APPENDIX K

ENVIRONMENTAL ASPECTS

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CHAPTER I LEGAL AND INSTITUTIONAL FRAMEWORK

1.1 Laws, Regulations and Institutions on Environmental Protection

The main environmental legislations were enacted in the late 1970's and made operational in the 1980's. Among these are Presidential Decree No. 1151, otherwise known as the Philippine Environmental Policy, and Presidential Decree No. 1152 or the Philippine Environment Code.

Presidential Decree No. 1151 states that "it shall be the policy of the state: (a) to create conditions under which man and nature can thrive in productive and enjoyable harmony with each other; (b) to fulfill the social, economical and other requirements of present and future generations of Filipinos; and (c) to insure the attainment of an environmental quality that is conducive to a life of dignity and well being." P.D. No. 1152 tried to address total environmental enhancement by requiring the establishment of standards for air and water quality, and prescribing guidelines for land use management, natural resources management and conservation, utilization of surface and groundwater, and waste management.

One of the most important provisions of P.D. No. 1151 (Section 4) is the requirement for "all agencies and instrumentalities of the national government, including government-owned or controlled corporations, as well as, private corporations, firms and entities, to prepare an environmental impact statement (EIS) on their every action, project or undertaking which significantly affects the quality of the environment." The requirement was formally administered with the establishment of the Philippine EIS system through Presidential Decree No. 1586. The decree was actually based on the environmental impact assessment requirement of Section 4 of P.D. No. 1151. The system's scope was also delimited to "environmentally critical projects or projects to be built in environmentally critical areas" (identified in Proclamation No. 2146).

Prior to this, the system underwent transition from a decentralized process to a centralized one, starting December 23, 1979 by virtue of an NEPC Special Memorandum. From lead agencies, processing of EIS documents and issuance of Environmental Compliance Certificates (ECCs) for projects which have satisfactorily complied with the EIA requirement, was centralized in the NEPC which was under the Ministry of Human Settlements. Various other ministries, including the Ministry of Public Works and Highways (MPWH), were designated under Letter of Instruction (LOI) No. 1179 as lead agencies for various sectors. Thus the MPWH was the lead agency for major infrastructure projects, such as roads and bridges.

With the change of government in 1986 came the reorganization of environmentally related agencies. The Department of Environment and Natural Resources (DENR) was established out of the Ministry of Natural Resources and the National Pollution Control Commission (NPCC). The Environment Management Bureau (EMB) also became the main implementing body of the Philippine EIS System.

The DENR started to decentralize field operations to the respective regions in 1992. Part of the EIA function of EMB was assigned to the newly formed regional offices of DENR (DENR-ROs), particularly the Environmental Management and Protected Areas Services (EMPAS) headed by a Regional Technical Director (RTD). Based on Department Administrative Order (DAO) 21 (series of 1992), the DENR-ROs shall be responsible for projects located in environmentally critical areas (ECAs), exemptible projects and all other applications that do not fall under environmentally critical projects (ECPs). DAO 21 also underlined the importance of public participation in processing and review of EIA documents

as well as in compliance monitoring.

1.2 EIS System

The EIS System refers to the entire process of organization, administration and procedure institutionalized for the purpose of assessing the significance of the effects of physical development on the quality of the environment.

Environmental Impact Assessment (EIA) is done during the feasibility stage of the project cycle where inputs from the study can really help in shaping a particular project to be both environmentally sound and economically viable. It should be started as early as possible and in parallel with other studies so that the environmental consequences of the project can be taken into account from the earliest planning stage. Recommendations also can be easily implemented without considerable change in plans and increase in capital outlay.

The following environmentally critical projects and areas fall under the scope of the EIS system. Proponents are required to apply for Environmental Compliance Certification (ECC) before these projects can be implemented.

(1) Environmentally Critical Project (ECP)

(a) Heavy Industries

i) Iron and steel mills

ii) Petroleum and petro-chemical industries

iii) Smelting plants

(b) Resources Extractive Industries

i) Major mining and quarrying projects

ii) Forestry projects

iii) Fishery projects

(c) Infrastructure Projects

i) Major dams

ii) Major power plants

iii) Major reclamation projects

iv) Major roads and bridges

The Department of Public Works and Highways (DPWH) prepared a department order (DO) which revised Ministry Order (MO) No. 72 proclaiming certain areas and types of projects as environmentally critical and within the scope of the EIS system. New guidelines were issued for other infrastructure projects covered by the EIS system in consonance with the Memorandum of Agreement (MOA) entered into by and between DENR and DPWH dated 26 June 1992. The supplemental projects include development, construction and maintenance of national roads, bridges and major flood control infrastructure projects. Major flood control projects refer to any large scale activity which will involve river control works, channel widening, dredging and embankment and urban drainage works including cross drainage of highway. The cost of this type of project shall at least be one hundred million pesos (₱100,000,000). Therefore, it is desirable that the projects proposed in this study should follow the EIS

procedure.

(2) Environmentally Critical Areas

(a) All areas declared by law as national park, watershed reserve, wildlife preservation and sanctuaries;

(b) Areas set aside as aesthetic potential tourist spot;

(c) Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna);

(d) Areas of unique historical, archaeological or scientific interests;

(e) Areas traditionally occupied by cultural communities or tribes;

(f) Areas frequently visited and/or hard-hit by natural calamities (geologic hazard, flood, typhoon, volcanic activity, etc.);

(g) Areas with critical slopes;

(h) Areas classified as prime agricultural lands;

(i) Recharge areas of aquifers;

(j) Water bodies characterized by one or any combination of the following conditions:

i) Tapped for domestic purposes;

ii) Within the controlled and/or protected areas declared by appropriate authorities; and

iii) Which support wildlife and fishery activities.

(h) Mangrove areas characterized by one or any combination of the following conditions:

i) With primary pristine and dense young growth;

ii) Adjoining mouth of major river system;

iii) Near or adjacent to traditional production of fry or fishing grounds;

iv) Which act as natural buffer against shore erosion, strong winds and storm floods; and

v) On which people are dependent for their livelihood.

(i) Coral reefs characterized by one or any combination of the following conditions:

i) With 50% and above live coral cover;

ii) Spawning and nursery ground for fish; and

iii) Which act as natural breakwater of coastlines.

1.3 EIS System Procedures

According to the manual on Environmental Impact Assessment (EIA) in the Philippines and as stated in Section 1.2, EIA is done during the feasibility stage of the project cycle where inputs from the study can really help in shaping a particular project to be both environmentally sound and economically viable. It should be started as early as possible and in parallel with other studies so that the environmental consequences of the project can be taken into account from the earliest planning stage.

The following procedures for the EIS system shall be conducted according to the procedures for the EIS shown in Fig. K.1.1.

(1) Pre-Study Phase

(a) Pre-screening

Prior to any project implementation, project proponents (PP) are to coordinate with the Environmental Management Bureau (EMB) or the nearest DENR Regional Offices (DENR-RO) to initially determine if the proposed project falls under the purview of the EIS System.

The project proponent, with the assistance of the EMB or the DENR-RO initially determines if a project falls within the EIS System by filling up ENFORM1.

If the project falls under the EIS System , the EMB/DENR-RO determines whether it is an Environmentally Critical Area (ECA).

If the project is not an ECP but is located in an ECA, the proponent shall submit a Project Description (PD) to the DENR-RO.

(b) Scoping

For projects identified to need an EIS, scoping sessions with DENR will follow. Scoping is a stage in the process where the information requirements for the EIS is established. This stage is considered to be important as it can provide to the proponent a clear direction for the environmental impact assessment work.

(2) The Study Phase

(a) Site Characterization and Prediction of Impacts

Once the study is scoped, the proponent shall now proceed with the EIS by collecting the necessary data information and predicting the project impacts. The main activities at this stage are Impact Identification and Impact Prediction.

(b) Evaluation of Impacts and Proposal of Alternatives

The identified impacts are compared with pre-defined acceptability criteria or existing environmental standards. The key activity at this stage is the evaluation of the significance of impacts, that is, judgment about which impacts found in the study are considered important and therefore needs to be mitigated.

(c) Identification and Assessment of Mitigating Measures

On the basis of the evaluation of impact, the corresponding mitigation measures are then identified and assessed. This stage also involves re-evaluation of impacts to determine whether the measures lead to acceptable levels of impact.

(d) Preparation of Environmental Impact Assessment (EIS)

After determination of impacts and the corresponding mitigating measures, the next stage involves the preparation of the Environmental Impact Statement (EIS).

(3) The Post Study Phase

(a) Review of the EIS

For EIS, the EMB reviews and evaluates the documents. An ocular inspection may be conducted to check the veracity of the data contained in the EIS.

The EIS may be referred to the EIS Review Committee for further review and evaluation. The Committee may require the holding of a public hearing to be conducted by DENR.

After thorough evaluation of all inputs the Review Committee recommends

approval or denial of the ECC.

(b) Granting of Environmental Compliance Certificate (ECC)

Upon satisfaction of the process as prescribed by law, the DENR now grants an ECC to the proponent. The ECC shall contain several conditions that will specifically address the identified problems in the EIS. Once a proponent has obtained an ECC, he/she can now proceed with the establishment and construction of the proposed plant.

CHAPTER II EXISTING ENVIRONMENTAL CONDITIONS

2.1 Physico-chemical Environment

2.1.1 Water Quality

Water of the Laoag River is clean at any point from upstream to downstream. People enjoy life at the waterfront along rivers. Laoag City which is only 7 km from the estuary still use the waterfront for washing, bathing and recreation. The water quality monitoring station at Gilbert Bridge in Laoag City was established by DENR in 1990 with station identification LG-1, Laoag River. Results of monitoring reveal that suspended solids (SS) are highly concentrated during the rainy season which is attributed to soil erosion at the upper portion of the Laoag River watershed. All the other parameters are within the standard set for Class A of DAO No. 34, DENR Water Quality Criteria. Records of water quality monitoring from 1990 to 1996 at LG-1 are shown in Table K.2.1.

According to information from the Provincial Environment and Natural Resources Office-Ilocos Norte (PENRO-Ilocos Norte), two other water quality monitoring stations in Laoag River were established in 1996. One is at the middle stream in Sarrat, and another is just downstream of the agro-processing factory of the Northern Foods Corporation (NFC) at Sarrat which is located near the municipal boundary of Laoag City and Sarrat. Records of monitoring of these stations are not yet available.

The prospective sources of water pollution in the river basin are the Coca Cola Bottling Factory in San Nicolas and NFC in Sarrat. Both factories, however, have wastewater treatment facilities with the necessary permits.

The water quality of the Laoag River shall be kept at least in the present level, where the clean river water is valuable not only for domestic, irrigation and industrial use but also as a resource for recreation and tourism.

2.1.2 Air Quality

Two air quality monitoring stations were established by DENR in Ilocos Norte Province, at Laoag City and Bangui. Total Suspended Particles (TSP) observed in 1996 were 69.41 and 98.7μg/NCM, which are acceptable. At present, there is no problem on air pollution in the Laoag River Basin.

According to the Statistical Report of PENRO-Ilocos Norte, 1994, 1,105 air pollutant firms are listed with only 32 firms equipped with air pollution control devices. The remaining firms which are mostly ricemills in barangays in the rural areas, are without control devices.

2.2 Biological and Geological Environment

2.2.1 Flora and Fauna

(1) Vegetation

The vegetative cover of the province is similar to those of the other provinces in the Ilocos Region. This is perhaps attributed to the geological formation of the province being linked with the other provinces.

The mountainous northern portion of the province is covered with primary forest. The primary forest consists of different species of commercial trees. Underneath the

towering trees is a dense growth of vines, creepers and saplings.

The secondary or second growth forest and brushwood which cover the hills and foothills adjoining the primary forest consist mostly soft-wood trees, scrub tree, shrubs and vines. In some places specially along the courses of streams there is an inter-growth of a tough spiny climbing bamboo and other vines making the forest very dense.

The reforestation projects in Ilocos Norte Province were initiated in 1939, and continuous efforts are still being undertaken for the sustainable development of forest resources and the social equity and efficiency in resources use.

The grasslands are found in rolling to hilly areas. Cogon and other drought resistant grasses are the main vegetation with sporadic growth of *duhat, binayoyo*, guava and other shrub trees. The grasslands are presently used for cattle grazing.

Croplands cover the level to nearly level and gently sloping areas. Among the most common crops planted are rice (lowland and upland), corn, tobacco (native and Virginia), sugarcane, onion, garlic, tomato, vegetables and root crops. Bananas are planted on the sloping areas. Mongo and other leguminous crops are also planted.

The threatened flora listing in the ENR-Statistical Report, PENRO, Ilocos Norte,1994 are "Mahogany and Dipterocarp forest."

Table K.2.2 is the list of flora commonly grown in Ilocos Norte.

(2) Wildlife Resources

The threatened fauna listing in the ENR-Statistical Report, PENRO, Ilocos Norte, 1994 are Sea Turtle, Philippine Deer, Philippine Monkey, Woodpecker, Fruit Bats, Horn Bill, Kingfisher, Quail, Starlings, Maya, Wild Chicken, Sunbird, Pigeon, Crow, Oriole, Cuckoo, Painted Snipe and Philippine Owl.

Table K.2.3 is the list of wild fauna observed in the Paoay Lake National Park and fishes caught in the Laoag River and offshore.

2.2.2 Sand Dune

Sand dunes extend along the coastal line of Ilocos Norte from Currimao in the South to Bacarra in the North covering 3,350 ha of land. The National Committee on Geological Sciences (NCGS) considers these sand dunes to be established as one of the National Geological Monuments to be protected and preserved in their natural conditions.

As part of its coordinative function, the NCGS had accomplished a high innovative measure in initiating the establishment of geological monuments in the country with the primary objective of protecting and preserving geological areas with scientific and aesthetic values as well as to promote an active awareness for geology among the public. At present, two national geological monuments had been established by the Committee. These are the Limestone Caves of Montalban and Taal Volcano in Batangas. In addition to these, prospective geological monuments being eyed by the Committee include the Chocolate Hills of Bohol, Salinas Salt Springs in Nueva Viscaya, the Currimao Sand Dunes of Ilocos Norte, and Mayon Volcano in Albay.

Some areas in the sand dune zone are already disturbed from their natural conditions by artificial changes such as road, housing, cultivation, grazing and/or reforestation. It is difficult to totally protect and preserve the sand dune area. The NCGS shall scientifically and aesthetically investigate, study and evaluate the value of sand dunes, and determine the boundary to be protected and preserved as national geological monument.

2.3 Social Environment

2.3.1 Demographic Characteristic

(1) Population Level

Ilocos Norte had the total population of 461,661 in 1990 and 482,651 in 1995, an increase of 20,990 within five (5) years. In 1995, among the municipalities, Batac was the most populated which account for 9.4% followed by Dingras, 6.5%, San Nicolas, 6.0%, Bacarra, 5.8%, Vintar, 5.7% and Badoc, 5.5%. Laoag City was far more populated than the municipality of Batac. Carasi had the least population, with only 750 or 0.2% of the total population.

Population in the Laoag River Basin was estimated at 196,938 in 1995.

(2) Population Density

With a population of 482,651 in 1995 and a land area of 3399.34 km^2, the population density of the province including Laoag City is 142.0 persons per square kilometer. The population density of the river basin is estimated at 147.9 persons per square kilometer in 1995. The river basin is relatively high in population within Ilocos Norte.

(3) Labor Force and Employment

In 1990, the household population of 15 years old and over in the Province was 303,300. Of this, 212,000 were in the labor force while 91,000 were not. About 51.3% of the labor force are engaged or employed in the agricultural sector. In the river basin, the trend of labor force and employment is similar with that of the Province.

(4) Educational Attainment

As for the educational attainment of people in the Province, 50% of the household population of age 7 years and over are graduates of elementary schools, 25% high school and 8% college. Academic degree holders are counted at 7.5%. Literacy rate of household population age 10 years old and over as of 1990 is 94.8%.

(5) Language/Dialect

Widely spoken by the people of the province is Ilocano, one of the major dialects in the country.

2.3.2 Land Use

As for land use in Laoag River Basin, Laoag City and the municipalities of Sarrat, Dingras and Banna (Espiritu) use more than 50% of land for agricultural production. On the other hand, forest areas in the municipalities of Nueva Era, Carasi and Vintar share more than 85%. Ilocos Norte is an agricultural province.

2.3.3 Fishery

In dry season, people living in the riverside make a fish shelter (local name is "Kunokon") made of twigs of shrubs, bamboo or stones as sanctuary for spawning of freshwater fishes. Occasionally, people catch fish around the fish shelter by net. Major catches are gubis and freshwater shrimps.

Another fishing gear used in the river course, especially in the upper stream of rivers during early dry season when water flow is still abundant in the riverbed, is the fish-trap or cage (Bubo) made of bamboo skins or vines and installed in the water flow on man-made brushdam or on naturally formed drop.

The gill nets stationed in the brackish water zone near the estuary of Laoag River and the fike nets (Bukatot) at its tributary creeks are used for fishing. Major fish catches are tilapia, mullet, shrimps and tiger prawns (Monodon).

In the offshore, gill netting and long line trolling are the methods used in catching fish. Fishing is limited along the shoreline due to lack of large or medium size fishing vessels. Fishermen use boats (bangka) with or without motors for fishing at the offshore and brackish water zone.

Aquaculture in Ilocos Norte can produce about 120 tons of tilapia and milkfish per annum at inland fishponds and along the coastal line of the province. The Provincial Agricultural Office has nursery facilities at Laoag City, Batac, Pasuquin and Burgos to provide tilapia fingerlings to fish farmers and for stocking in rivers and other communal waters.

Production of fish in Ilocos Norte Province is around 2,000 to 3,000 tons per annum which is less than the 6,700 to 7,700 tons of fish consumption in the province. Deficit in production is covered by imports from other provinces such as Pangasinan and Metro Manila.

In Laoag River Basin, fish caught in fresh and brackish water is estimated to be 80 tons and sea fish is about 300 tons per annum. Tilapia breeding in fishponds is about 25 to 50 tons. Another fishing activity at the estuary of Laoag River is gathering of milk fish (Bangus) fry during March to September for sale to the fish farmers in other provinces such as Pangasinan and Bulacan.

2.3.4 River Utilization

River water in the Laoag River Basin is utilized mainly for irrigation purposes. Potable water in the urban areas is supplied from springs or deep wells.

Aside from fishing in the rivers, the waterfront of rivers and tributaries is closely linked to the life of people nearby. Washing of clothes can usually be seen at any place along the riverside. Private fishing is also one of the people's attraction to the river. Shallow water flows at some places are used for cultivating water vegetables and root crops locally called "Kangkong" and "Gabi", respectively.

People enjoy recreation such as luncheon parties, games, swimming and music at the waterfront where crystal water and shade under decorated trees or bridges are available. Typical recreation spots at the waterfront are the sites of five diversion dams at alluvial fan apexes: Karingking Mountain Resort at Solsona River, Bato River Resort at Sarrat and Bagbag Bridge of Cura River. The Bato River Resort provides some temporary huts and services for visitors during dry season but other places have no service facilities. The Karingking Mountain Resort is now abandoned.

2.3.5 Historical Area and Tourism Attraction

(1) Historical Characteristics of Ilocos Region

Before the coming of the Spaniards, the coastal plains in the northwestern tip of Luzon, stretching from Bangui in the north to Namacpacan (Luna, La Union) in the south, were known as a progressive region rich in gold. This region hemmed in between the China Sea on the west and Northern Cordilleras on the east was isolated from the rest of Luzon. The inhabitants built their villages near the small bays and coves called "looc" in the native dialect. These coastal inhabitants were referred to as "Ylokos" which literally meant "from the lowlands". The entire region was then called by the ancient name "Samtoy" from "Sao ditoy" which in Ilocano meant "dialect here". The region was later called by the Spaniards "Ylokos" or "Ilocos" and its people, "Ilocanos". The Ilocos region was already a thriving, fairly advanced cluster of towns and settlements familiar to Chinese, Japanese and Malay traders when the Spanish

explorer Don Juan de Salcedo and members of his expedition arrived in Vigan on June 13, 1572. Salcedo then proceeded to Laoag and rounded the northeastern tip of Luzon on his way back to Bicol and Manila. Two years later, the whole Ilocos region was finally awarded to Don Juan de Salcedo as his "encomienda" or fiefdom for service rendered to the Spanish throne.

The first inhabitants of the province were the Apayaos, Igolots, Itnegs and Tingguians. Invasions by groups with superior weapons and number of men drove these natives to the mountains where they still thrive until today.

The historical dates are:

Historical Date	Event
1572	Juan de Salcedo led the first expedition to the region. He founded the province of Ilocos which embraced the present Ilocos Norte, Ilocos Sur, Abra, La Union and parts of Mountain Province.
1611	Pangasinan was created, a part of La Union (then Ilocos) was annexed to it.
Feb. 1818	A Royal Decree divided the Ilocos province into Ilocos Norte and Ilocos Sur. The South (Sur) included the northern part of La Union and Abra and the sub-provinces of Lepanto and Amburayan which were portions of Mountain Province.
1846	Abra was created as a province with Lepanto as its subprovince.
1854	La Union was created out of towns belonging to Ilocos Sur and Pangasinan.
Feb. 1905	Abra was again annexed to Ilocos Sur through passage of Act No. 1306.
Mar. 1917	Republic Act 2711 separated Abra from Ilocos Sur.

(2) Historical Area

The historic areas in Ilocos Norte are the buildings and structures built in the Spanish era. The old towns were planned and designed by the Spanish colonizers. The centuries old churches in these towns which formed the nucleus of the plaza complex are testimonies to the colonial past. Major tourism spots of historical churches are the Paoay Church in Paoay, the Laoag Cathedral and the Sinking Bell Tower in Laoag City, the ruins of Dingras Church in Dingras, and the ruins of the old town hall in Sarrat, which were built in the middle of the 17th century. The Tobacco Monopoly Monument beside Mini-Aurora Park in Laoag City is also of historical interest.

(3) Tourism Attraction

Tourism attraction spots in the province are: (a) historic Spanish colonial churches, museums and monuments; (b) white sand beaches and resorts; and (c) Paoay Lake National Parks, falls, springs and caves.

About 75,000 tourists visited the Province in 1995. About 50% of them were foreign tourists. About 32,000 tourists or 42.8% of the total tourists were visitors from Taiwan. They enjoyed the beaches, playing sports such as tennis, golf, swimming, shooting, etc., visiting the historical churches, museums and towns, and shopping.

With 386.5 ha of natural land including water surface of lake and its surrounding forest land, the Paoay Lake National Parks was established in 1969. The parks preserve the birds and trees as sanctuary of wildlife.

Tourism spots in the Laoag River Basin are the churches and monuments at Laoag City, Sarrat and Dingras. These tourism areas are located in high lands and are not threatened by floods of the rivers.

2.3.6 Ethnic Minorities

Areas in the river basin where the ethnic minorities live are in the municipalities of Nueva Era, Marcos, Dingras Solsona and Carasi. Almost all minority groups work on their ancestral lands at hilly/mountain areas or on the reforestation projects, but they do not permanently lodge in the mountainside because they have set up their own cultural communities at the barangays located along the fringes of mountain areas. One community in Solsona, however, is located in the Labugaon River watershed area.

Municipality	Groups	Community	Households (Approx.)
Nueva Era	Tingguian and Itneg	4 barangays	100
Marcos	Itneg	1 barangay	40
Dingras	Itneg	1 barangay	40
Solsona	Itneg	2 barangays	50
Carasi	Itneg	3 barangays	140

CHAPTER III ENVIRONMENTAL IMPACT ASSESSMENT

3.1 Areas Under ECP and ECA

As described in Chapter I, major flood control works involving river control works, channel widening, dredging, embankment and urban drainage are among the projects covered by the EIS system.

The project components of the proposed Master Plan are presented in Fig. K.3.1. These components include river protective structures, sabo dams and bridge reconstruction, and the project cost is excessively over the criteria of 100 million pesos. Thus, the proposed Master Plan is defined as an environmentally critical project (ECP), so that this plan should follow the EIS procedure.

The characteristics of the Laoag River Basin as an environmentally critical area (ECA) are listed as follows. The listed characteristics shall be described on the project description (PD) and discussed in the preparation of EIS.

Item	Watershed Areas	Alluvial Fan Areas	Laoag Main River Areas
(1) National Parks			
Watershed Reserves	Δ		
Wildlife Preserve and Sanctuaries			
(2) Aesthetic Potential Tourist Spots			Δ
(3) Habitat for Endangered or Threatened Species of Indigenous Wildlife (flora and fauna)			
(4) Unique Historical, Archeological or Scientific Interest			Δ
(5) Cultural Communities or Tribes	O	O	
(6) Frequently Visited and/or Hard-hit by Natural Calamities		O	O
(7) Critical Slopes	Δ		
(8) Classified as Prime Agricultural Lands		O	O
(9) Recharge Area of Aquifers		O	
(10) Water Bodies tapped for Domestic Purposes			
Water Bodies within the Controlled and Protected Areas			
Water Bodies Supporting Wildlife and Fishery Activities		O	O
(11) Mangrove Area			
(12) Coral Reefs			

Note: Items marked Δ means the subjects to be slightly impacted by the M/P, while items marked O means the subjects to be strongly impacted by the M/P.

The reasons of the marking in the above table are explained as follows:

(1) National Parks/Watershed Reserves/Wildlife Preserve and Sanctuaries & (7) Critical Slopes

There is no area declared by law as national park, watershed reserve, wildlife preserve and sanctuary in the basin. The Paoay Lake National Parks which is the only national park in the Province is located just outside of the basin. PENRO-Ilocos Norte is continuously carrying out various projects for reforestation and watershed management in the mountainous area of the basin. Sediment control works such as the construction of sabo dams will be coordinated with these projects, but will not indulge in the watershed management works, since watershed management will require a long period and involves various works.

(2) Aesthetic Potential Tourist Spots, & (4) Unique Historical, Archeological or Scientific Interest

Tourist spots in the province are the white sand beaches and sand dunes along the coastal line, Paoay Lake and historical and archeological buildings. The historical and archeological buildings are located at relatively high lands and will not be affected by floods. Although sand beaches and sand dunes are also located outside of the basin, proposed sediment control structures may slightly affect the sediment balance in the supply of sediment to the coastal areas.

(3) Habitat for Endangered or Threatened Species of Indigenous Wildlife

There is no record regarding the habitat of endangered or threatened species of indigenous wildlife in the basin.

(5) Cultural Communities or Tribes

The dwelling area of cultural communities are along the fringes of mountain areas in the barangays of Nueva Era, Marcos, Dingras, Solsona and Carasi. The lifestyle of the cultural communities were considered in the feasibility study, because they occasionally use the river courses for their ancestral cropping works or on the reforestation projects at hilly/mountain areas.

(6) Frequently Visited and/or Hard-hit by Natural Calamities & (8) Classified as Prime Agricultural Lands

The basin is classified as an area frequently visited by natural calamities and prime agricultural lands. The sediment control and flood control components of the Master Plan will mitigate the damage by floods and bring significant beneficial impacts for the physical and socio-economic condition of the basin.

(9) Recharge Area of Aquifers

The alluvial fan areas are the recharge areas of aquifers. Effect of the sediment and flood control works on the recharging of groundwater to aquifers were studied and evaluated in the feasibility study stage.

(10) Water Bodies

The water bodies of Laoag River and its tributaries are the sources of local fisheries and the activities of the people such as washing of clothes, bathing, cultivation of water vegetable, as well as the source of irrigation water.

(11) Mangrove Area & (12) Coral Reefs

There is neither a mangrove area nor a coral reef in the basin.

Thus, the prediction and assessment of environmental impact were carried out based on the characteristics marked in the preceding tables.

3.2 Future Environment without the Projects

Without implementation of the projects under the Master Plan, environmental conditions of the basin are expected to remain as the present or may deteriorate. The flood-prone areas will continue to be subjected to flooding during the typhoon season. Potential flood area is estimated at 19,900 ha which is equivalent to 14.9% of the total drainage area or 50.2% of lowland areas.

Especially in the alluvial fan areas, fertile lands and residential area along the riverside of tributaries will be facing the threat of being washed away. The estimated annual riverbed aggradation is in the range of 0.4 cm/year to 5.1 cm/year. The sediment deposit from the watershed is estimated at 625,900 m^3/year which is not distributed uniformly over the whole river stretches of the basin. About 31% of the deposit will concentrate in the alluvial fan apexes and 56% in the middle and end of the alluvial fans.

This excessive sediment deposit at the fan apex will cause the rising of flood water level and trigger channel shifting, creating a new river channel. The channel aggradation of rivers in the middle and end of alluvial fans will cause overbanking floods or bank erosion. These phenomena of sediment deposit will result not only in the loss of farmlands and damage to irrigation facilities but also devastate a wide area of farmlands.

Bank erosion is a major sediment problem in the lower reaches of the Laoag River which covers the Lower Bongo and the Laoag main courses. The presence of stream convergence appears alternately on the right and left river banks, but their locations are almost fixed. Therefore, bank erosion will occur at specific portions of riverbanks. More serious problem in the lower reaches is the overbanking floods and inundation on farmlands and residences. The overbanking floods occasionally submerge main roads and stop traffic.

Thus, if sediment and flood control works are not undertaken, the devastation of lands will continue resulting in deterioration of the natural environment and the stagnation of socio-economic activities in the basin.

Probable damage by floods without the Master Plan is estimated as follows.

Item	Return Period	
	25-year	100-year
Inundation Area	17,290 ha	20,220 ha
Affected Population	61,118	78,858
Damageable Value of (million pesos in 1996 price)		
Living Quarters	1,075.7	1,375.4
Crop Production	229.5	263.2
Industrial Establishments	73.2	100.6
Infrastructure	873.5	1,053.4
Total	2,251.9	2,792.6

3.3 Prediction and Assessment of Project Impact

3.3.1 Physico-chemical Aspects

(1) Surface Water

The construction works of the Master Plan components will be carried out within the dry season when the surface water is shallow. The tributaries in the alluvial fans seep the surface water to the subsurface around the alluvial fan apexes recharging the aquifer. The stretches from the fan apex to about 5 to 6 km downstream dry up during the dry season (from December to April).

Regarding turbidity of surface water, the underwater works and dewatering works using pumps will be limited only at the site of sabo dams and some portions of riverbank. Further, these works will be done during the dry season, and the riverbed materials to be excavated contain few silt and clay which are sources of water turbidity. Therefore, these construction works will not much affect the surface water.

The chemical pollution of surface water will not occur during the construction stage, because use of toxic chemical materials is not necessary in the project.

The following common management errors will happen during the construction stage, but they may not be serious. Some attention should be paid to them at the sites.

(a) Dumping of surplus cement, fresh concrete, slush oil and garbage produced through the construction works onto the river courses; and

(b) Stockpiling of excavated materials near irrigation intakes, which will cause sediment inflow to the irrigation canals.

On the other hand, frequency of flooding will be drastically reduced by the project implementation.

(2) Groundwater

Riverbed dredging is not planned in the lower reaches of the Laoag River. Only the Cura River will be dredged in its upper and lower reaches, but dredging rate will be 1-2 m deep from the present riverbed surface. The groundwater level near the dredging stretch, however, will not be affected, because the groundwater will be recharged mainly by rain and irrigated water.

The proposed sabo dam sites in Cura, Labugaon, Madongan and Papa rivers are covered by river deposits and subsurface water flows down through the river deposits. The sabo dams in these rivers will be constructed on the river deposits as floating structure. Hence, they will not affect the existing subsurface flow of the rivers.

Consequently, the construction works under the Master Plan will not affect the present groundwater conditions.

(3) Topography

The sabo dam will accumulate the sediment inflow in its sedimentation basin. Thus, the existing topographic features of the valley will change in line with the progress of sediment accumulation. The impact, however, will not be significant to the topography.

(4) Air, Noise and Offensive Odor

Air quality will be affected during the construction stage through the emission of exhaust gases from various construction equipment and facilities, and the dust from the dredging/excavation works. Unpleasant noise by the operation of heavy equipment will also occur at the construction sites. Fortunately, most of the construction sites are

located far from residential areas. Furthermore, the scale of construction work beside the urban areas of Laoag City is regarded as small and short. Accordingly, the construction works will not seriously disturb the residents. Offensive odor will not be emitted by the project.

3.3.2 Biological and Geological Aspects

The construction works in the proposed Master Plan will be executed almost inside the river course. The species of vegetation and animals in the riverbed are not much diverse, and there are no endangered or threatened species of flora and fauna. Thus, the biological and geological disturbance by the construction works will not occur except for minor effects on the growth of aquatic fauna. The place of spawning, growing and moving of fishes in the river is not yet fully determined. In addition, terrestrial species, such as animals living in the mountains, may also be affected by the sabo dam construction work.

Further studies on the spawning and growing spots and seasonal movement of fishes were carried out in the feasibility study stage.

3.3.3 Socio-economic Aspects

(1) Economic Activities

The economic activities in the basin will become more active than the present, since fear of damage to properties and investments due to floods or inundation will vanish from the people's mind. The built-up area including residential and industrial zone will expand along the major roads. Investment to farming will increase.

The construction works will activate the regional economic activities through equipment and material supply, and increase in employment opportunities, although temporary.

(2) Land Use

(a) Land Acquisition

As mentioned above, most of the proposed construction sites will be limited inside the existing river courses. Although the proposed sites are mostly located in the abandoned areas, these lands may be owned by the residents.

Farmland of 50 ha will be acquired under the Master Plan project. This adverse effect is considered small compared to the magnitude of the beneficial effects generated by the project. The detailed survey for the right of way are taken at the feasibility study stage in cooperation with the local government.

(b) Relocation/Resettlement of Dwellers

Eleven (11) houses will be resettled under the Master Plan project. Further, relocation/resettlement problem may arise in the proposed sabo dam site in the Labugaon River, because one community is located upstream of the site. In addition, people working for reforestation projects or farmers cultivating ancestral crops occasionally build temporary logging houses in the mountain area. It is necessary to survey all the proposed sites of sabo dams during the feasibility study stage, so as to determine the necessity of relocation, resettlement, and compensation for settlers.

(c) Land Use Enhancement

The safety of lands from floods will be upgraded by the construction of sediment and flood control structures. About 1,800 ha of presently abandoned areas such as

river wash and riverbed will be converted to grazing area, upland cropping area and paddy. The productivity of the existing productive area will also increase.

(3) Transportation and Traffic

The existing traffic volume is small. Most of the construction works will be performed within the river courses. The impact on traffic by the project implementation is considered negligible.

The Master Plan will not separate the cluster of existing local communities, communication and traffic. On the contrary, the flood control works can stabilize and enhance the accessibility of road network in the alluvial fan area.

(4) Historical and Archeological Interest

There are no valuable historical and archeological assets in the project area.

(5) Health and Social Services

A considerable number of hospitals and schools are prone to floods at present. The project will improve the medical and educational services in the project area by protecting the hospitals and schools from floods.

(6) Lifestyle and Communities

The existing communities along the Cura/Labugaon River are separated by braided river channels causing inconveniences in their daily life. The project will improve this situation by eliminating the braided river channels and linking the communities.

Besides, the waterfront of rivers including tributaries are closely linked to the life of residents. Accessibility to the waterfront shall be considered in the design stage of the proposed structures.

(7) Cultural Communities

The ethnic minorities have mainly established their cultural communities at the barangays located along the fringes of the mountains except for one community which is located in the watershed of the Labugaon River. Most minority groups work on the ancestral lands at hill/mountain areas and on the reforestation projects. Their access routes to the mountain areas are only along the river courses. The sabo dams with heights of about 8 to 10 m may interrupt their routes, while their accessibility will be improved by the construction road. Therefore, the design of the sabo dams will be considered to utilize the construction road as a permanent access route for people who work at the areas upstream of the sabo dams.

3.4 Summary of Initial Environmental Examination

The prediction and assessment of environmental impact of the Master Plan is summarized in the interaction matrix as shown in Table 3.1. Referring to this matrix, evaluation for the environmental impacts are enumerated as follows.

(1) Significant beneficial impacts of the projects

(a) Drastic improvement in hydraulic conditions of river systems;

(b) Drastic decrease of loss of land which are washed out during floods;

(c) Increase of productive area by converting river wash or riverbed;

(d) Increase of land use potential and land value of the existing flood prone area;

(e) Increase of possibility to construct rural roads and bridges in the alluvial fans due

to the stabilization of river courses;

(f) Relief of people from fear of losing their properties and investments;

(g) Activation of the regional economy by providing flood free areas; and

(h) Local employment generation during the period of project construction.

(2) Probable adverse impacts

(a) Turbid water discharged from the construction sites;

(b) Minor effects of emission of exhaust gas, dust and unpleasant noise produced by the operation of construction equipment;

(c) Construction work of Sabo dam will affect animals living in the mountains;

(d) Change of fishing ground in the rivers;

(e) Land acquisition of farmland and relocation/resettlement of inhabitants; and

(f) Change in distance for waterfront utilization.

TABLES

Table K.2.1 Water Quality of Laoag River

LOCATION STATION: LG-1, Guilbert Bridge, Laoag City, Ilocos Norte

Date	Temp. (C)	TDS (mg/l)	DO (mg/l)	pH	Turbidity (FTU)	TSS (mg/l)	Color (PCU)	Heavy Metals (mg/l) (Cu)	(Cr+6)	(Fe)	Chlorides (mg/l)
03-27-90	36.0	120.6	12.1	7.5				0.02	0.01		
04-26-90	34.5	122.7	10.5					0.02		0.02	
05-25-90	30.6	121.1						0.03	0.02	0.02	
06-01-90		89.9		8.0	25.00	32.00					
07-30-90	27.9	109.3			106.00	125.00					
08-21-90	29.8	139.4			44.00	63.00	206.00				
09-28-90	31.4	101.6			450.00	118.00	510.00				
10-31-90	29.9	102.4			2.00	2.00	14.00				
11-29-90	29.8	98.9			3.00	3.00	12.00				
03-19-91	32.5	136.0				41.00	11.00				
05-30-91	31.2	115.0			2.00	110.00	12.00				
06-21-91	29.1	315.0			4.00	3.00	31.00				
08-10-93	27.0	280.0	5.6	8.0							7.6
09-27-94	29.8	125.8	7.3	7.5							
03-15-95	32.0	130.0	11.5	7.0							
06-16-95	30.3	111.4	7.3	7.0	2.00	2.00	20.00	0.13	0.00	0.23	
11-27-95	29.9	106.9	6.5	7.0		10.00	22.00	0.01	0.12	0.1	
03-15-96	26.7		7.2	7.0		1.00		0.10	0.00		
2nd Q -96			6.3	7.1		77					
DENR Standard											
Class AA water		500	5.0 min	6.5 - 8.5		25.0	15.0	1.00	0.05		250
Class A water		1,000	5.0 min	6.5 - 8.5		50.0	50.0	1.00	0.05		250

Source : DENR Region I

Note: The water quality monitoring station at Gilbert Bridge, Laoag City had been established since 1990 with station identification LG-1, Laoag River was officially classified as Class A Water for Public Water Supply II.

Table K.2.2 Common Flora in Ilocos Norte

Scientific Name	Common Name
I. Species of Trees in Primary Forest	
Tarrietia sylvatica (Vidal) Merr.	Dungon
Shorea polysperma (Blanco) Merr.	Tanguile
Shorea guiso (Blanco) Blume	Guijo
Dipterocarpus grandiflorus (Blanco)	Apitong
Anisoptera thurifera (Blanco) Blume.	Palosapis
Vitex parviflora Juss.	Molave
Pentacme contorata (Vidal) Merr. & Rolfe	White Lauan
Balanocarpus cagayanensis Foxw.	Narek
II. Species of Trees in Second Growth Forest	
Albizzia procera (Roxb.) Benth.	Akleng parang
Antidesma bunius (Linn.) Spreng.	Bignay
Antidesma ghaesembilla Gaertn.	Gaertn.
Bambusa spinosa Roxb.	Bamboo (common)
Gliricidia sepium (Jacq.) Steud.	Madre cacao
Schizostachyum lumampao (Blanco) Merr.	Boho
Eugenia cumini (Linn.) Druce	Duhat
III. Species Planted in Reforestation Projects	
Pinus insularis	Benguet Pines
Tectona grandis	Teak
Shorea guisok	Yakal
Grulina Arborea	
Acacia auriculiformis	
Acacia mangium	
Eucalyptus Camaldulensis	
Swietenia macrophyla	Mahogany
Pterocarpus indica	Narra
Casuarina equisitifolia	Agoho
Glericidia sipium	Kakawate
IV. Grassland	
Cogon, Duhat, Binayoyo guava and other shrub trees	

Source: PENRO Ilocos Norte

Table K.2.3 Wild Fauna in Paoay Lake and Laoag River

Common Name (Local Name)
I. Birds
Cuckoo (Kakok), Pigion (Balud), Pipit, Oriole (Kiyaw), Crow (Uwak), Rails (Tikling), Maya (Billit Shina), Quail (Pugo), Wild chicken (Abuyo), Sunbird (Palal), Starlings (Martinez), Sway (Layang-layang), Lawin, Kingfisher (Salaksak), Balicasiano, Fantail, Graybird, Wagtail, Bulbul, Nightjar, Koal, Longtail warbler, Heron, Turtle Dove, Ruffon Night Heron, Oliveback flowerpicker, Wondering whistling duck
II. Reptiles/Amphibian
Frogs (Tukak), Snake (Uleg), Lizard (Banias), Skink (Alibot)
III. Fish
Species in Fresh Water Guby (Bukto/Palileng), Tilapia, Eel, Mudfish (Dalag), Catfish (Paltaf), Freshwater shrimp (Udang), Carp (Carpa), Gouramy, Climbing fish (Ar-aro)
Species in Brackish Water Goby (Ipusam), Eel (Igat), Mullet (Porong), Shrimps and Crabs Milkfish (Bangus)
Species in Offshore Tuna spp., Tuna-like, Croacker, Terapon, Sea bass, Skipjack, Mackerel, Sailfish, Barracuda, Stringrays, Squid

Source: Office of Paoay Lake National Park (for wild fauna)
Provincial Agricultural Office, Ilocos Norte

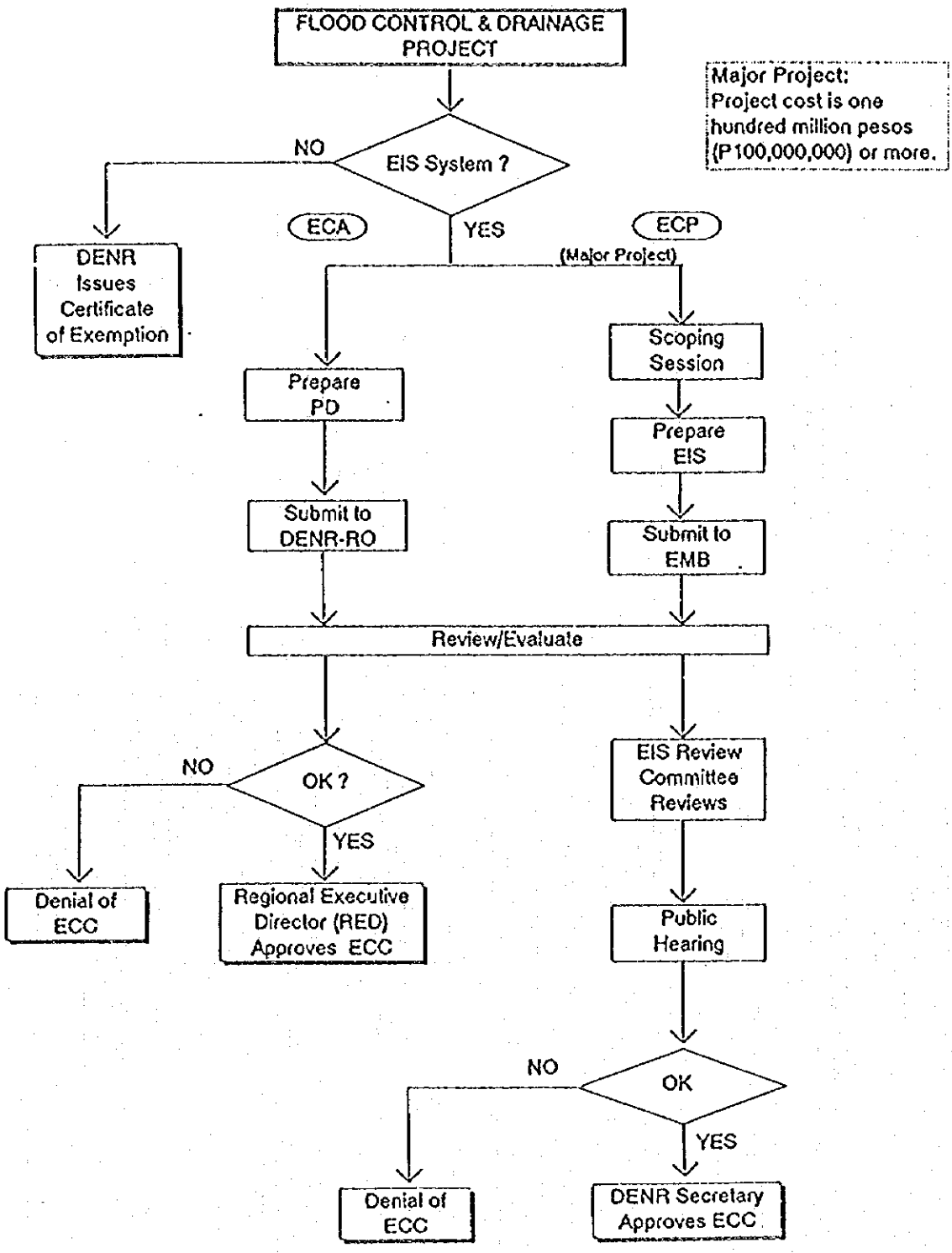
Table K.3.1 Environmental Interaction Matrix for the Master Plan

MAJOR ACTIVITIES (which may cause of Impacts)		ENVIRONMENTAL FACTORS														
		Physico-Chemical				Biological		Geological		Socio-Economic						
Project Stage	Activities	Surface Water	Groundwater	Topography	Air, Noise & Offensive Odor	Terrestrial Species	Aquatic Species	Scientific Interest	Aesthetic Potential	Economic Activities	Land Use	Transportation & Traffics	Historical & Archeological Interest	Health and Social Services	Life Style & Community	Cultural Communities
Pre-Construction	Land Acquisition										-					-
	Relocation or Resettlement										-					-
Construction	Labor Mobilization									+						
	Sabo Dam	-			-	-	--			++	-					
	Reinforcement of Existing Dike				-					+						
	New Dike				-		-			+	-					
	Channel Dredging	-			-		-			+	-					
	Spur Dikes				-		-			+	-					
	Bank Protection				-		-			+	-					
Post-Construction	Sabo Dam	+					-			+++	+++					
	Dikes	+++								+++	+++	++		+	++	
	River Channel	++								+++	+++	+++			++	

Note: + : Positive (Beneficial) Impact - : Negative (Adverse) Impact

Impact Categories : + or - : Possible but Minor Impact
++ or -- : Minor to Moderate Impact
+++ or --- : Moderate to Major Impact

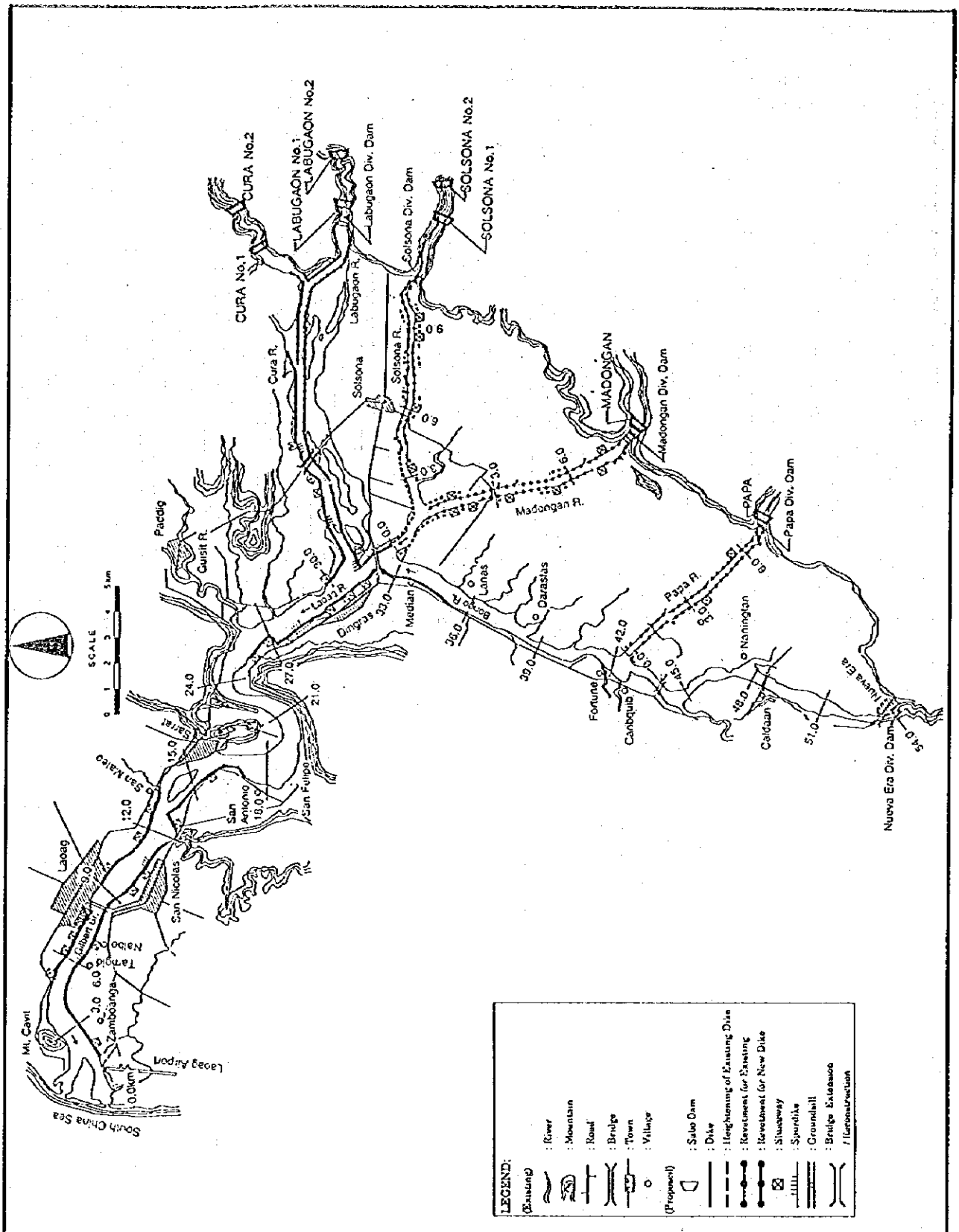
FIGURES



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. K.1.1
Conceptual Flow Chart of EIS System



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. K.3.1 Master Plan Components
JAPAN INTERNATIONAL COOPERATION AGENCY	

APPENDIX L

AEROPHOTOGRAMETRIC AND TOPOGRAPHIC SURVEY

APPENDIX L

AEROPHOTOGRAMETRIC AND TOPOGRAPHIC SURVEY

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CHAPTER I AEROPHOTOGRAMETRIC SURVEY

1.1 Outline

From the results of 1/20,000 scale aerial photography, ground surveying, and field verification were undertaken. For photo interpretation, aerial photographs with scale of 1/20,000 were used. Photogrammetric mapping which was done in Japan (refer to Fig. L.1.1) enabled the production of topographic maps with a scale of 1/10,000.

1.2 Field Surveying Work

The field survey works involved aerial photography and ground surveying (aerial photo signalization, monumentation, GPS surveying, leveling and field verification) which were undertaken as follows:

(1) Work Volume

Aerial Photo Signalization/Monumentation	:	20 points
Aerial Photography	:	1,100 km^2 (photo scale: 1/20,000)
GPS Surveying	:	23 stations
Leveling	:	220 km (pricking points: 500 points)
Field Verification	:	465 km^2

(2) Work Method

(a) Aerial Photo Signalization/Monumentation

Prior to aerial photography, aerial photo signals and monuments were set up in basketball courts and cultivated areas whose boundaries were clearly identifiable on the aerial photographs.

The concrete monuments were 20 cm by 20 cm by 60 cm in size with a pile nailed in at the center. Each monument has its name and "1996" marked on the surface.

Aerial photo signals located in the basketball courts were made by painting four leaves on the concrete base and the rest were made of wooden piles and white nylon sheets with each leaf having a size of 300 cm by 80 cm.

Coordinates and Heights of Monuments

Point Name	Coordinates E	Coordinates N	Height	Remarks
ILN-1	457,278.457	2,034,691.882		existing GPS point
ILN-3	480,250.294	2,000,321.738	117.114	existing GPS point
FCP-1	460,051.435	2,002,070.770	30.809	new control point
FCP-2	454,693.509	2,006,942.481	12.255	new control point
FCP-3	450,198.027	2,011,698.032	2.989	new control point
FCP-4	453,575.167	2,016,709.293	3.206	new control point
FCP-5	462,711.610	2,016,421.710	25.504	new control point
FCP-6	462,154.555	2,008,388.811	10.449	new control point
FCP-7	469,802.942	2,014,350.172	64.197	new control point
FCP-8	469,875.894	2,009,308.932	45.896	new control point
FCP-9	473,176.291	2,010,091.260	45.119	new control point
FCP-10	479,041.395	2,005,007.217	74.381	new control point
FCP-12	475,009.671	1,996,919.224	49.380	new control point
FCP-13	467,849.803	2,005,679.219	22.431	new control point
FCP-14	468,090.910	1,998,722.829	31.207	new control point
FCP-15	465,312.131	1,992,785.510	53.127	new control point
FCP-16	470,378.350	1,989,111.157	87.993	new control point
FCP-17	468,395.324	1,983,408.292	163.955	new control point
FCP-18	464,307.048	1,981,544.604	127.702	new control point
FCP-19	463,637.191	1,983,265.863	103.906	new control point
FCP-20	463,739.865	1,986,499.597	61.288	new control point

The two control points used as base points for determination of coordinates (horizontal positions) were ILN-1 and ILN-3. For height control, a total of 5 bench marks, i.e., BM LN-29, BM LN-31, BM GB-6, BM PR-7 and BM PR-14, were used as base points, assuming the height of BM LN-29 to be 10.910.

(b) Aerial Photography

Aerial photography was conducted by using a WILD RC30 aerial camera (f = 152.68 mm) mounted in Cesna 441 aircraft.

Flying 12 courses, it produced 157 sheets of aerial photographs in one roll at a scale of 1/20,000. Forward overlapping and side overlapping were 60% plus or minus 5% and 30% plus or minus 5%, respectively.

Course and Photo Names of Aerial Photography

Course Name	Direction	Photo Number	No. of Sheets
C01	West - East	01 - 15	15
C02	East - West	01 - 15	15
C03	West - East	01 - 19	19
C04	East - West	01 - 21	21
C05	West - East	01 - 19	19
C06	East - West	01 - 15	15
C07	West - East	01 - 11	11
C08	West - East	01 - 12	12
C09	West - East	01 - 11	11
C10	East - West	01 - 08	8
C11	West - East	01 - 06	6
C12	East - West	01 - 05	5

(c) GPS Surveying

To ensure the accuracy of horizontal positions in photogrammetric mapping (aerial triangulation and plotting), GPS surveying was carried out with the existing GPS stations of ILN-1 and ILN-2 as given to obtain coordinates of 19 newly established points. Observations and computations to determine the coordinates were made in the following manner:

i) Five or more satellites were observed for signals with 3 receivers in simultaneous use.

ii) The average height of satellites as observed was more than 15 degrees above the horizon.

iii) Observation was made for a duration of more than one hour at a time at each station.

iv) The results of initial computations were based on WGS-84 ellipsoid and, therefore, WGS-84 based coordinates were converted to Philippine standard Clark 1886 ellipsoid based coordinates by applying conversion parameters. After the conversion, they were made into plane coordinates of PTM zone 3.

The GPS computation results were found to be within the specified limits of accuracy:

Horizontal Positions	:	±2PPM × distance between two points observed simultaneously.
Height	:	±5PPM × distance between two points observed simultaneously.

(d) Leveling

Direct leveling was undertaken to determine the heights of 500 pricked points, which are important to ensure the accuracy of heights in photogrammetric mapping. Leveling routes were laid down in 7 loops with 6 spikes.

With respect to those spiked routes which included those starting from an existing point but not closing at an existing point as well as those not completing a loop closure, two-way observations were made.

The closure errors of minor order leveling with two-way observations and

complete loop closures were within the specified limit of 6 cm times square root of S (S= distance covered by one-way observation in km).

(e) Field Verification

Field verification was conducted to identify and reaffirm in the field such items to be represented in photogrammetric mapping, including geographical names and administrative boundaries, based on the map symbols and their application rules, and findings were incorporated in the two-time enlarged aerial photographs and other related materials to help subsequent plotting and compilation. Prior to the field survey, aerial photographs and other related materials were studied for areas and features that were not clearly identifiable and needed to be clarified, which then were marked on the aerial photographs and other related materials with color dermatograph pencils. The findings of the field verification were edited on the two-time enlarged aerial photographs using color drafting pens to help the compilation work that followed.

(3) Principal Instruments Employed

GPS Surveying	:	TRIMBLE ST4000 (3 sets)
Leveling	:	WILD NAK 2 (3 sets)
Computer	:	TOSHIBA (2 sets)
Printer	:	Canon BJ-30 (1 set)

(4) Work Periods

The field survey was started on 1 April 1996 and completed on 5 June 1996, as originally planned.

Aerial photo		
Signalization/Monumentation	:	02 April 1996 to 04 April 1996
Aerial Photography	:	02 April 1996 to 09 April 1996
GPS Surveying	:	02 April 1996 to 30 May 1996
Leveling	:	02 April 1996 to 23 May 1996
Field Verification	:	11 April 1996 to 25 May 1996

(5) Final Results of Field Surveying Work

(a) Description of Control Points : one set

(b) Results of Aerial Photography

Original Photo Negatives	:	1 roll
Contact Prints	:	314 sheets (2 sets)
Two-time Enlarged Aerial Photographs	:	157 sheets
Diapositive Films	:	157 sheets
Flight Index Maps	:	one set

Note: The complete sets of aerial photographic materials as listed above, were delivered to the Mapping Center of the Republic of the Philippines except for the flight index maps.

(c) Results of GPS Surveying

Computation Sheets*	:	one set
A GPS Surveying Points Index Chart	:	one set

* : Description of control points (entered in the same description as listed in (a)

(d) Results of Leveling

Observation Notes	:	one set
Computation Sheets	:	one set
A Leveling Routes Index Chart	:	one set

(e) Results of Field Verification

The results were entered in the above two-time enlarged aerial photographs.

1.3 Mapping in Japan

Photogrammetric mapping was made from the aerial photographs and ground surveying results which were brought to Japan accompanied by Philippine security officers because of the sensitive nature of the materials. In the presence of the security officers, aerial triangulation, plotting, compilation and drafting were carried out to produce 1/10,000 scale topographic maps. The aerial photographs and related materials were returned to the custody of the Philippine Mapping Center after the mapping was concluded.

(1) Work Volumes

Aerial Triangulation	:	143 models
Plotting	:	465 km^2(1/10,000), 22 sheets (A1 size)
Compilation	:	22 Sheets
Drafting	:	22 sheets

(2) Work Method

(a) Aerial Triangulation

Aerial triangulation was performed on the 1/20,000 scale diapositive films, with photo coordinates of control points determined by using a coordinatgraph which included tie points, GPS stations, bench marks, pricked points, as necessary for plotting, and adjustment computations made based on the camera calibration report and GPS surveying/leveling results to obtain PTM coordinate values (horizontal positions and heights) and orientation elements for machine plotting.

(b) Plotting

Plotting was done by placing a pair of consecutive aerial photographs (diapositive films) side by side in the stereo-plotter and recreating the photographed features in stereo (by setting orientation elements of the aerial photographs involving positions, rotation, tilts, etc.). By observing the stereo images a topographic map with the scale 1/10,000 was created, which were delineated initially to make plotting manuscript sheets. Intermediate contour lines were shown at intervals of 2 meters in principle with the exception of some parts of mountainous areas where the interval is 5 meters. (For the flat lands, supplementary contour lines were

delineated at 1-meter intervals). Spot heights were represented by one point for an area of 5 cm by 5 cm. The map sheet size was 60 cm by 80 cm, or A1 size, as measured along the inside neatlines.

(c) Compilation

The plotting manuscript sheets were edited according to the map symbols and their application rules and made into 1/10,000 scale compilation manuscript sheets with penciled representations.

(d) Drafting

Based on the compilation manuscript sheets, original topographic maps were drawn on the polyester base (#500) least subject to expansion/contraction in black ink by the standard drafting method (fair drawing) according to the map symbols and their application rules as agreed to by the Department of Public Works and Highways of the Philippine Government.

The same map design as that of the existing 1/10,000 scale topographic maps was applied.

(3) Principal Instruments Employed

Aerial Triangulation, FACOM M760-4 (Fujitsu)	:	1 set
Plotting, Autograph A8	:	4 sets

(4) Work Periods

The photogrammetric mapping was started on 21 May 1996 and completed on 31 July 1996, as originally planned.

Aerial Triangulation	:	21 May 199 to 04 June 1996
Plotting	:	05 June 1996 to 20 June 1996
Compilation	:	17 June 1996 to 01 July 1996
Drafting	:	02 July 1996 to 31 July 1996

(5) Final Results of Photogrammetric Mapping

(a)	Results of Aerial Triangulation		
	- Observation Notes/Computation Sheets	:	1 set
	- Index Chart	:	1 sheet
(b)	Results of Plotting		
	- Scale Plotting Manuscript Sheets	:	22 sheets
(c)	Results of Compilation		
	- Scale Compiled Manuscript Sheets	:	22 sheets
(d)	Results of Drafting		
	- Scale Original Topographic Maps	:	22 sheets
	- Scale Duplicated Topographic Maps (Sheets Nos. 1 to 21 and 18 - 1)	:	1 set

CHAPTER II TOPOGRAPHIC SURVEY

2.1 Objective Rivers

Longitudinal profile and cross-sectional surveys were conducted for the following rivers:

(1) Laoag River
(2) Bongo River
(3) Papa River
(4) Madongan River
(5) Solsona River
(6) Cura River
(7) Labugaon (1) River
(8) Labugaon (2) River
(9) Guisit River

In addition to the above longitudinal and cross-sectional survey, bathymetric survey (sounding) was conducted for the coastal line at the river mouth of the Laoag River.

Location of the objective river stretches and coastal area are shown in Fig.L.2.1.

2.2 Contents and Quantities of Survey Works

Contents and quantities of the survey works are summarized as follows:

(1) Control Point Survey : 27 points
(2) Leveling Survey of Bench Mark : 60 km for 20 bench marks
(3) Survey for Kilometer- Post Setting-up : 148 km for 327 posts
(4) Longitudinal Profile and Cross-sectional Survey

River	Longitudinal Survey Length (km)	No. of Cross-sections	Average Cross-section Width (m)	Total Cross-section Survey Length (km)
Laoag	16.2	56	1,130	63.28
Laoag / Bongo	43.8	81	450	36.45
Papa	12.0	27	360	9.72
Madongan	17.0	36	180	6.48
Solsona	19.5	43	440	18.92
Cura	18.0	38	790	30.02
Labugaon (1)	11.0	25	300	7.50
Labugaon (2)	2.2	7	170	1.19
Guisit	8.3	14	315	4.41
Total	148.0	327		177.97

(5) Sounding Survey at the Laoag River Mouth

Survey Area	:	11 km^2
Width	:	11.0 km along the coastal line
Length	:	1.0 km toward offshore
No. of Survey Sections	:	16 sections

2.3 Method of Survey

2.3.1 Control Point and Bench Mark Leveling Surveys

The control point survey and bench mark leveling survey were conducted based on the control points and bench mark managed by the National Mapping and Resources Information Authority (NAMRIA). They are as shown below.

(1) Control Point: UTM. PHILIPPINE COORDINATES SYSTEM

a) Pasuquin 1 LN 1

b) Solsona 1 LN 3

(2) Bench Mark: PHILIPPINE VERTICAL DATUM

BM (GB6) at Laoag Airport

Location of the above control points and bench mark are shown in Data Book.

Thirty (30) control points were set up along the main river and tributaries by using GPS, based on the above NAMRIA control point. They are made of concrete pile (30 cm x 30 cm).

Fifteen (15) bench marks were set up along the left bank of the Laoag and Bongo rivers of 60 km between the river mouth and Nueva Era, based on the above NAMRIA bench mark. They are made of concrete.

The above surveys were performed with the following accuracy.

a) Control Point Survey: Closing error of coordinates < 1 /5,000

b) Bench Mark Leveling Survey: Error < 10 mm S,
where, S : one way distance (km)

2.3.2 Survey for Kilometer Post Installation

The kilo-posts were set up through the following procedures.

(1) The kilo-posts were located on 1 / 50,000 maps.

(2) The coordinates of river center lines and kilo-posts were calculated on the maps.

(3) The river center lines and kilo-posts on the river banks were set up by using GPS, based on the coordinates of the above control points.

The kilo-posts were set up at the following intervals.

a) Laoag River (0 km - 16.2 km) : 300 m

b) Laoag - Bongo River (16.2 km - 60.0 km) : 600 m

c) Tributaries : 500 m

The concrete-made kilo-posts (30 cm × 30 cm) were set up at an interval of 1,000 to 1,200 m and the others are made of wood.

The kilo-post installation survey was performed with the following accuracy:

Closing Error < 1 /3,000

2.3.3 Longitudinal Profile Survey

The longitudinal profile survey was conducted based on the above-mentioned bench marks. The longitudinal profile survey measured the elevation of the kilo-posts, tributary confluence, drainage culverts, intake pumps ,intake dams and other major river structures.

The longitudinal profiles are drawn in the following scales:

(1) Horizontal : 1 / 20,000

(2) Vertical : 1 / 100

The survey was performed with the following accuracy:

Error < 20 mm × S, where, S : one way distance (km)

2.3.4 Cross-sectional Survey

The cross-sectional survey was carried out for the 300 river sections at kilo-post. The survey width in cross-sectional direction is as follows:

Lower Reaches	:	Up to the riverbank 10m higher than the riverbed or up to the neighboring road.
Alluvial Fan Area	:	Up to 100 m inner point from the riverbank
Valley Area	:	Up to the riverbank 20 m higher than the riverbed.

The cross-sections are drawn in the following scales:

(1) Horizontal : 1 / 2,000

(2) Vertical : 1 / 100

The survey was performed with the following accuracy.

(1) Distance : Error < 1 /300

(2) Elevation : Error < 5 cm + 15 cm × S/100, where, S : survey length (m)

2.3.5 Sounding Survey at the River Mouth

The survey was carried out along the coastal line at the river mouth for a total distance of 11 km (5.5 km each toward north and south from the river mouth center). The sounding was conducted along 16 traversal sections set perpendicular to the coastal line up to 1.0 km offshore.

A bathymetric map and cross-sections were prepared based on the sounding survey. The sounding was performed with the following accuracy:

(1) Distance : Error < 1 / 300

(2) Depth : Error < 30 cm

2.4 Work Period

All survey works were completed within three (3) months from April 1,1996 to June 30, 1996.

2.5 Results of the Survey

All the results are compiled in the following maps, drawings, tables, notes and calculations.

(1) Bench Mark Leveling Survey

(a) Data of the existing bench mark
(b) Networks of leveling survey and location of bench marks
(c) Results of bench mark leveling survey
(d) Survey notes

(2) Control Point Survey

(a) Data of the existing control points
(b) Networks of control point survey
(c) Results of control point survey
(d) Survey notes

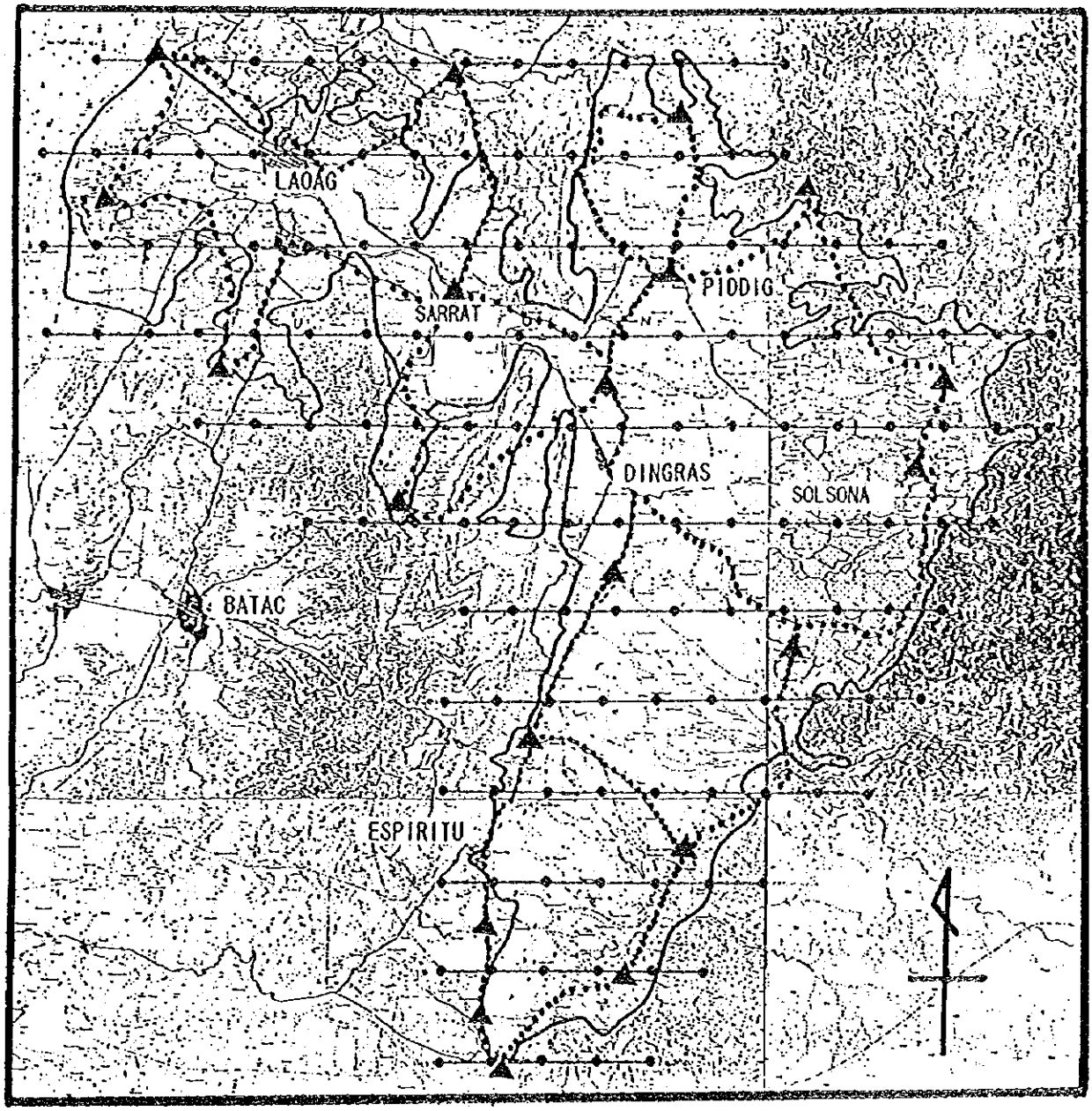
(3) Survey of Center Line and Kilo-post Installation

(a) Calculations of center line coordinates
(b) Calculations of kilo-post coordinates
(c) Location map of center line and kilo-post

(4) Drawings

River	Longitudinal		Cross-Section		Map	Floppy Disk
	A1	A3	A1	A3		
Laoag - Bongo	5	5	94	94		Available
Papa	2	2	8	8		Available
Madongan	2	2	15	15	1:10,000	Available
Solsona	3	3	15	15	1:20,000	Available
Cura	2	2	16	16	21 Sheets Each	Available
Labugaon - 1	2	2	7	7		Available
Labugaon - 2	1	1	1	1		Available
Guisit	2	2	3	3		Available
Sounding			12	12	2	
Index Map	1:20,000 (8 sheets), 1:50,000 (2 sheets)				10	
Total	19	19	167	167	33	

FIGURES



Legend

●——●	Aero-Photo Shooting (Scale 1:20,000)	12 courses (157 sheets) 245km length
▲	Control Points (GPS)	20 points
●●●●●●●●●	Leveling Survey	220km
●——●	Aerial Triangulation	143models

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

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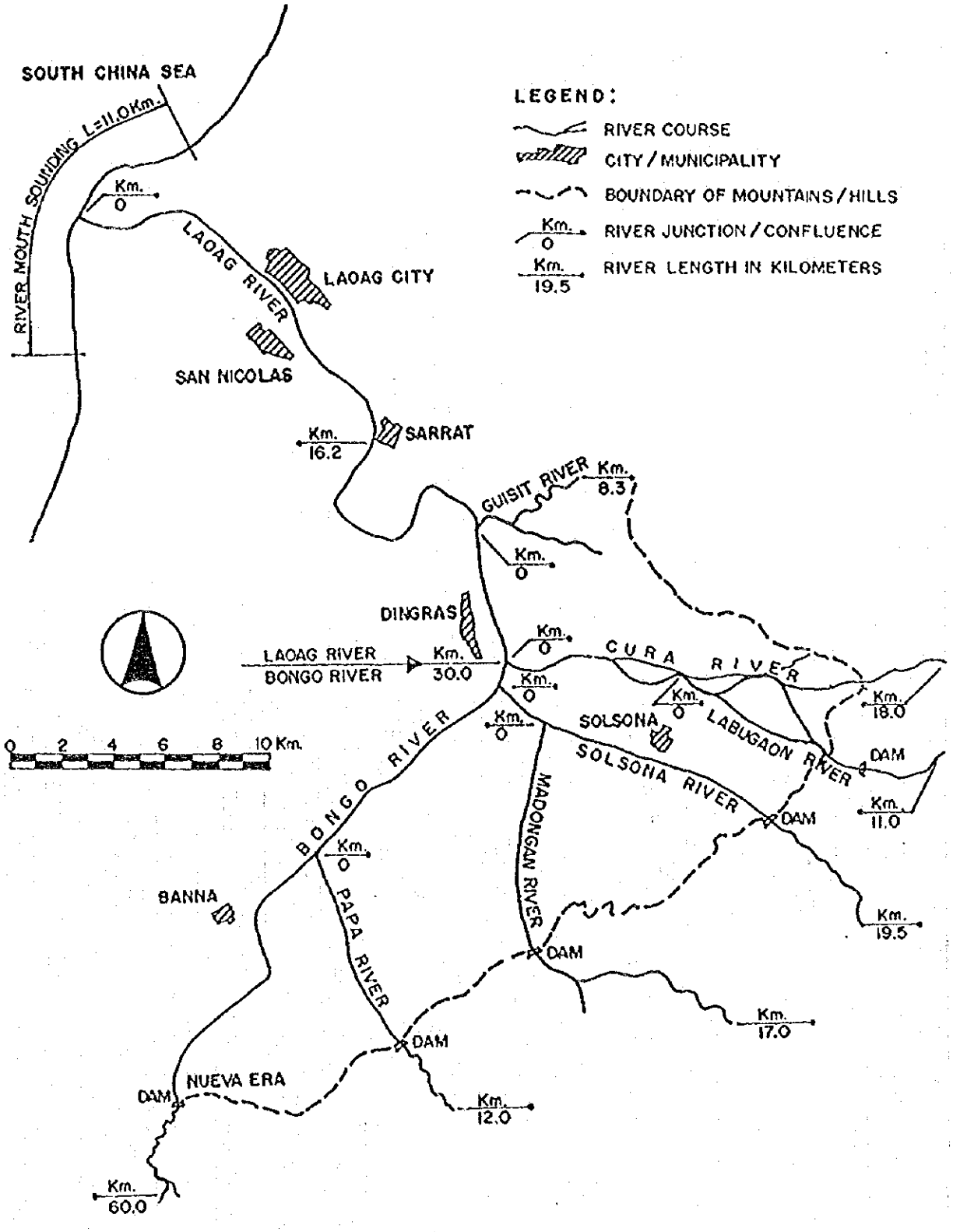
Fig. L.1.1
Plan of Aerophotogrametric Survey



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. L.2.1 Location of River and Sounding Surveys