefflera odorata	medicinal
Auraucariaceae	almaciga	Agathis philippinensis	premium wood, resin
Aspleniaceae	pako	Athyrium esculentum	food
Bambusaceae	kauayan tinik	Bambusa blumeana	food, construction material, basketry
	botong	Dendrocalamus latiflorus	food, construction material, basketry
	bolo	Gigantochloa levis	food, construction material
	bikal	Schizostachyum diffusum	basketry
Bombacaceae	duldul / kapok	Ceiba pentandra	fiber
Burseraceae	pagsahingin	Canarium asperum	resin
Compositae	hagonoy	Chromolaena odorata	medicinal
Cucurbitaceae	melon melon	Trichosanthes cucumerina	medicinal
Cyperaceae	tambo	Arundo dorax	broom making
Dipterocarpaceae	apitong	Dipterocarpus grandiflorus	timber
	bagtikan	Parashorea malaanonan	timber
	white lauan	Shorea contorda	timber
	red lauan	Shorea negrosensis	timber
	tangile	Shorea polysperma	timber
Euphorbiaceae	iniam / binayuyo	Antidesma frutescent	food, condiment
	bangkiling	Cicca acida	medicinal
	pobreng kahoy	Euphorbia tirucalli	alcohol, medicinal
Fabaceae	kadyos	Cajanus cajan	food
	kakawate	Glincidia sepium	medicinal
Guttiferae	batuan / binucao	Garcinia binucao	food, animal feed
Lauraceae	kaningag / kalingag	Cinnamomum mercadoi	essential oil, medicinal
	avocado	Persea americana	food, medicinal
Marantaceae	bamban	Donax cannaeformis	fiber
Melostomataceae	pulo-pinakas	Medinilla spp.	ornamental
Meliaceae	lanzones	Lansium domesticum	food, medicinal
Mimosaceae	auri	Acacia auriculiformis	pulp, firewood
	acacia	Acacia mangium	pulp, firewood
	ipil-ipil	Leucaena leucocephala	animal feed, firewood
	raintree	Samanea saman	furniture
	camachile	Pittecelobium dulce	food, firewood
	mahogany	Swietenia macrophylla	timber
	santol	Sndoricum koetjape	food
Moraceae	antipolo	Artocarpus blancoi	food
	langka	Artocarpus heterophyllus	food, medicinal
	marang-banguhan	Artocarpus odoratissimus	food
	paper mulberry	Morus alba	silkworm
Musaceae	abaca	Musa textiles	fiber
Myrsinaceae	tagpo	Ardisia squamulosa	medicinal
Myrtaceae	guava	Psidium guajava	food, medicinal

TABLE 3.1.24
Cont'd

LIST OF SOME USEFUL PLANTS

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME	USED
Palmae	bunga	Areca cetachu	medicinal
	kaong	Arenga pinnata	food, broom/brush making
	botongan/tagiktik	Calamus filispadix	basketry/furniture
	palasan	Calamus merrillii	food, basketry/furniture
	kalapi/limuran	Calamus ornatus var. philippinensis	food, basketry/furniture
	bogtong/sumulid	Daemonorops ochrolepis	food, basketry/furniture
	gatasan/ditaan	Daemonorops mollis	food, basketry/furniture
	bilis	Heterospathe sibuyanensis	food
Papilionaceae	kakawate	Gliricidia sepium	fencing
	narra	Pterocarpus indicus	timber, furniture
Pinaceae	benguet pine	Pinus kesiya	timber, furniture
Rhizophoraceae	bakauan-gubat	Carallia brachiata	animal feed
Rubiaceae	kape	Coffea spp.	food
Rutaceae	lukban	Citrus maxima	food, medicinal
Sapindaceae	tubu-tubu	Dodonaea viscosa	medicinal
Sapotaceae	caimito	Chrysophyllum caimito	food, medicinal
	tiesa	Pouteria macranatha	food
Tiliaceae	datiles	Muntingia calbura	fiber, medicinal
	kolot-kolotan	Triumfetta rhomboides	fiber
	balobo	Diplodiscus paniculatus	fiber
Ulmaceae	anabiong	Trema orientales	fiber, medicinal
Urticaceae	langala / lipang aso	Fleurya interrupta	medicinal
	lagasi	Leucosyke capitellata	medicinal
	handalamai	Pipturus arborescens	medicinal
Verbenaceae	yemane	Gmelina arborea	timber
	sentimiento	Starchytarpeta jamaicensis	medicinal
Zingiberaceae	tagbak	Kolowratia elegans	medicinal

TABLE 3.1.25 LIST OF ENDEMIC SPECIES

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Anacardiaceae	lamio	Dracontomelon edule
	pahutan	Mangifera altissima
	anagas	Semecarpus elmerianus
Actinidriaceae	kolalabang	Saurauia latibractea
Araceae	gabi	Aglaonema desinewium
	Tiger gabi	Alocasia zebrina
	bagak / amlong	Raphidophora merrillii
	lukmoi	Scindapsus curranii
Bambusaceae	bikal	Schizostachyum diffusum
	pawa	Schizostachyum fenixii
Boraginaceae	balabaga / halimumog	Ehretia philippinensis
Burseraceae	pagsahingin	Canarium asperum
Compositae	malasambong	Vernonia vidalii Merr.
Dipterocarpaceae	white lauan	Shorea contorda
Euphorbiaceae	hamil-ig	Macaranga bicolor
Guttifeae	binukao	Garcinia binucao
Juglandaceae	bagna	Engelhardtia parviflora C. DC.
Lauraceae	bakan / marang	Litsea philippinensis
Lecythidaceae	toog	Petersianthus quandrialatus
Melastomataceae	tungao-tungao	Everettia octodonta
Meliaceae	lumbanao	Aglaia everettii
	balokanag	Chisocheton clementis
	malatumbaga	Chisocheton pentadrus
	bagolangka	Dysoxylum leytense
	miao	Varaea amicorum
Menispermaceae	ambal	Pycnarrhena maniflensis
Moraceae	antipolo	Artocarpus blancoi
	lunok	Ficus balete
	agosahis	Ficus cumingii
	labnog	Ficus hauili
	tibig	Ficus nota
	pakiling	Ficus odorata
	durarog	Ficus pedunculosa
	niog-niogan	Ficus pseudopalma
	takinis	Ficus ulmifolia
	kuyus-kuyus	Taxotrophis macrophylla
Myristicaceae	duguan	Myristica philippinensis
Myrsinaceae	tagpo	Ardisia squamulosa
Myrtaceae	taguhangin	Eugenia Clausa
Musaceae	abaca	Musa textiles
	saging-matsing	Musa errans
Palmae	botongan	Calamus filispadix
	ditaan	Daemonorops mollis
	bogtong	Daemonorops ochrolepis
Pandanaceae	pandan	Pandanus exaltatus
Rutaceae	kaldemon	Atalanta disticha
Tiliaceae	manabo / balobo	Diplodiscus paniculatus
Ulmaceae	mala-ikmo	Celtis luzonica
Urticaceae	lipa	Laportea luzonensis
Zingiberaceae	torch ginger	Zingiber negrosense

TABLE 3.1.26 LIST OF ENDANGERED SPECIES

FAMILY	LOCAL/COMMON NAME	SCIENTIFIC NAME
Auraucariaceae	almaciga	Agathis philippinensis
Apocynaceae	lanite	Wrightia pubescens
Cyatheaceae	giant tree fern	Cythea contaminas
Dipterocarpaceae	apitong	Dipterocarpus grandiflorus
	bagtikan	Parashorea malaanonan
	red lauan	Shorea negrosensis
Lauraceae	kaningag	Cinnamomum mercadoi
Melastomataceae	pulo-pinakas	Medinilla sp.
Palmae	palasan	Calamus merrillii
	bilis	Heterospathe sibuyanensis

F. PLANTS AS INDICATORS OF CHANGE IN THE ENVIRONMENT

Plants suffer from adverse changes in the physical environment, such as high temperature, limited moisture, extreme/high light conditions and low soil fertility. Prolonged dry spells or drought may cause yellowing of leaves or premature leaf detachment. Changes in climate, e.g., in amount of rainfall, expose vegetation to stress. The "El Niño" effect, for example, caused tremendous crop loss and low yield due to the water stress on plants.

In operation of a geothermal plant, steam and chemical pollutants may be emitted into the atmosphere, which can cause changes in the environment. The vegetation in the project site is composed of some plants that are indicators, as listed in **Table 3.1.27**. The presence of *Imperatacylindrica* and *Lycopodium cernuum* usually suggests that the soil is acidic. Mosses and lichens, on the other hand, are sensitive to air pollution.

There are plants found in the project site and its vicinities that are good absorbers of major air pollutants, such as sulfur dioxide and nitrogen dioxide. According to the report of the Natural Science Research Center (1979), *Leucaena leucocephala, Gmelina arborea, Pandanus exaltatus and Cassia spectabilis* are good absorbers of sulfur dioxide. *Areca catechu* has been reported to be effective in absorbing nitrogen dioxide.

3.1.4 TERRESTRIAL ECOLOGY - AGRICULTURE

The study area for the agriculture component covers the potential agriculture impact areas of the Northern Negros Geothermal Development Project (NNGDP). These impact areas cover :

a. the immediate vicinity of the drilling sites in Minuyan (Murcia), Pataan (Bago City) and Hagdan (Bago City).

b. the areas along both sides of the access roads to the drill sites in Minuyan, Pataan and Hagdan.

Tab. 3.1.27 List of Indicator Plants

INDICATOR PLANT	ENVIRONMENTAL CHANGES
Lycopodium cernuum	Highly leached, acidic soils
Imperata cylindrica	Acidic soils, pioneering weed species in cleared areas pioneering trees in cleared areas
Trema orientalis	pioneering trees in cleared areas
Macaranga	
Mollotus	
Helianthus annuus	Highly leached soil
Chrysopogon aciculatus	Overgrazed pasture areas
Mosses	Indicator of the environment polluted with heavy metals, can accumulate in their tissue large amounts of elements.

3.1.5 TERRESTRIAL ECOLOGY - FAUNA

3.1.5.1 INTRODUCTION

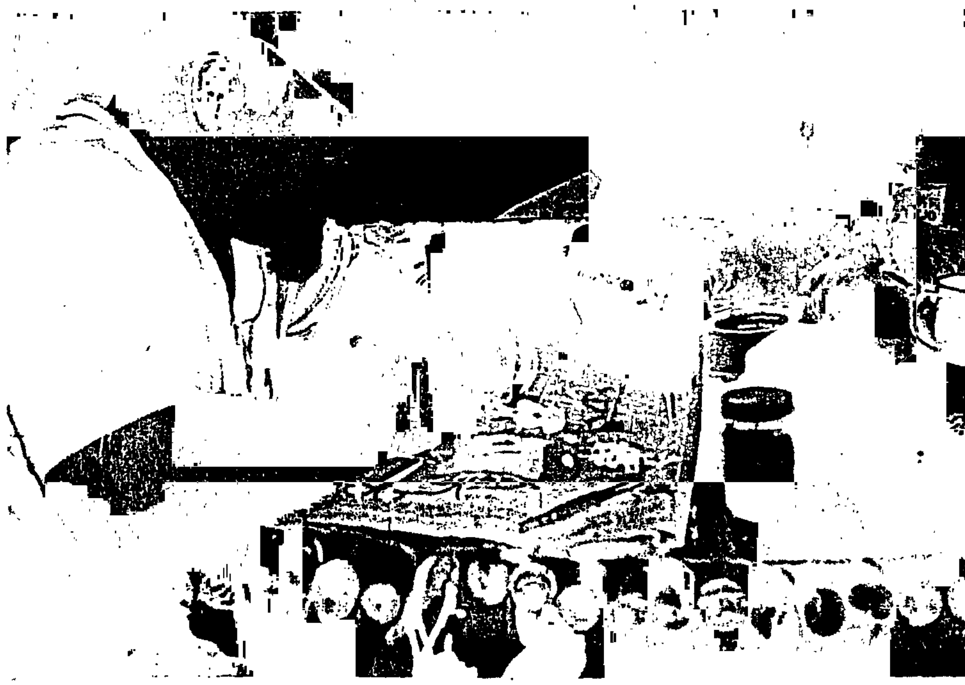
As the geothermal project will be located in the periphery of the Mt. Canlaon National Park, the impact on the wildlife which use the forest as their habitat must be studied. Thus, the existing environmental conditions for terrestrial fauna are presented below. The study for the terrestrial fauna component was conducted from February 13-18, 1994. The team was composed of a wildlife biologist, a research assistant and field guides (**Fig. 3.1.65**). The guides for the Wildlife Team included Mr. Jose Banes and Mr. Gary Navarro of Sitio PNOC, Catugasan, Minoyan, Murcia.

3.1.5.2 METHODOLOGY

Field reconnaissance was made in the proposed development sites in addition to the areas already identified during the previous study (exploration phase). The characteristic vegetation and conditions of these area were noted, especially in affected areas inside the Mt. Canlaon National Park. The wildlife team established six (6) new transect lines for the bird census, in addition to the four (4) transect lines established a year ago during the exploratory phase. Each transect line has a distance of roughly two (2) km.

The King Census Method was used in the bird species inventory. Species observed and calls heard were identified and recorded along the transect line. Census records were made of the bird species using their scientific names and their corresponding number. Along the transect line, lizards, faecal dropping,diggings, and other wildlife activities and signs were also noted.

Ten (10) mistnets of 20 feet (ft.) each and 25 snaptraps were set-up in the forest at *Sitio* Pagba, Mambucal area (near transect V) at 750 meters above sea level. The mistnets and traps were set-up for a period of six (6) days from February 13-18,1994. Mammal species trapped, such as



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
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TITLE:

Study Team: Fauna

FIG. 3.1.65

bats and rats, were preserved in alcohol while others were prepared as museum skins specimen and deposited at the UPLB Natural History Museum for future reference.

Ecological parameters analyzed in this study are the following: Dominance index (C), Evenness Index (e), Species Diversity Index (H). The index of dominance was derived using Simpson's (1994) formula :

$$C = \Sigma\,(ni/N)^2$$

where:

C	=	Dominance Index
ni	=	Importance values per species
N	=	Total importance value.

The Species Diversity Index (H) was based on the Shannon Index of General Diversity (Shannon-Weaver,1963), the formula for which is :

$$H = \Sigma\,(ni/N \log (ni/N))$$

where:

H	=	Species Diversity Index
ni	=	Importance values,
N	=	Total importance values,
log	=	Natural logarithm

The Evenness Index (e) used was that formulated by Pielou (1966), as follows.

$$e = H/\log S$$

where:

H	=	Shannon Index,
S	=	Number of species,

log = Natural logarithm

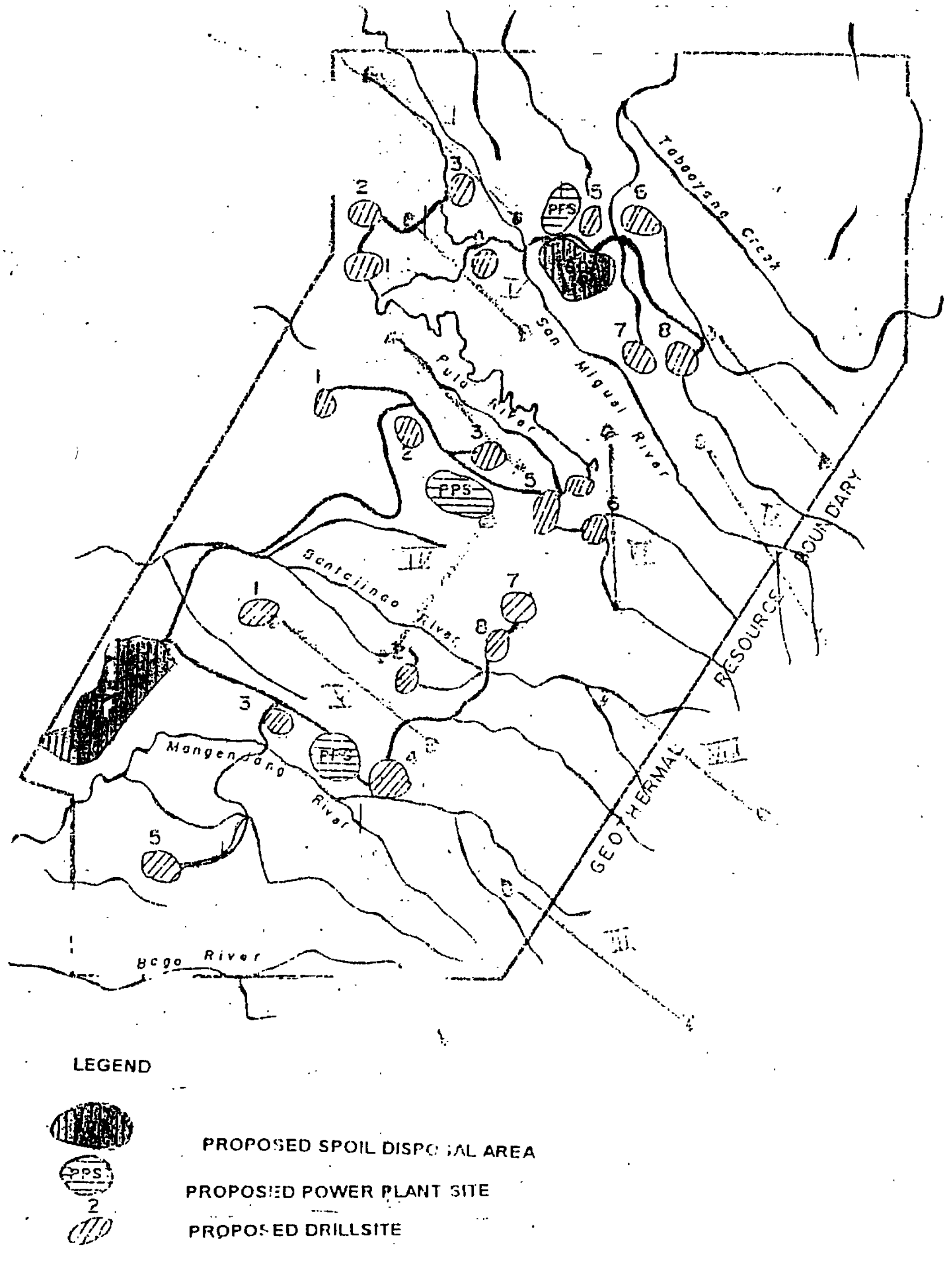
As stated in the EIA study, the three drilling sites of Catugasan, Pataan and Hagdan were considered as one single locality as they are relatively close to each other. The three sites are within the normal home range of wildlife which are mobile, such as most birds and bats. The primary impact areas for wildlife were designated within one (1) km. radius from MC-C drilling site (the northernmost site to HG-B), in Hagdan, which is the southern most site. The secondary impact areas lie primarily in the remaining forested area within the western slopes of Mt. Canlaon National Park.

The first four transect lines established in the EIA Exploration Phase are as follows: Transect I - in Upper Minoyan; Transect II - in Catugasan from MC-C towards the Mt. Canlaon Northwestern Slopes; Transect III - from upper Hagdan up to the inside of the Mt. Canlaon National Park; and Transect IV - from Hagdan to Pataan. The additional transect lines are as follows: Transect V- Mambucal Ridge (400-750 masl); Transect VI - Mambucal- Pataan Trail; Transect VI - Pataan ridge; Transect VIII - Kapatagan-Pataan Mountain Slope; Transect IX - Mambucal Mt. Canlaon Trail (750-1000 masl); and Transect X - Hagdan Ridge (**Fig. 3.1.65A**).

Of the ten transects established, six are inside the resource block and primary impact areas while four are outside the resource block but inside Mt. Canlaon National Park (Transects I,III,VIII and IX). These transects are important especially if the geothermal resource extends inside the National Park. Furthermore, the projected wind dispersion of hydrogen sulfide (H_2S) from the proposed power plant, if located in Pataan or in Hagdan of barangay Mailum, Bago City may affect some areas inside the park.

3.1.5.3 RESULTS AND DISCUSSION

The present survey of wildlife in the vicinity of the PNOC Geothermal Power Project in Mt. Canlaon included three (3) new records of amphibians, in addition to the four (4)



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TITLE:
Additional Transect Lines Established for the Development Phase

FIG. 3.1.65a

previously recorded; three (3) new records of reptiles from the previous record of ten (10) species; 26 additional records of birds; and two (2) new records of mammals (**Tab. 3.1.34a-3.1.34j**).

Transect VIII had the highest number of recorded species of birds with 30. This was followed by Transect V with 29 species; Transect VI with 28 species; and Transect IX with 25 species of birds. These transects are located in forested areas, except Transect V, where the forest is predominantly secondary with some reforested areas. Transects VII and X are found in ridges that have been deforested and are abandoned *kaingin* covered primarily with grasses and shrubs.

On species diversity index values (H), Transect VIII in Kapatagan-Pataan (700-750 masl) had the highest value of 3.07961, closely followed by Transect V - Lower Mambucal Trail (500-600 masl) with a value of 3.01389, and Transect II - Catugasan (650-700 masl) with a value of 3.01330. Kapatagan-Pataan and Catugasan transects are located in an ecotone between forest and grassland - "kaingin" areas. Here, forest birds and grassland birds form a mixed community thereby increasing bird diversity. Lower Mambucal Trail transect is also in an ecotone of second growth forest with orchard and reforested areas also having two groups of birds from the forest and second growth converging in a protected area, thereby increasing bird diversity.

Transect I - Mambucal Resort (300-400 masl) and Transect IV Pataan (400-450 masl) had the lowest value of 1.89670 and 1.34610 respectively because these areas are located in cleared, human disturbed habitats of agricultural crops where bird diversity is minimal. While Transects III in Hagdan (800-850 masl), Transect VI Mambucal-Pataan Trail (750-800 masl), and Transect X - Mt. Canlaon Trail (1000-1200 masl) are located in forested areas have moderate values on species diversity index. This is due mainly to the fact that the birds observed in these areas are composed mainly of forest birds, there are no contributions from grassland or from second growth bird communities.

In dominance index values, Transect I in Mambucal Resort had the highest value of 0.30470, mainly because the dominance of one species, the Philippine Spine-Tailed Swift (*Hirundapus*

TABLE 3.1.34

SUMMARY OF ECOLOGICAL PARAMETERS OF VARIOUS BIRD TRANSECTS MT. CANLAON GEOTHERMAL POWER PROJECT PNOC, February 1993-1994

TRANSECTS	SPECIES DIVERSITY INDEX (H)	DOMINANCE INDEX (C)	EVENNESS INDEX (e)
Mambucal Resort	1.89670	0.30470	0.65620
Catugusan	3.01330	0.07080	0.86180
Hagadan	2.87330	0.09150	0.84480
Pata-an	1.34610	0.06190	0.45420
Lower Mambucal Trail	3.01389	0.07126	0.89505
Mambucal - Pata-an Trail	2.95666	0.07739	0.88730
Pata-an Ridge	2.51087	0.09914	0.90560
Kapatagan - Pata-an	3.07961	0.06160	0.90545
Mt. Canlaon Trail	2.84277	0.08310	0.88316
Hagdan Ridge	2.68110	0.08579	0.89497
TOTAL	**26.21430**	**1.00718**	**8.18853**
AVERAGE	**2.62143**	**0.10072**	**0.81885**

TABLE 3.1.34a BIRD CENSUS IN TRANSECT I AND ECOLOGICAL PARAMETER VALUES OF EACH SPECIES IN CATUGUSAN, UPPER MINOYAN MURCIA, NEGROS OCCIDENTAL

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Collocalia esculenta	50	0.5319	0.2829	-0.6313	-0.3358
Hirundapus celebensis	10	0.1064	0.0113	-2.2407	-0.2384
Apus pacificus	4	0.0425	0.0018	-3.1571	-0.1343
Pycnonotus goiavier	4	0.0425	0.0018	-3.1571	-0.1343
Zosterops nigrorum	4	0.0425	0.0018	-3.1571	-0.1343
Hirundo tahitica	3	0.0319	0.0010	-3.4448	-0.1099
Streptopelia chinensis	3	0.0319	0.0010	-3.4448	-0.1099
Lanius cristatus	2	0.0213	0.0005	-3.8499	-0.0819
Lonchura malacca	2	0.0213	0.0005	-3.8499	-0.0819
Megalurus palustris	2	0.0213	0.0005	-3.8499	-0.0819
Motacilla cinerea	2	0.0213	0.0005	-3.8499	-0.0819
Saxicola caprata	2	0.0213	0.0005	-3.8499	-0.0819
Anthus novaeseelandiae	1	0.0106	0.0001	-4.5431	-0.0483
Cisticola exilis	1	0.0106	0.0001	-4.5431	-0.0483
Cuculus fugax	1	0.0106	0.0001	-4.5431	-0.0483
Nectarinia jugularis	1	0.0106	0.0001	-4.5431	-0.0483
Orthotomus atrogularis	1	0.0106	0.0001	-4.5431	-0.0483
Tyto capensis	1	0.0106	0.0001	-4.5431	-0.0483
N =	94		0.3047		-1.8967

Species Diversity Index (H) = 1.8967

Index of Dominance (C) = 0.3047

Evenness Index (e) = 0.6562

TABLE 3.1.34b BIRD CENSUS IN TRANSECT II AND ECOLOGICAL PARAMETER VALUES OF EACH SPECIES IN CATUGASAN, UPPER MINOYAN MURCIA NEGROS OCCIDENTAL

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Hypsipetes philippinus	15	0.1402	0.0196	-1.9648	-0.2754
Collocalia esculenta	15	0.1402	0.0196	-1.9648	-0.2754
Cacomantis merulinus	11	0.1028	0.0106	-2.2749	-0.2339
Lonchura malacca	7	0.0654	0.0043	-2.7269	-0.1784
Megalurus palustris	7	0.0654	0.0043	-2.7269	-0.1784
Lanius cristatus	5	0.0467	0.0022	-3.0634	-0.1432
Centropus viridis	4	0.0374	0.0014	-3.2864	-0.1229
Dicrurus balicassius	4	0.0374	0.0014	-3.2864	-0.1229
Muscicapa gresiesticta	4	0.0374	0.0014	-3.2864	-0.1229
Orthotomus atrogularis	4	0.0374	0.0014	-3.2864	-0.1229
Pycnonotus goiavier	4	0.0374	0.0014	-3.2864	-0.1229
Aethopyga flagrans	2	0.0187	0.0003	-3.9797	-0.0744
Dicaeum bicolor	2	0.0187	0.0003	-3.9797	-0.0744
Megalurus timoriensis	2	0.0187	0.0003	-3.9797	-0.0744
Surniculus lugubris	2	0.0187	0.0003	-3.9797	-0.0744
Zosterops nigrorum	2	0.0187	0.0003	-3.9797	-0.0744
Accipiter trivirgatus	1	0.0093	0.00009	-4.6728	-0.1437
Brachypteryx montana	1	0.0093	0.00009	-4.6728	-0.1437
Copsychus saularis	1	0.0093	0.00009	-4.6728	-0.1437
Dicaeum pygmaeum	1	0.0093	0.00009	-4.6728	-0.1437
Ficedula hyperythra	1	0.0093	0.00009	-4.6728	-0.1437
Gallus gallus gallus	1	0.0093	0.00009	-4.6728	-0.1437
Hemiprocne comata	1	0.0093	0.00009	-4.6728	-0.1437
Lalage nigra	1	0.0093	0.00009	-4.6728	-0.1437
Lanius schach	1	0.0093	0.00009	-4.6728	-0.1437
Luscinia calliope	1	0.0093	0.00009	-4.6728	-0.1437
Nectarinia jugularis	1	0.0093	0.00009	-4.6728	-0.1437
Phapitreron leucotis	1	0.0093	0.00009	-4.6728	-0.1437
Phylloscopus olivaceus	1	0.0093	0.00009	-4.6728	-0.1437
Rhipidura javanica	1	0.0093	0.00009	-4.6728	-0.1437
Rostratula benghalensis	1	0.0093	0.00009	-4.6728	-0.1437
Sarcops calvus	1	0.0093	0.00009	-4.6728	-0.1437
Spilornis holospilus	1	0.0093	0.00009	-4.6728	-0.1437
	N = 107		0.0708		-3.0133

Species Diversity Index (H) = 3.0133

Index of Dominance (C) = 0.0708

Evenness Index (e) = 0.8618

TABLE 3.1.34c BIRD CENSUS IN TRANSECT III AND ECOLOGICAL PARAMETER VALUES OF EACH SPECIES IN SITIO HAGDAN, MAILUM, BAGO CITY, NEGROS OCCIDENTAL

SPECIES	Ni	ni/N	(ni/N)2	log ni/N	ni/N log ni/N
Hypsipetes philippinus	25	0.2232	0.0498	-1.4996	-0.3347
Collocalia esculenta	15	0.1339	0.0179	-2.0104	-0.2693
Eudynamys scolopacea	10	0.0893	0.0079	-2.4159	-0.2157
Dicaeum trigonostigma	6	0.0536	0.0029	-2.9267	-0.1568
Cacomantis merulinus	5	0.0446	0.00199	-3.1091	-0.1388
Zosterops nigrorum	5	0.0446	0.00199	-3.1091	-0.1388
Lanius cristatus	4	0.0357	0.0013	-3.3322	-0.1190
Nectarinia jugularis	4	0.0357	0.0013	-3.3322	-0.1190
Zosterops montana	4	0.0357	0.0013	-3.3322	-0.1190
Gerygone sulphurea	3	0.0268	0.0007	-3.6199	-0.0970
Orthotomus atrogularis	3	0.0268	0.0007	-3.6199	-0.0970
Brachypteryx montana	2	0.0178	0.0003	-4.0254	-0.0719
Chalcophaps indica	2	0.0178	0.0003	-4.0254	-0.0719
Loriculus philippensis	2	0.0178	0.0003	-4.0254	-0.0719
Phylloscopus trivirgatus	2	0.0178	0.0003	-4.0254	-0.0719
Rhipidura cyaniceps	2	0.0178	0.0003	-4.0254	-0.0719
Sarcops calvus	2	0.0178	0.0003	-4.0254	-0.0719
Sitta frontalis	2	0.0178	0.0003	-4.0254	-0.0719
Tanygnathus lucionensis	2	0.0178	0.0003	-4.0254	-0.0719
Zosterops nigrorum	2	0.0178	0.0003	-4.0254	-0.0719
Copsychus saularis	1	0.0089	0.00008	-4.7186	-0.0421
Chrysocolaptes lucidus	1	0.0089	0.00008	-4.7186	-0.0421
Dicaeum australe	1	0.0089	0.00008	-4.7186	-0.0421
Dicaeum hypoleucum	1	0.0089	0.00008	-4.7186	-0.0421
Eurystomus orientalis	1	0.0089	0.00008	-4.7186	-0.0421
Hypothymis azurea	1	0.0089	0.00008	-4.7186	-0.0421
Nectarinia sperata	1	0.0089	0.00008	-4.7186	-0.0421
Penelopides panini	1	0.0089	0.00008	-4.7186	-0.0421
Pachycephala homeyeri	1	0.0089	0.00008	-4.7186	-0.0421
Stachyris capitalis	1	0.0089	0.00008	-4.7186	-0.0421
	N = 112		0.0915		-2.8733

Species Diversity Index (H) = 2.8733

Index of Dominance (C) = 0.0915

Evenness Index (e) = 0.8448

TABLE 3.1.34d BIRD CENSUS OF TRANSECT IV AND ECOLOGICAL PARAMETER VALUES OF EACH SPECIES IN SITIO PATA-AN, MAILUM, BAGO CITY, NEGROS OCCIDENTAL

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Collocalia esculenta	10	0.1613	0.0260	-1.8061	-0.2943
Apus pacificus	6	0.0968	0.0094	-2.3354	-0.2260
Hirundo tahitica	5	0.0806	0.0065	-2.5178	-0.2030
Hypsipetes philippinus	5	0.0806	0.0065	-2.5178	-0.2030
Lonchura malacca	4	0.0645	0.0042	-2.7408	-0.1768
Artamus leucorhynchus	2	0.0323	0.0010	-3.4339	-0.1108
Centropus benghalensis	2	0.0323	0.0010	-3.4339	-0.1108
Megalurus palustris	2	0.0323	0.0010	-3.4339	-0.1108
Lanius cristatus	2	0.0323	0.0010	-3.4339	-0.1108
Halcyon chloris	2	0.0323	0.0010	-3.4339	-0.1108
Pycnonotus goiavier	2	0.0323	0.0010	-3.4339	-0.1108
Saxicola caprata	2	0.0323	0.0010	-3.4339	-0.1108
Aethopyga siparaja	1	0.0161	0.0003	-4.1271	-0.0666
Anthus novaeseelandiae	1	0.0161	0.0003	-4.1271	-0.0666
Cisticola exilis	1	0.0161	0.0003	-4.1271	-0.0666
Haliastur indus	1	0.0161	0.0003	-4.1271	-0.0666
Hirundapus celebensis	1	0.0161	0.0003	-4.1271	-0.0666
Motacilla cinerea	1	0.0161	0.0003	-4.1271	-0.0666
Nectarinia jugularis	1	0.0161	0.0003	-4.1271	-0.0666
Streptopelia bitorquata	1	0.0161	0.0003	-4.1271	-0.0666
N =	52		0.0619		-1.3461

Species Diversity Index (H) = 1.3461

Index of Dominance (C) = 0.0619

Evenness Index (e) = 0.4542

TABLE 3.1.34e BIRD TRANSECT V ALONG LOWER MAMBUCAL RIDGE
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 1[illegible]-19, 1994

SPECIES	Ni	ni/N	(ni/N)2	log ni/N	ni/N log ni/N
Hypsipetes philippinus	15	0.17857	0.03189	-1.72277	-0.30764
Zosterops montana	10	0.11905	0.01417	-2.12521	-0.25336
Zosterops nigrorum	6	0.07143	0.00510	-2.63904	-0.18851
Collocalia esculenta	5	0.05952	0.00354	-2.82144	-0.16793
Lonchura malacca	4	0.04762	0.00227	-3.04450	-0.14498
Lanius cristatus	4	0.04762	0.00227	-3.04450	-0.14498
Pycnonotus goiavier	4	0.04762	0.00227	-3.04450	-0.14498
Apus pacificus	3	0.03571	0.00128	-3.33232	-0.11900
Centropus viridus	2	0.02381	0.00057	-3.73765	-0.08900
Chrysocolaptes lucidus	2	0.02381	0.00057	-3.73765	-0.08900
Lalage melanoleuca	2	0.02381	0.00057	-3.73765	-0.08900
Lalage nigra	2	0.02381	0.00057	-3.73765	-0.08900
Lonchura leucogastra	2	0.02381	0.00057	-3.73765	-0.08900
Motacilla cinerea	2	0.02381	0.00057	-3.73765	-0.08900
Nectarinia jugularis	2	0.02381	0.00057	-3.73765	-0.08900
Orthotomus atrogularis	2	0.02381	0.00057	-3.73765	-0.08900
Pachycephala cinerea	2	0.02381	0.00057	-3.73765	-0.08900
Parus elegans	2	0.02381	0.00057	-3.73765	-0.08900
Pericrocotus flammeus	2	0.02381	0.00057	-3.73765	-0.08900
Picoides maculatus	2	0.02381	0.00057	-3.73765	-0.08900
Aethopyga siparaja	1	0.01190	0.00014	-4.43122	-0.05273
Coracina striata	1	0.01190	0.00014	-4.43122	-0.05273
Eumyias panayensis	1	0.01190	0.00014	-4.43122	-0.05273
Ninox philippinensis	1	0.01190	0.00014	-4.43122	-0.05273
Otus scops	1	0.01190	0.00014	-4.43122	-0.05273
Phapitreron leucotis	1	0.01190	0.00014	-4.43122	-0.05273
Sitta frontalis	1	0.01190	0.00014	-4.43122	-0.05273
Spilornis cheela	1	0.01190	0.00014	-4.43122	-0.05273
Streptopelia bitorquata	1	0.01190	0.00014	-4.43122	-0.05273
N =	84		**0.07126**		**-3.01389**

Species Diversity Index (H) = 3.01389

Index of Dominance (C) = 0.07126

Evenness Index (e) = 0.89505

TABLE 3.1.34f BIRD TRANSECT VI ALONG MAMBUCAL-PATAAN TRAIL
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	$(ni/N)^2$	log ni/N	ni/N log ni/N
Hypsipetes philippinus	18	0.19780	0.03912	-1.62050	-0.32053
Zosterops nigrorum	10	0.10989	0.01208	-2.20827	-0.24267
Zosterops montana	8	0.08791	0.00773	-2.43144	-0.21375
Eumyias panayensis	6	0.06593	0.00435	-2.71916	-0.17927
Coracina striata	4	0.04396	0.00193	-3.12448	-0.13735
Lonchura leucogastra	4	0.04396	0.00193	-3.12448	-0.13735
rthotomus atrogularis	3	0.03297	0.00109	-3.41216	-0.11250
Parus elegans	3	0.03297	0.00109	-3.41216	-0.11250
Pewricrocotus flammeus	3	0.03297	0.00109	-3.41216	-0.11250
Aethopyga siparaja	2	0.02198	0.00048	-3.81762	-0.08391
Centropus viridus	2	0.02198	0.00048	-3.81762	-0.08391
Cuculus fugax	2	0.02198	0.00048	-3.81762	-0 08391
Dicrurus balicassius	2	0.02198	0.00048	-3.81762	-0.08391
Ficedula westermani	2	0.02198	0.00048	-3.81762	-0.08391
Lonchura malacca	2	0.02198	0.00048	-3.81762	-0.08391
Loriculus philippinensis	2	0.02198	0.00048	-3.81762	-0.08391
Megalarus palustris	2	0.02198	0.00048	-3.81762	-0.08391
Motacilla cinerea	2	0.02198	0.00048	-3.81762	-0.08391
Pachycephala cinerea	2	0.02198	0.00048	-3.81762	-0.08391
Picoides maculatus	2	0.02198	0.00048	-3.81762	-0.08391
Sarcops calvus	2	0.02198	0.00048	-3.81762	-0.08391
Sitta frontlatis	2	0.02198	0.00048	-3.81762	-0.08391
Cacomantis merulinus	1	0.01099	0.00012	-4.51077	-0.04957
Dryocopus javensis	1	0.01099	0.00012	-4.51077	-0.04957
Megalaima haemacephala	1	0.01099	0.00012	-4.51077	-0.04957
Ninox philippensis	1	0.01099	0.00012	-4.51077	-0.04957
Phapitreron amethystina	1	0.01099	0 00012	-4.51077	-0.04957
Phapitreron leucotis	1	0.01099	0.00012	-4.51077	-0.04957
N =	91		0.07739		-2.95666

Species Diversity Index (H) = 2.95666

Index of Dominance (C) = 0.07739

Evenness Index (e) = 0.88730

TABLE 3.1.34g BIRD TRANSECT VII ALONG PATA-AN RIDGE
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	$(ni/N)^2$	log ni/N	ni/N log ni/N
Aplonis panayensis	10	0.16393	0.02687	-1.80832	-0.29644
Collocalia esculenta	10	0.16393	0.02687	-1.80832	-0.29644
Apus pacificus	8	0.13115	0.01720	-2.03141	-0.26642
Hirundo tahitica	5	0.08197	0.00672	-2.50140	-0.20504
Artamus leucorhynchos	4	0.06557	0.00430	-2.72464	-0.17865
Lonchura leucogastra	4	0.06557	0.00430	-2.72464	-0.17865
Pycnonotus goiavier	4	0.06557	0.00430	-2.72464	-0.17865
Lanius cristatus	3	0.04918	0.00242	-3.01227	-0.14814
Cisticola exilis	2	0.03279	0.00108	-3.41763	-0.11206
Hirundapus celebensis	2	0.03279	0.00108	-3.41763	-0.11206
Megalurus timoriensis	2	0.03279	0.00108	-3.41763	-0.11206
Nectarinia jugularis	2	0.03279	0.00108	-3.41763	-0.11206
Saxicola caprata	2	0.03279	0.00108	-3.41763	-0.11206
Anthus novaeseelandiae	1	0.01639	0.00027	-4.11108	-0.06738
Centropus viridis	1	0.01639	0.00027	-4.11108	-0.06738
Hemiprocne comata	1	0.01639	0.00027	-4.11108	-0.06738
N =	61		0.09914		-2.51087

Species Diversity Index (H) = 2.51087

Index of Dominance (D) = 0.09914

Evenness Index (e) = 0.90560

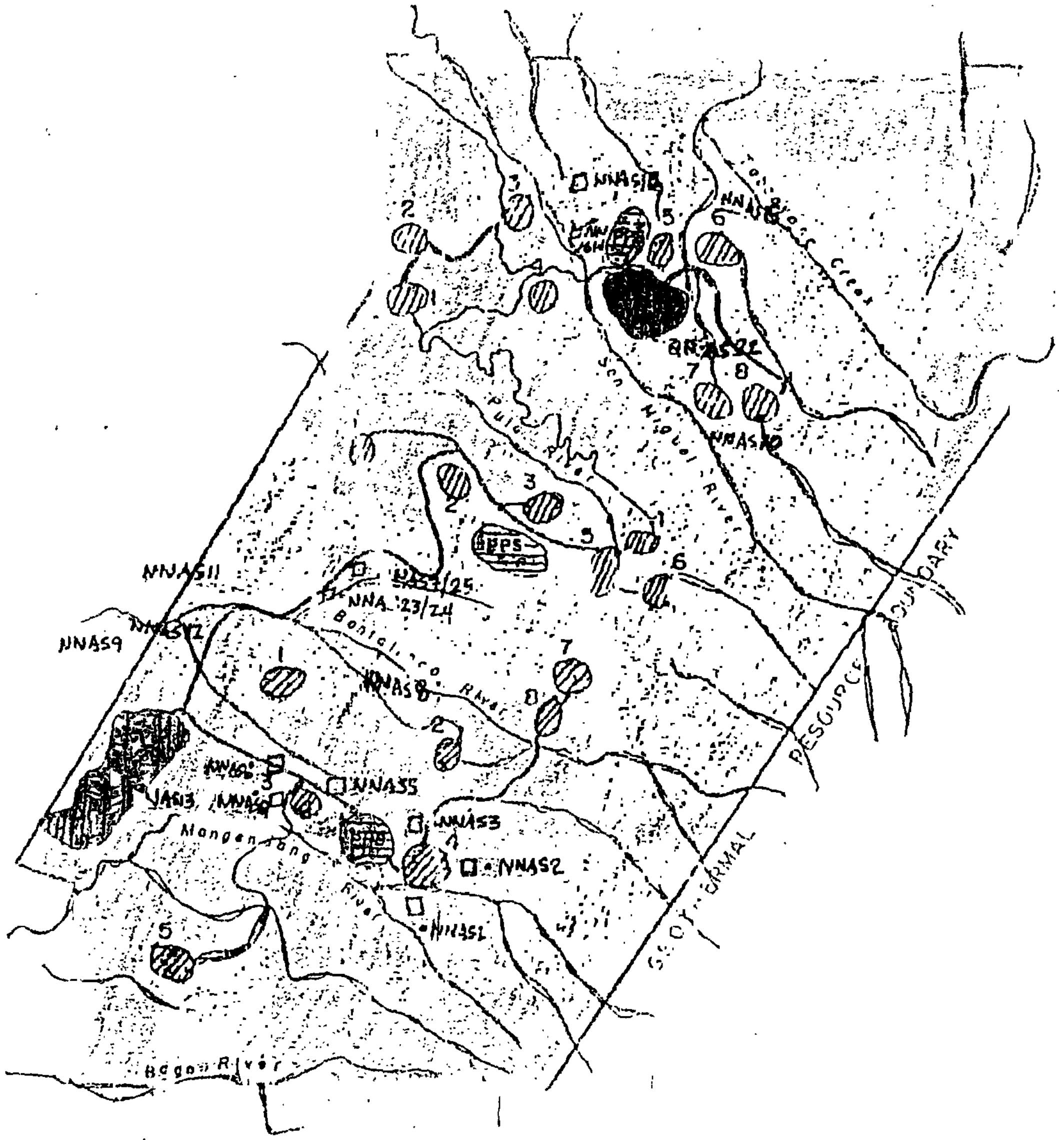
c. the areas irrigated by water from the Bago river and its tributaries like: the Asia and San Miguel rivers in the town of Murcia and the Magondong, Bantolinao, Maugbi, Mailum and Ma-ao rivers

Figure 3.1.62 shows the geothermal block as well as the agricultural and sampling stations.

3.1.4.1 IRRIGATION WA ER

The study area is serviced by one (1) big irrigation system, three (3) irrigation systems, one (1) private diversion dam and several small diversions of water coming from springs, creeks and rivers. Many of these springs, creeks and rivers are tributaries of the big Bago river. The following irrigation system/water sources and estimated area irrigated provide an indication of the extent of water use in the project site:

Irrigation System	Water Source Irrigated	Area
Bago River Irrigation System	Bago River	12,700 ha.
Ma-ao Communal Irrigation System	Ma-ao River	20 ha
Bacus Communal Irrigation System	San Isidro River	25 ha.
Tabidiao Communal Irrigation System	Maragandang River	20 ha.
Diversions:	Buñag spring	<5 ha.
	Hagdan spring	- same -
	Pataan creek	- same -
	Erly creek	- same -
	Maugbi creek	- same -
	Catugasan creek	- same -
	Simaguan river	- same -
	Mambucal spring	- same -



LEGEND:

PROPOSED SPOIL DISPOSAL AREA

PROPOSED POWER PLANT SITE

PROPOSED DRILLSITE

ROADS

RIVER

LEGEND:

Ricefield Stations

Non-ricefield stations (sugarcane, camote, abaca, mulberry)

Rice areas

Road (existing)

River

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Agricultural Sampling Stations within the Geothermal Block

FIG. 3.1.62

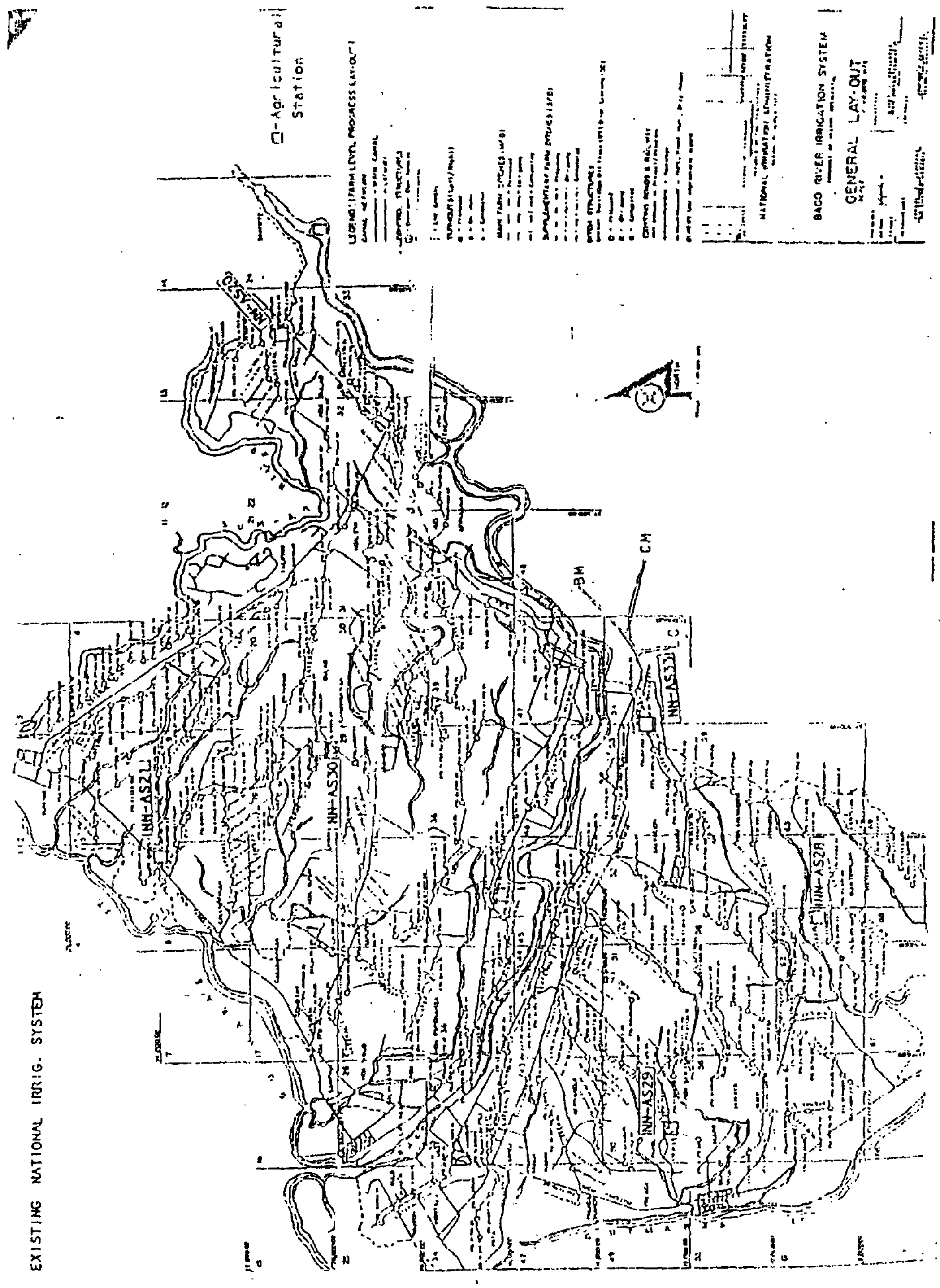
The quality of irrigat on water w s studied by subjecting water samples to chemical an **Table 3.1.28** lists the sampling sta ions, water source and crops grown. **Figure 3.1.63a-d** the sampling stations within the arious National Irrigation Administration (NIA) - in irrigation systems. The data in **Table 3.1.29**, shows very low levels of Lithium, Boron, A and other heavy metals.

3.1.4.2 FARM AND SOII

Cultivated farms include those with topographies that are level to nearly level (**A**) (0-8% sl moderately sloping or rolling (**B**) (9-18% slopes); strongly sloping or rolling (**C**) (19-30% the hilly to mountainous farm lands. A farms are mostly found in the irrigated lowlands a planted to rice; B farms are dominant on areas approaching the geothermal block and are p to sugarcane, annual field crops, fruit trees, and coconuts; and C farms are found geothermal block and its immediate vicinity although one can see patches of areas along and springs which are terraced and planted to lowland rice whenever water impoundn possible.

The soils in the study area vary greatly among farms located in different elevations. Soils lowlands are dominated by Guibalaon clay. Farms found along the Bago river, however soils with textures of Guimbalaon loam, Silay sandy loam, Bago fine sandy loam, Guim fine sandy loam, and Tapi fine sandy loam. Farms within and around the vicinity geothermal block are characterized by the presence of rough mountainous stones.

Further study of the soil was made by gathering soil samples in strategic points of the stud The chemical and physical characteristics of these samples were analyzed in the laborator data in **Table 3.1.30, Appendix 3-B** indicates high pH for soils in the uplands compare the lowlands. Except for iron, metals like Boron and lead are quite low.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

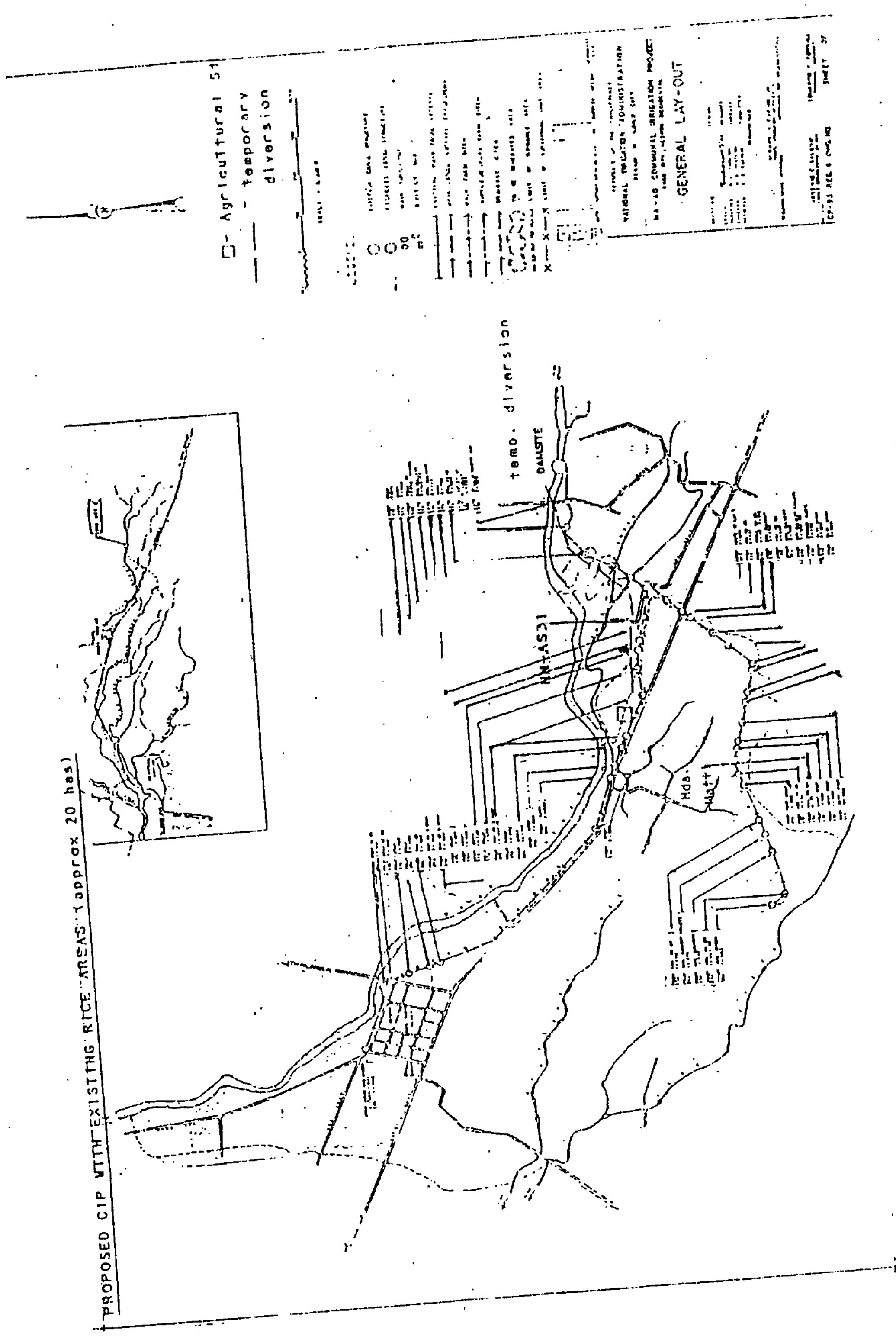
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Sampling Stations in the BRIS

FIG. 3.

TABLE 3.1.28 AGRICULTURAL SAMPLING STATIONS, WATER SOURCE AND CROPS GROWN

STATION NO.	LOCATION	WATER SOURCE	CROP GROWN
1. NN-AS1	South of HG-C pad	Rainfed	Rice
2. NN-AS2	North of HG-C pad	Rainfed	Gabi
3. NN-AS3	West of HG-C pad	Rainfed	Peanut, Cassava
4. NN-AS4	West of power plant	Rainfed	Sugarcane
5. NN-AS5	Hagdan, Mailum	Buna Spring	Rice
6. NN-AS6	Hagdan, Mailum	Hagdan Spring	Rice
7. NN-AS7	Pataan, Mailum	Pataan Creek	Rice
8. NN-AS8	Pataan, Mailum	Erly creek	Rice
9. NN-AS9	Kipot	Magubi Creek	Rice
10. NN-AS10	Catugasan (pad west of CT-A)	Spring	Rice
11. NN-AS11	West of project boundary (above SDA)	Rainfed	Sugarcane
12. NN-AS12	West of project boundary (above SDA)	Spring	Rice
13. NN-AS13	Disposal area of HG/PT, Lunao	Rainfed	Sugarcane
14. NN-AS14	MC-1, Sitio PNOC	Catugasan Creek	Rice
15. NN-AS15	NE of MC-1 (below pad)	Simaguan River	Rice
16. NN-AS16	Above mambucal resort	Mambucal Spring	Rice
17. NN-AS20	Cansilayan, Dampsite, Lateral A	BRIS	Rice
18. NN-AS21	Taloc, Bago City (lat C)	BRIS	Rice
19. NN-AS22	Sitio PNOC (game fowl)	Spring	Fowl
20. NN-AS22	Sitio PNOC	Rainfed	Mulberry
21. NN-AS23	Sitio PNOC	Rainfed	Abaca
22. NN-AS24	Pataan	Rainfed	Coffee
23. NN-AS25	Pataan	Pataan R.	Rice
24. NN-AS26	Tabidiao	Tabidiao IS	Rice
25. NN-AS27	Tabidiao	Tabidiao IS	Rice
26 NN-AS28	Batuan (Lateral G-2)	BRIS	Rice
27. NN-AS29	Pakol (Lateral J1)	BRIS	Rice
28. NN-AS30A	Camingawan	BRIS	Rice
29 NN-AS30B	Camingawan (Lat C-2)	BRIS	Rice
30. NN-AS31	Hacienda Pader, Maao	Maao CIS	Rice
31. NN-AS32A	San Isidro, Maao	Bacus CIS	Rice
32 NN-AS32B	San Isidro, Maao	Bacus CIS	Sugarcane
33. NN-AS33	Allansa, Bago City (Lateral G-2)	BRIS	Rice



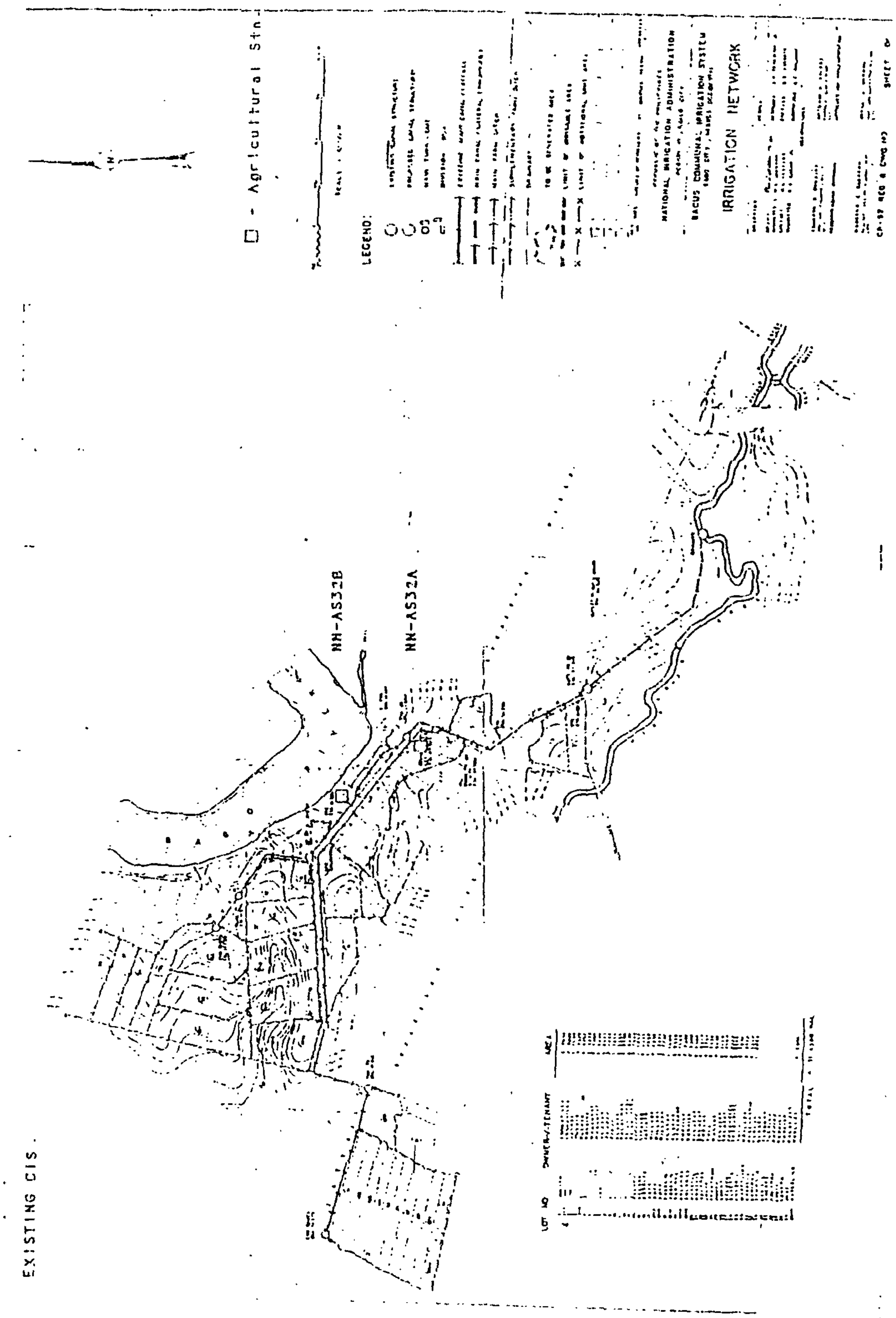
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Sampling Stations in
the MCIS

FIG. 3.1



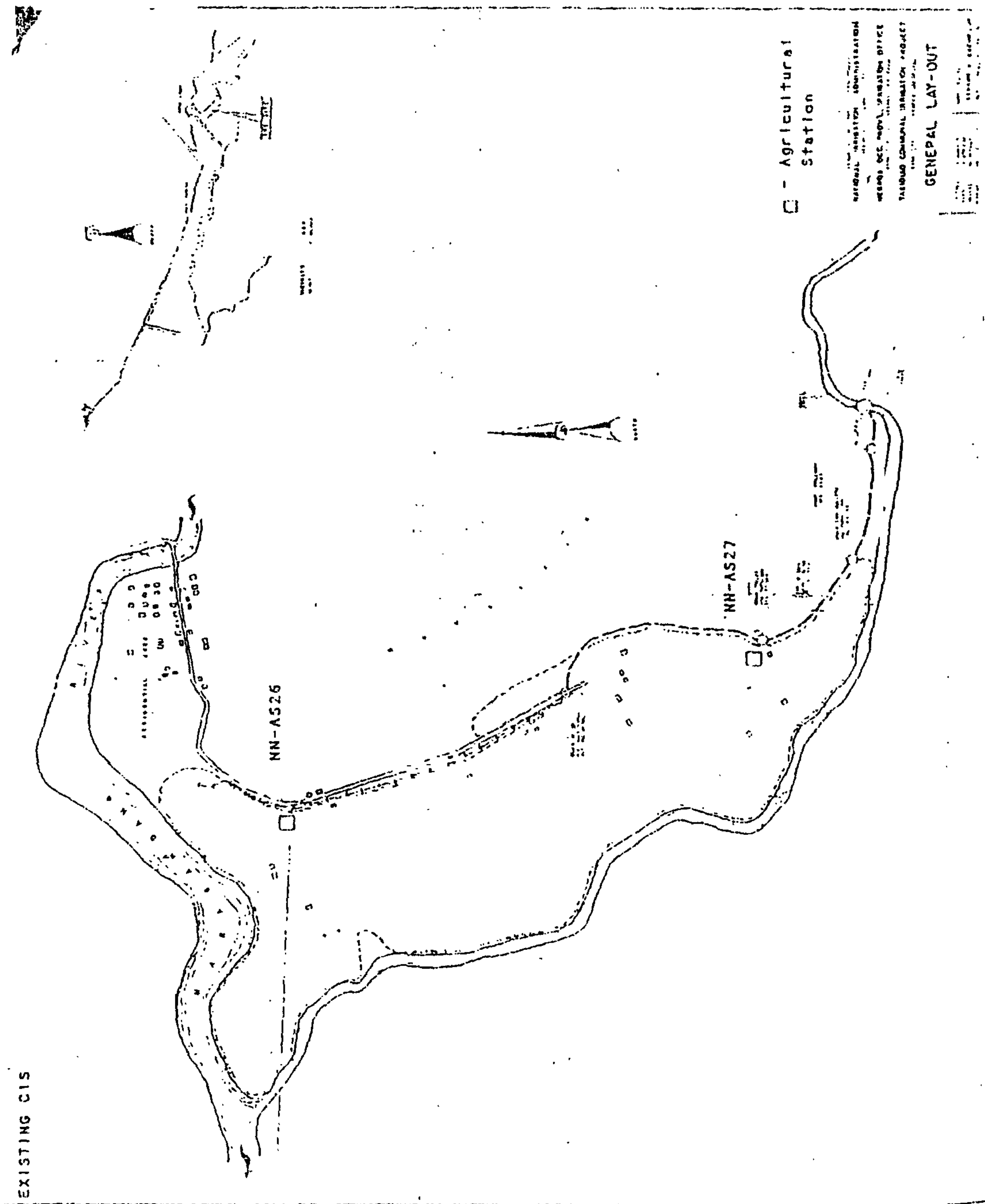
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Sampling Stations in the BCIS

FIG. 3.1(



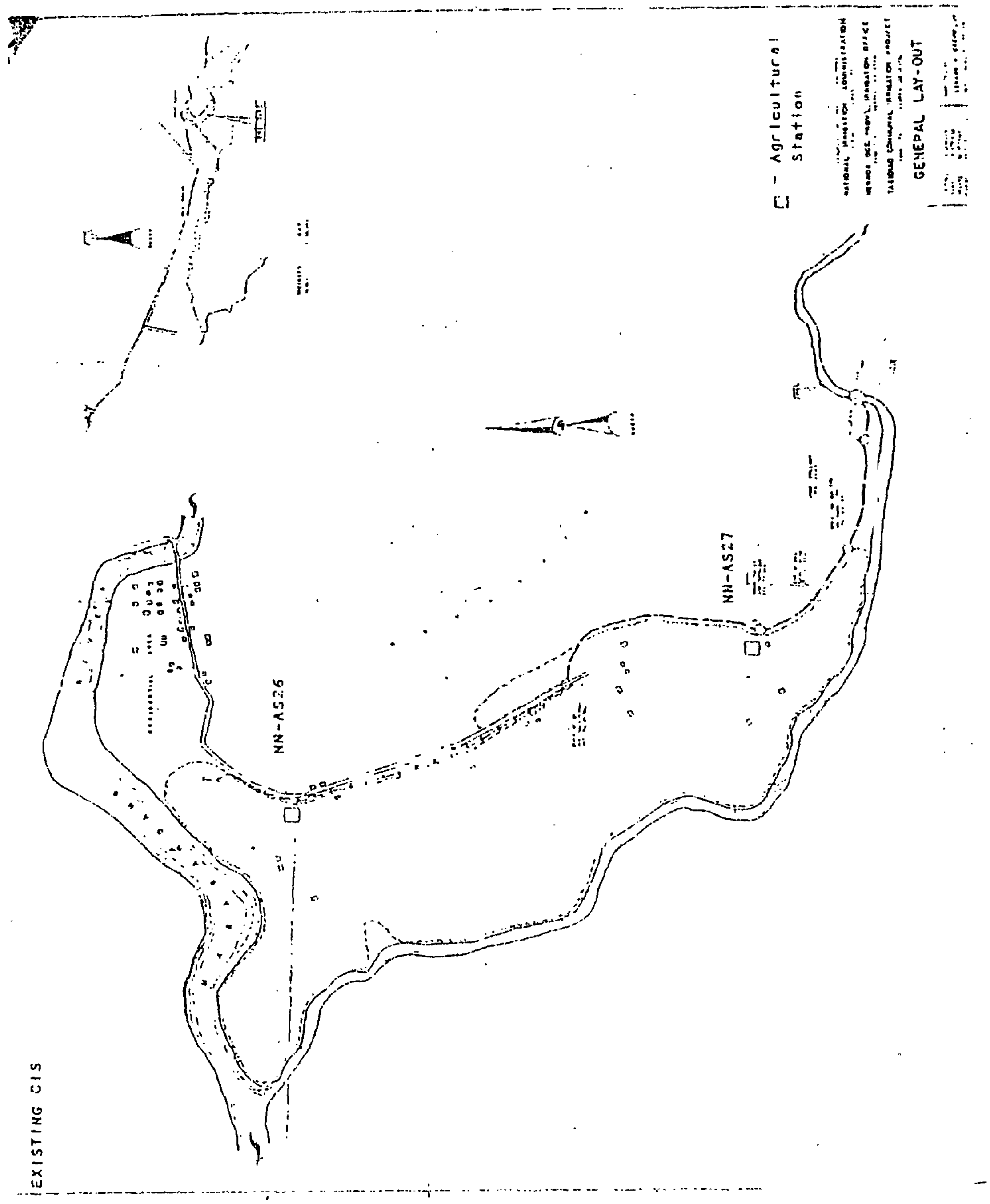
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Sampling Stations in the TCIS

FIG. 3.1.63d



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC

TITLE:

Sampling Stations in the TCIS

FIG. 3.1.6

TABLE 3.1.29 QUALITY OF IRRIGATION WATER

PARAMETER	RANGE OF VALUES
Metals (ppm)	
Li	<0.01 - 0.48
Na	1.8 - 140
Fe	<0.02 - 12
Mn	<0.01 - 0.29
Cu	<0.03
Cr	<0.05
Cd	<0.01 - 0.04
Pb	<0.10
Zn	<0.01 - 0.04
As	<0.01 - 0.28
K	<0.6 - 13.0
Mg	1.1 - 12.0
Ca	2.4 - 41.6
Inorganic Nontal (ppm)	
B	<0.10 - 5.2

TABLE 3.1.30

SOIL ANALYSIS

PROJECT AREA: NORTHEN NEGROS GEOTHERMAL PROJECT | TYPE OF SAMPLE: SOIL | PURPOSE OF ANALYSIS: DEV. EIA | DATE SAMPLE RECEIVED: | DATE REPORT RELEASED:

STATION	SAMPLING DATE	LAB CODE	Ph	B	Cd	Cr	Pb	Cu	Mn	Zn	Fe	Cl	SO4	Li	Mg	Ca	Na	K	As	Hg
			PARAMETERS (CONCENTRATIONS IN PPM)																	
NN-AS 22 MF	02-13-94	94-430	6.50	0.80	1.0	3.40	22.00	49.00	550.00	22.00	44,000.00	120.00	0.88	2.30	210.00	740.00	38.00	170.00	0.92	0.07
NN-AS 23 SF	02-13-94	94-431	7.20	2.60	0.98	2.20	15.00	40.00	1,000.00	40.00	28,000.00	54.00	180.00	5.00	290.00	2,100.00	44.00	2.10	<0.10	0.60
NN-AS 24 CF	02-13-94	94-432	7.30	1.00	1.50	3.70	42.00	70.00	900.00	83.00	54,000.00	51.00	81.00	1.80	350.00	2,900.00	49.00	89.00	<0.10	0.12
NN-AS 25 RF	02-13-94	94-433	6.60	1.20	1.10	2.00	18.00	53.00	400.00	38.00	39,000.00	32.00	95.00	3.20	310.00	1,600.00	99.00	400.00	<0.10	0.08
NN-AS 26 RF	02-13-94	94-434	6.60	<0.50	1.00	1.50	15.00	60.00	1,100.00	47.00	38,000.00	26.00	56.00	2.20	210.00	860.00	75.00	640.00	0.40	0.56
NN-AS 27 RF	02-13-94	94-435	7.30	0.49	1.10	1.60	16.00	64.00	1,300.00	47.00	44,000.00	43.00	68.00	4.30	260.00	1,200.00	82.00	540.00	<0.10	0.60
NN-AS 28 RF	02-13-94	94-436	6.20	0.77	0.25	1.20	5.00	12.00	530.00	8.40	4,600.00	24.00	170.00	3.30	190.00	1,000.00	59.00	120.00	0.85	<0.04
NN-AS 29 RF	02-13-94	94-437	4.80	0.70	0.55	2.10	7.50	15.00	180.00	28.00	18,000.00	25.00	62.00	2.50	160.00	870.00	52.00	220.00	0.65	<0.04
NN-AS 30A RF	02-13-94	94-438	6.20	1.20	0.62	3.40	11.00	14.00	1,500.00	11.00	21,000.00	40.00	64.00	3.20	260.00	1,500.00	59.00	190.00	<0.10	<0.04
NN-AS 30B RF	02-13-94	94-439	5.80	1.30	0.55	2.30	12.00	19.00	680.00	16.00	8,400.00	24.00	64.00	4.30	240.00	1,600.00	49.00	140.00	0.23	0.47
NN-AS 31A RF	02-13-94	94-440	6.30	<0.50	0.85	2.10	14.00	42.00	840.00	24.00	34,000.00	25.00	160.00	2.30	290.00	1,200.00	51.00	180.00	3.00	0.04
NN-AS 32A RF	02-13-94	94-441	6.50	<0.50	0.70	2.00	11.00	22.00	640.00	23.00	26,000.00	28.00	480.00	3.00	270.00	1,200.00	51.00	160.00	<0.10	0.47
NN-AS 32B SF	02-13-94	94-442	5.80	<0.50	0.70	1.80	10.00	22.00	680.00	26.00	23,000.00	25.00	98.00	3.30	240.00	1,100.00	38.00	340.00	2.20	0.57
NN-AS 33 RF	02-13-94	94-443	6.60	<0.50	0.50	1.70	12.00	18.00	1,200.00	8.60	16,000.00	25.00	100.00	3.10	420.00	1,700.00	72.00	160.00	1.10	0.04
AB-12 TS		94-449	6.50	<0.50	1.0	0.80	1.40	9.80	30.00	530.00	39.00	16,000.00	77.00	2.20	470.00	5,900.00	38.00	810.00	2.20	0.052
-12 SS		94-450	6.60	<0.50	0.55	0.98	8.50	35.00	360.00	23.00	12,000.00	30.00	77.00	2.30	110.00	1,400.00	33.00	670.00	0.50	0.05
AB-13 TS		94-451	6.20	<0.50	0.82	1.30	15.00	37.00	480.00	24.00	21,000.00	41.00	52.00	2.20	160.00	580.00	37.00	340.00	<0.50	0.07
-13 SS		94-452	5.60	<0.50	0.65	1.00	13.00	48.00	230.00	22.00	22,000.00	46.00	15.00	1.90	42.00	200.00	51.00	220.00	<0.10	0.05
AB-14 TS		94-453	7.00	<0.50	0.90	1.80	13.00	40.00	680.00	26.00	29,000.00	41.00	83.00	2.40	230.00	940.00	40.00	530.00	<0.10	0.07
-14 SS		94-454	6.30	<0.50	0.82	1.30	14.00	50.00	510.00	31.00	26,000.00	120.00	64.00	3.50	120.00	490.00	88.00	530.00	[illegible]	[illegible]
AB-1[illegible] TS		94-455	6.60	<0.50	1.10	3.60	18.00	64.00	1,000.00	32.00	40,000.00	49.00	29.00	1.60	200.00	730.00	30.00	[illegible]	0.24	0.11
-16 SS		94-456	6.20	<0.50	0.95	3.70	16.00	69.00	550.00	30.00	37,000.00	93.00	12.00	2.00	130.00	480.00	37.00	470.00	<0.10	0.14
AB-17 TS		94-457	6.40	<0.50	1.20	2.50	18.00	58.00	710.00	37.00	51,000.00	27.00	30.00	1.80	150.00	590.00	33.00	440.00	0.65	0.07
-17 SS		94-458	6.20	<0.50	0.98	2.50	15.00	100.00	210.00	33.00	45,000.00	30.00	15.00	1.90	150.00	660.00	45.00	520.00	0.33	0.08
AB-18 TS		94-459	6.20	<0.50	0.88	0.98	9.80	52.00	590.00	38.00	24,000.00	92.00	32.00	2.80	68.00	490.00	65.00	500.00	1.80	0.06
-18 SS		94-460	6.00	<0.50	0.80	0.91	9.20	55.00	540.00	39.00	23,000.00	170.00	35.00	3.30	82.00	640.00	120.00	420.00	1.70	0.07
PIT-1 TS		94-461	7.20	<0.50	1.40	5.80	21.00	83.00	690.00	35.00	46,000.00	31.00	49.00	1.50	240.00	880.00	51.00	440.00	2.00	0.08
-1 SS		94-462	6.30	<0.50	1.40	5.10	19.00	100.00	340.00	31.00	44,000.00	32.00	45.00	1.70	110.00	470.00	47.00	460.00	0.44	0.09
PIT-2 TS		94-463	7.40	<0.50	1.30	1.90	18.00	54.00	1,300.00	31.00	38,000.00	33.00	120.00	1.40	210.00	1,200.00	33.00	650.00	0.38	0.117
-2 SS		94-464	5.70	<0.50	1.20	1.90	15.00	70.00	240.00	20.00	40,000.00	40.00	22.00	1.40	38.00	350.00	41.00	340.00	0.20	0.13
PIT-3 TS		94-465	5.20	<0.50	1.60	3.50	20.00	67.00	960.00	47.00	58,000.00	27.00	38.00	1.80	91.00	460.00	33.00	420.00	0.19	0.11
-3 SS		94-466	6.00	<0.50	1.40	2.60	17.00	84.00	370.00	40.00	51,000.00	26.00	24.00	1.80	67.00	350.00	37.00	430.00	0.15	0.11
PIT-4 TS		94-467	6.70	<0.50	1.00	1.00	14.00	49.00	920.00	46.00	26,000.00	190.00	150.00	2.40	120.00	640.00	120.00	590.00	0.18	0.05
-4 SS		94-468	6.80	<0.50	0.95	1.10	16.00	61.00	1,100.00	42.00	27,000.00	130.00	45.00	0.90	150.00	610.00	98.00	780.00	0.20	0.04
PIT-5 TS		94-469	6.20	<0.50	1.30	2.20	13.00	50.00	230.00	27.00	39,000.00	34.00	31.00	1.70	270.00	1,500.00	34.00	400.00	1.50	0.05
-5 SS		94-470	6.10	<0.50	1.10	2.40	9.20	42.00	68.00	25.00	39,000.00	28.00	25.00	1.60	390.00	1,200.00	41.00	260.00	0.15	<0.040
PIT-6 TS		94-471	6.30	<0.50	0.94	1.00	7.50	51.00	450.00	32.00	20,000.00	55.00	60.00	2.00	220.00	1,500.00	48.00	360.00	0.51	0.09
-6 SS		94-472	6.90	<0.50	0.81	0.98	6.90	60.00	430.00	36.00	22,000.00	280.00	91.00	2.20	55.00	450.00	150.00	570.00	1.10	0.07

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ENVIRONMENTAL MANAGEMENT DIVISION

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

MULBERRY PLANTATION AND
SERICULTURE IN MINOYAN

FIG. 3

CONTINUATION

SOIL ANALYSIS

PROJECT AREA: NORTHERN NEGROS GEOTHERMAL PROJECT

TYPE OF SAMPLE: SOIL

PURPOSE OF ANALYSIS: DEV. EIA

DATE SAMPLE RECEIVED:

DATE RESULT RELEASED:

			PARAMETERS (CONCENTRATIONS IN PPM)																	
STATION	SAMPLING DATE	LAB CODE	Ph	Cl	B	Cr	Pb	Cd	Cu	Zn	Mg	Fe	SO4	Li	Mn	Ca	Na	K	As	Hg
NN-AS 1	02-04-94	94-317	7.00	74.00	<0.50	1.60	8.40	0.42	43.00	21.00	350.00	14,000.00	96.00	26.00	44.00	360.00	56.00	240.00	3.50	0.067
NN-AS 4	02-04-94	94-318	7.00	57.00	0.90	1.80	14.00	0.68	70.00	43.00	450.00	26,000.00	68.00	29.00	96.00	720.00	39.00	560.00	<0.10	0.061
NN-AS 5	02-04-94	94-319	7.80	25.00	1.10	2.80	16.00	0.68	54.00	38.00	390.00	29,000.00	150.00	3.80	200.00	1,300.00	120.00	370.00	<0.10	0.05
NN-AS 6	02-04-94	94-320	7.10	76.00	2.80	3.00	18.00	1.30	85.00	37.00	120.00	120,000.00	1,300.00	3.80	180.00	1,700.00	100.00	360.00	<0.10	0.08
NN-AS 7	02-05-94	94-321	7.30	42.00	1.10	4.70	17.00	0.74	59.00	41.00	320.00	83,000.00	250.00	3.80	220.00	1,700.00	86.00	370.00	4.20	0.076
NN-AS 8	02-05-94	94-322	7.10	72.00	0.73	4.00	17.00	0.71	67.00	35.00	270.00	20,000.00	200.00	3.40	220.00	1,200.00	110.00	290.00	<0.10	0.077
NN-AS 9	02-05-94	94-323	7.30	19.00	1.30	2.70	15.00	0.66	48.00	48.00	240.00	32,000.00	350.00	2.90	220.00	1,500.00	68.00	230.00	0.62	0.07
NN-AS 11	02-09-94	94-324	7.20	66.00	0.80	6.40	21.00	0.77	64.00	37.00	840.00	43,000.00	42.00	2.60	110.00	630.00	43.00	390.00	0.59	0.071
NN-AS 12	02-09-94	94-325	7.70	73.00	0.97	4.20	21.00	0.77	60.00	49.00	700.00	41,000.00	160.00	2.40	160.00	1,300.00	87.00	320.00	<0.10	0.07
NN-AS 13	02-09-94	94-326	6.90	48.00	1.40	2.40	13.00	0.60	40.00	34.00	450.00	30,000.00	95.00	2.70	200.00	970.00	40.00	460.00	1.20	0.065
NN-AS 14	02-09-94	94-327	7.40	44.00	1.20	7.20	19.00	0.74	59.00	32.00	230.00	33,000.00	110.00	2.50	180.00	980.00	63.00	260.00	1.10	0.10
NN-AS 15	02-09-94	94-328	7.40	18.00	2.20	5.90	18.00	0.74	54.00	45.00	340.00	36,000.00	130.00	2.90	120.00	720.00	56.00	330.00	1.10	0.065
NN-AS 16	02-09-94	94-329	7.80	19.00	1.30	14.00	23.00	0.83	62.00	48.00	730.00	42,000.00	230.00	2.70	290.00	1,500.00	64.00	210.00	1.70	0.16
NN-AS 20	02-12-94	94-330	7.60	66.00	0.80	4.70	13.00	0.46	22.00	9.90	980.00	23,000.00	66.00	4.80	370.00	1,700.00	69.00	[illegible]	[illegible]	<0.04
NN-AS 21	02-12-94	94-331	7.30	49.00	1.40	4.30	13.00	0.40	12.00	14.00	200.00	16,000.00	91.00	2.40	160.00	740.00	54.00	150.00	0.24	<0.04

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3.1.4.3 CROPS AND LIVESTOCKS

An estimated 50,000 ha. of cultivated land are within the agriculture impact areas of Murcia, Bago City, Bacolod City, Villadolid, and La Carlota City. From the 1991 economic profile repo of Negros Occidental, it is estimated that the area devoted to each major crop is as follows :

Crop	Percentage	Area Coverage
Sugarcane (*Sacharum officinarum*)	55%	27,500 ha.
Rice (*Oryza sativa*)	35%	17,500 ha.
Coconut (*Cocos nucifera*)	3%	1,500 ha.
Banana (*Musa spp*)	1.5%	750 ha.
Coffee (*Cofea spp*)	1%	500 ha.
Mango (*Magefera indica*)	0.5%	250 ha.
Abaca (*Musa textiles*)	0.5%	250 ha.
Root crops	0.5%	250 ha.
Vegetables	2.0%	1,000 ha.

New crops like mulberry *(Muros negra)* and flowering plants are being expanded, but the aggregate area could not be more than 100 ha. at the time of the study (see **Fig. 3.1.64**). Suga cane remains the most important crop within the study area, considering that one of the big sugar central is located at Bago City (Ma-ao Sugar Company, Inc.). Rice productior however, is a big industry. Bago City alone accounts for more than 50% of the total rice production in the province. **Figure 3.1.64B** shows photos of rice and sugar farms in the area

The biggest irrigation system - The Bago River Irrigation System - is also right at the center o the study area. At the time of the study, more than 70% of the ricelands in the study area are irrigated and many farms are able to grow 2-3 crops per year. The yields are quite high at 100 140 cavans per hectare per harvest. This is attributed to the reliability of available water for irrigation and high production inputs in terms of fertilizers, herbicides and insecticides

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

RICE AND SUGAR FARMS IN STUDY AREA

FIG.

The area devoted to the planting of vegetables and most root crops does not appear large in terms of hectarage, but considering the short cycle of these crops, the effective area planted and harvested could easily be 2-3 times that which is reflected in the data. Rainfed rice, particularly those in low-laying patches within the sugarcane fields, is rotated with cucurbits and other upland crops like corn and sorghum.

About fifty (50) farmers in the upper part of Bgy. Minoyan are presently engaged in the planting of mulberry (**Table 3.1.31**). A total of 33 ha. is presently planted to different varieties of mulberry, with about 330,000 plants at various stages of growth. Farmers have received training from Japanese technicians and a pilot rearing project has been conducted in the area, which shows the potential of cocoon plantation.

Abaca and coffee are grown as permanent crops in the steep slopes of the mountains. These crops undergo a cycle of good growth during the wet season but experience stunted growth during the dry season. Worst still, the dreadful diseases of abaca, mosaic and bunchy top are found in the area.

Livestock production in the study area consists mainly of game fowls, swine raising and poultry raising. Cattle fattening, duck and goat raising ventures have been observed but are not comparable to the attention given to game fowls, poultry and swine raising. Work carabaos abound in the area as these are the major source of power in breaking the soil (plowing) preparatory to puddling the rice fields.

3.1.4.4 CROP PRODUCTION TECHNOLOGIES

Except for PSB-RC-8 and 10, no new rice varieties in the '90s are in cultivation in the irrigated lowlands as well as uplands of the study area. As a matter of fact, IR-64, IR-36, Burdagol (appears to be a strain from IRRI but named locally) and IR-72, enumerated in the order of their popularity, are the most common rice varieties grown. The yield levels are quite high (100-1[illegible] cavans/ha).

Tab. 3.1.31 MULBERRY PLANTATIONS AND PLANT POPULATIONS

		TOTAL PLANTS	DATE 1992 & Earlier	PLANTED 1993
GROUP I				
1.	Edgardo Caspolinao	13,053	6,700	6,353
2.	Rolando Colantro	12,000	1,700	10,700
3.	Rogelio Panaligan	4,050	1,150	2,900
4.	Maria Belarmino	6,150	2,320	3,830
5.	Emma Belarmino	5,415	330	5.085
6.	Monito Tiranilla	4,446	-	4,446
7.	Anecito Belarmino	10,500	2,500	8,000
8.	Gloria Garfil	7,371	998	6,373
9.	Jose Besanes, Jr.	2,588	400	2,188
10.	Rogelio Gerelli	3,360	-	3,300
GROUP II				
1.	Generoso Navarro	7,410	2,035	5,375
2.	Rogelio Aialza	6,039	1,956	5,375
3.	Eia Alisto	6,800	300	4,083
4.	Tarcela Gaspolinao	8,117	2,587	5,530
5.	Napoleon Navasero	7,359	-	7,359
6.	Gerry Navarro	5,138	2,098	3,040
7.	Rebecca Dorias	2,500	-	2,500
8.	Pacifico Cerveza	7,350	-	7,350
9.	Manuel Monteflor	3,478	-	-
10.	Juni Repoyla	NO REPORT		
11.	Nonito Natibo-oc	NO REPORT		

Tab. 3.1.31 cont'd. MULBERRY PLANTATIONS AND PLANT POPULATIONS

		TOTAL PLANTS	DATE PLANTED 1992 & Earlier	1993
GROUP III				
1.	Ernesto Gandoce	8,310	1,277	7,033
2.	Ana Ganata	5,730	-	5,730
3.	Mario Ramil	8,715	4,475	4,240
4.	Leah Garfil	11,875	-	11,875
5.	Norberto Garfil	9,350	-	9,350
6.	Edwin Gandoce	6,194	2,628	3,566
7.	Jerrry Canete	9,666	5,275	3,941
8.	Fernando Cauntao	7,034	3,077	3,957
9.	Alejandro Formas	4,729	-	4,729
10.	Wilfredo Formas	NO REPORT		
11.	Loreto Cahilig, Jr.	NO REPORT		
GROUP IV				
1.	Ardelindo Magbanua	10,215	3,300	6,915
2.	Mario Murillo	6,500	-	6,500
3.	Rolando Decatoria	6,964	1,987	4,977
4.	Serafin Sarmiento	7,500	-	7,500
5.	Nelson Magbanua	4,535	423	4,535
6.	Edmer Magbanua	7,350	3,550	3,800
7.	Wilfredo Decatoria	5,616	-	5,616
8.	Reynaldo Magbanua	6,493	-	6,493
9.	Ernesto Dada	2,910	-	2,910
10.	Donato Tagle	11,602	-	11,602
11.	Edgardo Pernelo	NO REPORT		
GROUP V				
1.	Hernane Malabor	9,262	2,237	7,025
2.	Ramon Cabatuan	5,250	-	5,250
3.	Hernan Garfil	5,954	-	5,954
4.	Efren Malabor	6,019	895	5,124
5.	Nolito Garfil	8,794	4,200	4,588
6.	Freddie Lapu-on	8,000	3,000	5,000
7.	Apolonio Ezina	16,603	3,161	13,442
8.	Peter Englatria	10,056	2,[illegible]	7,641
9.	Rainy Garfil	2,851	-	2,851
10.	Armando Pausanos	NO REPORT		

The high yield levels could be attribute l to the direct seeding method of rice culture, the v reliable irrigation water, the high fertili atio n rates, and the liberal use of pesticides (herbici insecticide and fungicide). The dat in Table 3.1.32 show the extent of fertilizer additi and pesticide application in the study area. There is, however, a decreasing use of fertilizer a pesticide as the farm location moves further away from the commercial center to the uplan This is easily the result of high transportation costs and the long distance.

Sugarcane production technology remains a very high input venture as far as fertilizers a pesticides are concerned. Many farmers admit to applying almost 200 kilogram (kg.) N per l per season. This explains the very high yield of sugarcane in the study area. From intervie made and confirmed by published data, the yield of 60-100 piculs per ha. is indeed high and n uncommon in the flat and slightly rolling lands.

Rainfed lowland rice as well as sugarcane grown in the upland rolling lands, receives le amounts of fertilizers and pesticides. The only other heavy users of farm inputs are corn a vegetables Upland crops like abaca, coffee and rootcrops seldom, if at all, receive fertilizer (sprayed with pesticides. The most important reason, as gleaned from the interviews, is th difficulty of transporting these inputs to the uplands, not to mention their high costs.

The culture, planting, harvest dates, yield, expenses and gross income of various crops grown i the study area are summarized in **Table 3.1.33**.

Tab. 3.1.32 FERTILIZER USED IN THE STUDY AREA

	BASAL	RATE/HA	SIDE DRESSED	RATE	
1)	14-14-14	6 bags	46-0-0	4 bags	1.5 has
2)	16-20-0 46-0-0	2 bags 2 bags	46-0-0 0-0-46	3 bags 1 bag	1.7 has
3)	14-14-14 46-0-0	2 bags 1 bag	21-0-0 46-0-0	2 bags 1 bag	7.0 has
4)	14-14-14	3 bags	46-0-0 0-0-60	2 bags 1 bag	3.3 has
5)	14-14-14 46-0-0	4 bags 2 bags	46-0-0	2 bags	0.5 has
6)	16-20-0 14-14-14 46-0-0	2 bags 2 bags 2 bags	21-0-0 or 46-0-0	4 bags 4 bags	5.0 has
7)	46-0-0	2 bags	solid harvest (foliar pest)	3.5 qrt/ha	1.0 ha
8)	46-0-0 mixed 16-20-0	2 bags			0.35 ha
9)	14-14-14 46-0-0	1 bag 1 bag			0.5 ha
10)	46-0-0 15 DAS	14-14-14 (2) 35 DAS	0-0-60 (2) 45 DAS		0.8 ha
11)	18-46-0 46-0-0 0-0-60 Basal	3 bags 2 bags 1 bags	46-0-0 0-0-60 40 DAS	2 bags 1 bags	4.0 has
12)	16-20-0 46-0-0	2 bags 3 bags 15 DAS	14-14-14 46-0-0 45 DAS	2 bags 1 bag	1.0 ha

Tab. 3.1.32 cont'd.

MAAO CIS

13)	16-20-0	2 bags	16-20-0	2 bags	
	46-0-0	3 bags	46-0-0	2 bags	2.3 has
		30 DAS	45 DAS		
14)	14-14-14	16 bags	46-0-0	2 bags	
	16-20-0	16 bags	16-20-0	2 bags	
	18-46-0	16 bags	0-0-60	1 bag	1.62 ha
		10 DAS			
15)	16-20-0	3 bags	16-20-0	2 bags	
	46-0-0	basal	46-0-0	top dressing	2.0 has
16)	46-0-0	1 bag	14-14-14	1 bag	0.25 ha
17)	18-20-0	0.5 bag	46-0-0	0.5 bag	1.5 has
	46-0-0				
18)	16-20-0	3 bags			
	46-0-0	3 bags			1.0 ha
19)	21-0-0	1.5 bags			0.25 ha
20)	46-0-0	2 bags			0.25 ha
21)	46-0-0	1 bag mixed			
	16-20-0	1 bag			1.0 ha
22)	16-20-0	2 bags			
	46-0-0	3 bags			2.0 ha
23)	46-0-0	3 bags			
	organic	3 bags			2.0 ha
24)	46-0-0	2 bags			
	0-0-60	1 bag			2.0 ha

TABLE 3.1.33 CROP PRDUCTION AND YIELD IN THE STUDY AREA

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CROPS						
BRIS						
Rice	Flooded	1)Dec-Feb	1) March-May	65-100	P 8,500	P 16,500
		2) April-June	2) Aug-Oct	118-150	9,000	26,000
		3) Sept-Nov	3) Jan-March	111-120	7,000	23,000
CIS						
Rice	Flooded	1) Dec-Feb	1) March-May	60-80	7,000	14,000
		2) April-June	2) Aug-Oct	90-120	7,500	21,000
		3) Sept-Nov	3) Jan-March	95-100	6,000	19,000
SPRING/DIVERSION						
Rice	Flooded	1) Dec-Feb	1) March-May	50-70	4,000	12,000
		2) April-June	2) Aug-Oct	60-80	5,000	14,000
		3) Sept-Nov	3) Jan-March	95-100	4,500	13,000
OTHER CROPS						
Mulberry	Rainfed	Still at establishment stage				19,000
Sugarcane	Rainfed	March	Dec-Feb	50-70 piculs/ha	8,000/ha	4,500
Abaca	Rainfed	Perennial	As plant matures	300 kg/ha	700/ha	
Coffee	Rainfed	Perennial	Once a year	45 sacks	18,000	
Root crops	Rainfed	June-July	Nov-Dec	was recorded only for home consumption		
Upland	Rainfed		Nov-Dec			

TABLE 3.1.34e BIRD TRANSECT V ALONG LOWER MAMBUCAL RIDGE
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)2	log ni/N	ni/N log ni/N
Hypsipetes philippinus	15	0.17857	0.03189	-1.72277	-0.30764
Zosterops montana	10	0.11905	0.01417	-2.12521	-0.25336
Zosterops nigrorum	6	0.07143	0.00510	-2.63904	-0.18851
Collocalia esculenta	5	0.05952	0.00354	-2.82144	-0.16793
Lonchura malacca	4	0.04762	0.00227	-3.04450	-0.14498
Lanius cristatus	4	0.04762	0.00227	-3.04450	-0.14498
Pycnonotus goiavier	4	0.04762	0.00227	-3.04450	-0.14498
Apus pacificus	3	0.03571	0.00128	-3.33232	-0.11900
Centropus viridus	2	0.02381	0.00057	-3.73765	-0.08900
Chrysocolaptes lucidus	2	0.02381	0.00057	-3.73765	-0.08900
Lalage melanoleuca	2	0.02381	0.00057	-3.73765	-0.08900
Lalage nigra	2	0.02381	0.00057	-3.73765	-0.08900
Lonchura leucogastra	2	0.02381	0.00057	-3.73765	-0.08900
Motacilla cinerea	2	0.02381	0.00057	-3.73765	-0.08900
Nectarinia jugularis	2	0.02381	0.00057	-3.73765	-0.08900
Orthotomus atrogularis	2	0.02381	0.00057	-3.73765	-0.08900
Pachycephala cinerea	2	0.02381	0.00057	-3.73765	-0.08900
Parus elegans	2	0.02381	0.00057	-3.73765	-0.08900
Pericrocotus flammeus	2	0.02381	0.00057	-3.73765	-0.08900
Picoides maculatus	2	0.02381	0.00057	-3.73765	-0.08900
Aethopyga siparaja	1	0.01190	0.00014	-4.43122	-0.05273
Coracina striata	1	0.01190	0.00014	-4.43122	-0.05273
Eumyias panayensis	1	0.01190	0.00014	-4.43122	-0.05273
Ninox philippinensis	1	0.01190	0.00014	-4.43122	-0.05273
Otus scops	1	0.01190	0.00014	-4.43122	-0.05273
Phapitreron leucotis	1	0.01190	0.00014	-4.43122	-0.05273
Sitta frontalis	1	0.01190	0.00014	-4.43122	-0.05273
Spilornis cheela	1	0.01190	0.00014	-4.43122	-0.05273
Streptopelia bitorquata	1	0.01190	0.00014	-4.43122	-0.05273
N =	84		0.07126		-3.01389

Species Diversity Index (H) = 3.01389

Index of Dominance (C) = 0.07126

Evenness Index (e) = 0.89505

TABLE 3.1.34f BIRD TRANSECT VI ALONG MAMBUCAL-PATAAN TRAIL
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Hypsipetes philippinus	18	0.19780	0.03912	-1.62050	-0.32053
Zosterops nigrorum	10	0.10989	0.01208	-2.20827	-0.24267
Zosterops montana	8	0.08791	0.00773	-2.43144	-0.21375
Eumyias panayensis	6	0.06593	0.00435	-2.71916	-0.17927
Coracina striata	4	0.04396	0.00193	-3.12448	-0.13735
Lonchura leucogastra	4	0.04396	0.00193	-3.12448	-0.13735
rthotomus atrogularis	3	0.03297	0.00109	-3.41216	-0.11250
Parus elegans	3	0.03297	0.00109	-3.41216	-0.11250
Pewricrocotus flammeus	3	0.03297	0.00109	-3.41216	-0.11250
Aethopyga siparaja	2	0.02198	0.00048	-3.81762	-0.08391
Centropus viridus	2	0.02198	0.00048	-3.81762	-0.08391
Cuculus fugax	2	0.02198	0.00048	-3.81762	-0.08391
Dicrurus balicassius	2	0.02198	0.00048	-3.81762	-0.08391
Ficedula westermani	2	0.02198	0.00048	-3.81762	-0.08391
Lonchura malacca	2	0.02198	0.00048	-3.81762	-0.08391
Loriculus philippinensis	2	0.02198	0.00048	-3.81762	-0.08391
Megalarus palustris	2	0.02198	0.00048	-3.81762	-0.08391
Motacilla cinerea	2	0.02198	0.00048	-3.81762	-0.08391
Pachycephala cinerea	2	0.02198	0.00048	-3.81762	-0.08391
Picoides maculatus	2	0.02198	0.00048	-3.81762	-0.08391
Sarcops calvus	2	0.02198	0.00048	-3.81762	-0.08391
Sitta frontlatis	2	0.02198	0.00048	-3.81762	-0.08391
Cacomantis merulinus	1	0.01099	0.00012	-4.51077	-0.04957
Dryocopus javensis	1	0.01099	0.00012	-4.51077	-0.04957
Megalaima haemacephala	1	0.01099	0.00012	-4.51077	-0.04957
Ninox philippensis	1	0.01099	0.00012	-4.51077	-0.04957
Phapitreron amethystina	1	0.01099	0.00012	-4.51077	-0.04957
Phapitreron leucotis	1	0.01099	0.00012	-4.51077	-0.04957
N =	91		0.07739		-2.95666

Species Diversity Index (H) = 2.95666

Index of Dominance (C) = 0.07739

Evenness Index (e) = 0.88730

TABLE 3.1.34g BIRD TRANSECT VII ALONG PATA-AN RIDGE
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Aplonis panayenis	10	0.16393	0.02687	-1.80832	-0.29644
Collocalia esculenta	10	0.16393	0.02687	-1.80832	-0.29644
Apus pacificus	8	0.13115	0.01720	-2.03141	-0.26642
Hirundo tahitica	5	0.08197	0.00672	-2.50140	-0.20504
Artamus leucorhynchos	4	0.06557	0.00430	-2.72464	-0.17865
Lonchura leucogastra	4	0.06557	0.00430	-2.72464	-0.17865
Pycnonotus goiavier	4	0.06557	0.00430	-2.72464	-0.17865
Lanius cristatus	3	0.04918	0.00242	-3.01227	-0.14814
Cisticola exilis	2	0.03279	0.00108	-3.41763	-0.11206
Hirundapus celebensis	2	0.03279	0.00108	-3.41763	-0.11206
Megalurus timoriensis	2	0.03279	0.00108	-3.41763	-0.11206
Nectarinia jugularis	2	0.03279	0.00108	-3.41763	-0.11206
Saxicola caprata	2	0.03279	0.00108	-3.41763	-0.11206
Anthus novaeseelandiae	1	0.01639	0.00027	-4.11108	-0.06738
Centropus viridis	1	0.01639	0.00027	-4.11108	-0.06738
Hemiprocne comata	1	0.01639	0.00027	-4.11108	-0.06738
N =	61		0.09914		-2.51087

Species Diversity Index (H) = 2.51087

Index of Dominance (C) = 0.09914

Evenness Index (e) = 0.90560

TABLE 3.1.34h BIRD TRANSECT VIII IN KAPATAGAN-PATA-AN AREA
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)2	log ni/N	ni/N log ni/N
Hypsipetes philippinus	15	0.15000	0.02250	-1.89712	-0.28457
Collacolia esculenta	10	0.10000	0.01000	-2.30258	-0.23026
Dicrurus balicassius	8	0.08000	0.00640	-2.52573	-0.20206
Zosterops nigrorum	8	0.08000	0.00640	-2.52573	-0.20206
Treron vernans	6	0.06000	0.00360	-2.81341	-0.16880
Coracina striata	4	0.04000	0.00160	-3.21888	-0.12876
Dicaeum bicolor	4	0.04000	0.00160	-3.21888	-0.12876
Dicaeum trigonostigma	4	0.04000	0.00160	-3.21888	-0.12876
Parus elegans	4	0.04000	0.00160	-3.21888	-0.12876
Cacomantis merulinus	3	0.03000	0.00090	-3.50656	-0.10520
Aceros leucocephalus	2	0.02000	0.00040	-3.91200	-0.07824
Aethopyga siparaja	2	0.02000	0.00040	-3.91200	-0.07824
Dicaeum pygmaeum	2	0.02000	0.00040	-3.91200	-0.07824
Eudynamis scolopacea	2	0.02000	0.00040	-3.91200	-0.07824
Eumyias panayensis	2	0.02000	0.00040	-3.91200	-0.07824
Hemiprocne comata	2	0.02000	0.00040	-3.91200	-0.07824
Loriculus philippinensis	2	0.02000	0.00040	-3.91200	-0.07824
Megalaima haemacephala	2	0.02000	0.00040	-3.91200	-0.07824
Pachycephala cinerea	2	0.02000	0.00040	-3.91200	-0.07824
Phapitreron leucotis	2	0.02000	0.00040	-3.91200	-0.07824
Poliolimnas cinereus	2	0.02000	0.00040	-3.91200	-0.07824
Ptilinopus occipitalis	2	0.02000	0.00040	-3.91200	-0.07824
Tanygnathus lucionensis	2	0.02000	0.00040	-3.91200	-0.07824
Sitta frontalis	2	0.02000	0.00040	-3.91200	-0.07824
Accipiter trivirgatus	1	0.01000	0.00010	-4.60517	-0.04605
Columba vitiensis	1	0.01000	0.00010	-4.60517	-0.04605
Dryocopus javensis	1	0.01000	0.00010	-4.60517	-0.04605
Hirundapus celebensis	1	0.01000	0.00010	-4.60517	-0.04605
Nectarinia sperata	1	0.01000	0.00010	-4.60517	-0.04605
Spilornis holospilus	1	0.01000	0.00010	-4.60517	-0.04605
N =	100		0.06160		-3.07961

Species Diversity Index (H) = 3.07961

Index of Dominance (C) = 0.06160

Evenness Index (e) = 0.90545

TABLE 3.1.34i BIRD TRANSECT IX MT CANLAON TRAIL
(750-1000 METERS ABOVE SEA LEVEL)
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, FEBRUARY 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)(ni/N)	log ni/N	ni/N log ni/N
Hypsipetes philippinus	20	0.17391	0.03025	-1.74922	-0.30421
Collacolia esculenta	15	0.13043	0.01701	-2.03692	-0.26569
Zosterops nigrorum	12	0.10435	0.01089	-2.26000	-0.23583
Dicrurus balicassius	10	0.08696	0.00756	-2.44231	-0.21237
Apus pacificus	8	0.06957	0.00484	-2.66556	-0.18543
Phipidura cyaniceps	6	0.05217	0.00272	-2.95325	-0.15408
Coracina striata	5	0.04348	0.00189	-3.13545	-0.13632
Dicaeum trigonostigma	4	0.03478	0.00121	-3.35871	-0.11682
Orthotomus atrogularis	4	0.03478	0.00121	-3.35871	-0.11682
Parus elegans	4	0.03478	0.00121	-3.35871	-0.11682
Zosterops montana	4	0.03478	0.00121	-3.35871	-0.11682
Aethopyga siparaja	2	0.01739	0.00030	-4.05186	-0.07047
Dicaeum bicolor	2	0.01739	0.00030	-4.05186	-0.07047
Loriculus philippinensis	2	0.01739	0.00030	-4.05186	-0.07047
Picoides maculatus	2	0.01739	0.00030	-4.05186	-0.07047
Prioniturus discurus	2	0.01739	0.00030	-4.05186	-0.07047
Phinomyias gularis	2	0.01739	0.00030	-4.05186	-0.07047
Sarcops calvus	2	0.01739	0.00030	-4.05186	-0.07047
Sitta frontalis	2	0.01739	0.00030	-4.05186	-0.07047
Treron vernans	2	0.01739	0.00030	-4.05186	-0.07047
Cacomantis merulinus	1	0.00870	0.00008	-4.74558	-0.04127
Lalage melanoleuca	1	0.00870	0.00008	-4.74558	-0.04127
Megalaima haemacephala	1	0.00870	0.00008	-4.74558	-0.04127
Pericrocotus flammeus	1	0.00870	0.00008	-4.74558	-0.04127
Ptilinopus occipitalis	1	0.00870	0.00008	-4.74558	-0.04127
N	115		0.08310		-2.80177

Species Diversity Index (H) = 2.80177

Index of Dominance (C) = 0.08310

Evenness Index (e) = 0.88316

TABLE 3.1.34j BIRD TRANSECT X IN ALONG HAGDAN RIDGE
MT. CANLAON GEOTHERMAL POWER PROJECT
PNOC, February 12-19, 1994

SPECIES	Ni	ni/N	(ni/N)□+2□	log ni/N	ni/N log ni/N
Collacolia esculenta	12	0.16216	0.02630	-1.81917	-0.29500
Hypsipetes philippinus	10	0.13513	0.01826	-2.00152	-0.27047
Zosterops nigrorum	8	0.10811	0.01169	-2.22461	-0.24050
Lanius cristatus	6	0.08108	0.00657	-2.51232	-0.20370
Lonchura malacca	6	0.08108	0.00657	-2.51232	-0.20370
Artamus leucorhynchos	4	0.05405	0.00292	-2.91784	-0.15771
Dicaeum bicolor	4	0.05405	0.00292	-2.91784	-0.15771
Merops viridis	4	0.05405	0.00292	-2.91784	-0.15771
Pycnonotus goiavier	4	0.05405	0.00292	-2.91784	-0.15771
Centropus viridis	2	0.02703	0.00073	-3.61080	-0.09760
Chalcophaps indica	2	0.02703	0.00073	-3.61080	-0.09760
Coturnix chinensis	2	0.02703	0.00073	-3.61080	-0.09760
Megalurus palustris	2	0.02703	0.00073	-3.61080	-0.09760
Nectarinia jugularis	2	0.02703	0.00073	-3.61080	-0.09760
Caprimulgis affinis	1	0.01351	0.00018	-4.30432	-0.05815
Cisticola exilis	1	0.01351	0.00018	-4.30432	-0.05815
Corvus macrorhynchos	1	0.01351	0.00018	-4.30432	-0.05815
Halcyon chloris collaris	1	0.01351	0.00018	-4.30432	-0.05815
Haliastur indus	1	0.01351	0.00018	-4.30432	-0.05815
Streptopelia chinensis	1	0.01351	0.00018	-4.30432	-0.05815
N =	74		0.08579		-2.68110

Species Diversity Index (H) = 2.68110

Index of Dominance (C) = 0.08579

Evenness Index (e) = 0.90545

celebensis) in the transect. The lowest dominance value was in Transect VIII - Kapatagan-Pataan having only a value of 0.06160, because the number of individuals per species were almost equally distributed among the 5 commonly observed species.

As to evenness (E), both Transects VII and VIII had an almost equal value of 0.90, while the rest of the transects also had values close to 0.90.

In Transect IX along the Mt. Canlaon Trail, it was observed that earthworm castings abound along the trail and forest floor. This indicates that earthworms are not being preyed upon by wild pigs, which also means that Mt. Canlaon's population of wild pigs is now depleted to a dangerous level, probably because of overhunting. Fruit bearing species, such as Strangling figs, were likewise noted to be relatively rare since these trees are susceptible to strong winds and also perhaps due to illegal logging and charcoal making. Several carabao logging trails traversing the northwestern slopes of Mt. Canlaon were also observed. These activities will surely deplete the remaining forest trees in the National Park.

A. Presence of rare, endemic endangered wildlife

The number of rare, endemic, endangered species of wildlife are relatively few in Mt. Canlaon National Park. The Negros Fruitdove *(Ptilinopus arcanus)*, Negros Writhed Hornbill *(Aceros waldeni)* and the Negros Bleeding Heart Pigeon *(Gallicolumbia keayi)* are the three most endangered endemic bird species in the area. They are also relatively rare that none was observed in the geothermal block. But most probably found in forested areas of the said national park. The same is true with the three most endangered species of mammals of Negros, which are the Visayan Spotted Deer (*Cervus alfredi*), the Visayan Warty Pig (*Suscebifrons*), and the Negros Tube-nose Fruitbat (*Nyctimene rabori*). The Negros Tube-nose Fruitbat is found mostly in Sourthern Negros and could be found also in Mt. Canlaon However, all three species of endangered mammals were not observed within geothermal block. This is due mainly to over-hunting.

B. Important Wildlife Habitat

The most important wildlife habitat in the area is located in the forest at elevation between 1200 to 1800 meters above sea level (masl). The forest at these elevations are frequented by imperial pigeons and fruitdove that the mountaineers in Negros call it "Hardin ng Balod". But is area is far from the geothermal block.

C. Important Ecological Indication Species

The most important indicator species in the area are the swiftlets (*Collocalia esculenta*), White-rumped Swift (*Apus pacificus*), Philippine Bulbul (*Hypsipetes philippinus*), and the Spangled Drongo (*Dicrurus balicassius*). The swifts and swiftlets are important indicator in open areas, which are usually around agricultural areas indicator for fruit-eating birds, while Spangled Drongo is a good indicator for insect-eating bird in the forest (**Fig. 3.1.67**). All species are common in the geothermal block and the absence of such species in the vicinity of the operation or drilling site indicate increasing disturbance either of ~~the~~ noise or noxious gases.

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

Consolidated Asian
Systems Development Inc.

TITLE:

Important Indicator Species

FIG. 3.1.67

3.2 THE WATER

3.2.1 INTRODUCTION

The surface water and ground water systems in the areas surrounding the proposed geothermal facilities are utilized by a significant portion of the population of Bago City and Murcia. Therefore, any adverse effects on these systems will be felt strongly by the people, particularly those residing near the power plant facilities. This section describes the present condition of these water systems.

3.2.1 HYDROLOGY

3.2.2.1 METHODOLOGY

A. SURFACE WATER STUDIES

The investigation of the surface water resources involved in the identification of the creeks and rivers which will be directly affected by the geothermal development project. The characterization of these streams included the definition of the bank characteristics, discharge characteristics and hydraulic gradient. While most of the activities involved visual inspection, streamflow mesurements were obtained from existing records of the National Irrigation Administration (NIA) and the Department of Public Works and Highways (DPWH).

The more accurate albeit, incomplete records of streamflow were obtained from the Bago River Irrigation System office and the provincial irrigation office at Bago City.

Actual streamflow measurements were not performed since spot measurements will hardly indicate the year-round variations in streamflow. They will not be adequate to extrapolate flows in the future, particularly during the rainy months.

B. GROUND WATER STUDIES

Records of existing wells and springs were collected from the DPWH District Engineer's and the Bago City Engineer's Office. Additional information were gathered from drillers in the area. The records of PNOC were also consulted regarding the thermal springs around Mambucal.

The wells and springs were located in the field. Their discharges and water levels were measured at this time. Water samples were collected from selected wells and springs and tested for heavy metals and other constituents.

Since the origin of the springs were highly significant, the characteristics of the rocks and soil from which water was being derived were examined to determine the nature of the groundwater system.

3.2.2.2 SURFACE WATER RESOURCES

For this report, only the major drainage systems originating from the northwestern slopes will be discussed in detail.

Based on the project description obtained; the surface water resources within this area will be within the scope of the proposed geothermal block.

A. PHYSICAL CONDITIONS OF MAJOR RIVERS

1. *Bago River*

This river system is the largest in the island of Negros. Its headwaters are located about five (5) km. east of Mt. Canlaon near Bgy. Quezon. At this point, the creeks form part of Initihan River as they move in a generally easterly direction to Quezon before turning north. Several small streams feed Initihan River before it joins Bago River.

Several creeks from Mt. Mandalagan also drain into the Initihan River about three (3) km northwest of Brgy. Lambunao. Together, they form Bago River which flows in a generally westerly direction towards the Guimaras Strait. Bago River traverses portions of Murcia and Bago City.

Bago River is characterized by steep banks and narrow channels. Its banks sometimes rise more than 50 m. above the stream beds particularly in its upper reaches. Its deeply incised valleys suggest that the river system is at a youthful stage.

Its tributaries exhibit the same characteristics. Near the foothills of Mts. Canlaon and Mandalagan, the river banks are also steep. However, at the lower levels and near the Bago City plains, the valleys are wider and the banks are lower.

Streamflow Measurements

Before the construction of the Bago River Irrigation System (BRIS), continuous measurements of the river discharge were undertaken by the Bureau of Public Works and the National Irrigation Administration (NIA). However, after the construction of the ogee dam and the operation of the system, streamflow measurements were only undertaken sporadically. The closest approximation of the streamflow may be derived from the diversions to BRIS.

Available streamflow records from NIA are presented in **Table 3.2.1**. The records cover the period from 1949 to 1970. **Table 3.2.2** also shows the amount of diversions by the BRIS for the period from 1965 to early 1993.

The location of the stream gauging stations are indicated in **Fig. 3.2.1**. A longer record was obtained from the stream gauging station in Ma-ao, Bago City, although another gauging station was also established in Pandanon, Murcia. At the Ma-ao station, the drainage area of Bago river

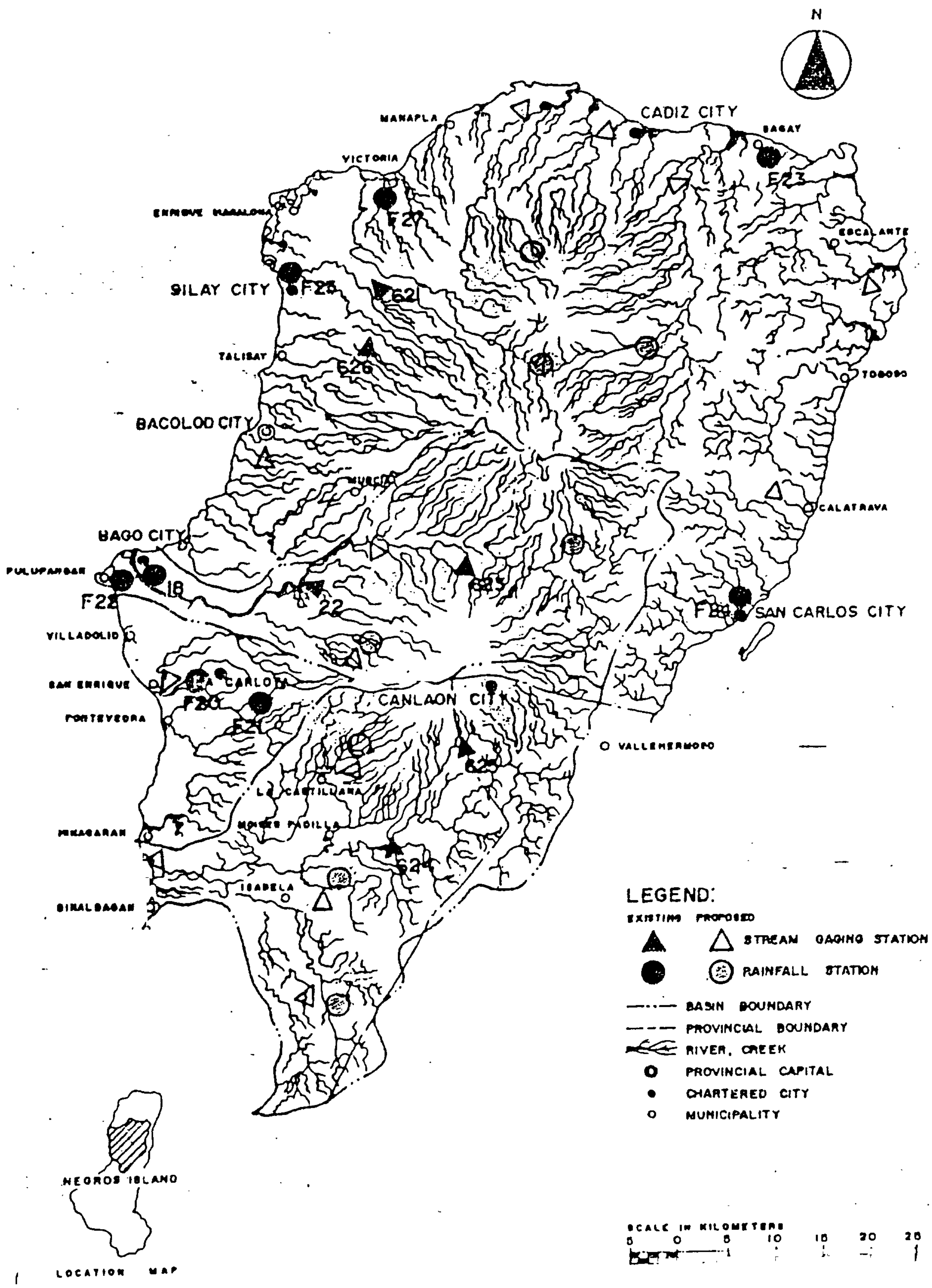
Tab. 3.2.1 Annual Peak Discharge (cu.m./sec) of the Bago River at Ma-ao, Bago City

YEAR	PEAK DISCHARGE
1949	1650.00
1950	833.00
1951	2500.00
1952	3425.00
1953	684.80
1954	677.00
1955	1305.00
1956	1287.00
1957	1890.00
1958	509.30
1959	404.65
1960	
1961	
1962	
1963	
1964	
1965	677.00
1966	677.00
1967	
1968	
1969	367.50
1970	487.80
NO. OF YEARS	15.00
MEAN	2,964.60
STANDARD DEVIATION	0.295
SKEWNESS COEFFICIENT	0.5262

Tab. 3.2.2 Average Daily Diversions (in l/s)

Location: Bago River Cansilayan, Murcia

	1986	1987	1988	1989	1990	1991	1992
January	22,498	21,154	12,138	21,283	17,229	13,500	15,732
February	21,496	20,567	12,037	21,014	9,642	7,500	8,400
March	18,884	13,235	9,113	21,154	6,454	2,377	3,033
April	15,260	7,500	11,093	19,366	4,578	0*	4,084
May	17,909	10,480	12,016	21,722	11,506	10,480	7,984
June	21,543	10,253	15,390	19,700	17,326	11,416	10,366
July	12,194	16,180	21,180	16,258	18,442	17,980	16,670
August	12,803	21,877	13,964	20,306	13,049	13,487	17,312
September	19,686	8,445	15,430	21,000	21,960	17,140	16,780
October	19,977	21,890	6,761	18,538	21,419	19,709	17,503
November	20,506	21,496	16,483	19,100	19,100	18,443	18,913
December	19,693	19,158	19,438	18,074	21,400	17,225	14,900



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Location of Stream Gauging Stations FIG. 3.2.1

is 683 square kilometers (sq. km.) while at Pandanon, Bago River drains an area of 445 sq. km.

Based on the records at Ma-ao, the minimum daily discharge of Bago River is 12 cubic meters per second (CMS) against a maximum daily discharge of 712 CMS. The computed mean daily discharge for the same period is 47 CMS.

The minimum flows occur mostly during the months of March and April. High flows are experienced from August to December.

Utilization of Bago River

Bago River supplies water for the irrigation of ricelands in Bago City. At present, BRIS serves 15,000 ha. of agricultural land. The extent of the irrigation service area is shown in **Fig. 3.2.2.**

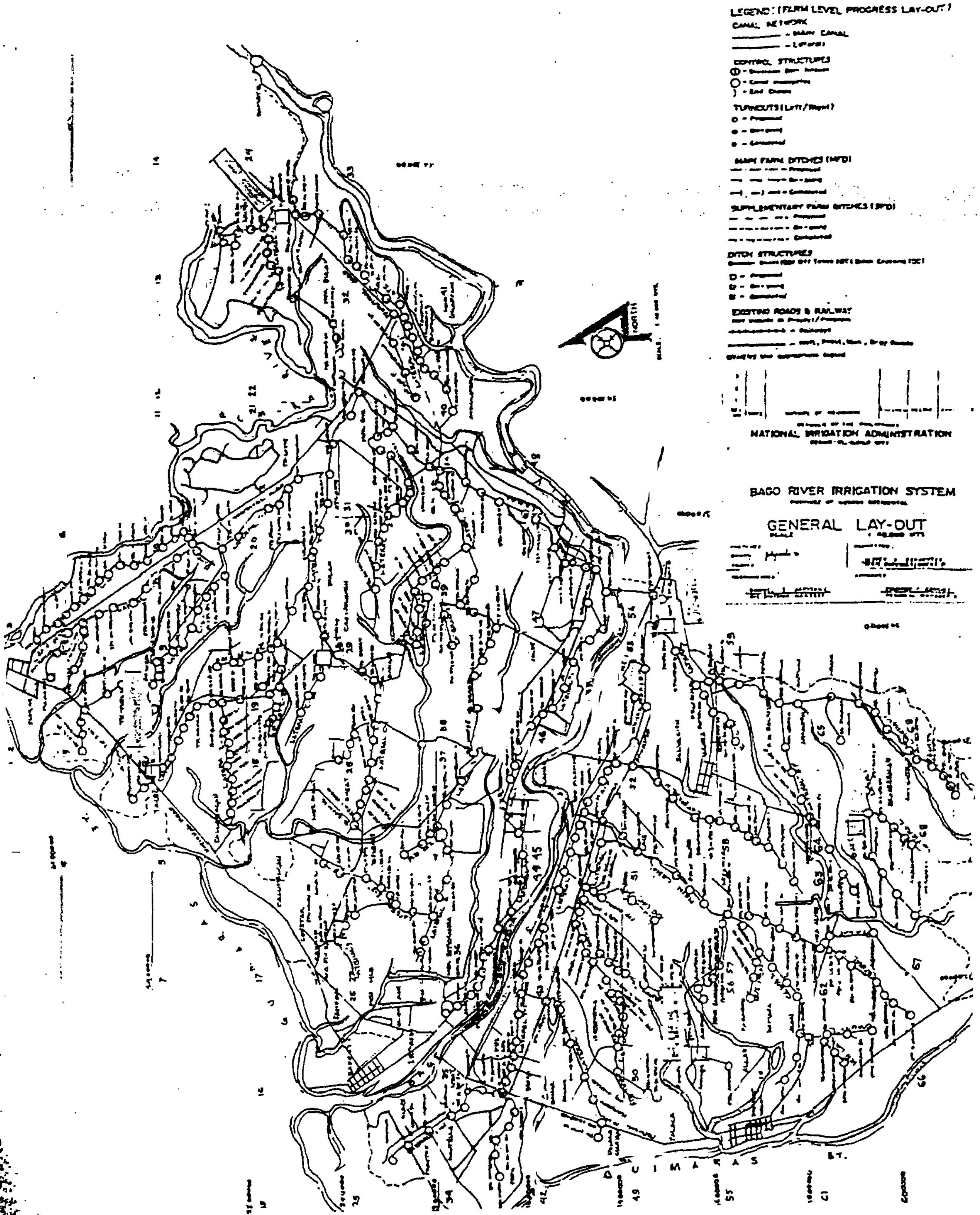
Aside from this diversion at Cansilayan, Murcia, Bago River has been used mainly for domestic and laundry use. Occasionally, sugar cane planters draw water from the river to irrigate their farms.

According to the records of BRIS, the maximum daily diversion is nearly 22.5 CMS. Large diversions are apparently possible only from August to January when the measured diversions generally exceed 16 CMS. During the dry months, and particularly in the 1990s, the diversions decreased to less that 10 CMS. For all practical purposes, diversions of less than 22 CMS represent the entire flow of Bago River at Cansilayan.

2. *Maragandang River*

This river system drains the watershed area where the Hagdan project sites are located. It, therefore, deserves some discussion.

The Maragandang River drains into the Tubidiao mountain range. Three (3) major tributaries



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TITLE:

Bago Irrigation Service Area

FIG. 3.2.2

originate from the mountains and meet near Hacienda (Hda.) Nakalang as the river flows in the westerly direction. It is characterized by a fairly wide valley with numerous boulders forming the streambed. Its water flow is generally turbulent throughout its course.

The river joins the Araal River before it drains into the Bago River below Ma-ao.

Streamflow Measurements

Streamflow records of the Maragandang River are not available. They have not been monitored at all by the National Irrigation Authority and any other government agencies. However, based on visual observation, the streamflow approximates the water flow at the Bantolinao River (as discussed in the next section) and may still be more because of the greater drainage area.

Utilization of Maragandang River

Except for washing clothes, the Maragandang River is not being used for domestic purposes. However, some sugarcane planters occasionally divert water from the river to irrigate their fields. Water from the river is allowed to flow through canals that are directed towards the cane fields. The total irrigated area is approximately less than 100 ha.

Spot Streamflow Measurements

Instantaneous streamflow measurements have limited use for predicting future flows. However, in the absence of reliable long-term streamflow records, future flows at specific points may be estimated by relating them proportionally to the total flow of Bago River. The ratio of the drainage area above the desired gauging station to the total drainage area of the Bago River can be used for this estimate.

3. *Bantolinao River*

The Bantolinao River divides the Pataan and Tubidiao mountain ranges. These mountain ranges are situated west of Canlaon Volcano. While it does not compare with the Bago River in terms of volume flow, this river system drains to the proposed project site at Kinabkaban and may be directly affected by any adverse conditions that may occur during the development of the geothermal project.

This river flows in a generally westerly direction and joins the Ma-ao River before its junction with Bago River. It originates at the northwestern slope of Canlaon volcano and follows a WNW direction until it reaches Hda. Buenavista. At this point, the river assumes a westerly direction. The Mailum and Maugbi rivers likewise contribute water to the Bantolinao River.

The sparse tributaries of Bantolinao River nearly run parallel to the course of the main river. Their banks are steep but not as high as Bago River.

Streamflow Measurements

The discharge of Bantolinao river became important to NIA because of a proposed communal irrigation system at Ma-ao. A few spot measurements were therefore undertaken in 1991 (**Table 3.2.3**). At the gauging station, the drainage area of the river is 15.25 sq. km.

Records showed that more than 2.5 CMS flowed through the river during the months of October and November. Low flow was recorded during the month of May at 0.37 CMS.

Utilization of Bantolinao River

This river has not been extensively utilized. Occasionally, some sugar cane planters draw water from the river for the irrigation of their farms. This withdrawal occurs only during extremely dry periods.

TABLE 3.2.3 Streamflow Measurements of Selected Rivers in Bago City

LOCATION	Tubidiao Creek Mailum, Bago City	Ma-ao River	Bantolinao River Ma-ao
DRAINAGE AREA	2.20 sq. km.	19.15 sq. km.	15.25 sq.km.
LONGITUDE	123 04'54"	122 59'13.80"	123 03'06.60"
LATITUDE	10 27'25.2"	10 30'00"	10 28'49.80"
1 9 9 1	AVERAGE Q (L/s)	AVERAGE Q (L/s)	AVERAGE Q (L/s)
JANUARY		993.94	643.33
FEBRUARY		683.24	561.03
MARCH			
APRIL			
MAY	70.90		367.44
JUNE			
JULY			2,145.60
AUGUST			2,120.40
SEPTEMBER			
OCTOBER			2,582.86
NOVEMBER	168.66	1,080.04	2,636.51
DECEMBER	144.75	911.41	1,060.86

Source: Provincial Irrigation Office - Bago City periods.

3.2.2.3 RESULTS AND DISCUSSIONS

A. GROUND WATER

1. *Aquifers and Ground Water Resource*

Pyroclastic rocks and alluvial deposits underlie the basin bounded by Bago River and Maragandang River. This basin includes the surface water systems which may be affected by the operation of the proposed geothermal facilities around Mt. Canlaon.

The tuffaceous sandstone beds serve as the main aquifer within the pyroclastic rock unit. They often occur as distinct layers between tuff and other tuffaceous claystone and siltone. Some conglomeratic sections also appear occasionally together with the sandstones.

The thickness and texture of the sandy and conglomeratic sections vary widely. Nearer the volcanic centers, the coarse fragments consist of coarse sands, angular pebbles and some cobbles. The sorting is extremely poor and fine volcanic ash comprise the major component of the rocks. Owing to the high tuff content, the sandstones and coarse pyroclastic rocks are only fairly to moderately permeable. The bedding of the lithologic units may be indistinct in these areas.

Towards the coastal areas, the pyroclastic rocks and the loosely consolidated alluvial deposits were subjected to erosional processes which improved the sorting of the coarse fragments and removed some of the fine clay and tuff materials. The bedding structures became better defined and layers are more distinct. The better sorting of the coarse materials improved the porosity and permeability of the sandstones and conglomerates compared to those rocks found near Mt. Canlaon.

sandstone and conglomerate layers reach about 50 to 60 meters in wells drilled to depths of 150 meters in Bacolod City and Bago City.

Occurrence of Ground Water

The groundwater in the subject area occurs in the pore spaces between the coarse fragments of the tuffaceous sandstones and conglomerates in the pyroclastic rock units. Some agglomeratic series may be fractured and water may be stored in the interstitial spaces in these rocks. Intervening clay beds act as confining layers which permit the buildup of artesian pressure in the porous and permeable layers. Thus, in some cases, free-flowing wells exist near the coastal areas. In general, these water-bearing layers are under confined or artesian conditions.

The alluvial deposits also store water in the pore spaces between the sands and gravel materials. However, the prevalent occurrence of clay and volcanic ash in the sands and gravel reduced somewhat the storage and transmissive capacity of the coarse lithologic units. The shallowest water-bearing formations within the alluvial deposits invariably exist as water table aquifers although the deeper aquifers often exhibit higher artesian head.

The top soil also contains some water which have been tapped through shallow dug wells. The ground water in this phreatic zone is definitely under water table or unconfined conditions.

B. *Wells*

Twenty (20) shallow wells were located during the field survey. These included eight (8) wells in the Lopez Jaena Area in Murcia and another 12 in the Ma-ao Mailum area. The summary of well data is shown in **Table 3.2.4**.

The wells in Lopez Jaena were constructed by the Department of Public Works and Highways (DPWH) in the last ten (10) years. They reached depths averaging twenty six (26) m. The wells were cased with 100-millimeter diameter pipes. Cylinder pumps have been installed in the wells.

TABLE 3.2.4 Summary of Well Data

WELL NO.	LOCATION	CASING (mm)	DRILLING DEPTH (m)	STATIC WATER LEVEL (mbgs)	ACTUAL CAPACITY (Q)	REMARKS
	NJC'S Carinderia	50	14.00	3.00	0.34	Shallow well
	California, Ma-ao	50	14.00	4.30	0.32	Shallow well
	Mailum Elementary School	50	16.00	5.00	0.63	Shallow well
BPW 15953	Ma-ao	50	15.24	5.49	0.32	Shallow well
BPW 15954	Ma-ao Market	50	9.10	3.66	0.32	

WELL NO.	LOCATION	BOREHOLE DIA. (m)	DEPTH (m)	STATIC WATER LEVEL (mbgs)	ACTUAL CAPACITY (Q)	REMARKS
	California, Ma-ao	1.2	5.0	2.0		Dug well
	Louisiana, Ma-ao (Front of High School)	1.2	6.5	5.0		Dug well
	Louisiana, Ma-ao (Crossing Gareta)	1.0	2.0	1.0		Dug well
	Louisiana, Ma-ao (Gareta)	1.2	6.0	3.0		Dug well
	Ma-ao (Front of Mailum Elem. Sch.)	1.0	7.0	4.0		Dug well
	Sitio Taytay Lube	1.0	9.0	6.3		Dug well
	Mailum Crossing, Ma-ao	1.0	7.0	5.5		Dug well

Bago City: February 21, 1993

In the Mailum-Ma-ao area, drilled wells are uncommon owing to the difficulty of boring through boulders. Instead, wells have been dug and constructed in depths ranging from 2.0 to 9.0 meters. Water is drawn from the well by buckets. A few jetmatic pumps have been installed in some of these wells. Such wells seldom exceed six (6) meters in depth.

Groundwater is derived from the porous sandy sections in the pyroclastic rocks. Although driller's logs are not available, a visual inspection of the wells dug shows that the subsurface materials are composed of the top soil, 3 to 4 m of clay boulders and sandy clay layers at the bottom.

Information obtained from the drillers of the DPWH suggests that in the Lopez Jaena area, tuff layers are intercalated with clays and some thin sections of tuffaceous sandstone. The tuffaceous sandstone serves as the main water-bearing formation in Murcia.

Based on the lithologic data on the shallow wells and the depth of the water level, the shallow aquifers in both Lopez Jaena and Ma-ao are classified as water table or unconfined aquifers.

Well Yields

The water yields of the existing wells in the Murcia and Ma-ao areas are insignificant. Cylinder pumps are capable of producing no more than 3.0 liters of water per second (L/s). In wells that are dug, their yield depends entirely on how fast the buckets can be lowered and raised from the well.

Water Levels

In Ma-ao and Mailum, the measured water levels were generally shallow, ranging from 1.0 to 6.3 m below ground surface. Water levels of wells in Lopez Jaena were much deeper. These wells had static water levels close to 7.0 m below ground surface.

Based on information obtained from the few wells in the area, a generalized water table map was drawn to show the general direction of groundwater flow in the covered area (**Fig. 3.2.3**).

The map shows that the water table in the area closely follows the topography of the land where the wells are located. In the Ma-ao area, ground water moves in a generally westerly direction. In Lopez Jaena, the groundwater flow is towards the northwest.

Cold Water Springs

Numerous cold water springs have been located in the vicinity of the proposed geothermal project sites. These springs are normally being utilized as sources of drinking water for the surrounding communities.

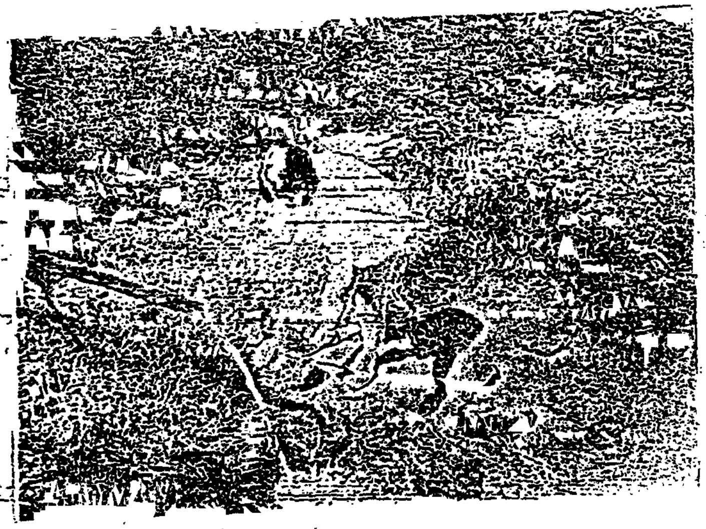
Five (5) cold water springs each have been examined in Mambucal and in the vicinity of Mailum. The springs are essentially water table springs. Water accumulates in the soil and weathered portions of the volcanic rocks and issues out of the ground whenever there is an abrupt change in the topography.

The water yield from these springs is often small, averaging less than one (1) L/s. However, the Mambucal springs and Lunao springs in Mailum produce considerably more water, exceeding six liter/second. Intake tanks have been provided to collect the spring water before they are piped to the nearby barangays. Bgy. San Miguel is supplied with water from a spring nearly three (3) kms. from the barangay.

The higher yield of the Mambucal springs and the Lunao springs may be attributed to the larger watershed area located above them.

Thermal Springs

Five (5) thermal springs have been reported in the vicinity of Mambucal and Hagdan (**Fig. 3.2.4**).



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TITLE:
Thermal Springs in Mambucal

FIG. 3.2.4

Two (2) springs in Hda. Paz and Hda. Montilla are warm water springs with temperatures of about 36 degrees Centigrade (^{0}C). The Hda. Montilla spring has a reported discharge of 3.3 L/min. while the Hda. Paz spring produces about 220 L/min. The Kinabkaban spring is slightly warmer at 38 ^{0}C.

The Hagdan and Mambucal springs are hot springs with water temperatures higher than 42 ^{0}C. The water discharges are also considerably larger than the other springs although they have not been actually measured.

These thermal manifestations are concentrated within the Mambucal-Bucalan lineament block. Other thermal springs in this block are located on the southern part of Canlaon volcano.

Spring Hydrology

The movement of the thermal waters in the area appears to be structurally and stratigraphically controlled. The rocks within the lineament block developed secondary porosity through fracturing and hydrothermal alteration.

Water of meteorologic origin seeps into the ground and percolates along the structures in the same manner that water contained in the highly permeable limestone and conglomerates of the Talave formation moves westwards beneath Canlaon volcano. This water is heated up when it reaches the geothermal reservoir cap, then rises and flows out to the northwest towards Mambucal and Hda. Montilla along the northwesterly lineaments.

Gerardo (1990) confirms this observation with isotopic studies on the meteorologic origin of the thermal springs around Mt. Canlaon are of meteoric origin.

3.2.3 WATER QUALITY

3.2.3.1 METHODOLOGY

A. COLLECTION OF SAMPLES

Sampling and analysis of surface and ground water in the town of Murcia and the city of Bago were conducted in March 1993 and February 1994. Sixty-one (61) river water samples from 47 different sites, eight (8) well water samples, and 14 spring water samples were taken.

Surface Water. Grab (or catch) samples of water were taken upstream (headwater) and after the confluence of rivers. As a rule, the samples were taken from the middle of the stream at mid-depth. Flow measurements and on-site determination of dissolved oxygen, temperature and pH were done. Sediment samples were also collected.

The necessary precaution and proper preservation techniques were undertaken to ensure the integrity of the water samples taken from the rivers. These include the addition of nitric acid to samples for determining the total metal concentrations in the water and the refrigeration (using ice boxes) of samples for suspended solid determination.

Forty seven (47) sampling stations were established along the different rivers in Murcia and Bago City to determine the quality of surface water in the area. The locations of these sampling stations are listed in Table 3.2.5 and shown in Fig. 3.2.5.

A total of 61 samples was collected from these 47 stations, 17 of which were taken in March 1993 and 44 in February 1994. The samples taken in 1993 were included in the analysis since the data from the common stations showed that there has not been much change in the characteristics of the rivers from 1993 to 1994.

TABLE 3.2.5 - SAMPLING STATIONS
WATER QUALITY

STATION NUMBER	NAME OF RIVER	LOCATION
BAGO RIVER		
4	Bago	After confluence with Maragandang River
6	Bago	After confluence with Maao River
7	Bago	At confluence with Maao River
14	Bago	After confluence with Pula River
15	Bago	After confluence with San Miguel River
MARAGANDANG RIVER		
31	Maragandang	Before confluence with Bago
34	Maragandang	Downstream of Jalandoni Piggery at Hacienda Bigornia
36	Maragandang	After confluence with Araal River
38	Araal	Lowest reach of Araal River before confluence with Maragandang River
39	Maragandang	After confluence with Nakalang River
40	Maragandang	Before confluence with Nakalang River
41	Nakalang	Before confluence with Maragandang River
46	Maragandang	
48	Maragandang	Headwater upstream of test well site
50	Tubidiao	Before confluence with Maragandang

TABLE 3.2.5 SAMPLING STATIONS (CONTINUED)
WATER QUALITY

MAAO RIVER

62	Maao	At barangay Maao
64	Maao	Confluence with Mailum River
65	Mailum	Lower reach of Mailum River
70	Maao	Before confluence with Maugbi River
71	Maugbi	Lower reach of Maugbi River
72	Maugbi	Northern-most tributary at lower reach, Hacienda Torres
73	Maugbi	Southernmost tributary
74	Maao	Hacienda Buenavista Bridge
76	Maao	Upper tributary (Pag-ulingan)
77	Maao	Near Hagdan
78	Maao	Upper tributary
80	Maao	Upper tributary

STATION NUMBER	NAME OF RIVER	LOCATION

PULA AND MINUYAN RIVERS

121	Pula	Lowest reach of Pula River
122	Pula	Confluence with Minuyan River
124	Minuyan	Lower reach of Minuyan River
125	Minuyan	Middle reach of Minuyan River
126	Minuyan	Upper reach of Minuyan River
128	Pula	Sitio Gayas

ASIA RIVER

[illegible]	Asia	Lower reach, confluence with Panginan-an before Bago River
[illegible]	Asia	Before confluence with Panginan-an
[illegible]	Panginan-an	Lower reach of Panginan-an before confluence with Asia River
[illegible]	Asia	After the Mambucal Hotsprings (near bridge)
[illegible]	Asia	Asia River west of well NC1

TABLE 3.2.5 SAMPLING STATIONS (CONTINUED)
WATER QUALITY

SIMAGUAN RIVER

181	Simaguan	After confluence with Batuan River
182	Simaguan	Before confluence with Batuan River
193	Marikato	Headwater
194	Simaguan	Confluence with Catugasan
195	Catugasan	Catugasan Creek
196	Simaguan	Confluence with Mambanig
197	Simaguan	Simaguan west of CT-A
198	Mambanig	Downstream from CT-A
201	Marikato	Marikato-Mingay confluence

Well Water. Water samples from eight (8) wells were gathered, six (6) of which were collected and analyzed in March 1993 while two (2) were taken in February 1994. The 1994 samples were taken from Hda. Weber in Maao (S.N. 7) and from Taytay Lubi in Mailum (S.N. 8). Samples from pump wells were taken only after the well has been pumped sufficiently to insure that the sample represents the groundwater that feeds the well.

Spring Water. Ten (10) cold springs and four (4) hot springs were sampled for analysis. Four (4) of the cold springs are located in Bago City while the rest are in Murcia. Seven (7) of the samples were taken in March 1993 while three (3) were collected in February 1994 from Tabadiang (S.N. 8), *Sitio* PNOC (S.N. 9) and *Sitio* Kipot in Mailum (S.N. 10). All hot spring samples were taken from the Mambucal Hot Spring Resort.

B. ANALYSIS OF SAMPLES

All water samples were analyzed using methods prescribed in the Standard Methods for the Examination of Water and Wastewater, 14th edition, 1975.

3.2.3.2 RESULTS AND DISCUSSIONS

A. RIVER WATER

Results of laboratory analysis indicate that the upstream portions of the rivers in Murcia and Bago City are of relatively high quality but that the quality of these rivers deteriorates as they flow downstream. The turbidity of the river water is higher downstream due to soil erosion brought about by agricultural and other human activities along the rivers. A summary of the existing characteristics of the river water in Murcia and Bago City is given in Table 3.2.6.

TABLE 3.2.6 Characteristics of Rivers in Murcia and Bago City

Parameter	Range of Values	Usual/ Average Value	DENR Water Quality Criteria[b]
pH	3.5 - 7.5	7.0	6.5 - 8.5
Dissolved Oxygen(mg/l)	2.0 - 9.0	6.5	5
Metals (ppm)			
Li	<0.01 - 0.48	<0.01	-
Na	1.8 - 140	<8.00	-
Fe	<0.02 - 12	<0.10	1.0
Mn	<0.01 - 0.29	<0.02	0.5
Cu	<0.03	<0.03	1.0
Cr	<0.05	<0.05	0.05
Cd	<0.01 - 0.04	<0.01	0.01
Pb	<0.10	<0.10	0.05
Zn	<0.01 - 0.04	0.02	5.0
As	<0.01 - 0.28	<0.01	0.05
K	<0.6 - 13.0	3.5	-
Mg	1.1 - 12.0	4.5	50
Ca	2.4 - 41.6	18.0	75
Inorganic Nontal (ppm)			
SO_4	<0.05 - 320	<20.0	
Cl	4.0 - 320	<20.0	
B	<0.10 - 5.2	<0.10	2.0[a]
SiO_2	20 - 110	40	

NOTES: a - For irrigation purposes, Boron should not exceed 2.0 mg/l.
b - For Class AA fresh surface water

Although in general Table 3.2.6 aptly describes the river systems in Murcia and Bago City, marked differences in the characteristics of some rivers should be noted. The Maragandang River, compared with the other rivers, has a high concentration of metals such as sodium (ave. <8.00 ppm), iron (ave. <.10 ppm), manganese (ave. <0.02 ppm), zinc (ave. 0.02 ppm), magnesium (ave. 4.5 ppm) and calcium (ave. 18.0 ppm). It also has the highest concentration of sulfates, chloride and silicates. It is the most acidic, with a pH of as low as 3.5 in some portions. Its dissolved oxygen levels downstream of the Jalandoni Piggery and after the sugar central are low. An odor of decaying biomass can be perceived at these points.

The following sections summarize the characteristics of the major river systems that may be affected by the geothermal development in the area.

Maragandang River and its tributaries

A total of 13 samples was taken from nine (9) sampling stations in the Maragandang River and its tributaries. Analysis of these samples, which are presented in Tables 3.2.7 and 3.2.8, show that the river is slightly acidic with a pH ranging from 3.5 upstream at its headwater (Station No. 46) to about 6.0 before it joins Bago River (S.N. 31). These pH values are lower than the DENR Water Quality Criteria for Class D surface water. Its two tributaries, Araal Creek and Nakalang River, have neutral to slightly basic water (S.N. 36, 38, 39,40).

Upstream of the river (S.N. 49, 50), the water is very clear with a high dissolved oxygen level and a relatively high concentration of metals such as sodium (0.01 ppm), iron (<0.05 ppm), manganese (<0.02 ppm), zinc (0.01 ppm), magnesium (3.8 ppm) and calcium (11.0 ppm). At this portion, the sulfate, chloride and silicate content of the river is also high. Its banks and bottom are brownish yellow in color due to ferric colloidal precipitates, which settle on the stone surfaces.

TABLE 3.2.7 Inorganic Non-metallic Constituent Analysis of MAragandang River and its Tributaries

S.N.	pH	SO_4	Cl	B	SiO2	DO	DATE SAMPLE TAKEN
31	5.4	52.0	22.0	0.2	66	2.0	02/13/94
31	5.9	40.0	7.0	0.10	68	-	02/05/94
34		100.0	29.0	0.52	64	-	02/14/94
34	6.8	100.0	24.0	0.10	68	-	02/05/94
35	5.3	92.7	12.0	-	34	3.4	03/07/93
36		97.0	38.0	0.31	69	5.0	02/14/94
36	6.4	110.0	22.0	0.10	71	-	02/05/94
38	7.4	37.0	9.0	0.14	59	-	02/05/94
39	4.7	140.0	28.0	0.11	84	-	02/05/94
40	4.5	150.0	34.0	0.24	88	-	02/04/94
41	7.0	16.0	7.0	<0.10	56	-	02/05/94
46	3.5	260.0	45.0	0.20	100	-	02/04/94
46	4.6	165.0	56.0	-	49	6.8	03/26/93
48		320.0	65.0	0.66	110	6.4	02/15/94
50		15.0	6.3	0.28	48	8.5	02/15/94

TABLE 3.2.8 Metal Analysis of Maragandang River and Its Tributaries

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
31	<0.01	12.0	1.80	0.29	<0.02	<0.05	<0.01	<0.10	0.02	<0.02	-	8.4	31.0
31	<0.01	9.8	0.50	0.23	<0.03	<0.05	0.03	<0.10	0.03	0.20	9.2	7.4	24.0
31	<0.01	40.4	0.13	<0.01	0.007	<0.01	<0.01	<0.10	<0.01	<0.1	7.3	bdc	30.4
34	<0.01	12.0	0.64	0.22	<0.02	<0.05	<0.01	<0.10	0.02	<0.02	-	7.8	28.0
34	<0.01	8.9	0.22	0.04	<0.03	<0.05	0.02	<0.10	0.02	<0.02	5.0	7.0	20.0
36	<0.01	12.0	0.74	0.21	<0.02	<0.05	<0.01	<0.10	0.02	<0.02	-	7.4	26.0
36	<0.01	9.1	0.18	0.17	<0.03	<0.05	0.02	<0.10	0.04	<0.02	6.5	6.9	20.0
38	<0.01	7.3	0.17	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	4.8	6.0	15.0
39	<0.01	11.0	0.46	0.23	<0.03	<0.05	0.02	<0.10	0.04	<0.02	8.5	7.4	25.0
40	<0.01	11.0	0.23	0.25	<0.03	<0.05	0.02	<0.10	0.04	<0.02	9.0	8.0	29.0
41	<0.01	5.0	0.05	<0.02	<0.03	<0.05	0.02	<0.10	0.03	<0.02	4.9	4.3	11.0
46	0.01	15.0	1.20	0.43	<0.03	<0.05	0.02	<0.10	0.05	<0.02	12.0	9.4	36.0
46	<0.01	28.0	0.03	<0.01	0.005	<0.01	<0.01	<0.10	0.02	<0.1	5.8	11.3	41.6
48	<0.01	23.0	12.00	0.60	<0.02	<0.05	<0.01	<0.10	0.04	<0.02	-	12.0	51.0
50	<0.01	5.8	<0.05	<0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	3.8	11.0

At the point of confluence with Araal Creek (S.N. 36), the river is already a bit turbid. Its turbidity further increases at the point downstream of the Jalandoni Piggery in Hda. Bigornia (S.N. 34). At this site, a slight odor is discernible and the measured dissolved oxygen level is 5.0 mg/l much lower than the level upstream. Further downstream, at the point after the sugar central (S.N. 31), the color of the water has changed to deep olive green and its dissolved oxygen is down to 2.0 mg/l. Decaying biomass in the river water makes it odoriferous and gives it its dark color.

Although the water upstream of the river is clear, it is neither used for drinking and cooking because of its bitter taste nor for bathing because it gives an itchy sensation according to residents. This maybe due to the low pH of the water. Water from the river is being used for irrigation although it is acidic.

Maao River and Its Tributaries

The results of the analysis of the fifteen (15) samples taken from the twelve (12) sampling stations in Maao River and its tributaries (Bantolinao, Mailum, Maugbi, Pag-ulingan) are shown in Tables 3.2.9 and 3.2.10. The pH of Maao and its tributaries ranges from 6.5 to 7.4. The dissolved oxygen at any point of the river is high, ranging from 6.4 to 9.0 mg/l The concentration of metallic and inorganic non-metallic constituents of this river system is low and is more or less constant at any point.

The Maao River is already slightly turbid before its confluence with the Maugbi River (S.N. 70). Its turbidity further increases downstream, after it meets with the Mailum River (S.N. 64). This is because of the suspended solids brought about by soil erosion due to agricultural and other human activities along the river.

TABLE 3.2.9 Inorganic Non-metallic Constituent Analysis of Maao River and Its Tributaries

S.N.	pH	SO4	Cl	B	SiO2	DO	DATE SAMPLES TAKEN
62	6.5	13.9	bdc	-	26	6.4	03/07/93
64	6.7	12.0	4.7	0.10	58	8.0	02/13/94
65	6.9	7.6	6.9	0.12	59	-	02/13/94
70	6.8	12.0	5.3	0.10	32	9.0	02/13/94
71	6.6	22.0	9.4	0.10	56	8.4	02/13/94
72	6.7	12.0	7.5	<0.10	48	-	02/04/94
73	7.0	33.0	11.0	<0.10	55	-	02/04/94
74	6.7	14.9	bdc	-	34	6.8	03/06/93
74	6.8	15.0	6.0	<0.10	56	-	02/04/94
76		11.0	15.0	0.25	60	8.3	02/15/94
77	6.8	15.0	5.0	<0.10	54	8.8	02/13/94
77	7.4	14.0	6.0	<0.10	62	-	02/04/94
78	6.7	14.0	4.0	-	37	6.7	03/06/93
78	6.8	9.2	6.0	<0.10	65	-	02/04/94
80	6.5	29.4	bdc	-	35	6.9	03/06/93

TABLE 3.2.10 Metal Analysis of Maao River and Its Tributaries

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
62	<0.01	7.6	0.28	<0.01	0.002	<0.01	<0.01	<0.10	0.03	<0.1	1.8	bdc	8.0
64	<0.01	4.8	0.15	<0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	2.2	8.8
65	<0.01	6.0	<0.05	<0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	4.2	12.0
70	<0.01	4.2	0.11	<0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	2.4	8.6
71	<0.01	6.2	0.09	0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	4.4	16.0
72	<0.01	6.4	0.09	<0.02	<0.03	<0.05	0.01	<0.10	0.03	<0.02	5.7	3.6	8.4
73	<0.01	6.9	0.06	<0.02	<0.03	<0.05	0.02	<0.10	0.03	<0.02	5.1	4.3	11.0
74	<0.01	6.2	0.04	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	2.0	bdc	9.0
74	<0.01	4.7	<0.05	<0.02	<0.03	<0.05	0.02	<0.10	0.03	<0.02	4.5	2.3	9.6
76	<0.01	6.4	<0.05	<0.02	<0.02	<0.05	<0.01	<0.10	0.01	<0.02	-	4.6	16.0
77	<0.01	5.4	0.41	0.03	<0.03	<0.05	<0.01	<0.10	0.02	<0.02	-	3.0	19.0
77	<0.01	4.2	0.06	<0.02	<0.03	<0.05	0.01	<0.10	0.03	<0.02	12.0	2.2	7.0
78	<0.01	9.7	<0.02	<0.01	0.005	<0.01	<0.01	<0.10	0.06	<0.1	2.8	bdc	8.0
78	<0.01	3.8	<0.05	<0.02	<0.03	<0.05	0.02	<0.10	0.03	<0.02	5.3	1.9	7.0
80	<0.01	9.0	<0.02	<0.01	0.002	<0.01	<0.01	<0.10	0.03	<0.1	2.3	bdc	19.2

Pula and Minoyan Rivers

Eight (8) samples have been collected from the Pula and Minoyan Rivers. The results of the analysis of the samples are shown in Tables 3.2.11 and 3.2.12. The pH of these rivers vary from 6.6 to 7.5. Just like the Maao River, the concentration of metallic and non-metallic constituents in the Pula and Minoyan rivers is low and is quite constant all throughout. Dissolved oxygen at the lowest reach of the Pula River, just before it joins Bago River averages 7.0 mg/l. At this point, the river is also slightly turbid. Several meters upstream of the sampling station, women can be seen washing clothes, and some carabaos wallowing in the waters.

Asia River

Five (5) stations have been set up at various points in Asia River, from which six (6) samples were taken. The results of the analysis of the samples are shown in Tables 3.2.13 and 3.2.14. The pH level of Asia River ranges from 7.1 to 7.3. Its dissolved oxygen level of 6.2 to 7.2 is higher that the DENR Water Criteria for Class AA fresh surface water.

The concentration of sodium and chloride in the river water is high after the river traverses the Mambucal Hot Springs (S.N. 152, 156). Its Arsenic content of 0.12 ppm at S.N. 152 and 0.28 ppm at S.N. 156 is much higher than the DENR standard of 0.05 ppm. The Boron levels of 2.70 ppm at S.N. 151; 3.00 ppm at S.N. 152; and 5.20 ppm at S.N. 156 are much higher than the allowable level of 2.0 ppm for irrigation waters.

Simaguan River and Its Tributaries

Nine (9) sampling stations were established along the Simaguan River and its tributaries (Catugasan, Marikato and Mingay). Results of the sampling conducted, as shown in Tables 3.2.15 and 3.2.16, indicate that of all the river systems in Murcia and Bago City, the Simaguan River has the highest quality as evidenced by its very low metal and non-metal constituents, high dissolved oxygen level and moderate pH values of 6.6 to 7.5. The water of Simaguan and

TABLE 3.2.11 Inorganic Non-metallic Constituent Analysis of Pula and Minoyan Rivers

S.N.	pH	SO4	Cl	B	SiO2	DO	DATE SAMPLES TAKEN
121	7.5	14.0	7.1	<0.10	53	7.6	02/11/94
121	7.4	15.0	7.8	<0.10	56	-	02/07/94
121	6.6	1.7	4.0	-	23	6.5	03/07/94
122	7.5	21.0	6.0	<0.10	56	-	02/05/94
124	7.3	7.0	12.0	<0.10	31	-	02/07/94
125	7.1	3.4	5.1	<0.10	38	-	02/05/94
126	6.9	26.0	6.1	<0.10	40	-	02/05/94
128	6.9	37.0	5.7	<0.10	51	-	02/05/94

TABLE 3.2.12 Metal Analysis of Pula and Minoyan Rivers

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
121	<0.01	6.1	0.41	0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	3.4	4.1	12.0
121	<0.01	7.2	0.14	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	4.9	3.1	10.0
121	<0.01	5.3	0.07	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.0	bdc	12.8
122	<0.01	5.3	<0.05	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	5.2	3.1	10.0
124	<0.01	8.2	0.22	<0.02	<0.03	<0.05	0.04	<0.10	0.04	<0.02	5.0	2.2	5.4
125	<0.01	2.6	0.06	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	3.1	1.5	3.8
126	<0.01	4.6	0.06	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	4.3	2.8	7.8
128	<0.01	4.8	<0.05	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	4.5	2.9	10.0

TABLE 3.2.13 Inorganic Non-metallic Constituent Analysis of Asia River

S.N.	pH	SO4	Cl	B	SiO2	DO	DATE SAMPLES TAKEN
151	7.3	12.0	160.0	2.70	52	-	02/07/94
152	7.4	7.2	170.0	3.00	48	7.2	02/11/94
153	7.2	1.7	97.0	1.20	26	6.2	02/11/94
156	7.1	10.0	320.0	5.20	58	-	02/06/94
157	7.2	6.5	4.0	<0.10	47	-	02/06/94
157	6.7	4.0	bdc	-	71	6.5	03/07/93

TABLE 3.2.14 Metal Analysis of Asia River

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
151	0.22	77.0	0.06	<0.02	<0.03	<0.05	0.02	<0.10	0.02	0.09	13.0	3.2	14.0
152	0.24	90.0	0.15	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	0.12	12.0	4.0	16.0
153	0.01	43.0	<0.05	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	4.8	4.2	11.0
156	0.48	140.0	0.17	0.03	<0.03	<0.05	0.02	<0.10	0.03	0.26	13.0	2.8	15.0
157	<0.01	2.8	0.06	0.05	<0.03	<0.05	0.01	<0.10	0.04	<0.02	6.0	7.3	22.0
157	<0.01	5.5	<0.02	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.2	[illegible]	8.0

TABLE 3.2.15 Inorganic Non-metallic Constituent Analysis of Simaguan River and Its Tributaries

S.N.	pH	SO4	Cl	B	SiO2	DO	DATE SAMPLES TAKEN
181	6.8	3.8	bdc	-	25	6.8	03/26/93
182	-	9.8	-	<0.10	44	8.2	02/12/94
193	6.5	2.3	bdc	-	21	7.0	03/26/93
194	7.3	<0.05	4.8	<0.10	34	7.2	02/12/94
195	6.5	3.1	bdc	-	19	6.5	03/07/93
196	7.4	<0.05	5.2	<0.10	38	7.8	02/12/94
196	7.2	1.2	4.5	<0.10	30	-	02/05/94
197	6.8	4.2	bdc	-	20	6.8	03/07/93
197	7.2	1.5	4.3	<0.10	26	-	02/05/94
198	7.3	<0.05	4.7	<0.10	46	-	02/05/94
201	7.5	1.4	4.8	<0.10	42	8.0	02/12/94

TABLE 3.2.16 Metal Analysis of Simaguan and Its Tributaries

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
181	<0.01	5.5	0.03	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.2	0.2	15.2
182	<0.01	3.4	0.14	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	4.1	2.2	6.9
193	<0.01	3.6	<0.02	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	0.6	bdc	2.4
194	<0.01	2.8	0.16	0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	2.8	2.4	5.8
195	<0.01	2.8	0.07	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	0.6	bdc	3.2
196	<0.01	2.8	0.06	<0.02	<0.03	<0.05	<0.01	<0.10	0.02	<0.02	2.7	2.8	7.6
196	<0.01	2.5	0.08	<0.02	<0.03	<0.05	0.02	<0.10	0.02	<0.02	2.2	1.1	3.0
197	<0.01	2.8	<0.02	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	0.8	bdc	6.4
197	<0.01	1.8	0.08	<0.02	<0.03	<0.05	0.03	<0.10	0.03	<0.02	3.3	1.1	3.0
198	<0.01	3.4	0.17	<0.02	<0.03	<0.05	0.04	<0.10	0.04	<0.02	3.4	1.5	4.2
201	<0.01	3.4	0.20	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	3.6	2.7	8.4

its tributaries is clear, although it is slightly turbid downstream after it meets with the Calaglagan Creek (S. N. 182).

The areas along the Simaguan River and its tributaries are steeply sloped, covered with vegetation and sparsely populated. These apparently have contributed in maintaining the high water quality of Simaguan.

Bago River

An analysis of the six (6) samples taken from five (5) stations along the Bago River shows that it is more or less neutral with a high dissolved oxygen concentration. The concentration of metals in the river is low. Results of the analysis are shown in Tables 3.2.17 and 3.2.18.

B. WELL WATER

Samples from eight (8) wells were taken (six in March 1993 and two in February 1994) in Bgy. Mailum, Bago City. The depths of these wells ranged from 6 to 85 ft. Four (4) of these wells are pump wells while four have been dug. Water from these wells, as shown by the results of the laboratory analysis, is fit for drinking. However, five (5) of the wells located at Mailum are slightly acidic, with pH values slightly below the minimum value of 6.5. The results of the analysis are given in Tables 3.2.19 and 3.2.20.

C. SPRING WATER

Cold Spring. The springs sampled are the drinking and domestic water sources of the community. Laboratory analysis shows that these freshwater springs are suitable for drinking. However, some of these springs have pH values slightly below the standard. Results of the water analysis are shown in Tables 3.2.21 and 3.2.22.

TABLE 3.2.17 Inorganic Non-metallic Constituent Analysis of Bago River

S.N.	pH	SO4	Cl	B	SiO2	DO	DATE SAMPLES TAKEN
4	6.2	15.3	6.0	-	20	6.4	03/07/93
6	6.6	5.4	bdc	-	24	6.4	03/07/93
7	6.5	12.6	bdc	-	25	6.8	03/07/93
14	6.8	2.0	bdc	-	21	7.0	03/07/93
15	7.7	<0.05	5.7	<0.10	42	7.7	02/11/94
15	7.1	13.2	bdc	-	28	6.5	03/07/93

TABLE 3.2.18 Metal Analysis of Bago River

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	As	K	Mg	Ca
4	<0.01	9.0	<0.02	<0.01	0.004	<0.01	<0.01	<0.10	<0.01	<0.1	2.2	bdc	16.0
6	<0.01	6.0	0.33	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.4	bdc	22.4
7	<0.01	8.0	0.31	<0.01	0.002	<0.01	<0.01	<0.10	0.02	<0.1	1.7	bdc	11.2
14	<0.01	5.2	0.12	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.0	4.8	6.4
15	<0.01	4.5	0.15	<0.02	<0.03	<0.05	<0.01	<0.10	<0.01	<0.02	3.8	2.5	9.0
15	<0.01	9.6	0.24	<0.01	<0.001	<0.01	<0.01	<0.10	<0.01	<0.1	1.7	bdc	20.9

TABLE 3.2.19 Inorganic Non-metallic Constituents Analysis of Well Water Samples

S.N.	pH	SO_4	Cl	S	SiO_2	As	HCO_3
1	6.77	4.57	.9	1.52	48.36	<0.01	68
2	6.35	6.72	bdc	2.24	52.64	<0.01	96
3	6.17	7.23	38	2.41	49.43	<0.01	76
4	6.51	15.24	6	5.08	51.79	<0.01	76
5	6.18	13.89	5	4.63	24.61	<0.01	36
6	5.88	55.98	17	18.66	27.61	<0.01	16
7		23	18	7.67	100	<0.02	
8	5.7	6.2	4.5	2.07	82	<0.02	
STD.*	6.5	200	200	-	-	0.05	-8.5

* National Standards for Drinking Water

TABLE 3.2.20. Metal Analysis of Well Water Samples

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	Hg	K	Mg	Ca
1	<0.01	11.2	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	9.62	<0.05	2.9	12.0	8.8
2	<0.01	177.1	0.04	<0.01	0.003	<0.01	<0.01	<0.01	0.02	<0.05	2.3	bdc	29.6
3	<0.01	11.1	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	2.8	16.1	18.4
4	<0.01	21.94	0.04	<0.01	0.008	<0.01	<0.01	<0.01	<0.01	<0.05	2.7	0.96	24.8
5	<0.01	10.69	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	1.1	bdc	27.2
6	<0.01	16.73	<0.02	<0.01	0.003	<0.01	<0.01	<0.01	<0.01	<0.05	1.6	0.24	15.2
7	<0.01	1.7	<0.05	0.05	<0.02	<0.05	<0.01	<0.10	0.02			7.5	16
8	<0.01	6	<0.05	<0.02	<0.02	<0.05	<0.01	<0.10	0.02			4.6	15
STD*		-	1.0	0.5	1.0	0.05	0.01	0.05	5.0	0.002	-	50	75

* National Standards for Drinking Water

TABLE 3.2.21 Inorganic Non-metallic Consituents Analysis of Spring Water

Spring Number	pH	SO_4	Cl	S	SiO_2	As	HCO_3
Cold Spring							
1	6.77	4.57	9	1.52	48.36	<0.01	68
2	6.35	6.72	bdc	2.24	52.64	<0.01	96
3	6.17	7.23	38	2.41	49.43	<0.01	76
4	6.51	15.24	6	5.08	51.79	<0.01	76
5	6.18	13.89	5	4.63	24.61	<0.01	36
6	5.88	55.98	17	18.66	27.61	<0.01	16
7		23	18	7.67	100	<0.02	
8	6.5	<0.05	5	<0.02	64.1	<0.02	--
9		6.9		2.3	23	<0.02	
10	6.1	11	6.7	3.7	47	<0.02	
STD.*	6.5 -8.5	200	200	-	-	0.05	
Hot Springs							
1	6.4 6.6	8.2 13.0	2 10	2.92 4.3	90.74 160	<0.02 <0.02	308
2	6.2	1316.0	1650	438.9	82.6	<0.02	92
3	5.8	36075.0	11700	11979.0	50.08	<0.02	56
4	6.4	52.0	1900	17.3	170	2.6	

* National Standards for Drinking Water

TABLE 3.2.22 Metal Analysis of Spring Water

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	Hg	K	Mg	Ca
1	<0.01	14.4	<0.02	<0.01	0.004	<0.01	<0.01	<0.01	<0.01	<0.05	2.3	bdc	4.6
2	<0.01	11.5	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	2.3	5.0	8.0
3	<0.01	8.4	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	2.0	2.9	7.2
4	<0.01	5.25	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	1.8	bdc	3.2
5	<0.01	2.38	<0.02	0.35	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	0.5	2.9	3.2
6	<0.01	4.09	<0.02	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	0.8	bdc	4.8
7	<0.01	16.51	<0.02	2.00	<0.001	<0.05	<0.01	<0.10	<0.01	<0.05	1192	bdc	19.2
8	<0.01	3.7	<0.05	<0.02	<0.03	<0.05	<0.01	<0.01	<0.01		3.6	2.1	7.9
9	<0.01	2.2	<0.05	0.36	<0.03	<0.05	<0.01	<0.01	<0.01		1.7	1.4	3.9
10	<0.01	5.4	<0.05	<0.02	<0.03	<0.05	<0.01	<0.10	0.02			7.5	11
STD*	-	-	1.0	0.5	1.0	0.05	0.01	0.05	5.0	0.002	-	50	75

Hot Springs

S.N.	Li	Na	Fe	Mn	Cu	Cr	Cd	Pb	Zn	Hg	K	Mg	Ca
1	0.03	48.1	0.06	0.08	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	9.7	22.7	50.0
	0.03	38	0.015	0.56	<0.03	<0.05	0.02	0.29	0.03		14	25	27
2	5.37	950.0	0.52	0.95	<0.001	<0.01	<0.01	<0.01	<0.01	<0.05	114.3	1.9	96.8
3	8.65	4942.0	0.49	3.52	<0.001	<0.01	<0.01	<0.01	0.02	<0.05	2599.0	bdc	440.0
4	3.3	930	0.33	1	<0.03	<0.05	0.02	0.33	0.03		110	26	51

* National Standards for Drinking Water

Hot Spring. The four (4) hot springs sampled in Mambucal include two (2) sulfur hot springs (Spring No. 2 and 3), one (1) hot spring beside the Mambucal Lodge (Spring No. 4) and one (1) by the grotto (Spring No. 1), which was sampled in 1993 and 1994.

Although the two (2) sulfur springs have very high concentrations of sulfur, chloride, sodium and potassium, their physical properties and chemical attributes differ. The sulfur content of Spring No. 3, at 11,979 ppm sulfur is more than 27 times that of Spring No. 2. Its 11,700 ppm chloride content is more than seven times that of Spring No. 2. These variations are due to the difference in their temperature. (Solubility of salt increases with temperature). The temperature of Spring No. 2 is 60 °C while that of Spring No. 3 is 75 °C. Hydrogen sulfide gas also emanates from the sulfur springs, emitting a rotten egg odor. The odor level, however, is still tolerable.

The 2.6 ppm arsenic level of Hot Spring No. 4 is much higher than the permissible level of 0.1 for class D water.

3.2.4 FRESHWATER BIOLOGY

3.24.1 METHODOLOGY

Field sampling was conducted from 12 February to 16 February, 1994. Some of the local residents who joined the sampling team during the EIA of the exploration phase were hired again to act as guides in looking for the impact rivers/creeks. They also took an active part in the collection of biological samples from the water and the stream bed.

SELECTION OF SAMPLING STATIONS

...eering studies on the freshwater communities of the different river systems running through ...eas that will be affected by the development of the geothermal resource in Hagdan (Option ...aan (Option 2), and Catugasan (Option 3), were undertaken during the EIS of the ...tion phase. The investigation was done exactly a year before the present study commenced. All the sampling points established were considered as part of the EIA of the development phase. Where there are no major physical changes within the vicinity of the different sampling sites, it was assumed that the species composition are basically the same, especially in the headwater region and upstream portion of the rivers. However there could be variations in the population density. According to Hynes (1974), even within one (1) water course whose general characteristics do not change as one proceeds downstream, trends in the abundance of certain species can often be discerned. Marked differences in the composition and density of the flora and fauna could occur if there are significant changes in the water quality and the physical nature of the substratum of the impact rivers. This could be brought about by extrinsic factors, such as a change in land use, the disposal of inorganic and organic wastes, flash floods, quarrying, and other earthmoving activities. Thus, additional sampling points (marked with an * in the list of sampling stations) were established in areas where changes have occurred.

One (1) station along the Maragandang River (HGC-6) was reinvestigated. Based on last year's findings, it was already in an advanced stage of pollution. Found along the river banks were piles of solid waste. However, when the area was revisited this year, there were no more piles of solid waste although traces of burnt garbage were still evident. Along the Simaguan River, just after its confluence with Catugasan Creek, a small bridge made of steel and wood was constructed sometime in the middle of 1993. A sampling station was established just after the point of confluence of the two water bodies. New stations were also established upstream of the Maao River and also along the Maragandang River because of earthmoving activities undertaken in preparation for the exploration of the geothermal resource. In Bgy. Binubuhan, samples were collected near the Hda. Pacita Piggery. The smell of piggery waste prevails in the area, although it is not known how the wastes from such an operation are disposed.

Aside from these considerations, sampling stations were established at an appproximate distance of one (1) km after the confluence of a river and its tributary. It is assumed that at this distance, considerable mixing of water has already taken place and the resulting water quality will affect the distribution of organisms.

Following is a list of all sampling stations and their locations. As to their exact points, please refer to Fig. 3.2.6. To easily identify the river stations in each study area, they are coded as follows: CTA for Catugasan; PTA for Pataan; and HGC for Hagdan. The significance and classification of all the stations are shown in Table 3.2.23.

Simaguan River:

CTA - 2	=	Headwater
CTA - 4	=	After the drilling site (exploration phase)
CTA - 10	=	Approximately one (1) km. after the confluence with Marikato, Tabadyang, and Mingay Creeks
CTA-13	=	Approximately one (1) km. after the confluence with Batuan River
CTA - 16*	=	Approximately 500 m. after the confluence with Mambanig creek
CTA - 17*	=	After the confluence with Catugasan creek
CTA - 19*	=	After the confluence with Calaglagan creek

Tributaries of Simaguan River:

CTA - 1	=	Headwater of Marikato River
CTA - 7	=	Marikato River after the drilling site (exploration phase)
CTA - 18*	=	Marikato River after the confluence with Mingay Creek
CTA - 5	=	Catugasan Creek
CTA - 6	=	Mambanig Creek
CTA - 8	=	Mingay Creek
CTA - 9	=	Tabadyang Creek

TABLE 3.2.23 CLASSIFICATION OF SAMPLING POINTS

	OPTION 1 (Hagdan-HGC)	OPTION 2 (Pataan-PTA)	OPTION 3 (Catugasan-CTA)
CONTROL STATIONS			
Within the National Park	1	-	1
			2
			3
			8
			9
Outside the National Park			4
			6
			7
Direct Impact Stations			
Road Construction	2	1	4
	3	2	5
	4	8	11
	5	11	12
	-	13	16
	-	-	17
	-	-	18
Drilling of Pads/Wells	2	1	5
	-	8	10
	-	11	11
	-	-	12
	-	-	17
	-	-	18
Power Plant Construction	2	2	5
	3	8	11
	-	-	12
	-	-	17
Secondary Impact Stations	6	3	13
	8	4	14
	9	5	15
	10	6	19
	11	7	20
	12	9	21
	-	10	-

Asia River:

CTA - 3	=	Headwater
CTA - 11	=	After the drilling site (exploration phase)
CTA - 12	=	After the hotspring in Mambucal (near the bridge)

Pula River:

PTA - 8	=	Upstream portion
PTA - 9	=	Before the confluence with Bago River

Maao River:

PTA - 1	=	Headwater
PTA - 3	=	Near Hacienda Buenavista
PTA - 11*	=	After the confluence with Pataan and Hagdan
PTA - 4	=	At Maao proper
PTA - 5	=	Before the confluence with Bago River
PTA - 12*	=	Before the confluence with Maugbi River
PTA - 15*	=	After the confluence with Mailum River

Tributaries of Maao River:

PTA - 2	=	Headwater of Pataan River
PTA - 13*	=	Maugbi River
PTA - 14*	=	Mailum River Maragandang River:
HGC - 1	=	Headwater
HGC - 2	=	After the drilling site
HGC - 3	=	Maragandang River approximately one (1) km. after the confluence with Tabidyao Creek

HGC - 4	=	Maragandang River approximately one (1) km. after the confluence with Naciu Creek
HGC - 5	=	Maragandang River approximately after the confluence with Nakalang Creek
HGC - 6	=	Maragandang River at 1.2 km. before the confluence with Bago River
HGC - 6b*	=	Same as HGC-6 (re-sampling)
HGC - 10*	=	At Sitio Lunoy
HGC - 11*	=	After confluence with Araal River
HGC - 12*	=	Near the Hacienda Pacita Piggery

Bago River:

CTA - 14	=	Approximately one (1) km. after the confluence with San Miguel River
CTA - 15	=	Approximately 500 m after the confluence with Simaguan River
CTA - 20*	=	Approximately 500 m after the confluence with Tayumaan River
CTA - 21*	=	Approximately 500 m after the confluence with San Miguel River
PTA - 6	=	Confluence with Maao River
PTA - 7	=	After the confluence with Maao River
PTA - 10	=	After the confluence with Pula River
HGC - 7	=	Approximately 1.5 km. after the confluence with Maragandang River
HGC - 8	=	At Baranggay Lumangob
HGC - 9	=	Mouth of Bago River

Important physical parameters such as water temperature, width of stream, depth of sampling point, flow speed and condition of the river bed were recorded.

3.2.4.2 COLLECTION AND ANALYSIS OF BIOLOGICAL SPECIES

A. ZOOPLANKTON AND DRIFT FAUNA

Zooplankton rarely inhabits lotic environment. However, from the qualitative and quantitative analyses of these organisms, information on drift fauna could also be obtained. These are usually composed of larvae and nymphs of insects that are carried by the water current downstream. The presence of drifting organisms makes the recolonization of disturbed habitat possible.

Fifteen (15) liters of water are filtered through a plankton net with a mesh size of 35 microns (μ) in each of the established sampling stations. The water is concentrated in the collecting tube of the plankton net and transferred to a four (4) ounce (oz.) polyethylene bottle, properly labelled as to station, time, and date of collection. To preserve the samples, ten (10) drops of 5 % formalin solution have been added.

The total zooplankters contained in the samples were counted and identified up to the genus level, using a Bausch and Lomb stereozoom microscope with a magnification of 4x. The following formula was used to convert the quantity of zooplankters to organisms per cubic meter:

$$\text{organisms/m}^3 = \frac{N/CF}{Vs} \times 1000 \times 1000$$

where:

N	=	Number of organisms counted
CF	=	Correction factor (TV/CV)
TV	=	Total volume of sample (ml)
CV	=	Concentrated volume of sample (ml)
Vs	=	Volume of subsample (ml)

B. BENTHIC FAUNA

For shallow rivers and creeks, a surber sampler was used to collect benthic organisms, while for deeper waters, such as in the mouth of Bago River and at some points along its stretch, an Ekman dredge was used to collect the sediments.

The Surber sampler was positioned against the current and whenever possible, samples were collected in the middle of the stream. The area to be sampled was marked out by a one square foot frame where all stream bed materials, such as rocks and stones are either scrubbed or brushed lightly to dislodge the clinging organisms. Other bottom dwelling organisms were dislodged with hands or trowel to a depth of about five to ten (5-10) cm. All the debris were allowed to be swept by the current into the net where a collecting tube is securely fastened at the end. Other organisms that were not carried into the net by the current were handpicked. Rinsing of the net was done several times before transfering the content to a plastic container.

The collection of sediment samples at the deeper portions of Bago River was done by the use of an Ekman dredge. This sampling device has a box-like part that holds the sediment and could be opened manually to facilitate the transfer of its content to a suitable container, e,g,. plastic bag The sediment collected was then passed through a series of sieves to seggregate the animals according to their size. Bigger animals were handpicked while those retained in sieves of smaller mesh size were rinsed into the four (4) oz. polyethylene bottles A 5% formalin solution was used as preservative. To facilitate the identification of the animals, Rose Bengal staining solution was added to the sample 24 hrs. prior to analysis. Qualitative and quantitative examinations were made under a stereozoom and compound microscope. The counts were expressed as number of organisms per square meter and calculated as follows:

$$\text{organisms/m}^2 = \frac{\text{Number of animals}}{\text{Area of sampler}}$$

C. BENTHIC/PLANKTONIC ALGAE

Samples were collected by scraping or brushing submerged stones contained within a one square foot area, in a plastic basin containing river water. The water sample, together with some debris, was transferred to a polyethylene bottle and preserved with Lugol's solution. An inverted microscope was used for qualitative and quantitative analysis. Algal density was calculated per unit area of substrate as follows:

$$\text{Organisms/m}^2 = \frac{N \times At \times Vt}{Ac \times Vs \times As}$$

where:

N	=	Number of organisms counted
At	=	Total area of chamber bottom
Vt	=	Total volume of original sample suspension
Ac	=	Area counted
Vs	=	Sample volume used in chamber
As	=	Surface area of substrate

D. DIVERSITY INDEX

The most common diversity index (D) for benthos (Lind,1974) was used in this study, the formula of which is:

$$D = \frac{m}{N^{1/2}}$$

where:

m	=	Total number of species
N	=	Total number of individuals

Diversity is dependent not only on the number of species in a collection but also on the relative abundances of each species (Poole,1974). Thus, there are cases wherein the value of D is very small even if the number of species is higher due to big differences in the relative density of species. The latter is computed as follows:

$$\text{Relative Species Density (RSD)} = \frac{N}{Nt}$$

where:

N = number of organisms per species

Nt = total number of organisms

3.2.4.3 WATER QUALITY ASSESSMENT BASED ON INDICATOR SPECIES

The biological investigation of either lotic (e.g.rivers) and lentic (e.g.lakes) environments necessitates the preparation of long lists of species collected from either the stream bed or sediments and from the water. This is a prerequisite before any attempt could be made on assessing the environmental conditions of any body of water. For convenience, the species referred to in this study are organisms identified up to the genus level

The advantages of biological investigation lie in the fact that the animals and plants provide a more or less static record of the prevailing conditions (Hynes,1976) and that they are not affected by a temporary alteration of the environment The assessment of river water quality was done based on the method applied by the National Institute of Environmental Studies (NIES) in Japan and the more conventional biological assessment of pollution, wherein organisms are classified as clean water indicators (CWI) and polluted water indicators (PWI). For benthic organisms, aquatic insects belonging to the Orders *Plecoptera, Ephemeroptera, Megaloptera*, and *Trichoptera* are generally classified as sensitive organisms and as such are indicators of good water quality while *Oligochaetes* and *Dipterans* (with the exemption of *Simulium sp*) are considered as indicators of poor water quality. Some species of chironomid larvae possess a type of hemoglobin in their blood that functions efficiently at low oxygen concentrations (Wetzel,1983). Thus, they are initially considered as polluted water indicator. Findings of the biological investigation for both the EIA of the exploration phase and this study show that chironomids can be found in both clean and polluted water. Such ubiquitousness classifies this group of midge larvae as a non-indicator organism.

With regard to the benthic algae, the classification of indicator organisms was based on the Standard Methods for the Examination of Water and Wastewater (APHA,AWWA,WPCF, 1989).

3.2.4.4 RESULTS AND DISCUSSIONS

A. LOTIC COMMUNITIES

Simaguan River

The headwater of the Simaguan River (CTA-2) runs through a thickly forested area of the Mt. Canlaon National Park. The water is very clear and through visual observation, the water could be readily classified as Class AA (DENR Administrative Order No.34). Residents of *Sitio* PNOC who have frequented the place before claimed that they drink directly from the river.

At the upstream portion, which is in *Sitio* Catugasan, Bgy. Minoyan, the river is joined by its five (5) tributaries namely: Catugasan, Mambanig, Marikato, Mingay, and Tabadyang Creeks. At the midstream portion, it is fed by waters coming from Calaglagan Creek and before it drains downstream to Bago River, it is joined by Batuan River.

There were no major changes observed in areas along the course of the river after the EIA investigation done in February 1993 in connection with the exploration of the geothermal resource in Catugasan. Thus, it was assumed that no significant changes in species composition occurred, although there could be variations in numbers (please refer to Sec.1.1.1). Since the concern was more on the quality of organisms in order to assess the biological status of the different rivers, the baseline data generated last year was incorporated in this study. This assumption holds true with the other river systems.

However, additional stations were investigated to augment the data requirements specially at the point of confluence of a major river with its tributaries. Based on the 1993 study, the population of benthic fauna along the stretch of Simaguan River ranges from 42 organisms/m^2 in station CTA-2 to 1955 organisms/m^2 in station CTA-13 (**Table 3.2.24**). In the former, this is composed solely of the nymphs of *Caenis sp.* and *Baetis sp* of the Order *Ephemeroptera*, each exhibiting a relative species density (RSD) of 50%. Since this station is at the headwater region and situated near a waterfall, the water flows faster and as Hynes (1974) observed, *Baetis sp.* can inhabit turbulent water because it relies on its claws and swimming power to resist the current Likewise, *Caenis sp.* and *Baetis sp.* are good indicators of clean water and thrives best in conditions of high dissolved oxygen (DO) content.

In station CTA-13, the mollusc *Tarebia sp.* dominated the population at 1582 organisms/m^2, with an equivalent RSD of 80.92%. Such single species dominance gave an DI of 0.181. The presence of aquatic insects was also observed, but there was none of the polluted water indicators, thus the moderately polluted water classification of station CTA-13 (**Fig. 3.2.7**).

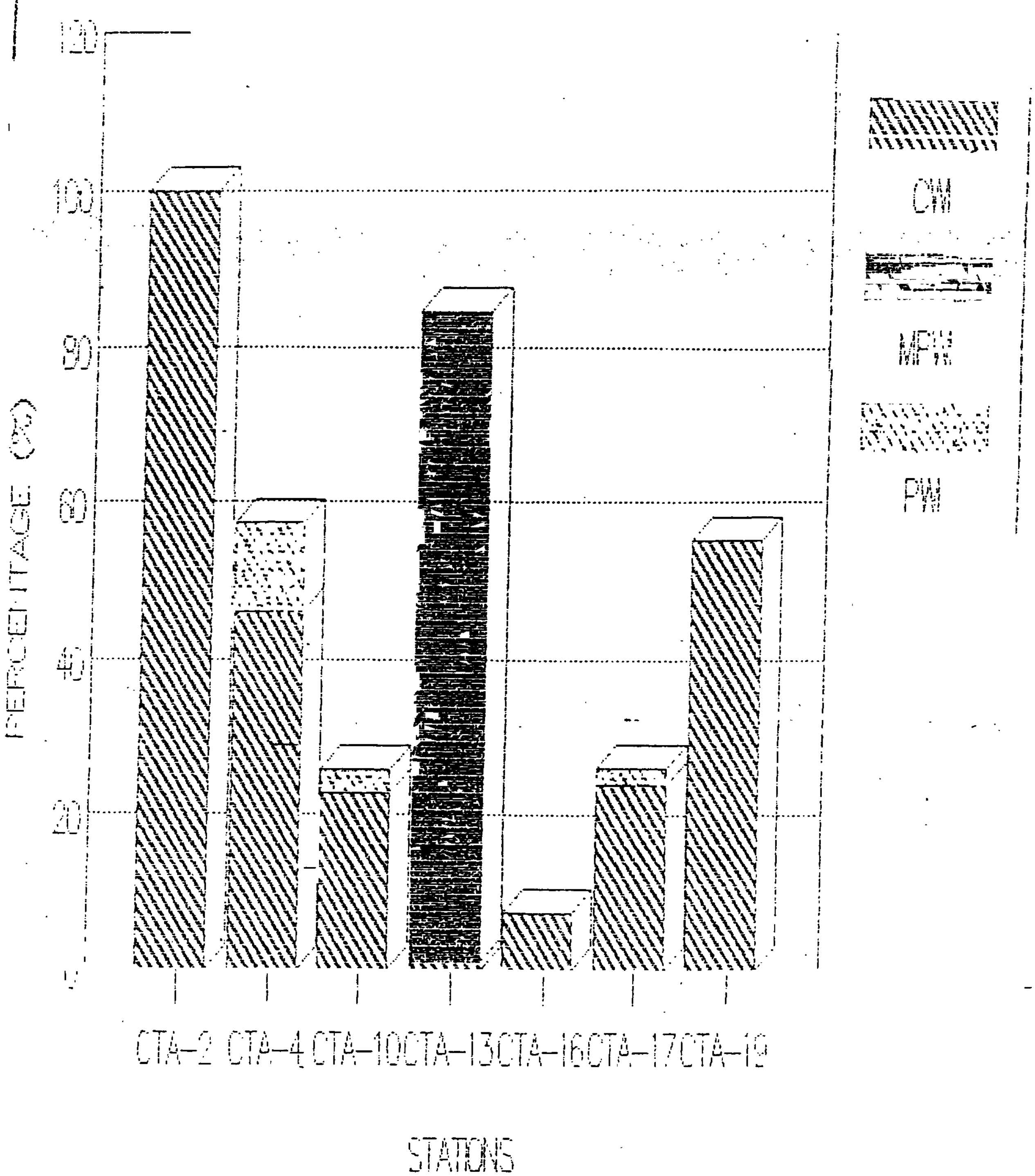
Among the additional stations in the Simaguan River that were investigated in this study, (CTA-16, CTA-17, CTA-19) CTA-17 has the highest density of benthic fauna belonging to the Order *Ephemeroptera* which are clean water indicators. The same indicator organisms have also been found in the other two (2) stations (**Fig. 3.2.8**). In station CTA-16, the abundance of non-indicator organisms has likewise been observed, 93 % of which are chironomid larvae.

Among the five (5) upstream tributaries of Simaguan River, the highest species diversity was observed in Mambanig Creek (CTA-6). Very few organisms were observed, but their

TABLE 3.2.24

BENTHIC FAUNA OF IMPACT RIVERS (CATUGASAN)
ORGANISMS PER SQUARE METER

SPECIES	CTA-2 Counts	CTA-2 RSD	CTA-4 Counts	CTA-4 RSD	CTA-10 Counts	CTA-10 RSD	CTA-13 Counts	CTA-13 RSD	CTA-16* Counts	CTA-16* RSD	CTA-17* Counts	CTA-17* RSD	CTA-19* Counts	CTA-19* RSD
					SIMAGUAN RIVER									
CLEAN WATER INDICATORS:														
Phylum Arthropoda														
Class Insecta														
Order Plecoptera														
Perla											39	0.73	78	5.56
Order Ephemeroptera														
Caenis	21	50	86	13.25	75	5.75			78	2.19	820	15.33		
Baetis	21	50	86	13.25	64	4.90			117	3.29	78	1.46	195	13.89
Ecdyonorus			10	1.54	10	0.77			39	1.10	117	2.19	390	27.78
Habroleptoides											78	1.46		
Paraleptophlebia			32	4.93										
Leptophlebia			32	4.93										
Epeorus											39	0.73		
Torleia											78	1.46		
Rithrogena											39	0.73		
Order Tricoptera														
Hydroptila			21	3.24	96	7.36								
Hydropsyche			21	3.24	21	1.61			39	1.10			117	8.33
Ryacophila					10	0.77	21	1.07					78	5.56
Unid Trichoptera (pupation)					21	1.61								
Order Megaloptera														
Sialis			10	1.54										
SUB-TOTAL	21	100	298	45.92	297	22.76	21	1.07	273	7.68	1288	24.08	858	61.11
MODERATELY POLLUTED WATER INDICATORS														
Phylum Mollusca														
Class Gastropoda														
Order Basammatophora														
Radix							53	2.71						
Order Mesogastropoda														
Tarebia							1582	80.92						
SUB-TOTAL							1635	83.63						
POLLUTED WATER INDICATORS														
Phylum Arthropoda														
Class Insecta														
Order Diptera														
Psychoda			10	1.54	32	2.45								
Culicidae			64	9.86										
Unid Dipteran					10	0.77								
Corethra											117	2.19		
SUB-TOTAL			74	11.40	42	3.27					117	2.19		
OTHERS														
Phylum Arthropoda														
Class Insecta														
Order Diptera														
Chironomid			107	16.49	548	41.99			3164	89.03	3046	56.96	156	11.11
Chironomid pupa			21	3.24	64	4.90								
Order Coleoptera														
Narpus			129	19.88	301	23.07	21	1.07						
Helmis									39	1.10	156	2.92	78	5.56
Psephenidae											39	0.73	156	11.11
Hydrocius											78	1.46		
Haliplidae													78	5.56
Dytiscus									39	1.10	507	9.48	39	2.78
Grynidae									39	1.10			39	2.78
Order Hemiptera														
Ilyocoris							53	2.71						
Aphelocheirus			10	1.54	32	2.45	172	8.80			117	2.19		
Microvelia							43	2.20						
Class Crustacea														
Potamonidae			10	1.54	21	1.61								
Phylum Chordata														
Class Pisces														
Gobiidae							10	0.51						
SUB-TOTAL			277	42.68	966	74.02	299	15.29	3281	92.32	3943	73.73	546	38.89
GRAND TOTAL	42	100	649	100	1305	100	1955	99.99	3554	100	5348	100	1404	100

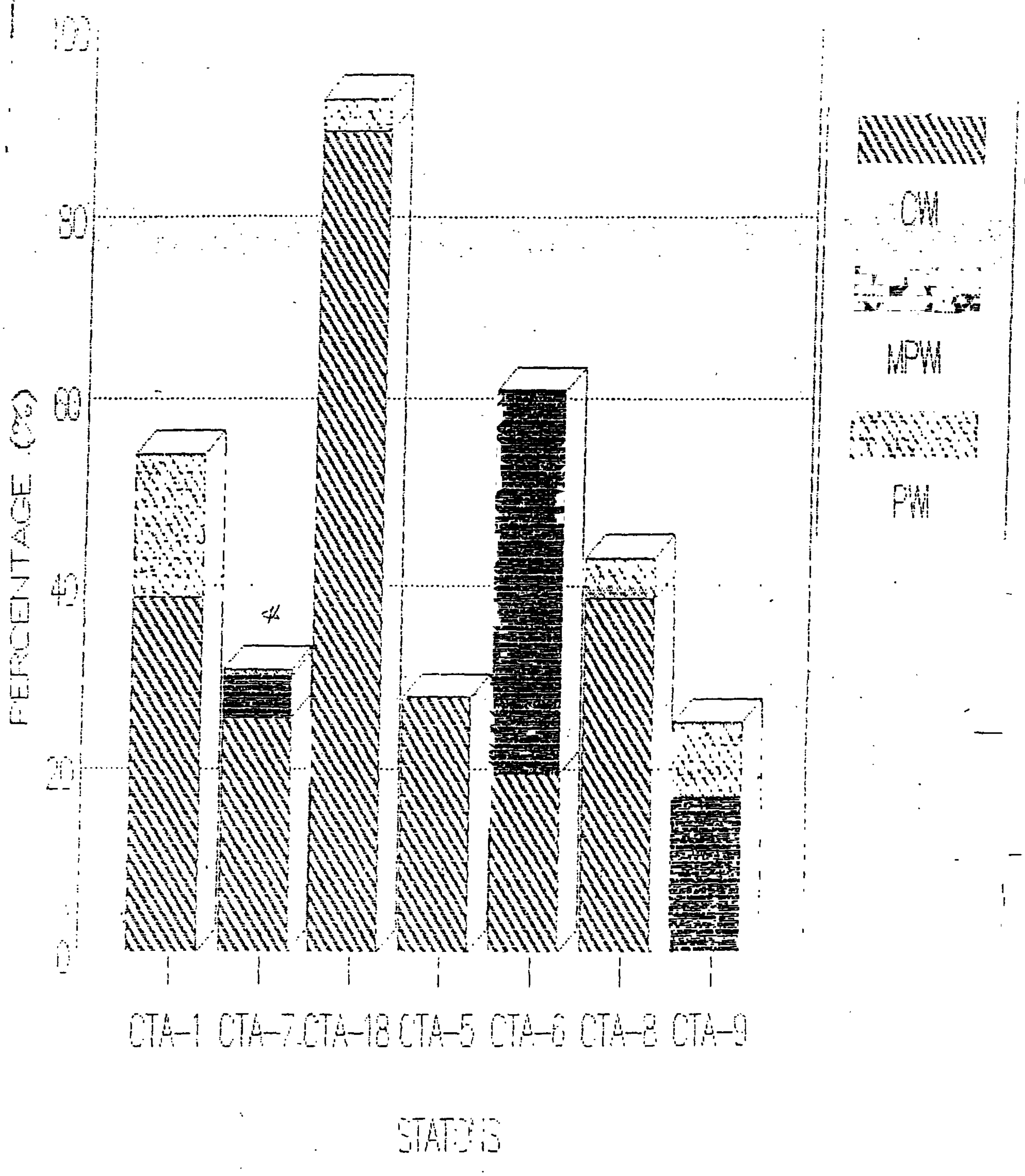


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Distribution of Indicator Organisms Simaguan river

FIG. 3.2.7



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Distribution of Indicator Organisms Tributaries: Simaguan river

FIG. 3.2.8

distribution is relatively even. According to Poule (1974), a community with all the species having about equal population density is more diverse than another community of the same number of species but has some common species while the others are rare. Clean water indicators were found in all the tributaries, except in Tabadyang where there are about ten (10) households in the immediate vicinity. The water was turbid due to the irrigation water that passes through the rice paddies upstream.

The investigation of the algal community showed that station CTA-13 (before the confluence of Simaguan River with Bago River) has the highest density with 49,842 organisms/m^2, of which 87% was due to the abundance of *Gomphonema sp.* (**Tab. 3.2.25**).This diatom could be found in both epilethic and epiphytic subcommunities and is used as an indicator of polluted water. Hynes (1976) has stated that as one proceeds downstream, the water becomes more eutrophic and the algal community also changes. In station CTA-19, the flora consists only of algae belonging to the Division *Chrysophyta*. Fewer organisms have been found, which was also true in CTA-18 and CTA-17.

Drifting organisms found along Simaguan River (**Tab. 3.2.26**) and its tributaries (**Tab. 3.2.27**) consisted mainly of chironomid larvae. However, some *Ephemeropterans* were also found such as *Ecdyonorus sp.* and *Caenis sp.* According to Muller (1954) and Waters (1961), the drift represents, as it were, excess production from the habitat. As the animals reproduce and grow, the area becomes overcrowded and some specimens are displaced and drift away. Some of these will replace specimens further down that have died or been eaten and the rest are swept on to be eaten or lost (Hynes,1970). In some stations such as CTA-16, 19 and 18, some planktonic microcrustaceans, such as copepods and the rotifers *Euchlanis sp.* and *Lecane sp.*, were also found. Data on benthic fauna found at the Simaguan River tributaries are shown in **Tab. 3.2.28**.

Asia River

The upper reach of Asia River (CTA-3) extends also to the Mt. Canlaon National Park and is

TABLE 3.2.25

ALGAL POPULATION OF IMPACT RIVERS (CATUGASAN)
ORGANISMS PER SQUARE METER

SPECIES	SIMAGUAN RIVER													
	CTA-2		CTA-4		CTA-10		CTA-13		CTA-16*		CTA-17*		CTA-19*	
CLEAN WATER INDICATORS	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD
Division Chlorophyta														
Cladophora					9	0 33								
Ulothrix			28	0 19					9	0.63				
Division Chrysophyta														
Cocconeis					28	1.02	177	0.36	9	0.63			28	10.00
Navicula	112	18.82	2715	18.86	121	4 41	233	0.47	627	44.22	375	59 90	56	20.00
Pinnularia	112	18.82	662	4.60	9	0.33	9	0.02	9	0.63	19	3 04		
Surirella	9	1.51	112	0.78					9	0.63	9	1.44		
SUB-TOTAL	**233**	**39.16**	**3517**	**24.43**	**167**	**6.09**	**419**	**0.84**	**663**	**46.76**	**403**	**64.38**	**84**	**30.00**
POLLUTED WATER INDICATORS														
Division Cyanophyta														
Anabaena			9	0.06	9	0.33	37	0.07						
Oscillatoria			457	3.17	47	1.71	19	0.04	9	0.63				
Division Chlorophyta														
Spirogyra			112	0 78	103	3 76	9	0 02	9	0.63				
Stigeoclonium					9	0.33								
Division Chrysophyta														
Gomphonema	28	4 71	28	0.19	177	6 46	43538	87.35	131	9 24			9	3.21
Nitzschia	47	7.90	196	1.36					56	3 95	9	1 44		
SUB-TOTAL	**75**	**12.61**	**802**	**5.57**	**345**	**12.59**	**43603**	**87.48**	**205**	**14.46**	**9**	**1.44**	**9**	**3.21**
OTHERS:														
Division Chlorophyta														
Crucigenia					37	1 35								
Pediastrum			9	0 06										
Hormidium			56	0.39							9	1.44		
Closterium			28	0 19	9	0 33			19	1 34	9	1.44		
Cosmarium			28	0.19										
Oedogoniales									9	0.63				
Division Chrysophyta														
Biddulphia													56	20.00
Caloneis	9	1.51												
Stephanodiscus			280	1 95										
Amphora	9	1 51	84	0.58	28	1.02	9	0.02						
Cymbella	9	1 51	681	4 73	28	1.02	149	0 30	37	2 61	28	4.47	19	6.79
Epithemia					65	2 37	2617	5 65	9	0.63				
Fragilaria	93	15.63	8060	56 00	960	35 75	336	0.67	112	7 90				
Mastogloia											9	1 44		
Pleurosigma					9	0 33			9	0 63	56	8 95	37	13.21
Rhopalodia	9	1 51	28	0 19			261	0 52						
Stauroneis	9	1 51	28	0 19					187	13 19	37	5 91		
Synedra	103	17.31	560	3 89	1045	38 12	2239	4.49	140	9.87	66	10.54	66	23.57
Achnanthes	46	7 73	233	1 62	28	1.02	9	0.02	28	1.97			9	3.21
SUB-TOTAL	**287**	**48.24**	**10075**	**69.99**	**2229**	**81.32**	**5820**	**11.68**	**550**	**38.79**	**214**	**34.19**	**187**	**66.79**
TOTAL	**595**	**100**	**14394**	**100**	**2741**	**100**	**49842**	**100**	**1418**	**100**	**626**	**100**	**280**	**100**

TABLE 3.2.26

DRIFT FAUNA OF IMPACT RIVERS (CATUGASAN)

SPECIES	SIMAGUAN RIVER													
	CTA-2		CTA-4		CTA-10		CTA-13		CTA-16*		CTA-17*		CTA-19*	
Phylum Arthropoda	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD
Order Ephemeroptera														
Ecdyonurus							13	6.57						
Caenis	734	26.85									91	3.72		
Epeorus							13	6.57					100	25
Baetis													100	25
Order Trichoptera														
Hydropsyche					26	50								
Unid Trichoptera							13	6.57						
Order Hemiptera														
Aphelocheirus					13	25	26	13.13						
Order Diptera														
Chironomid	2000	73 15	26	100	13	25	133	67.17	1063	78.57	1995	81.46		
Class Crustacea														
Nauplius									193	14.25				
Tigroipus									97	7.16				
Oncaea											181	7.39		
Phylum Nematoda														
Unid Nematode													100	25
Phylum Annelida														
Order Oligochaeta														
Naididae											91	3.72		
~~Phylum~~ Nemertea/														
Rhynchocoela											91	3.72		
Phylum Rotifera														
Euclanis													100	25
GRAND TOTAL	2734	100	26	100	52	100	198	100	1353	99.98	2449	100	400	100

TABLE 3.2.27 DRIFT FAUNA OF IMPACT RIVERS (CATUGASAN)

SPECIES	TRIBUTARIES: CTA-7		CTA-18*		SIMAGUAN RIVER CTA-5		CTA-6		CTA-9	
Phylum Arthropoda	Counts	RSD	Count	RSD	Counts	RSD	Counts	RSD	Count	RSD
Order Ephemeroptera										
Baetis	13	5.18	66	25						
Order Trichoptera										
Hydropsyche	106	42.23			13	50				
Hydroptila	13	5.18								
Order Diptera										
Chironomid	119	47.41	66	25	13	50	868	100	13	100
Phylum Annelida										
Order Oligachaeta										
Naididae			66	25						
Phylum Rotifera										
Lecane			66	25						
GRAND TOTAL	251	100	264	100	26	100	868	100	13	100

TABLE 3.2.28

BENTHIC FAUNA OF IMPACT RIVERS (CATUGASAN)
ORGANISMS PER SQUARE METER

SPECIES	TRIBUTARIES: SIMAGUAN RIVER													
	CTA-1		CTA-17		CTA-18		CTA-5		CTA-6		CTA-8		CTA-9	
CLEAN WATER INDICATORS:	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD
Phylum Arthropoda														
Class Insecta														
Order Pleoptera														
Perla					2539	26.84								
Isoperla					2393	25.30								
Order Ephemeroptera														
Caenis			43	3.69	742	7.84	10	6.80	10	19.61	32	6.82		
Baetis			149	12.80										
Ecdyonorus			32	2.75	820	8.67								
Habrophlebia			21	1.80										
Epeorus					1406	14.86								
Ephemerella					195	2.06								
Order Tricoptera														
Hydroptila							21	14.29						
Hydroptilidae			21	1.80										
Hydropsyche.	53	38.69			273	2.89	10	6.80			139	29.64		
Orchrotricha											10	2.13		
Ryacophila			21	1.80										
Polycentropodidae			10	0.86										
Plectrohemia					39	0.41								
Order Diptera														
Simulium					39	0.41								
SUB-TOTAL	53	38.69	297	25.52	8446	89.28	41	27.89	10	19.61	181	38.59		
MODERATELY POLLUTED WATER INDICATORS														
Phylum Mollusca														
Class Gastropoda														
Order Mesogastropoda														
Tarebia			53	4.55					21	41.18			43	16.80
SUB-TOTAL			53	4.55					21	41.18			43	16.80
POLLUTED WATER INDICATORS														
Phylum Arthropoda														
Class Insecta														
Order Diptera														
Chaoborus											10	2.13		
Culex					117	1.24								
Psychoda	21	15.33	10	0.86										
Ablasmyia											10	2.13		
Phylum Nematoda														
Order Phaptida														
Unid Nematode													21	8.20
Phylum Coelenterata														
Hydrozoa					195	2.06								
SUB-TOTAL	21	15.33	10	0.86	312	3.30					20	4.26	21	8.20
OTHERS														
Phylum Arthropoda														
Class Insecta														
Order Diptera														
Chironomid	53	38.69	322	27.66			86	58.50	10	19.61	226	48.19	139	54.30
Chironomid pupa			21	1.80			10	6.80					32	12.50
Order Coleoptera														
Narpus	10	7.30	53	4.55									21	8.20
Psephenidae					195	2.06								
Hydrophilidae					39	0.41								
Helmis					234	2.47								
Dytiscus					195	2.06								
Grynidae					39	0.41								
Order Hemiptera														
Ilyocoris											10	2.13		
Aphelocheirus			398	34.19										
Class Crustacea														
Potamonidae			10	0.86			10	6.80	10	19.61				
Phylum Chordata														
Class Amphibia														
Rana (tadpole)											32	6.82		
SUB-TOTAL	63	45.99	804	69.07	702	7.42	106	72.11	20	39.22	268	57.14	192	75.00
GRAND TOTAL	137	100	1164	97.53	9460	100	147	99.99	51	100	469	99.99	256	100

situated above the proposed drilling pad in Catugasan. As in any headwater region, the river bed is composed of big boulders. It is the same river that runs through the Mambucal Hot Spring Resort and as it meanders downstream to join Bago River, it is called San Miguel River.

Based on the findings of the EIA for the exploration phase, there were only three (3) species of benthic fauna at the headwater station (CTA-3), namely: *Simulium sp.*, *Rhabdolaimus sp.*, and *Narpus sp.* (**Tab. 3.2.29**). The latter is a non-indicator organism while *Rhabdolaimus sp.*, whose RSD was very low at 6.29%, is a polluted water indicator. *Simulium sp.*, which is considered as an indicator species of clean water, has a relative species density of 40.26%.

Further downstream to the Mambucal Hot Spring Resort (CTA-12), an increase in the number of species was observed. The distribution of individuals was closer, accounting for the highest diversity index of 0.622 among all the stations in Asia River. There were four (4) species of CWI: three (3) species of non-indicator organisms; and one (1) species of PWI. The water may still be considered clean due to the higher number of CWI species (**Fig. 3.2.9**).

Maao River and its tributaries

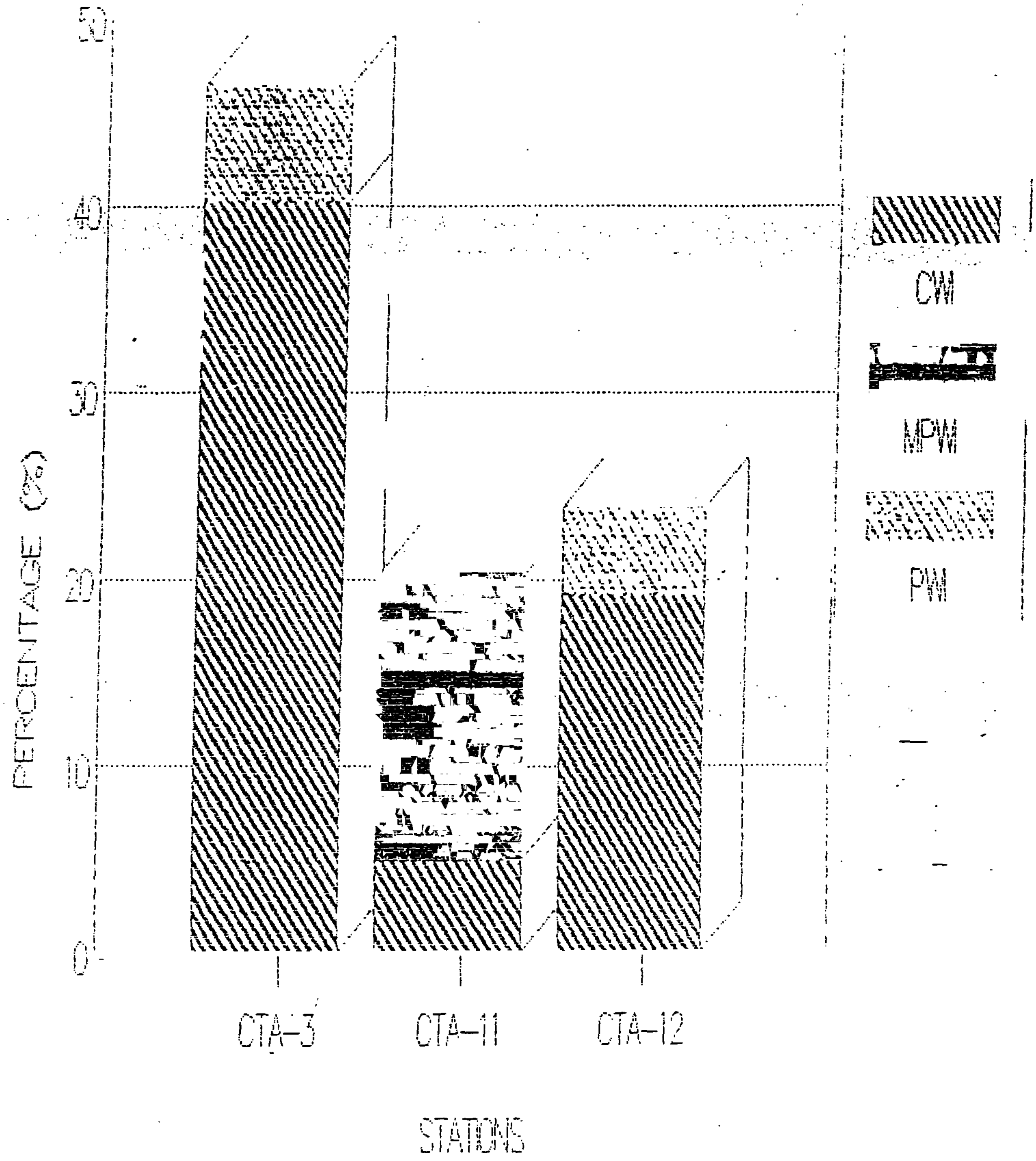
There are three (3) main tributaries of the Maao River. Upstream is the Pataan River (PTA-20) and at the midstream section are Maugbi and Mailum Rivers. Stations PTA-1, 2 and 3 have been classified as clean water (1993 study), but the former has a more diversified species of benthic organisms, having an index of 0.602 (**Table 3.2.30**).

Station PTA-11, which is located after the confluence of Pataan and Ma-ao River, was investigated because of the on-going earthmoving activities just above this section of the river. Findings of the present study showed the abundance of benthic fauna found in clean waters. More than half of the benthic fauna population is composed of clean water indicators such as mayflies, stoneflies and caddisflies (**Figure 3.2.10**). The same condition was observed in PTA-12.

TABLE 3.2.29

BENTHIC FAUNA OF IMPACT RIVERS (CATUGASAN)
ORGANISMS PER SQUARE METER

SPECIES			ASIA RIVER			
	CTA-3		CTA-11		CTA-12	
CLEAN WATER INDICATORS:	Counts	RSD	Counts	RSD	Counts	RSD
Phylum Arthropoda						
Class Insecta						
Order Ephemeroptera						
Caenis			10	4.95		
Baetis					10	4.78
Epeorus					10	4.78
Order Tricoptera						
Hydroptila					10	4.78
Hydropsyche					10	4.78
Order Diptera						
Simulium	64	40.25				
SUB-TOTAL	**64**	**40.25**	**10**	**4.95**	**40**	**19.12**
MODERATELY POLLUTED WATER INDICATORS:						
Phylum Mollusca						
Class Gastropoda						
Order Basammatophora						
Radix			10	4.95		
Order Mesogastropoda						
Tarebia			21	10.40		
SUB-TOTAL			**21**	**10.40**		
POLLUTED WATER INDICATORS						
Phylum Arthropoda						
Class Insecta						
Order Diptera						
Culicidae					10	4.78
Phylum Nematoda						
Order Rhaptida						
Rhabdolaimus	10	6.29				
SUB-TOTAL	10	6.29			10	4.78
OTHERS:						
Phylum Arthropoda						
Class Insecta						
Order Diptera						
Chironomid	75	47.17	161	79.70	75	35.89
Chironomid pupa					10	4.78
Order Coleoptera						
Narpus	10	6.29			32	15.31
Order Hemiptera						
Ilyocoris					10	4.78
Aphelocheirus					32	15.31
SUB-TOTAL	85	53.46	161	79.70	159	76.07
GRAND TOTAL	159	100	202	100	209	99.97



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

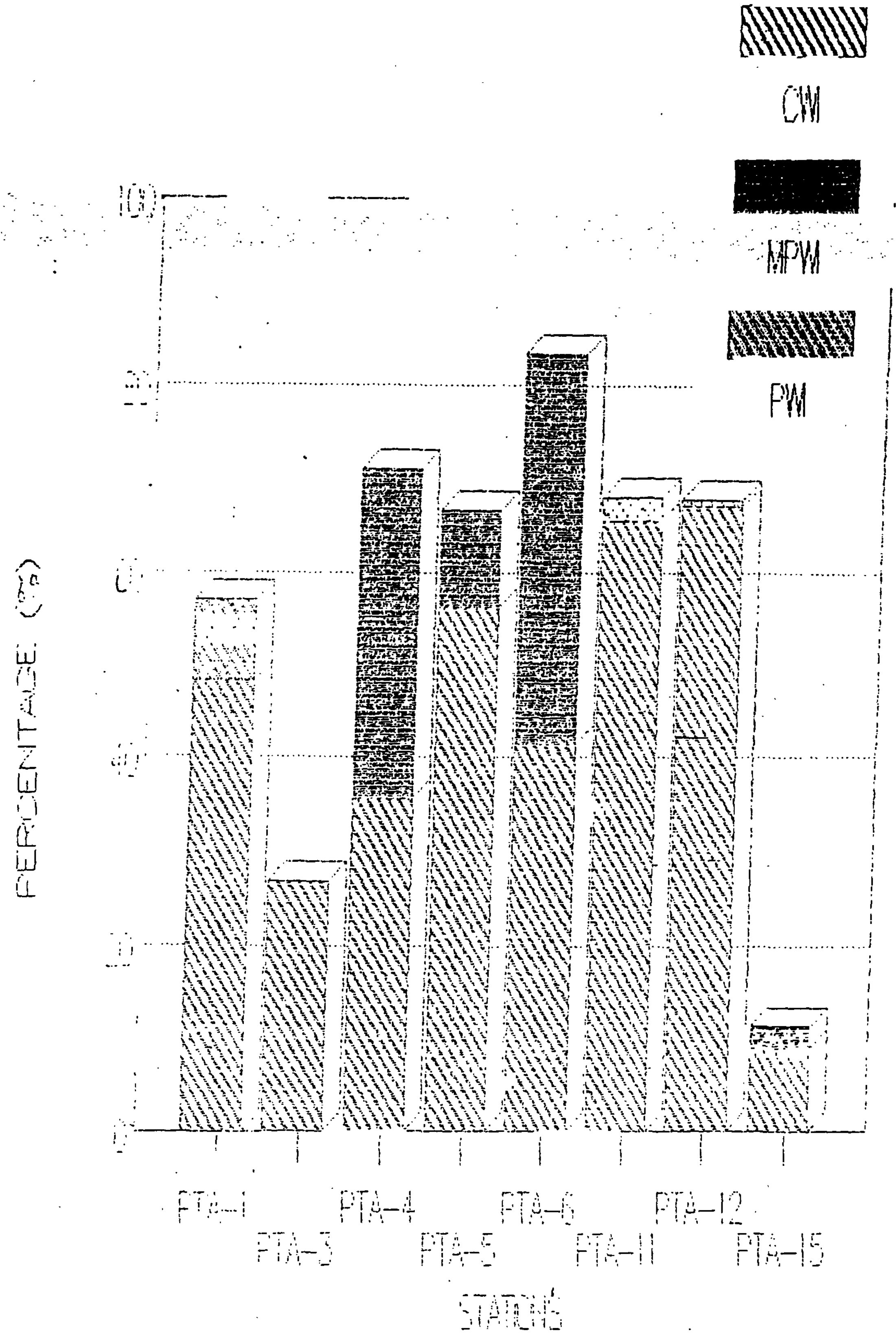
TITLE:
Distribution of Indicator Organisms Asia river

FIG. 3.2.9

TABLE 3.2.30

BENTHIC FAUNA OF IMPACT RIVERS (PATAAN)
ORGANISMS PER SQUARE METER

SPECIES	MAAO RIVER PTA-1 Counts	PTA-1 RSD	PTA-3 Counts	PTA-3 RSD	PTA-4 Counts	PTA-4 RSD	PTA-5 Counts	PTA-5 RSD	PTA-6 Counts	PTA-6 RSD	PTA-11* Counts	PTA-11* RSD	PTA-12* Counts	PTA-12* RSD	PTA-15* Counts	PTA-15* RSD
CLEAN WATER INDICATORS																
Phylum Arthropoda																
Class Insecta																
Order Plecoptera																
Perla											1445	23.43				
Isoperla											937	15.19			78	0.86
Taeniopteryx											39	0.63				
Order Ephemeroptera																
Caenis	53	13.55	21	2.80	43	13.11	193	46.39	10	7.94	156	2.53	351	5.48	195	2.14
Baetis	21	5.37	21	2.80	43	13.11			21	16.67	117	1.90	859	13.42	117	1.29
Ecdyonorus			10	1.34							312	5.06	937	14.64	234	2.57
Habrophlebia							21	5.05								
Leptophlebia											39	0.63				
Epeorus											781	12.66	1562	24.40		
Ephemerella											78	1.26				
Torleia													156	2.44		
Order Tricoptera																
Hydroptila			21	2.80	10	3.05										
Hydroptilidae											39	0.63				
Hydropsyche	75	19.18	129	17.22	21	6.40	10	2.40	21	16.67	156	2.53	78	1.22	195	2.14
Philopotamidae							10	2.40					117	1.83		
Plectrocnemia											39	0.63				
Hydrocoma													234	3.66		
SUB-TOTAL	149	38.11	202	26.97	117	35.67	234	56.24	52	41.27	4138	67.08	4294	67.08	819	9.00
MODERATELY POLLUTED WATER INDICATORS																
Phylum Mollusca																
Class Gastropoda																
Order Basammatophora																
Neretina					10	3.05										
Order Mesogastropoda																
Tarebia					10	3.05										
Class Pelecypoda																
Order Heterodonta																
Corbicula					96	29.27	43	10.34	53	42.06						
Sphaeridae															195	2.14
SUB-TOTAL					116	35.37	43	10.34	53	42.06					195	2.14
POLLUTED WATER INDICATORS																
Phylum Arthropoda																
Class Insecta																
Order Diptera																
Psychoda	10	2.56														
Tipulid	21	5.37														
Tubifera	10	2.56														
Dichonota											39	0.62				
Eristalomyia											78	1.24				
Phylum Nematoda																
Order Rhaptida																
Unid Nematode													39	0.61		
SUB-TOTAL	41	10.49									117	1.86	39	0.61		
OTHERS:																
Phylum Arthropoda																
Class Insecta																
Order Diptera																
Chironomid	86	21.99	312	41.66	53	16.16	43	10.34			1054	17.09	976	15.25	7031	77.28
Chironomid pupa	10	2.56	64	8.54	32	9.76										
Order Coleoptera																
Narpus	75	19.78	129	17.22			96	23.08	21	16.67						
Psephenus	10	2.56	21	2.80												
Helmus											234	3.79	39	0.61		
Hydrobius											39	0.63				
Dytiscus											507	8.22	585	9.14	156	1.71
Psepheridae													78	1.22	78	0.86
Gyrinidae													117	1.83		
Hydrophilidae															39	0.43
Order Hemiptera																
Aphelocheirus			21	2.80							39	0.63	156	2.44	351	3.86
Gerres	10	2.56														
Order Odonata																
Onychogomphus											39	0.63				
Order Arachnoidea																
Arrenurus											39	0.63				
Class Crustacea																
Potamonidae	10	2.56														
Triops											39	0.63	78	1.22		
Planaria													39	0.61		
SUB-TOTAL	201	51.41	547	73.03	85	25.91	139	33.41	21	16.67	1990	32.25	2068	32.31	7655	84.14
Phylum Chordata																
Class Pisces																
Gobiidae					10	3.05										
Phylum Annelida																
Oligochaeta											39	0.63			312	3.13
Polychaeta															117	1.29
SUB-TOTAL											[illegible]	[illegible]			[illegible]	[illegible]



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Distribution of Indicator Organisms Ma-ao river

FIG. 3.2.10

The benthic fauna population of Maugbi River is composed mostly of non-indicator organisms, but representatives of clean water indicators of aquatic insects have also been found.

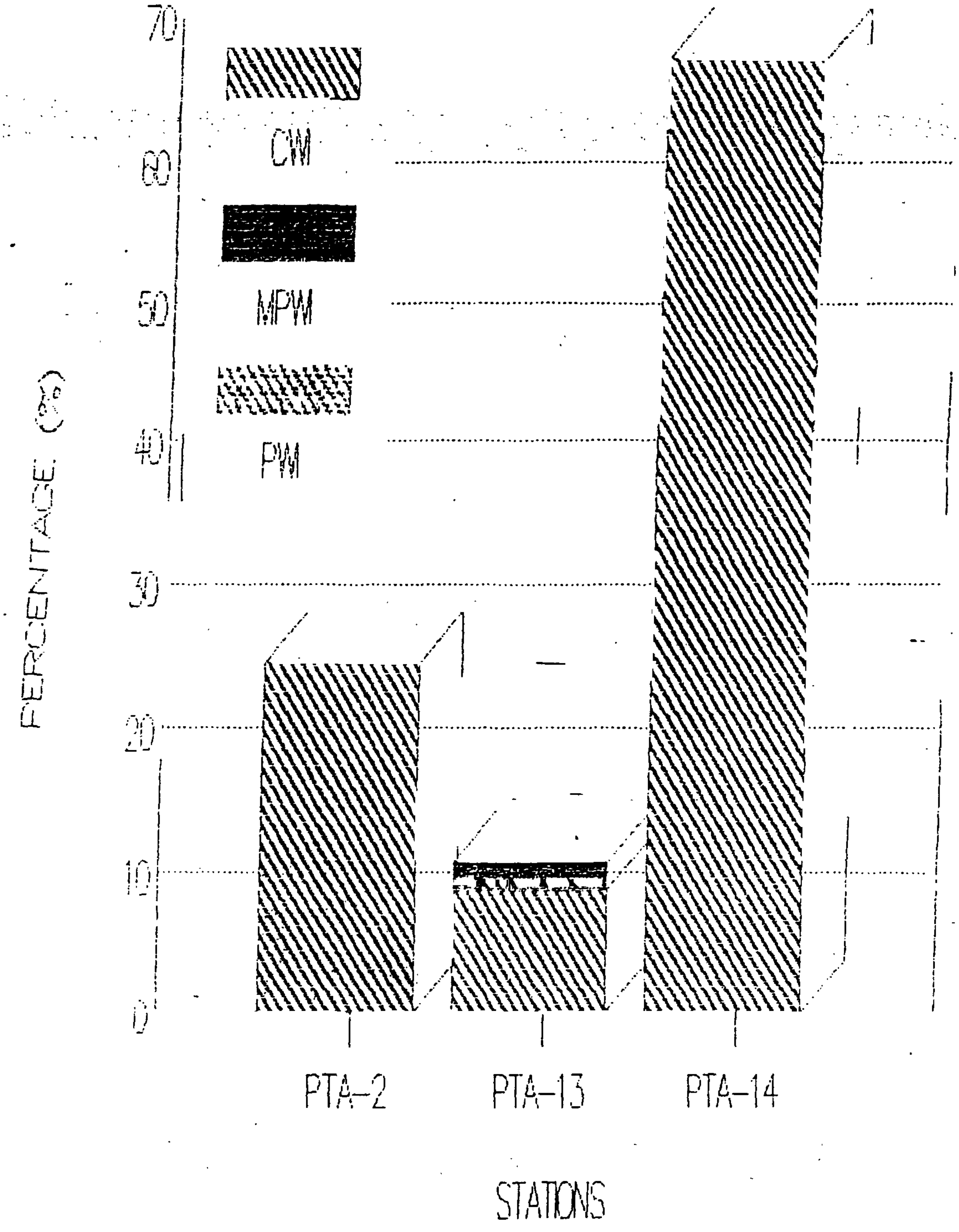
In the Mailum River, only clean water indicators were present, recorded at 66.91% of the total population, the rest being made up of non-indicator organisms (**Figure 3.2.11** and **Tab. 3.2.31**).

The algal population was very high, at 13,962 organisms/m^2, in station PTA-12. Among the benthic flora, *Navicula sp.* was abundant accounting for 44% of the total population. This alga species belongs to the epipelic subcommunity, which consists mostly of motile forms since motility is necessary to enable the species to move to the surface after a disturbance of the sediment (Round,1962).

Pula River

The substratum of the upstream section (PTA-8) is an assortment of head-sized and fist-sized stones and boulders. Just before its confluence with Bago River, the downstream portion forks into two Station PTA-9 is located before the separation. The stream bed is almost similar in characteristic to the upstream station, although there are smaller and fewer boulders.

Among all the rivers investigated, the Pula River exhibited a higher diversity index of the benthic fauna, i.e., 0.514 and 0.741, corresponding to the upstream and downstream stations (**Table 3.2.32**) Only the CWI's were found in the former, which consisted mainly of the mayfly, *Caenis sp* and the stoneflies, *Hydroptila sp.* and *Hydropsyche sp.* (**Figure 3.2.12**). The rest of the population was composed of non-indicator organisms belonging to Class Insecta. In the downstream station, the density of benthic animals was twice as much as in the upstream station. Representative species of CWI, PWI, and MPWI were present, but the latter has a higher RSD of 48.45% and is composed mostly of the molluscs *Tarebia sp.*, and *Vivipara sp.*, of the Order *Mesogastropoda*.



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CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Distribution of Indicator Organisms
Tributaries: Ma-ao river

FIG. 3.2.11

TABLE 3.2.31 BENTHIC FAUNA OF IMPACT RIVERS (PATAAN)
ORGANISMS PER SQUARE METER

SPECIES	TRIBUTARIES: MAAO RIVER					
	PTA-2		PTA-13*		PTA-14*	
CLEAN WATER INDICATORS:	Counts	RSD	Counts	RSD	Counts	RSD
Phylum Arthropoda						
Class Insecta						
Order Plecoptera						
Perla			39	0.39	1054	9.45
Isoperia			78	0.79	795	7.13
Order Ephemeroptera						
Caenis			507	5.13	1406	12.61
Baetis			78	0.79	2695	24.16
Leptophlebia					312	2.80
Epeorus					546	4.90
Rithrogena					39	0.35
Ephemerella			39	0.39	128	1.15
Order Tricoptera						
Hydroptilidae			78	0.79		
Hydropsyche	10	24.39	39	0.39	273	2.45
Order Megaloptera						
Siales					39	0.35
SUB-TOTAL	10	24.39	858	8.68	7287	65.34
MODERATELY POLLUTED WATER INDICATORS						
Phylum Mollusca						
Class Gastropoda						
Order Basommatophora						
Galba			39	0.39		
Class Pelecypoda						
Order Heterodonta						
Sphaeriidae			156	1.58		
SUB-TOTAL			195	1.97		
OTHERS						
Phylum Arthropoda						
Class Insecta						
Order Diptera						
Chironomid	10	24.39	8281	83.82	2109	18.91
Order Coleoptera						
Narpus	21	51.22				
Psephenidae			195	1.97	1406	12.61
Dytiscus			78	0.79	234	2.10
Helmis					39	0.35
Order Odonata						
Cordulegaster			39	0.39		
Order Zygoptera						
Calopteryx			39	0.39		
Class Crustacea						
Gammarus			39	0.39		
Planaria					39	0.35
Phylum Chordata						
Class Pisces						
Gobiidae			78	0.79		
Phylum Nemertenea/						
Rhynchococla					39	0.35
Phylum Annelida*						
Oligochaeta			78	0.79		
SUB-TOTAL	31	75.6	8827	89.34	3866	34.66
GRAND TOTAL						

TABLE 3.2.32 BENTHIC FAUNA OF IMPACT RIVERS (PATAAN) ORGANISMS PER SQUARE METER

SPECIES	PULA RIVER			
	PTA-8		PTA-9	
CLEAN WATER INDICATORS:	**Counts**	**RSD**	**Counts**	**RSD**
Phylum Arthropoda				
Class Insecta				
Order Ephemeroptera				
Caenis	32	23.53		
Order Tricoptera				
Hydroptila	10	7.35	10	3.82
Hydropsyche	10	7.35	10	3.82
Order Diptera				
Simulium	10	7.35		
SUB-TOTAL	**62**	**45.59**	**20**	**7.64**
MODERATELY POLLUTED WATER INDICATORS				
Phylum Mollusca				
Class Gastropoda				
Order Basammatophora				
Lymnaca			10	3.82
Planorbis			32	12.21
Order Mesogastropoda				
Tarebia			53	20.23
Vivipara			32	12.21
SUB-TOTAL			**127**	**48.47**
POLLUTED WATER INDICATORS				
Phylum Arthropoda				
Class Insecta				
Order Diptera				
Psychoda			21	8.02
SUB-TOTAL			**21**	**8.02**
OTHERS				
Phylum Arthropoda				
Class Insecta				
Order Diptera				
Chironomid	21	15.44	43	16 41
Chironomid pupa			21	8 02
Order Coleoptera				
Narpus	43	31.62	10	3.82
Psephenus			10	3.82
Order Hemiptera				
Aphelocheirus	10	7.35	10	3.82
SUB-TOTAL	**74**	**54.41**	**94**	**35.88**
GRAND TOTAL	**136**	**100**	**262**	**100**

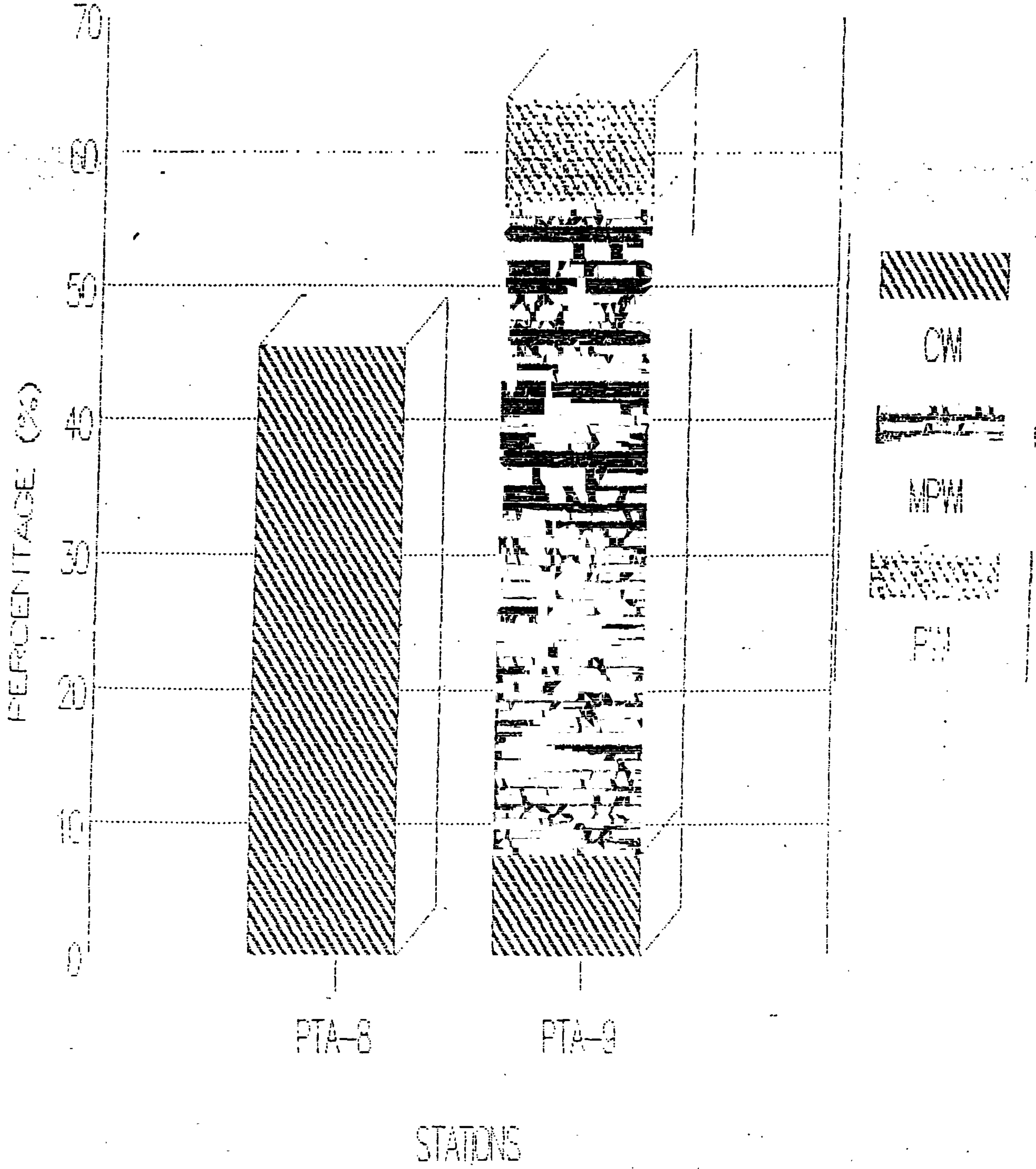

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FIG. 3.2.12

The algal population is composed of both benthic and planktonic species and all the three (3) divisions(taxa) (*Chlorophyta. Cyanophyta,* and *Chrysophyta*) were represented. Both stations have a higher density of diatoms considered as CWI (**Table 3.2.33**).

The drift fauna consisted only of chironomid larvae, with a very low density of 13 individuals/m^3 (**Tab. 3.2.34**).

Maragandang River and its tributaries

This river system differs in physico-chemical and biological characteristics from the other impact rivers. The headwater station, which is situated above a water fall, is characterized by hut-sized boulders and big rocks, with the stream bed filled with rocks of varying sizes. There is a distinct rusty coloration and the water temperature is high at 33°C. There are about seven (7) creeks that drain into the Maragandang River among which are Tabidyao, Naciu, Nakalang, and Araal Creeks. Even up to the downstream stations at HGC-6, the rusty coloration of stones is still evident.

The physico-chemical characteristics of the headwater region have been found to be unsuitable for the propagation of aquatic life. This was supported by the absence of any living organism in the water and stream bed investigated. Only the genus *Hydropsyche sp.* was found in HGC-2, and in HCC-3, the only organisms present were the larvae of chironomids (**Table 3.2.35**).

Station HGC-6 and HGC-6b are the same stations situated a few kilometers away from the Maao Sugar Central, but differ only in the time of investigation, i.e., 1993 and 1994, respectively. This is one of the critical stations of the Maragandang River, because of its polluted nature, and there is a need to revalidate its biological characteristics. In the 1993 study, no benthic and drifting organisms were observed, but the growth of *Sphaerotilus sp.* was evident along the river bank. This sewage fungus forms massive colonies in organically polluted water. When the station was reinvestigated after one year, the growth of *Sphaerotilus sp.* was still observed but the mayfly,

TABLE 3.2.33 ALGAL POPULATION OF IMPACT RIVERS (PATAAN) ORGANISMS PER SQUARE METER

SPECIES	PULA RIVER PTA-8		PTA-9	
CLEAN WATER INDICATORS	**Counts**	**RSD**	**Counts**	**RSD**
Division Chrysophyta				
Cocconeis	373	5.74	112	1.48
Navicula	2342	36.06	4925	64.95
Pinnularia	28	0.43	9	0.12
Sub-Total	**2743**	**42.24**	**5046**	**66.54**
POLLUTED WATER INDICATORS				
Division Cyanophyta				
Anabaena	9	0.14		
Oscillatoria	75	1.15	252	3.32
Division Chlorophyta				
Spirogyra	9	0.14		
Division Chrysophyta				
Gomphonema	709	10.92	289	3.81
Nitzschia			65	0.86
Sub-Total	**802**	**12.35**	**606**	**25.46**
OTHERS				
Division Chlorophyta				
Scenedesmus	75	1.15		
Closterium	9	0.14		
Cosmarium	19	0.29	224	2.95
Division Chrysophytta				
Biddulphia	326	5.02	75	0.99
Terpsinoe	672	10.35	-	
Amphora	93	1.43	19	0.25
Cymbella	458	7.05	448	5.91
Diploneis	9	0.14		
Epithemia			65	0.86
Fragilaria	858	13.21	37	0.49
Pleurosigma	19	0.29	102	1.35
Rhopalodia	19	0.29	19	0.25
Stauroneis	19	0.29	37	0.49
Synedra	364	5.61	858	11.31
Achnanthes	9	0.14	47	0.62
Sub-Total	2949	45.41	1931	25.46
TOTAL	6494	100	7583	100

TABLE 3.2.34 DRIFT FAUNA OF IMPACT RIVERS (PATAAN)

SPECIES	TRIBUTARIES: MAAO RIVER				PULA RIVER	
	PTA-13*		PTA-14*		PTA-8	
Phylum Arthropoda	**Counts**	**RSD**	**Counts**	**RSD**	**Counts**	**RSD**
Order Ephemeroptera						
Baetis	111	6.23	725	36.38		
Rithrogena			181	9.08		
Order Diptera						
Chironomus						
Chironomid	1225	68.74	544	27.30	13	100
Order Plecoptera						
Isoperla	223	12.51				
Order Arachnoidea						
Argyroneta			181	9.08		
Phylum Nematoda						
Unid. Nematode	223	12.51	362	18.16		
GRAND TOTAL	**1782**	**100**	**1993**	**100**	**13**	**100**

Note: No drift fauna seen in PTA-2

TABLE 3.2.35

BENTHIC FAUNA OF IMPACT RIVERS (HAGDAN)
ORGANISMS PER SQUARE METER

SPECIES	MARAGANDANG RIVER															
	HGC-2		HGC-3		HGC-4		HGC-5		HGC-6b*		HGC-10*		HGC-11*		HGC-12*	
CLEAN WATER INDICATORS	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD
Phylum Arthropoda																
Class Insecta																
Order Plecoptera																
Perla													39	10		
Order Ephemeroptera																
Caenis																
Baetis													78	20	78	5.55
Ecdyonorus															78	5.55
Epeorus									78	18.18			78	20	781	55.59
Order Tricoptera																
Hydropsyche	10	100					21	28.38			39	1.65			78	5.55
Philopotamidae															39	2.78
Plectronemia											39	1.65				
SUB-TOTAL	10	100					21	28.38	78	18.18	78	3.30	195	50	1054	75.02
POLLUTED WATER INDICATORS																
Phylum Arthropoda																
Class Insecta																
Order Diptera																
Dichonota											39	1.65				
Corethra													39	10		
Phylum Nematoda																
Order Rhaptida																
Unid Nematode													39	10		
SUB-TOTAL											39	1.65	78	20		
OTHERS																
Phylum Arthropoda																
Class Insecta																
Order Diptera																
Chironomid			172	100					234	54.55	2169	91.75			351	24.98
Chironomid pupa					10	8.55	10	13.51								
Order Coleoptera																
Psephenidae									39	9.09						
Helmis									39	9.09			78	20		
Dytiscus													39	10		
Order Hemiptera																
Ilyocoris							43	58.11								
Aphelocheirus											39	1.65				
Microvelia					107	91.45										
Order Arachnoidea																
Argyroneta											39	1.65				
Phylum Annelida																
Polychaeta									39	9.09						
SUB-TOTAL			175	100	117	100	53	71.62	351	81.82	2247	95.05	117	30	351	24.98
GRAND TOTAL	10	100	172	100	117	100	74	100	429	100	2364	100	390	100	1405	100

Epeorus sp was present. According to (Roback, 1974), all mayflies are restricted to waters of relatively high oxygen content, but are widely distributed even in waters with moderate organic loading. Some species can regulate the respiratory movement of their gills in response to changing oxygen concentrations (Eriksen, 1964). However, it is also possible that the existence of *Epeorus sp.* in the water could be due to the current.

The ubiquitous chironomid larvae was found both in the streambed and in the drift. The mayfly *Baetis sp.*, together with some oligochaetes and nematodes, was also included in the drift fauna (**Table 3.2.36**). With respect to the algal population, there were very few species observed.

As mentioned earlier, there was a significant improvement in the physical characteristics of HGC-6. The existence of organisms other than the *Sphaerotilus sp.* could be attributed to this positive development. But then, the effect of water movement to the distribution of organisms should also be considered.

Another significant observation in the Maragandang River is the biological condition of station HGC-12. The main reason for investigating this portion of the river is its proximity to the piggery in Hda. Pacita, and it was anticipated that possibly some of the wastes find their way in to the river. Results show the abundance of CWI, with an RSD of 75%, indicating the availability of oxygen for the needs of these organisms (**Figure 3.2.13**).

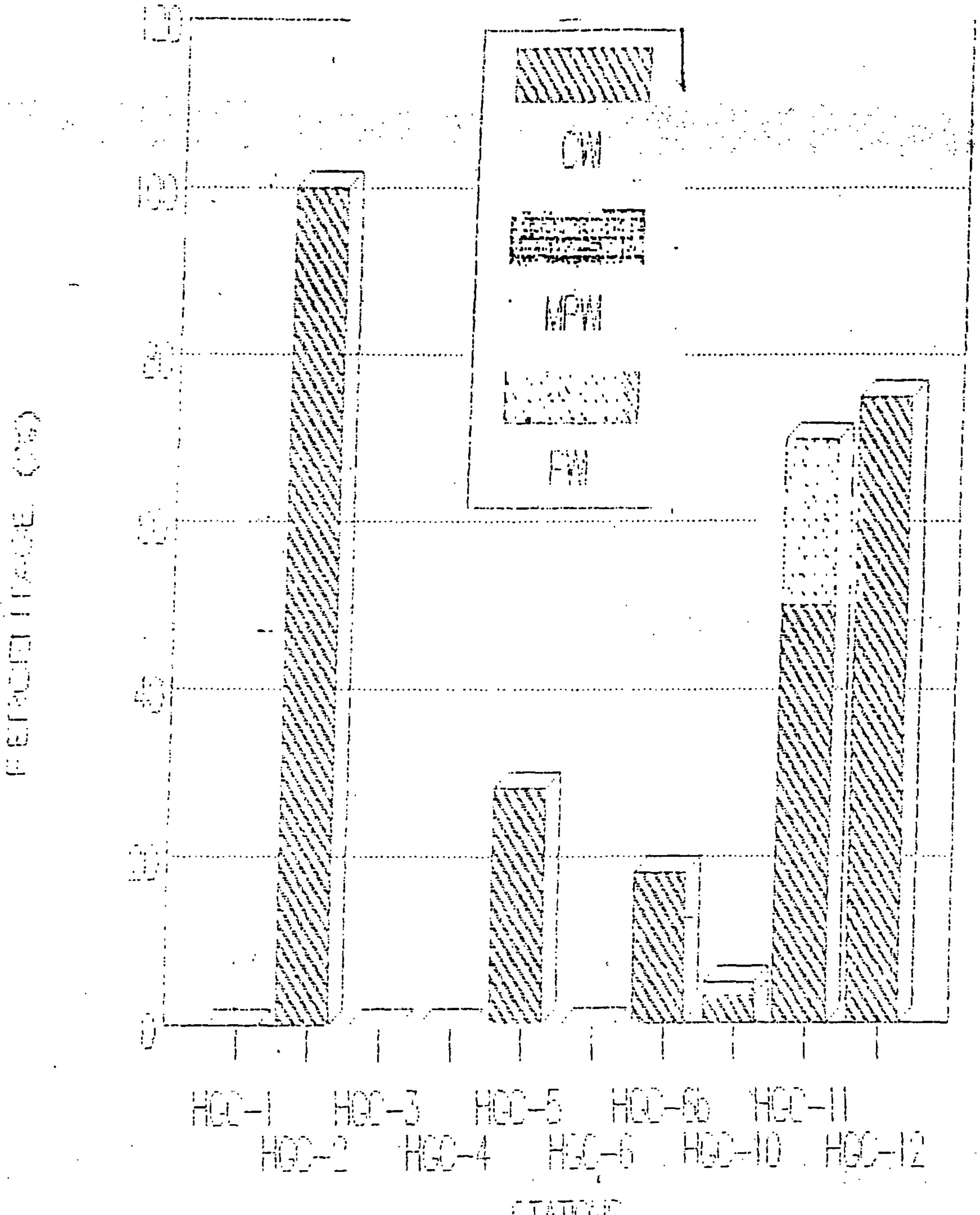
With regard to benthic algae, none were found in the headwater region. The highest counts were observed after the point of confluence with the Tabidyao and Naciu creeks, i.e., 3851 and 16158 individuals/m^2, and were a mixture of both CWI, PWI, and non-indicator species. The dilution with waters coming from these creeks could be one of the reasons for the observed growth of algae.

Bago River

This is the main river that receives the waters coming from all the rivers investigated in this

TABLE 3.2.36 DRIFT FAUNA OF IMPACT RIVERS (HAGDAN)

SPECIES	MARAGANDANG RIVER											
	HGC-3		HGC-4		HGC-6b*		HGC-10*		HGC-11*		HGC-12*	
Phylum Arthropoda	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD	Counts	RSD
Order Ephemeroptera												
Baetis					10667	38.1						
Order Trichoptera												
Hydropsyche	13	100									60	12.45
Order Diptera												
Chironomid			66	100	10667	38.1			145	14.26	181	37.55
Order Plecoptera												
Isoperla									145	14.26		
Order Arachnoidea												
Hydrodroma					1333	4.76	57	50				
Class Crustacea												
Nauplius							57	50	291	28.61		
Phylum Nemertea/												
Rhynchocoela											181	37.55
Phylum Nematoda												
Unid. Nematode					2667	9.52			291	28.61		
Phylum Annelida												
Order Oligochaeta												
Naididae					2667	9.52						
Phylum Rotifera												
Euclanis									145	14.26	60	12.45
GRAND TOTAL	13	100	66	100	28001	100	114	100	1017	100	482	100



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study. The river bed consists of boulders, head-sized and fist-sized stones and pebbles. As the river approaches the sea, the rocky substrate is mixed with sand and fine silt. Heavy quarrying activities have been observed along the stretch of Bago River from the confluence with Maao up to the main bridge of Bago City.

A population of benthic fauna was observed only from CTA-16 to PTA-7 (**Table 3.2.37**). In HGC-7, only 32 chironomids/m^2 were found, while stations HGC-8 and HGC-9 exhibited an absence of any group of bottom dwelling animals. Instead, planktonic forms were found, which are the characteristic fauna of lakes and oceans. Since these stations are already estuarine in nature and opens at Guimaras Strait, tidal fluctuation and current are the main factors accounting for the presence of rotifers and copepods, which are collectively called zooplankton.

Edible species such as *Corbicula sp.* have also been found and this indicates the existence of soft or sandy substratum. Except in stations HGC-7 to HGC-9, considerable numbers of CWI and MPWI have been found in all the sampling stations.

The decrease in population of benthic organisms along the course of Bago River may be attributed to the quarrying activities at the different sections of the river The continuous disturbance of the river bed discourages the growth and proliferation of these type of organisms. Quarrying causes a change in the nature of the substratum from rocky to sandy. Thus, the edible species *Corbicula sp.*, which live in soft substratum, have been found in some stations. The collection of edible molluscs by gleaners have been observed in the estuarine portion of Bago River, and this also causes a disturbance on the river bed.

With respect to benthic and planktonic algae, almost all of the groups (taxa) are represented in all the stations. Their role as primary producers is very essential in supporting aquatic life in this major river. Their density ranges from 40 individuals/m^2 in HGC-9 to 17234 in HGC-7, 97% of which is attributed to the growth of the blue-green algae, *Spirulina sp.*

The water quality assessment based on indicator organisms (benthic fauna) of the different impact

TABLE 3.2.37

BENTHIC FAUNA OF IMPACT RIVERS (BAGO RIVER)
ORGANISMS PER SQUARE METER

SPECIES	BAGO RIVER															
	CTA-14		CTA-15		CTA-20*		CTA-21*		PTA-6		PTA-7		PTA-10		HGC-7	
CLEAN WATER INDICATORS	Count	RSD	Count	RSD	Count	RSD	Count	RSD	Count	RSD	Count	RSD	Count	RSD	Count	RSD
Phylum Anthropoda																
Class Insecta																
Order Pleoptera																
Leuctra											10	2.76				
Order Epnemeroptera																
Caenis			10	10 75	156	3.84			10	7 94			10	8.85		
Baetis					117	2.88	39	2 44	21	16 67	32	8.84				
Ecdyonorus											10	2 76				
Paraleptophlebia											10	2.76				
Leptophlebia							78	4.88								
Epeorus					117	2.88					21	5.80				
Order Tricoptera																
Hydroptilidae													10	8.85		
Hydropsyche			10	10.75	117	2.88			21	16.67						
Ryacophila													10	8.85		
Philopotamidae					1132	27.88	39	2 44								
Order Diptera																
Simulium	10	4 72									161	44 48				
SUB-TOTAL	10	4.72	20	21.50	1639	40.37	156	9.76	52	41.28	244	67.40	30	26.55		
MODERATELY POLLUTED WATER INDICATORS																
Phylum Mollusca																
Class Gastropoda																
Order Mesogastropoda																
Tarebia													32	28.32		
Class Pelecypoda																
Order Heterodonta																
Corbicula			21	22 58					53	42.06	113	32.60	10	8.85		
Sphaeridae							195	12 19								
SUB-TOTAL			21	22.58			195	12.19	53	42.06	118	32.60	42	37.17		
POLLUTED WATER INDICATORS																
Phylum Anthropoda																
Class Insecta																
Order Diptera																
Psychoda	21	9 91	10	10 75					21	16 67						
Dicronota													10	8 85		
Phylum Nematoda																
Order Rhabtida																
Unid Nematode					39	0 96	39	2 44								
SUB TOTAL	21	9.91	10	10.75	39	0.96	39	2 44	21	16 67			10	8 85		
OTHERS																
Phylum Anthropoda																
Class Insecta																
Order Diptera																
Chironomid	107	50 47	32	34 41	1992	49 06	1054	65 88							32	100
Chironomid pupa	21	9.91											10	8 85		
Order Coleoptera																
Narpus	53	25 00	10	10 75									21	18 58		
Hydrobius					39	0 96										
Dytiscus					273	6 72										
Order Arachnoidea																
Argyroneta					39	0.96	78	4 88								
Phylum Nemertea/																
Rhynchocoela					39	0 96										
SUB-TOTAL	181	85 38	42	45.16	2382	58.67	1132	70 76					31	27.43	32	100
Phylum Chordata																
Class Pisces																
Gobiidae							78	4 88								
SUB-TOTAL							78	4.88								
GRAND TOTAL	212	100	93	99 99	4060	100	1600	100	126	100	362	100	113	100	32	100

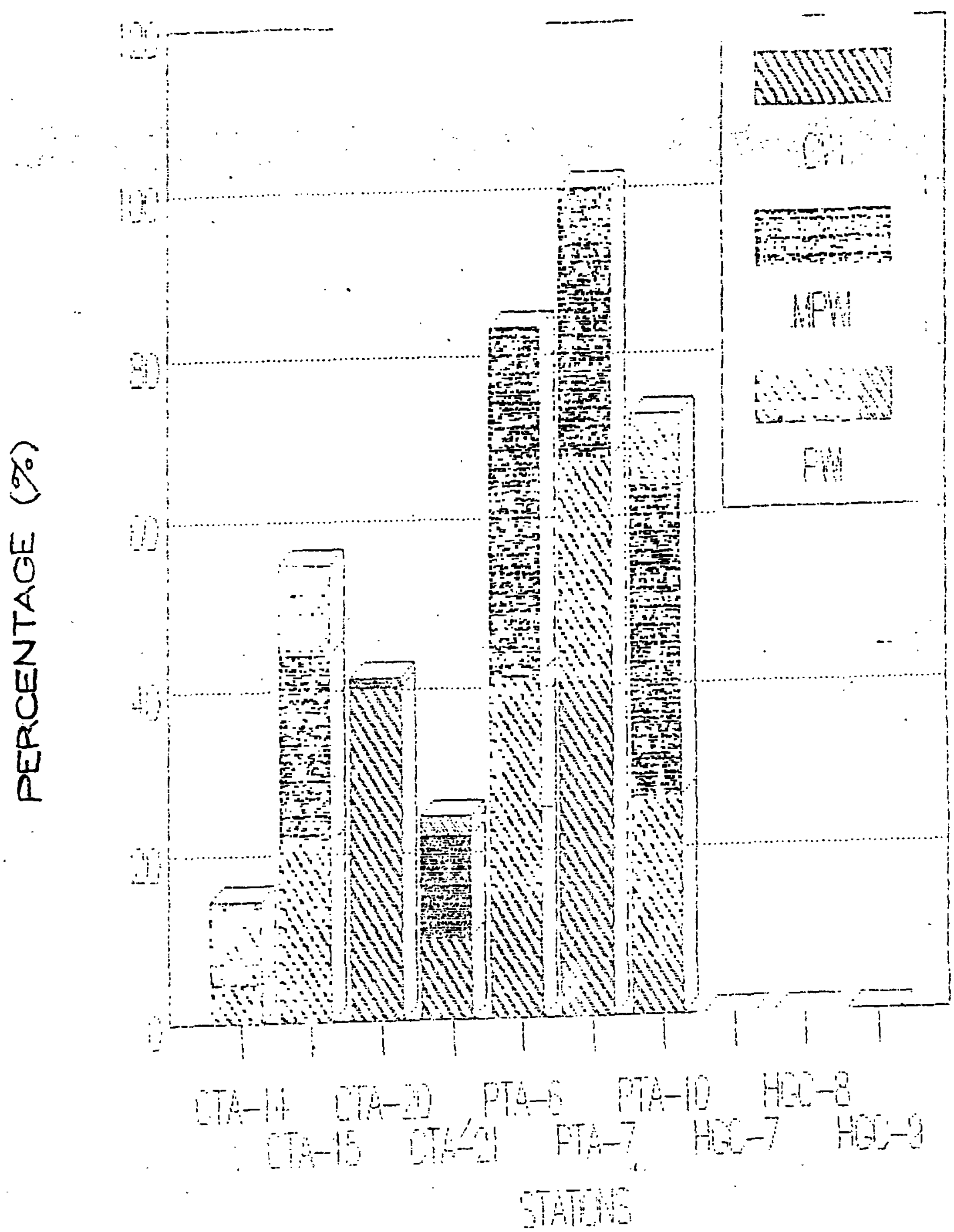

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FIG. 3.2.14

rivers is summarized in Tables 3.2.38a to d.

3.2.4.5 ECONOMICALLY IMPORTANT SPECIES

With the exemption of Maragandang River, edible species of molluscs and crustaceans have been found in the upstream portion of all the rivers. Among them are small freshwater crabs (*Potamonidae*) and shell fish (*Tarebia sp.* or "banag" in the local dialect) and clams (*Corbicula sp.*). Fish fry have been seen along the river banks and this has also been observed in the Maragandang River at the station near the confluence with Naciu creek. Some of the *Tilapia* species are also reared in fish ponds and this is a common practice in areas upstream of Catugasan. Freshwater eel, *Anguilla sp.* or "sili" in the local dialect is also caught together with *Tilapia sp.* and *Trichogaster sp.* (gouramy).

In Bago River, electro-fishing was observed near the confluence with Pula River. Another fishing method employed was the use of "taon" or "pacosad" (fish traps). Among the fish species caught are *Clarias sp.* (catfish), *Tilapia sp.*, and *Oxyurichthys sp.* (mudskipper or "talimusak"). However, the people's engagement in fishing activities is mostly for family consumption.

A. TROPHIC STRUCTURE

A self-sustaining biological community has been found in all the river stations investigated, except in some portions of Maragandang River. The first trophic level, which is composed of primary producers, consists of all planktonic and benthic algae and the primary consumers (algal feeders) are the benthic fauna and those found in the drift, such as *Baetis sp.* and *Leuctra sp.* There are also the secondary consumers (carnivores), which are represented by *Perla sp.* *Hydrdopsyche sp.*, *Ryacophila sp.*, *and Philipotamus sp.* **Table 3.2.39** presents the food preferences of aquatic insects found in all the impact rivers. Both the primary producers, primary and secondary consumers can sustain the fish population of the rivers and together with

TABLE 3.2.38a WATER QUALITY ASSESSMENT BASED ON THE BENTHIC FAUNA POPULATION OF SIMAGUAN AND ASIA RIVERS

SAMPLING STATIONS	No. of Species	N	DI	CWI (%)	MPWI (%)	PWI (%)	OTHERS (%)	WQA
SIMAGUAN RIVER								
CTA-2	2	42	0.390	100.0	0.0	0.0	0.0	CW
CTA-4	14	649	0.589	45.9	0.0	11.4	42.7	CW
CTA-10	13	1305	0.388	22.8	0.0	3.2	74.0	CW
CTA-13	8	1955	0.181	1.1	83.6	0.0	15.3	MP
CTA-16*	11	3677	0.181	7.4	0.0	0.0	32.6	CW
CTA-17*	16	5387	0.218	23.9	0.0	2.2	73.9	CW
CTA-19*	12	1560	0.304	55.0	0.0	0.0	45.0	CW
TRIBUTARIES:								
SIMAGUAN RIVER								
CTA-1	4	137	0.342	38.7	0.0	15.3	46.0	CW
CTA-7	13	1164	0.410	25.5	4.6	0.9	69.1	CW
CTA-18*	16	9460	0.164	89.3	0.0	3.3	7.4	CW
CTA-5	5	147	0.495	27.9	0.0	0.0	72.1	CW
CTA-6	4	51	0.560	19.6	41.2	0.0	39.2	CW
CTA-8	8	469	0.369	38.6	0.0	4.3	57.1	CW-MP
CTA-9	4	256	0.312	0.0	16.8	8.2	75.0	MP
ASIA RIVER								
CTA-3	4	159	0.317	40.3	0.0	6.3	53.5	CW
CTA-11	4	202	0.281	5.0	15.4	0.0	79.7	MP
CTA-12	9	209	0.622	19.1	0.0	4.8	76.1	MP

Legend:

N = Number of individuals
DI = Diversity index
CWI = Clean water indicator
MPWI = Moderatly polluted water indicator
PWI = Polluted water indicator
NOF = No organisms found
* = New stations
WQA = Water quality assessment

TABLE 3.2.38b WATER QUALITY ASSESSMENT BASED ON THE BENTHIC FAUNA POPULATION OF MAAO AND PULA RIVERS

SAMPLING STATIONS	No. of Species	N	DI (%)	CWI (%)	MPWI (%)	PWI (%)	OTHERS (%)	WQA
MAAO RIVER								
PTA-1	11	466	0.602	48.1	0.0	8.8	43.1	CW
PTA-3	9	749	0.365	27.0	0.0	0.0	73.0	CW
PTA-4	9	328	0.552	35.7	35.4	0.0	29.0	MP
PTA-5	7	416	0.343	56.2	10.3	0.0	33.4	CW
PTA-11*	23	6323	0.302	65.5	0.0	2.5	32.1	CW
PTA-12*	17	6401	0.212	67.1	0.0	0.6	32.3	CW
PTA-15*	13	9098	0.136	9.0	2.1	0.0	88.9	CW
TRIBUTARIES:								
MAAO RIVER								
PTA-2	3	41	0.468	24.4	0.0	0.0	75.6	CW
PTA-13*	17	9880	0.171	8.7	2.0	0.0	89.3	CW
PTA-14*	17	11685	0.157	66.9	0.0	0.0	33.1	CW
PULA RIVER								
PTA-8	7	136	0.514	45.6	0.0	0.0	54.4	CW
PTA-9	11	262	0.741	7.6	48.5	8.0	35.9	MP

Legend:

N = Number of individuals
DI = Diversity index
CWI = Clean water indicator
MPWI = Moderately polluted water indicator
PWI = Polluted water indicator
WQA = Water quality assessment
NOF = No organisms found
* = New stations

TABLE 3.2.38c WATER QUALITY ASSESSMENT BASED ON THE BENTHIC FAUNA POPULATION OF MARAGANDANG RIVER

SAMPLING STATIONS	No. of Species	N	DI (%)	CWI (%)	MPWI (%)	PWI (%)	OTHERS (%)	WQA
MARAGANDANG RIVER								
HGC-1	NOF	0	0.000	0.0	0.0	0.0	0.0	
HGC-2	1	10	0.316	100.0	0.0	0.0	0.0	CW
HGC-3	1	172	0.076	0.0	0.0	0.0	100.0	PW
HGC-4	2	117	0.185	0.0	0.0	0.0	100.0	CW
HGC-5	3	74	0.349	28.4	0.0	0.0	71.6	CW
HGC-6	NOF	0	0.000	0.0	0.0	0.0	0.0	
HGC-6b*	5	429	0.241	18.2	0.0	0.0	81.8	PW
HGC-10*	6	2364	0.123	3.3	0.0	1.7	95.1	
HGC-11*	7	390	0.354	50.0	0.0	20.0	30.0	CW
HGC-12*	6	1409	0.160	75.0	0.0	0.0	25.0	CW

Legend:

N = Number of individuals
DI = Diversity index
CWI = Clean water indicator
MPWI = Moderately polluted water indicator
PWI = Polluted water indicator
WQA = Water quality assessment
NOF = No organisms found
* = New stations

TABLE 3.2.38d WATER QUALITY ASSESSMENT BASED ON THE BENTHIC FAUNA POPULATION OF BAGO RIVER

SAMPLING STATIONS	No. of Species	N	DI (%)	CWI (%)	MPWI (%)	PWI (%)	OTHERS (%)	WQA
BAGO RIVER								
CTA-14	4	212	0.275	4.7	0.0	9.9	85.4	CW
CTA-15	6	93	0.622	21.5	22.7	10.8	45.2	CW
CTA-20*	11	4060	0.173	40.4	0.0	1.0	58.7	CW
CTA-21*	8	1600	0.200	9.8	12.2	2.4	75.6	MP
PTA-6	5	126	0.445	41.3	42.1	0.0	16.7	CW-MP
PTA-7	7	362	0.368	67.4	32.6	0.0	0.0	CW
PTA-10	5	113	0.470	26.6	37.2	8.9	27.4	CW
HGC-7	1	32	0.177	0.0	0.0	0.0	100.0	
HGC-8	NOF	0	0.000	0.0	0.0	0.0	0.0	
HGC-9	NOF	0	0.000	0.0	0.0	0.0	0.0	

Legend:

N = Number of individuals
DI = Diversity index
CWI = Clean water indicator
MPWI = Moderately polluted water indicator
PWI = Polluted water indicator
WQA = Water quality assessment
NOF = No organisms found
* = New stations

TABLE 3.2.39 FOOD TYPES OF AQUATIC INSECTS FOUND IN THE DIFFERENT IMPACT RIVERS

SUBDIVISION BASED ON DOMINANT FOOD	AQUATIC INSECT TAXA AND PREDOMINANT EXAMPLES
Herbivores : algae and associated microflora attached to living and substrates	Ephemeroptera : Caenidae, leptophlebiidae, Heptageniidae, Baetidae
	Coleoptera : Psephenidae
	Diptera : Chironomidae
Herbivore - detrivores living algal cells, decomposing organic particulate matter	Trichoptera : Philopotamidae, Hydropsychidae
	Diptera : Simuliidae, Chironomidae, Culicidae
Detritivores (fine particle detritivores) : decomposing organic particulate matter	Ephemeorptera : Caenidae, Ephemeridae, Leptophlebiidae, Baetidae, Ephemerellidae, Heptagenidae
	Hemiptera Gerridae
	Diptera Chironomidae
Carnivores : whole animals (or parts)	Megaloptera Trichoptera Rhyacophilidae, Hydropsychidae
	Diptera Chironomidae

the detritivores or detritus feeders, they maintain the integrity of the different river systems for self-purification.

3.2.5 COASTAL AND MARINE ECOLOGY

3.2.5.1 INTRODUCTION

This section of the report presents the results of the assessment of the coastal and marine environments of the areas covering the PNOC Northern Negros Geothermal Project (PNOC-NNGP). These findings are used to: (1) characterize the present environment likely to be affected by the project activities (the immediate past status of the environment may be viewed from these findings); (2) assess the existing and future quality of the coastal and marine environment with and without the project; and (3) provide useful input in the development of a plan for the management of impact mitigation, waste, and monitoring. Emphasis is placed on the likely responses of the physiognomically dominant benthic and planktonic communities to the probable impacts of the development activities and specially on how they could affect the livelihood base of the coastal inhabitants.

The results of the assessment done in the exploratory phase of the project in 1993 and the present survey undertaken in February.March 1994 are integrated and with related concerns from the Oceanographic and Socioeconomic Components are used to come up with an indicative biophysical *cum* social profile (or a resource map) of the coastal environment.

3.2.5.2 METHODOLOGY

For this development phase of the project, the methodology used to assess the coastal and marine environments was similar to that of the exploration phase. For reference, this is reiterated below, but the modifications that had to be resorted to because of the generally unfavorable sea conditions during the 1994 survey are also incorporated. As recommended in the EIA for the exploration phase, a study of the plankton community in the area was also conducted. In addition, more effort was focused on fisheries, specially at the mouth of Bago River (see **Appendix 3-I**), in order to augment and validate the findings of the earlier work.

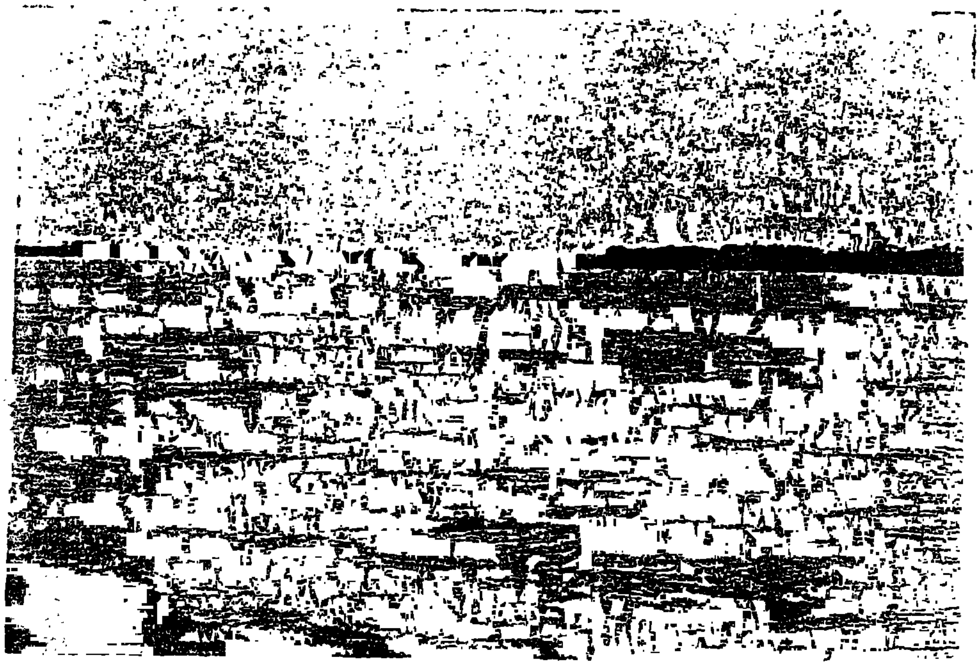
The socioeconomic survey undertaken by the Aquatic Ecology (Marine) Component was largely indicative in nature. This was focused on interviews with coastal inhabitants previously uninterviewed during the exploration phase of the project, especially at *Sitio* Caban of Bgy. Tapong at the western side of the mouth of Bago River (**Fig. 3.2.15**). The communities are represented by a typical fisherman shown in (**Fig. 3.2.16**). A more intensive survey of the coastal areas for this current phase was conducted by the Socioeconomic Component of the project team.

A. SITE SELECTION

For a higher degree of reliability and for practical purposes, the study sites chosen for the exploration phase (February 1993) were covered for the development phase of the project (February 1994). Initially, the selection of the specific study sites was based on a preliminary analysis of the latest SPOT XS and Landsat MSS data on the biophysical features of the coastal environs of northwestern Negros Island (1:50,000). This information was digitally classified, color-coded, and translated into the base map. The primary concerns were focused on vegetated, non-vegetated, and turbid areas of the coastal zone; mangrove and fishpond areas; and coastal population centers.

B. RAPID VISUAL COMMUNITY SURVEY

The survey and assessment of the underwater communities were undertaken in 12-13 February and 4 March 1994, almost exactly a year after the initial study (16-18 February 1993) was conducted. The test method used was the manta board technique for coral communities (Dartnall and Jones 1986). This was, however, slightly modified in order to incorporate an assessment of seaweed and seagrass assemblages (Rapid Appraisal of Plant Structure in Tropical Reefs or RAPSTRE)(Fortes 1992).



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Western side of the Mouth of Bago River at Sitio Caban at Bgy. Tapong

FIG. 3.2.15

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Fisherman from Sitio Caban,
Brgy. Tapong

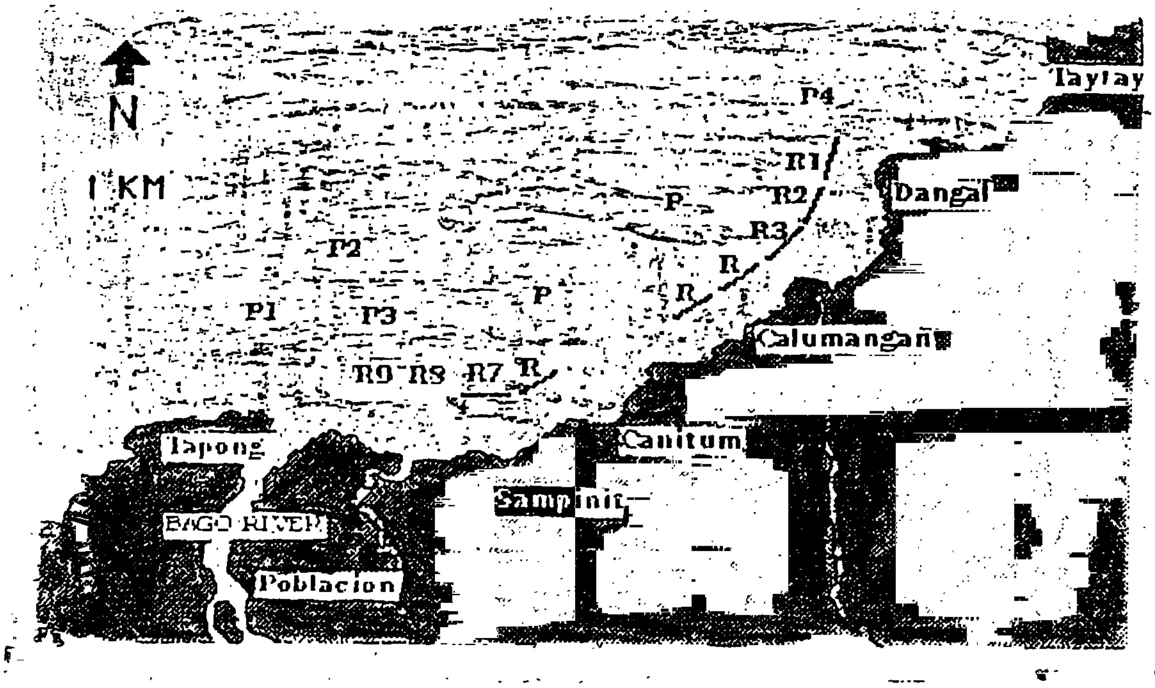
FIG. 3.2.16

This technique involves two (2) snorkellers, holding on to the opposite sides of a manta board tied behind a motorized banca and towed at a speed of 1 - 1.5 knots over the reef or sand. A tow lasting five (5) minutes over the communities allowed the snorkellers ample time to rapidly describe the habitats semi-quantitatively. Sufficient tows were made to cover and represent the areas covered. While nine (9) tows (covering at least 9 km) were made in 1993, only six (6) were made in the current survey due to the strong surf which prevented the survey at the middle three of the tow paths. The paths, still parallel to the coastline and approximately 100 m from it were made from Bgy. Dangal down to near the mouth of Bago River as it opens to the sea **(Fig. 3.2.17)**. The time and compass bearings of each start and end of a tow were recorded by an assistant on board the boat. At each stop, the snorkellers recorded the data (% cover of the communities) on underwater writing slates. A standard and illustrated coverage guide (Dartnall and Jones 1986) was placed on the manta board for quick reference. When cross-referenced with the map indicating the position of individual tows, information on the condition of different locations of the surveyed area was readily obtained.

C. PLANKTON SURVEY

For the areas covered, two (2) components of the plankton community (phytoplankton and invertebrate zooplankton) were studied within a general space-time dimension of four (4) stations in one season (February, cool-dry season) **(Fig. 3.2.17)**. The limited scope of the investigation is due largely to time constraints. Two (2) of the originally targeted sites were not sampled due to strong surf during the period.

Phytoplankton - For the determination of phytoplankton biomass, chlorophyll *a* measurements using the fluorometric method (Parsons *et al.* 1984) were done. Chlorophyll *a* measurements were made using the spectrophotometric method (Parsons *et al.* 1984) for each of the four (4) stations. Secchi dish depths were also obtained to determine light attenuation coefficients and the compensation depths.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

The Coastal and Marine Area of Concern of the NNGDP; P, Plankton station; R, RAPSTRE tow path; those w/o numbers were aborted due to strong surf (Feb. 1994)

FIG. 3.2.17

Replicate 1.0 L water samples from 0.5 m depths were taken using a dipper and were stored in a Blue-Ice cooled chest while on board the boat. In the station, samples were then filtered unto individual 4.5 cm GF/C filter paper and were kept in individual petri plates and stored in the freezer.

In the laboratory, each sample was transferred into 15 ml test tubes with cap and a 10 ml 90% acetone solution was added to each. The test tubes were kept in the dark prior to reading for 12 hrs when the fluorometer was used. Biomass measurements were expressed as mg chl*a* m^{-3}.II.

Invertebrate Plankton - Zooplankton was sampled from each of the four (4) stations by vertically towing replicate conventional plankton nets of 64 µm mesh from 1 m above bottom to the surface, four (4) times. Two samples were obtained for counts and two (2) for biomass determination. On board, each sample was concentrated and preserved in a 10% formalin solution. Sampling was done in February 1994.

In the laboratory, samples for counts were subdivided into two (2) groups: the >500 µm and the <500 µm fractions, using a 500 µm mesh sieve. The >500 µm fraction was counted fully while the <500 µm fraction was subsampled. The zooplankton species were identified to major taxa level and counted. Their total densities were estimated for each of the stations. Counts were expressed as nos. m^{-3} and rounded off to the nearest 1's.

D. FIELD SAMPLING/LABORATORY PROCESSING

From the results of the site selection and visual community survey, transect sites were further selected for an intensive assessment of community structure (species identification, % cover, density or frequency of each species) and other significant characteristics (**Fig. 3.2-17a**). The final selection was confirmed with the help of the boatmen who were themselves chosen due to their wide and first-hand experience and knowledge of the location, kinds, and abundance of the most important representative communities at the sites.

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Transect Site Assessment Using 0.25m^2 Quadrat

FIG. 3.2.17a

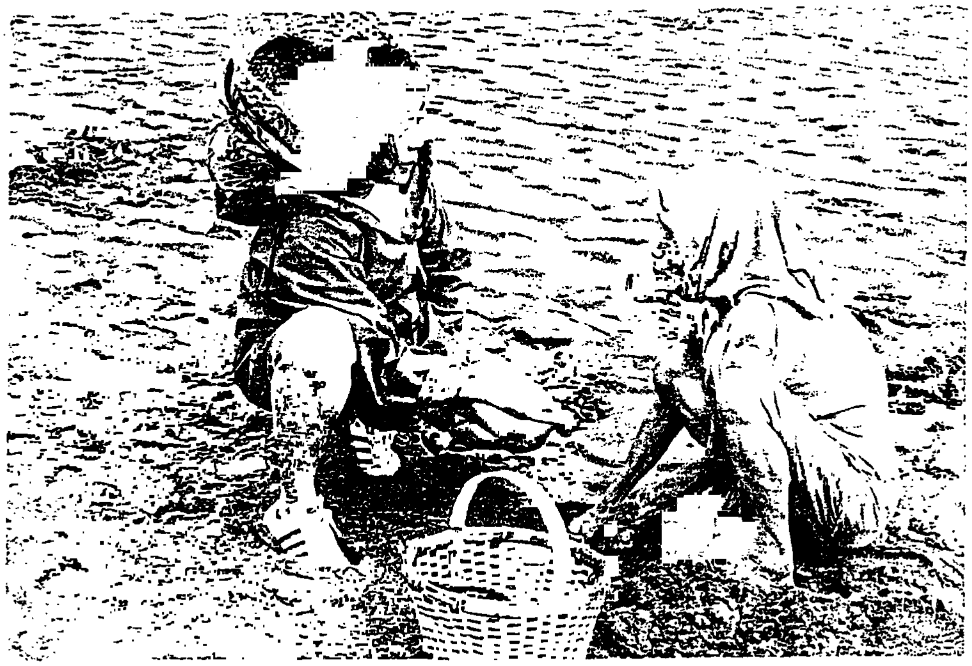
E. INDICATIVE SOCIOECONOMIC SURVEY

As in 1993, an indicative socioeconomic survey was conducted through on-site interviews of fishermen and other coastal inhabitants (**Fig. 3.2.18**). This survey, however, was concentrated at the barangays near the mouth of Bago River, aimed primarily at getting first-hand information on the patterns of use of the coastal resources at this environmentally critical site, the status of and threats to these resources, and the people's perception of existing and planned environmental efforts and the coastal and marine environment as a whole.

F. INTERACTIVE PARTICIPATORY APPROACH

One of the encouraging aspects of the coastal and marine survey was the active participation demonstrated by some of the parties concerned with the outcome of the project. As in 1993 when two (2) representatives of two (2) non-governmental organizations based in Bacolod actually participated in the marine survey, in February 1994, three (3) concerned personnel participated: two (2) from media (GMA TV Bacolod) and one (1) fisherman-representative (EIA Workshop participant) from the town of Manapla (north of the coastal area of concern). Video footages of the sampling activities were made and more could have been documented were it not for the rough sea conditions which prevented the media personnel from completing their work. They were helpful in interviewing some of the coastal inhabitants, specially in Calumangan and Canitum.

Later on, the fisherman-representative from Manapla requested the marine component leader for help in their initial effort to reforest a coastal portion of Bgy. Chambre. In coordination with the Institute for Social Research & Development (ISRAD), he was assisted in the organization of a three-day seminar-workshop on coastal zone management for the barangay officials of the municipalities of Manapla and Sagay. Held last 3-5 March 1994, the marine component leader was the resource person (refer to **Appendix 3-J** for the newspaper clipping on the activity). The emphasis of the activity was on basic ecological principles as basis of the EIA process, the latter being considered as a useful tool in the management of coastal resources.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Socio-econ interview of coastal inhabitants (March 1994)

FIG. 3.2.18

G. COMPONENT LOCATION

As in the exploration phase of the PNOC-NNGP undertaken in 1993, the coastal and marine area of concern in the development phase is the 10-km portion of the coast of Bago City in the north northwestern section of the island of Negros. An indirect impact area, it is bounded by the coast of Bgy. Dangal in the north and *Sitio* Caban, Bgy. Tapong of upper Pulupandan in the south (**Fig. 3.2.19**). Four (4) other barangays comprise the middle section: Calumangan, Canitum, Sampinit, and Poblacion (Canitum was not included in the 1993 report).

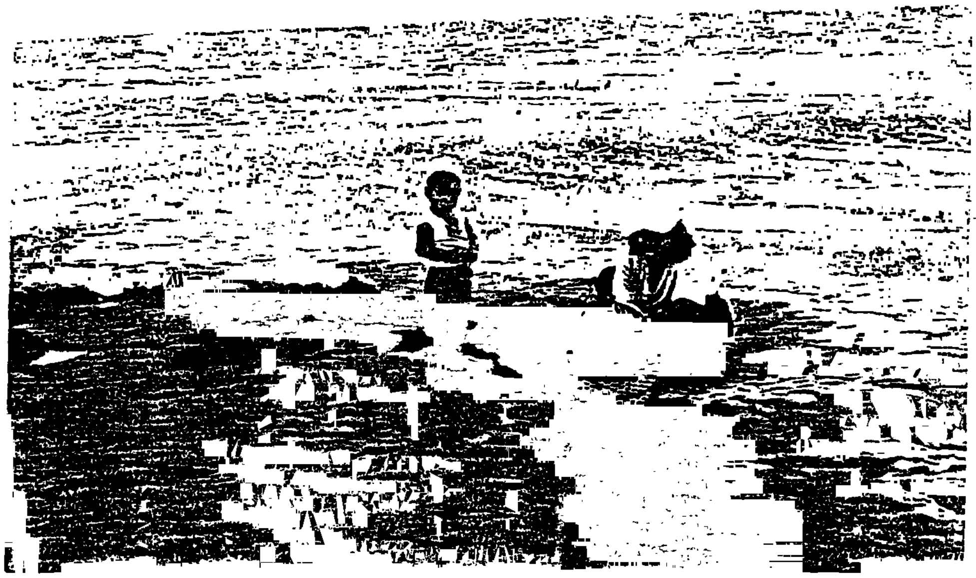
3.2.5.2 ENVIRONMENTAL CONDITIONS

The existing coastal and marine environments of the area covered remain relatively the same as in the exploration phase of the PNOC-NNGP. The coastal activities of the two (2) phases are separated by exactly a year - 16-18 February 1993 and 11-13 February-03-05 March 1994. However, appropriate modifications, in the form of new observations or deviations from earlier records, are incorporated in the present report.

A. THE PHYSICAL SETTING

The mouth of Bago River is relatively narrow due to extensive sandy mud flats on either side of the main channel. In February 1994, a larger build-up at the left (northwest) section has been observed and this attributed in large measure to the prevailing northeast and east winds (see Oceanography Component). Only farther seaward does the river widen into the deeper zone of the mid-northeastern section of Guimaras Strait.

As in the previous study, outside the 5-m bathymetric contour farthest from the shore, the waters are turbid, the resident benthic and pelagic communities reportedly being depauperate (**Fig. 3.2.19**). There is a similar turbid counterpart to this zone comprising a kilometer-wide (to 3-m deep) area closest to land. Here, the communities are relatively richer due primarily to the hard coralline-rocky substrate, which presumably allows the settlement and development of larvae or



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Sandy bare area outside the 5m contour farthest from the shore where the resident benthic communities are depauperate

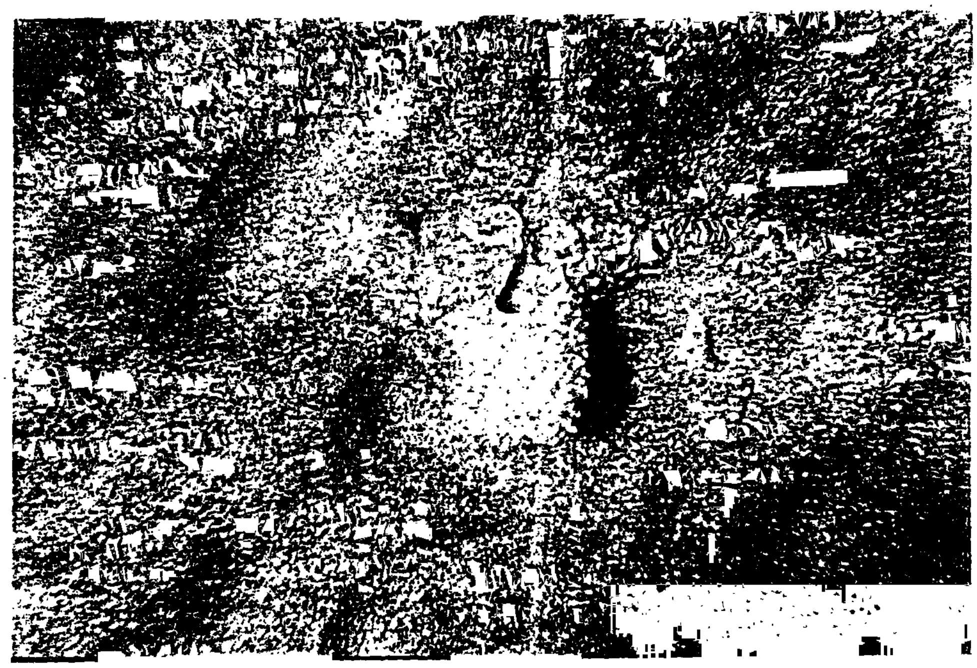
FIG. 3.2.19

propagules of marine organisms. The area between the two (2) turbid zones is characterized by less turbid sandy-muddy substrate which is practically devoid of macrobenthic sessile organisms. For the present assessment, the specific area of interest was the nearshore turbid zone with the higher diversity of important marine organisms (**Fig. 3.2.20**).

The coasts of Bgy. Dangal down to Calumangan are characteristically basaltic, (the substrate overgrown by shells of littorines, neritids, oysters, gastropods, and coralline algae), being subjected to the onslaught of waves and currents (**Fig. 3.2.21**). This turbulence brings a substantial amount of organic debris into the shore. The land portions of the area are characteristically flat to very gently sloping (0 - 3%, see slope map, EIA for the exploration phase). Hence, these are not prone to erosion ("no apparent erosion", see erosion map, EIA for the exploration phase) with the exception of Bgys. Dangal, Calumangan, Sampinit, and Pulupandan, which are built-up areas. The coastal zone comprises largely of fishponds, coconut plantations, salt pans, rice paddies, and irrigated fields.

The maj~~or~~ sources of *man-made pollution and environmental disturbance* in the coastal area of Bago City from the north southward are:

1. Distileria de Bago, a newly operational alcohol distillery plant in Bgy. Taloc, right beside Bgy. Dangal. It's effluents are discharged into ponds for treatment, but emit a highly undesirable (sickening) smell to the discomfort of the nearby barangay inhabitants, as of this writing, there is no progress with regard to the three (3) km submarine pipeline through which the treated effluents are supposed to be dispersed deep down the Guimaras Strait (please see EIA for the Distileria Bago 1992);
2. Waste effluent discharged from fishponds (also occurring near the mouth of Bago River), salt ponds, rice paddies, resorts, and shrimp hatcheries;
3. Domestic effluent emanating from population centers along the coast;
4. Cutting of coastal vegetation for domestic purposes and to catch fish;
5. Cemented embankments perpendicular the shoreline which deflect waves and currents;



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

High Diversity Sabellid Reef

FIG. 3.2.20

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Rocky coast at Bgy. Dangal

FIG. 3.2.21

6. Improper placement of fish traps across rivers using illegal mesh sizes and blocking river and stream flows and boat traffic (**Fig. 3.2.22**);
7. Waste dumps on top of reclaimed banks at and adjacent the river mouth, with a strong wind, loose garbage are flown into the nearby river and flow to the sea or, with a wind reversal, back to the nearby barangays;
8. Asian Alcohol, located at Pulupandan, disposing its wastes into the coast. With southwest winds, the liquid effluent and smoke from its stacks reach the project area. Although largely scientifically undocumented, the people have been complaining about fish and shellfish kills and bad odor from the complex. A standing case is in court; and
9. Ma-ao Sugar Central located at Ma-ao, disposing its effluent into Bago River.

As in the earlier report, the *natural sources of disturbances* in the area of concern are: (1) discharges especially from Bago River and Calumangan River; (2) tidal movement bringing pieces of plastics, cardboard paper, plastic containers, pieces of furniture, cellophane, and fine particles of sludge, distributed over a wide area in the shallow parts of the coasts where homes and industries are located (**Fig. 3.2.23**); and (3) in February 1994, a major factor which disturbed the coastal environment in the area was the strong winds which created big waves and turbulence and significantly reduced the abundance of benthic communities.

In the absence of current data, water quality as reported in 1993 could be used as a descriptor of the current water situation (see EIA for the exploration phase). Hence, the quality of the water and sediment samples collected from the coastal stations could generally be regarded as normal and well within the range allowable for the specific water and sediment types. This was true for the inorganic and organic nonmetallic and metallic constituents. The dissolved oxygen content in the water ranged from 6.8 to 6.9 ppm, while the pH ranged from 7.42 to 7.50. The organic constituents (represented by G & O and BOD) were from nil to 2 mg/l and 2 to 5 mg/l, respectively. It should be noted, however, that the Cu and Hg contents of the sediments collected from the area where the community of "*bagahog*" ("*ahoy*" in the earlier report) abound registered relatively and significantly higher values when compared with those from the other sampling

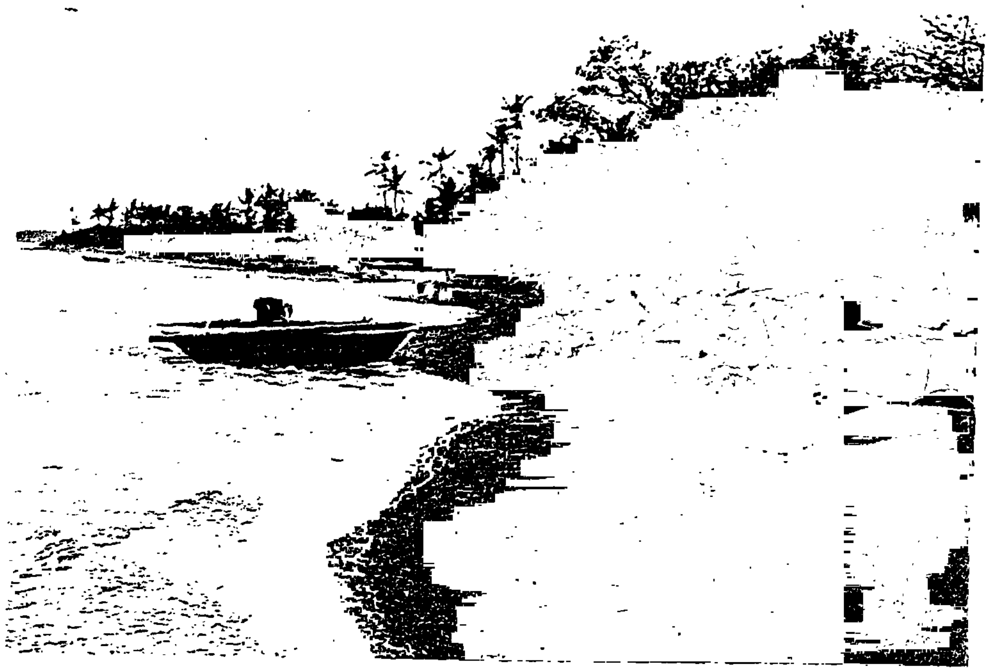
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Illegal Fish Traps at Bago River

FIG. 3.2.22



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Tidal Currents Bring Pollutants
to the Shore

FIG. 3.2.23

points. It could only be speculated that these are due to accumulated inputs from existing pollutive sources and activities unrelated to the proposed project. At the shallow portions of the coast, it is only the physical structures provided by the tubes of the sabellid worms which serve as a barrier that could accumulate suspended matter. Otherwise these would all be washed to shore or offshore.

B. THE BIOLOGICAL SETTING

Benthos

As confirmed by the present study, the existing communities at the coastal and marine environments are of the marine-estuarine type, dominated by the characteristically silt- and inorganic nutrient-tolerant benthic organisms. They appear to represent a prolonged early stage in the ecological succession of the highly stressed and unstable environment. Most of the populations and communities are known to be "r-selected", implying their pioneering capacities to quickly react to stress conditions and colonize all available substrate types. This is exemplified by the soft corals (**Fig. 3.2.24**), sponges and tunicates, which generally represent an earlier seral stage in the ecological development of a reef community. On the other hand, the bluegreen and lithophilic or epiphytic algae indicate the abundance of inorganic sources of energy (**Fig. 3.2.25**). The remains of cut stumps of the brown seaweed, *Sargassum polycystum* indicated that the population has just reached or passed a stage of senescence. This is a well-documented observation in most parts of the country where the seaweed exhibits peak abundance during the colder parts of the year (December to early February), only to experience a decline at the onset of summer. Much like the tubes of the sabellid worms, the tall and richly diversified structures of the thalli of *S. polycystum* provide an effective and protective refuge specially for juvenile and small organisms.

It should be emphasized, and as noted in the EIA for the exploratory phase of the project, that the tubes of the sabellid worms are the only structures that serve as relief/refuge (or

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DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Soft Coral at Early Seral Stage

FIG. 3.2.24

NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Blue-Green Algal Mats

FIG. 3.2.25

spawning grounds?) for the predominantly juvenile fish assemblages in the area (**Fig. 3.2.26**). In addition, the fishermen utilize the worms, which are the most easily accessible, reliable and effective baits to use in fishing offshore (at seven or more kilometers from the coast). There is an obvious and concerted effort on the part of the people to protect the resource.

The benthic macroflora and fauna at the stations surveyed appeared more as a result of the prevailing sediment conditions and hydrographic factors, rather than as an offshoot of biological factors. Their structure indicated a tendency toward gradual impoverishment interrupted by temporarily successful colonization, which disturbs both the resistance and the resilience of the community. Such a broad fluctuation in abundance, including sudden breakdown, is accompanied by a steady impoverishment in species. This phenomenon may be attributed to geological and hydrographic factors, especially oxygen depletion, and as the present study found, to light conditions in specific water layers. Given these existing conditions, as long as the current and general circulation pattern transport oxygen and effective light condition to these layers, the resident flora and fauna will survive. Hence, the area may be considered ecologically sensitive, and is not suited to withstand sudden or pulsed disturbances such as excessively strong surf, dumping of excessively large amounts of wastes, silt and other pollutants. That the first factor was operative in structuring the benthic communities has been shown by its effect in significantly reducing the abundance of these communities.

Mangroves

What was reported in the 1993 survey of the mangrove habitats still holds true in the present survey. With additional data from *Sitio* Caban at the northwest part of the mouth of Bago River, the mangrove cover has been found to be relatively more extensive near the mouth of the rivers (especially Bago River) where the relief is low, the influence of fluvial deposits great, and tidal penetration prevents competition from non-salt tolerant species (**Fig. 3.2.27**). As is true for mangroves, these conditions result in three (3) distinct components and are likewise observable in the local mangroves:

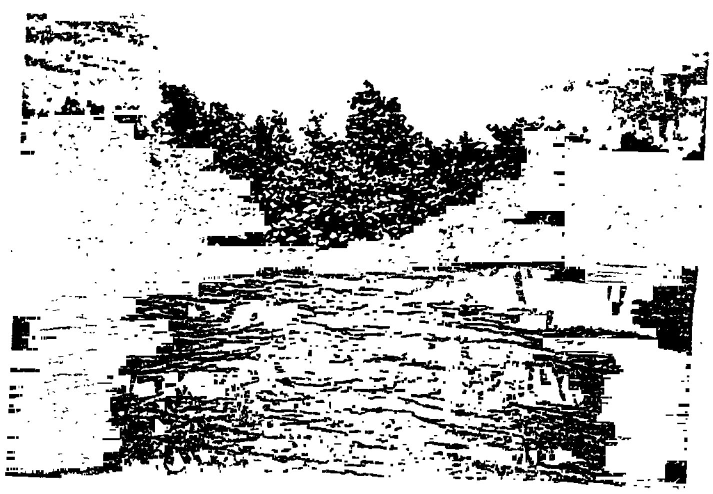
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Sabellid Worms

FIG. 3.2.26



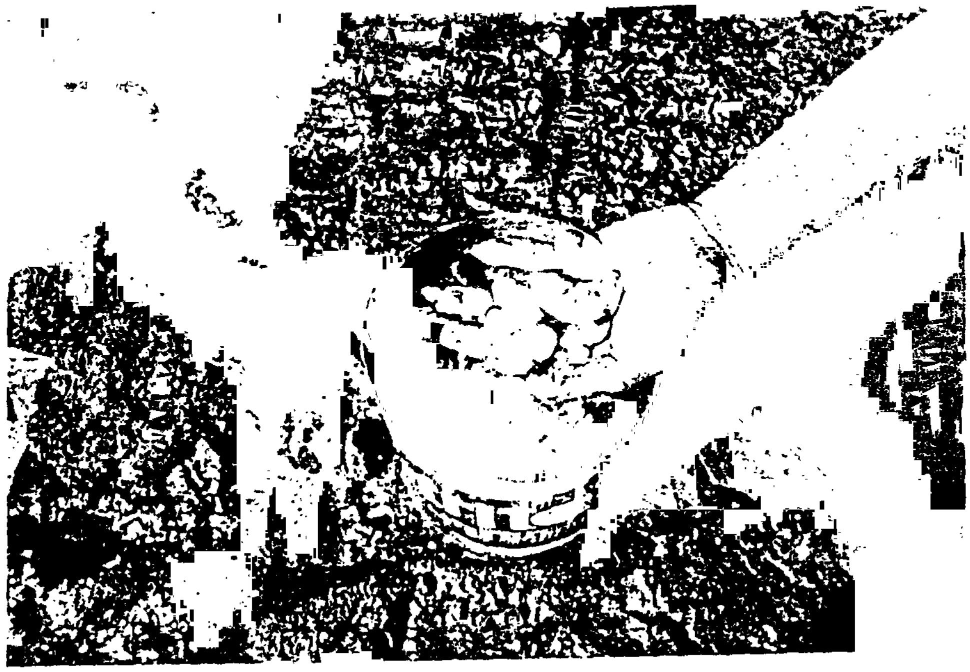
NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

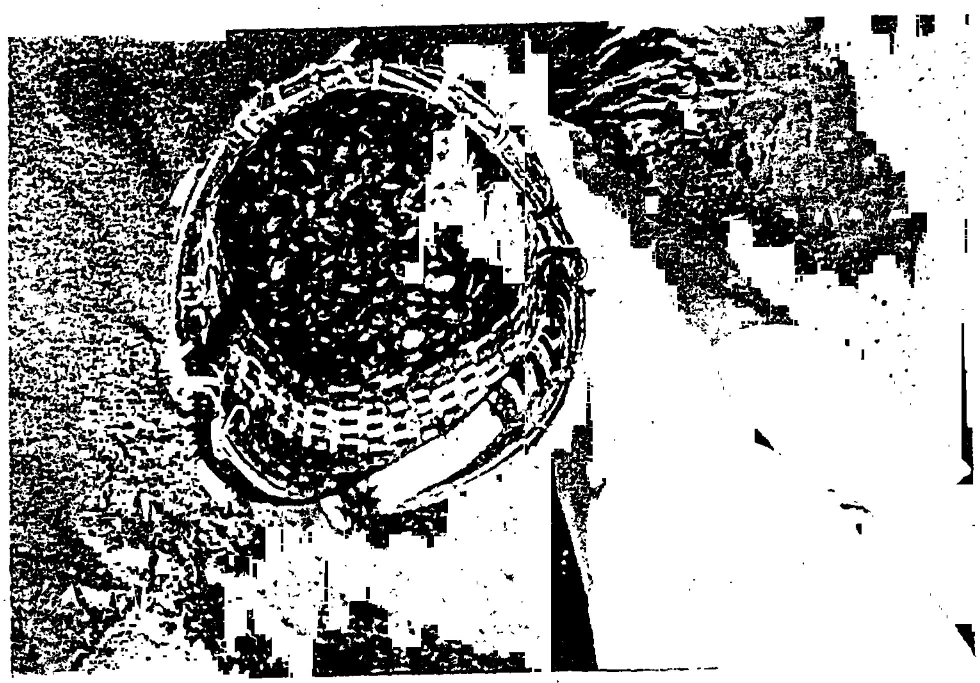
CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Mangrove Vegetation

FIG. 3.2.27





NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Harvests from the seashore

FIG. 3.2.28 & 29

(1) major elements - species with specialized morphological and physiological adaptations that allow them to become established and compete successfully with other species, and eventually to dominate the structure of the ecosystem; they do not intrude into the terrestrial environments (e. g., *Rhizophora mucronata*, *R. apiculata*, *Avicennia officinalis*, *Sonneratia caseolaris*, and *Ceriops tagal*);

(2) minor elements - those that occupy peripheral habitats and only rarely form pure communities, such as the fern *Acrostichum* sp. or the shrubby *Acanthus* sp. They can be normal components of the secondary succession pattern in some transitional environments or at disturbed sites, specially at the highest elevations where there are freshwater inputs; and

(3) mangrove associates - plants usually found in transitional environments such as sandy areas (strand environments), areas influenced by large exchanges of freshwater or those subjected to extreme saline conditions (e. g., *Terminalia cattappa, Casuarina* sp.). For purposes of restoration, only the species making up the major elements are generally used but it should be mandatory under some circumstances to use the minor elements and the associates because of their affinity for unusual or restrictive sites within the mangrove environment, their contribution to landscape diversity, or for aesthetic purposes

(Cintron-Molero 1992). Along the coast of Bago City, the small patches of mangroves are composed principally of secondary growths of the major elements.

Like the benthic communities at the site, the mangroves have pronounced characteristics of pioneer species in their reproductive biology and "mature phase" attributes in their community structure and vegetative growth. These "r-strategist" features of mangroves observed at the site include:

(1) broad tolerance to varied environmental factors (e. g. from the relatively exposed sandy-rocky conditions at Calumangan to the sheltered, muddy coves near the mouth of Bago River and inside);
(2) light-demanding species;
(3) continuous or almost continuous flowering and propagule production;
(4) high propagule production in a wide range of environmental conditions;
(5) adaptations for short and long-distance dispersal by tides.

The occupation by mangroves of newly accreted substrates at the site has led to an accumulation of biomass at maturity, which reflects the fertility of the site, predominant geomorphic and hydrologic processes, and the disturbance regime of the region. However, an observable decrease in persistent biomass along the gradient of increasing environmental stress, due to a decrease in the influence of factors favorable for mangrove growth and development (i. e., from the mouth of Bago River up along the coast to the northeast till Barangay Dangal), has been noted. This is also seen in the remarkable stunting of the mangrove stands presumably due to sand accretion and nutrient limitation. In addition, along this gradient is a corresponding increase in the number of households; hence, the degree of disturbance mainly through cutting for firewood, development of fishponds, and other coastal uses.

3.2.5.4 RESULTS AND DISCUSSION

A. BENTHIC COMMUNITY STRUCTURE

Table 3.2.40 gives the results of the RAPSTRE survey undertaken in February 1994. Among the nine (9) tow paths targeted for study, only six (6) were actually done due to the strong surf and poor water visibility. Compared with the 1993 survey, the current survey expectedly yielded a lesser number of both benthic and pelagic organisms and communities. At Tow Path 2 where the first benthic communities were observed in both the 1993 and 1994 surveys, there was a drop in the percentage cover of the sabellid worm (from 10% to 5%). No fishes were seen (due perhaps to the poor visibility). At Tow Path 3, the patchily distributed seagrass *Halophila minor* was not observed; Tow path 7 consisted predominantly of gorgonian colonies. No seaweeds, which dominated the earlier survey, were observed. At Tow Path 8, while the hard corals *Porites* and fungids were still present, their cover was not quantified due to poor visibility. No seaweeds were observed in the area. At Tow path 9, there was a drop in the cover of the seaweed *Gracilaria coronopifolia* from 10% in 1993 to about 5% in 1994. Tow paths 4-6 were aborted due to the strong surf.

Table 3.2.41 shows that at the two (2) intensive study stations, five (5) benthic communities dominated during the survey period: the sabellid worm ("*bagahog*", "ahoy" in the 1993 report), sponges, tunicates, seaweeds, and soft corals. Compared with the results obtained in 1993, there was a general reduction in the relative abundance of their populations.

Table 3.2.40 RESULTS OF THE RAPSTRE SURVEY (12-13 FEBRUARY 1994)

TOW NUMBER	OBSERVATIONS
1	no observable organisms; very poor visibility;
2	sabellid worm to 5% cover,tubes heavily epiphytized by Aglaophenia sp. hydroids;poor visibility;
3	sabellid worm to 10% cover,colonies of gorgonians;sandy when visible;
4	ABORTED DUE TO STRONG SURF
5	ABORTED DUE STRONG SURF
6	ABORTED DUE TO STRONG SURF
7	Gorgonian colonies; some coralline rubbles,sandy sediment when visible
8	Porites sp. and fungids,sponges,soft corals (felt only,visibility very poor; sandy sediment;
9	G. coronopifolia, to less tahn 5% cover; algal mats (?) on sandy rocky sediment

Table 3.2.41 RELATIVE ABUNDANCE (DENSITY, NO./0.25M³, AND FREQUENCY, %) OF THE DOMINANT BENTHIC ORGANISMS AT STATIONS 10 AND 11 (BAGO CITY, 12-13 FEBRUARY 1994)

QUADRA NO	SABELLID		SPONGE (DENSITY)		TUNICATES		SEAWEEDS (FREQUENCY)		SOFT CORAL	
	S10	S11	S10	S11	S10	S11	S10	S11	S10	S11
1	3	7	13	8	17	6	0	0	0	0
2	6	11	3	0	0	0	0	0	0	0
3	11	13	1	3	2	17	3	7	0	0
4	6	14	0	0	11	0	7	8	0	3
5	0	0	0	0	8	2	3	4	0	1
6	7	3	2	5	16	3	3	0	0	0
7	11	9	0	0	9	0	0	0	0	0
8	0	0	0	0	3	7	11	4	6	8
9	7	3	0	0	1	8	2	0	[illegible]	0
10	6	19	0	0	9	0	0	0	0	0
11	14	3	0	0	3	7	12	8	3	11
12	16	20	3	18	0	1	3	9	6	0
13	0	0	0	0	0	2	11	0	4	0
14	7	11	18	0	0	0	0	0	3	0
15	2	9	3	0	0	0	0	0	1	0
16	0	11	25	13	3	7	0	3	6	8
17	4	0	3	0	12	7	3	7	1	7
18	0	0	16	11	9	6	7	11	0	3
19	21	17	3	10	0	0	7	6	4	2
20	2	7	12	6	0	0	0	4	11	3
Mean	6.2	7.9	5.1	3.7	5.2	3.7	3.6	3.6	2.3	2.3
[illegible]	5.92	6.62	7.43	5.5	5.71	4.43	4.1	3.8	3.1	3.44

These are summarized below:

	1993	1994
Sabellid worm (density, no./m^2)	31	29
Sponge (density, no./m^2)	36	18
Tunicates (frequency, %)	20	20
Seaweeds* (frequency, %)	0.8	20
Soft coral (frequency, %)	47.2	9.2

* In the 1993 survey, only *Caulerpa racemosa* was considered, in 1994, all seaweeds were considered.

It should be noted that the general reduction in the relative abundance of the dominant benthic populations may not have reflected the true structure of the communities. The results are not conclusive and therefore may not be similar at all to the 1993 study. The findings are more a result of the difficulty in sampling due to the strong surf and poor visibility conditions. This is evidenced by the large number and kinds of benthic organisms found drifted along the beach especially near Brgys. Calumangan (southern part), Canitum, Sampinit (see **Annex 3-K**). Random sampling of the drifted materials (beach samples from 32 0.25 m^2 quadrats) yielded the following (means and standard deviations):

Dominant Species	Abundance
sabellid worm (tube only, no./quadrat)	18 (9.3)
sponges (no./quadrat)	6 (8.1)
seaweeds (frequency, %)	11 (9.2)
fish (dead, no./quadrat)	2 (6.3)
seagrass (frequency, %)	3 (7.1)

Although the exact source could not be ascertained, the above data (and those given in the tables) give the following indications: (1) the area could yield significantly higher abundances of benthic organisms and their structure could be more complex; the benthic communities observed at Manapla (a coastal municipality north of the area of concern with a coast of similar topography as in Bago City, subjected to similar stressors with the exception of the absence of much larger river inputs) present a relatively diverse assemblages of what could have existed along the coast of Bago City in the last 10-20 years; (2) strong surf is a major factor structuring these communities; (3) the benthos is characteristically heterotrophic, i. e., light is a limiting factor; and (4) where the substrate is favorable for plant attachment, a community shift from heterotrophism to autotrophism has occurred, indicated by the overgrowth of re-selected (pioneering) seaweed species on hard substrates at the shallower portions; this is an indication of disturbance and high inorganic nutrient load.

Table 3.2.42 gives the comparative frequency of occurrence of the economically important, agar-yielding red seaweed, *Gracilaria coronopifolia* at the coastal area of concern. As in the case of the other benthic communities and populations during the 1994 survey, there was a highly

Table 3.2.42 FREQUENCY (%) OF G. CORONOPIFOLIA AT RAPSTRE PATHS 8 AND 9 IN FEBRUARY 1993 AND 1994 (DIFFERENT QUADRAT LOCATIONS; VALUES WERE ROUNDED UP)

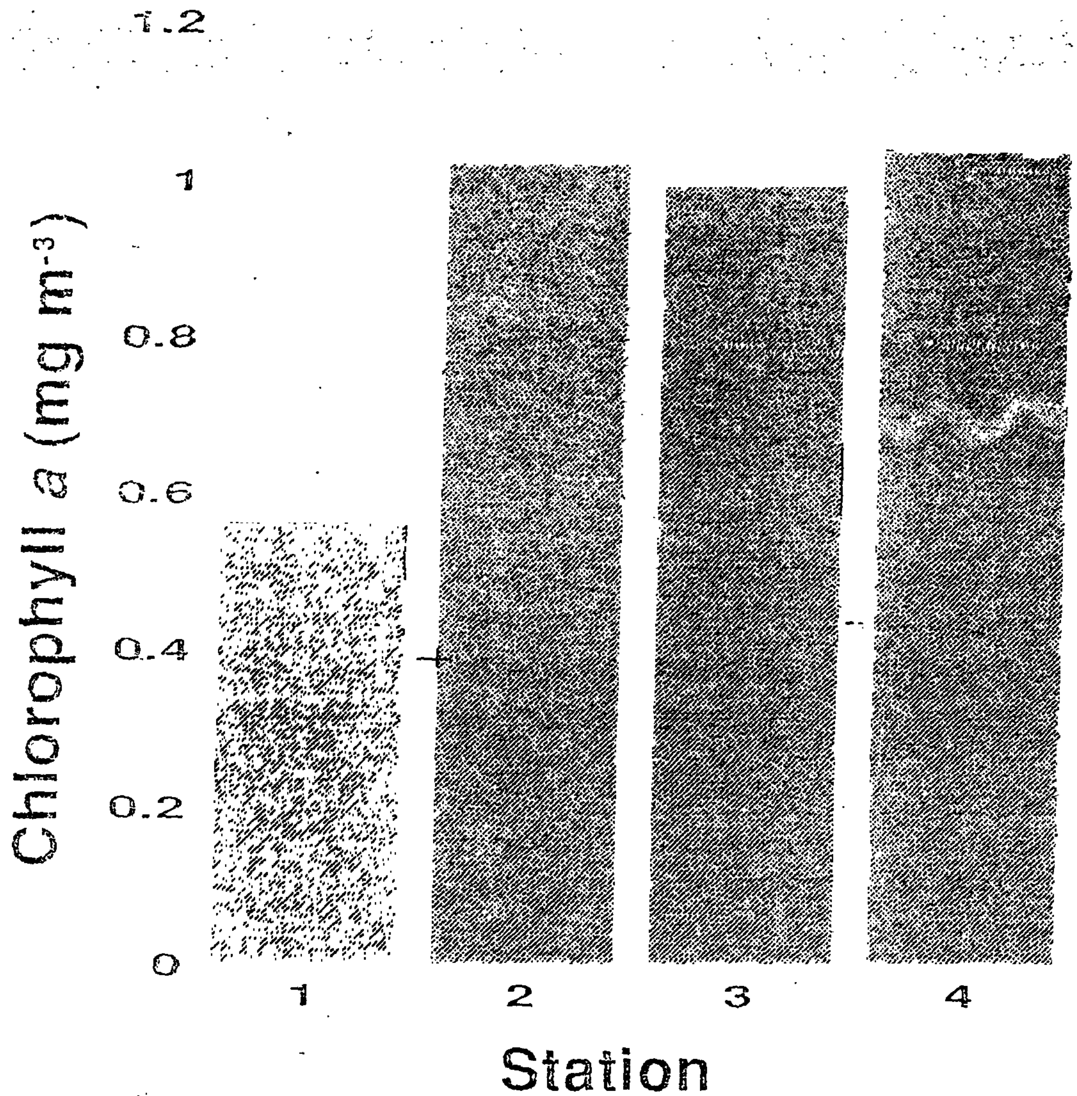
Quadrat No.	February 1993 Absolute	February 1993 Relative	February 1994 Absolute	February 1994 Relative
1	32.00	11.40	17.02	18.30
2	5.00	1.80	0.00	0.00
3	0.00	0.00	2.00	2.20
4	15.00	5.22	7.00	7.42
5	25.00	8.90	12.00	12.80
6	40.00	14.20	0.00	0.00
7	5.00	1.80	0.00	0.00
8	10.00	3.60	3.00	3.21
9	25.00	8.90	11.00	11.82
10	15.00	5.30	0.00	0.00
11	10.00	3.61	5.00	5.40
12	0.00	0.00	9.00	9.70
13	5.00	1.80	3.00	3.22
14	0.00	0.00	6.00	6.50
15	10.00	3.60	9.00	9.70
16	50.00	17.63	2.00	2.20
17	30.00	10.54	0.00	0.00
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
20	5.00	1.70	7.00	7.53
Mean	14.10		4.70	
s.d.	14.40		4.84	
Total	282.00	100.00	93.00	100.00

significant comparative decline in abundance of the seaweed (mean and total frequency: 1993 = 14.10% and 282; 1994 = 4.70% and 93%, respectively). It should be emphasized, however, that the decrease in the parameter could be due largely to the known seasonality of the species, reportedly the species reaches its peak in abundance during the warmer months of April-May. Not observed in the 1993 survey, however, was the occurrence of the species at the shallow (exposed during spring low tides) portions at the northwest portions of the mouth of Bago River near Sitio Caban. Juvenile clumps of the seaweed were observed attached to rocks and pebbles littered along these areas. This finding validates and confirms the earlier and present claims of fishermen and seaweed gatherers regarding the seasonality of the species in the area. It should be noted that the phenology of the seaweed in the Philippines appears site-specific, although in the same general area, (e. g. Brgy. Chambre in Manapla), peak in abundance is also in summer (information obtained through interview with six fishermen-seaweed gatherers).

B. PLANKTON COMMUNITIES

The amount of biomass and energy present at the base of the energy or food network of all living resources in the coastal and marine systems is indicated by estimates of plankton productivity (EPAI 1993). On the other hand, the importance of invertebrate zooplankton lies in their contribution as food for planktivorous fish and commercially important invertebrates. Thus, zooplankton drive the secondary production circuit. In addition, an index of their abundance could help assess the extent of fish recruitment into the coastal area.

In relation to the plankton communities, the profile of mean chlorophyll *a* content in the water samples obtained in February 1994 is shown in **Fig. 3.2.30**. Stations 2, 3 and 4 had similar chlorophyll a values ranging from 0.9665 mg m^{-3}-1.0402 mg m^{-3} and which were higher than the value obtained for Station 1 (0.5629 mg m^{-3}). In terms of primary production, Station 1 produced about 11.8 g C m^{-2} yr^{-1}, the lowest estimate. Stations 2, 3 and 4 produced 21.8, 16.8 and 21.4 g C m^{-2} yr^{-1}, respectively. One major reason why Station 1 had low primary production was the low amount of light that could penetrate the highly turbid waters at the river mouth. Ratios of light compensation depth to water depth were 0.2, 0.4, 0.4 and 0.5 for Stations 1, 2, 3 and 4.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Chlorophyll a values for station 1-4 in February, 1994

FIG. 3.2.30

A total of 22 taxa were obtained for the four stations. The top ten dominant forms were calanoids, bivalve veligers, copepod copepodites, cyclopoids, harpacticoids, copepod nauplii, gastropod veligers, chaetognaths, barnacle nauplii and larvaceans (Fig. 3.2.31). Together, they comprised more than 90% of the total numbers caught.

Zooplankton densities are shown in Fig. 3.2.32. The highest density of 35679 plankters m^{-3} was obtained at depth range 0-3.5 m at station 2 while the lowest density of 11059 plankters m^{-3} was obtained at depth range 0-7.3 m at station 1.

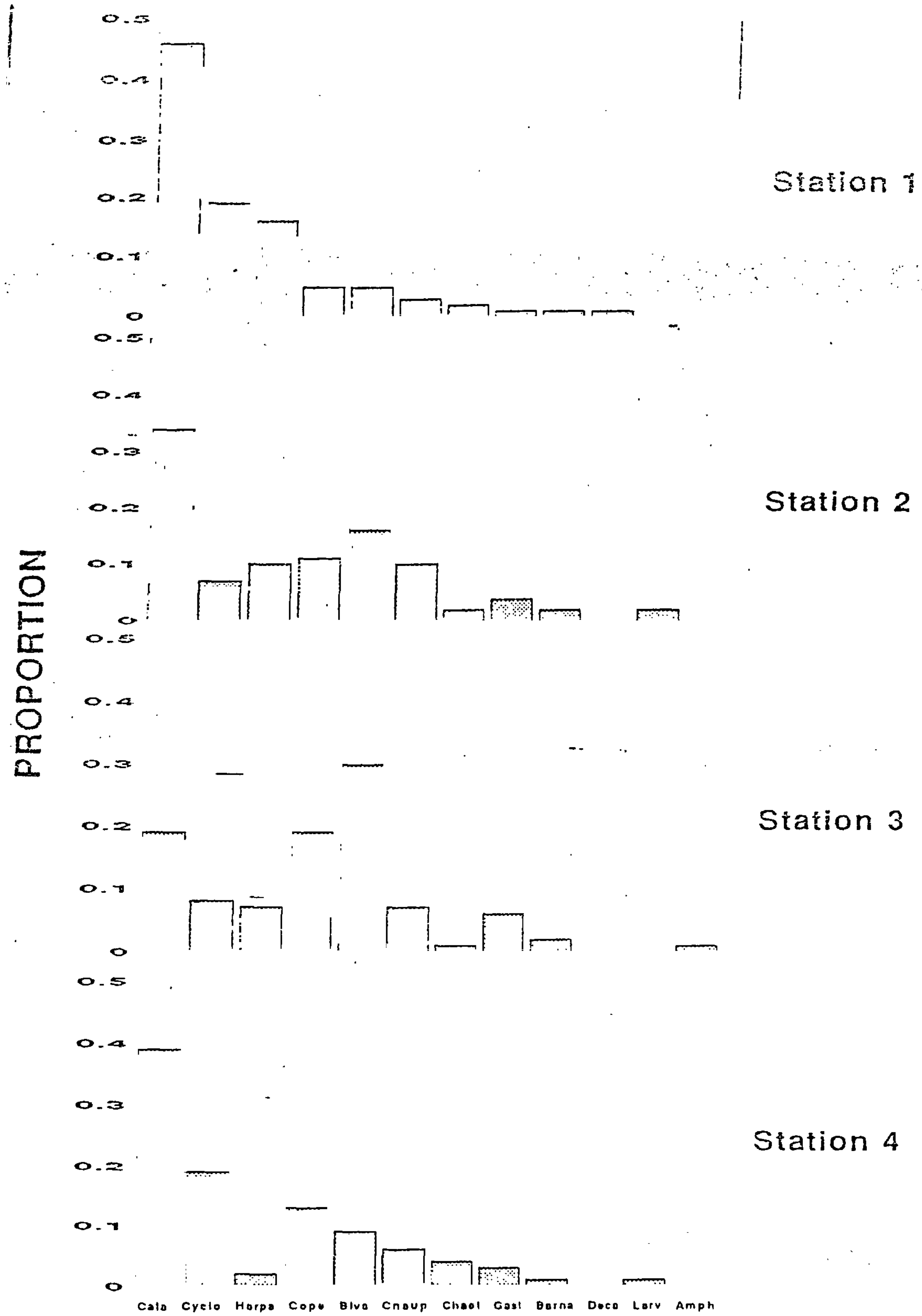
The taxonomic composition of plankton in Station 1 differed markedly from Stations 2, 3, and 4. Only Station 1 had a significant proportion of harpacticoids (16%). Harpacticoids, mostly of benthic habitat, indicate a high wave energy environment where resuspended microbenthos may inhabit the water column for transient periods.

Stations 2,3 & 4 had varying proportions of bivalve veligers (16%, 30% % 9%) respectively. This trend is indicative of a rich source of bivalve propagules from within the site or from adjacent sites. A similar observation was made of the composition of holoplankton in the Bolinao reef system, where bivalve veligers comprised the fourth most dominant group.

On the whole, the composition of holoplankton in Bacolod is very similar to the composition of holoplankton in the Bolinao reef system, specifically in Balingasay where riverine influence is significant. However, the importance of copepod nauplii which is the most numerically dominant group in Bolinao, has been reduced in Bacolod waters, where adult calanoids were most dense. Perhaps, the high wave energy and the high amounts of suspended matter may reduce the numbers of copepod nauplii through direct interference with their feeding.

C. COASTAL RESOURCES ASSESSMENT

Fig. 3.2.33 gives an indicative resource and use map of the coastal environment in Bago City collated from the 1993 and 1994 surveys. At least ten dominant uses have been identified and



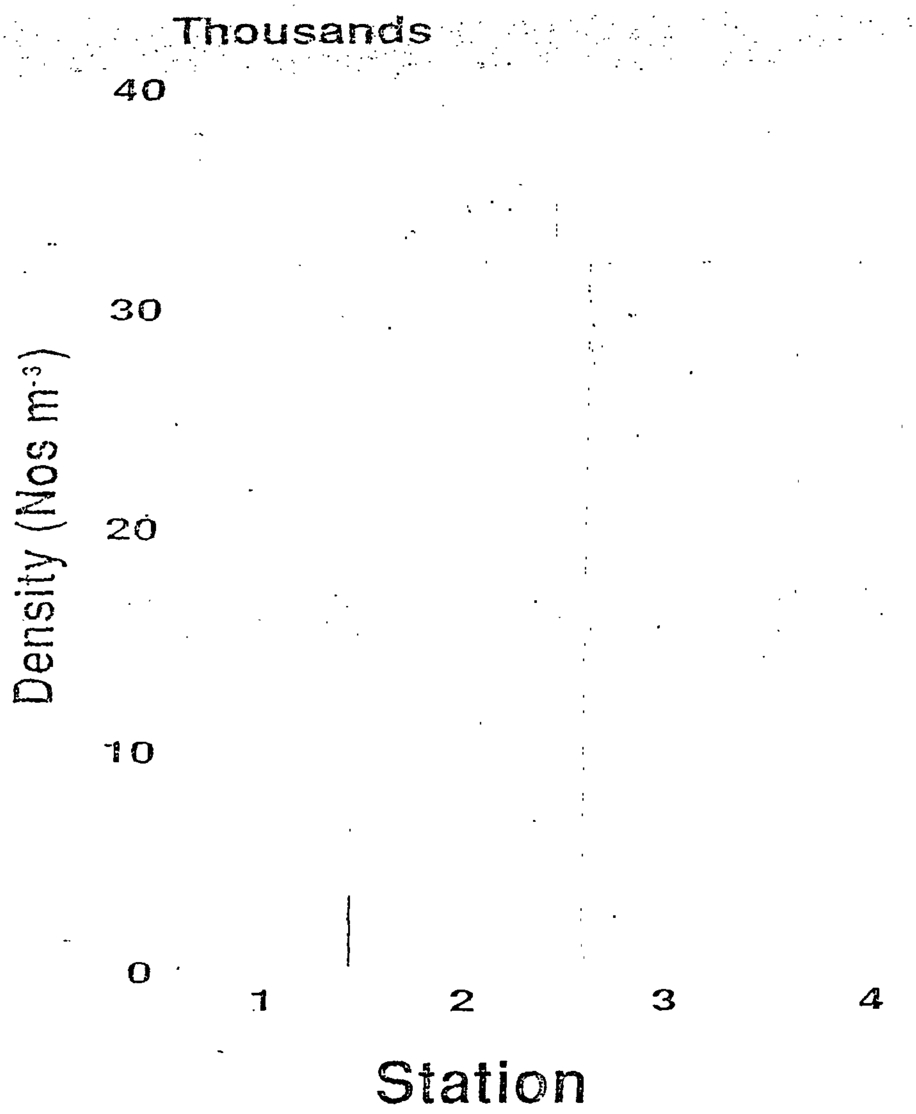
(Cala=Calanoids, Cyclo=Cyclopoids, Harpa=Harpacticoids, Cope=Copepodite, Biva=Bivalve veligers, Cnaup=Copepod nauplii, Chaet=Chaetognaths, Gast=Gastropod veligers, Barna=Barnacle nauplii, Deca=Decapod shrimps, Larv=Larvaceans, Amph=Amphipods).

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Zooplankton catch composition per station for the 1 month sampled

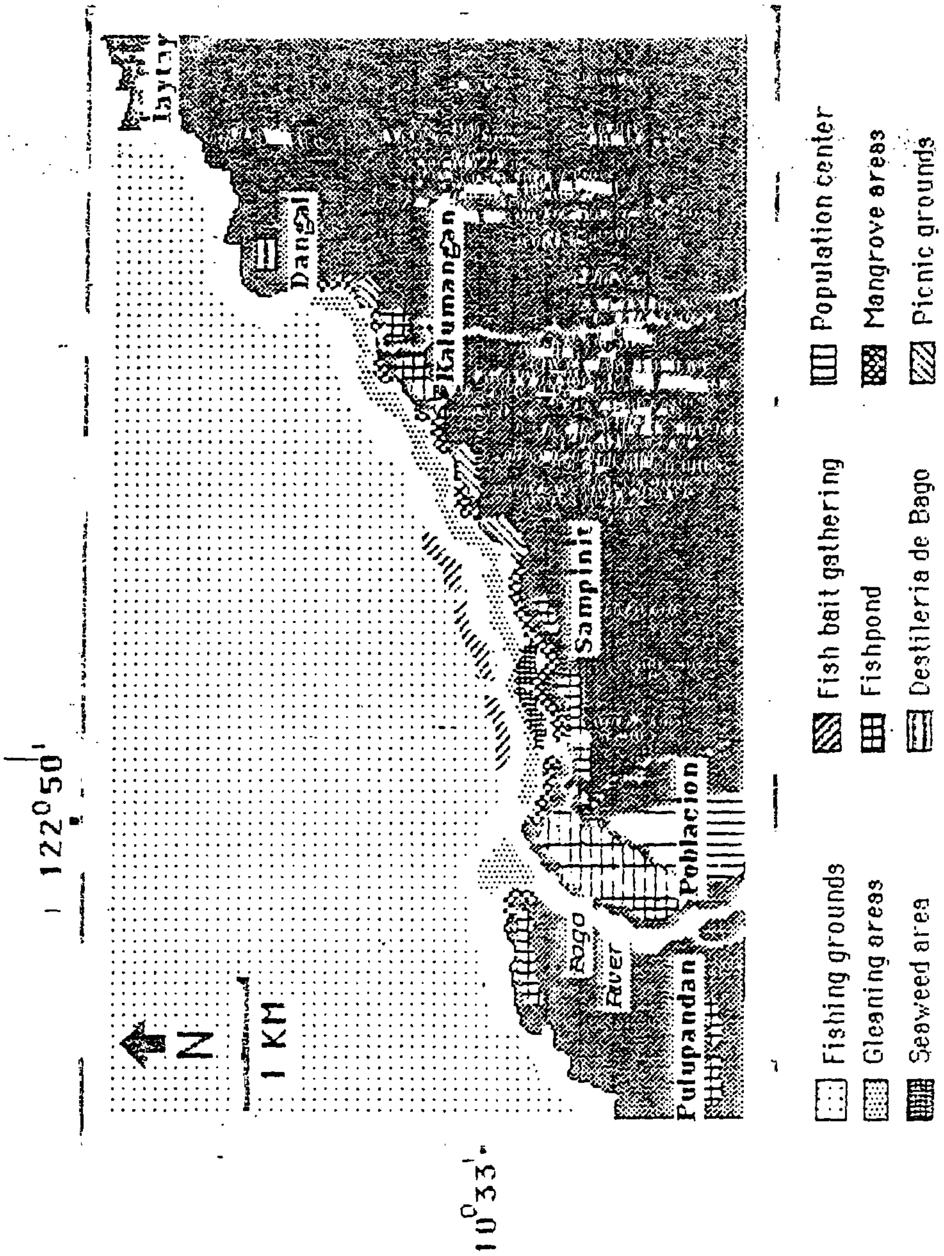
FIG. 3.2.31



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Zooplankton densities per station for the 1 month sampled

FIG. 3.2.32



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY
CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Indicative resource map of the coastal environment in Bago City (February 1993-94)

FIG. 3.2.33

these range from the less intensive, highly individualized or family-type fishing, gleaning for shelled mollusks, seaweeds, and diving for fish bait, to the recreational and homestead type of activity in resorts and population centers, and finally to the highly intensive, corporate type of activity in coastal conversion for fish and shrimp hatcheries, fishpond development and construction of industrial complexes with large-scale effluent discharge into the marine environment (e. g. Ma-ao Sugar Central, Distileria de Bago, and Asian Alcohol).

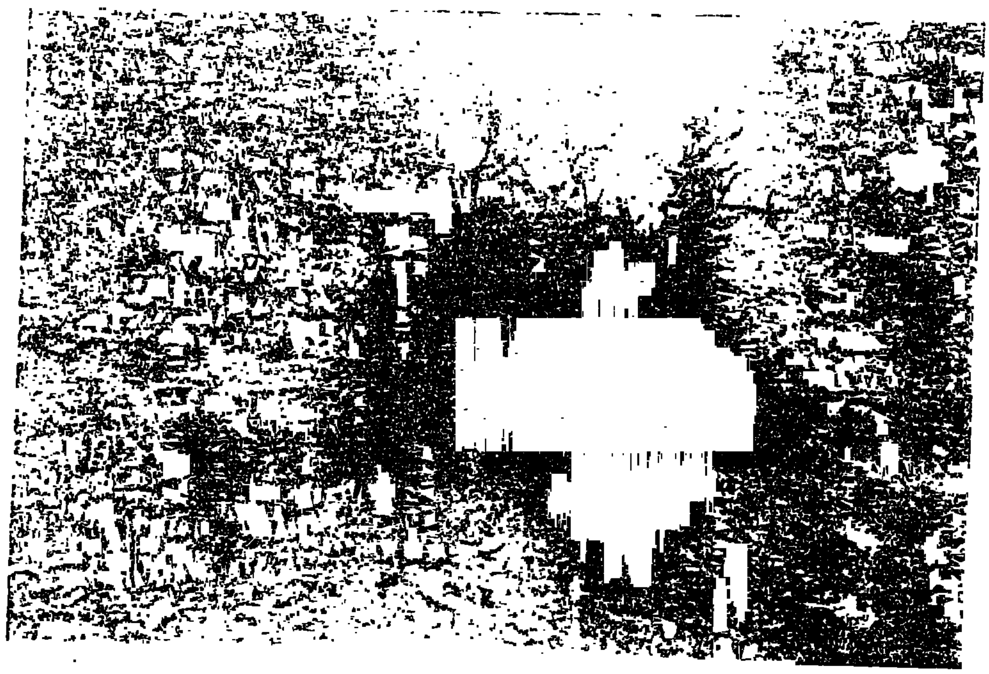
As fishing is still the main source of income of the population in the area of concern, and it is their almost regular preoccupation, it takes the largest share of manpower (reportedly 505 compose the regular fishermen group, although not all of these reside in the coastal towns of Bago city). It should be noted, however, that about 90% of them dive for fish bait at the "bagahog" area, about 20% of them also glean for shells and about 10%, for seaweeds when conditions become favorable (the latter two categories do not include women and children who compose the majority of the gleaners, **Appendix 3-L**). At the mouth of Bago River alone, at least 50 gleaners can be seen gathering shelled mollusks within a period of about two hours when the tide is low, exposing the sand bars, where they dig for the shells and eels.

Seven major fishery items are the prime target of the livelihood activities of the inhabitants especially at the mouth of Bago River (**Table 3.2.43**). Two of these e. g. "diwal" (*Pholas* sp.) and "gulaman" (*Gracilaria*, **Fig. 3.2.34**) are highly seasonal, while the rest are harvested daily especially during low tide. On a daily basis, assuming a period of two hours spent per day, a gleaner of "barisala" and "batitis"(**Fig. 3.2.35 a and b**) gets an average of PHP 200.00 On the other hand, a gleaner of the eels, "sili-sili" and "ogbok" gets an average of PHP 120.00, and a gleaner of "ogban", only PHP 5.00. For the highly priced "diwal", during the peak season, a gleaner gets PHP 234.00. A seaweed gatherer gets at least PHP60.00 for his harvest. Hence, at least PHP600.00 worth of fishery items are derived from the gleaning activity at the mouth of Bago River daily. In total, and considering the number of gatherers, this is equivalent to at least PHP 18,000.00 as a daily subsidy for the human population along the coast.

Table 3.2.43 DAILY CATCH PER UNIT EFFORT OF THE MAJOR FISHERY ITEMS AT AND NEAR THE MOUTH OF BAGO RIVER (FEBRUARY-MARCH 1994)

ITEM	NUMBER	DURATION (HR)	NUMBER OF GATHERERS	CPUE (AMOUNT/HR)	PRICE (PESO)
"diwal" (Pholas sp.)	20-80	3-6[1]	20-30	7-13	1-9/pc
"barisala"	100	1	55	100	5/supot 10/bottle[3]
"ogban" (Lingula sp.)	30	2	35	15	4-5/30pc
"sili-sili" (white eel)	110	1	3-10	110	30
"ogbok" (dark eel)	100	1	3-10	100	30
"batitis"	100	1	55	100	5/supot
"gulaman"	1 basket[2]	1-2	10	1 basket	30 5/atado

[1], seasonal, peak in June, August, Dec-May; [2], seasonal, peak in April, May; [3], meat only; the other items are harvested daily during low tide.



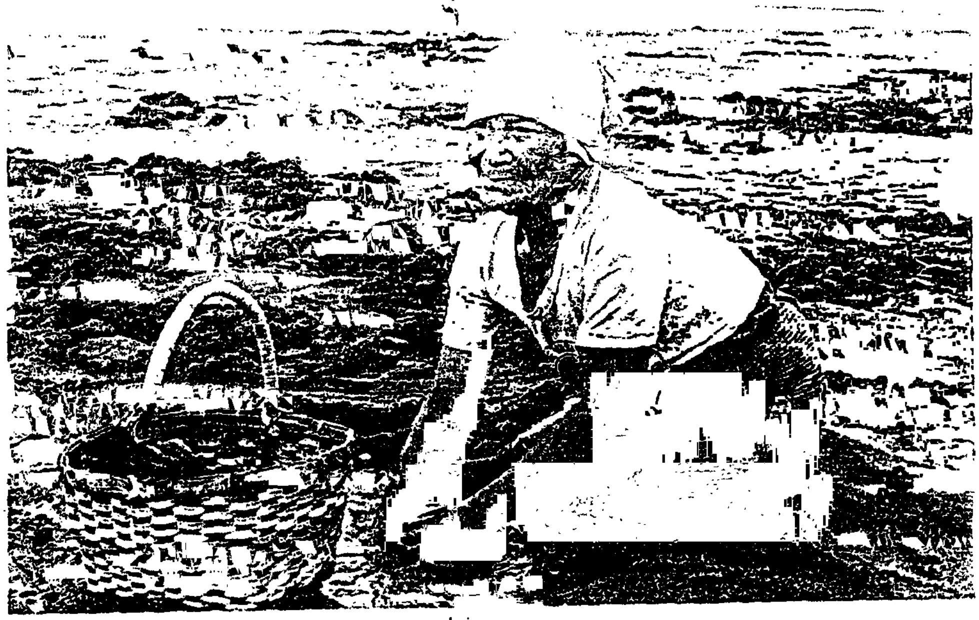
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

DIWAL/GULAMAN being harvested

FIG. 3.2.34



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Gleaners of "BARISALA"

FIG. 3.2.35

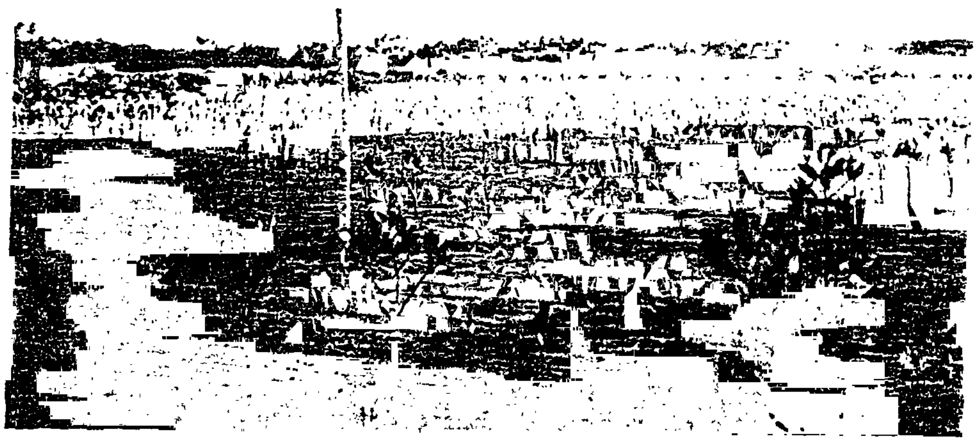
D. INDICATIVE SOCIOECONOMIC SURVEY

While the personal interviews were conducted with 37 coastal inhabitants in the 1993 survey, it was with 40 different persons in the 1994 survey: 12 from Barangay Calumangan, seven from Canitum, four from Sampinit, seven from Sitio caban, and 17 from among the 55 gleaners at the mouth of Bago river. The information gathered revealed (and this confirms the earlier finding) that most of the families **for the most part** survive through fishing or sea-related activities. The coastal residents perceive the sea (and the rivers) as a source of income (i. e., from the fishes, shells and seaweeds gathered) and a place where they can swim, or their children can play. The main fishing area is approximately ten (seven as they earlier reported) kilometers offshore, at generally 12 (20) fathoms deep. The catch mainly comprises the following: "danggit" (*Siganus* sp.), "hito" (*Plotosus* sp.), "lapu-lapu" (*Epinephelus* sp.), "nukus" (*Loligo* sp.), shrimps (*Penaeus* spp.), and "bangus" (*Chanos chanos*). However, these are highly seasonal in occurrence. The other fishes caught include "ingaw", "alimusan", "ragakrak", "indangan", and "banagan" (*Panulirus* sp.). Gill net is the most common fishing gear used, although hook-in-line and fish traps are common. Gill net is used any time of the year, while hook-in-line, only during calmer seas (May to June). At the mangrove areas, coastal inhabitants dig for shells and worms they use directly either as food or as fish bait.

A confirmation of the earlier findings, the average catch per fisherman is 3-10 (3-7 previously) kilos for a three-hour work in a day. The monetary returns from the fishing activity amounts to Pesos 250 (5 kilos of catch sold at P50/kilo); however this is highly dependent on the season. Majority of the fishermen do not own the boat they use in fishing. In Barangay Calumangan, at least 50 small outrigger boats were parked during the time of the interview. From the catch of the boats, only one-third goes to the fishermen. The continually decreasing fish catch is attributed principally to the pollution ("reddening") of the waters caused b the Asian Alcohol and now, the Distileria de Bago. In the earlier report, they have attributed this to the more rapid increase in the number of fishermen. In both surveys, the use of dynamite and illegal fishing methods were often mentioned as causative factors. As in the first survey, no illegal fishing methods have been reported since about eight years ago before which dynamite fishing was rampant. Their relative success in stopping the practice [illegible] tiated throu[illegible] gram of the government called Bantay Dagat, encouraging the peopl[illegible] ave a concer[illegible] rt to protect their fishing grounds from blast fishermen who came from outside the city or the province. However, the use of electric fishing is still going on in the upper stretches of Bago River.

At Canitum, reforestation of the mangrove (Fig. 3.2.36) was undertaken though a government initiative, but with the help of a Japanese Institution (OISCA) wherein 3-6 yr-old children did the planting. Within the total reforestation area of 40 ha, seedlings of *Avicennia* were surviving, although at different rates, some greatly hampered by the floating debris of seaweeds (*Sargassum* sp.) observed during the period of study. At present, the estimated percent survival (of the seedlings) is about 20%.

The mangrove trees are used mainly as firewood, pegs for fish corrals, and household fences. This has significantly depleted the resource. Interestingly, and as revealed in the 1993 survey, the Integrated Social Forestry Program of the Department of Environment and Natural Resources (DENR) has failed due largely to the practice of the awardees to sell their reforested lands to fishpond operators. Hence, the mangroves were converted into fishponds and the ISF contractors have to go back to fishing again.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Photo of mangrove reforestation project in the area

FIG. 3.2.36

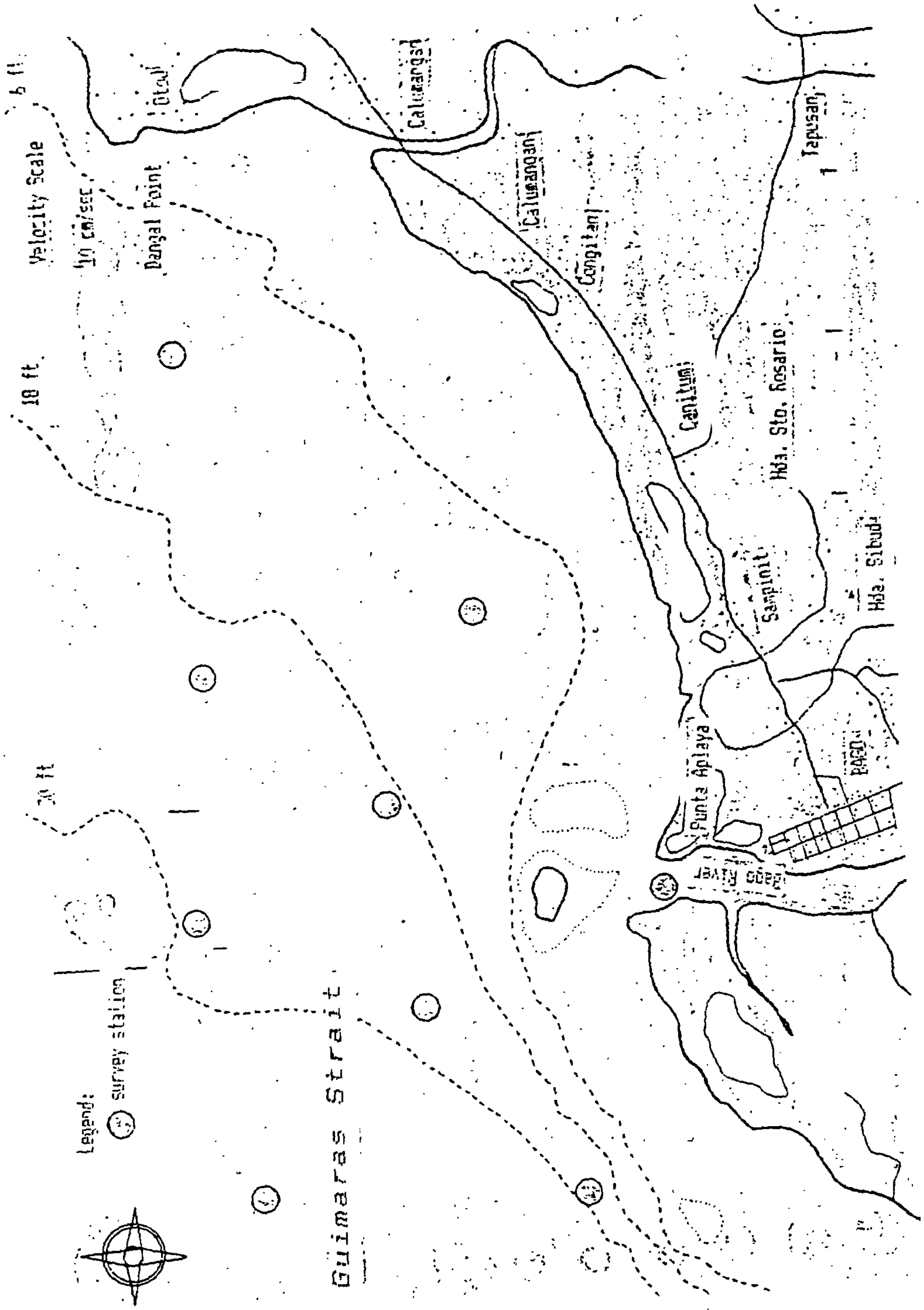
3.2.6 PHYSICAL OCEANOGRAPHY

3.2.6.1 HYDROGRAPHY

The study area is a portion of the Guimaras Strait which includes the Bago River estuary. It extends from Pandan Point in the east to Dangal Point to the west covering the coastal waters up to about 4 km offshore. As shown in **Figure 3.2.37**, the bathymetry is characterized by steep slopes in the western portion to gentler slopes in the eastern portions. The depths ranges from less than one fathom at about 1 km offshore to about 5 fathoms at about 4 km from the river mouth.

The sea bed consists mainly of sand and during the Northeast Monsoon season the coastal waters become very turbid due to resuspension of fine sediments by wave action. There are two sand bars in front of the river mouth which are below high tidal water levels. These sand bars experience constant sedimentation and erosion processes. Strong undertow currents carry sediments to the west and northwest directions through bed load transport. Longshore currents cause a net transport of suspended sediments towards the westsouthwest. The river mouth is about 300-m wide with an average depth of about 3 meters. The average outflow velocity is about 7 cm/s during ebb tide. The river is heavily silted. The high sedimentation rates may be attributed to sand and gravel quarrying activities and watershed erosion.

Sea surface temperatures are warmest from April to July averaging 30.0°C and coldest in January and February with averages about 26.0°C. The annual average sea surface temperature is about 27.0°C. Temperatures are almost constant with depth near the shore indicating that the water column is well mixed. The surface salinity near the river mouth varies with the tidal regime with values ranging from 25 ppt to 30 ppt. In the open ocean, the salinity ranges from 32.0 ppt to 34.2 ppt.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

The Bago River Estuary

FIG. 3.2.37

3.2.6.2 WAVES AND TIDES

The waves in the area are relatively small since the site is protected by the Guimaras Island. However, during Northeast Monsoon season, maximum surface winds are about 7 m/s and offshore significant wave heights reach about 1.2 meters.

On February 12, 1994, the observed wave heights in the study area ranged from calm in the morning up to 11:30 AM to 0.3 - 1.0 meter breaking waves in the afternoon. The wind was northerly with mean speed of 2 m/s in the morning and 3.5 m/s in the afternoon with gusts of 5 to 7 m/s.

Two types of tides prevail over the area. The diurnal type of tide, characterized by one high water and one low water in a lunar day prevails when the moon approaches its maximum declination. The maximum tide range occurs during this period. The other one is the semi-diurnal type which exhibits two high water and two low water in a lunar day. This type begins to occur when the moon's declination approaches zero.

The tidal patterns at the project area follow closely the tidal characteristics in Banago Pier, Bacolod, Negros Occidental which is the reference station for the project site. The geographical location of the reference station is at 10° 42' N latitude and 122° 56' E longitude. The various tidal levels at the site are:

Mean High Water (MHW)	=	1.760 m
Mean Tide Level (MTL)	=	1.010 m
Mean Low Water (MLW)	=	0.260 m
Mean Higher High Water (MHHW)	=	2.050 m
Mean Lower Low Water (MLLW)	=	0.000 m
Bench Mark Elevation	=	3.872 m

The bench mark is set in a drilled hole on concrete in the north side of Negros Navigation Company harbor.

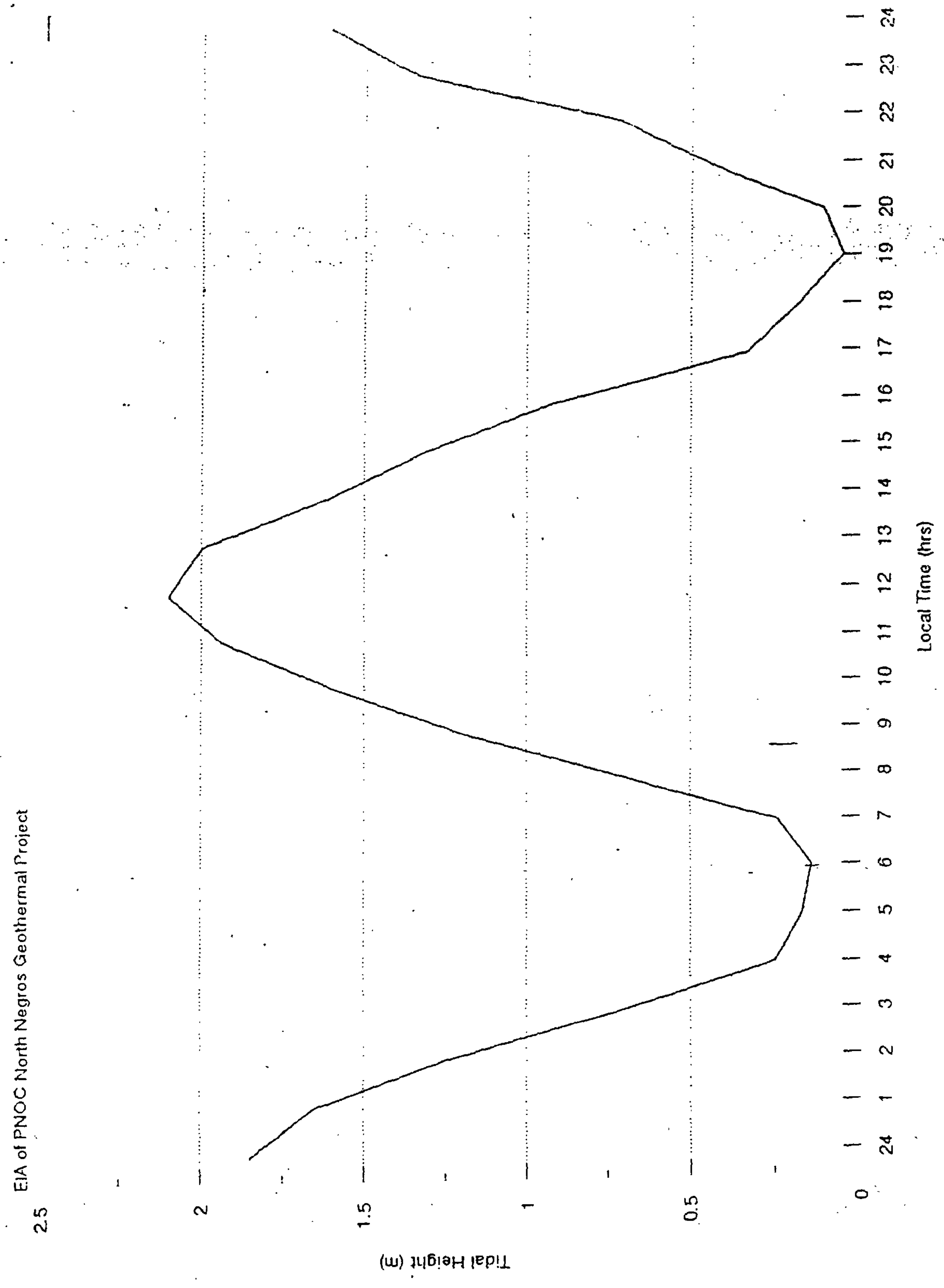
On February 14-15, 1993, the tidal pattern in the area was observed to be of semi-diurnal type. Reckoned from an arbitrary datum of about 0.5 m below Mean Lower Low Water (MLLW), the Lower Low Water (LLW) of 0.2 m occurred at 5:00 AM local time while the Higher Low Water was observed at about 3:00 PM. The Higher High Water (HHW) of 2.8 m occurred at about 10:00 PM and the Lower High Water (LHW) at 11:00 AM. The total range for the whole tidal day was about 2.6 meters.

On February 12, 1994, the tidal oscillation was semi-diurnal with a tidal range was about 2 meters. The Lower High Water (LHW) was observed at about 12:00 NN. The HHW, LLW and HLW occurred at about 1:00 AM, 7:00 AM and 8:00 PM, respectively. The tidal oscillation for the duration of the survey is presented in **Figure 3.2.38**.

3.2.6.3 OCEAN CURRENTS

The existing current patterns within Bago River estuary result from the combined effects of the wind and tidal forcing and, to a lesser extent, from the fresh water discharge from the river. The latter becomes important only during the rainy season which occurs during the months of June to October.

The drogue tracking (with line attached) was conducted on February 12, 1994. The points of release were the 9 stations shown in **Figure 3.2.39**. The mean Lagrangian currents as measured by the drogue during flood tide (7:00 AM to 12:30 PM) and ebb tide (12:30 PM to 5:00 PM) are presented in **Table 3.2.44**. The observed current speed at the mouth was about 7 cm/s while at the offshore stations the speeds ranged from 11 to 44 cm/s except at station 6 where the current was only about 4 cm/s which was measured close to the transition between flood and ebb tide regimes. These currents are plotted in **Figure 3.2.40**. The currents observed by current meter measurements for the ebb and flood regimes are presented in **Figures 3.2.41**.



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

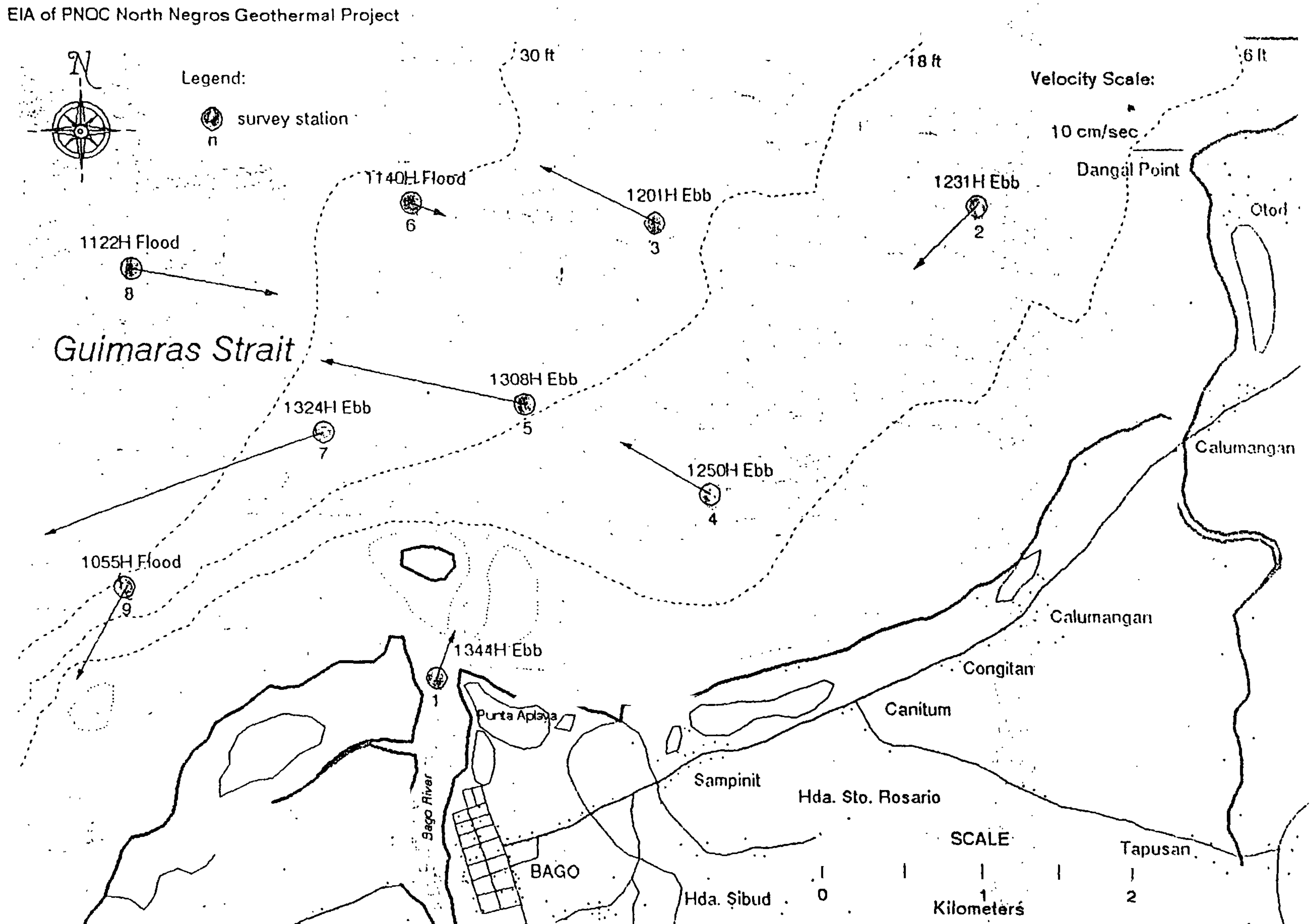
TITLE:

Tidal heights in Bago estuary
(12-13 Feb. 1994)

FIG. 3.2.38

NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.



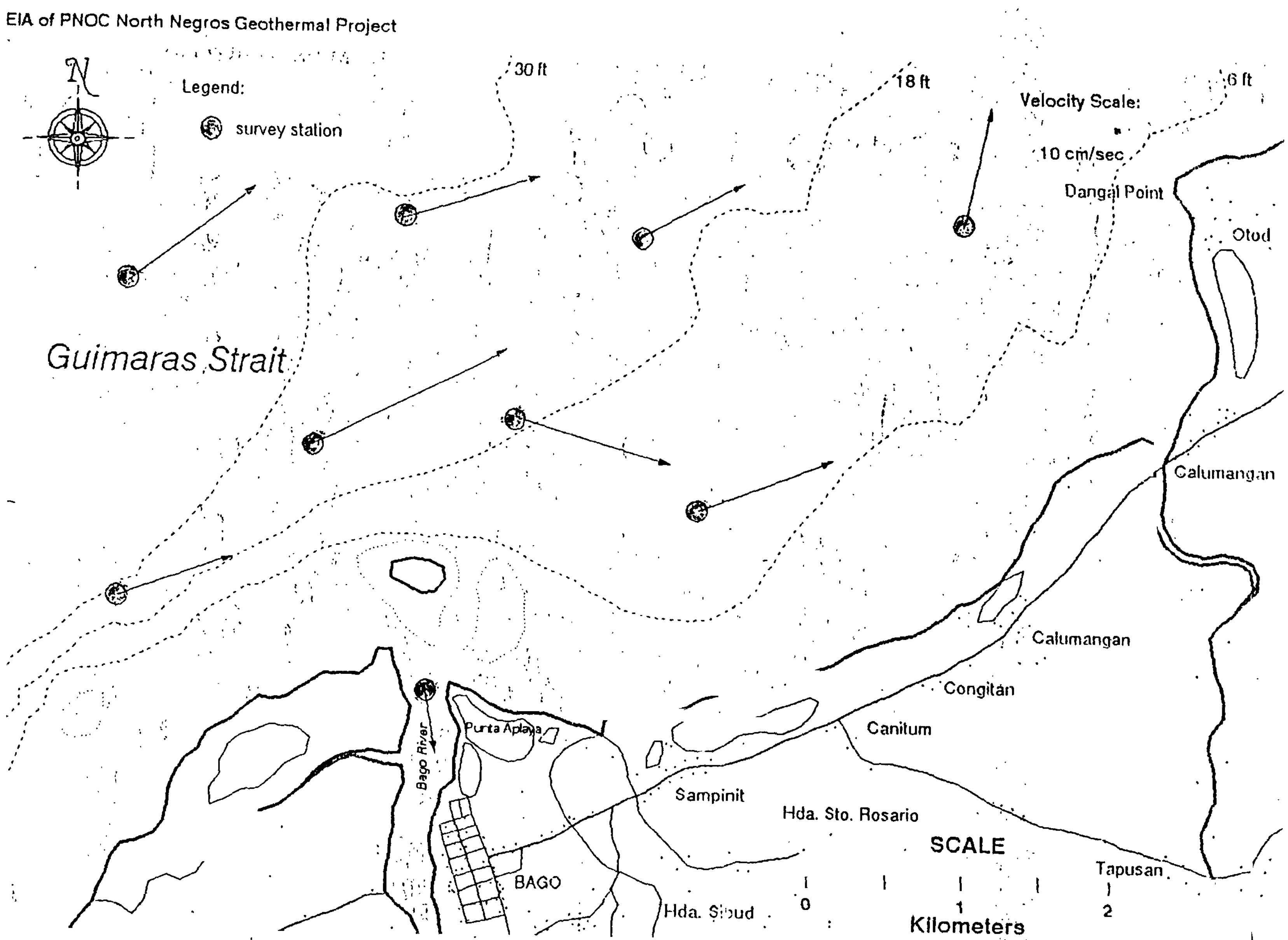
TITLE:

Vector plot of observed currents from drogues on 12 Feb. 1994

FIG. .2.39

Table 3.2.44 OBSERVED CURRENTS FROM DROUGES RELEASED AT 9 SURVEY STATIONS (12 FEBRUARY 1994)

Station	Time	Current Speed (cm/s)	Current Direction	Depth (m)
1	1344H(Ebb)	6.67	N 15° E	3.0
2	1231H(Ebb)	11.11	S 45° W	4.0
3	1201H(Ebb)	14.81	N 75° W	5.0
4	1250H(Ebb)	13.33	N 60° W	3.5
5	1308H(Ebb)	33.33	N 80° W	1.5
6	1140H(Ebb)	4.17	S 80° E	4.0
7	1324H(Ebb)	44.44	S 70° W	2.0
8	1122H(Fld)	22.22	S 80° E	5.5
9	1055H(Fld)	16.67	S 30° W	1.5

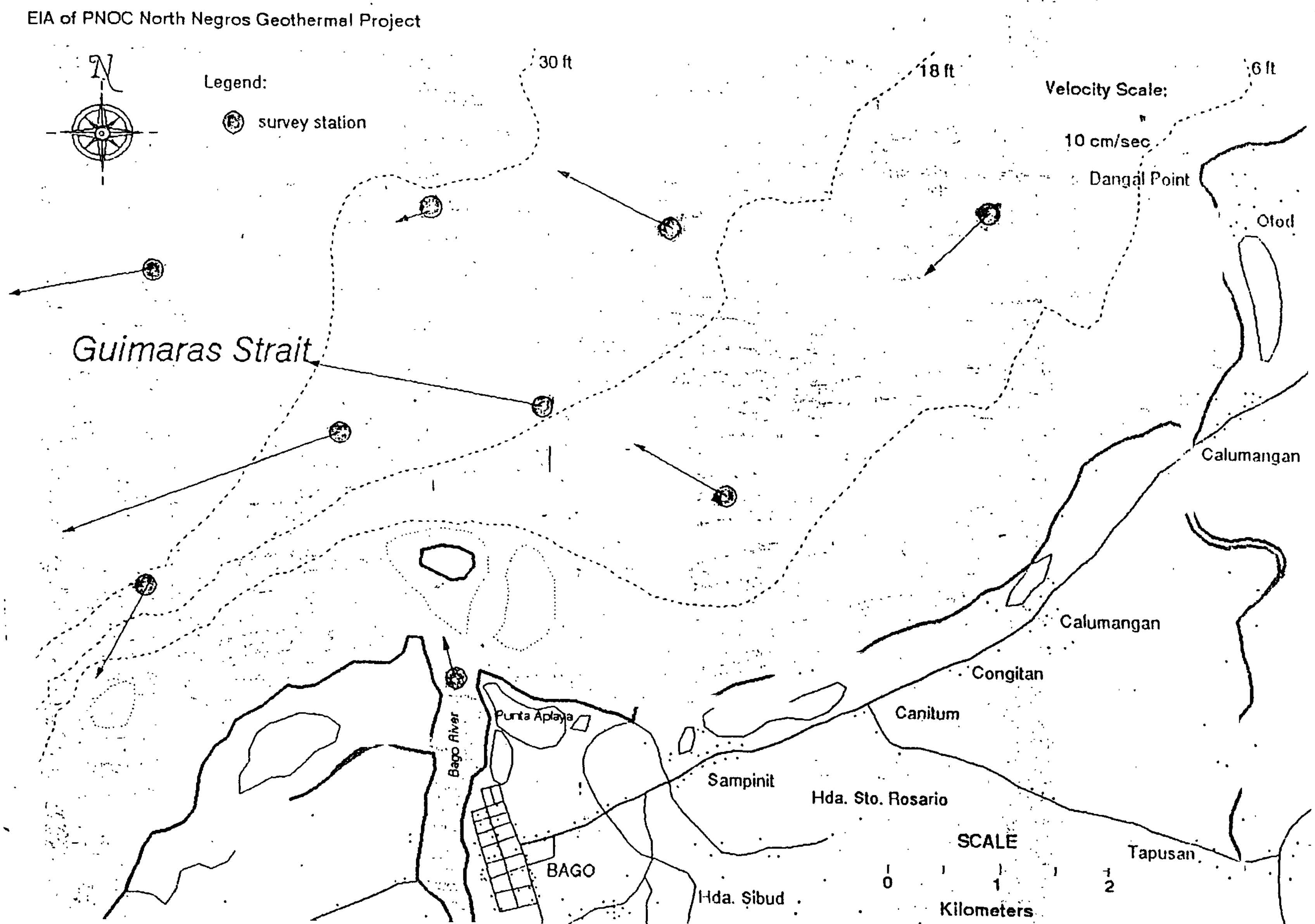


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Vector plot of flood tide currents from current meter (12 Feb. 1994)

FIG. 3.2.40



NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:

Vector plot ebb tide currents from current meter (12 Feb. 1994)

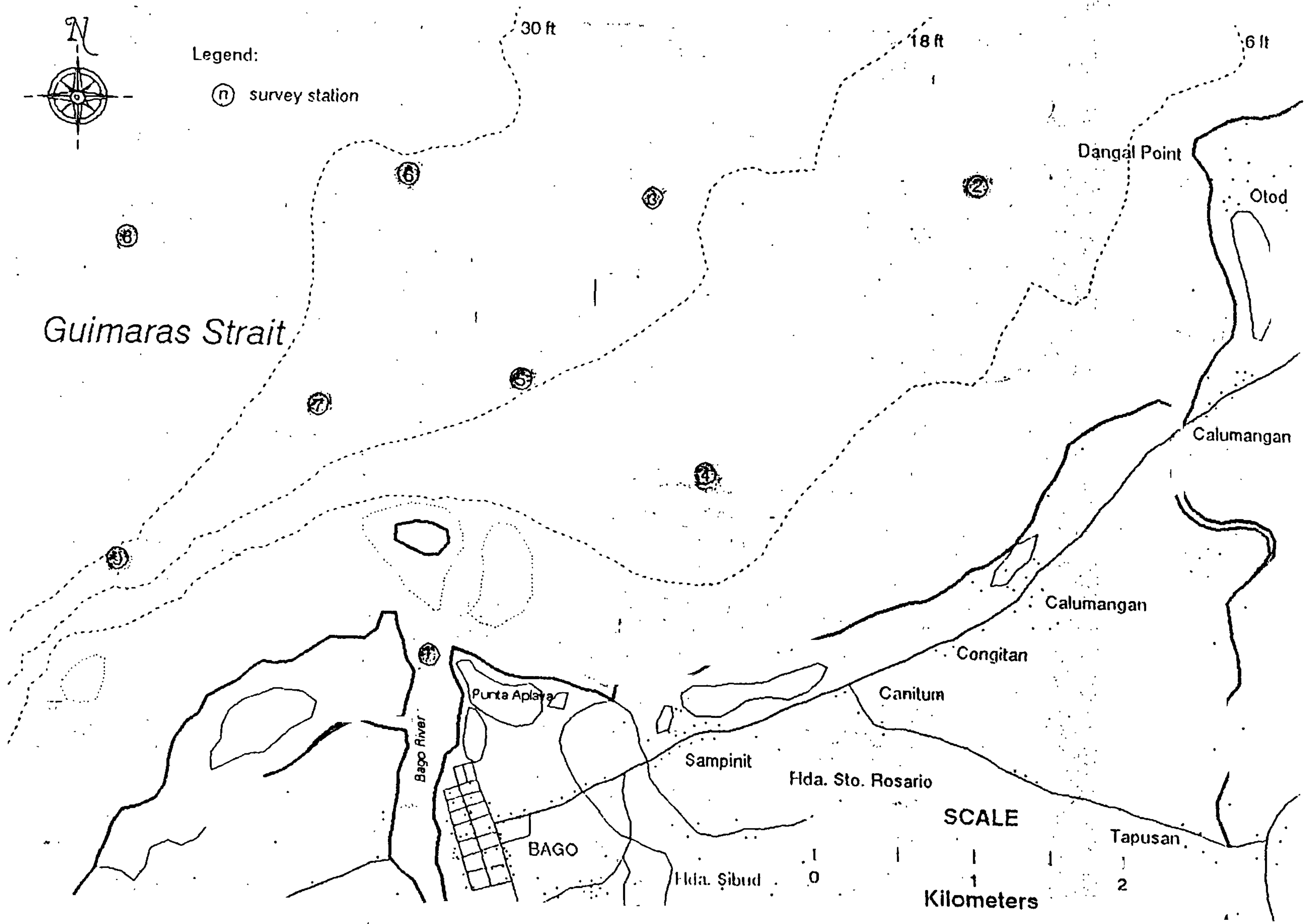
FIG. 3.41

Current meter measurements made at the mouth of the river showed that the average current for flood tide was 5.4 cm/s while that for ebb tide was 7.1 cm/s.

3.2.6.4 WATER QUALITY

Sampling of marine water quality was conducted last February 9, 1994 at survey stations indicated in **Figure 3.2.42**. **Figure 3.2.43 shows** actual sampling being conducted. The results of the analyses of the samples are presented in **Table 3.2.45**. The present sources of pollution in the study area are the Bago Distillery and a sugar factories in upstream reaches of the Bago River. Some residents reported of periodic fish kills along the lower reaches of the river due to discharges of some chemicals which smell like alcohol upstream. It is also observed that sand and gravel quarrying activities are going on in the upstream reaches of the river. This could contribute significantly to the siltation of the river and the estuary.

EIA of PNOC North Negros Geothermal Project

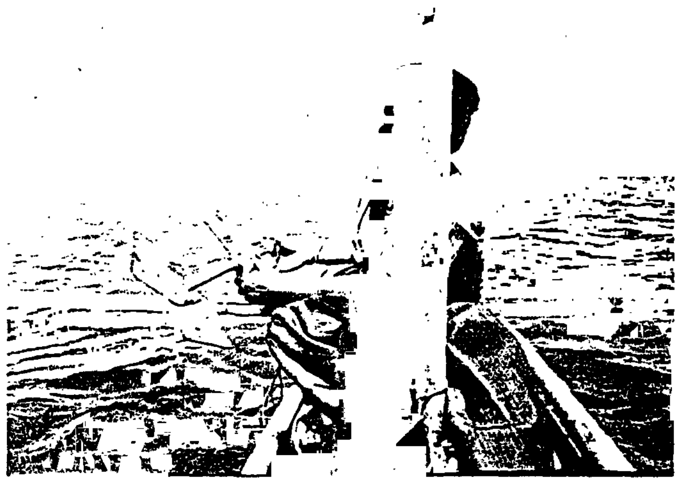


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:
Marine Water Quality Sampling Stations

FIG. 3.2.42



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Sampling of Marine Water Quality undertaken last February, 1994

FIG. 3.2.43

Table 3.2.45 Observed Water Quality Parameters (ppm) in the Study Area
(9 February 1994)

Parameter	Sampling Station 1	2	3	4	5	6	7	8	9
Arsenic	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Cadmium	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.08
Chromium	<.05	0.06	0.07	0.21	<.05	<.05	<.05	0.06	<.05
Lead	0.33	0.57	0.58	0.57	0.58	0.69	0.68	0.68	0.45
Copper	<.03	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.05
TSS	305	848	771	788	861	860	834	846	792
pH	6.8	7.9	7.8	7.9	7.9	8.1	8.0	8.2	8.1
Boron	1.4	3.6	3.7	3.6	3.7	3.8	3.6	3.8	3.8
Zinc	0.04	0.07	0.07	0.06	0.08	0.06	0.07	0.07	0.05
Chloride[1]	6.80	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
Lithium	0.04	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09
Sodium[1]	3.80	9.70	9.40	10.00	9.80	9.80	9.70	9.80	9.80
Calcium	150	340	350	340	340	360	340	340	340
Potassium	180	440	440	450	440	450	450	460	450
Magnesium[1]	0.45	1.29	1.26	1.30	1.23	1.33	1.3	1.31	1.28
SO_4[1]	.05	2.60	2.80	2.60	2.80	2.80	2.80	2.70	2.80
SiO_2	28.00	2.80	2.60	4.10	3.00	4.60	3.60	4.70	0.87
Iron	0.35	0.37	0.39	0.40	0.61	0.52	0.49	0.46	0.52

[1] expressed in 10^3 ppm

3.3 METEOROLOGY AND AIR QUALITY

3.3.1 METHODOLOGY

3.3.1.1 DETERMINATION OF BASELINE METEOROLOGICAL CONDITIONS

Data to characterize the climate at the North Negros Geothermal Project (NNGP) site came from historical weather records obtained at the La Granja Agrometeorological Station, which is supplied by the Philippine Atmospheric Geophysical and Astronomical Sciences Administration (PAGASA). Supplemental data was obtained from the ASEAN Compendium of Meteorology (1982) for the meteorological stations at Ma-ao and La Carlota Sugar Central.

3.3.1.2 MEASUREMENT OF AIR QUALITY AND NOISE

For air quality, primary data at representative locations on hydrogen sulfide (H_2S) was obtained using a Jerome H_2S sampler, while total suspended particulate (TSP or dust) levels were determined using a Samplex High Volume sampler. H_2S is the principal gaseous effluent from a geothermal project with highest and most likely health and environmental impact. Background ambient noise levels were determined with an Extech Noise Level Meter.

3.3.1.3 THE GAUSSIAN MODELLING APPROACH

The details of the Gaussian modelling approach, which was used to estimate long and short-term ambient concentrations of H_2S due to geothermal operations were discussed in detail in the Environmental Impact Assessment for the Northern Negros Geothermal Exploration Project (NNGEP-EIA) and is summarized in **Appendix 3-M**. The method predicts the height of the center of a smoke plume at any downwind location, then estimates the concentration around the center by assuming that the concentration decreases at a rate described by a bell-shaped function referred to as the Gaussian distribution. The procedures adopted in this study follows methodologies prescribed by the U. S. Environmental Protection Agency (USEPA) applicable to point and area-source emissions, with adjustment for elevated receptors in rough terrain.

3.3.1.4 PREDICTION OF NOISE LEVELS

Noise levels at various distances from known sources associated with geothermal operations were predicted using the noise model described in **Appendix 3-N**. The model assumes that noise levels decrease logarithmically with distance due to the spherical propagation of the sound wave, and the sound-absorbing effects of vegetation and terrain. In addition, whenever there are more than one sources, the model sums up the contribution of each source, then replaces them with a single point source emitting at the same total noise level.

3.3.1.5 METEOROLOGY

Based on historical weather records at PAGASA stations surrounding the site, the following describe the baseline meteorological conditions at the project location. Unless indicated, the source station is La Granja, whose data is listed in **Table 3.3.1**. Estimates of the weather parameters at the actual site are shown where possible.

A. TEMPERATURE

Highest maximum temperatures are experienced at La Granja during April at 34.6°C while coldest minimum temperatures occur during February at 20.3°C (**Table 3.3.1**). Average temperatures are highest during April and May (28.5°C), and lowest during January (25.9°C). Temperature data from Ma-ao (shown in **Table 3.2.2**) generally confirm those experienced in La Granja. The only difference is the relatively lower reading obtained for minimum temperature in Ma-ao.

Because the project sites are at a higher elevation, the temperatures therein are expected to be cooler. Assuming a vertical temperature decrease of 0.65°C per 100 meters (m), the estimated temperature difference between the La Granja and the project site would be between 3°C to 6°C.

TABLE 3.3.1 AVERAGE METEOROLOGICAL CONDITIONS AT LA GRANJA

Month	Cloudiness (octas)	Daily Temperature Max	Daily Temperature Min	Daily Temperature Mean	Rel. Hum. (%)	No. of Rainy Days	Rain-fall (mm)	24-hr Max (mm)
Jan	5	31.2	20.8	25.0	85	9	84.0	138.3
Feb	4	32.2	20.3	26.7	82	6	32.4	77.0
Mar	3	33.9	21.0	27.3	78	7	53.0	155.6
Apr	3	34.6	22.3	28.4	75	8	85.4	87.6
May	4	33.8	23.4	28.5	80	16	214.0	133.3
Jun	6	31.9	23.0	27.3	84	19	352.4	161.3
Jul	6	31.4	22.7	27.9	84	22	391.2	135.2
Aug	6	31.4	22.8	27.9	84	19	355.5	111.9
Sep	6	31.5	22.6	27.9	84	21	384.1	160.9
Oct	5	31.9	22.4	27.9	84	19	329.4	170.7
Nov	5	31.9	22.0	26.5	83	15	216.7	233.4
Dec	4	31.3	21.1	26.5	83	10	86.8	83.7
Annual	5	32.2	22.0	27.3	82	179	2582.6	-

Source: Climatology Division, PAGASA
Station : La Granja Agromet Station
Period of Records : 1975-90

TABLE 3.3.2 TEMPERATURE DATA OF LA CARLOTA AND MA-AO

	La Carlota		Ma-ao				
Month	Monthly rainfall (mm)	No. of rainy days	Monthly rainfall (mm)	No. of rainy days	Temperature (C°)		
					Max	Min	Ave
Jan	66	5	61	5	31.2	18.9	25.0
Feb	54	4	29	4	32.0	19.6	25.8
Mar	44	5	37	4	33.2	19.4	26.3
Apr	108	6	82	5	34.3	20.0	27.2
May	224	14	223	15	33.7	21.2	27.4
Jun	356	18	302	19	32.1	20.8	26.4
Jul	388	18	378	20	31.2	20.4	25.8
Aug	362	17	371	18	31.0	20.4	25.7
Sep	336	18	338	19	31.2	20.5	25.8
Oct	339	16	311	18	31.5	20.0	25.7
Nov	231	12	205	12	31.6	19.8	25.7
Dec	128	9	91	7	31.6	19.6	25.6
Annual	2636	141	2428	146	32.1	20.2	26.1

Source: ASEAN Compendium of Climatic Statistics (1982)

B. HUMIDITY

March and April are the driest months with relative humidity below 80% (**Table 3.2.2**). It is consistently high during the rainy season from June to October, but the actual maximum is during January when temperatures are lower and the atmosphere is close to saturation.

C. CLOUDINESS

Cloudiness as shown in **Table 3.3.1** is highest during the months of June to August at six octas (1 octa equals one-eighth of the sky with cloud cover). March and April are the least cloudy months at three octas. Annual average cloud cover is five octas. Average cloudiness at the sites may be higher due to clouds formed by the elevated topography.

D. CLIMATE CLASSIFICATION

Climate in the project site may be ranked as a Cf type according to the Koppen system of climate classification (Flores and Balagot 1980). This type is common among mountainous areas of the country. Areas of this type do not possess a distinct dry season, and even during the driest month they may receive more than 30 millimeters (mm) of rainfall. Using the Coronas classification system, the area is classified as type 3 climate (Flores and Balagot 1980), having no sharply defined maximum rain period. In simple terms these mean that the area receives moderate and mildly uniform rainfall throughout the year.

E. MONTHLY RAINFALL

The rainy season in La Granja is well-pronounced between May to November, with expected monthly totals over 200 mm (See **Table 3.3.1**). The wettest month is July followed by September at over 350 mm. February is the least rainy month at only 32 mm, followed by March with a monthly total of 53 mm. The column on the number of rainy days reflect the same extreme as the monthly rainfall.

Maximum 24-hour rainfall recorded in La Granja between 1975 to 1990 is listed in the last column. The heaviest recorded rainfall occurred on November 2, 1990 when 233.4 mm fell during a 24-hour period. From entries of maxima for the other months it is clear that a 24-hour rainfall of more than 100 mm is not unusual.

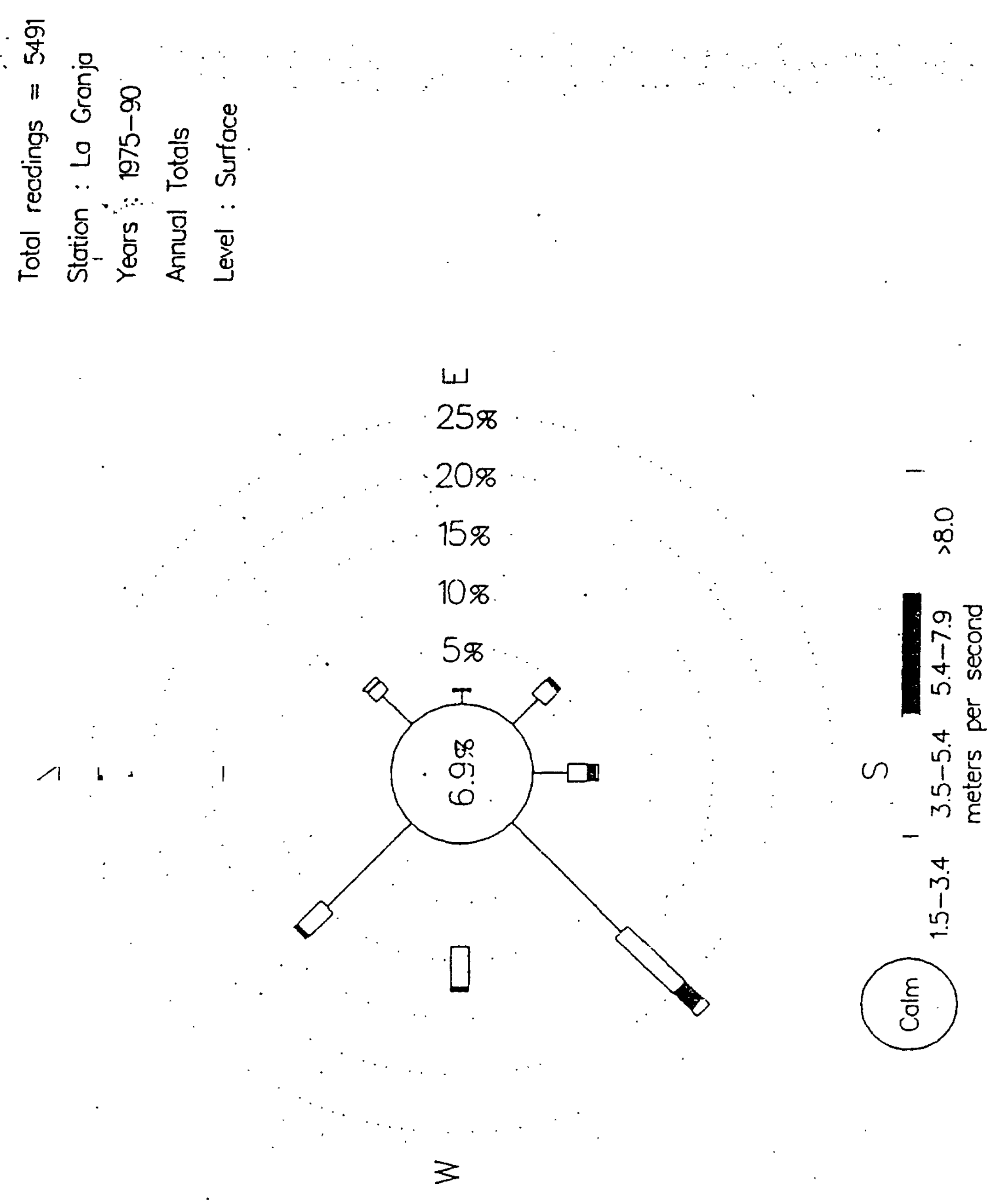
The data from La Carlota and Ma-ao (Table 3.3.2) agree remarkably with those from La Granja. Although slight differences among these three may be seen, such features as the July rainfall maximum, the nearly uniform rainfall between May to November, and the drier but still substantial rainfall during the rest of the year is reflected by all three stations. Differences in the total annual rainfall among the three is less than 10% of their average.

Like cloudiness, rainfall may be expected to be higher at the sites due to the topography.

F. PREVAILING WINDS

An annual summary of the ~~winds~~ at La Granja is presented in **Fig. 3.3.1**. The principal winds in the area come from either the north or the southwest 50% of the time. Clearly, these correspond to the annually oscillating winds of the Asian monsoon. The blocking effect of Mt. Canlaon is seen in the dominance of northerly instead of the usual northeasterly winds during the winter monsoon.

From **Figs. 3.3.2, 3.3.3 and 3.3.4**, northerly winter winds dominate from November to March. The prominence of northerly winds wanes beginning February, and by April the northwesterly wind asserts itself. In May the wind varies between northwesterly to southwesterly. The southwest monsoon then controls the windflow during the months of June to October. The months with the highest percentage of calm winds are October and November when the wind speeds are less than 1.4 ms^{-1} for more than 10% of the time.



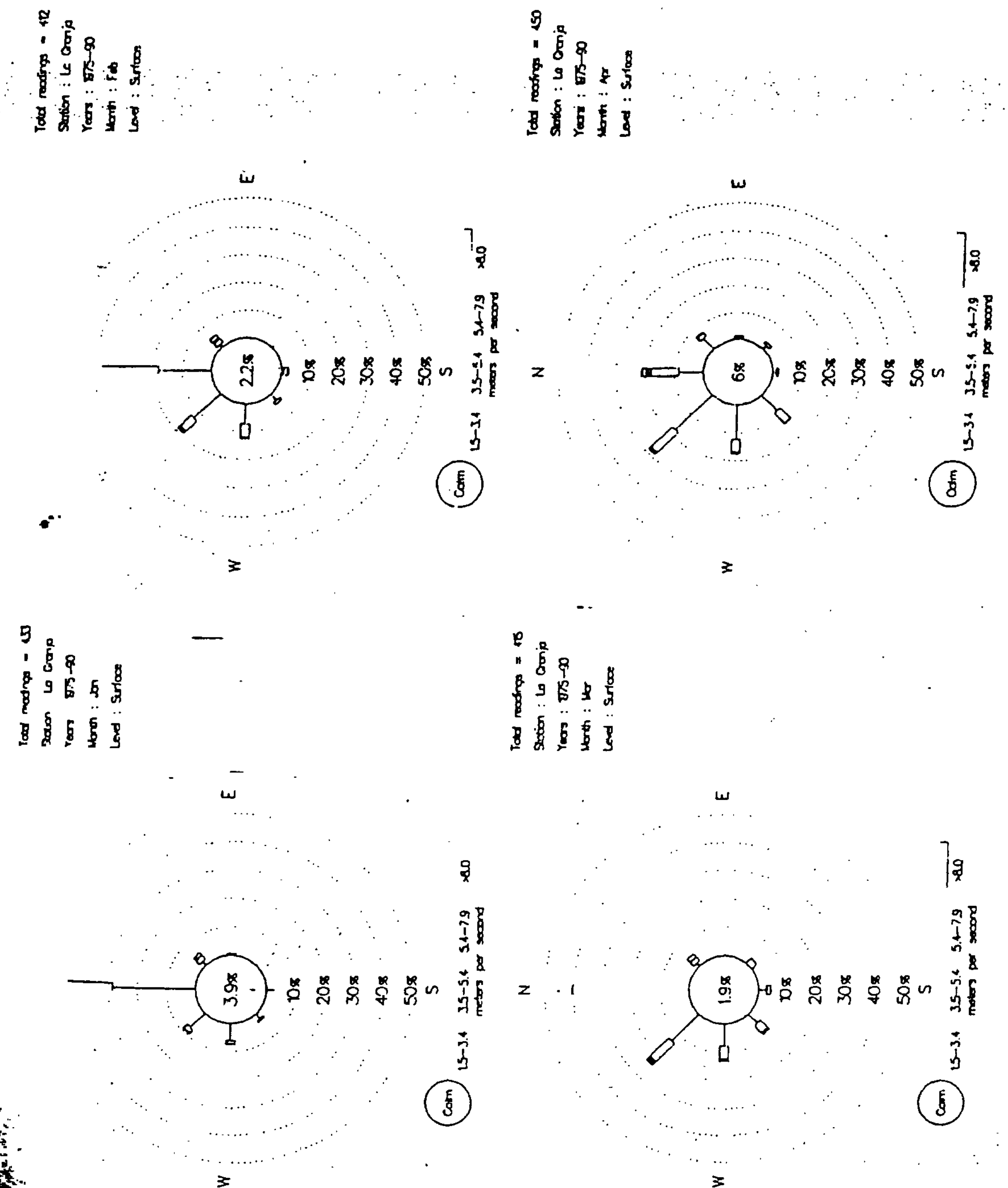
NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC

TITLE:

Annual wind frequencies at La Granja

FIG. 3.3.1



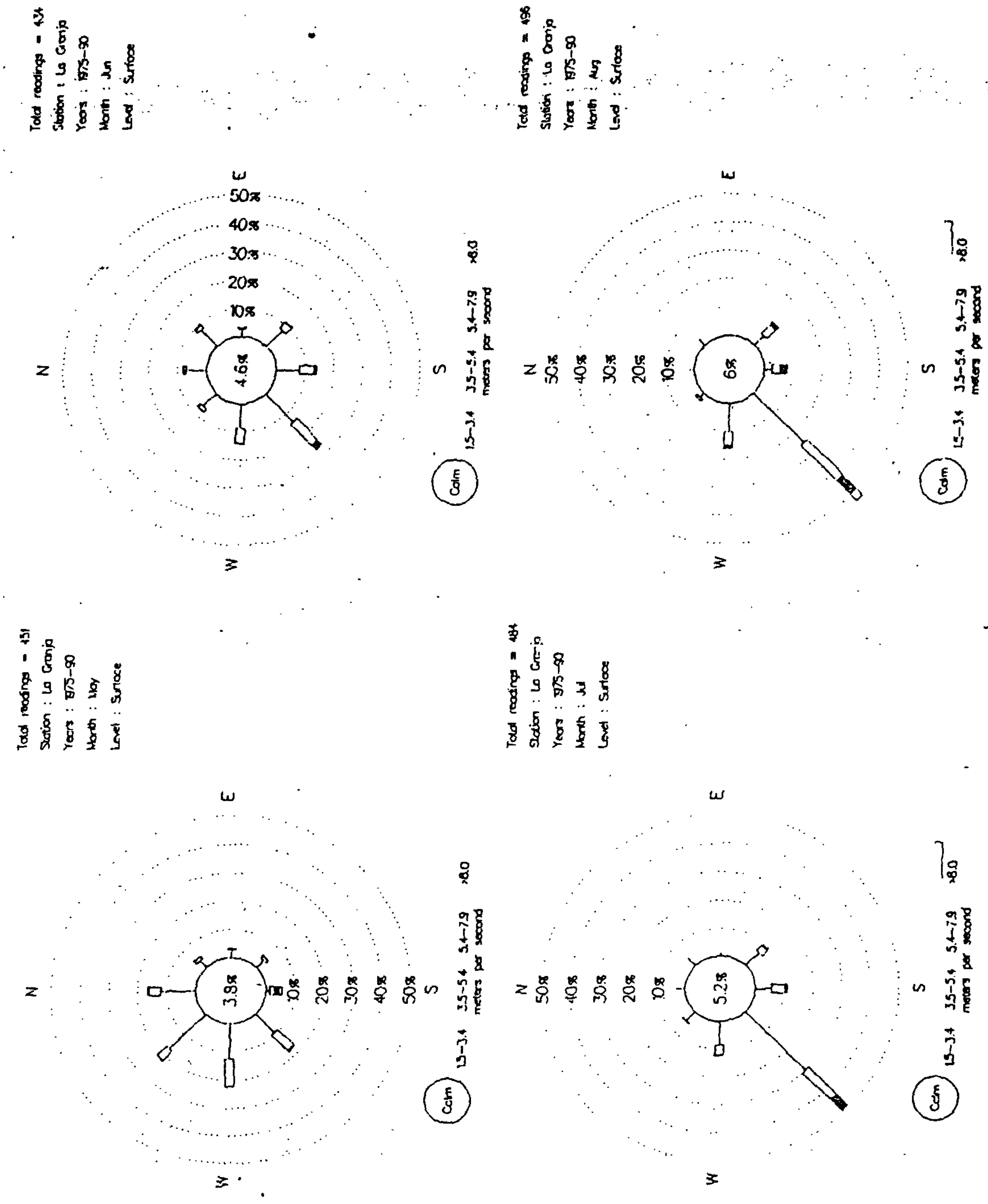
NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:

Monthly wind frequencies at
La Granja (Jan. to Apr.)

FIG. 3.3.2

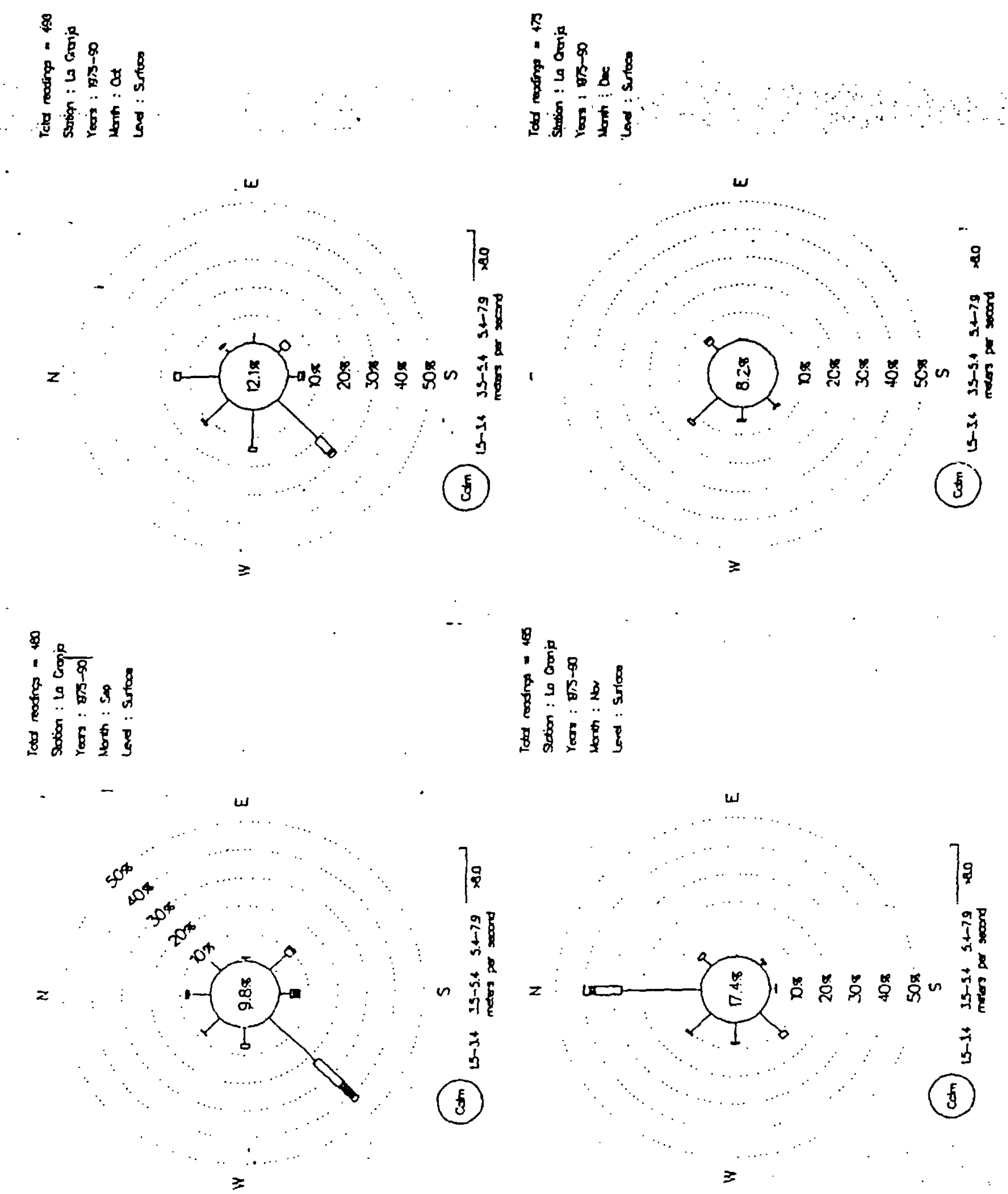


NORTHERN NEGROS GEOTHERMAL POWER DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN SYSTEMS DEVELOPMENT INC.

TITLE:
Monthly wind frequencies at La Granja (May to August)

FIG. 3.3.3



NORTHERN NEGROS GEOTHERMAL POWER
DEVELOPMENT PROJECT
EIA STUDY

CONSOLIDATED ASIAN
SYSTEMS DEVELOPMENT INC.

TITLE:
Monthly wind frequencies
at La Granja (Sept. to December)

FIG. 3.3.4

3.3.2 RESULTS AND DISCUSSION

No special criterion was applied in the selection of the sampling sites for noise and air quality because of the uniformly unpolluted conditions existing in the area. However, the hot springs at Mambucal makes the conditions in this location slightly different from the rest. The TSP sampling stations were both made at dirt roads but the traffic at the Pook Mahogany station, which was very light and mostly of jeepneys, was in sharp contrast to those at the Hagdan area where heavy trucks conveying materials and personnel to the drilling site regularly crossed the sampling station. **Table 3.3.3** shows the results of the sampling. Further sampling with TSP using a High-Volume Sampler was hampered by the lack of electricity. Noise level measurements were made at many locations, some of which accompanied the air sampling. For reference, **Table 3.3.4** is drawn up, the National Ambient Air Quality Standards set in Administrative Order No. 14 (A.O. 14) by the Environmental Management Bureau (EMB).

It is clear that baseline air quality in the impact area generally satisfies health standards of air quality for the pollutants tested. In Mambucal, the measured concentrations of H_2S appear to exceed the ambient allowable level of 100 micrograms per Normal cubic meter (μg/Ncm), but the samples were taken with a shorter interval than is required for ready comparison with the allowable standard. The levels of H_2S concentration obtained at this location exceed the odor threshold.

Dust levels are also within the standard (300 μg/Ncm for a one-hour sample). Since these samples were taken at the roadsides, actual general levels should be much better than these. Not surprisingly, levels at Hagdan, where construction was being undertaken during the sampling, is about twice that of Catugasan.

For noise, the study area may be classified as either Class AA (40-50 decibels or dBA) or A (45-55 dBA) from **Table 3.3.5**, referring to areas that are primarily used for residential purposes or quieter. Except in Mambucal where tourist traffic is common, ambient sound comes mainly from rustling leaves, flowing water or domestic animals.

Table 3.3.3 BASELINE AIR QUALITY AT THE PROJECT SITE

STATION	H_2S conc (µg/Ncm)	H_2S conc (ppm)	Noise (dBA)	Dust conc (µg/Ncm)
I. Catugasan Site				
1. Mambucal Resort	125.1	0.09	54-56	**
2. Mambucal Hot Spring	180.9	0.13	53-55	**
3. Sitio PNOC	*	*	48-50	**
4. CT-A Pad site	*	*	46-48	**
5. Bgy. Minoyan	*	*	55-57	**
6. Pook Mahogany	**	**	48-55	145.9
II. Pataan/Hagdan Site				
1. Bgy. Mailum basecamp	*	*	52-56	**
2. Sitio Lunao	*	*	48-50	283.8
3. Sitio Hagdan	*	*	49-51	**
4. Hagdan Power Plant site	*	*	46-49	**
5. HG-C Pad site	5.6	0.00	58-63	**
6. Sitio Kipot	*	*	52-56	**
7. Sitio Pataan	*	*	65-70	**
8. Pataan Power Plant site	*	*	46-49	**
9. PT-A Pad Site	*	*	45-47	**

Sampling Period: Feb. 10-12, 1994

Legend:
* - Not detectable
** - No samples taken

Table 3.3.4 EMISSION STANDARDS FOR H_2S RELEVANT TO NNGP

ACTIVITY	STANDARD
Geothermal Power Plants	150 grams per gross megawatt-hour
Geothermal Exploration	Best practicable

Table 3.3.5 NPCC ENVIRONMENTAL QUALITY STANDARDS FOR NOISE IN GENERAL AREAS

AREA	MAXIMUM dBA		
	Daytime	Morning/Evening	Nightime
AA (Hospitals, Schools)	50	45	40
A (Residential)	55	50	45
B (Commercial)	65	60	55
C (Light Industrial)	70	65	60
D (Heavy Industries)	75	70	65

Note: The division of the 24-hour period shall be as follows:

Morning .... 5:00 a.m. to 9:00 a.m.

Daytime .... 9:00 a.m. to 6:00 a.m.

Evening .... 6:00 p.m. to 10:00 a.m.

Nightime .... 10:00 p.m. to 5:00 a.m.

Source: DENR Administrative Order No. 14 (1993)

Levels at other times of the day are expected to be lower and in accordance with the prescribed levels for this type of location.

It was noted that there were other sources of air pollution near the sites visited, although the pollutants likely released were not necessarily related to geothermal resource exploration. These include: traffic-related emissions from jeepneys and trucks, suspended particulates (TSP) from unpaved roads, and burning of sugarcane wastes. The last process is significant because it usually takes place over a hectare or more, impairing visibility and emitting ash and carbon dioxide (CO_2) for at least a day.

3.4.0 THE PEOPLE - SOCIO ECONOMICS

3.4.1 METHODOLOGY

The conduct of a socio-economic survey is part of the EIA process requirements. The objective is to generate primary data on the perceptions of the stakeholders on the environment as well as the proposed project and to give a socio-economic profile of the project's host communities.

Further, the socio-economic survey aims to validate and update the secondary data that is currently available.

The methodology used for the socio-economics survey conducted for the EIA of the exploration phase of this project was similarly adopted for the development phase EIA which this module is a part of. These are discussed below.

3.4.1.1 IDENTIFICATION OF IMPACT AREAS

The identification of impact areas took into account the project's development activities and its proximity to population as well as livelihood centers. It was done in consultation with other specialists who were part of the EIA team and with the project stakeholders.

Each specialist was requested to delineate the probable direct and indirect impact areas. As each specialist represented the biophysical spectrum of the environment, the socio-economics team was able to get the possible areal extent of the project's impacts and to super-impose this on the various communities within the project's impact radius.

It should be noted that this development phase EIA encompasses a proposed geothermal development block which is larger in scope than the exploration phase. It follows then that the scope of EIA and the socio-economic survey areas would be more complex and larger.

The technical delineation of the impact areas was further complemented by the scoping session conducted with the stakeholders during courtesy calls made and during the EIA Training Seminar, as well as during the socio-economic enumerator's training.

Based on the above considerations and taking into account the exploratory EIA, the probable direct impact areas are, Bgy. Minoyan in the Municipality of Murcia specifically Sitios Catugasan, PNOC and Mambucal and Bgy. Mailum in Bago City especially Sitios Hagdan and Pataan, Abaca, Buenavista, Humayan, Quipot, Kalubihan, Lunao and Valiente.

The other barangays of Murcia and Bago City which lie along the Bago River and its tributaries were classified as indirectly affected areas. In Bago City, these include the barangays of Napoles, Alianza, Bacong, Poblacion, Lag-asan, Sampinit, Ilijan, Malingin, Binubuhan, Barrio (Bo.) Ma-ao, Ma-ao Central, Caridad, Pacol, Atipuluhan and Abuanan.

In Murcia, areas considered indirectly affected include barangays Damsite, Iglau-an, Talotog, Lopez Jaena and San Miguel.

3.4.1.2 HOUSEHOLD SOCIO-ECONOMIC SURVEY

As stated earlier, the socio-economic survey for this EIA was conducted in a similar manner as the exploration phase. One aspect of similarity was the use of qualified host community residents as the enumerators for the survey.

With the assistance of the local resource person who was also a school principal, experienced and educationally qualified residents were invited to join the free Socio-Economic Enumerators' Training initiated by the EIA team and conducted by the socio-economic consultant. This was held on 12-13 February 1994 at the Brg. Hall of Bago City.

The socio-economic enumerators' training was conducted to :

1. impart the scientific way of conducting a household survey with an emphasis on

objectivity and the non-contamination of data by personal habits;

2. impart the mechanics for conducting the interview and then tabulating the survey results;
3. impart the mechanics for quality control of the data generated (team checker for each group to be monitored by the three research supervisors and finally checked by the socio-economic consultant);
4. present the draft household questionaire for the participants' comments and correction, if ever. This makes the survey instrument formulation transparent and community-based;
5. test the approved survey instrument by interviewing nearby households. This gave the participants a chance to practice their newly-acquired training;
6. ascertain the competence and sincerity of the participants in conducting an objective and scientific household survey.

Respondents were chosen at random based on the computed range. That is, the total households divided by 10% of the household population. The following equation was then used :

$$R = \frac{P}{S}$$

Where:

P - refers to the population; and

S - refers to the 10% sample size.

Based on the above formulation, listed below are the barangays covered and the corresponding number of respondents :

Barangay	No. of Respondents
Minoyan	
Catugasan	103
PNOC	80

Barangay	No. of Respondents
Minoyan	
Mambucal	90
San Miguel	20
Lopez Jaena	40
Talotog	25
Iglau-an	25
Damsite	35
Sub-Total	**423**
Bago	
Binubuhan	96
Sampinit	80
Bago Poblacion	142
Lag-asan	111
Pacol	50
Napoles	80
Caridad	50
Malingin	70
Bacong	100
Ilijan	43
Ma-ao Central	120
Bo. Ma-ao	120
Abuanan	60
Alianza	30
Atipuluhan	35
Mailum	71
Pataan	23

Barangay	No. of Respondents
Bago	
Hagdan	36
Abaka	35
Buenavista	12
Humayan	11
Quipot	1
Kalubihan	6
Lunao	2
Valiente	2
Sub-Total	**1386**
TOTAL	**1809**

3.4.1.3 KEY INFORMANTS

Key informants were likewise interviewed to gain deeper insights, perceptions, and awareness of the geothermal plant. Key informants are those who by their educational attainment, work experience (in the area), socio-economic (and even political) standing in the community and long years of residence in the area have the insights and perception regarding the socio-economic, political and environmental conditions of the area to be studied. A total of 94 key informants were interviewed from Bago City, Murcia and Bacolod City, which included teachers, drivers, students, local government officials, religious groups, midwives, health officers, military men, businessmen, retired and active government employees and representatives of non-governmental organizations (NGOs).

3.4.1.4 DATA ANALYSIS

Data analysis was conducted using frequency counts and percentages, both for Bago and Murcia.

The figures were then tabulated and presented on a per barangay basis. This affords the reader the opportunity of a detailed view of the survey results on a municipality/city scale and on a barangay (the smallest political unit) scale.

3.4.2 SURVEY RESULTS

The details of the result of the surveys conducted are presented in Appendix 3.4-A. this gives an extensive profile of the different barangays that may be directly or indirectly affected by the project. Selected results are incorporated with data from other sources to describe the existing socio-economic conditions in the study area. In addition, Appendix 3.4-A can provide useful information in formulating development plans for the barangays, as well as the city/municipality of Bago and Murcia.

3.4.3 POLITICAL STRUCTURE

The political structure in the province of Negros Occidental adheres to the political structure of the nation. It is based on the 1987 Constitution, which prescribes a Presidential form of government and a multi-party system.

3.4.3.1 PROVINCE / CITY/ MUNICIPALITY/ BARANGAY

The highest political figure in the province is the Governor who is elected along with a Vice-Governor and a Sangguniang Panlalawigan. Like the President for the nation, he is tasked with initiating and implementing programs for the good of the province.

In Negros Occidental, apart from the Governor and Vice-Governor, there are 13 elected members of the Provincial Board or Sangguniang Panlalawigan which formulates policies and programs of the provincial government.

In Negros Occidental, the governor and the mayors of Murcia and Bago City come from old and landed families. Thus, their current political power is supported by their personal wealth and socio-economic and familial ties.

The province is further subdivided into cities or municipalities depending on the level of development and population, which are headed by either City or Municipal Mayors. These officials are assisted by an elected Council and salaried administrative and technical staff. There are 6 city mayors and 26 municipal mayors in the province.

Cities or municipalities are lastly divided intos the basic political unit, the **barangay, which is** headed by a barangay captain and an elected barangay council.

The barangay captain exerts a strong moral pressure on his constituents to live good, and upright lives. This is made possible by the closely-knit social structure characteristic of an agriculture-based society. The influence of the barangay captain may unfortunately be subverted by unscrupulous and wealthier landlords in the area for whom a significant number of residents work for.

PROVINCIAL DEVELOPMENT COUNCIL

The province of Negros has a Provincial Development Council which is headed by a Governor and composed of all the mayors of the province, the Chairman on Appropriations of the Sangguniang Panlalawigan, the Congressmen or their representatives and the representatives of Non-governmental organizations operating within the province but who shall not constitute less than one-fourth (1/4) of the council.

The functions of the PDC are to:

1. formulate long-term, medium-term and annual socio-economic development plans and policies;
2. formulate the medium-term and annual public investment programs;
3. appraise and prioritize the socio-economic development programs;
4. formulate local investment incentives to promote the inflow and direction of

private investment capital;

5. coordinate, monitor and evaluate the implementation of development programs;
6. perform such other functions as may be provided by law or competent authority.

NON-GOVERNMENTAL ORGANIZATIONS (NGO)

NGOs proliferated in Negros Occidental starting in 1986 was a result of the economic dislocation caused by the collapse of the sugar industry which till then had spurred and sustained the economic growth of the province. NGOs in the province perform a variety of services from environmental advocacy to community organization, livelihood, skills training, technology transfer, institution building and human resources development, research, information, linkaging and networking and education.

A 1990 survey by the HOPE Foundation listed 52 NGOs and an additional 12 people's organizations. This is attached as **Appendix 3.4b.**

3.4.4 DEMOGRAPHIC PROFILE

3.4.4.1 POPULATION

As shown in **Tab. 3.4.1**, the 1990 population of the probable host barangays namely Mailum and Minoyan are 5,376 and 4,037 respectively. These figures translate to only 0.23% and 0.18% respectively of the total population of Negros Occidental. Even in terms of percentage of the Bago City and Murcia populations, the density affected population is also small (4.4% and 7.9% respectively).

TABLE 3.4.1 POPULATION

YEAR	1990	1980	1975	1970	1960
Mailum (Bago)	5376				
Minoyan (Murcia)	4037				
Bago City	122,863 (2.33%)	99,631 (1.17%)	89,213 (2.45%)	71,653 (2.18%)	58,834
Murcia	50,996 (1.29%)	45,162 (1.68%)	38,668 (2.02%)	32,176 (3.70%)	23,482
Negros Occ.	2,256,908 (1.69%)	1,930,301 (0.81%)	1,785,792 (1.87%)	1,503,782 (1.29%)	1,332,323
Philippines	60,477,000 (2.57)				

Note : ( ) - Average Annual Increase
NA - Data not available

The table also shows that the population of Bago City (Mailum) is growing much faster (2.33%) than the whole province whereas Murcia (Minoyan) is growing much less (1.29%). Both figures are less than the national average (1.29%). Both figures show that Bago City and to a certain extent, Mailum may have relatively more problems with respect to increasing population.

In terms of population density (see **Tab. 3.4.2**), both Mailum and Minoyan are less than the average for Bago City and Murcia, respectively. The figures are also much less than the provincial, regional and national values. This can be explained by the very rural nature of the project site areas.

3.4.4.2 FAMILY SIZE AND AGE PROFILE

More than 42% of the families in both Mailum and Minoyan have seven or more members (see **Tab. 3.4.3**). Moreover, 7% have more than 10 family members in Minoyan. The predominance of large families in this barangay shows a very high birthrate in the area. This should result in a very young population profile in both barangays.

TABLE 3.4.2 POPULATION, LAND AREA AND DENSITY

PLACE	POPULATION	LAND AREA	POPULATION DENSITY
MAILUM (BAGO)	4,414	33	134
MINOYAN (MURCIA)	5,584	33	169
BAGO CITY	122,863	39	316
MURCIA	50,079	43	104
NEGROS OCCIDENTAL	2,260,000	7,926	285
REGION IV	5,379,000	20,223	266
PHILIPPINES	60,477,000	300,048	202

TABLE 3.4.3 HOUSEHOLD SIZE

PLACE	4 and Below	5-6	7-9	10 and over
MAILUM	9.0*	49.0**	39.0	3.0
MINOYAN	16.0*	39.0**	38.0	7.0
BAGO	37.37	31.09	25.53	6.03
MURCIA	38.3	32.35	24.41	4.95
NEGROS OCCIDENTAL	37.52	30.8	25.44	6.24

* Range of age in survey : 1-3
** Range of age in survey : 4-6

This is indicated in Tab. 3.4.4. The data shows that at least 75.8% of the total populations for both Bago City and Murcia are only 34 years of age and younger. More than 41% of the population are within the 14 and below age bracket. Thus, every year, a significant number of people enter the job market. This trend should persist for quite sometime.

3.4.4.3 RELIGION

Most of the population in the study area are Roman Catholics. The figures shown in **Tab. 3.4.5** are more or less consistent with the reported figures for the entire province of Negros Occidental and even with the other regions in the country. Minoyan, however, has a relatively larger number of residents practicing other religions.

3.4.4.4 ETHNIC ORIGIN AND MIGRATION

The population in the area may be classified as strongly homogenous in terms of religion (see above) and ethnic origin. Practically all the residents of Mailum and Minoyan (also Bago City and Murcia) are Hiligaynon **Tab. 3.4.6**. Moreover, most of the population stay in their barangay practically all their lives (10 years and more) as shown in **Tab. 3.4.7**. This strongly shows that there is hardly any in-migration in the area.

In general, families in the two barangays have large families resulting in a very young population. There is negligible in-migration since the place is hardly attractive economically. On the contrary, emigration is significant such that the overall population growth is maintained lower than the national average (see again **Tab. 3.4.7**), despite the high birthrate/family size. This condition makes the entire population in the area highly homogenous in terms of the same cultural and religious tradition and at the same time very conservative in their outlook and thinking.

TABLE 3.4.4 POPULATION BY AGE GROUP BY PERCENTAGE

AGE GROUP	BAGO CITY	MURCIA	NEGROS OCCIDENTAL	PHILIPPINES
14 AND BELOW	41.1	43.5	40.7	38.2
15-24	20.7	19.6	20.8	20.4
25-34	14	15	14	15.1
35-44	9.5	9.1	9.8	10.3
45-59	9.8	8.4	9.7	9.1
60 +	4.9	4.4	5	5.2

TABLE 3.4.5 RELIGIOUS AFFILIATION

PLACE	ROMAN CATHOLIC	AGLIPAY	IGLESIA ni KRISTO	OTHERS
MAILUM (BAGO)	85.0	5.0	4.0	6.0
MINOYAN (MURCIA)	75.3	3.9	10.8	10.0
BAGO CITY	82.4	7.5	3.4	6.7
MURCIA	90.9	0.2	2.3	6.6
NEGROS OCCIDENTAL	86.1	3.1	1.8	9.0

TABLE 3.4.6 HOUSEHOLD POPULATION BY MOTHER TONGUE

PLACE	HILIGAYNON	CEBUANO	TAGALOG	OTHERS
MAILUM *	97.0	2.0	0.0	1.0
MINOYAN *	96.0	3.0	0.0	1.0
BAGO	98.4	0.7	0.1	0.8
MURCIA	97.2	1.0	0.3	1.5
NEGROS OCCIDENTAL	0.0	18.1	0.3	0.8

* Applied to household head only

TABLE 3.4.7 PLACE OF RESIDENCE FIVE (5) YEARS AGO

PLACE	SAME CITY / MUNICIPALITY	SAME PROVINCE	OTHER PROVINCE
MAILUM *			
MINOYAN *			
BAGO	96.25	2.33	0.77
MURCIA	95.51	2.73	1.01
NEGROS OCCIDENTAL	95.87	2.45	1.15

* Applied to household head only and least 10 years in the barangay

3.4.4.5 LITERACY AND EDUCATION

The literacy rate in Bago City and Murcia, as shown in **Tab. 3.4.8**, is comparable to that of the whole province. Although Murcia has slightly lower literacy (91%).

In terms of educational attainment, the study area (Mailum and Minoyan) has significantly lower educational attainments (**Tab. 3.4.9**) More than thirty one percent (31%) of the population of Mailum had only four (4) years or less of education while that of Minoyan, the figure is even higher at 40%. Moreover, only three percent (3%) of the household heads in both Mailum and Minoyan attained 11-14 years of education. These figures show that the study area provides very limited educational opportunities to its residents.

3.4.5 ECONOMIC PROFILE

3.4.5.1 COMMERCE AND INDUSTRY

The commercial activities in the city of Bago are concentrated in and around the three public markets located in Barangays Poblacion, Ma-ao and Ma-ao Central. These commercial establishments are small-scale businesses employing at most fifteen (15) laborers and derive their sales through the multiplier effects of the income generated by the rice and sugar industries. The reported collections from the operation of these markets in 1990 are as follows:

• Poblacion	-	P	474,000.00
• Ma-ao	-		68,000.00
• Ma-ao Central	-		28,000.00
TOTAL		**P**	**570,000.00**

The total number of commercial establishments reported in 1990 was 419 and most of these are retail or "sari-sari" stores (316), with some peddlers (15), meat dealers (15), rice retailers/wholesalers (16) and bakery (9). the city is serviced by two (2) rural banks and one (1) development bank. There are also other service establishments namely: food retail (28), dental clinics (2), theaters (2), and others.

TABLE 3.4.8 LITERACY

PLACE	LITERATE	ILLITERATE
BAGO	93.7	6.3
MURCIA	90.96	9.04
NEGROS OCCIDENTAL	92.64	7.36

TABLE 3.4.9 HIGHEST EDUCATIONAL ATTAINMENT

PLACE	BELOW ELEMENTARY	ELEMENTARY	HIGH SCHOOL	ACADEMIC DEGREE HOLDER	NOT STATED
MAILUM *	31*	44**	12***		
MINOYAN *	40*	41***	16***		
BAGO	5.88	58.2	24.89	3.47	7.56
MURCIA	6.92	63.09	21.85	2.37	5.77
NEGROS OCCIDENTAL	6.9	55	23.76	5.21	9.31

+ Applied to household head and wife only
* 4 yrs. in school and below
** 5-6 years
*** 7-10 years
**** 11-14 years

The profile of the commercial establishments in the municipality of Murcia is similar to that of Bago City although the total reported is only 206 and the total aggregate commercial area is only 0.52 hectare. These establishments also cater to the daily and immediate needs of the community. The breakdown of these establishments are: eateries (31), sari-sari stores (51), fish vendors (19), vegetable and fruit vendors (21), repair shops (12), drug stores (2), rice and corn retailers (10), dried tobacco leaf vendors (7), and other small businesses. The municipality is serviced by one (1) rural bank and there are also other service and recreational small and micro enterprises.

The industry in the study area is very limited. Bago City has one big industrial establishment - the Ma-ao Sugar Central Company. In 1990, the assets of the company amounted to around ₱38 million with a personnel component of 674, making is the single biggest employer in the area. The other industrial establishments are small and micro in size. Some of these that can be cited are as follows:

fishing boat building	-	1
salt making	-	2
rice mill	-	43
bakery	-	9
hollow blocks-making	-	3
warehousing (for rice)	-	43

It can be seen from this list that all these industries are agriculture-based (except for hollow blocks) and all except the sugar central are small and micro industries.

Industrial activity in Murcia is practically non-existent. These are only two (2) small scale industrial establishments in the municipality - a small food processor of preserves and a small metal shop. Others that can be mentioned are the small rice mills scattered throughout the area.

3.4.5.2 AGRICULTURE AND FORESTRY

The communities in the study area are highly dependent on agricultural activities. This has been highlighted in the agricultural study in Chapter 3. The existing physiography and climate in the area as well as the fertile volcanic soil make the area most suited for agriculture. The cool climate in the upland areas and infrequent occurrence of typhoons make the breeding of fowls and other animals highly profitable.

The city of Bago has a total cultivated and planted area of 34,000 has. The major crops in the city are palay and sugar.

More than 15,700 has. are planted with palay or 46% of the total cultivated area. These farmlands may be classified into irrigated farms (39% of the total), lowland rained (3%) and upland rained (4.0%). Palay production during the past five years were :

YEAR	NO. OF CAVANS
1985 - 1986	1,240,000 cavans
1986 - 1987	1,420,000 cavans
1987 - 1988	1,450,000 cavans
1988 - 1989	1,080,000 cavans
1989 - 1990	1,300,000 cavans

The productivity of irrigated farms are comparable to other fertile farmlands in the country averaging 90 cavans per hectare for the first cropping and 85 cavans per hectare for the second cropping. The average yield for the rained farms on the other hand is only 50 cavans per hectare and only one cropping per year.

In 1990, it was reported that there were a total of 47 cooperatives with a total membership of 2157 farmers.

Sugar constitutes the main bulk of export earnings of Bago City. The total area planted is around 20,000 has. or 58% of the total agricultural area. The total sugar production in Bago City for crop year 1989/90 was 1,717,000 piculs but only about 50,000 piculs were milled at the Ma-ao sugar central. The other crops raised in the city and the total production is shown in **Tab. 3.4.10**. Livestock and poultry is also actively pursued in the city and in 1990, the head count is shown in **Tab. 3.4.11**.

Similar to Bago City, Murcia is mainly an agricultural area. Fifty eight percent (58%) of the total area (24,900 has) is used for agricultural purposes.

The primary agricultural product in the municipality is sugar covering around eighty percent (80%) of the crop area. Sugar yields an average of 100 piculs per hectare. This crop alone contributes around ₱ 235 Million to the local economy.

The only other crop of significance in Murcia is rice. Around 9% of the total crop area is planted with palay. For irrigated rice lands, the average yield is only 63.8 cavans per hectare and for rained farms, the yield is 59 cavans. The contribution to the local economy of rice may be estimated at less than ₱10 Million.

There are five (5) poultry farms in Murcia primarily engaged in breeding fighting cocks. These poultry farms have at least 100 birds each. This agricultural activity should be contributing a few million pesos a year to the local economy.

There is still some logging activities going on in the area specially in Bgy. Igmaya-an even though the forest cover is now only 32% of the total land area. The last reported valuation of this activity (based on 1980 statistics) was only ₱500,000.

TABLE 3.4.10 PRODUCTION OF CORN AND OTHER AGRICULTURE CROPS
CY 1989 - 1990

ITEM	AREA PLANTED (IN HAS.)	TOTAL ANNUAL PRODUCTION (IN MT)
COCONUT & OTHER FEEDGRAINS	434.33	477.76
COCONUT	285.00	404.25
COFFEE	421.27	412.84
ORCHARD	327.75	1,474.87
ABACA	259.19	181.43
VEGETABLES	478.25	2,032.56
ROOTCROPS	628.25	3,769.50
BANANA	817.28	9,488.62
FISHPOND	331.59	1,621.47
BAMBOO	315.98	1,421.91

TABLE 3.4.11 LIVESTOCK AND POULTRY

ANIMAL	NUMBER OF HEADS
CHICKEN	59,192
DUCKS	9,940
GEESE	252
TURKEYS	788
GOATS	2,476
SHEEPS	137
CATTLE	493
HORSES	83
CARABAOS	11,452
HOGS	16,640

3.4.5.3 TOURISM

Bago City has a negligible tourist industry although undeveloped potentials exist. There are now three functioning beach resorts namely: Jara Beach Resort in Bgy. Calumawgan, Cora Beach Resort in Bgy. Sampinit and the Taloc Beach Club in Bgy. Taloc. Aside from these, there are also two (2) summer resorts, one in Bgy. Mailum and another in Bgy. Binubuhan. The utilization od these facilities is minimal and mostly limited to friends and relatives of the owners.

Murcia may be considered the tourist attraction of the whole province of Negro Occidental. The main facility is the famous Mambucal summer resort. The resort is 24 has. and has the following facilities/attractions:

- Natural Waterfalls (7)
- Swimming pools
- Hot sulfur springs
- Hot and cold bath houses
- Tourist lodge (15 rooms)
- Log cabin
- Rest houses
- Cottages
- Function rooms for meeting and conventions

There are no available statistics on tourist arrivals or the utilization of the resort. However, the study team observed very limited tourist traffic during weekdays. There is also observable deterioration of the facilities especially the function room or convention hall.

3.4.5.4 EMPLOYMENT AND HOUSEHOLD INCOME

Employment statistics in Bago and Murcia are comparable to the figures of Negros Occidental (**Tab. 3.4.12**). The figures show that almost half of the population, 15 years and older, do not enter the job market. These are mostly farmers or self employed residents. Although there are no statistics available for Mailum and Minoyan, it is expected that the percentage employed should be much lower since these barangays are more rural.

The statistics on household income are shown in **Tab. 3.4.13** and validates this observation. The average income of Mailum is less than half of the national average while that of Minoyan is less than 80%. These income levels are hardly enough to support the basic needs of the family considering the larger size of the family in these barangays.

3.4.6 RESOURCES AND INFRASTRUCTURE

The resources of the local government units are limited and thus, their services and expenditures for infrastructures ~~are~~ are also limited. Although the figures are not updated, **Tab. 3.4.14** gives an indicative figure of annual revenues of Bago City, Murcia and Negros Occidental. These revenue figures are grossly inadequate to initiate the much needed infrastructure considering the large population and area covered.

3.4.6.1 WATER UTILITIES/SERVICES

On September 1987, the Bago City Water District (BACIWAD) was created through Presidential Decree (PD) 198. This PD took control of the water system facilities serving the city. These facilities included two (2) water wells in Barangay Balingasag and another one (1) at Barangay Ma-ao. As of December 1990, BACIWAD service was enjoyed by only 412 households and 18 commercial establishments or about 1.8% of the families in Bago City. These are limited to residents of five (5) barangays - Poblacion,

TABLE 3.4.12 EMPLOYMENT STATUS

PLACE	EMPLOYED	UNEMPLOYED	NOT IN LABOR FORCE
BAGO	47.56	9.19	43.24
MURCIA	44.16	6.47	49.37
NEGROS OCCIDENTAL	44.97	6.48	48.56

TABLE 3.4.13 TOTAL ANNUAL FAMILY INCOME

PLACE	20,000 & BELOW	20,000-30,000	30,000-40,000	40,000-50,000	HIGHER THAN 50,000	AVE. INCOME
MAILUM (1993)	67	13	7	4	2	P 16,924
MINOYAN (1993)	60	7	8	7	19	P 31,385
REGION VI (1988)						P 31,164
PHILIPPINES (1988)						P 40,408

TABLE 3.4.14 GOVERNMENT REVENUE

PLACE	ANNUAL REVENUE (MILLION)
BAGO (1986)	P 14.5
MURCIA (1990)	7.6
NEGROS OCC. (1986)	49.6

Balingasag, Lag-asan, Sampinit and Ma-ao. The rest of the population of Bago City uses various sources for their drinking water namely: artesian wells; dug wells; springs, and lakes. As of December 1990, there were 956 artesian wells being used in the different barangays.

The city government has also organized rural water works associations. At the end of 1990, five (5) were already organized. These self-help associations assist the city in operating and maintaining micro water distribution systems to serve their own neighborhood. They initially installed communal faucets for every 4-5 houses.

The status of the water supply system in Murcia in terms of supply and coverage is much better. The local water works system is now serving the poblacion and barangays Salvacion and Blumentritt through a local pumping station located in Barangay Alegria. Upland barangays like Minoyan (project site) are not yet serviced by any kind of water supply system but they avail of the streams and rivers which flow down from Mt. Canlaon.

3.4.6.2 POWER / ELECTRICAL SERVICES

Since June 1979, the Central Negros Electric Cooperative (CENEC0) has been serving the power needs in the study area. CENECO used to get its power source from the Talisay electric plant but since June 1984, the Palimpinon geothermal power plant in Negros Oriental has been the power supplier of the cooperative.

As of December 1990, there are 4,522 power consumers within the sixteen (16) energized barangays in Bago City while Murcia has several hundred more consumers mostly in barangays Poblacion and Blumentritt. It is also observed that the average consumption of energized households is lower than 50% of the standard consumption of commercial establishments (74 KWH) is also around 50% lower than the standard established nationwide.

In terms of coverage, the percentage of households with electric power is very small in both Bago and Murcia and should be worse in the upland barangays like Mailum and Minoyan (host barangays). Moreover, those energized households consume much less electric energy than what is normal. These observations are further validated by **Tab. 3.4.15** and **3.4.16**. The first table shows that in Mailum only 20% of households use electricity for lighting while in Minoyan, the figure is only 10.3%. The figures for Bago and Murcia are not much better with 26.6% and 26.6% respectively. For cooking purposes, no household in Mailum and Minoyan use electricity and the same is practically true for Bago, Murcia and the whole province (refer again to **Tab. 3.4.16**).

The main reasons for the low number of energy consumers in the study area are the high cost involved in the installation and the costly rate of monthly charges. **Tab. 3.4.17** shows the power rate schedule in the study area. These rates are hardly within the means of the residents.

3.4.6.3 TRANSPORTATION AND COMMUNICATION FACILITIES

The agricultural nature of Bago and Murcia is the primary reason why most of the roads are farm to market or barangay roads.

The total road length in Bago is 327 km and this may be classified as follows :

National road	:	81.8 km	(25%)
City road	:	7.1 km	(2.2%)
Barangay road	:	238 km	(72.8%)

In terms of road condition, 18.9% are first class (concreted or asphalted) and 81.1% are gravel roads. This translates to 0.16 km of good roads per 100 has. of land 2.95 km of roads for every 1000 population. This is slightly higher than the recommended density of 2.4 km per 1000 individuals.

Murcia has a total of 159.4 km of road length. Out of this 3.58 km may be classified as urban roads and the balance are barangay roads.

TABLE 3.4.15 HOUSEHOLDS BY TYPE OF FUEL USED FOR LIGHTING, BY PERCENTAGE

PLACE	ELECTRICITY	KEROSENE	LPG	OTHERS
MAILUM	20			
MINOYAN	10.31			
BAGO	26.59	71.07	0.79	0.14
MURCIA	26.92	72.53	0.2	0.34
NEGROS OCCIDENTAL	40.59	57.71	1.17	0.53

TABLE 3.4.16 KIND OF FUEL USED FOR COOKING BY PERCENTAGE

PLACE	ELECTRICITY	KEROSENE	LPG	CHARCOAL/WOOD	OTHERS
MAILUM				14.36	
MINOYAN		6.15	1.89	57.68	
BAGO	0.94	8.79	2.95	84.32	2.96
MURCIA	0.45	3.62	2.09	93.6	0.24
NEGROS OCCIDENTAL	1.4	5.97	7.11	84.93	0.52

TABLE 3.4.17 POWER RATE SCHEDULE
BAGO CITY, MARCH 1991

ITEM	PESOS PER KWH
I. RESIDENTIAL CONSUMERS	
MINIMUM BILL (KWH)	2.70437
II. COMMERCIAL	
A. SMALL SCALE	
MINIMUM BILL (KWH)	|
B. LARGE SCALE	
MINIMUM BILL (KWH)	2.73437
III. INDUSTRIAL	
MINIMUM BILL (KWH)	2.73437
IV. PUBLIC BUILDING	
MINIMUM BILL (KWH)	2.70437
V. STREET LIGHTS	
RATE PER KWH	2.79437

The prevailing means of transportation in both Bago and Murcia are jeepneys, motorized tricycles, and trucks for cargo goods. At present, the required movements of people and goods are adequately saved. Traffic density even during peak hours and at the poblacion proper is still manageable reaching more than 1000 vehicles per hour.

Both Bago and Murcia are relatively near the capital city of Bacolod and hence communication facilities are accessible. News, messages and other information are able to reach the area through Bacolod.

The telecommunication facilities in Bago City are provided by the Philippine Long Distance Telephone company (PLDT), POLCOM radios and RCPI. Whereas Murcia only relies on the postal services of the Bureau of Telegraph. In addition, single side band radios are also used usually by the landowners.

There is one post office each in both poblacions to take care of mail receipts and delivery services. In both places, however, the postal personnel are deemed inadequate in number to service the population of the area. —

3.4.7 HEALTH AND SANITATION

3.4.7.1 GENERAL PROFILE AND HEALTH FACILITIES

A. BAGO

The Bago City Health Office at the end of CY 1990 recorded the following statistics. There were 67,595 patients who sought medical consultation from health personnel of the city. Computing the general consultation rate, it showed that 548 individuals or 54.8% of the populace for every 1,000 population availed of health services. (Mid-year Population - 123,289). While the number of live births registered was 1,458 with 750 males and the rest, females. **Tab. 3.4.18** reflects births attended to by the different health personnel of the city. As to the number of deaths, there were 535 deaths from all ages registered. Mortality rate then was computed at 4.3% or 4 deaths for every 1,000 inhabitants. Out of this total number, there were 86 infant deaths or an infant mortality rate of 5.9% or 59 infant deaths for every 1,000 live births reported. There were no maternal deaths reported for the period ending CY 1990.

Bago City has a 15-bed community hospital constructed in a 2,398 sq.m-lot located at Barangay Balingasag. This hospital is managed and maintained by a city health board with the city government. Referral system will still be continued in cases of major ailments or injuries.

On the other hand, the Ma-ao Sugar Central has a 15-bed emergency hospital but it only caters to its employees and their immediate family members.

Furthermore, there are only twenty four (24) barangay health stations and five (5) sub-stations all over the city. Only barangays Balingasag and Lag-asan have not been provided with health stations because of its nearness to the Poblacion Health Station. There are, however, midwives assigned to take care of the health needs of the barangay populace especially those who can not afford to visit private medical practitioners. Mailum, in particular, has one health center in the barangay proper and a sub-center in Sitio Lunao. Each has a staff of one midwife.

There are also two (2) puericulture centers in the City. These are located in the Barangays of Poblacion and Ma-ao. Additionally, there are seven (7) private medical clinics in the city. These are located in the following barangays: Poblacion - 3; Lag-asan - 1; Ma-ao -1; and Ma-ao Central -2. On dental clinics, there are seven (7) of them; five (5) private and two (2) public. There is also an X-ray clinic owned and operated by the city that caters to patients under the National Tuberculosis Program (NTP) of the government and other clientele as well.

TABLE 3.4.18 CHILD DELIVERY,BY BARANGAY
BAGO CITY, NEGROS OCCIDENTAL

BARANGAYS		HOME	HOSPITAL	CLINIC	NA	TOTAL
Binubuhan	NR	61	8	3	7	79
	%	77.2	10.1	3.8	8.9	
Sampinit	NR	42	10	0	1	53
	%	79.25	18.87	0	1.88	
BagoPoblacion	NR	108	31	2	1	142
	%	76.06	21.83	1.41	0.7	
Lag-asan	NR	98	10	1	2	111
	%	88.29	9.02	0.9	0.8	
Pacol	NR	40	5	1	4	50
	%	80	10	2	8	
Napoles	NR	73	6	0	1	80
	%	91.25	7.5	0	1.25	
Caridad	NR	43	3	1	2	49
	%	87.75	6.12	2.04	4.08	
Malingin	NR	60	5	0	5	70
	%	85.71	7.14	0	7.14	
Bacong	NR	90	8	1	1	100
	%	90	8	1	1	
Ilijan	NR	40	3	0	0	43
	%	93	7	0	0	
Mailum	NR	188	2	2	5	197
	%	95.4	1	1	2.5	
Maao Central	NR	93	25	0	1	120
	%	77.5	20.83	0	1.67	
Maao	NR	81	38	0	1	120
	%	67.5	31.7	0	0.8	
Abuanan	NR	54	4	1	1	60
	%	90	6.67	1.67	1.67	
Alianza	NR	28	1	0	1	30
	%	93.33	3.33	0	3.33	
Atipuluan	NR	28	6	0	1	35
	%	80	17.1	0	2.9	
Total	**NR**	**1127**	**165**	**12**	**35**	**1339**
	%	**84.16**	**12.32**	**0.9**	**2.61**	

B. MURCIA

The municipality of Murcia has inadequate health facilities. Probably due to its proximity to the city of Bacolod, no hospitals not additional health centers have been constructed as of 1980.

Health facilities present in the municipality of Murcia include one (1) rural health unit, two (2) private clinics, ten (10) barangay health station and six (6) nutrition day care centers dispersed among the barangays. There are specialized family planning centers both with the barangay service points organized by the full time outreach workers of the municipal population office, family planning service are available in covered barangays. In particular Minoyan is serviced by a barangay health center/station.

Despite the fact that there were nine (9) physicians in Murcia, only one (1) doctor serves the municipality. This may be due to the fact that doctors serve in nearby Bacolod City where clients are numerous while some were employed in other places. The same is true for the three (3) dentists in the municipality wherein only one (1) served the 44,953 people of Murcia in 1980. Government health personnel include one (1) doctor, two (2) nurses, twelve (12) midwives, one (1) dentist, two (2) sanitary inspectors, one (1) nursing aide, and one (1) attendant.

3.4.7.2 MORTALITY AND MORBIDITY

The leading cause of mortality in the study area (DIA and IIA) in comparison with the provincial and national averages are shown in **Table 3.4.19**. The table shows that upper respiratory diseases including Pulmonary Tubercolosis (PTB) cause the most deaths in the study area. It should be noted that the rates are much higher than the provincial and national statistics.

TABLE 3.4.19 LEADING CAUSES OF MORTALITY PER 1,000 POPULATION BY PERCENTAGE

ITEM	DIA	IIA	PROVINCIAL	NATIONAL
COUGH AND COLDS	1.59	4.53	2.34	2.46
DIARRHEA	1.25	2.7	1.07	1.52
ABDOMINAL PAIN	1.29	2.26	0.15	0.13
DERMATITIS	0.19	0.18	0.05	0.09
PTB	1.04	2.66	0.31	0.25
PNEUMONIA	0.05	0.05	0.05	0.07
CVA	0.04	0.03	0.06	0.05
CANCER	0.02	0.015	0.025	0.04
HEART DISEASES	0.05	0.04	0.062	0.07

The ten (10) leading causes of morbidity in the two areas (Bago and Murcia) are shown in **Table 3.4.20**. Morbidity rates are high in the area and the leading causes are attributable to nutritional deficiencies and poor sanitary practices. Both in turn are caused by the existing poverty in the area which puts severe constraints on the purchase of nutritious food, and the construction of sanitary facilities.

3.4.7.3 SANITARY FACILITIES AND PRACTICES

A. BAGO CITY

Of the twenty four (24) barangays in the city, only the barangays of Poblacion and Ma-ao have garbage trucks to collect and dispose of their garbage while others have none.

Eighty six (86) percent of the 22,354 households in the city, use burning as their means of garbage disposal, 7.2% use open pits, 4.1% use compost pits and 2.2% use the wrap and throw method.

As to sewage disposal, 18.9% or 4,250 households have septic tanks while the remaining 81.1% or 18,239 use the open canal system.

Sewage disposal in the poblacion is a combination of pipe, canal, curb and gutter and box culvert with their corresponding location:

1. RC Pipe - Parts of Gen. Luna, Rizal, Bonifacio, H. Yulo, 2nd & 3rd Strs., Araneta, Mabini and Sarmiento Streets.
2. Canal - Parts of Gen. Luna to Balingasag, Sarmiento, Matti, Torres, Lopez Jaena, Mabini, Carlos Dreyfus, Trinidad, Pescadores, Natalia Araneta, Dela Rama, Celis, Bonifacio, Sarmiento, 5th Araneta, Mabini, Carlos Dreyfus Streets.
3. Curb & Gutter - Gen. Luna, Rizal, H. Yulo, 1st - 5th Araneta Streets.
4. Box Culvert - Hilario Yulo, Bantayan.

B. MURCIA

The sanitary facilities and sanitation practices in the municipality of Murcia is similar to that of Bago City. Because of the more rural character of Murcia there are less facilities. Most of the population resort to burning of garbage while few households have adequate sewage disposal facilities.

3.4.8 LOCAL RESIDENTS PERCEPTIONS ON THE PROJECT

An extensive survey of the local residents as well as pre-selected key personalities such as community leaders, local government officials and NGO/PVO representatives was initiated to determine their perceptions on the project.

3.4.8.1 PROJECT AWARENESS

The residents of Bago and Murcia have very high awareness of the project (76.6% and 64.3% respectively). In fact almost all the respondents in Mailum and Minoyan (project host barangays) are aware of the project. This result may be due to any or combination of the following factors:

- the exploration project has started and was on-going when the survey was conducted.
- information dissemination activities by the proponent of the project.
- media coverage and commentaries
- discussions (formal and informal) by local government officials with their constituencies:
- information campaigns of some NGOs opposing the project.
- consultation meetings conducted by the proponent.

Majority of the residents of both Bago and Murcia however, said that they were not consulted up to the time of the survey.

It should be noted hat awareness of the project does not mean adequate understanding of the project and its implcations. Since the awareness came from different sources, the perceptions on the effects of theproject vary from very negative to very positive.

3.4.8.2. PROJECT ACCEPTANCE

When the residents were surveyed on whether they are in favor of the project, 57 percent in Bago City were affirmative whereas only 27.6 percent of the respondents from Murcia favors the project. Among the respondents in the host barangays, Mailum and Minoyan, the acceptability percentages were 38 and (32%) respectively.

Majority of the respondents who are not in favor of the project could not give any reason for their negative opinion although some mentioned pollution and potential bad effects to their health and livelihood as their reasons. This indicates that although there is high degree of awareness in general, the residents still do not know enough of the project to form an intelligent opinion. This premise was further confirmed during the re-validation workshop on May 28-29, 1994. A survey questioner referendum was conducted among the participants and the results are as follows:

	MAILUM (%)		MINOYAN (%)	
	Before	After	Before	After
In favor	52	82	36	58
Against	18	5	30	21
No Opinion	30	13	33	21

The significant swing in opinion before and after the presentation and discussion of the project and its impacts proved that the general population needs further information and education to be able to arrive at an informed opinion about the project.

As meioned above key informantwere interviewed on several issues and concerns about the projectA total of 93 persons wereselected broken down as follows:

Table 3.21

Key Informant Profile

Location	Gov't Officials	NGO Rep.	Private Persons	Total
Bacolod	8	7	2	17
Bago	27	10	16	53
Murcia	10	5	8	23
TOTAL	45	22	26	93

In general, the key informants are more knowledgeable about the project and its possible effects and implications than the general population of Bago and Murcia. Many have adequate understanding of the project and some even know some very technical aspects of the Project. Their avareness of different environmental issues and concerns is quite high and many have adequate information on the potential effects of the project. Almost all the informants recognize that the project will have both negative and positive effects of the physical and social environment.

Taking everything into account, 48 (52%) are in favor of the project, 12 (13%) are against and 33 (35%) did not want to comment or have not formed an opinion at the time of the interview

The high percentage (35%) of the key informants without any stand one way or another indicate that the project is controversial or that the key leaders of the community still lacks informatio about the project and its environmental impacts to be able to decide.