PN AF 381

FEASIBILITY STUDY AND MASTER PLANNING
DRAFT FINAL REPORT

FOR

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
AND
COORDINATING COUNCIL OF THE PHILIPPINE ASSISTANCE PROGRAM

CAGAYAN DE ORO - ILIGAN AIRPORT

VOLUME II — MASTER PLAN

Prepared by:

LOUIS BERGER INTERNATIONAL, INC.

in association with

LOCKWOOD GREENE INTERNATIONAL, INC.

GLOBETROTTERS ENGINEERING CORPORATION

TRANS-ASIA (PHILS.) INC.

CONSULTANT MANAGEMENT SERVICES, INC.

ERNST & YOUNG

Under
U.S. Agency for International Development
Contract No. 492-0452-C-00-000990
Philippine Assistance Program Support Project No. 492-0452

September 1991

The completion of this study/report was funded by the United States Agency for International Development (USAID). The views, statements, and opinions contained in this report are the authors' alone and are not intended as USAID recommendations, conclusions or statements of USAID policy.

LOUIS BERGER INTERNATIONAL, INC.
TM 8910, Mile Long Center
Amorsolo St., Legaspi Village
Makati, Metro Manila, PHILIPPINES

Architects • Engineers • Economists • Planners

Telephone 63 (2) 88 06 80
88 06 90
817 0405
Telefax 63 (2) 819 3965

Ref. No.: SBD/152C/91-1867/rgt

October 4, 1991

Mr. Alex Sundermann, P.E.
Project Officer/Office of Capital Projects
USAID/Manila
18F, Ramon Magsaysay Center
1680 Roxas Boulevard
Manila, Philippines

Subject: **DRAFT FINAL REPORT**

Project: **DELIVERY ORDER NO. LBII-03**
FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN CORRIDOR AIRPORT
PHILIPPINE ASSISTANCE PROGRAM SUPPORT
CONTRACT NO. 492-0452-C-00-0099-00

Dear Mr. Sundermann:

Pursuant to Section V.C. of the Scope of Work for the subject Delivery Order Contract, we are pleased to submit herewith for your review and comment three (3) copies of the Draft Final Report for the Cagayan de Oro - Iligan Airport Study. The report is arranged in three Volumes:

Volume I:	Feasibility Study
Volume II:	Master Plan
Volume III:	Geotechnical Report

In accordance with our previous discussions, we are concurrently distributing copies of this report as per the attached distribution list.

By copy of this letter, we request that the recipient agencies named on the attached list review this Draft Final Report and direct any comments or inquiries to the following office:

Undersecretary Mr. Rogelio L. Singson
Executive Director, CCPAP
Room 1400, 14F, Multi-storey Building
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A. Mabini Street, Ermita, Manila

We further request that a briefing meeting be scheduled for this project at your convenience, but preferably within ten (10) days of receipt of this document. In the meantime, we shall proceed with our own in-house review of the report in preparation for submission of the Final Report.

Should you have any questions, or require further information, please feel free to contact this office.

Very truly yours,
LOUIS BERGER INTERNATIONAL, INC.

WILLIAM J. PARENTE
PAPS Project Manager

STEVEN B. DOERR
Team Leader

xc: Pat Quinn, Group Vice President, Louis Berger-Wash., D.C.
Ron Kornell, Regional Vice President, Louis Berger-Bangkok
Joseph Weiss, Home Office Coord., Louis Berger-East Orange

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FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO — ILIGAN AIRPORT

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Acronyms and Abbreviations

AASHTO	*American Association of State Highway and Transportation Officials*
A300	*Airbus Industrie, wide-body aircraft, model A300*
ACC	*Area Control Center*
AOA	*Airport Operating Area*
APP	*Approach Control Office*
ATO	*Air Transportation Office*
ATS	*Air Traffic Services*
B737-300	*Boeing Commercial Airplane Co., wide-body aircraft, model 737, series 300*
BAC1-11	*British Aerospace (Commercial Aircraft) Ltd., narrow-body aircraft, model 1-11*
BOT	*Build, Operate, Transfer*
CATC	*Civil Aviation Training Center*
CBR	*California Bearing Ratio*
CFR	*Crash, Fire, Rescue Facility*
CODA	*Committee on Official Development Assistance*
DAR	*Department of Agrarian Reform*
DBST	*Double Bituminous Surface Treatment*
DCIC	*Diamond Cement and Industrial Corporation*
DME	*Distance Measuring Equipment*
DOTC	*Department of Transportation and Communications*
ea	*east*
ea	*each*
ENE	*east-northeast*
ESE	*east-southeast*
F50	*Fokker Airplane Co., turboprop aircraft, model 50*
FAA	*Federal Aviation Administration (USA)*
FIR	*Flight Information Region*
FSS	*Flight Service Station*
GA	*general aviation*
GEC	*General Engineering Consultant*
GOP	*Government of the Philippines*
GP	*Glide Path*
GS	*Glide Slope*
h	*hour*
ha	*hectare*
HIRL	*High Intensity Runway Lights*
HITAER	*High Intensity Taxiway and Apron Edge Right*
HLURB	*Housing and Land Use Regulatory Board*
ICAO	*International Civil Aviation Organization*
IFR	*Instrument Flight Rule*
ILS	*Instrument Landing System*
km	*kilometer*
LLZ	*Localizer*
lm	*linear meter*
MALS	*Medium Intensity Approach Lighting System*
MDA	*Medium Decent Altitude*
MDD	*Maximum Dry Density*
MIRLS	*Medium Intensity Runway Approach Lighting System*
MITLS	*Medium Intensity Taxiway Lighting System*
MLS	*Microwave Landing System*
MM	*Middle Marker Facility*
mt	*metric ton*
MV	*Major Vehicle*
N	*north*
NAIA	*Ninoy Aquino International Airport*
NAMRIA	*National Mapping and Resource Information Authority*
NAVAID	*Navagational Aid*
NDB	*Non-Directional Beacon*
NE	*northeast*
NM	*nautical mile*
NNE	*north-northeast*
NNW	*north-northwest*
NW	*northwest*
OM	*Outer Marker Facility*

PAGASA *Philippine Atmospheric, Geophysical, Astronomical Services Administration*
PAL *Philippine Airlines*
PAPI *Precision Approach Path Indicator*
PCC *Portland Cement Concrete*
PCN *Pavement Classification Number*
PHILVOL *Philippine Institute of Volcanology*

REIL *Runway End Identification Light*
RESA *Runway End Safety Area*
RIV *Rapid Intervention Vehicle*
RVR *Runway Visual Range*

S *south*
SALS *Simple Approach Lighting System*
SD360 *Short Brothers, Inc., turboprop aircraft, model 360*
SE *southeast*
SSE *south-southeast*
SSW *south-southwest*
SW *southwest*

TOR *Terms of Reference*
TWR *Aerodrome Control Tower*

USAID *United States Agency for International Development*

VASIS *Visual Approach Slope Indicator System*
VFR *Visual Flight Rule*
VHF *Very High Frequency*
VOR *VHF Omnidirectional Radio Range*

W *west*
WDI *Wind Direction Indicator*
WNW *west-northwest*
WSW *west-southwest*

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EXECUTIVE SUMMARY

This study examines the alternative airport facilities for meeting the future needs for the agricultural and industrial development of the Cagayan de Oro-Iligan Corridor, in North-Central Mindanao. The technically adequate sites for airport development are identified, and their feasibility determined, based on economic criteria. An airport master plan is developed for the site chosen as the most appropriate, from both technical and economic standards.

The Corridor is a major growth area in Mindanao, and includes the provinces of Bukidnon, Misamis Oriental, Lanao del Norte, Lanao del Sur (excluding Malabang), and the island province of Camiguin. The total Corridor population is about three million, and the area covers 1.8 million hectares. The two main cities are Cagayan de Oro, located toward the eastern side of the Corridor, and Iligan, located on the western side. Both are major industrial and commercial centers, surrounded by a rich agricultural region, with primary production including a wide variety of high valued-added fruits and vegetables, fish, and meat, along with staples such as corn and rice. The area is relatively free from typhoons, and has potential for new agribusiness ventures, such as cut flowers and ferns, in addition to the expansion of more traditional high-valued primary products.

There are currently two commercial airports in the region: the Cagayan de Oro (Lumbia) Airport, 8 kilometers SSW of the central business district of Cagayan de Oro City; and the Iligan (Balo-i) Airport, 17 kilometers SSW of Iligan City. Together they generate nearly 350,000 emplanements/year, a number expected to grow, under conservative assumptions, to about 650,000 by the end of the 20-year study period, in 2011.

Both airports have terrain restrictions that rule out both night flights and wide-body aircraft. Balo-i is limited to receiving turboprop aircraft only, and Lumbia cannot handle wide-body jets. Cargo-handling capacity is virtually non-existent at Balo-i, which handled only 134 tons in 1990, and is severely restricted at Lumbia, where 4,512 tons were handled, despite the ample potential of high value-added shipments in the Corridor. Flight cancellations due to weather at the two terminals, although a small percentage of total flights, are more frequent than they would be at locations nearer sea level, and a number of accidents have occurred in the vicinity of Balo-i, including two crashes of small commercial aircraft with no survivors in a 20-year period.

In addition to the two existing airports, three additional sites were identified where airports could be built in the Corridor. The first, Linamon, lies 15 kilometers SW of Iligan and, except for a somewhat lower altitude, has the same limitations as the existing site at Balo-i. The second, Iponon, is 6 kilometers west of Cagayan de Oro and, aside from lower elevation, has the same limitations as the existing site at Lumbia, although it would reduce access travel distance from the Iligan side by 14 kilometers. Neither the Iponon nor the Linamon alternatives is economically viable. Although construction was initiated at Linamon some years ago, the terrain is so unfavorable for construction that its completion would cost more than a new airport at the Iponon site, making Linamon the least attractive site among the three.

The only site capable of handling wide-body jets is at Laguindingan, located between Cagayan de Oro and Iligan. A runway 2,500 meters x 45 meters could be constructed near sea level with both approaches over water, an ideal situation for aircraft operations. This runway can accommodate the A300 wide-body aircraft, and can, if necessary, be lengthened in the future to accommodate B747s, the largest commercial aircraft presently in use. In relation to the Lumbia Airport which handles 83 percent of current air trips and over 90 percent of air passenger mileage, the Laguindingan site reduces the ground access distance for west-side (Iligan) passengers by 43 kilometers, while increasing the ground access distance for east-side (Cagayan de Oro) passengers by only 29 kilometers.

Although both Lumbia and Balo-i airports could be upgraded to continue handling the type of aircraft they now receive without any capacity problems during the 1992-2011 study period, Laguindingan offers several advantages. Laguindingan can accommodate night flights, reducing the number of days needed to spend a full business day at the destination from the current two or three to only one. Moreover, the additional flight(s) can be added at low marginal cost to the airline(s): crews and planes are available, while the number of night destinations in the Philippines is currently very limited. Second, there would be a minimum of cancellations due to terminal weather on the Corridor side. Thirdly, larger, more comfortable, and more economic aircraft could be used, and these would, for the first time, make significant amounts of cargo space available to local shippers. This would make new investments feasible in agribusiness, industry, and commerce that require a reliable supply of air cargo space.

The Laguindingan alternative would require closure of the two existing airports, as it would be uneconomic to maintain three airports in such close proximity. It would result in increased frequencies, greater capacity aircraft, and night flights, service variables that are expected to increase passenger levels by some 14 percent, to a total of 689,164 in 2011. Iligan passengers would be much better served than at present, except for the short route to Cotabato City, which is currently heavily cross-subsidized from PAL's other routes. Travelers from the Cagayan de Oro side would face longer access distance than at present, but other service variables would be improved. Under the one-airport assumption, the Laguindingan alternative is economically feasible, even under the very high real rate of discount of 15 percent per annum.

Current tariff rates, including the ₱1.50 boarding fee, are so low that maintenance and operation expenses at the two existing airports are not covered by user fees, nor would they be at Laguindingan. The proposed 1992 fee increase, would cover those expenses, without defraying any significant amount of construction costs.

The current Ninoy Aquino International Airport (NAIA) rates, featuring a ₱120 boarding fee, can be used to generate enough revenue to pay back the real value of construction costs (₱738 million), provided no interest is charged, and assuming that the rates are readjusted, as needed, to cover future inflation. The NAIA boarding fee is 80 times the current charges at Lumbia, and 20 times the level proposed for Lumbia and similar airports for 1992. It is equal to 6.6 percent of the price of the Cagayan de Oro-Manila trip, and to much higher percentages of ticket prices on shorter routes. Therefore, it is unlikely that a Build-Operate-Transfer (BOT) proposal would attract investments from the private sector to build and operate the proposed Laguindingan Airport.

Nevertheless, adoption of NAIA-level fees and administration by an independent authority could cover all operating and maintenance costs, and defray most of the real costs of construction, exclusive of interest. An alternative means of administration, however, such as administration by a private entity under contract, would be a more viable institutional manner of ensuring that a substantial share of the capital costs are in fact recovered. Contract operation would be more likely to provide guarantees of inflation-based adjustments of airport fees, and would encourage the commercial development of associated services at the terminal, generating additional revenue that could be partially passed on to the airport's public owner by means of revenue-sharing agreements in the contract.

In order to ensure the technical feasibility of the project a physical plan of the Laguindingan Airport was developed. All standards of the International Civil Aviation Organization (ICAO) can be accommodated at the proposed site. The 09/27 (N 85°30′12″ E) runway orientation places both approaches, and circling maneuvers over water, making for ideal, obstruction-free aviation operations.

The lack of obstructions permits Category 1, precision instrument operation which will allow all-weather, 24-hour use of the airport facility. Noise contours, generated for future air traffic levels, indicate that noise impacts will be minor, with most of the effects contained within the airport property. Approach and departing flight paths will be primarily over water, avoiding the major population centers.

The relatively sparsely populated area around the site minimizes the social impact of the airport project itself, although 50 families will have to be relocated. However, when an airport is constructed in a new area, rapid development usually occurs around the airport. A comprehensive zoning and master plan should be developed for the area to ensure that the necessary infrastructure is in place to support this development. Public hearings and consultations with area officials is an effective way of gaining public support for the project.

Once the decision is made to precede with the project a number of project tasks must be addressed immediately. These include land acquisition (purchase, lease, continued private ownership); geotechnical investigations; meteorological monitoring; and, the formulation of an engineering contracting strategy.

Three general approaches to the engineering implementation of the project are possible:

- Design-Build, under which a single contractor is selected to both design and build the project;
- Design-Award-Construct, the traditional approach under which the final design is performed under one contract and then a competitive selection of construction contractors is made, based on the final design; and,
- Fast Track, under which construction is begun prior to the completion of the final design (can be applied to either the Design-Build or the Design-Award-Construct approaches).

Given the scale of the airport project, the likely budgetary constraints, and the schedule requirements, as well as normal governmental contracting practices, the traditional Design-Award-Construct approach is likely to be the preferred method of implementation.

A variety of contractual arrangements are possible under the design-award-construct approach. Again, based on the specific characteristics and requirements of the project, the preferred contractual approach is likely to be the selection of a General Engineering Consultant (GEC), to perform detailed surveys and final design under the general supervision of the Department of Transportation and Communications and the Air Transportation Office. The GEC would supervise the construction of the airport, to be performed by a separate contractor, or contractors, with the GEC providing all quality control and contract administration services. The GEC can also be used to perform a variety of other functions during the implementation program.

This preliminary master plan and feasibility study is one of the first steps in the process of realizing the goals of the project. Implementation of the Laguindingan Airport will require an integrated, multi-disciplinary effort carefully coordinated by the Department of Transportation and Communications and the Air Transportation Office in order to ensure maximum efficiency.

CHAPTER 1

PROJECT OVERVIEW

1.1 INTRODUCTION

It is the policy of the Government of the Philippines (GOP) to spread industrialization to rural areas with high potential for development. In keeping with this policy the GOP approved the Cagayan de Oro Special Development Project which aims to contribute to the regional development by attracting new industries and investments to Northern Mindanao. The focus of the project is the development of the Cagayan de Oro-Iligan Industrial Corridor—the area from Claveria and Jasaan to the east of Cagayan de Oro to Kalambugan to the west of Iligan City. An element that is essential for the development of the Corridor into an industrial/agro-industrial center is the improvement of air transportation facilities.

1.2 GOALS AND OBJECTIVES

The Cagayan de Oro-Iligan Airport Feasibility Study and Master Plan has been conducted under the auspices of the Coordinating Council of the Philippine Assistance Program, for the Department of Transportation and Communications, to determine an airport facility that will meet the future agricultural and industrial development of the Cagayan de Oro-Iligan Corridor. The study was funded by the U.S. Agency for International Development.

The primary objectives of this study are to:

- evaluate the existing Corridor airport facilities to determine upgrades required to meet international standards and their capability of meeting the air traffic demand over the 1991-2011 study period;
- identify other sites, within the Corridor, capable of supporting international standard airport development;
- evaluate the existing airports and identified sites to determine the development alternative which is technically feasible and best meets the needs of the Corridor;
- perform detailed economic and financial analyses of the preferred alternative to determine its viability;
- investigate potential financing methods and sources;
- prepare an airport master plan of the general layout of the preferred alternative;
- produce a preliminary (10%) design of the proposed airport; and
- develop an implementation action plan.

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1.3 ORGANIZATION OF THE REPORT

The Cagayan de Oro-Iligan Airport Study is organized into three volumes, namely: Feasibility Study; Master Plan; and the Geotechnical Report. Chapters are arranged within each volume as follows:

VOLUME I — FEASIBILITY STUDY

Chapter 1 provides an overview of the goals, objectives, and organization of the Cagayan de Oro-Iligan Airport Study.

Chapter 2 presents the socio-economic setting of the airport service area including economic structure, population, and trends and prospects for growth in the five provinces making up the service area.

Chapter 3 discusses the present transportation systems in the airport service area. The chapter focuses on the aviation sector in its analysis.

Chapter 4 examines the existing air transport facilities; the Cagayan de Oro and the Iligan airports. Includes an inventory of existing facilities, operations and conditions at the airports and their vicinities.

Chapter 5 discusses the screening process used in the selection of five candidate sites: Cagayan de Oro Airport, Iligan Airport, the Iponon site, the Laguindingan site, and the Linamon site. Compares relative advantages and disadvantages of sites with respect to airport development and presents alternative airport development strategies.

Chapter 6 presents forecast of commercial aviation activity at the airport(s), including passengers, cargo, aircraft movements, and peaking patterns. Forecasts were made for the Cagayan de Oro Airport, the Iligan Airport, and a new Corridor airport.

Chapter 7 performs comparative economic analyses of sites identified for airport development as a means of narrowing the field of alternatives. Detailed economic and financial analyses of the preferred alternative is presented.

VOLUME II — MASTER PLAN

Chapter 1 herein, provides an overview of the goals, objectives, and organization of the Cagayan de Oro-Iligan Airport Study.

Chapter 2 outlines the planning process, and describes and addresses the purpose and objectives of an airport master plan.

Chapter 3 presents the physical plan and preliminary design of the proposed Laguindingan Airport. Cost estimates for the Laguindingan Airport is also included.

Chapter 4 reviews the existing organizational structure of the Cagayan de Oro and Iligan airports. Based on this review an operations organizational structure for the Laguindingan Airport is developed.

Chapter 5 develops an implementation action plan, including identification of the components of a coordinated implementation strategy and of alternative organizational structures for directing and implementing the airport development program.

VOLUME III — GEOTECHNICAL REPORT

Chapter 1 provides an overview of the goals, objectives, and organization of the Cagayan de Oro-Iligan Airport Study.

Chapter 2 presents the subsurface logs for test pits and auger holes excavated as part of the geotechnical investigation of the airport site. Laboratory test results: MDD and CBR tests; sieve analyses; and aggregate tests of material sources, are also included.

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CHAPTER 2

MASTER PLAN

2.1 INTRODUCTION

This chapter provides an overview of the master planning process followed for this study and presents the sequence and relationships between the various steps in the process; each step in the process is described in detail elsewhere in the report.

Master planning for the Cagayan de Oro-Iligan Corridor airport followed an eight-step process:

- statement of objectives
- resource evaluation
- activity forecast
- facility requirements assessment
- alternative analysis
- preferred alternative selection
- detailed analysis of the preferred alternative
- master plan formulation

This process conforms to airport master planning guidelines of both the International Civil Aviation Organization (ICAO) and the US Federal Aviation Administration (FAA), and is tailored to meet the specific requirements of the Corridor and the objectives of the planning authorities involved. The process follows a logical step-by-step approach which results in an optimal plan from both planning theory and public policy points of view.

A later section of this report (Volume II, Chapter 5) explains how this planning process forms a component of the overall implementation program.

Each of the planning process steps is discussed in the sections that follow.

2.2 STATEMENT OF OBJECTIVES

The master planning process for the Corridor airport facilities began with a clear understanding of the goals and objectives of the program. The key planning objective was presented in the project Terms of Reference (TOR): *the objective is to provide airport facilities in the Corridor which will accommodate international-standard commercial air service.*

In addition to this key guiding objective, a number of other objectives were analyzed and articulated during the study. These objectives included:

- national development policy for both general economic development and infrastructure development;
- level of commercial air services to be provided to all areas of the Corridor;
- ground accessibility to all portions of the Corridor;
- utilization of existing facilities, if feasible;
- maximization of socio-economic benefits (cost-benefit relationship);
- minimization of negative environmental impacts, and mitigation of avoidable impacts;
- international standards for aviation operational reliability and safety;
- other policy objectives, as described elsewhere in the report.

All subsequent steps in the master planning process are guided by these objectives.

2.3 RESOURCE EVALUATION

The second step in the master planning process is the evaluation of the resources available to meet the objectives. In this study, this step, which is often referred to as the inventory process, included the analysis of the following factors:

- existing airports and other aviation facilities in the Corridor;
- the resources of the Department of Transportation and Communications (DOTC) and the Air Transportation Office (ATO);
- the plans and resources of the national airline and other potential commercial aviation enterprises serving the Corridor;
- national defense requirements related to Corridor facilities;
- commercial aviation trends in the Philippines and world-wide, including technological developments;
- physical setting in the Corridor, including topography;
- environmental and socio-economic conditions in the Corridor, including forecasts of future economic growth; and
- spatial development of existing and future economic activity in the Corridor.

The resource evaluation step established the baseline information for the planning process and identified opportunities and constraints for later steps of the master planning process, in addition to detailed inventories of the existing airports

2.4 ACTIVITY FORECAST

The third step in the master planning process is preparation of aviation activity forecasts for the Corridor. Forecasts have been prepared for passenger, cargo, and aircraft movement volumes. The forecasts are prepared for base, low, and high economic growth scenarios (Volume I, Chapter 6).

The forecast is based on forecast economic development trends in the Corridor, as determined in the resource evaluation step. The forecasts form the basis for determining the scale of airport facilities which will be required to meet future Corridor commercial aviation needs, as described in the following step in the planning process.

Because the forecast of aviation activity is based on forecasts of economic activity prepared by others, the forecast must be viewed as an assessment of likely trends in aviation activity rather than a precise determination of future conditions. In light of this fact, sensitivity analysis is incorporated into the financial and economic evaluations of alternative airport development programs, to test the validity of assumptions and findings under various activity level scenarios.

2.5 FACILITY REQUIREMENTS ASSESSMENT

The fourth step in the master planning process is assessment of the airport facilities required to meet the forecast demand. This assessment, presented in detail elsewhere in this report (Volume I, Chapters 4 and 5), is based on application of international standards for airport demand-capacity relationships, as modified by local conditions.

The assessment results in determination of the scale of required future facilities in terms of factors including:

- number and required dimensions of runways;
- airfield facilities and equipment (NAVAIDS, CFR facilities, air traffic control, meteorological services);
- passenger terminal facilities;
- cargo facilities;
- operational; support facilities (operations center, aircraft refueling system, ramp equipment storage and maintenance);
- ground access facilities (parking, roadways)

The facility requirements form a basis for the following master planning step—alternatives analysis.

2.6 ALTERNATIVES ANALYSIS

The fifth step in the master planning process, alternatives analysis, involves development and assessment of alternative approaches to providing the required future Corridor airport facilities. The analysis compares alternatives with respect to criteria related to the program objectives, as developed in step one (Section 2.2).

In the case of this study, the alternatives analysis involved comparison of the costs and benefits of providing future airport facilities at either, or a combination, of the existing Corridor airports—Cagayan de Oro, Iligan, and the partially completed Linamon—and at potential new sites (Volume I, Chapter 5).

2.7 PREFERRED ALTERNATIVE SELECTION

The sixth step in the master planning process for Corridor airport facilities was the selection of the preferred alternative. In the case of this study, the choice of the preferred alternative was more straightforward than is often the case in airport planning. The Corridor's physical setting, and particularly its topography, which includes rapidly rising terrain immediately inland from the coast, exerted a profound influence on the final selection.

As detailed elsewhere in this study (Volume I, Chapter 5), the objective of providing international standard commercial air service and the resulting operational requirements and standards, coupled with the Corridor's physical constraints and the spatial pattern of its economic development, combine to indicate that construction of a new airport is the preferred alternative for both short and long-term airport facility development in the Corridor. The analysis further indicates that there is one site which is clearly superior to all others for such a new airport within the Corridor. Construction of a new airport at Laguindingan, which would serve the entire Corridor, is recommended.

The selection of the preferred alternative also included preliminary assessment of other key planning factors such as cost, environmental impacts, cost-benefit, and economic and financial feasibility.

2.8 DETAILED ANALYSIS OF THE PREFERRED ALTERNATIVE

The seventh step in the master planning process comprised detailed analyses of the preferred alternative, construction of a new airport at Laguindingan, to determine the proposed project's feasibility and conformance to the project objectives. The analyses performed include:

- **Environmental Assessment**

  The project Environmental Assessment presents a complete analysis of all environmental issues related to the development of the new airport including: socio-economic factors; social soundness; noise impacts; ground transportation issues; resource use; water quality; etc. (Environmental Assessment Report).

- **Economic Feasibility Analysis**

  The economic feasibility analysis finds that, because of significant economic benefits to the Corridor's development, the proposed new airport is economically justified (Volume I, Chapter 7).

- **Financial Feasibility Analysis**

  The financial feasibility analysis finds that the project is not financially feasible in terms of costs and revenues of the development and operation of the airport itself (Volume I, Chapter 7).

These studies confirm the selection of the preferred alternative and provide input to the public policy considerations involved in the project's future implementation.

2.9 MASTER PLAN FORMULATION

The final step in the master planning process is translation of the preferred alternative's facility requirements into a specific physical plan for the proposed airport. The master plan is composed of a set of physical plans, development guidelines, and other descriptions which should provide enough detail to meet two key objectives:

- guide future development and engineering for the new airport; and
- allow informed public policy decisions to be made about the airport's development.

The components of the airport master plan, which are presented in detail in other chapters of this report, include:

- airport land use plan, showing the general uses of land on the airport site (Volume II, Chapter 3);
- airport layout plan, showing the layout of, and relationship between physical facilities on the airport site (Volume II, Chapter 3, Drawing 2);
- planning guidelines for the airport vicinity, including suggested land use and development guidelines for areas near the airport based on noise impacts, ICAO height limitations, and safety considerations (Environmental Assessment Report); and
- implementation program, detailing the engineering, planning, operational, and public policy steps required to implement the airport master plan (Volume II, Chapter 5).

Other planning work presented in this study, which is related to the airport master plan includes an organization plan for staffing the new airport (Volume II, Chapter 4). Preliminary engineering of the airport's facilities is also included in this report (Volume II, Chapter 3).

In addition to the work presented in this report, the airport master plan has been incorporated into the Cagayan de Oro-Iligan Corridor Industrial Master Plan. Coordination of these two plans—the airport master plan and the Corridor master plan—will enhance the airport's economic benefits to the local and national interests.

CHAPTER 3

PHYSICAL PLAN AND PRELIMINARY DESIGN

3.1 INTRODUCTION

As discussed in Chapter 2, the objective of an airport master plan is to act as a guide for the:

- development of physical facilities of the airport—aviation and non-aviation uses;
- development of land uses for areas surrounding the airport;
- determination of environmental effects of airport construction and operation; and
- establishment of the access requirements of the airport.

The first, second, and fourth items were determined in the development of the physical plan and preliminary design phase, and are addressed in this chapter. The environmental assessment of the project has been prepared as a separate report.

In order to determine the technical feasibility of the Laguindingan site to support airport operations, a preliminary (10%) design of the airport facilities was developed. This design is the basis for the cost estimates used in the economic and financial analyses of the project. The drawings, developed as a result of this design, are included at the end of this chapter and referenced throughout the analysis.

The preliminary layout and design of the Laguindingan Airport requires the consideration of a number of factors, including:

- established airport design standards
- aircraft type which is expected to use the facility
- forecast activity levels
- site conditions (topography, soil conditions, etc.)

The aircraft types and forecast levels of activity were developed in the feasibility component of the project (Volume I), and are summarized in this chapter for reference.

3.2 AIRPORT DESIGN STANDARDS

Internationally accepted airport design standards have been developed by the International Civil Aviation Organization (ICAO) and the US Federal Aviation Administration (FAA). The Department of Transportation and Communications (DOTC) has adopted the ICAO standards for use in the Philippines. ICAO standards for the physical characteristics of an airport, and those for lateral separation of aircraft, facilities, and features are given in Tables 3-1 and 3-2, respectively. These criteria are referenced throughout this chapter.

Table 3-1
RECOMMENDED ICAO AIRPORT DESIGN STANDARDS
(Physical Characteristics)

Characteristics	Type of Aircraft									
	A300		B737-300		BAC1-11		F-50		SD-360	
	Type of Approach		Type of Approach		Type of Approach		Type of Approach		Type of Approach	
	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precison	Precision	Non-Precision	Precision
Runway										
Width (m)	45	45	45	45	45	45	30	30	30	30
Longitudinal slope[1] (max)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Longitudinal slope change (max. %)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Transverse slope	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0
Runway Strip										
Width (m)	300	300	300	300	300	300	300	300	300	300
Length beyond runway or stopway end (m)	60	60	60	60	60	60	60	60	60	60
Width of graded portion (m)	150	150	150	150	150	150	150	150	150	150
Longitudinal slope (max. %)	1.5	1.5	1.5	1.5	1.5	1.5	1.75	1.75	1.75	1.75
Longitudinal slope change (max)	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m	2% per 30m
Runway Shoulders										
Width (m)	7.5	7.5	7.5	7.5	7.5	7.5	15	15	15	15
Transverse slope (max. %)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Runway End Safety Areas										
Minimum distance from end of runway strip (m)	90	90	90	90	90	90	90	90	90	90
Minimum width of runway end safety area (m)	90	90	90	90	90	90	60	60	60	60
Maximum longitudinal downward slope (%)	5	5	5	5	5	5	5	5	5	5
Maximum upward or downward transverse slope (%)	5	5	5	5	5	5	5	5	5	5

Table 3-1 (Cont'd)
RECOMMENDED ICAO AIRPORT DESIGN STANDARDS
(Physical Characteristics)

Characteristics	Type of Aircraft									
	A300		B737-300		BAC1-11		F-50		SD-360	
	Type of Approach		Type of Approach		Type of Approach		Type of Approach		Type of Approach	
	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision
Taxiway										
Width (m)	23	23	15	15	15	15	15	15	10.5	10.5
Longitudinal slope (max. %)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	3.0	3.0
Longitudinal slope change (max. %)	1% per 30m	1% per 30m	1% per 30m	1% per 30m	1% per 30m	1% per 30m	1% per 30m	1% per 30m	1% per 25m	1% per 25m
Transverse slope (max. %)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2
Shoulder width (m)	7.5	7.5	5	5	5	5	5	5	—	—
Width of taxiway strip (m)	81	81	52	52	52	52	52	52	43	43
Graded portion of taxiway strip (m)	38	38	25	25	25	25	25	25	25	25
Maximum upward transverse slope of taxiway strip-graded area (%)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3
Max. downward transverse slope of taxiway strip-graded area (%)	5	5	5	5	5	5	5	5	5	5
Maximum upward transverse slope of taxiway strip-ungraded area (%)	5	5	5	5	5	5	5	5	5	5
Minimum clearance distance of aircraft outer main wheel to taxiway edge (m)	4.5	4.5	3	3	3	3	3	3	2.25	2.25

[1] *For airports servicing A300, B737-300, and BAC1-11 aircraft the transition between grade changes is 0.1% per 30 meters.*
Maximum slope on any portion should not exceed 1.25%, except that for the first and last quarter of the length of the runway, the longitudinal slope should not exceed 0.8%.
For airports servicing Fokker 50 aircraft the transition between grade changes is 0.2% per 30 meters.
Maximum slope on any portion should not exceed 1.5%, except that for the first and last quarter of the length of a precision approach runway Category II or III, the longitudinal slope should not exceed 0.8%.
For airports servicing SD-360 aircraft the transition between grade changes is 0.4% per 30 meters. Maximum slope on any portion should not exceed 2%.
Source: ICAO design standards (1990)

Table 3-2
RECOMMENDED ICAO AIRPORT DESIGN STANDARDS
(Lateral Separation Requirements)

Characteristics	Type of Aircraft									
	A300		B737-300		BAC1-11		F-50		SD-360	
	Type of Approach		Type of Approach		Type of Approach		Type of Approach		Type of Approach	
	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precision	Precision
Distance From Runway Centerline to:										
Parallel taxiway centerline	176	176	168	168	168	168	168	168	87	87
Apron taxiway centerline	176	176	168	168	168	168	168	168	87	87
Holding bay or taxi-holding position	75	90	75	90	75	90	75	90	40	60
Distance From Taxiway Centerline to:										
Parallel taxiway or apron taxiway centerline	66.5	66.5	44.0	44.0	44.0	44.0	44.0	44.0	33.5	33.5
Fixed or moveable object	40.5	40.5	26.0	26.0	26.0	26.0	26.0	26.0	21.5	21.5
Distance From Apron Taxiway Centerline to:										
Fixed or moveable object	40.5	40.5	26.0	26.0	26.0	26.0	26.0	26.0	21.5	21.5
Distance From Taxi-lane Centerline to:										
Fixed or moveable object	36.0	36.0	24.5	24.5	24.5	24.5	24.5	24.5	16.5	16.5
Minimum Clearance Between an Aircraft Using the Apron Stand and Any Adjacent Building, Aircraft, or Other Object	7.5	7.5	4.5	4.5	4.5	4.5	4.5	4.5	3.0	3.0

Source: International Civil Aviation Organization standards (1990)

The ICAO strives toward uniformity and safety on an international level. Its standards apply to all member nations of the Convention on International Civil Aviation and are published as Annex 14 to that convention. The FAA design standards are very similar to the ICAO requirements, providing for domestic uniformity of US airport facilities.

For the Cagayan de Oro-Iligan Airport Study, the ICAO criteria have been adopted. Where the ICAO has no established criteria, (sizing of airport buildings, drainage systems, and pavements), FAA criteria and recommendations have been followed.

3.3 AIRPORT CLASSIFICATION

The ICAO uses a two element reference code to classify the geometric design standards for airports. The code element consists of a numeric and alphabetic designation. The code numbers 1 through 4 classify the length of the runway available and the code letters A through E classify the wingspan and outer main gear wheel span for the design aircraft. The ICAO Aerodrome Reference Code (ARC) are given in Table 3-3.

Table 3-3
AERODROME REFERENCE CODE

Code Element 1		Code Element 2		
Code Number	Airplane Reference Field Length	Code Letter	Wing Span	Outer Main Gear Wheel Span[1]
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1,200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1,200 m up to but not including 1,800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1,800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m

[1] *Distance between outer edges of main wheel gears*
Source: International Civil Aviation Organization (1990)

3.4 AIRCRAFT AND FORECAST LEVEL OF ACTIVITY

Aircraft dimensions, weights and performance characteristics are determining factors in the design of runways, pavements, and facility layout. The physical and performance characteristics for present and future Corridor aircraft are given in Table 3-4; the classification of Corridor aircraft by ICAO code is given in Table 3-5.

Table 3-4
AIRCRAFT CHARACTERISTICS AND PERFORMANCE

Characteristics	Type of Aircraft				
	A300	B737-300	BAC-111	F-50	SD-360
Dimensions (m)					
Length	53.61	33.40	28.20	25.25	21.49
Wingspan	44.83	28.88	26.98	29.00	22.76
Wheelbase	18.60	12.45	10.09	9.70	7.06
Carriage width	9.60	5.23	4.34	7.20	4.20
Distance from nose to nose wheel	6.67	4.01	5.00	1.75	2.60
Vertical Clearances[1] (m)					
Tail height	16.70	11.07	7.24	8.77	6.88
Wing tip height	6.06	3.09	2.14	3.74	3.84
Height of fuselage top	7.71	5.26	4.35	3.67	3.60
Height of fuselage bottom	2.07	1.17	0.78	0.57	1.02
Sill height front doors	2.73	1.40	2.01	1.29	—
Sill height rear doors	3.09	1.37	—	1.58	—
Weight (kg)					
Maximum take-off weight	165,000	56,700	45,200	20,820	12,290
Maximum landing weight	136,000	51,710	39,460	19,730	12,020
Maximum payload	32,775	15,625	12,320	5,670	3,119[3]
Maximum zero fuel weight	126,000	47,625	36,740	18,600	11,059
Operating empty weight	93,225	32,000	24,420	12,930	7,940
Cargo hold capacity	30,600	5,813 (4,838[2])	5,630	1,875	635
Seating Capacity	246	141	109	54	36
Performance					
Type of engine	GE-CF6-50C2	GE-CFM56-3B1	RR-SPEY512-14	PW-125	PW-PT6A-67R
Thrust/engine (Lbs.)	52,500	20,000	12,550	2,500 SHP	1,424 SHP
Fuel capacity (kg)	48,320	15,667	10,989	4,000	1,700
Fuel consumption (kg/h)	6,579	2,185	2,552	540	345
Average block speed (Kts)	395	271	247	146	130
Average cruise speed (Kts)	477	455	426	238	200
Range at maximum payload	1,740	1,081	867	615	395
Approach speed (Kts/°Flaps)	141/35°	133/40°	126/45°	102/35°	113/15°

[1] *Vertical clearances indicated above are measured at operating empty weight*
[2] *Volume limited weight*
[3] *Based on a unit passenger weight of 69 kg, and a total cargo capacity of 635 kg*

Sources:
737-300/400/500 Airplane Characteristics for Airport Planning; Boeing Commercial Airplane Group, Revision A, July 1990
A300 Airplane Characteristics for Airport Planning; Airbus Industrie, France, revised Feb. 1980
Aircraft Data; Department of Transportation, Federal Aviation Administration, Jan. 12, 1968
The World's Airlines; William Green and Gordon Swanborough
Flight Technical Division, Philippine Airlines

Table 3-5
ICAO AIRCRAFT CLASSIFICATION BY CODE NUMBER AND LETTER

Aircraft Model[1]	Airplane Reference Field Length (m)	Wing Span (m)	Outer Main Gear Wheel Span (m)	Code Number and Letter
A300	2,605	44.83	10.9	4D
B737-300	2,295	28.88	6.4	4C
BAC1-11	2,420	28.50	5.2	4C
F50	1,670	29.00	7.9	3C
SD360	1,250	22.50	5.0	3B

[1] *Present Philippine Airlines fleet*
Source: International Civil Aviation Organization (1990)

The commercial aircraft expected to service the Laguindingan Airport are the A300, a wide-body jet aircraft; the B737-300, a narrow-body jet aircraft; and the F50 turboprop. The narrow-body BAC1-11 and the SD360 turboprop, presently servicing Corridor airports, are scheduled to be phased out of operation within five years.

3.5 FORECAST ACTIVITY LEVEL

The forecast methodology is discussed in Volume I, Chapter 6. In the economic analysis the *"base growth case"* was used to determine economic viability, thus ensuring a conservative approach in the analysis. In the design of the airport facilities, the *"high growth case"* is used for the layout of and sizing of facilities to ensure that the design will meet the highest level of forecast demand. A summary of the passenger and aircraft movement forecasts are given in Table 3-6.

Table 3-6
ANNUAL FORECAST ACTIVITY LEVEL
(High Growth Case)

Year	Number of Passengers	Aircraft Movements[1]			
		Commercial Aircraft			Non-Commercial Aircraft
		Class 1	Class 2	Class 3	
1996[2]	481,290	2,052	4,155	—	6,983
2001	609,704	2,489	4,052	729	7,985
2006	718,163	2,932	4,383	1,088	8,964
2011	835,111	3,409	4,740	1,475	9,946

[1] *Class 1: F50; Class 2: B737-300; Class 3: A300*
[2] *Opening year of the Laguindingan Airport*
Source: Consultant's estimates, see also Volume I, Chapter 6; Tables 6-14, 6-25, and 6-26

3.6 SITE CONDITIONS

The existing Laguindingan site conditions were analyzed to determine the most cost effective runway alignment and location of facilities. A soil survey, including sampling and a laboratory test program was conducted to determine sub-base conditions used in pavement and foundation design. The geology of the site was researched and geological hazards identified. The results of these analyses are presented in the following sections.

3.6.1 Topography

Site topography is an important consideration in airport design. The slope of the terrain, the location and variation of natural features, such as trees and watercourses, and the existence of man-made structures—buildings, roads, overhead lines—can affect the requirements for clearing, filling, grading and drainage. Natural slope and drainage of the site are important from a design and construction point of view because they determine the earthworks and grading operations necessary to produce the desired gradients, and thus the cost of preparing the site. Terrain which conforms closely to desirable grades and which is well drained will produce significant cost advantages.

The Laguindingan site was analyzed to determine a runway alignment and locations for airport facilities that takes advantage of the existing topography in order to minimize earthworks and site drainage, and maximize air operations safety. Data on the existing topography of the Laguindingan site were obtained from maps prepared by the National Mapping and Resource Information Authority (NAMRIA) and supplemented by site specific topographic surveys.

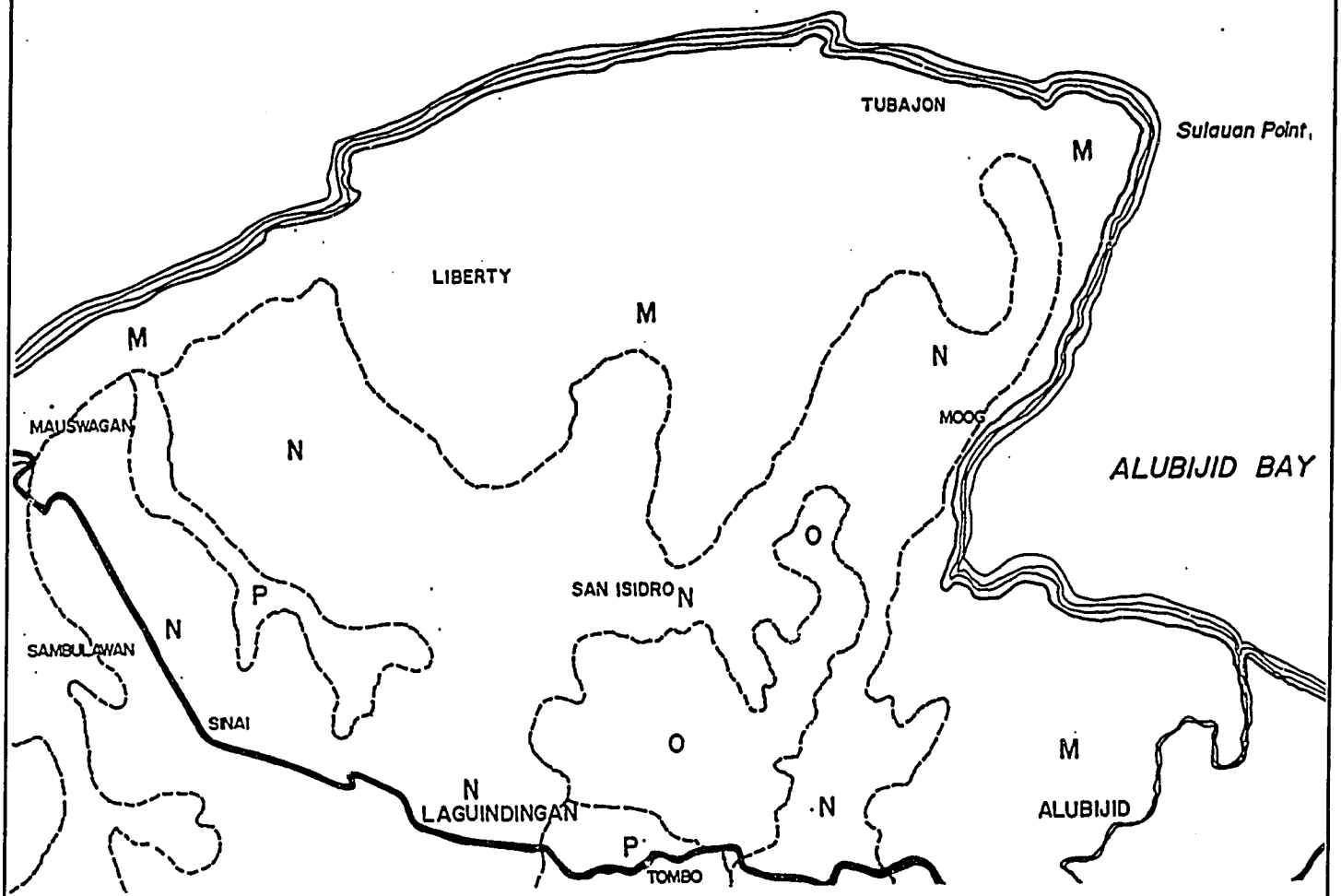
The proposed airport site is located on the upper terrace of a limestone plain. It has generally flat terrain, with slopes of zero to three percent. The areas south of the airport site are slightly undulating with slopes from three to eight percent. Near the Laguindingan town proper, the terrain consists of limestone hills of low relief, with rolling topography (8-10% slopes) and steeply sloping hills (18-30% slopes). A slope map of the area is given in Figure 3-1.

3.6.2 Geotechnical Investigations

The geotechnical investigations of the Laguindingan site performed for this project includes the the review of existing studies and maps, site inspections, and the development and implementation of a soil survey, sampling, and testing program.

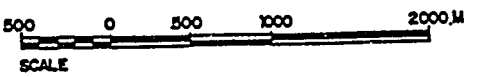
3.6.2.1 Site Geomorphology

The proposed airport site is located on uplifted coralline limestone which is a characteristic of the coastline of the region. These strata, referred to as the Indahag Limestone Formation, are known to be composed of Pliocene to Pleistocene sediments, of both marine and terrestrial deposition, which includes reef derived limestone, pyroclastics, and gravel deposits.



AREA DISTRIBUTION PER SLOPE CLASS

MAPPING SYMBOL	PERCENT SLOPE	MUNICIPALITY			TOTAL AREA	
		CITAGUM	LAGUINDINGAN	ALUBIJID	(HA.)	(%)
M	0–3%	10	1,084	566	1,660	45.21
N	0–8%	132	1,323	108	1,563	42.56
O	8–18%	–	201	28	229	6.24
P	18–30%	70	140	10	220	5.99
TOTAL		212	2,748	712	3,672	100.00



Source: Bureau of Soils and Water Management

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-1
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	SLOPE MAP OF PROJECT AREA	

In general, the geomorphic landscape of the project site consists of well-drained, non-acid, highly permeable soils (< 50 cm) underlain with soft coralline limestone. A significant portion of the site is characterized by eroded limestone outcrops and soil surfaces strewn with stone-sized limestone fragments. Some areas of the uplifted terrace have evidence of sink holes and solution cavities, which may result from the chemical reaction of rainfall generated carbonic acid and limestone. A Bureau of Mines and Geo-Sciences publication (Ugalde, 1980) listed 21 caves in the Tubajon area which is indicative of solutional cavity formations within the local geological formation.

The project area also includes the geologic formation referred to as the Opol Formation (Upper Miocene-Pliocene period) which consists of agglomerate, tuffaceous sandstone, tuff, conglomerate, and pebbly limestone. Fine-to-medium grained, unsorted and poorly compacted pebbly sandstones occur as interbeds with tuffaceous sandstone and tuff. Recent deposits of heterogeneous and unconsolidated detrital materials, including silt, fine to coarse sand, pebbles, gravels, and boulders are found along the rivers and watercourses near the coastline. A geological map of the project area is presented in Figure 3-2.

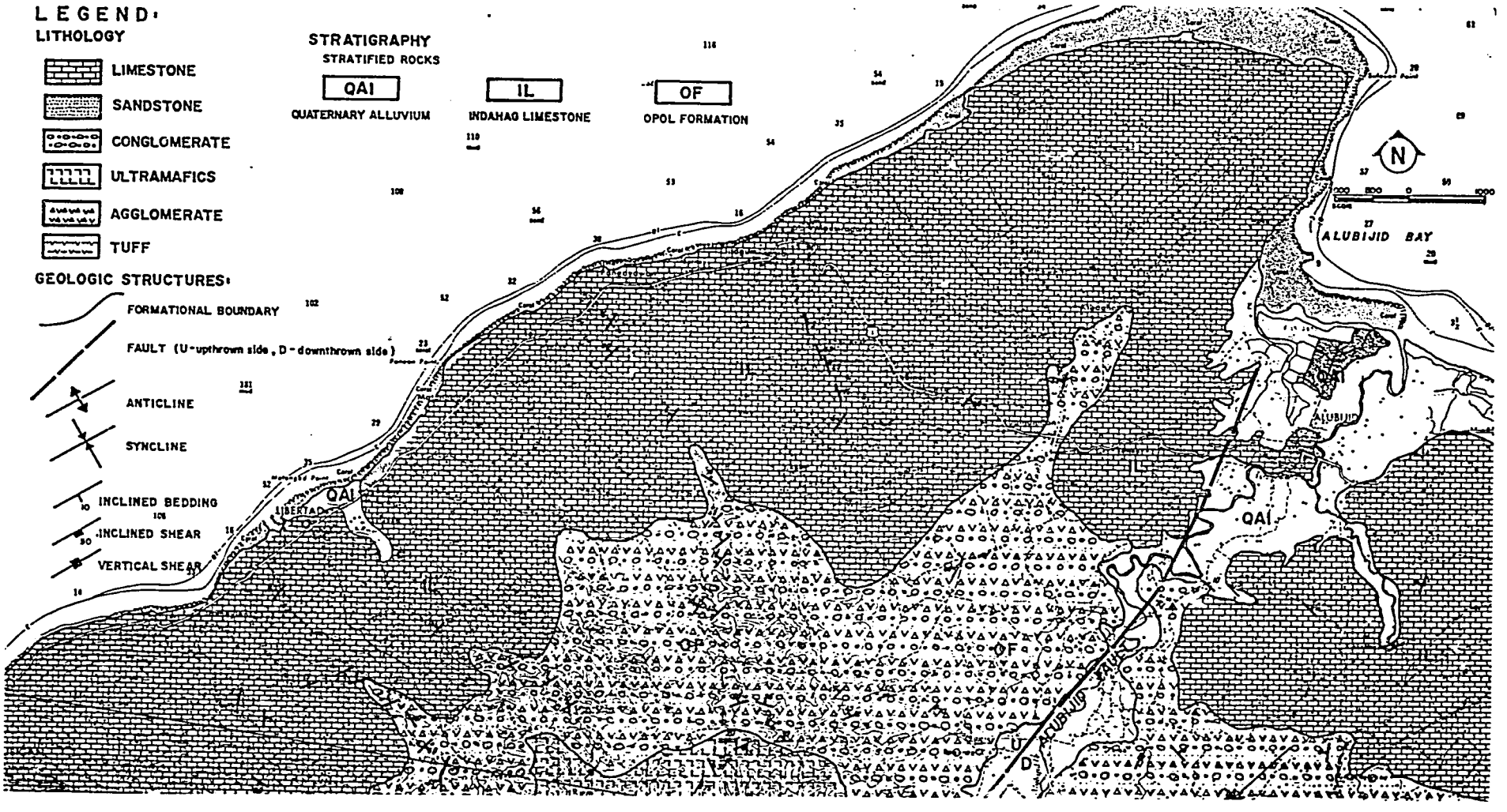
3.6.2.2 Geologic Hazards

Northern Mindanao is included in Zone 7 of the seismogenic, or seismic source, zones of the Philippines, which accounts for approximately 14% of seismicity within the country. Historically, however, the project area has been relatively free from serious geologic disturbances. Records and maps available from the Bureau of Mines and Geo-Sciences (BMG) indicate that none of the 9,763 earthquakes that have occurred in the Philippines from 1960 to 1988 have had epicenters located at or near the project site. The same is true for the epicenter locations of destructive earthquakes recorded to date (1619 to present), presented in Figure 3-3.

The distribution of major earthquake generators in the Philippines is presented in Figure 3-4. A potential branch of the Philippine Fault has been initially identified by the BMG as the Alubijid Fault. The location of the fault is inferred to traverse along a northeast to southwest direction, generally paralleling the Alubijid River. During a recent BMG survey, the north-northeast trending section of the Alubijid Fault was found to have affected recent sediments overlying the fault area, indicating that the fault area is relatively active. A January 17, 1969 tremor, having a magnitude of 5.1, and an epicenter located east of Naawan, could be related to a trace fracture of the fault. Local geologists consider it important to map the area in detail to determine the specific location and movement of the geologic faults in the Corridor area.

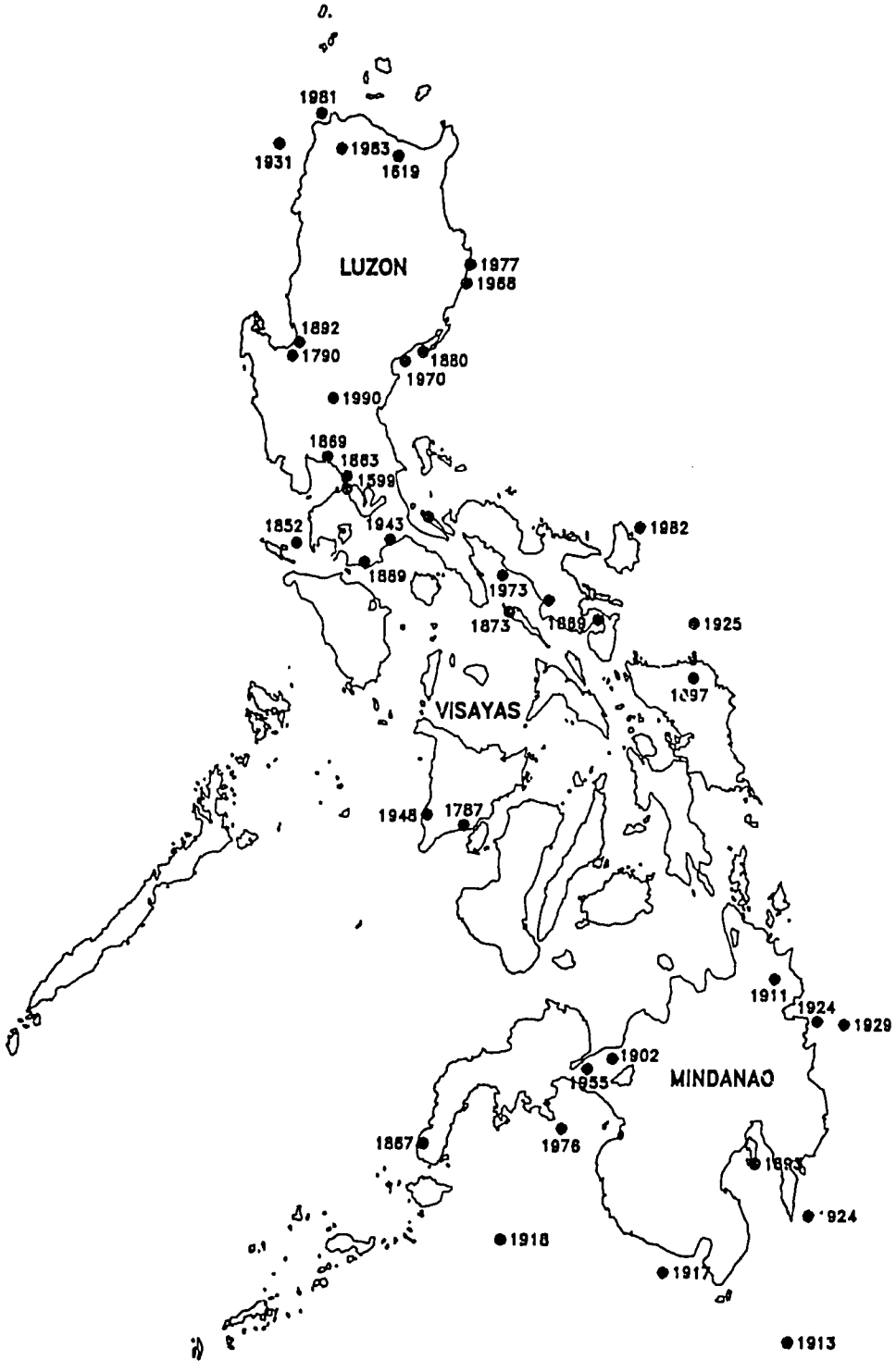
The areas south of the project site are mainly composed of the Opol Formation, where siliceous volcanic tuff is recorded. The BMG-Region X staff relate this geologic formation with active volcanism in the area (possibly that of Mt. Hibok-Hibok on Camiguin Island) suggesting that the area is potentially within the affected, or ash deposit influence areas of volcanic eruptions.

The Philippine Institute of Volcanology (PHILVOCS) has listed the Malindang Range, which straddles Zamboanga del Norte, Zamboanga del Sur, and Misamis Oriental as one of the country's active volcanos. Mt. Hibok-Hibok and Mt. Malindang are approximately 60 and 90 kilometers, respectively, from the proposed airport site.



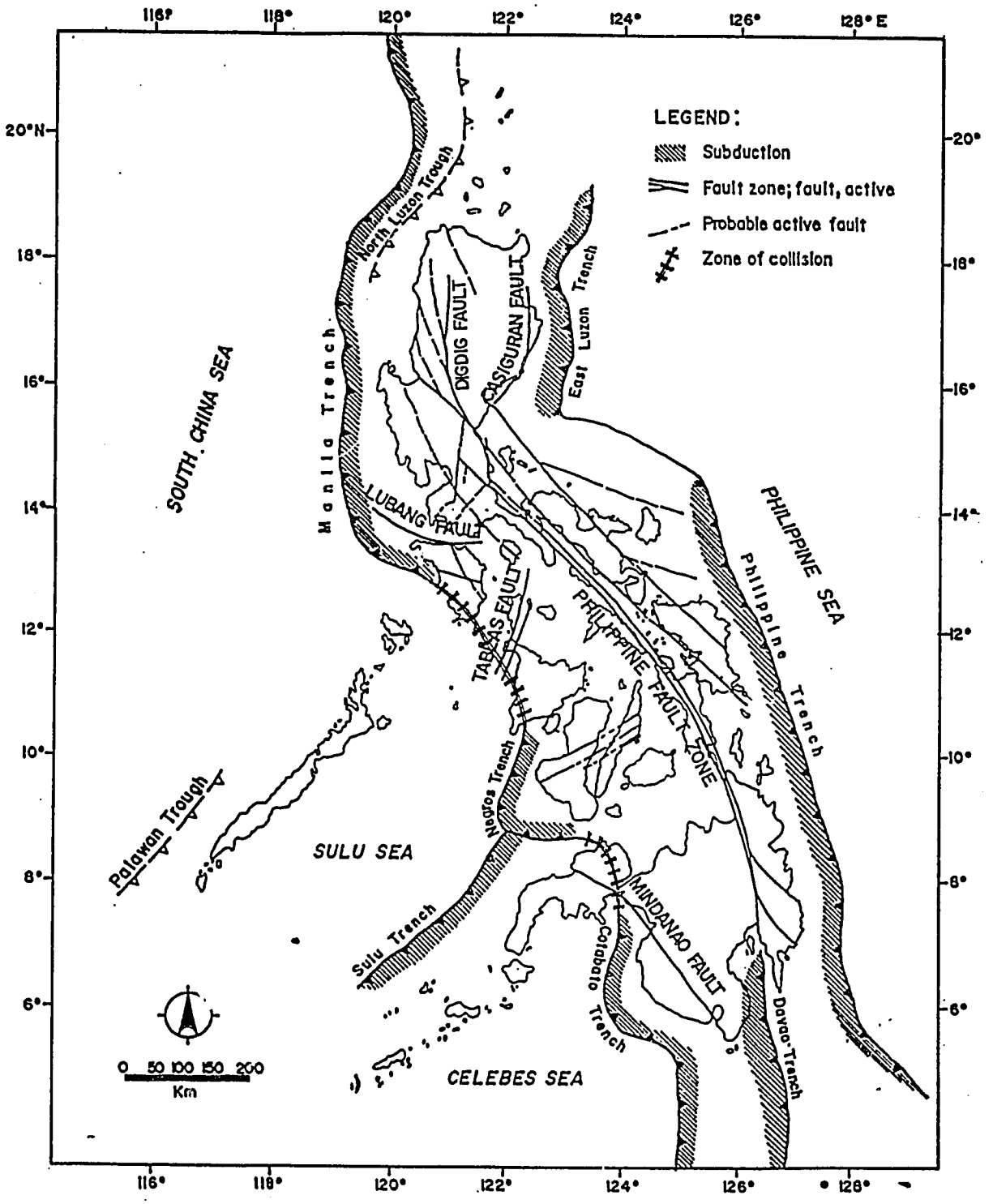
Source: Philippine Bureau of Mines and Geo-Sciences

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-2
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	GEOLOGICAL MAP OF THE PROJECT AREA	



Source: Philippine Institute of Volcanology

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-3
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	EPICENTER LOCATIONS OF DESTRUCTIVE EARTHQUAKES	



Source: Philippine Institute of Volcanology

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0752-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-4
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	DISTRIBUTION OF MAJOR EARTHQUAKE GENERATORS	

3.6.2.3 Soils and Materials

Preliminary geotechnical investigations were conducted at the proposed airport site and at potential construction material sources. The sampling, testing, and evaluation of soil and material samples were performed in accordance with American Association of State Highway and Transportation Officials (AASHTO) standards.

Thirteen test pits, at approximately 250 meter centers, were excavated along the longitudinal section of the proposed runway. Auger holes were bored approximately midway between the test pits. Test pits were excavated, and samples taken, at each aggregate source.

Samples from the airport site test pits and auger holes were tested to determine the natural moisture content, grain-size, Atterberg limits, moisture-density relationships, and the California Bearing Ratio (CBR). Aggregate sources were tested to determine natural moisture content, grain size, Atterberg limits, abrasion characteristics, unit weight, soundness, specific gravity, and absorption. A summary of the laboratory test results is included in Annex A.

The identification and location of possible construction material was facilitated through the aid of materials maps from the Department of Public Works and Highways, Bureau of Research and Standards. The location of aggregate sources and the sample composition are given in Figure 3-5 and Table 3-7, respectively.

Materials from these sources are suitable for use as sub-base and base coarse, and as aggregates for asphalt and concrete. For use as sub-base, no processing is required except for the removal of oversized material. For use as base coarse material, and as concrete or asphalt aggregates, processing will be required to meet the desired quality. Processing will mainly consist of screening and/or crushing, washing, and blending.

3.6.2.4 Groundwater Sources

The estimated depth and capacity of groundwater wells in the project site vicinity, given in Table 3-8, was obtained from interviews with area residents, in addition to available published studies. Well locations are shown in Figure 3-6.

The existing well opposite the Moog Elementary School has been in service since 1961. Equipped with a 1.5hp electric pump, this well reportedly supplies 40 households in the vicinity with high quality drinking water.

In contrast, communal wells on the lower terrace platform near Tubajon are shallow wells with recorded static water levels at 2.4 meters below ground surface; the water quality is described as brackish.

A free-flowing spring, as reported by area residents, is located in the tidal area near the existing Diamond Cement and Industrial Corporation (DCIC) wharf, northeast of the project site. This spring is utilized at low tides for laundry and bathing purposes and as a source of potable water to nearby households.

Table 3-7
AGGREGATE SOURCES

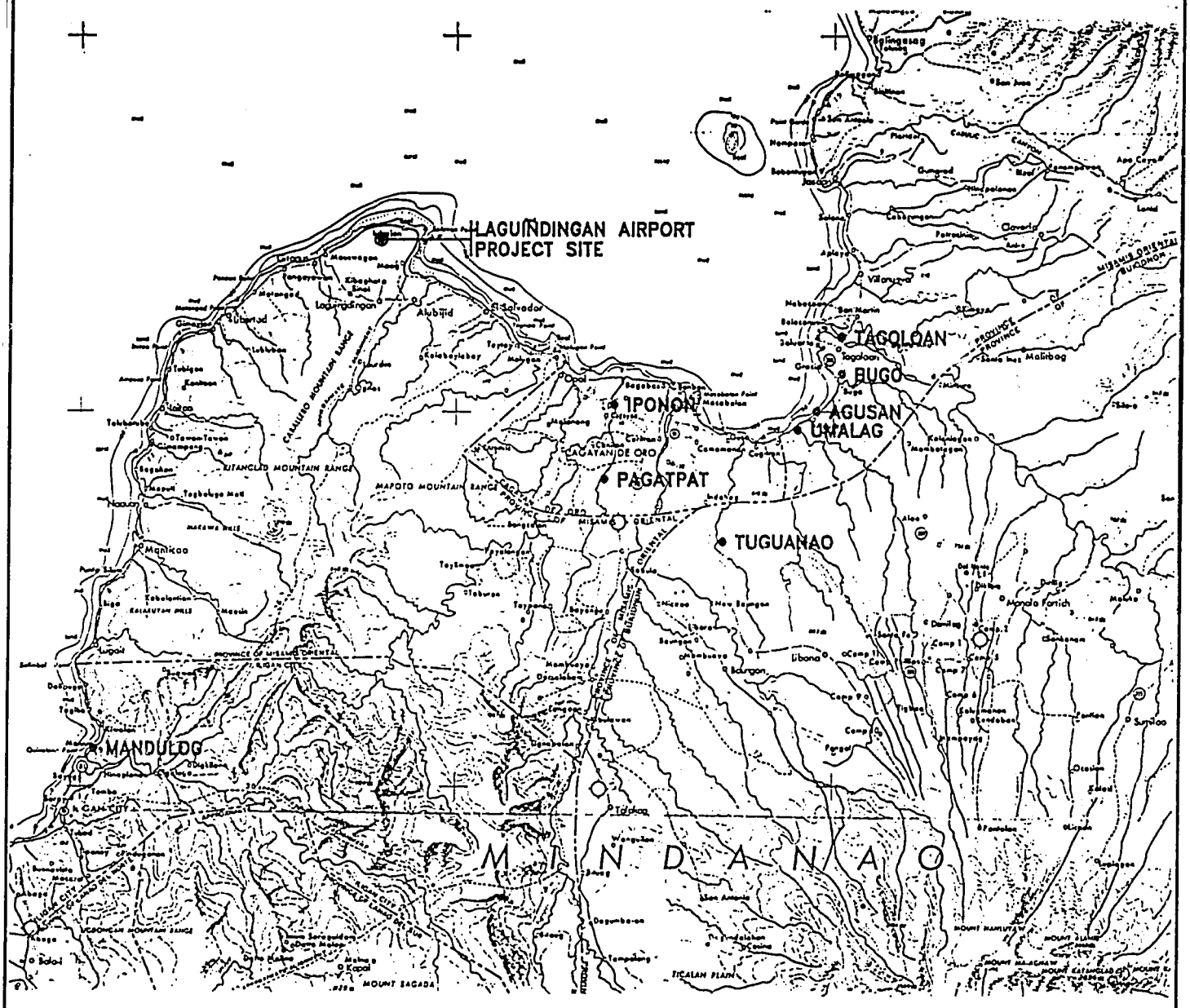
Source	Distance From Site (km)	Estimated Volume (m^3)	Composition
Iponon Site (Iponon River)	22.0	30,000	69% gravelly sand, cobbles, boulders 31% coarse to fine sand with presence of fine sediments
Pagatpat Site (Iponon River)	37.3	6,000	65% gravel, cobbles,boulders 35% coarse to fine sand with presence of fine sediment
Tuguanao Site (Cagayan River)	43.0	40,000	82% gravels, cobbles, boulders 18% coarse and fine sand
Umalag River	46.5	10,000	66% gravels, cobbles, boulders 34% coarse to fine sand
Agusan River	47.5	5,000	70% gravels, cobbles, boulders 30% coarse and fine sand
Bugo Site (Ala-e River)	50.7	20,000	70% gravels, cobbles, boulders 30% coarse and fine sand
Tagoloan River	54.3	unlimited	73% gravels, cobbles, boulders 37% coarse to fine sand with the presence of fine sediment
Mandulog River (3 sites)	61.5	unlimited	52% massive fragments of gravels, cobbles, boulders 48% coarse sand with presence of fine sediment

Source: Soil sampling and testing performed for the Consultant by Industrial Inspection International Inc. (1991)

Table 3-8
GROUND WATER AVAILABILITY

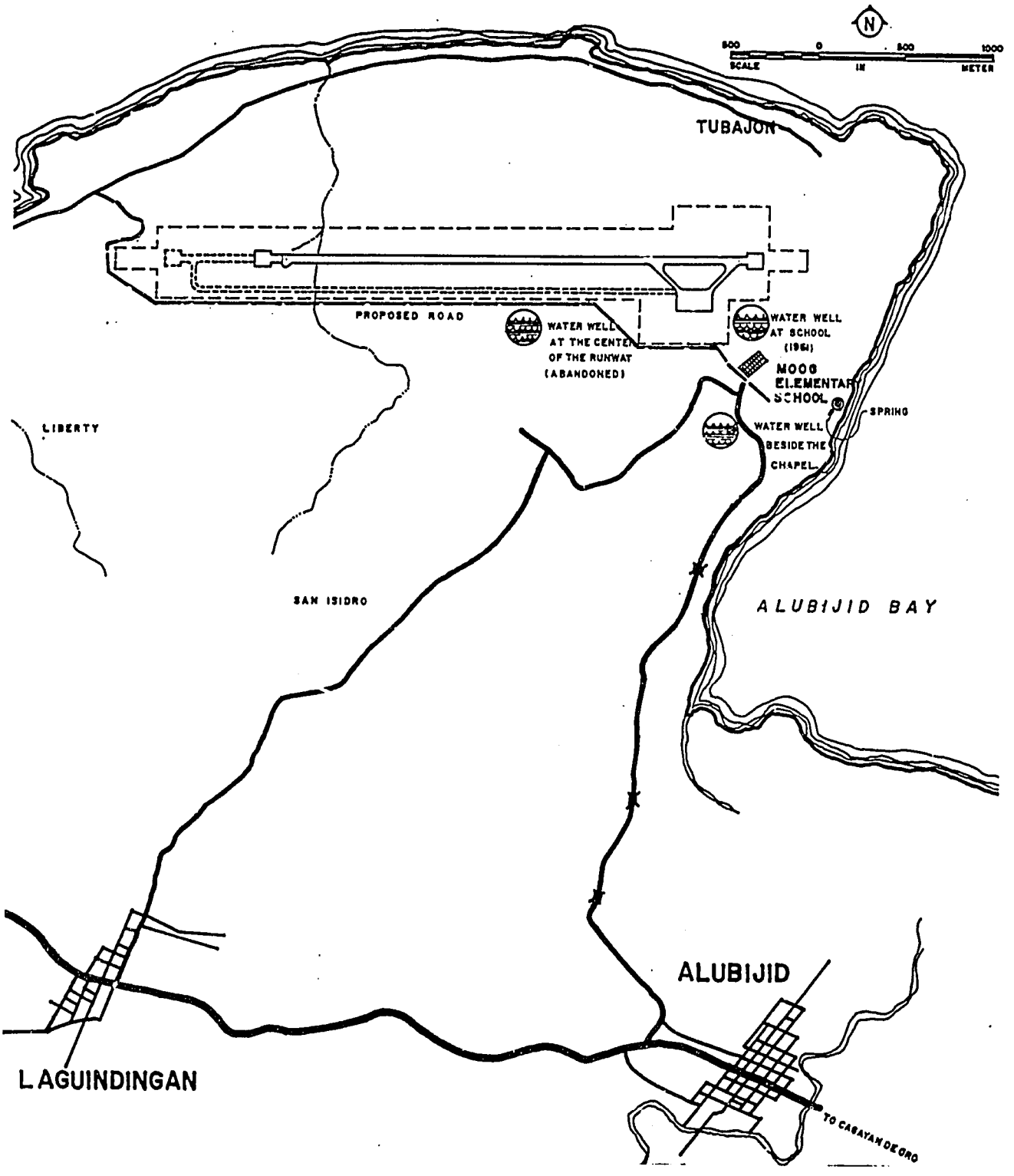
Source	Drilling Depth (m)	Capacity (l/s)	Specific Gravity (l/s/m)	Static Water Level[1] (m)
Moog	82.32	0.44	0.07	59.45
Laguindingan (high school)	71.63	0.51	0.16	22.80
Upper Laguindingan	59.45	0.95	0.07	28.04
Tubajon	42.99	na	na	2.40
Liberty	82.32	0.63	0.41	73.78
Centro Liberty	78.96	0.63	0.17	71.65
San Isidro	91.16	0.51	0.83	31.70

[1] *Depth below ground surface*
Source: National Water Resource Council (1982)



Source: DPWH Bureau of Research and Standards and Consultant's site investigations

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	**CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT**	**FIGURE 3-5**
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	**AGGREGATE SOURCE LOCATIONS**	



Source: Consultant's site investigations

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-6
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	WATER WELL LOCATIONS SAMPLING SITES	

3.6.2.5 Conclusions and Recommendations

Stripping and backfilling will be required to attain final grade elevations.

Solution cavities may possibly be found in the underlying formation, requiring further subsurface geotechnical exploration and seismic testing is required to locate and evaluate their influence on the design of the airport facilities.

The proximity of the project site to a potentially active fault requires consideration of seismic acceleration, within a reasonable return period, in the design of the airport facilities.

A cement-stabilized sub-base should be used in the pavement design to provide superior performance with regard to heavy aircraft loading. The 4.6 Mpa (650 psi) 90-day concrete flexural strength required for the runway, can be obtained using properly crushed and graded local aggregates, subject to verification by trial mixes.

Potable water will be required for the airport, and the development of the area around the airport. Pilot wells should be drilled, drawdown and recharge determined, and the water quality tested to determine if the groundwater table is capable of supporting the airport project and the area development. Other water sources may have to be identified.

3.7 GEOMETRIC DESIGN

Geometric design is the layout, orientation, and configuration of the various airport elements to provide safe and efficient operation of the facility. This section discusses the runway, taxiway and apron requirements of the proposed Laguindingan Airport.

3.7.1 Runway

The geometric design of the runway in particular, and the airfield as a whole, depends on the approach category, wing span and undercarriage width of the design aircraft, and the types of approaches performed on the runway system.

3.7.1.1 Capacity and the Number of Runways Required

According to FAA criteria, the hourly capacity of a single runway configuration under Visual Flight Rules (VFR) is somewhere between 50 and 100 operations per hour, while in Instrument Flight Rule conditions the capacity is reduced to 50 or 70 operations per hour, depending on the aircraft mix and navigational aids available.

These capacities are based on optimum conditions, with no support facility constraints. Airport capacity is not an absolute concept, however, it is directly related to the level of service provided by airport facilities.

Runway capacity is defined as the number of aircraft movements, the combined total of landings and take-offs, which can be accommodated within an hour. Capacity is determined by average runway occupancy time—the average time between consecutive aircraft movements.

Simulation studies for other Asian airports have shown that the effective hourly capacity of a single runway with no parallel taxiway is approximately 16 aircraft movements. By way of comparison, the capacity of a runway with a parallel taxiway is approximately 30-35 aircraft movements per hour.

At the end of the study period, 2011, the air traffic forecast (Table 3-6) for the Laguindingan Airport is estimated at 19,570 commercial and non-commercial aircraft movements, which results in 11 peak-hour aircraft operations, four commercial and seven non-commercial. Therefore, since the expected number of peak-hour movements is two-thirds the effective hourly capacity, and only one-fifth of the ultimate hourly capacity of a single runway configuration, a single runway is all that is required at the proposed Laguindingan Airport.

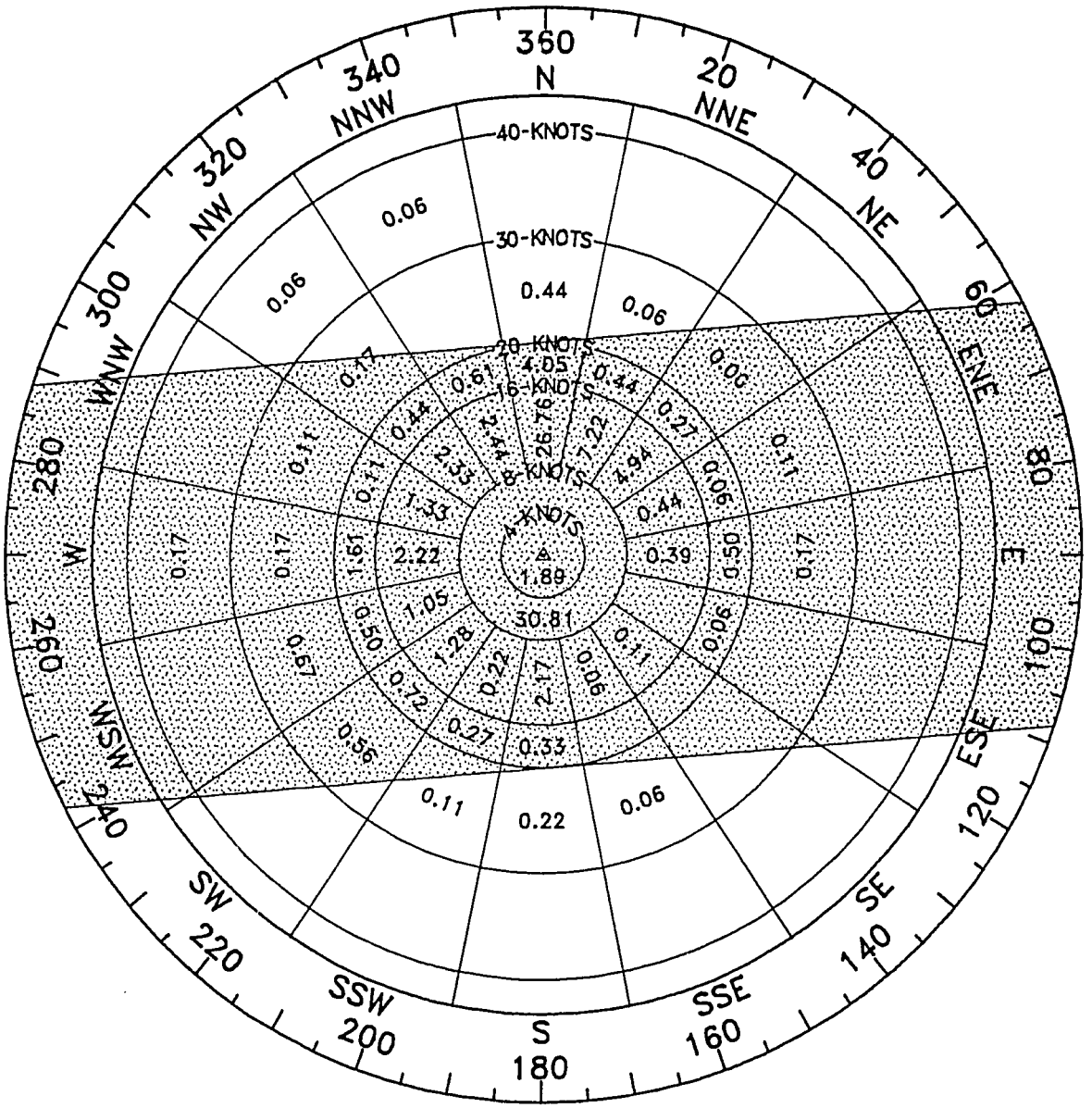
3.7.1.2 Runway Orientation

As a general rule, an airport's runway should be oriented as closely as practicable in the direction of the prevailing winds When landing or taking-off, aircraft are able to maneuver on a runway as long as the wind component at right angles to the direction of travel (*"crosswind"*) is not excessive. For the Laguindingan airport site, terrain and the surrounding topography limit runway orientation to a generally east-west direction.

The ICAO recommends that runways for transport category aircraft, including all commercial jets, be oriented so that crosswinds do not exceed 20 knots at least 95 percent of the time. Although the prevailing winds in the Corridor are in the north-south direction, they are light. As discussed in Volume I, Chapter 5, based on the available wind data recorded by the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA) station at the Cagayan de Oro Airport, the ICAO criterion of 95% wind coverage can be met with any runway orientation.

Airport wind data is typically analyzed through the preparation of a *"wind rose"*, a graphic depiction of wind direction and speed. The wind rose prepared in Figure 3-7 has been prepared from the PAGASA Cagayan de Oro station wind data using the maximum daily speed and direction. The shaded area in the figure represents the percentage of winds with speeds of 20 knots or less for the 09/27 runway orientation proposed for Laguindingan. This orientation results in 98.8% wind coverage and, therefore, meets ICAO criteria.

Another aspect of runway orientation is its affect on aviation operations. The ICAO has developed imaginary obstacle limitation surfaces which define the limits to which obstacles may project into the airspace. Since these surfaces extend up to 15 kilometers from the runway, the orientation of the runway can greatly reduce the number of terrain-related obstructions, and thus significantly improve the aviation operations at the airport. The limitation surfaces for a ICAO Code 4D airport, with a Category I precision approach are described as follows:



ALLOWABLE CROSSWIND COMPONENT = 20knots
MAXIMUM WIND COVERAGE = 98.80 %

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (1985-1990 wind data)

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-7
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	WIND ROSE	

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(a) *Primary Surface*

Longitudinally centered on the runway, the primary surface extends 150 meters left and right of the centerline and 60 meters beyond the end of the runway.

(b) *Horizontal Surface*

This surface consists of a horizontal plane, 45 meters above the established elevation of the runway, the perimeter of which is defined by 4,000 meter radii arcs centered at each end of the primary surface and connected by tangents. At Laguindingan, the airport reference point is 54.46 meters above mean sea level, and the horizontal surface has an elevation of 99.46 meters.

(c) *Conical Surface*

This surface extends 2000 meters from the horizontal surface at a slope of 20 to 1 (5%). The lower and upper elevations of this surface are 99.46 meters and 199.46 meters, respectively

(d) *Approach Surface*

A surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. The three sections of the instrument approaches at the Laguindingan Airport are defined as follows:

First Section:

Length	3,000 meters
Slope	50:1 (2.0%)

Second Section:

Length	3,600 meters
Slope	40:1 (2.5%)

Horizontal Section:

Length	8,400 meters
Slope	none (0%)

Total length of approach surface:	15,000 meters
Length of inner edge:	300 meters
Length of outer edge:	4,800 meters
Divergence at each side:	15 %

(e) Transitional Surfaces

These surfaces extend outward and upward at right angles to the runway centerline plus the runway centerline extended at a slope of seven to one from the sides of both the primary and approach surfaces.

Drawing 5 shows the airspace obstruction identification plan prepared for the proposed 09/27 runway orientation of the Laguindingan Airport. Minor non-standard terrain elevation exists south of the site in the inner horizontal and conical surfaces. Both runway approaches are over water and unconstrained.

3.7.1.3 Runway Length

The runway length required for a given airport depends on such factors as aircraft performance characteristics, flight length, altitude, slope, pavement surface condition, wind conditions, and temperature.

The runway length required by various aircraft in the Philippine Airlines fleet, based on typical mission requirements and meteorological conditions, are shown in Table 3-9 (see Volume I, Chapter 5, Section 5.3.1.1 for a discussion on runway length).

Table 3-9
REQUIRED RUNWAY LENGTH
TYPICAL COMMERCIAL DOMESTIC AIRCRAFT

Aircraft Type	Required Runway Length (m)	
	Average Operating Weight	Maximum Weight
SD-360	1,250	1,390
Fokker F50	1,180	1,415
BAC1-11	1,900	2,685
Boeing B737-300	1,650	2,100
Airbus A300 B4	2,500	2,930
Boeing B747-200	3,000	3,470

Source: Flight Technical Department, Philippine Airlines

An initial runway length of 2,500 meters is recommended for the new airport at Laguindingan. This runway length will accommodate an ICAO reference Code 4D aircraft, the A300, which is the largest aircraft expected to service the airport over the study period (1991-2011). The airport land area and facilities have been laid out to allow for future expansion (3000 m runway, parallel taxiway) in order to accommodate ICAO Code 4E aircraft, such as the B747.

3.7.1.4 Runway Width

For Code 4D aircraft, including the A300, the ICAO recommends a minimum runway width of 45 meters with 7.5 meter wide shoulders. These standards are adopted in the preliminary design of the Laguindingan Airport.

3.7.1.5 Runway Strip

The runway strip is defined as an area extending a specified distance from the longitudinal axis of the runway which is maintained clear of obstacles. The purpose of the strip is to reduce the risk of damage to an aircraft running off the runway, and to protect aircraft flying over the runway during landing or take-off operations.

The ICAO recommends that a 300 meter wide strip, symmetrical about the longitudinal axis of the runway, be provided for a precision approach runway (ICAO Code 4D). The length of the strip should extend a minimum of 60 meters beyond each end of the runway. As shown in Drawing 2, the runway strip proposed for the Laguindingan Airport meets the ICAO standards. In addition, the ICAO runway strip grading standards were adopted for the preliminary design, as shown on Drawings 3 and 6.

3.7.1.6 Runway Sight Distance and Longitudinal Profile

Sight distance and the allowable distance between vertical transition curves are factors considered in establishing the longitudinal profile of a runway. With respect to sight distance, for a Code D runway, the ICAO recommends that there be an unobstructed line of sight from any point three meters (10 feet) above the runway to any other point three meters above the runway within a distance of at least one-half the length of the runway.

It is desirable to minimize longitudinal grade changes as much as possible, however, it is recognized that this may not be possible for reasons of economy (grade changes may be required to follow the existing terrain, thus minimizing earthwork). The ICAO allows changes in grade, but limits their number and size. Grade changes are accomplished by means of vertical curves; for Code 4 runways, the minimum allowable distance between successive vertical transition curves (in meters) is calculated by multiplying the sum of the absolute values of the corresponding slope changes by 30,000 meters.

Another factor affecting the longitudinal profile is the maximum effective runway gradient, which is defined as the slope computed by dividing the difference between maximum and minimum elevations along the runway centerline by the overall length of the runway. The ICAO standards limit the runway gradient to 1.0 percent.

The longitudinal profile proposed for the Laguindingan Airport meets these criteria, see Drawing 3.

3.7.1.7 Runway Transverse Gradient

The runway surface should be cambered to allow for rapid drainage of storm water. For a Code D runway the transverse gradient should ideally be 1.5%, but in no case exceed 1.5% or fall below 1.0%, except at taxiway intersections where a flatter slope may be required for a smooth transition. For the preliminary design of the Laguindingan Airport a 1.5% cambered runway surface, symmetrical about the centerline, is provided along the entire length of the runway.

3.7.1.8 Runway End Safety Area

The Runway End Safety Area (RESA) is an area symmetrical about the extended runway centerline, and adjacent to the end of the strip, primarily intended to reduce the risk of damage to an aircraft undershooting or overrunning the runway.

The ICAO recommends that the RESA extend at least 90 meters from the end of the runway strip and have a width of at least twice that of the runway. For Laguindingan, this ICAO standard is met by the provision of a 90 meter long by 90 meter wide runway end safety area. In accordance with the standards, the longitudinal and transverse slope of the RESA does not exceed five percent.

3.7.1.9 Aircraft Turnaround Pad

Since the airport terminal facilities and stub taxiways are located at the east side of the runway, an aircraft turnaround pad is included at the west end of the runway to provide additional maneuvering room for aircraft landing on RWY 27 to turn around before taxiing to the parking apron. The turning radius of an A300 aircraft was used in determining the size of the pad.

3.7.2 Taxiways

The basic requirement of the taxiway is to provide aircraft access to, and egress from, the runway. Taxiway width requirements are determined by the size of aircraft to be accommodated by the taxiway. In accordance with ICAO standards, taxiways widths, like those for runways, are determined by the outer main gear wheel span. For a Code D airport, the clearance between the edge of the taxiway and the outer main gear of the aircraft, when stationed over the taxiway centerline, should not be less than 4.5 meters. For a taxiway serving A300 aircraft (the design aircraft for the Laguindingan Airport), the width should be a minimum of 23 meters.

Two stub taxiways, each measuring 206.5 meters long x 23 meters wide, are proposed for the new airport. For taxiway layout see Drawing 2, the typical cross-section is shown in Drawing 6.

3.7.2.1 Taxiway Shoulders

Double bituminous surface treated taxiway shoulders are provided to prevent aircraft engines, that overhang the edge of a taxiway, from ingesting stones or other objects which might damage the engine, and to prevent erosion of the area adjacent to the taxiway.

In accordance with ICAO standards for Code D airports, taxiways should be provided with shoulders sized so that the over-all width of the taxiway and shoulders is not less than 38 meters. A 7.5 meter wide shoulder, on each side of the taxiway, is proposed for the airport at Laguindingan.

3.7.2.2 Longitudinal and Transverse Slopes

The longitudinal slope of a Code D taxiway should not exceed 1.5 percent. Transverse slopes should be sufficient to prevent the accumulation of surface water, but not exceed 1.5 percent.

3.7.2.3 Taxiway Strip

The taxiway strip is an area free of obstructions, intended to protect an aircraft operating on the taxiway and to reduce the risk of damage to an aircraft accidentally running off the taxiway. An 81 meter wide taxiway strip, symmetrical about the centerline, is adopted for the preliminary design.

The preliminary taxiway design, as shown in Drawing 6, is in conformance with ICAO grading requirements for taxiway strips.

3.7.3 Aircraft Parking Apron

The aircraft parking apron is defined as the area intended to accommodate aircraft for the purposes of loading and unloading passenger or cargo, fuelling, and maintenance. It includes the apron taxiway and aircraft stand taxilane. The amount of area required for an aircraft parking apron depends upon the following factors:

- the size and maneuverability characteristics of the aircraft using the apron;
- the volume of aircraft traffic using the apron;
- clearance requirements;
- aircraft-parking type;
- aircraft ground activity requirements; and
- taxiways and service vehicle access.

3.7.3.1 Size and Maneuverability Characteristics of Aircraft

The sizes and turning radii of the mix of aircraft expected to use the apron are considered in the sizing of aircraft stand space. The aircraft fleet expected to serve the Laguindingan Airport includes the wide-body A300, the narrow-body B737-300, and the Fokker-50 turboprop. Manufacturer's airplane characteristic data (Table 3-4) for each aircraft were used in determining the size of the apron.

3.7.3.2 Volume of Aircraft Traffic

The number and size of aircraft stand positions needed at the apron are determined by the number of aircraft expected to use the apron at any one time. The forecast methodology for determining the expected annual commercial aircraft movements at the Laguindingan Airport is discussed in Volume I, Chapter 6. The *"high growth case"* forecast of aircraft movements for 2011 (Table 3-5) was used to determine the number of each type of aircraft that will park on the apron, and is summarized as follows:

Class 1 - Turboprop Aircraft (F50)	
Annual Regional Movements	3,409
Class 2 - Narrow-Body Jet Aircraft (B737-300)	
Annual Regional Movements	2,550
Annual Manila Movements	2,190
Total Class 2 Movements	4,740
Class 3 - Wide-Body Jet Aircraft (A300)	
Annual Manila Movements	1,475

Based on these aircraft movements, the number of flights per day to Laguindingan for each class of aircraft can be computed.

$$\text{Fokker-50 flights per day} = \frac{3{,}409 \text{ movements}}{365 \text{ days}} \times \frac{1}{2} = 4.7 \text{ say } 5 \text{ flights/day}$$

$$\text{B737-300 flights per day} = \frac{4{,}740 \text{ movements}}{365 \text{ days}} \times \frac{1}{2} = 6.5 \text{ say } 7 \text{ flights/day}$$

$$\text{A300 flights per day} = \frac{1{,}475 \text{ movements}}{365 \text{ days}} \times \frac{1}{2} = 2 \text{ flights/day}$$

Aircraft turnaround time (the time it takes to land, disembark/embark passengers, load/unload cargo, service the aircraft, and then take-off), and the total operating times are presented in Table 3-10. The total time of operations per day of all commercial aircraft expected to use the Laguindingan facility is 705 minutes, or 11.75 hours.

Table 3-10
AIRCRAFT TIME OF OPERATION
(High Growth Case)

Aircraft	Turnaround Time (minutes)	Number of Flights per day	Time of Operation (min)
F-50	25	5	125
B737-300	60	7	420
A300	80	2	160
Total Time of Operation			705 min = 11.75 h

Source: Philippine Airline and Consultant's estimates

The busy-hour movements expected at Laguindingan in 2011 are four commercial and seven non-commercial (general aviation) aircraft movements (for discussion of aviation peaking see Volume I, Chapter 6 and Table 6-27). These data indicates a maximum of two commercial, and 3.5 non-commercial aircraft are expected to use the parking apron during the peak hour. Space must be available for the following aircraft combinations, derived from the busy-hour aircraft movement forecast, to park simultaneously on the apron during the peak hour:

- (1) A300 and (1) B737-300
- (1) A300 and (1) Fokker-50
- (1) B737-300 and (1) Fokker-50
- (2) B737-300
- (2) Fokker-50

3.7.3.3 Clearance Requirements

An aircraft stand should provide the minimum clearances between aircraft using the stand, and between the aircraft on the stand and the terminal building or other fixed object (Table 3-2).

3.7.3.4 Aircraft-Parking Type

The aircraft-parking type refers to aircraft position with respect to the terminal building and to the manner in which aircraft maneuver in and out of the parking positions. Aircraft can be positioned at various angles with respect to the terminal building line and can maneuver in and out of parking positions either under their own power or with the aid of towing equipment.

The aircraft-parking type adopted in determining the size of the aircraft parking apron for the Laguindingan Airport is 45° angle in-power out. In this configuration the aircraft is parked on the apron with its fuselage centerline at 45° to the terminal building, allowing the aircraft to maneuver in and out of the gate under its own power. Although, it requires more apron area than the tractor-assisted method, there is an offsetting savings in numbers of the equipment and personnel required.

3.7.3.5 Aircraft Ground Activity Requirements

Aircraft services that occur while it is parked in a stand position include: toilet service; baggage handling; potable water service; fuelling; air conditioning; oxygen; electrical power supply; and compressed air. Most of these functions have vehicles and/or equipment associated with them, or have some type of fixed installation established to conduct these services. Space for access to the aircraft and the performance of these services must be provided.

3.7.3.6 Size of Aircraft Parking Apron for New Airport

In addition to the number and size of the individual aircraft stands, the area required for apron taxiways, stand taxilanes, and service vehicle access roads are considered in determining the size of an apron. The minimum lateral separation between aircraft, and between the aircraft and buildings and other objects, is also used.

After considering all factors influencing the size of an aircraft parking apron, a 125 meter wide x 200 meter long apron with 7.5 meter shoulders is recommended for the new airport at Laguindingan. This apron will accommodate any of the expected commercial aircraft combinations and meet general aviation demand.

In order to provide the flexibility of future airport and air service expansion, the ICAO Aerodrome Code 4E standard was adopted in determining the separation distance between the apron taxiway and runway centerlines. Although, the higher standard separation requirements will involve marginally higher apron construction costs, and place the airport buildings further from the runway, it will allow a future upgrade to accommodate the larger wide-body aircraft, such as the B747, without the relocation of airport buildings.

3.7.3.7 Apron Surface Gradient

A nearly level pavement surface is desired for the aircraft stand areas to achieve the proper fuel-mass tank balance in the fuelling of aircraft. For the Laguindingan Airport a 1.0% slope is recommended for stand areas, and a 1.5% slope for other apron areas. The apron slope is directed away from terminal building and other airport facilities.

3.7.4 Pavement Design

3.7.4.1 Pavement Surface Type

Cost, both in construction and long-term maintenance, plays an important role in the selection pavement types. Cement is locally available and relatively inexpensive; there are three cement factories in Iligan City, 58 kilometers from the proposed airport site. In addition, cement concrete pavements are more resistant to skidding and disintegration in wet climates with small daily temperature variations. The longer life and lower maintenance costs favor cement concrete pavement over asphalt.

Portland Cement Concrete (PCC) pavement is recommended for the runway, taxiway, aircraft parking apron, roads and vehicular parking area of new airport.

For the shoulders of the runway, taxiway and apron, which are expected to accommodate only light loading, Double Bituminous Surface Treatment (DBST) is recommended.

3.7.4.2 Pavement Thickness

The determination of pavement thickness is a complex engineering problem involving a large number of interacting variables. Factors which influence the determination of a pavement thickness that will provide satisfactory service are:

- the magnitude and character of aircraft loads to be supported;
- the volume of traffic;
- the quality of the subgrade soil; and
- the materials comprising the pavement structure (base and/or subbase);

The United States Federal Aviation Administration (FAA) method of pavement design, developed to provide a pavement with a 20-year life, free from major maintenance, was adopted in the design of pavements for the new airport.

(a) Magnitude and Character of Aircraft Loads

Aircraft loading on the runway is the determining factor in pavement design. The FAA-method is based on the total gross weight of the aircraft, which is assumed to be its maximum take-off weight.

(b) *Volume of Traffic*

Traffic volume is expressed in terms of departures, rather than landings, since the maximum aircraft landing weight is only about 75% of its maximum take-off weight. Therefore, the number of departures of the different aircraft types expected is used to determine pavement loading.

The landing gear type and configuration of an aircraft dictates how the aircraft weight is distributed to the pavement and determines the pavement response to aircraft loadings.

In the design of pavements for the Laguindingan Airport, the 2011 high-growth forecast of annual commercial and non-commercial aircraft (Table 3-5), was used to determine runway loading. The number of departures, maximum take-off weights, and gear types of the expected aircraft mix is given in Table 3-11.

Table 3-11
FORECAST AIRCRAFT ANNUAL DEPARTURES
MAXIMUM TAKE-OFF WEIGHTS AND MAIN GEAR TYPES

Aircraft Model	Gear Type	Forecast Annual Departures	Maximum Take-Off Weight (kg)
F-50	dual	1,705	20,820
B737-300	dual	2,370	56,700
A300	dual tandem	738	165,000
Non-Commercial Aircraft[1]	single	4,973	8,500

[1] *Non-commercial aircraft are assumed to have a passenger capacity of 2-10 passengers, a single landing gear, and an average maximum take-off weight of 8,500kg.*
Sources: Fokker 50 General Airplane Characteristics Data (1986)
737-300/400/500 Airplane Characteristics for Airport Planning (1990)
A300 Airplane Characteristics for Airport Planning (1980)

Of the aircraft expected to use the new airport, the design aircraft, is the one requiring the greatest pavement thickness. For the Laguindingan Airport, the design aircraft is the A300. The A300 has a maximum take-off weight of 165,000 kg, and a dual-tandem landing gear configuration.

In order to account for the differences in the weights and main gear types of the various aircraft using the facility, they must be expressed in terms of equivalent departures of the design aircraft.

Aircraft with different main gear types are converted, in terms of equivalent departures, to that of the design aircraft, using the FAA derived conversion factors given in Table 3-12.

Table 3-12
LANDING GEAR CONVERSION FACTORS

To Convert From Actual Gear Type	To Design Aircraft Gear Type	Multiply Departures By
Single wheel	Dual-tandem wheel	0.5
Dual wheel	Dual-tandem wheel	0.6
Dual-tandem wheel	Dual-tandem wheel	1.0

Source: FAA AC 150/5320-6C (1979)

After the aircraft have been converted to the same landing gear configuration, equivalent annual design aircraft departures are determined by the Equation 3-1.

$$\log R_1 = \log R_2 \times \left[\frac{W_2}{W_1}\right]^{\frac{1}{2}} \tag{3-1}$$

where:

R_1 = equivalent annual departures by design aircraft

R_2 = annual departures expressed in design aircraft landing gear

W_1 = wheel load of design aircraft

W_2 = wheel load of aircraft in question

For this computation, 95 percent of the aircraft gross weight is assumed to be distributed over the main gear span. By applying the conversion factors and Equation 3-1, the equivalent number of annual design aircraft departures, given in Table 3-13, were determined.

Table 3-13
EQUIVALENT ANNUAL DEPARTURES OF DESIGN AIRCRAFT

Aircraft Model	Dual-Tandem Gear Departures	Wheel Load (kg)	Wheel Load of Design Aircraft (kg)	Equivalent Annual Departures
F-50	1,023	4,945	19,594	33
B737-300	1,422	13,466	19,594	411
A300	738	19,594	19,594	738
Non-Commercial Aircraft	2,487	4,038	19,594	35
Total				1,217

Source: FAA AC 150/5370-10A and Consultant's calculations

The runway for the Laguindingan Airport is to be designed for 1,217 annual departures of A300 aircraft (dual tandem wheel gear) with a maximum take-off weight of 165,000 kilograms.

(c) *Subgrade Strength*

Subgrade soil supports the pavement and the loads imposed on the pavement surface. The more unstable the subgrade soil, the greater is the required area of load distribution and consequently a greater pavement thickness. The soil condition, therefore, is the most important items effecting the cost of construction of the landing areas and the pavements.

The results of soil investigation for the new airport reveals that soil layer in the area varies considerably from fat clay and coralline limestone (A-7-5) to clayey sandy with coralline gravel (A-2-6) and (A-2-7).

Eleven test pits were excavated along the initial length of runway and another two testpits were located in the area of the future runway extension. Testpits were located at an interval of approximately 250 meters up to the ultimate length of the runway. In order to have a thorough check of soil layers, auguring was also conducted between test pit locations. The locations of testpits and auger holes are shown on Drawing 3 and a summary of the soil analysis results is presented in Annex A.

California Bearing Ratio (CBR) values, at 95% Maximum Dry Density (MDD), are given in Table 3-14.

Table 3-14
CALIFORNIA BEARING RATIOS

Test Pit/Sample Number (i)	California Bearing Ratio (X)
1	12.70
2	9.10
3	13.30
4	3.70
5	10.60
6	16.80
7	4.10
8	17.00
9	11.20
10	4.30
11	12.90
12	2.38
Total $\sum X_i$	118.08

Source: Soil sampling and laboratory testing performed for the Consultant by Industrial Inspection International, Inc. (1991)

After having obtained the CBR values for each of the test pit samples, a conservative representative value for the site was established as the criteria for preliminary design purposes. This CBR value, determined by Equation 3-2, is exceeded by 75% of the actual (measured) CBR values of the samples.

$$CBR_r = \bar{X} - \left[\frac{2}{3}\right] \times S \tag{3-2}$$

where:

CBR_r = representative CBR

$\bar{X}$ = the mean CBR

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}, \quad X_i = \text{CBR value of sample } i \tag{3-3}$$

S = standard deviation of the test values obtained

$$S = \left[\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n - 1}\right]^{\left(\frac{1}{2}\right)}, \quad n = \text{total number of samples} \tag{3-4}$$

Based on the results of soil investigations for the Laguindingan airport site, the

$$\text{mean CBR, } \bar{X} = \frac{118.08}{12} = 9.84,$$

the standard deviation of the results is,

$$S = \left[\frac{289.19}{11}\right]^{\left(\frac{1}{2}\right)} = 5.11,$$

and the representative CBR is

$$S = 9.84 - \left[\frac{2}{3}\right] \times 5.13 = 6.42\%.$$

Therefore, the pavement for the Laguindingan runway is designed for a CBR value of 6.42%, corresponding to a Modulus of Subgrade Reaction, k, of 46 MN/m^3 (165 psi).

(d) Base and Sub-base Materials

The FAA recommends the use of stabilized base or subbase courses for new pavements designed to accommodate jet aircraft weighing 45,450 kilograms (100,000 lbs) or more. Since the design aircraft for the new airport is has a gross weight of 165,000 kilograms, a 150 mm (6 inch) cement stabilized crushed sub-base is recommended, which, as shown in Figure 3-8, increases the Modulus of Subgrade Reaction, k, from 46 MN/m^3 to 76.6 MN/m^3 (275 psi).

(e) Rigid Pavement Design Curves

The pavement thickness for the concrete runway proposed for the Laguindingan Airport was obtained from the FAA rigid pavement design curves, shown in Figure 3-9, by applying the following parameters:

- modulus of subgrade reaction, k = 76.6 MN/m^3 (275 psi);
- concrete flexural strength = 4.6 Mpa (650 psi);
- gross weight of an A300 = 165,000 kg; and
- annual equivalent departures = 1,217,

yielding a concrete pavement thickness of 370 mm (14.5 inches).

FAA standards allow a change in pavement thickness in the outer (non-critical) lanes of the runway to 70% of the designed slab thickness, thus, the outer lane pavement thickness is reduced to 260 mm (10.25 inches).

The typical runway section used in the preliminary design of the Laguindingan Airport is shown in Drawing 6.

3.8 AIRPORT DRAINAGE DESIGN

The primary purpose of an airport drainage system is:

- to dispose of water which may hinder any activity necessary to the safe and efficient operation of the airport.
- to collect and remove surface water runoff from each area and protect all slopes from erosion.
- to avoid the saturation of the subgrade, base and sub-base by the excessive ponding of water.

The factors that influence drainage system design are rainfall, storm frequency, runoff coefficients, time of concentration, and flow velocity.

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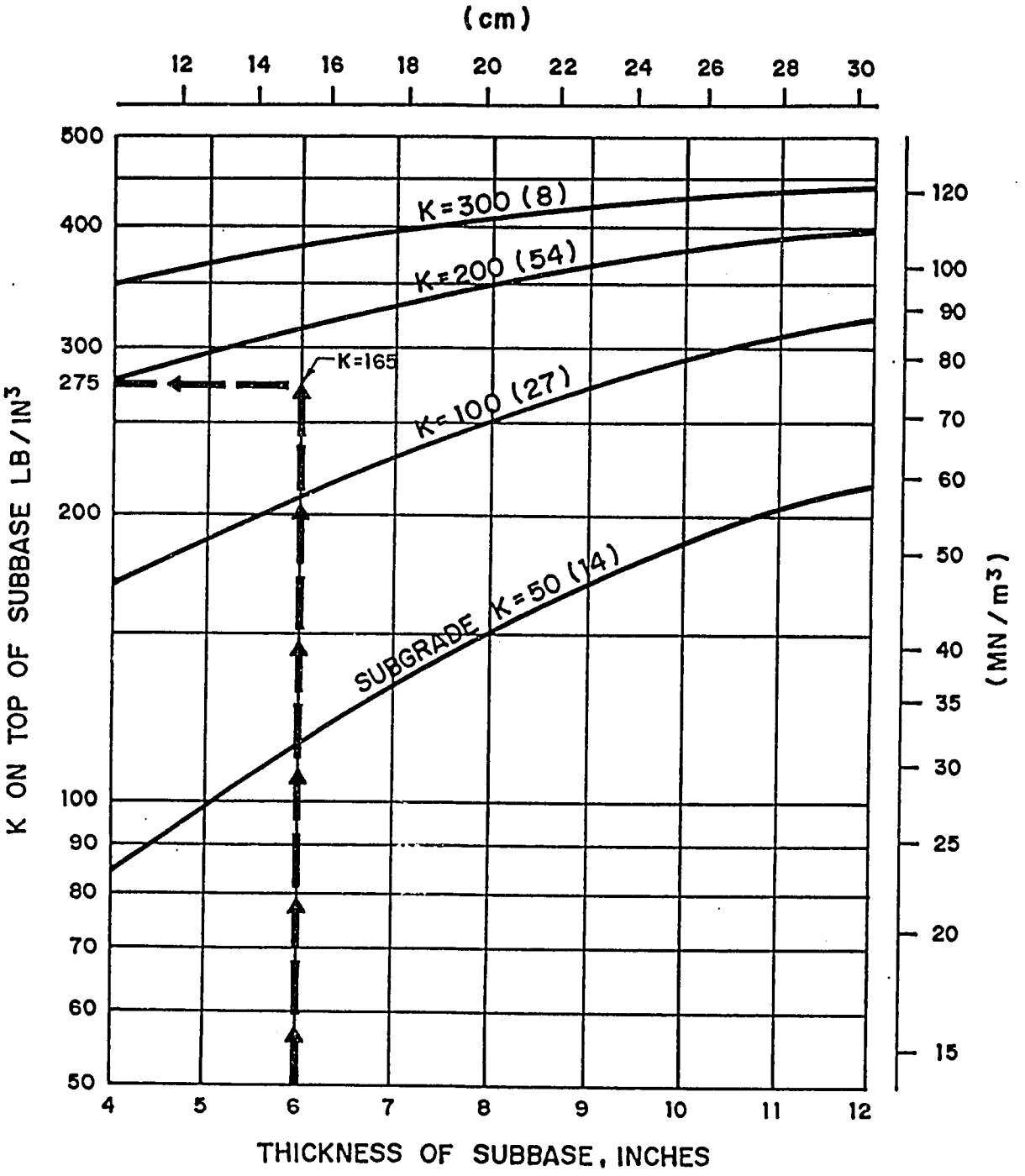

Source: Federal Aviation Administration

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-8
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	EFFECT OF STABILIZED SUB-BASE ON SUBGRADE MODULUS	

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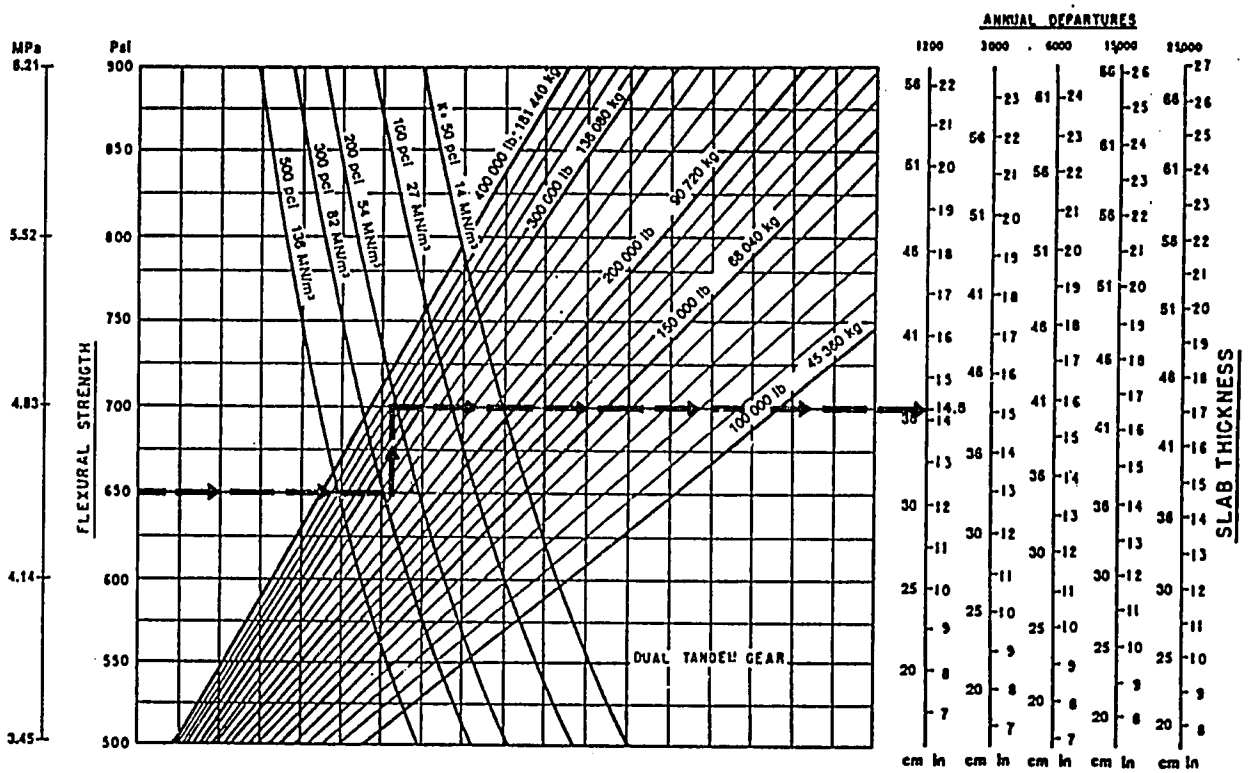


Source: Federal Aviation Administration

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	**CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT**	**FIGURE 3-9**
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	**RIGID PAVEMENT DESIGN CURVES** **DUAL TANDEM GEAR**	

3.8.1 Rainfall

Twenty-seven years of rainfall data (1963-1990), recorded by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) station at the Cagayan de Oro Airport, were used in plotting the rainfall intensity-duration frequency curves for various return periods shown in Figure 3-10.

3.8.2 Design Storm for Surface Runoff

The selection of the severity of the storm which the drainage system should accommodate is an economic consideration. Designing for an extremely severe storm (100-year return) will result in large drainage structures which may not be economically justified.

The FAA recommends that, for civil airports, the drainage system be designed for a storm whose probability of occurrence is once in 5 years. This recommendation is adopted for the preliminary design.

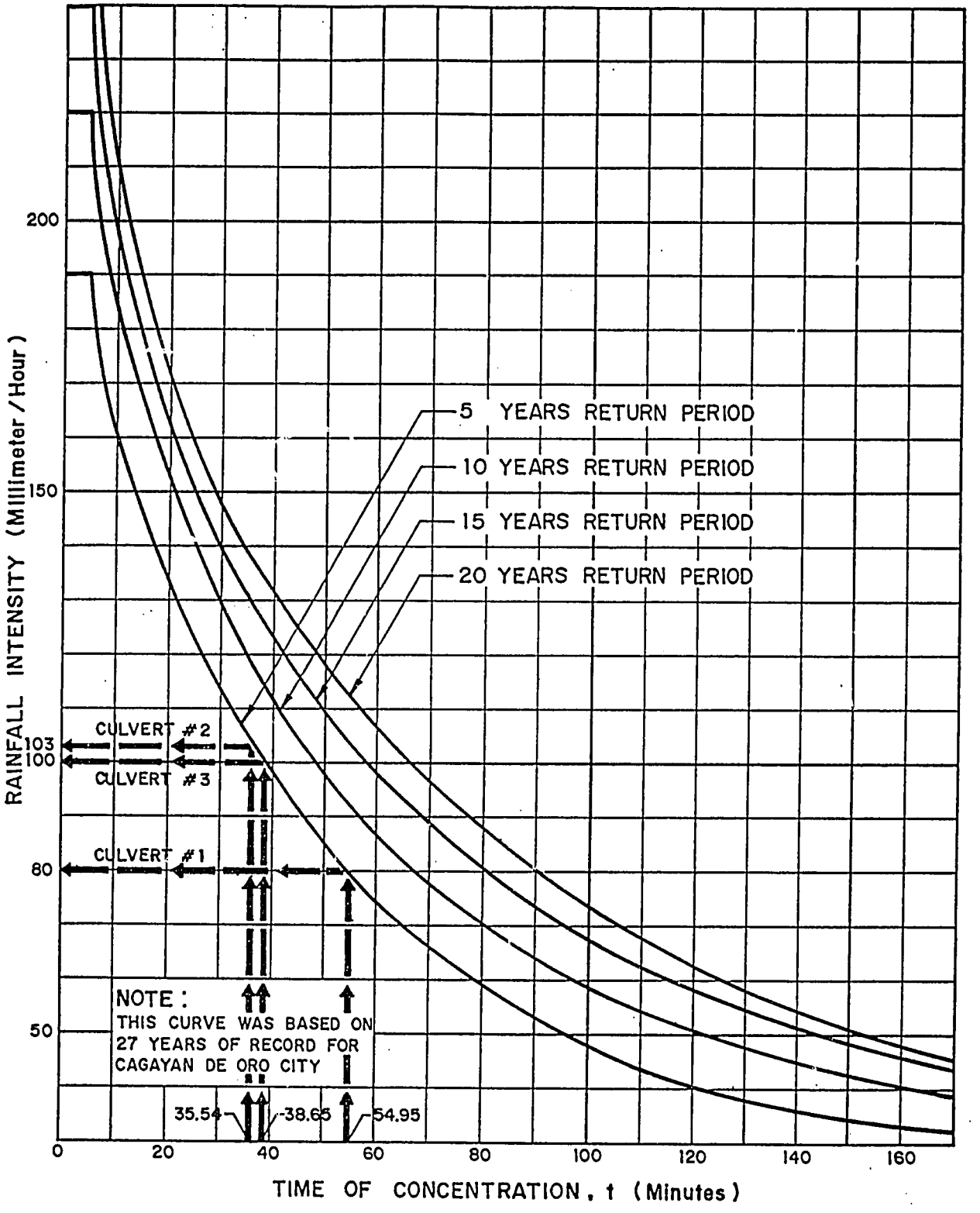
3.8.3 Runoff Coefficient

A runoff coefficient is defined as the percentage of rainfall on a given area that flows off as free water. The FAA has compiled runoff coefficients for various surface types, as given in Table 3-15. These values are used in the preliminary design of the airport drainage system

Table 3-15
RUNOFF COEFFICIENTS

Type of Surface	Runoff Coefficient, C
All watertight roof surfaces	0.75 to 0.95
Asphalt runway pavements	0.80 to 0.95
Concrete runway pavements	0.70 to 0.90
Gravel or macadam pavements	0.35 to 0.70
Impervious soils (heavy)†	0.40 to 0.65
Impervious soils, with turf†	0.30 to 0.55
Slightly pervious soils†	0.15 to 0.40
Slightly pervious soils, with turf†	0.10 to 0.30
Moderately pervious soils†	0.05 to 0.20
Moderately pervious soils, with turf†	0.00 to 0.10

† *For slopes from 1 to 2 percent*
Source: Federal Aviation Administration (USA)



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (1963-1990 rain data)

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-10
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	RAINFALL INTENSITY-DURATION FREQUENCY CURVES	

3.8.4 Time of Concentration

The time of concentration is defined as the time it takes stormwater to reach the drain inlet from the most remote point in the catchment area. The most remote point refers to the point from which the time of flow is the greatest. The time of concentration is calculated using Equation 3-5.

$$T_c = \frac{3.25 \times (1.1 - C)\sqrt{D}}{\sqrt[3]{S}} \tag{3-5}$$

where:

T_c = time of concentration, minutes

C = runoff coefficient, percent

D = watercourse distance, meters

3.8.5 Flow Velocity

Flow velocities, used in the design of culverts, are determined by Manning's Formula, given in Equation 3-6.

$$V = \frac{1}{n} \times R^{\left(\frac{2}{3}\right)} \times S^{\left(\frac{1}{2}\right)} \tag{3-6}$$

where:

V = velocity

n = roughness coefficient

R = hydraulic radius

S = slope

3.8.6 Drainage Culverts

The proposed runway at Laguindingan has an east-west orientation, perpendicular to the natural slope of the ground, which falls to the north. There are three watercourses that cross the runway; drainage structures are provided beneath the runway to handle the flow.

Of the three watercourses, the one crossing the runway at station 1+195 is the most severe, approximately 16 meters deep. This depth, however, appears to be more of a natural formation than one caused by water flow.

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According to longtime area residents, water flow within this ravine is described as intermittent and only flowing during periods of heavy rains. The observed maximum water level is not significantly high and, therefore, the provision of a drainage culvert conservatively designed to calculated runoff flows is considered adequate.

Drainage culverts, beneath the runway, are provided for the three natural waterways, catchment areas for each are shown in Figure 3-11.

The introduction of large paved areas (runway, access and service roads), with higher runoff coefficients, will significantly alter the drainage characteristics of the area. The culverts are designed with an assumed high runoff coefficient of 0.65 to handle the increased flows after construction of the airport facilities. Preliminary culvert design is presented below.

3.8.6.1 Culvert No. 1 (Station 1+015)

(a) Runoff Calculation

Concrete paved areas	=	14,513 m^2
Asphalt paved areas	=	4,838 m^2
Unpaved areas	=	144,160 m^2
Total Catchment Area	=	2,163,511 m^2

To account for the runoff characteristics of the different surface types, a weighted runoff coefficient, C_W, is determined.

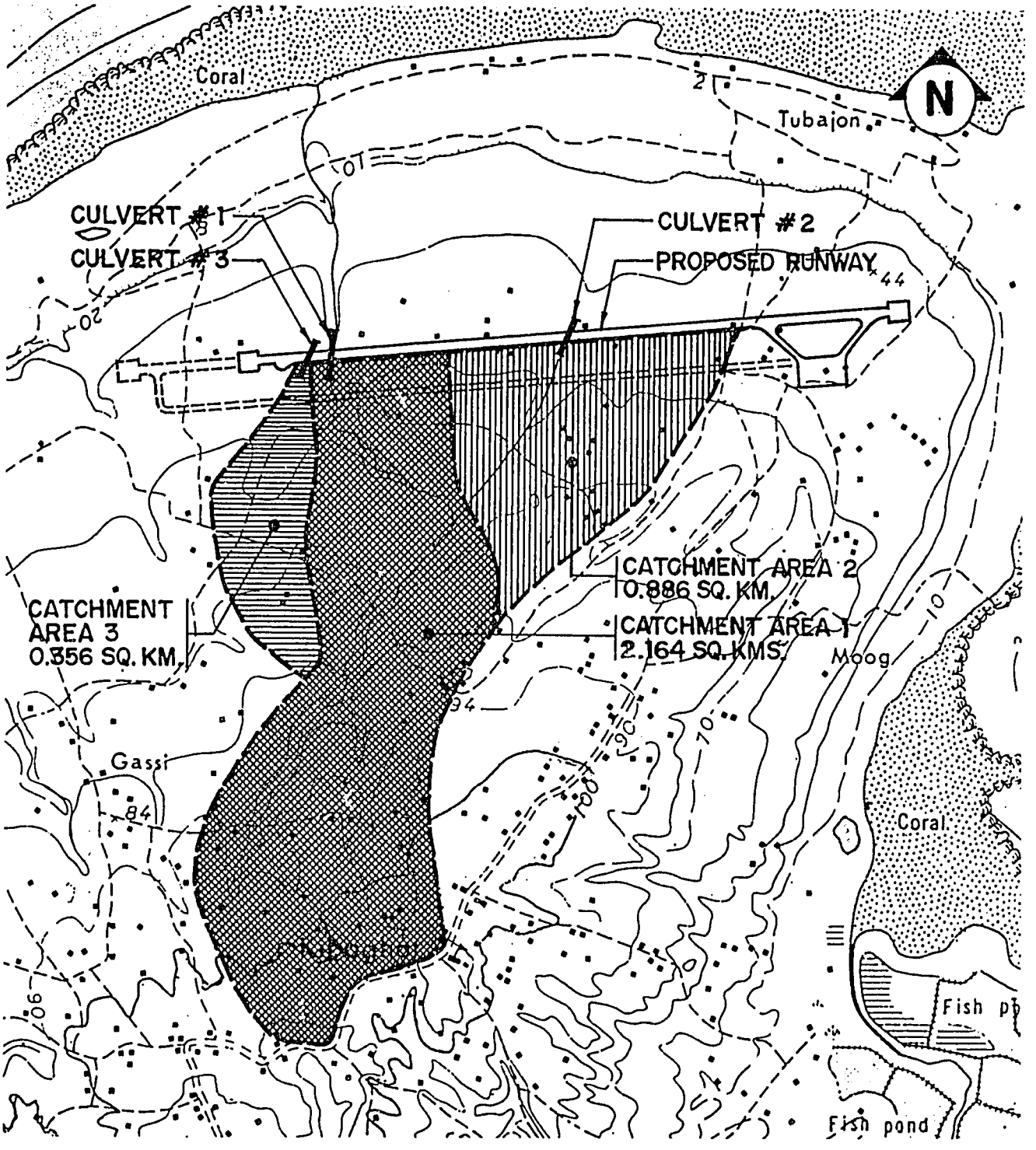
$$C_W = \frac{14{,}513(0.90) + 4{,}838(0.95) + 2{,}144{,}160(0.65)}{2{,}163{,}511} = 0.652$$

The watercourse distance, from the most remote point to the inlet, is 2,950 meters, the high end elevation is 130 meters, the low is 40 meters.

$$\text{Slope of watercourse, } S = \frac{130 - 40}{2{,}950} = 3.05\%$$

$$\text{Time of Concentration, } T_c = \frac{3.25 \times (1.1 - 0.652)\sqrt{2{,}950}}{\sqrt[3]{3.05}} = 54.70 \textit{ minutes}$$

From the rainfall intensity-duration frequency curve (Figure 3-10), the value of rainfall intensity, i = 81 mm/h for a 5-years return period.



Source: Consultant's estimates and area maps

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-11
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	CATCHMENT AREA PLAN	

Solving for runoff, $Q = CiA = \dfrac{0.652 \times 81\,mm/h \times 2{,}163{,}511\,m^2}{3{,}600\,s/h \times 1{,}000\,mm/m} = 31.70\ m^3/s$

where:

Q = runoff

C = runoff coefficient

i = rainfall intensity

A = area

(b) Determination of Culvert Size

Try 1 - 3.0m wide x 3.5m high barrel section:

$$\text{Area, } A = 3.0\,m \times 3.5\,m = 10.5\,m^2$$
$$\text{Wetted Perimeter, } P = (3.0\,m \times 2) + (3.5\,m \times 2) = 13.0\,m$$
$$\text{HydraulicRadius, } R = A/P = 10.5\,m^2/13.0\,m = 0.808\,m$$

Solving for Velocity, V, using Manning's Formula (Equation 3-6), assuming slope, $S = 0.0027$ and a friction coefficient, $n = 0.015$:

$$V = \frac{1}{0.015} \times (0.808)^{\left(\frac{2}{3}\right)} \times (0.0027)^{\left(\frac{1}{2}\right)} = 3.0\,m/s$$

$$Q = AV = 10.50\ m^2 \times 3.00\ m/s = 31.50\ m^3/s\ capacity \simeq 31.70\ m^3/s\ runoff$$

Therefore, a 3.0m wide x 3.5m high barrel section is adequate.

3.8.6.2 Culvert No. 2 (Station 1+195)

(a) Runoff Calculation

Concrete paved areas	=	31,932 m^2
Asphalt paved areas	=	11,858 m^2
Unpaved areas	=	842,696 m^2
Total Catchment Area	=	886,486 m^2

To account for the runoff characteristics of the different surface types, a weighted runoff coefficient, C_W, is determined.

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$$C_w = \frac{31{,}932(0.90) + 11{,}858(0.95) + 842{,}696(0.65)}{886{,}486} = 0.66$$

The watercourse distance, from the most remote point to the inlet, is 1,200 meters, the high end elevation is 80 meters, the low 45 meters.

$$\text{Slope of watercourse, } S = \frac{80 - 45}{1{,}200} = 2.92\%$$

$$\text{Time of Concentration, } T_c = \frac{3.25 \times (1.1 - 0.66)\sqrt{1{,}200}}{\sqrt[3]{2.92}} = 34.75 \textit{ minutes}$$

From the rainfall intensity-duration frequency curve (Figure 3-10), the value of Rainfall Intensity, i = 104 mm/h, for a 5-years return period.

$$\text{Solving for runoff, } Q = CiA = \frac{0.66 \times 104\, mm/h \times 886{,}846\, m^2}{3{,}600\, s/h \times 1{,}000\, mm/m} = 16.91\, m^3/s$$

(b) Determination of Culvert Size:

Try 1 - 3.0m wide x 2.0m high barrel section:

$$\text{Area, } A = 2.0\,m \times 3.0\,m = 6.0\,m^2$$
$$\text{Wetted Perimeter, } P = (2.0\,m \times 2) + (3.0\,m \times 2) = 10.0\,m$$
$$\text{HydraulicRadius, } R = A/P = 6.0\,m^2/10.0\,m = 0.60\,m$$

Solving for Velocity, V, using Manning's Formula (Equation 3-6), assuming slope, S = 0.0035 and a friction coefficient, n = 0.015:

$$V = \frac{1}{0.015} \times (0.60)^{\left(\frac{2}{3}\right)} \times (0.0035)^{\left(\frac{1}{2}\right)} = 2.806\, m/s$$

$$Q = AV = 6.0\,m^2 \times 2.806\, m/s = 16.84\, m^3/s \textit{ capacity} \simeq 16.91\, m^3/s \textit{ runoff}$$

Therefore, a 3.0m wide x 2.0m high barrel section is adequate.

3.8.6.3 Culvert No. 3 (Station 2+265)

(a) Runoff Calculation

$$\begin{aligned} \text{Concrete paved areas} &= 5{,}288\ m^2 \\ \text{Asphalt paved areas} &= 1{,}763\ m^2 \\ \text{Unpaved areas} &= \underline{349{,}249\ m^2} \\ \text{Total Catchment Area} &= 356{,}300\ m^2 \end{aligned}$$

To account for the runoff characteristics of the different surface types, a weighted runoff coefficient, C_W, is determined.

$$C_W = \frac{5{,}288(0.90) + 1{,}763(0.95) + 349{,}249(0.65)}{356{,}300} = 0.655$$

The watercourse distance, from the most remote point to the inlet, is 1,400 meters, the high end elevation is 80 meters, the low 40 meters.

$$\text{Slope of watercourse, } S = \frac{80 - 40}{1{,}400} = 2.86\%$$

$$\text{Time of Concentration, } T_C = \frac{3.25 \times (1.1 - 0.655)\sqrt{1{,}400}}{\sqrt[3]{2.86}} = 38.22\ \textit{minutes}$$

From the rainfall intensity-duration frequency curve (Figure 3-10), the value of Rainfall Intensity, i = 101 mm/h, for a 5-years return period.

$$\text{Solving for runoff, } Q = CiA = \frac{0.655 \times 101\ mm/h \times 356{,}300\ m^2}{3{,}600\ s/h \times 1{,}000\ mm/m} = 6.55\ m^3/\text{sec}$$

(b) Determination of Culvert Size

Try 2 - 1.2m ϕ reinforced concrete pipes (RCP):

$$\text{Area, } A = \frac{\pi \times (1.20\,m)^2}{4} \times 2 = 2.26\,m^2$$

$$\text{Wetted Perimeter, } P = (3.0\,m \times 2) + (3.5\,m \times 2) = 13.0\,m$$

$$\text{HydraulicRadius, } R = A/P = 10.5\,m^2/13.0\,m = 0.808\,m$$

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Solving for velocity, V, using Manning's Formula (Equation 3-6), assuming slope, $S = 0.01$ and a friction coefficient, $n = 0.015$:

$$V = \frac{1}{0.015} \times (0.30)^{\left(\frac{2}{3}\right)} \times (0.01)^{\left(\frac{1}{2}\right)} = 2.99\ m/s$$

$$Q = AV = 2.26\,m^2 \times 2.99\,m/s = 6.75\,m^3/s\ capacity > 6.55\,m^3/s\ runoff$$

Therefore, a 2-1.2m ϕ reinforced concrete pipe is adequate.

3.8.7 Open Ditch

An open ditch is provided outside the graded portion of the runway strip to intercept runoff from the higher ground to the south, and to direct the flow to the culvert inlet. The open ditch is designed such that the water level will not saturate the subgrade and sub-base materials.

3.9 AIRPORT PAVEMENT MARKINGS

In order to aid pilots in guiding the aircraft on the runway, taxiways and aircraft parking apron, pavements are marked with lines and letters. Standard markings are provided to established uniformity among airports for ease of recognition, and in the interest of safety and efficiency of aircraft operation.

3.9.1 Runway Markings

ICAO standard runway markings for precision instrument approaches are recommended for the Laguindingan runway. Required runway markings are as follows:

- runway designation marking
- runway centerline marking
- threshold marking
- fixed distance marking
- touchdown zone marking
- runway side stripe marking

The color of runway markings shall be white.

3.9.2 Taxiway Markings

The following taxiway markings are recommended for the Laguindingan Airport:

- taxiway centerline marking
- taxi-holding position marking

The color of taxiway markings shall be yellow.

3.9.3 Aircraft Parking Apron Markings

The apron and apron stand markings listed below are recommended by the ICAO standards, and should be adopted for at the Laguindingan Airport.

- lead-in lines
- turning lines
- lead-out lines
- stop lines
- alignment bars
- turn bars

The color of marking for an apron shall be yellow.

3.10 AIR TRAFFIC CONTROL EQUIPMENT AND FACILITIES

3.10.1 Air Traffic Control Tower

Air traffic control towers are the facilities from which the tower personnel control flight operations within the airport's designated airspace and control aircraft and vehicles on the ground within the Airport Operating Area (AOA). The primary consideration for control tower location is to provide visibility of all portions of the AOA and the surrounding airspace. Air traffic control towers should be sited to meet the following criteria:

- provision of maximum visibility of the airports traffic pasterns;
- provision of a clear, unobstructed, and direct line-of-site to the approaches, runways, taxiways, and aprons;
- the tower must not denigrate the signal generated by any existing or planned electronic navigational aid (NAVAID) or an air traffic control facility

The ICAO standards recommend, in addition to the above criteria, that the tower be located such that there is a 00°35′00″ minimum angle-of-sight from the tower to the runway threshold area.

The ATO requires the establishment of an airport control tower at airports where there are at least three daily scheduled turboprop flights, one daily scheduled jet flight, or 8,000 annual aircraft operations. An approach control facility is required by the ATO when there are at least six daily scheduled turboprop flights, two daily scheduled jet flights, or night operations.

Based on the forecast of commercial aircraft operations in 1996 (opening year of the new airport), there will be at least two daily scheduled F50 turboprop flights (or 4 aircraft movements) and five daily scheduled B737 flights (10 aircraft movements). For these flight frequencies, a tower control and an approach control facility are required at Laguindingan to meet ATO standards.

The tower control facility will provide positive control of the movements of aircraft on final approach and initial departure and control aircraft and vehicles moving within the AOA. The approach control facility will control instrument approaches and departures of aircraft within the terminal area of the airport.

The preliminary design of the air traffic control tower, developed for site layout and cost estimating purposes, is shown in Drawing 8.

3.10.2 Air and Ground Navigation and Visual Aids

To aid the pilot in navigating into and out of the airport, the establishment of air and ground navigation and visual aids are required. Due to the high approach speeds of the A300 wide-body jet aircraft (135 Knots or 250 km/h), instrument approach procedures are recommended.

The following radio and visual navigation aids are recommended to support Category I precision instrument approaches on Runway 27 and non-precision instrument approaches on Runway 09 of the proposed airport:

- **Instrument Landing System (ILS)**

  An ILS provides pilots with radio guidance for aircraft alignment, descent gradient, and position until visual contact is made with the runway alignment.

  The system consists of the Glide Slope (GS) facility which is used to establish and maintain the rate of descent of the aircraft until visual contact with the runway is made. It is the GS facility that differentiates precision from non-precision instrument approaches.

  Included in the Instrument Landing System is the Localizer (LLZ) which is used to establish and maintain the horizontal position of the aircraft. Outer, middle and inner marker beacons, which radiate cone or fan-shaped signals vertically, will activate aural and visual indicators in the cockpit, thus making the pilot aware of specific points along the ILS approach path.

- **Very High Frequency Omnidirectional Radio Range (VOR)**

  The ground-based VOR transmits azimuth information for instrument approach procedures. The VOR should be located 150 meters from the centerline of the runway and 75 meters from the centerline of the taxiway.

- **Distance Measuring Equipment (DME)**

  The DME provides the pilot with range information (distance to or from the airport) and is normally co-located with the VOR facility. However, since the precision instrument approach to the new airport will be over water, the DME should, instead, be co-located with the LLZ. The DME will take over the functions of the marker beacons in relaying distances along the approach path of the landing aircraft.

- **Simple Approach Light System (SALS)**

  This visual aid consists of a row of lights positioned symmetrically along the extended runway centerline over a distance of 420 meters before the threshold. One set each should be installed on the approach ends of Runway 27 and Runway 09, respectively.

- **Precision Approach Path Indicator (PAPI)**

  The PAPI provides, through a system of lights, the proper approach slope to the runway. PAPI's should be installed at both ends of the runway, approximately 300 meters after the threshold line and 37.5 meters from the centerline of the runway.

- **Runway Visual Range (RVR)**

  The Runway Visual Range, located behind the glide slope facility, gives the pilot information on the horizontal visibility in the touchdown area of the runway.

- **High Intensity Runway Lights (HIRL)**

  High intensity runway lights allows the pilot to differentiate the limits of the runway during landing and take-off operations.

- **High Intensity Taxiway and Apron Edge Lights**

  These visual aids are used to clearly identify the taxiway and apron. Blue-colored lights are used to differentiate them from the white-colored runway lights.

- **Runway End Identification Lights (REIL)**

  These red-colored lights, allow the pilot to clearly identify the end of the runway during roll-out or aborted take-off operations.

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- **Lighted Windcone**

  The lighted windcone provides the pilot with landing information regarding wind speed and direction during low visibility or night operations. Lighted windcones should be installed on the approach ends of Runway 27 and Runway 09.

3.11 AIRPORT BUILDINGS

It is not in the scope of this study to design in detail the airport buildings, however, preliminary building layouts were developed for cost estimating and site planning purposes for the following airport buildings:

- passenger terminal
- the cargo terminal
- crash-fire-rescue building
- operations and maintenance building
- power and pump house

These drawings are included at the end of this chapter for reference.

Aircraft related facilities (runway, taxiway, apron, etc.) used the high growth case forecast of aircraft movements to determine the structural section of the runway pavement, the lateral separation requirements for aircraft, and to size the apron and taxiway. This results in a conservative design that allows these facilities to handle increased demand over the long term planning horizons without costly upgrades, such as runway overlays. For the sizing of airport buildings, the base case forecasts are used, which ensures that the buildings are able to handle the demand for near and possibly medium term growth without being oversized to the point of being inefficient to operate. The building design should plan for future expansion(s) and the site layout should allow sufficient space around the buildings to accommodate the expansion.

3.11.1 Passenger Terminal

The primary function of the passenger terminal is to serve as a passenger-processing center. The passenger-processing system consists of those facilities required for the efficient handling of passengers and their baggage prior to, or after a flight. It is the element that links the ground access system to the air transportation system.

3.11.1.1 Terminal Functional Areas

The main components of the passenger terminal are as follows:

- **Access and Landside Interface Areas**

  Access to curbside loading and unloading areas designated for passenger cars, taxis, jeepneys and other surface modes of transportation.

- **Terminal Lobby Area**

  The functions performed in the lobby area are passenger ticketing, passenger and visitor waiting, and baggage check-in and baggage claiming. In general, the terminal lobby should provide for passenger queuing, circulation and waiting.

- **Airline Ticket Counter**

  The airline ticket counter is where the passenger makes his final travel arrangements: ticketing; seat assignment; baggage check-in and departure processing.

- **Security**

  Security screening of passengers and hand-carried baggage is required prior to boarding the aircraft. Depending on the configuration of the terminal and the policy of the airlines, security screening may be conducted at various locations within the terminal between the ticketing and the aircraft boarding areas.

- **Departure Lounges**

  The departure lounge serves as an assembly area for passengers waiting to board a particular flight and as an exit for deplaning passengers. The departure lounge is usually sized to accommodate the number of passengers expected to be in the lounge 15 minutes prior to departure, conservatively estimated as 90% of the boarding passengers.

- **Baggage Claim Facilities**

  The baggage claim lobby should be located so that checked baggage may be claimed at a reasonable distance from the terminal curb. Sufficient space should be provided in the baggage claim area to allow for waiting, and circulation.

- **Other Areas**

  Space should be allocated within the terminal building for activities other than passenger processing, including: baggage storage, administrative offices, concessionaires; restrooms, public lockers, telephones; etc.

3.11.1.2 Design Concept

A simple linear terminal is recommended for the Laguindingan airport. This type of terminal consists of a common waiting and ticketing area with exits leading directly to the aircraft parking apron. The concept offers ease of access and relatively short walking distances; it provides for efficient operation and at the same time is simple and economical. A linear terminal provides direct access from the curb front to the aircraft gate positions and affords a high degree of flexibility for expansion. Expansion may be accomplished by linear extension of the existing structure or by the addition of new terminal units with connectors. The preliminary design of the terminal building, developed for site layout and cost estimating purposes, is shown in Drawing 7.

3.11.2 Cargo Terminal

The cargo terminal prevents the interference between freight and passenger traffic at the airport. The cargo terminal has four principal functional areas:

- **Conversion Area** - which is further divided into the cargo *"build-up"* area where a number of small loads are combined into a larger unit which can be easily handled airside, and the cargo *"break-down"* area where a large unit is broken down into a number of small loads for delivery to customers.

- **Sorting Area** - where cargo bound for different destinations are sorted and combined into aircraft loads for individual destinations.

- **Storage Area** - since landside and airside cargo flow rates and patterns are not necessarily the same, storage is provided until connections can be made.

- **Documentation Area** - serves the administrative functions of the cargo handling process (documentation of cargo transfers between air and surface carriers).

The preliminary design of the cargo terminal, developed for site layout and cost estimating purposes, is shown in Drawing 9.

3.11.3 Crash-Fire-Rescue Building

For a Code 4D airport the ICAO requires a Category 8 Crash-Fire-Rescue (CFR) facility. The 4-bay building is sized to accommodate 28 firemen and the following equipment:

- one Rapid Intervention Vehicle (RIV); and
- three Major Vehicles (MV)

The preliminary design of the CFR facility, developed for site layout and cost estimating purposes, is shown in Drawing 10.

3.11.4 Operations and Maintenance Building

The operations and maintenance building serves as the office of the Airport Manager and his staff and functions as the administrative center for the airport. In addition the building houses the airport facility maintenance shop.

The preliminary design of the operations and maintenance building, developed for site layout and cost estimating purposes, is shown in Drawing 11.

3.11.5 Power and Pump House

The main switch gear for the airport electrical system and the emergency power generators are located in the power and pump house. The water pumps which supply water to the elevated storage tank are also located in this building.

The preliminary design of the power and pump house, developed for site layout and cost estimating purposes, is shown in Drawing 12.

3.12 CONSTRUCTION COST ESTIMATE

Based on the facility requirements discussed in the preceding sections and the preliminary design drawings the construction cost estimate shown in Table 3-16 has been prepared (the basis of the cost estimate, including the development of unit rates is presented in Annex B). The total financial cost of the Laguindingan Airport is estimated to be ₱737,582 million. This estimated cost of construction is used in the economic and financial analyses presented in Volume I, Chapter 7.

3.13 LAND USE PLANNING

The compatibility of an airport with its environs is an ideal which can be pursued by proper planning of the airport and the land use surrounding it. The goal is to provide the best possible conditions for the airport, the surrounding community, and the ecology of the environment.

3.13.1 Regional Land Use and Planning

The proposed industrial master plan for the Corridor (LBII, 1991) identifies light industrial and/or agro-industrial development as the most feasible development outside the metropolitan population centers of Iligan and Cagayan de Oro. The implementation of the proposed airport project prior to extensive planning for the economic expansion would foster a more orderly development process, The new airport facility would be located centrally within the Corridor, thus providing more equalized access to the proposed facilities while supporting the identified objective of dispersing development not only within the Corridor but also to the economic development zones throughout the region.

Table 3-16
CONSTRUCTION COST ESTIMATE
LAGUINDINGAN SITE
(Financial Costs in Thousands of Pesos)

Item	Description	Unit	Quantity	Cost Components			Financial less Taxes	Financial Cost
				Foreign	Local	Taxes		
1.	Earthworks							
	• Clearing/grubbing	ha	85	958	1,008	491	1,966	2,457
	• Stripping	m^3	36,610	769	972	382	1,741	2,123
	• Excavation	m^3	1,891,910	69,413	72,596	34,339	142,009	176,348
	• Borrow fill	m^3	458,359	33,918	38,860	16,602	72,778	89,380
	• Sub-grade preparation	m^2	201,950	303	343	162	646	808
2.	Runway, 45m wide	lm	2,500	46,225	46,227	23,113	92,452	115,565
3.	Apron, 125m x 200m	m^2	25,000	14,675	14,665	7,335	29,340	36,675
4.	Taxiway, 23m wide	lm	413	4,796	4,796	2,398	9,592	11,990
5.	Control Tower							
	• Building, 5 storey	m^2	325	1,419	1,726	690	3,145	3,835
	• Equipment	lot	1	1,312	1,248	640	2,560	3,200
6.	NAVAIDS							
	• VOR (relocation)	lot	1	0	344	76	344	420
	• ILS (relocation)	lot	1	0	369	81	369	450
	• PAPI	lot	1	1,630	1,407	759	3,037	3,796
7.	Airfield Visual Aids							
	• Runway edge lights	lot	1	2,649	2,279	1,232	4,928	6,160
	• Approach lights	lot	1	1,634	1,406	760	3,040	3,800
	• Lighted wind cone	ea	2	50	42	24	92	116
8	CFR Facilities							
	• Building	m^2	250	1,092	1,327	531	2,419	2,950
	• Equipment	lot	1	3,280	3,120	1,600	6,400	8,000
9	Airport Buildings							
	• Passenger terminal	m^2	2,400	14,515	17,657	7,061	32,172	39,233
	• Operations	m^2	525	2,292	2,788	1,115	5,080	6,195
	• Cargo terminal	m^2	360	1,853	2,253	901	4,106	5,007
	• Power plant	m^2	60	259	315	126	574	700
10.	Site Improvements							
	• Drainage	lot	1	1,288	1,496	696	2,784	3,480
	• Access road, 7.3m wide	km	13	16,323	18,969	8,823	35,292	44,115
	• Service roads, 6.1m wide	km	1	770	894	416	1,664	2,080
	• Perimeter fence	lm	9730	632	1,411	477	2,043	2,520
	• Landscaping/turfing	lot	1	295	2,061	589	2,356	2,945
11.	Vehicle Parking	m^2	8,200	1,205	1402	648	2,607	3,255
12.	Utilities							
	• Power supply	lot	1	595	930	335	1,525	1,860
	• Water supply	lot	1	474	740	266	1,214	1,480
	• Sewer	lot	1	128	200	72	328	400
	Total Construction Cost			224,752	243,851	112,740	468,603	581,343
	Contingencies, 10%			22,475	24,385	11,274	46,860	58,134
	Engineering & Supervision, 8%			17,980	19,508	9,019	37,489	46,507
	Land Acquisition	ha	167		45,090	5,010	45,090	50,100
	Relocation Cost	ea	190		1,414	353	1,414	1,767
	Total Amount			265,207	334,248	138,396	599,456	737,582

Source: Consultant's estimates (see also Volume II, Annex B)

3.13.2 Project Site Land Use and Planning

Implementation of the proposed airport project will directly impact the present, if marginal, agricultural use of the 167 hectare site, in addition to the limited areas displaced within the right-of-way of the existing road alignments.

Presently zoned for agricultural use, the 40 to 50 percent of the site owned by Diamond Cement and Industrial Corporation (DCIC) is under application for zoning conversion to industrial use, supported by municipal resolutions. At the same time, the entire DCIC property of 604 hectares has reportedly been in the process of land distribution in line with the national agrarian reform program since October 1988.

Recent discussions held with the officials of the Department of Agrarian Reform (DAR), including the regional director for Region X, indicate that the proposed airport project does not contradict the spirit of agrarian reform as it would be considered a project of national significance and facilitate the transfer to public ownership a large private holding. According to Region X officials of the Housing and Land Use Regulatory Board (HLURB), as a project of national significance zoning conversion for the airport could be considered as a special use variance (approved by the national-level office) with a locational clearance (approved at the regional-level office).

The recommended planning of the areas adjacent to the proposed airport is designed to ensure the compatibility of both the safety of aviation operations and the safety of the community around the airport. Primary physical constraints governing land use in the vicinity of the Laguindingan Airport include:

- **Height Limitations.** Height limitations deal mainly with aviation operations safety. The ICAO has established a series of obstacle limitation surfaces around the runway and aircraft approach paths that define the limits to which objects may project into the airspace. The Air Transportation Offices has been assigned the task of assuring that area development does not exceed these elevation limits.

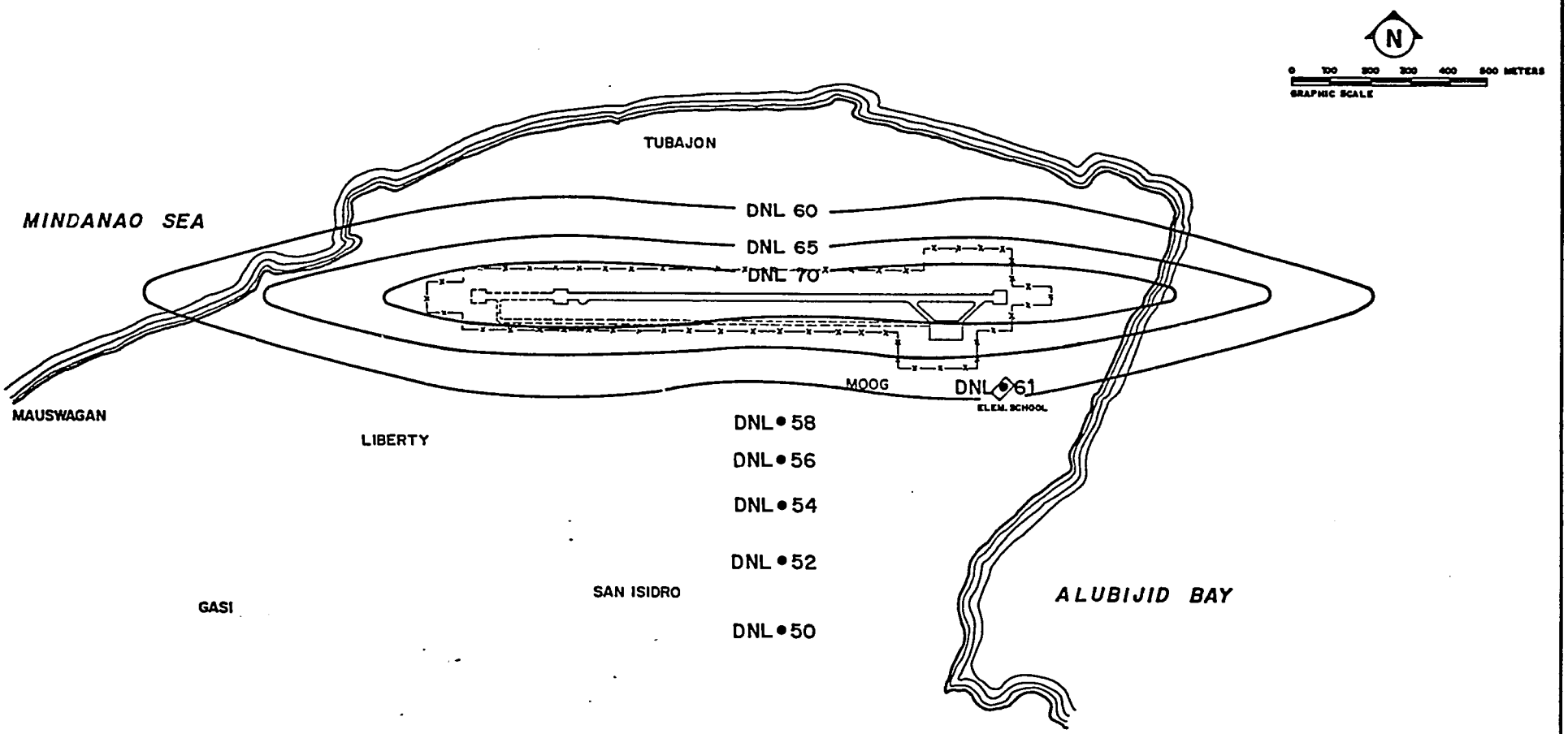
- **Noise Impact Restrictions.** Based on the forecast air traffic at the 20-year planning horizon (2011), noise generation models (FAA, Integrated Noise Model) indicate noise contours in the DNL 65 range extending approximately 150 meters beyond the proposed airport property perimeter, as shown in Figure 3-12, and encompassing a 310 hectare area. Compatible land use within this DNL 65 noise contour impact area, as shown in Table 3-17, include commercial, manufacturing, and recreational developments.

  The ICAO recommends a minimum of three zones for land use planning based on projected aircraft noise impact, summarized as:

  (a) no restrictions (no noise impact)

  (b) minor restrictions (moderate noise impact)

  (c) major restrictions (significant noise impact).



Source: US Federal Aviation Administration, Integrated Noise Model and Consultant's estimate

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-12
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L. INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	NOISE CONTOURS LAGUINDINGAN AIRPORT (2011 HIGH CASE FORECAST)	

Table 3-17
LAND USE NOISE LEVEL COMPATABILITY

Land Uses	Yearly Day-Night Average Sound Levels (DNL) (dB)					
	Below 65	65-70	70-75	75-80	80-85	Over 85
Residential						
Residential other than below	Y	N	N	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodging	Y	N	N	N	N	N
Commercial Use						
Offices, business and professionals	Y	Y	5	10	Y	N
Wholesale	Y	Y	Y	Y	N	N
Retail, building materials, hardware	Y	Y	Y	Y	Y	N
Retail, general	Y	Y	5	10	N	N
Utilities	Y	Y	Y	Y	Y	N
Communications	Y	Y	5	10		N
Manufactuing and Production						
Manufacturing, general	Y	Y	Y	Y	Y	N
Photographic and optical	Y	Y	5	10	N	N
Agriculture and forestry	Y	Y	Y	Y	Y	Y
Livestock farming and breeding	Y	Y	Y	N	N	N
MIning and fishing	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas, spectator sports	Y	Y	Y	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits, zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, camps	Y	Y	Y	N	N	N
Golf courses, riding stables, water recreation	Y	Y	Y	N	N	N

Notes: Y - Yes, the use is compatable with the indicated noise level.
N - No, the land is not compatable with the indicated noise level.
5,10 - Land use and related structures are generally compatable but measures to achieve noise level reductions of 5 to 10 DNL, outdoor to indoor, beyond that obtained by normal construction, should be incorporated into the design and construction of structures.

Source: FAA 150/5020-1, "Noise control and Compatable Planning for Airports" (1983)

- **Light, Glare and Emission Restrictions.** These include uses which may obstruct or confuse pilots approaching the airport, such as bright lights, smoke stacks, etc.

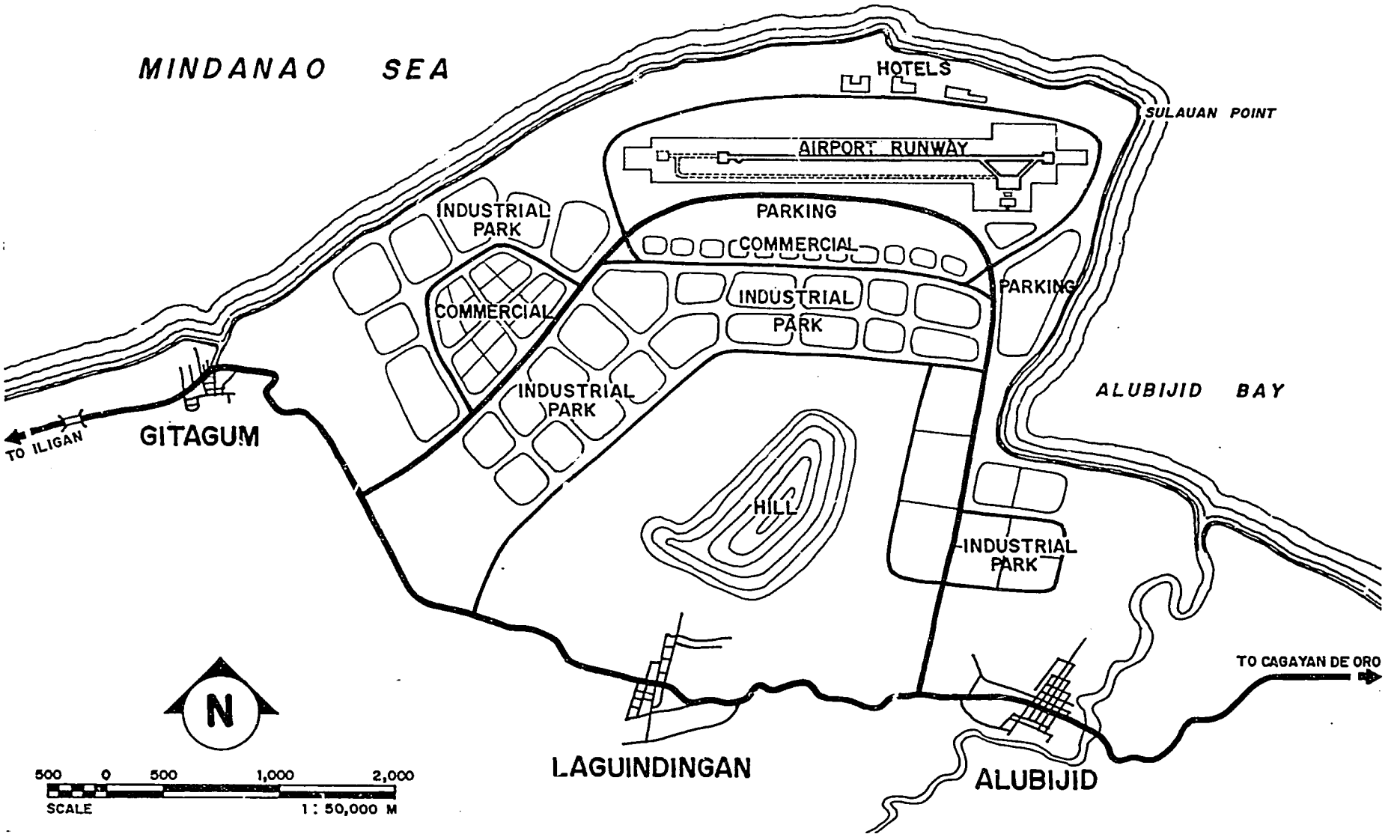
An illustrative land use plan showing the kinds of development compatible with the Laguindingan Airport is presented in Figure 3-18.

3.13.3 Land Use Control

Various means are available for controlling the land use around the airport. The effectiveness of these means should be considered for each particular situation. The most common land use controls are:

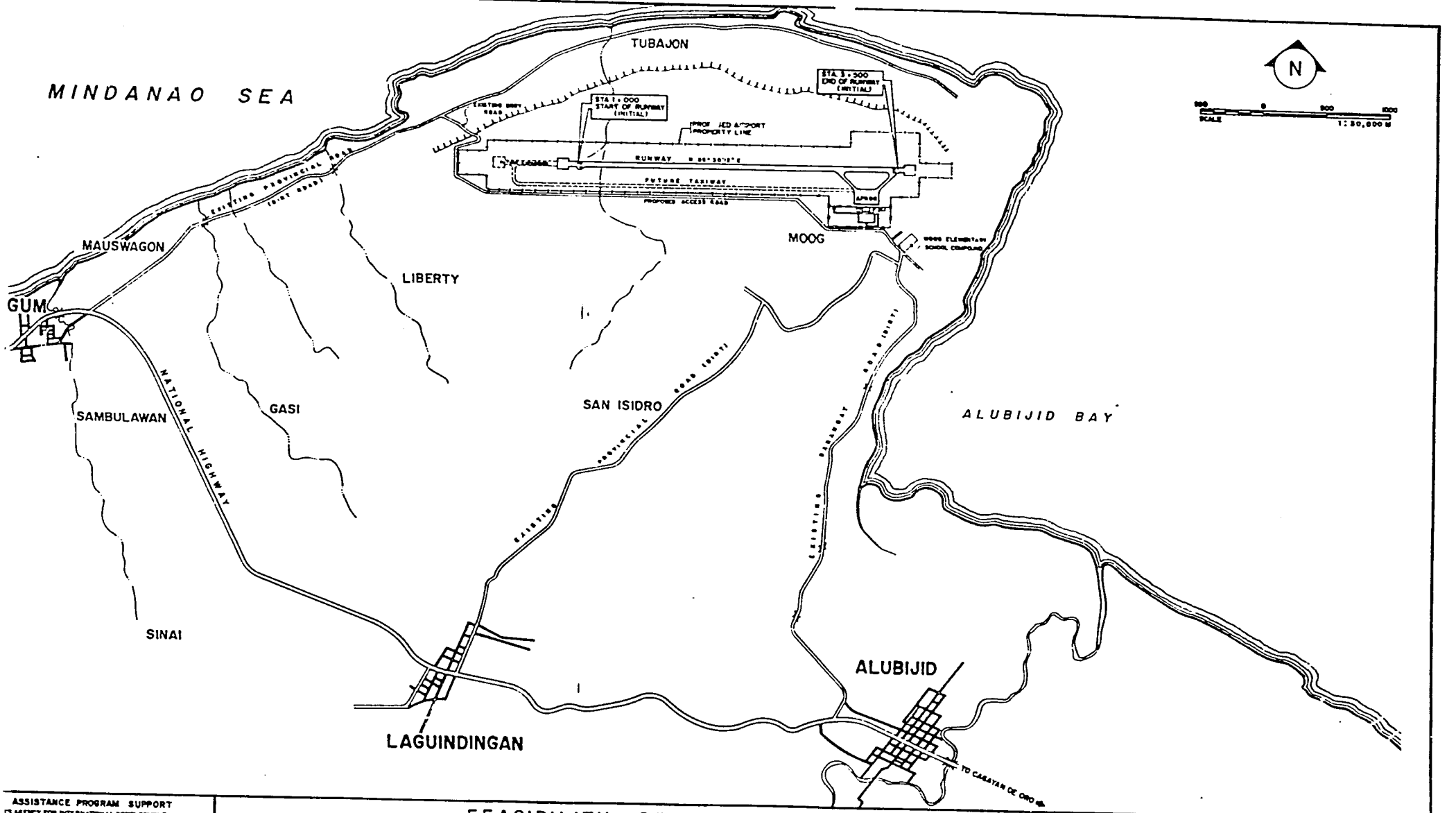
- **Planning.** The creation of a planning body to study, plan and advise on land use.
- **Zoning.** The legal means by which planning objectives are enacted
- **Easement.** The purchase of partial rights to land by the airport or other public authority.
- **Purchase.** The purchase of full ownership of land by the airport or other public authority.

Land use limitations and control are discussed in detail in the project Environmental Assessment report, submitted under separate cover.



Source: Feasibility Study and Industrial Master Planning, Cagayan de Oro-Iligan Corridor (LBII, 1991)

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 3-13
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	ILLUSTRATIVE LAND USE PLAN	



ASSISTANCE PROGRAM SUPPORT
US AGENCY FOR INTERNATIONAL DEVELOPMENT
CONTRACT NO. 492-0402-C-00-0099-00

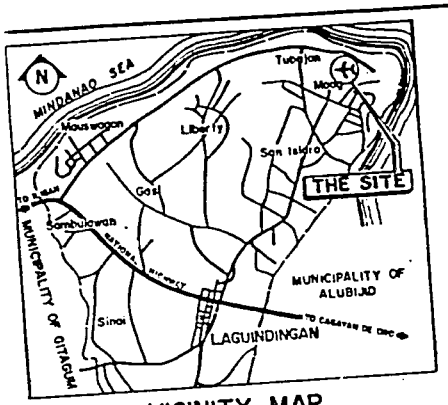
S BERGER INTERNATIONAL, INC.
DOD GREENE INT'L.
& YOUNG INT'L.
TROTTERS ENG'S. CORP.
+ TRANS-ASIA (PHIL.), INC.
+ CONSULTANT MANAGEMENT SERVICE, INC.

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

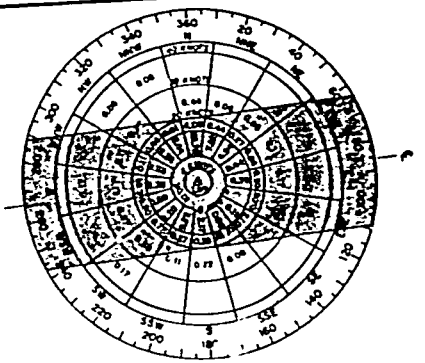
GENERAL SITE PLAN

DRAWING NO.
1

65

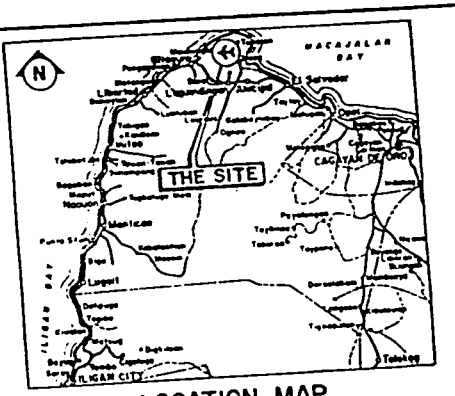


VICINITY MAP
SCALE 1:120,000 M

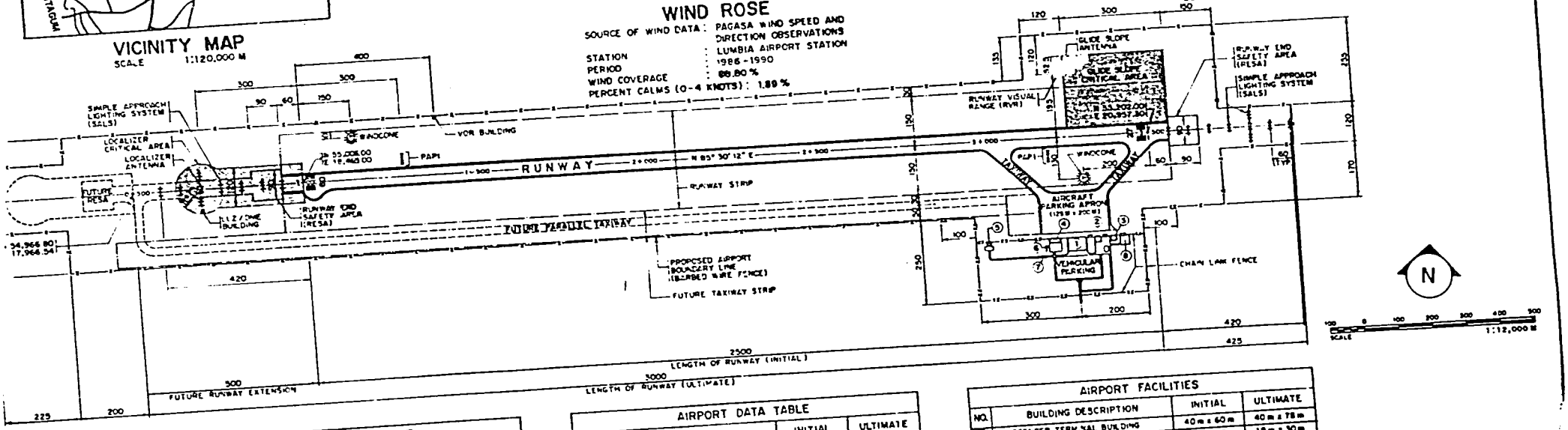


WIND ROSE

SOURCE OF WIND DATA: PAGASA WIND SPEED AND DIRECTION OBSERVATIONS
STATION : LUMBIA AIRPORT STATION
PERIOD : 1986 - 1990
WIND COVERAGE : 88.80 %
PERCENT CALMS (0-4 KNOTS) : 1.89 %



LOCATION MAP
SCALE 1:500,000 M



RUNWAY DATA TABLE		
ITEM	RUNWAY 09/27 INITIAL	RUNWAY 09/27 ULTIMATE
RUNWAY LENGTH	2500 m	3000 m
AVERAGE RUNWAY GRADIENT (%)	0.283 %	0.236 %
WIND COVERAGE (%), 20 KNOTS	99.80 %	98.80 %
RUNWAY CATEGORY	PRECISION-CAT I	PRECISION-CAT I
PAVEMENT STRENGTH	85,000 KG-DT	85,000 KG-DT
APPROACH SURFACES	50 1/50 1	50 1/50.1
RUNWAY LIGHTING	HIRL, REIL	HIRL, REIL
RUNWAY MARKING	PRECISION-CAT I	PRECISION-CAT I

AIRPORT DATA TABLE			
ITEM		INITIAL	ULTIMATE
AIRPORT REFERENCE POINT (ARP) ELEVATION		52.00 m	54.46 m
AIRPORT REFERENCE POINT (ARP)	LATITUDE	08° 37' 01.67"	08° 37' 01.03"
	LONGITUDE	124° 29' 21.30"	124° 29' 13.75"
AIRPORT REFERENCE CODE (ICAO)		4D	4E
MEAN ANNUAL TEMPERATURE		26.5°C	26.5°C
NAVIGATIONAL AIDS		VOR, ILS(CAT-I) SALS, RVR, PLPI, LIGHTED WINDCONE, DME	
TAXIWAY / APRON LIGHTING		HIGH INTENSITY TAXIWAY AND APRON EDGE LIGHTS	
TAXIWAY MARKINGS		TAXIWAY & AND TAXI-HOLDING POSITION MARKING	
AIRPORT PROPERTY		167.085 Ha	167.085 Ha

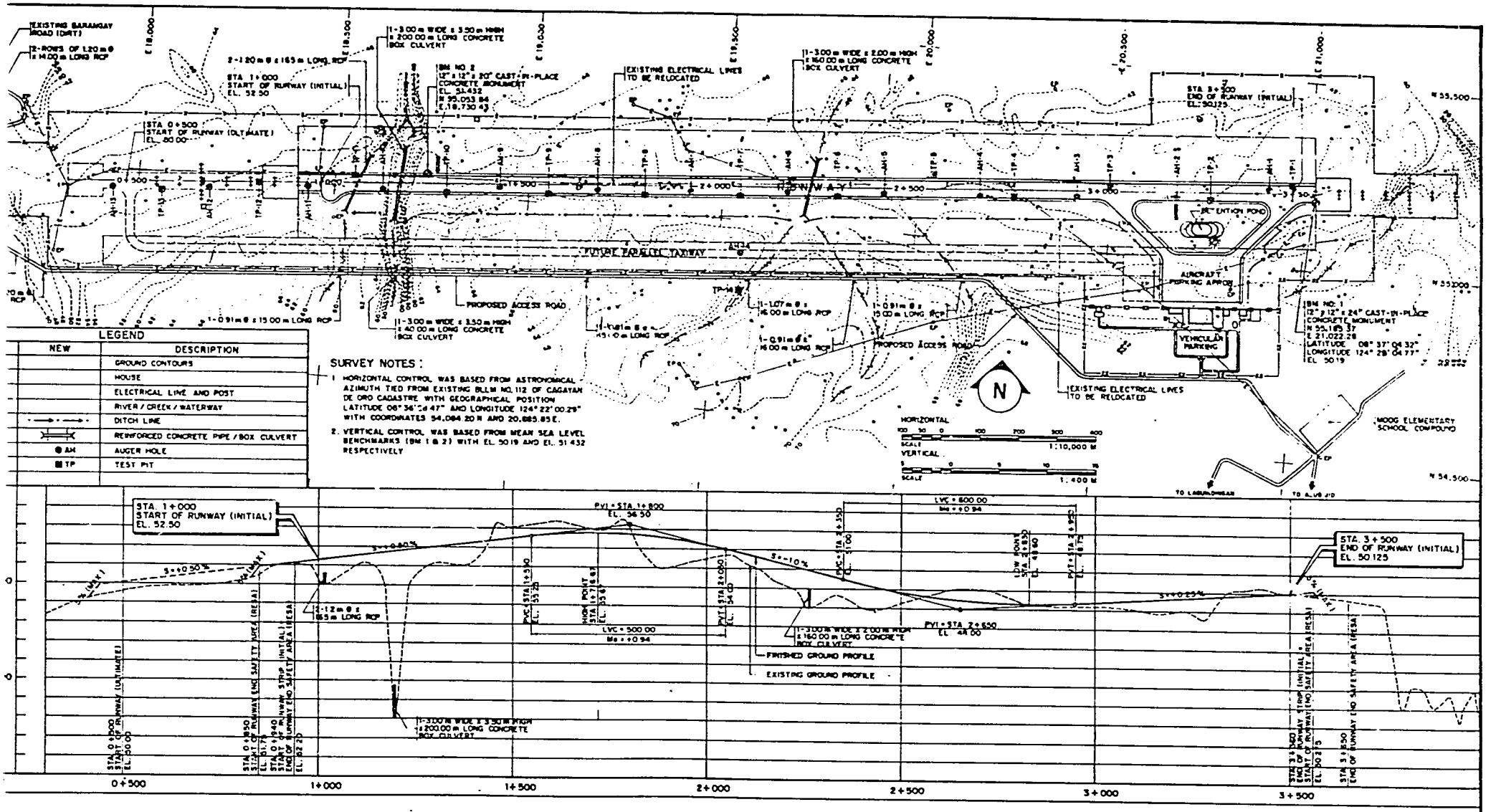
AIRPORT FACILITIES			
NO.	BUILDING DESCRIPTION	INITIAL	ULTIMATE
1	PASSENGER TERMINAL BUILDING	40 m x 60 m	40 m x 78 m
2	CARGO TERMINAL BUILDING	18 m x 18 m	18 m x 30 m
3	CRASH, FIRE AND RESCUE (CAT-8) BLDG	18 m x 18 m	–
4	OPERATIONS AND MAINTENANCE BLDG	10 m x 35 m	–
5	CONTROL TOWER	15 m x 15 m	–
6	POWER AND PUMP HOUSE	6 m x 10 m	–
7	ELEVATED CONC WATER TANK (CAP)	10,000 Gals.	–
8	AIRCRAFT FUEL FARM (CAP)	40,000 Gals	–

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

AIRPORT LAYOUT PLAN

DRAWING NO
2

PHILIPPINE ASSISTANCE PROGRAM SUPPORT
U.S. STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
CONTRACT NO 492-0452-C-00-0099-00



LEGEND

NEW	DESCRIPTION
	GROUND CONTOURS
	HOUSE
	ELECTRICAL LINE AND POST
	RIVER / CREEK / WATERWAY
	DITCH LINE
	REINFORCED CONCRETE PIPE / BOX CULVERT
AH	AUGER HOLE
TP	TEST PIT

SURVEY NOTES:

1. HORIZONTAL CONTROL WAS BASED FROM ASTRONOMICAL AZIMUTH TIED FROM EXISTING BLLM NO. 112 OF CAGAYAN DE ORO CADASTRE WITH GEOGRAPHICAL POSITION LATITUDE 08° 36' 04.47" AND LONGITUDE 124° 22' 00.29" WITH COORDINATES 54,084.20 N AND 20,685.85 E.
2. VERTICAL CONTROL WAS BASED FROM MEAN SEA LEVEL BENCHMARKS (BM 1 & 2) WITH EL. 50.19 AND EL. 51.432 RESPECTIVELY

NE ASSISTANCE PROGRAM SUPPORT
ATES AGENCY FOR INTERNATIONAL DEVELOPMENT
ONTRACT NO.: 492-0452-C-00-0099-00

IS BERGER INTERNATIONAL, INC.

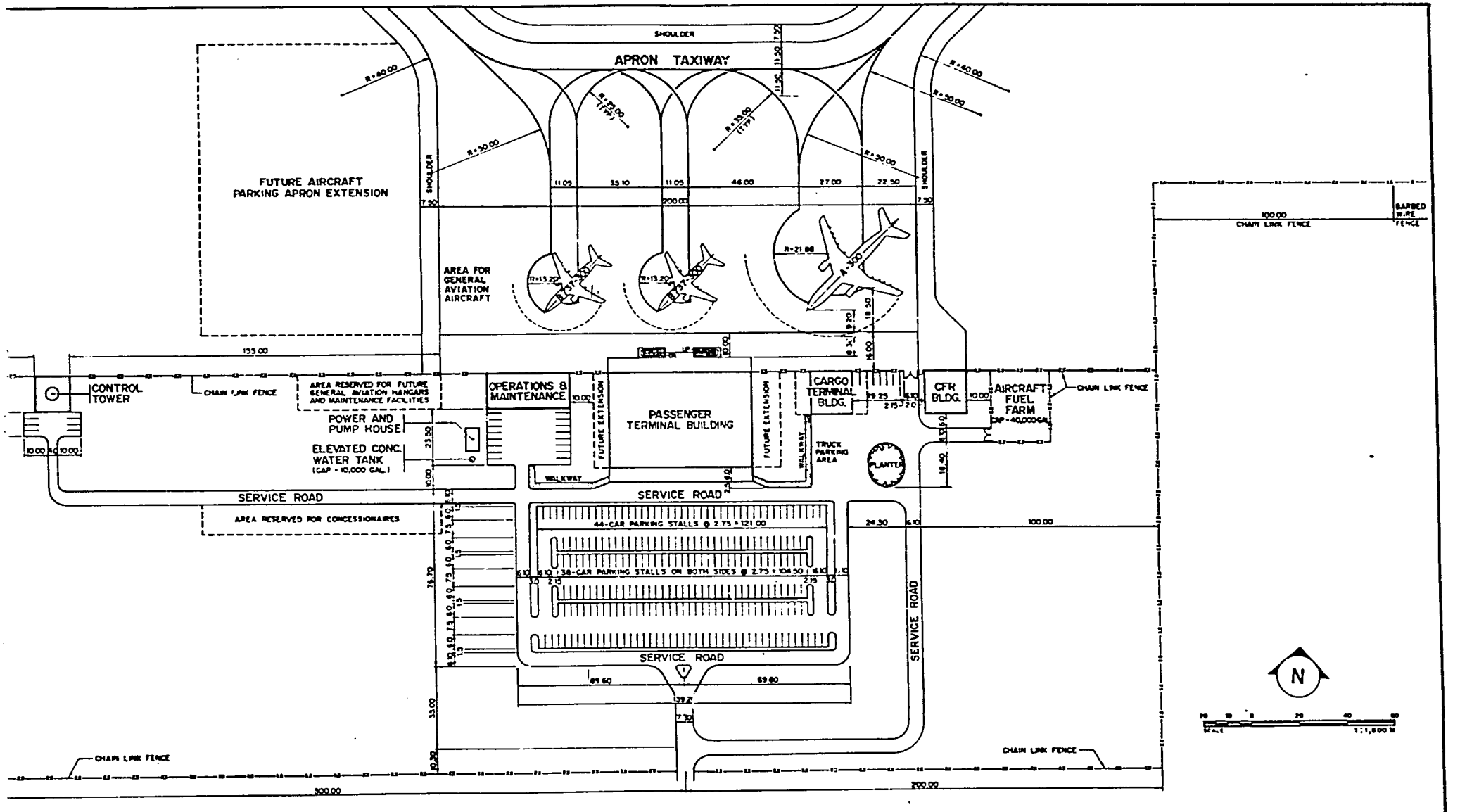
YWOOD GREENE INT'L.
ST & YOUNG INT'L.
ETROTTERS (INFIL CORP.
• TRANS-ASIA (PHIL.), INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

FEASIBILITY STUDY AND MASTER PLANNING CAGAYAN DE ORO - ILIGAN AIRPORT

PLAN AND PROFILE

DRAWING NO.

3



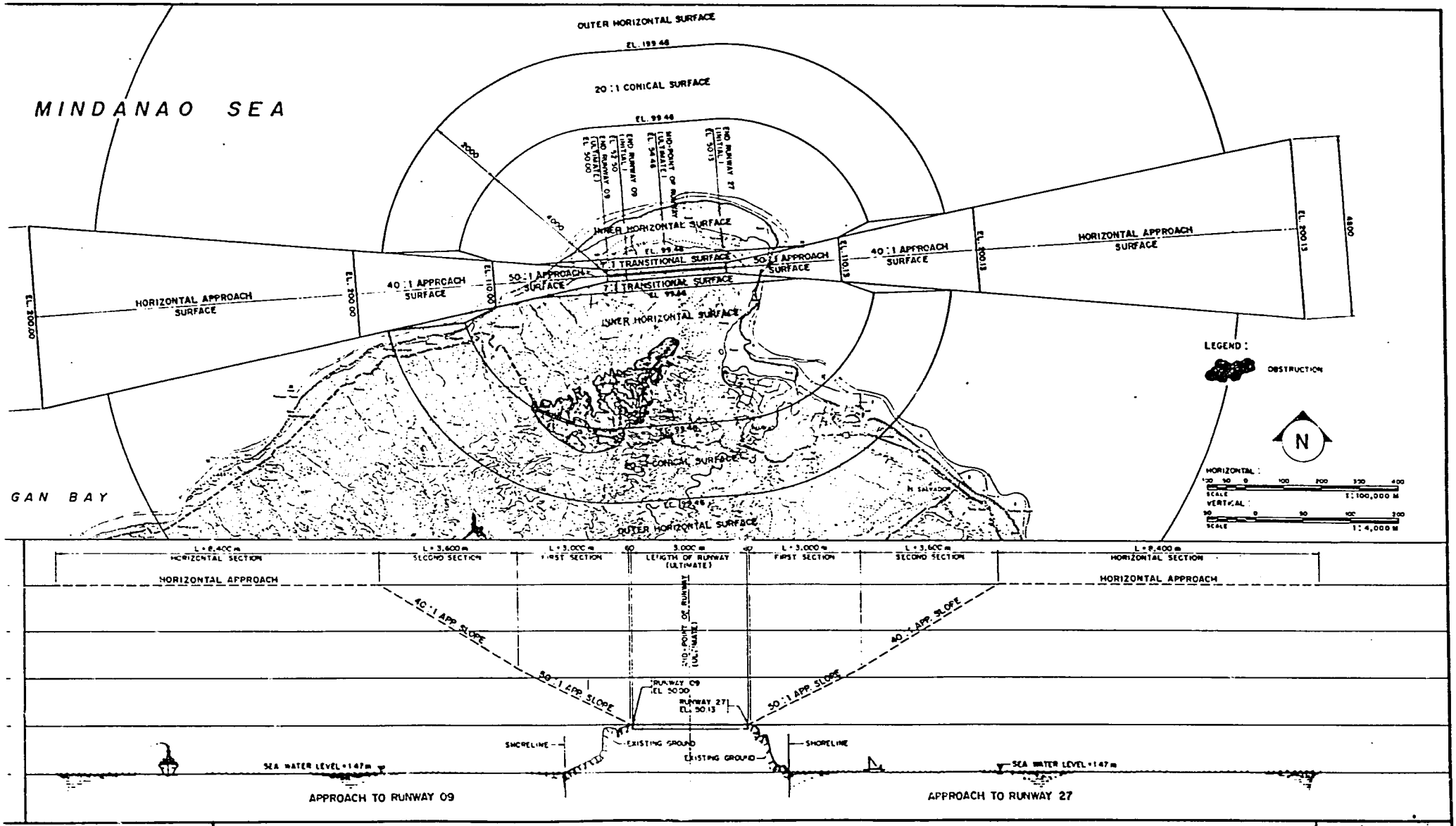
ASSISTANCE PROGRAM SUPPORT
US AGENCY FOR INTERNATIONAL DEVELOPMENT
CONTRACT NO.: 492-0452-C-00-0089-00

BERGER INTERNATIONAL, INC.

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

TERMINAL AREA AND VEHICLE PARKING LAYOUT PLAN

DRAWING NO.
4



E ASSISTANCE PROGRAM SUPPORT
TES AGENCY FOR INTERNATIONAL DEVELOPMENT
NTRACT NO.: 492-0452-C-00-0099-00

S BERGER INTERNATIONAL, INC.

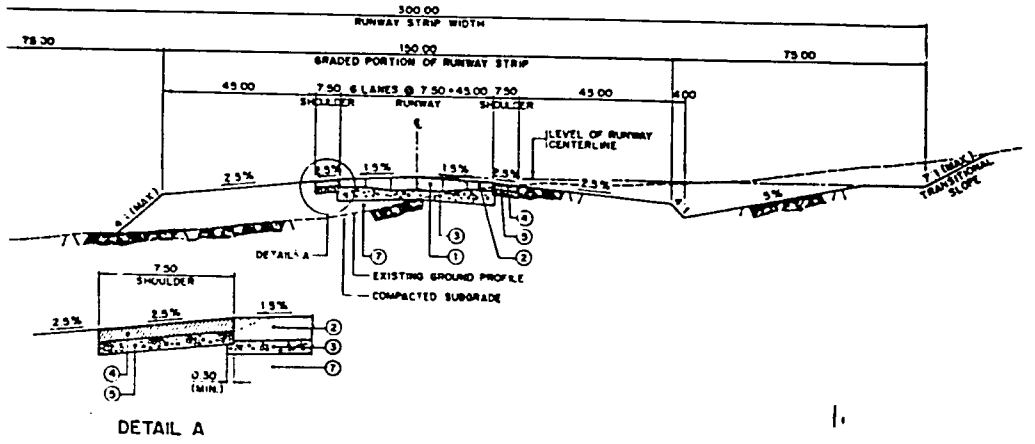
HOOD GREENE INT'L.
T & YOUNG INT'L.
TROTTER'S ENG'G. CORP.
• TRANS-ASIA (PHIL.) INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

AIRSPACE OBSTRUCTION IDENTIFICATION PLAN

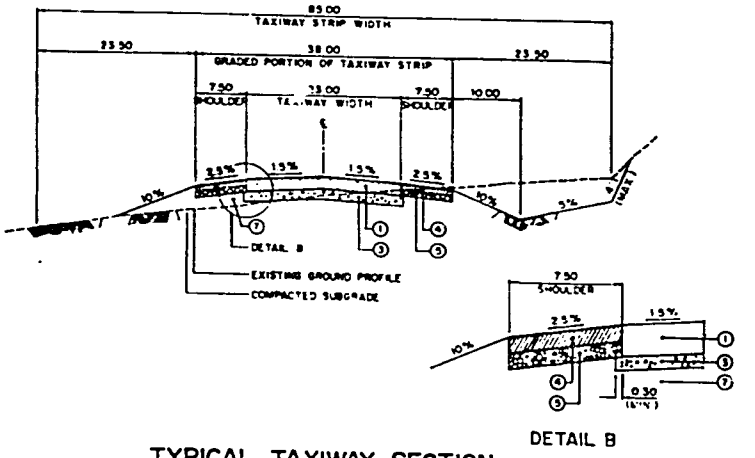
DRAWING NO.

5



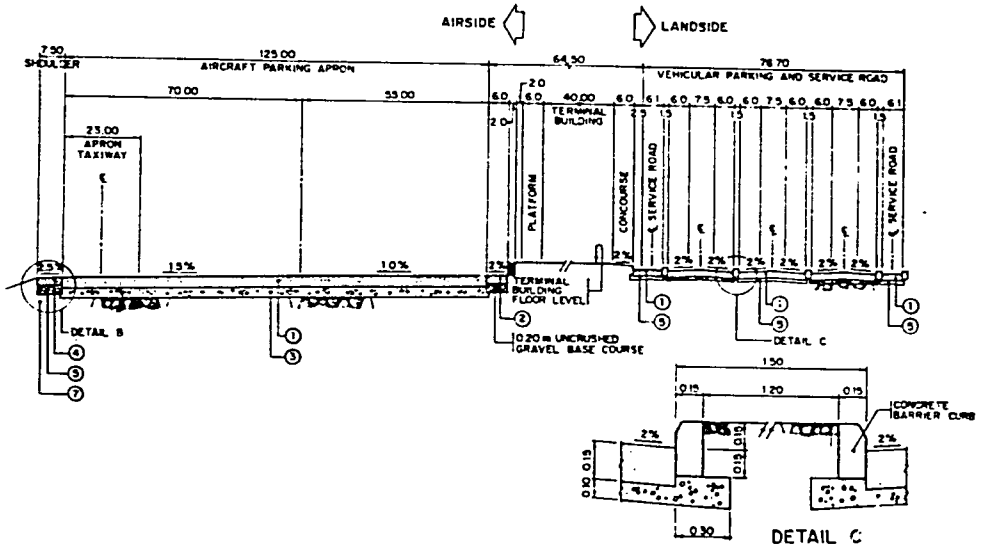
TYPICAL RUNWAY SECTION

NOT TO SCALE



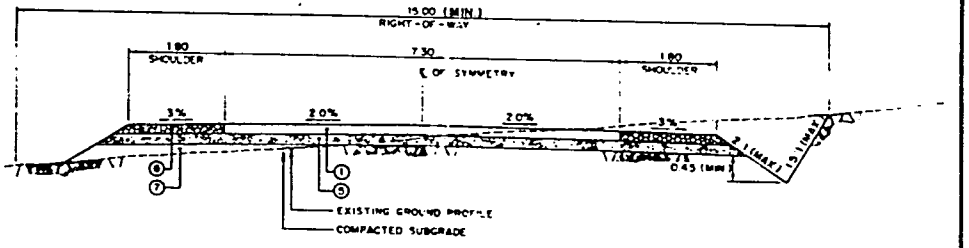
TYPICAL TAXIWAY SECTION

NOT TO SCALE



TYPICAL SECTION OF AIRCRAFT PARKING APRON, VEHICULAR PARKING AND SERVICE ROAD

NOT TO SCALE



TYPICAL ACCESS ROAD SECTION

NOT TO SCALE

MATERIALS	RUNWAY	TAXIWAY	AIRCRAFT PARKING APRON	ACCESS ROAD	VEHICULAR PARKING	SERVICE ROAD
	THICKNESS (cm)	THICKNESS (cm)	THICKNESS (cm)	THICKNESS (cm)	THICKNESS (cm)	THICKNESS (cm)
(1) PORTLAND CEMENT CONCRETE PAVEMENT	37	37	37	20	15	20
(2) PORTLAND CEMENT CONCRETE PAVEMENT	26	—	15	—	—	—
(3) CEMENT STABILIZED CRUSHED SUBBASE	15	15	15	—	—	—
(4) DOUBLE BITUMINOUS SURFACE TREATMENT				—	—	—
(5) UNCRUSHED GRAVEL BASE COURSE	30	30	30	20	10	15
(6) UNCRUSHED GRAVEL SHOULDER	—	—	—	15	—	—
(7) COMPACTED BORROW OR SELECTED MATERIALS AS REQUIRED FOR GRADE	VARIES	VARIES	—	VARIES	—	—

ASSISTANCE PROGRAM SUPPORT
AGENCY FOR INTERNATIONAL DEVELOPMENT
CT NO.: 492-0452-C-00-0099-00

ERGER INTERNATIONAL, INC.

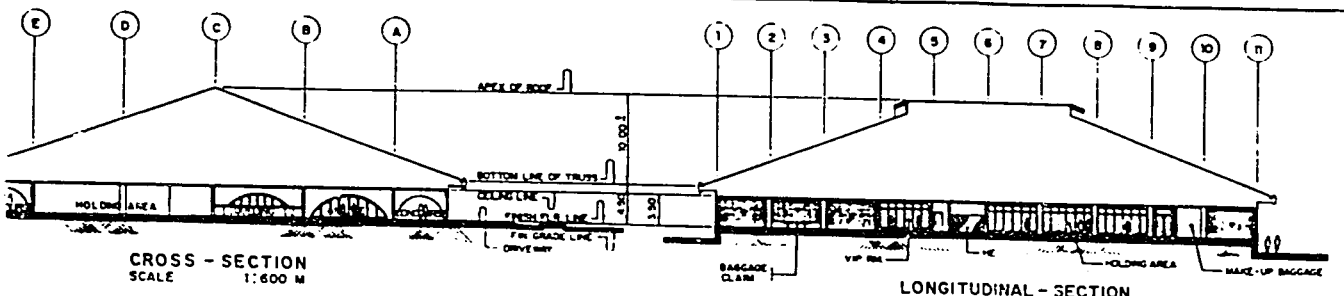
GREENE INT'L.
ZUNG INT'L.
TERS ENGR. CORP.

• TRANS-ASIA (PHIL.), INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

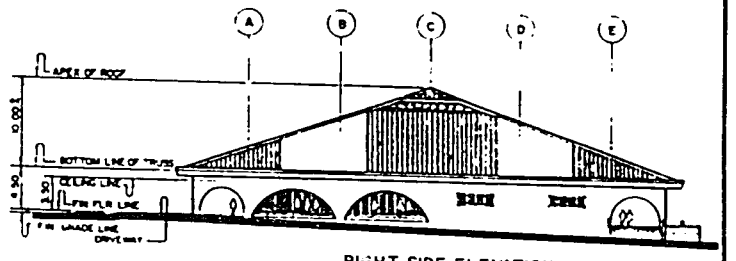
FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

TYPICAL SECTIONS OF RUNWAY, TAXIWAY, AIRCRAFT PARKING APRON, VEHICULAR PARKING, SERVICE ROAD AND ACCESS ROAD

DRAWING NO.
6

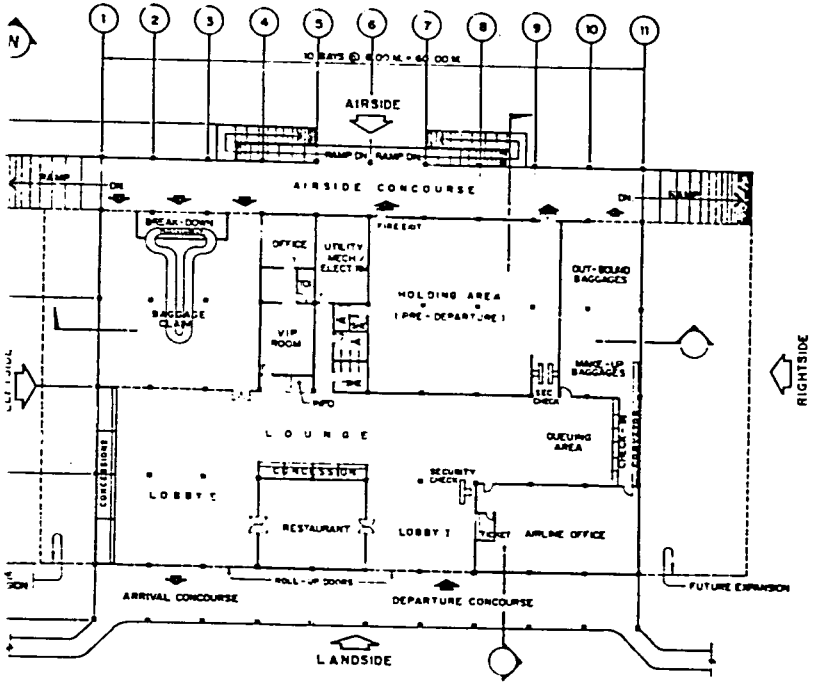


CROSS - SECTION
SCALE 1:600 M

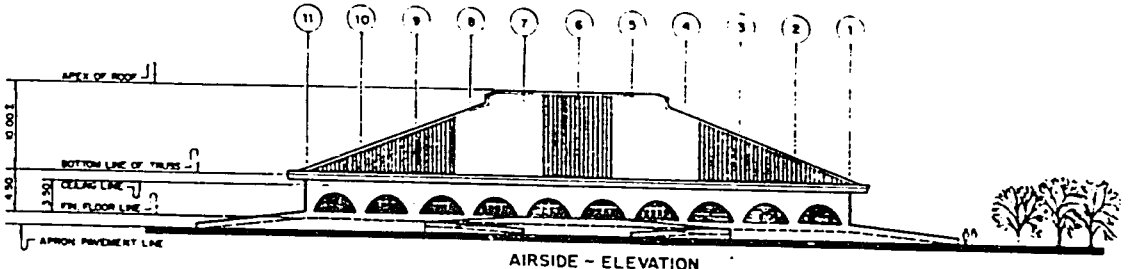


LONGITUDINAL - SECTION
SCALE 1:600 M

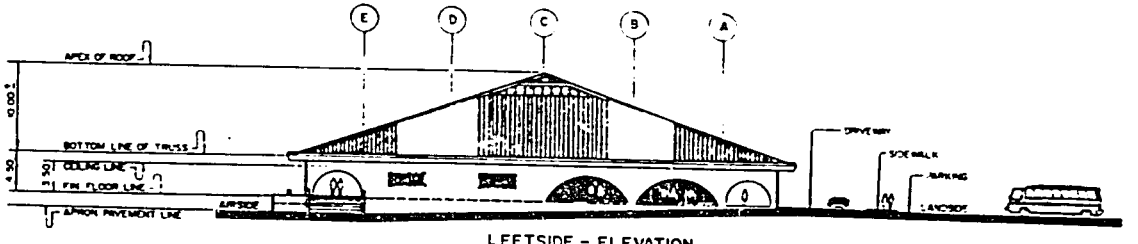
RIGHT SIDE ELEVATION
SCALE 1:600 M



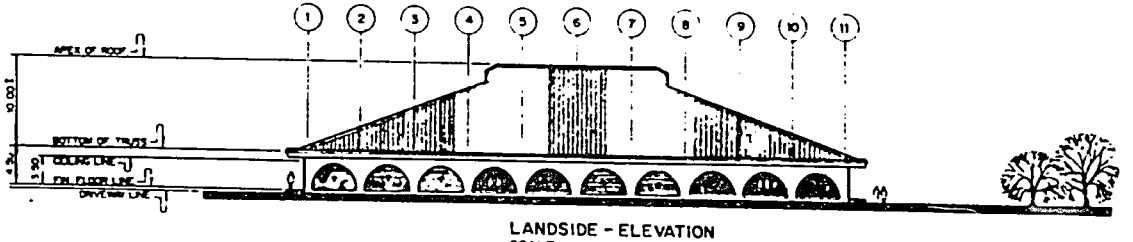
FLOOR PLAN
SCALE 1:600 M



AIRSIDE - ELEVATION
SCALE 1:600 M



LEFTSIDE - ELEVATION
SCALE 1:600 M



LANDSIDE - ELEVATION
SCALE 1:600 M

E ASSISTANCE PROGRAM SUPPORT
TES AGENCY FOR INTERNATIONAL DEVELOPMENT
NTRACT NO.: 492-0452-C-00-0099-00

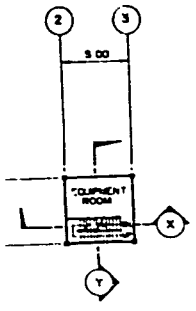
S BERGER INTERNATIONAL, INC.

HOOD GREENE INT'L.
Y & YOUNG INT'L.
TROTTERS E'NG CORP
• TRANS-ASIA (PHIL.), INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

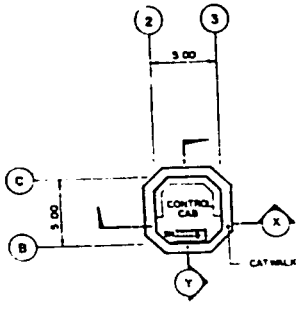
FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

PASSENGERS TERMINAL BUILDING

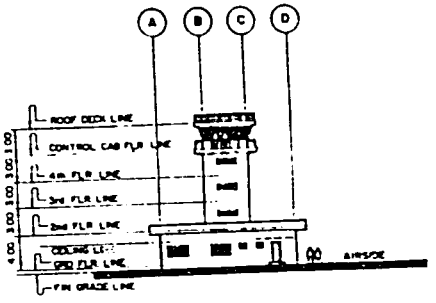
DRAWING NO.
7



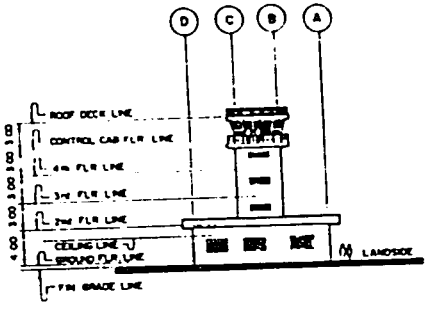
1., 3rd. & 4th. FLOOR PLAN
LE 1:400 M



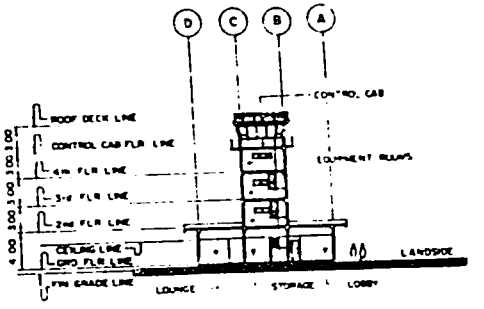
CONTROL CAB - PLAN
SCALE 1:400 M



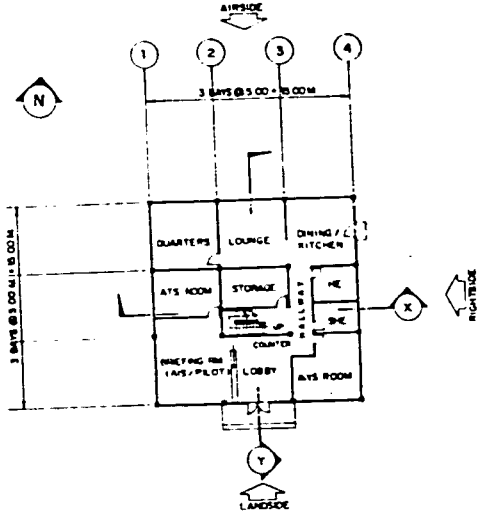
RIGHT SIDE ELEVATION
SCALE 1:600 M



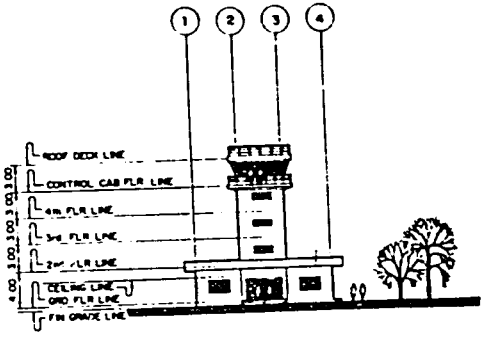
LEFT SIDE ELEVATION
SCALE 1:600 M



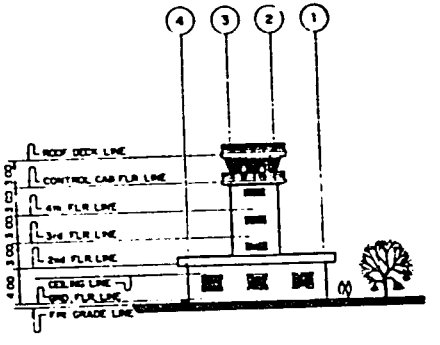
SECTION AT "Y"
SCALE 1:600 M



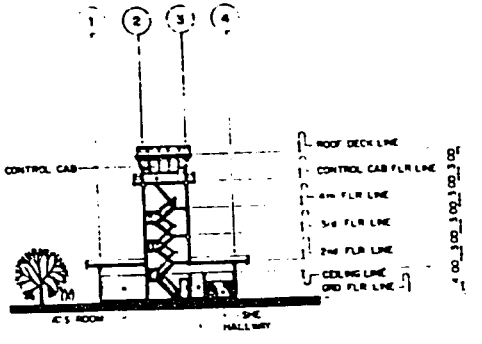
GROUND FLOOR PLAN
SCALE 1:400 M



LANDSIDE - ELEVATION
SCALE 1:600 M

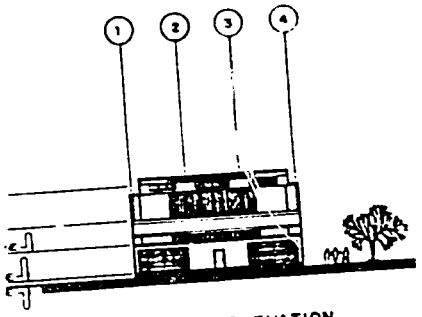


AIRSIDE - ELEVATION
SCALE 1:600 M

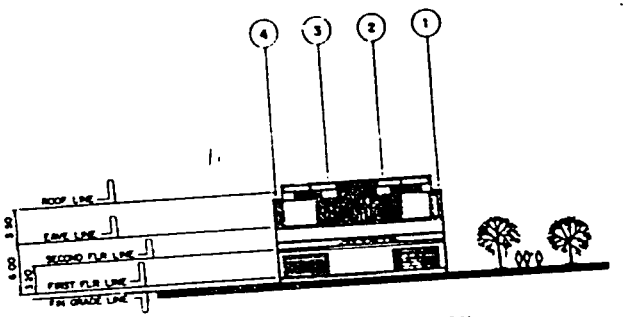


SECTION AT "X"
SCALE 1:600 M

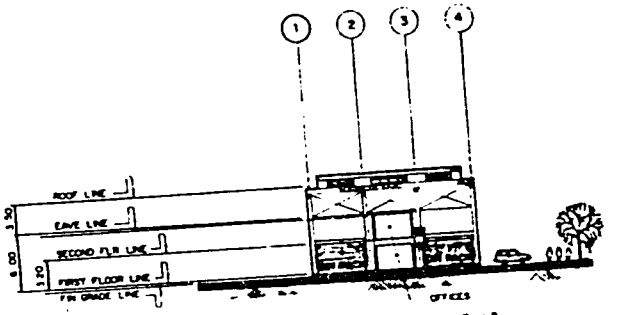
...INE ...SSISTANCE PROGRAM SUPPORT ...TATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0492-C-00-0099-00	FEASIBILITY STUDY AND MASTER PLANNING CAGAYAN DE ORO - ILIGAN AIRPORT	DRAWING NO.
...UIS BERGER INTERNATIONAL, INC. ...OODWOOD GREENE INT'L. ...POST & YOUNG INT'L. ...OBETROTTERS ENG'G CORP. • TRANS-ASIA (PHIL.), INC. • CONSULTANT MANAGEMENT SERVICES, INC.	CONTROL TOWER BUILDING	8



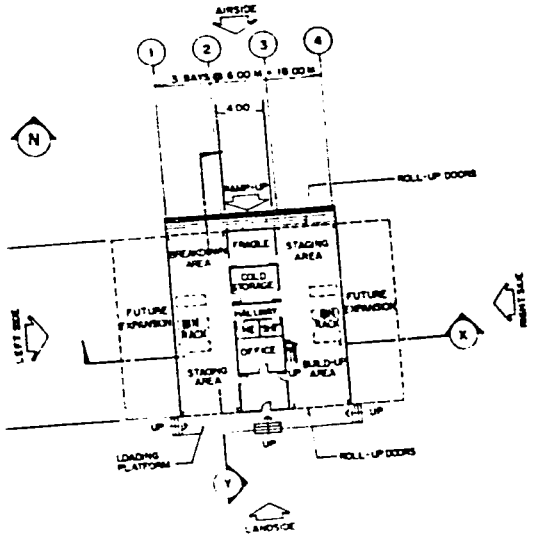
LANDSIDE-ELEVATION
SCALE 1:500 M



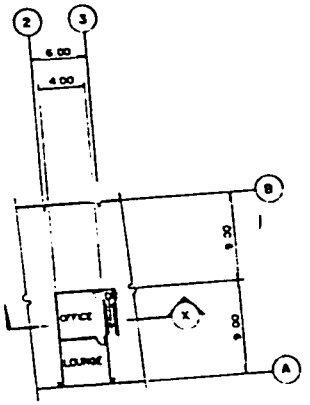
AIRSIDE - ELEVATION
SCALE 1:600 M



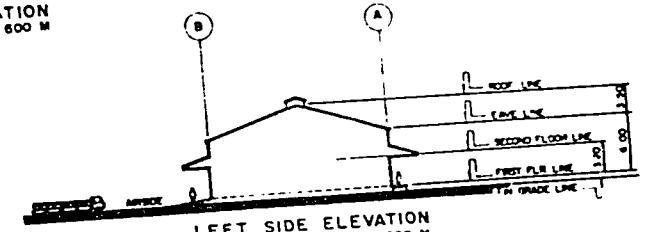
SECTION AT "X"
SCALE 1:600 M



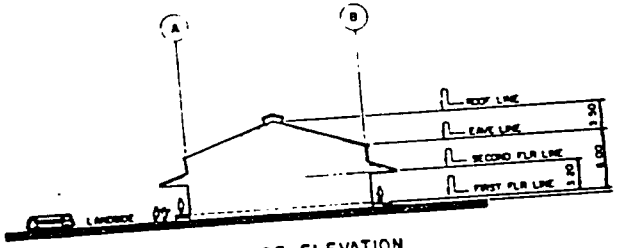
FIRST FLOOR PLAN
SCALE 1:600 M



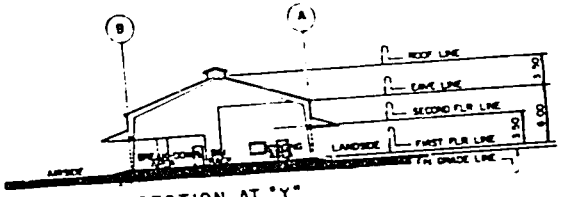
SECOND FLOOR PLAN
SCALE 1:600 M



LEFT SIDE ELEVATION
SCALE 1:600 M



RIGHT SIDE ELEVATION
SCALE 1:600 M



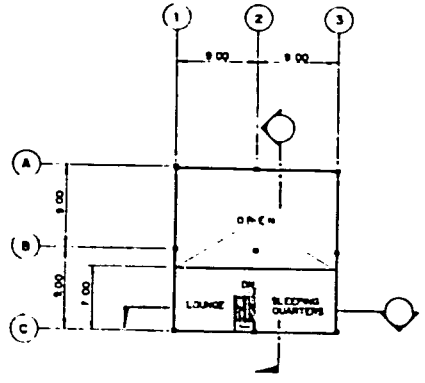
SECTION AT "Y"
SCALE 1:600 M

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

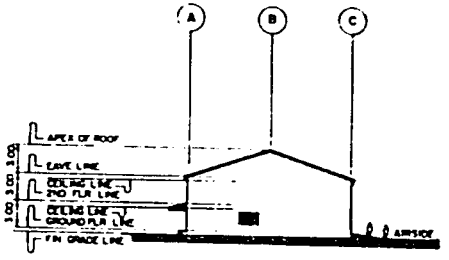
CARGO TERMINAL BUILDING

DRAWING NO.
9

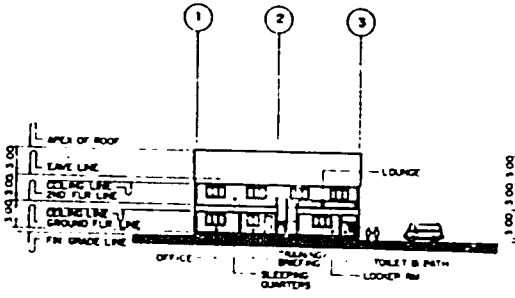
IPPINE ASSISTANCE PROGRAM SUPPORT
ED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
-00-0099-00



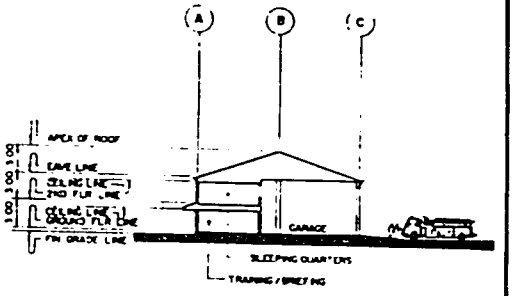
SECOND FLOOR PLAN
SCALE 1:600 M



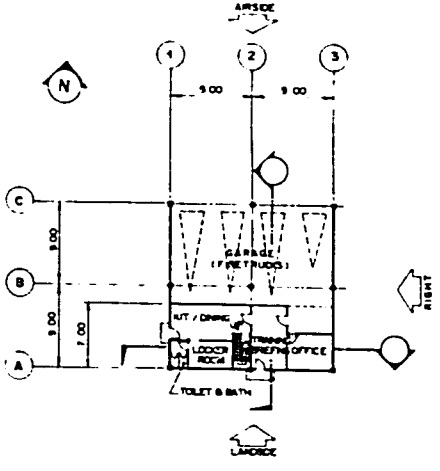
RIGHT SIDE-ELEVATION
SCALE 1:600 M



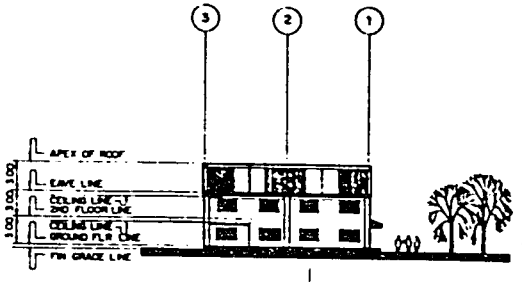
LONGITUDINAL - SECTION
SCALE 1:600 M



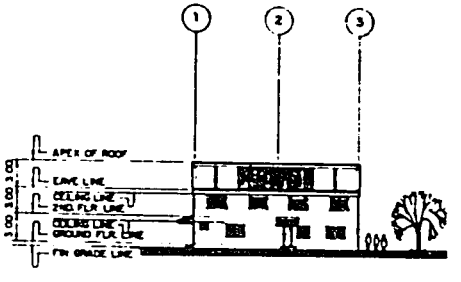
CROSS - SECTION
SCALE 1:600 M



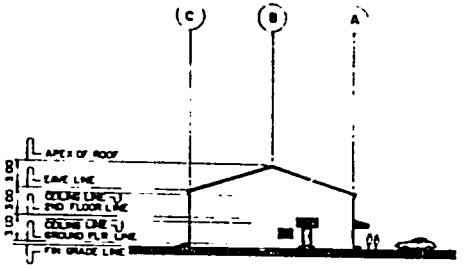
GROUND FLOOR PLAN
SCALE 1:600 M



AIRSIDE - ELEVATION
SCALE 1:600 M



LANDSIDE - ELEVATION
SCALE 1:600 M



LEFT SIDE - ELEVATION
SCALE 1:600 M

E ASSISTANCE PROGRAM SUPPORT
'ES AGENCY FOR INTERNATIONAL DEVELOPMENT
/TRACT NO.: 492-0492-C-00-0089-00

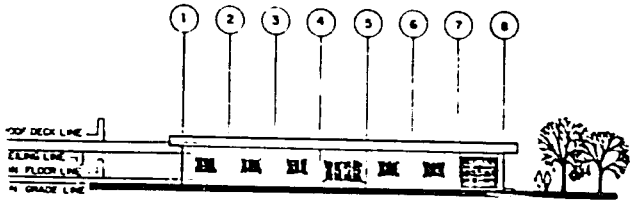
S BERGER INTERNATIONAL, INC.

OOD GREENE INT'L.
'B YOUNG INT'L.
TROTTERS ENG'G. CORP.
• TRANS-ASIA (PHIL.) INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

CRASH, FIRE AND RESCUE (CFR) BUILDING

DRAWING NO.
10



FRONT - ELEVATION
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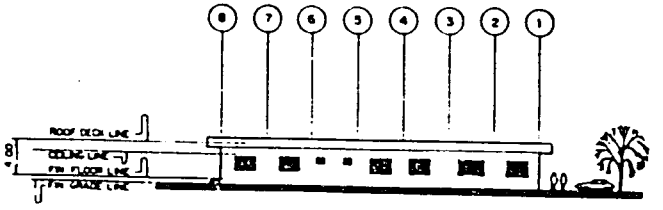

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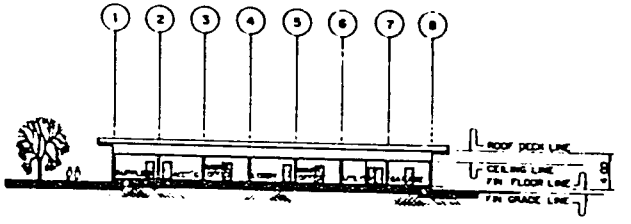

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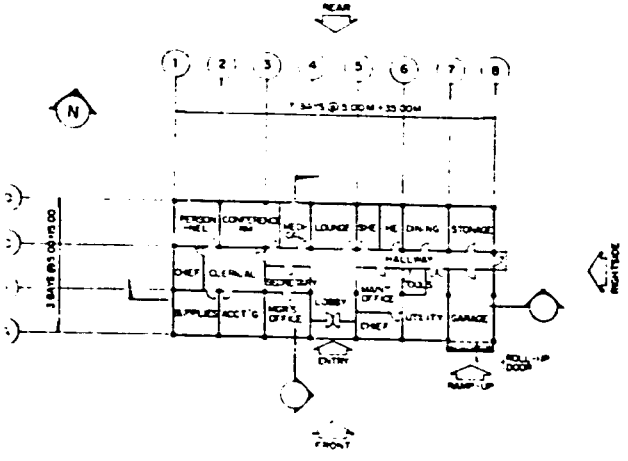

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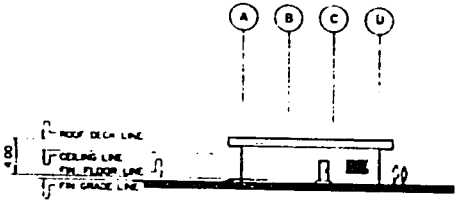

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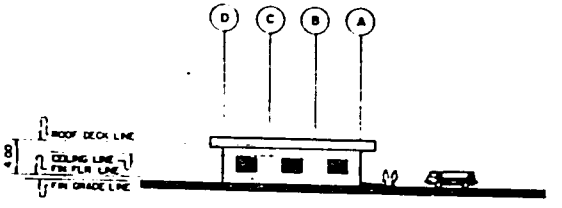

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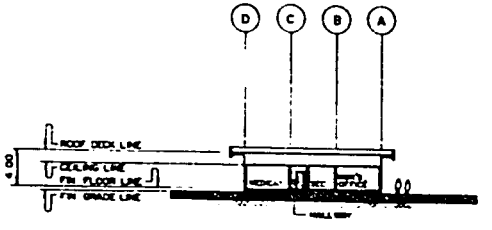

CROSS - SECTION
SCALE 1:600 M

ASSISTANCE PROGRAM SUPPORT
AGENCY FOR INTERNATIONAL DEVELOPMENT
CT NO.: 492-0452-C-00-0099-00

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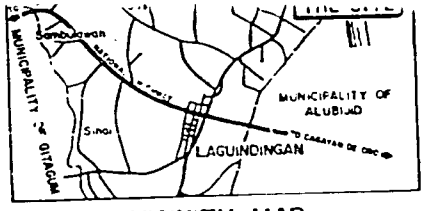
FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO – ILIGAN AIRPORT

OPERATIONS AND MAINTENANCE BUILDING

DRAWING NO.
11



VICINITY MAP
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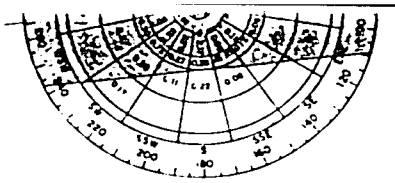
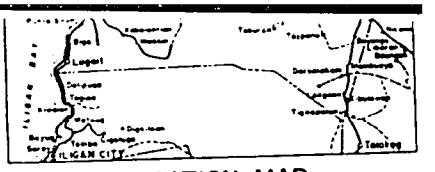
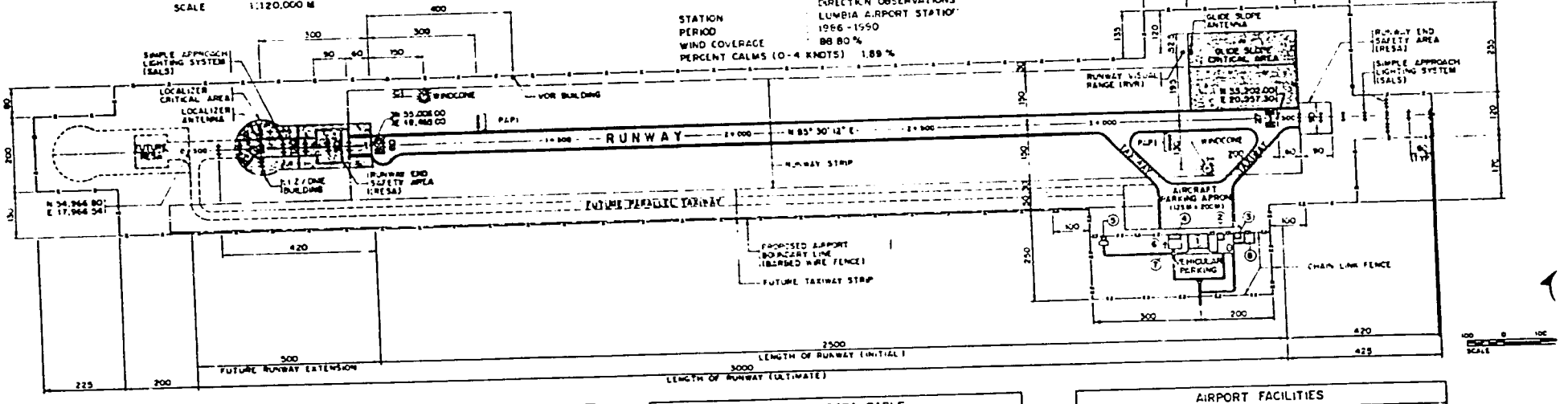


WIND ROSE

SOURCE OF WIND DATA : PAGASA WIND SPEED AND DIRECTION OBSERVATIONS LUMBIA AIRPORT STATION
STATION
PERIOD : 1986 - 1990
WIND COVERAGE : 88.80 %
PERCENT CALMS (0-4 KNOTS) 1.89 %



LOCATION MAP
SCALE 1:500,000 M



RUNWAY DATA TABLE		
ITEM	RUNWAY 09 / 27	
	INITIAL	ULTIMATE
RUNWAY LENGTH	2500 m	3000 m
AVERAGE RUNWAY GRADIENT (%)	0.263 %	0.236 %
WIND COVERAGE (%), 20 KNOTS	98.80 %	98.80 %
RUNWAY CATEGORY	PRECISION - CAT I	PRECISION - CAT I
PAVEMENT STRENGTH	85,000 KG - DT	85,000 KG - DT
APPROACH SURFACES	50 1/50 1	50 1/50 1
RUNWAY LIGHTING	MIRL, REIL	MIRL, REIL
RUNWAY MARKING	PRECISION - CAT I	PRECISION - CAT I

AIRPORT DATA TABLE			
ITEM		INITIAL	ULTIMATE
AIRPORT REFERENCE POINT (ARP) ELEVATION		52.00 m	54.46 m
AIRPORT REFERENCE POINT (ARP)	LATITUDE	08° 37' 01.67"	08° 37' 01.03"
	LONGITUDE	124° 29' 21.80"	124° 29' 13.79"
AIRPORT REFERENCE CODE (ICAO)		4D	4E
MEAN ANNUAL TEMPERATURE		26.5°C	26.5°C
NAVIGATIONAL AIDS		VOR, ILS (CAT - II SALS, RVR, PAPI, LIGHTED WINDCONE, DME	
TAXIWAY / APRON LIGHTING		HIGH INTENSITY TAXIWAY AND APRON EDGE LIGHTS	
TAXIWAY MARKINGS		TAXIWAY ℄ AND TAXI-HOLDING POSITION MARKING	
AIRPORT PROPERTY		167.085 Ha	167.085 Ha

AIRPORT FACILITIES			
NO.	BUILDING DESCRIPTION	INITIAL	ULTIMATE
1	PASSENGER TERMINAL BUILDING	40 m x 60 m	40 m x 78 m
2	CARGO TERMINAL BUILDING	18 m x 18 m	18 m x 30 m
3	CRASH, FIRE AND RESCUE (CAT-8) BLDG	18 m x 18 m	–
4	OPERATIONS AND MAINTENANCE BLDG	15 m x 25 m	–
5	CONTROL TOWER	15 m x 15 m	–
6	POWER AND PUMP HOUSE	6 m x 10 m	–
7	ELEVATED CONC WATER TANK (CAP)	10,000 Gals	–
8	AIRCRAFT FUEL FARM (CAP)	40,000 Gals	–

PHILIPPINE ASSISTANCE PROGRAM SUPPORT
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
CONTRACT NO. 492-0452-C-00-0099-00

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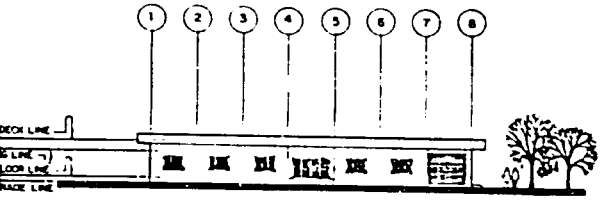
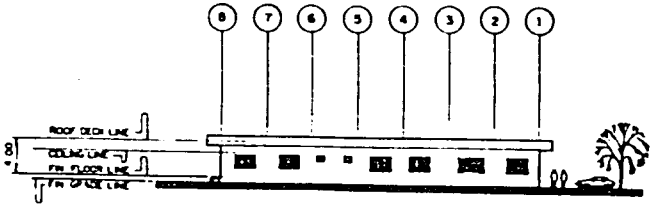
- TRANS-ASIA (PHIL.), INC.
- CONSULTANT MANAGEMENT SERVICES, INC.

FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

AIRPORT LAYOUT PLAN



FRONT - ELEVATION
SCALE 1:600 M



REAR - ELEVATION
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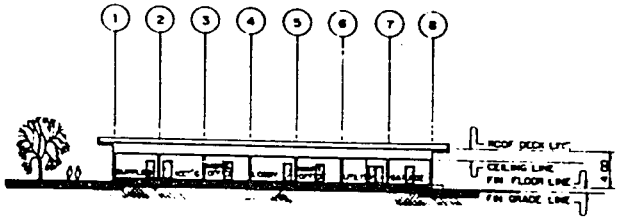

LONGITUDINAL - SECTION
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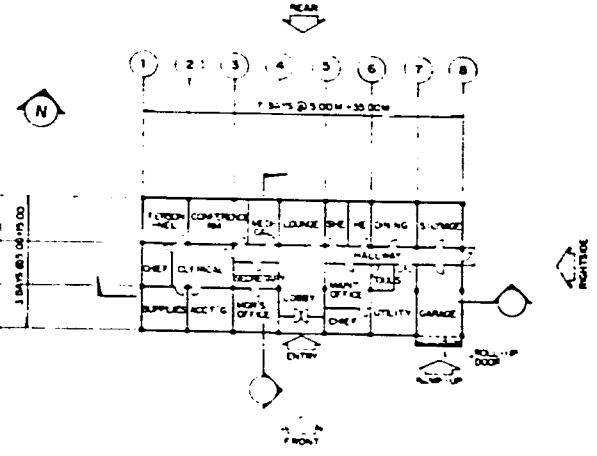
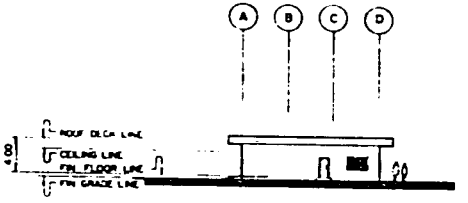


FLOOR PLAN
SCALE 1:600 M



RIGHT SIDE - ELEVATION
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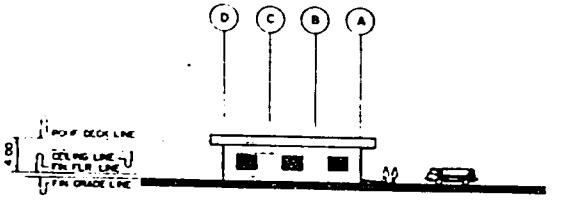
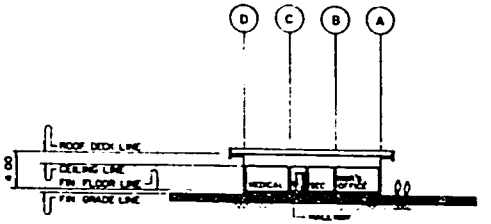


LEFT SIDE - ELEVATION
SCALE 1:600 M



CROSS - SECTION
SCALE 1:600 M

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NCY FOR INTERNATIONAL DEVELOPMENT
NO. 492-0452-C-00-0099-00

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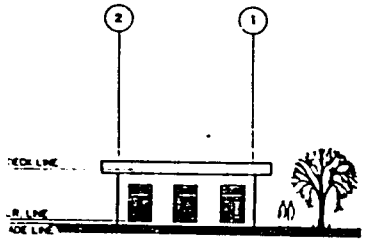
NG INT'L.
DRS ENG'G CORP

• TRANS-ASIA (PHIL.), INC.
• CONSULTANT MANAGEMENT SERVICES, INC.

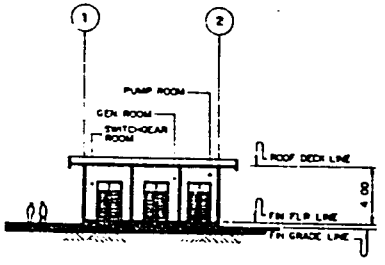
FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO – ILIGAN AIRPORT

OPERATIONS AND MAINTENANCE BUILDING

DRAWING NO.
11



REAR ELEVATION
SCALE 1:600 M



LONGITUDINAL - SECTION
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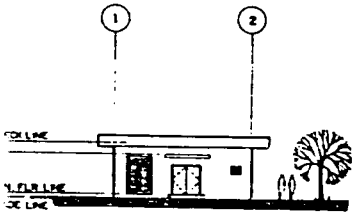
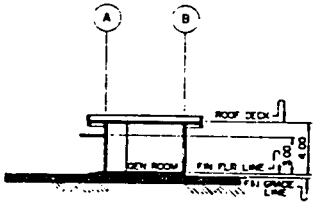
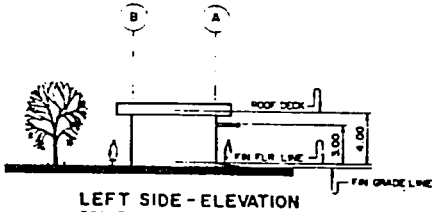


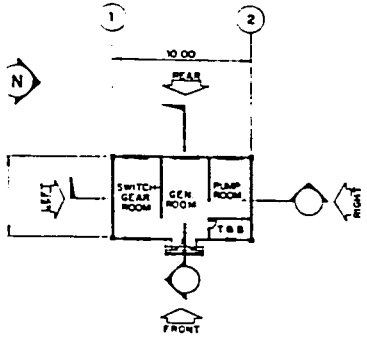
FRONT ELEVATION
SCALE 1:600 M



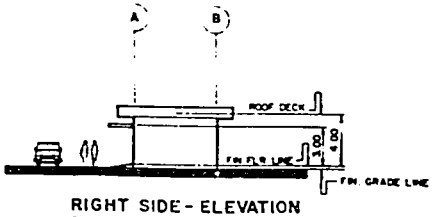
CROSS - SECTION
SCALE 1:600 M



LEFT SIDE - ELEVATION
SCALE 1:600 M



FLOOR PLAN
SCALE 1:600 M



RIGHT SIDE - ELEVATION
SCALE 1:600 M

ASSISTANCE PROGRAM SUPPORT
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TRACT NO.: 492-0492-C-00-0059-00

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FEASIBILITY STUDY AND MASTER PLANNING
CAGAYAN DE ORO - ILIGAN AIRPORT

POWER AND PUMP HOUSE

DRAWING NO.
12

76

CHAPTER 4

ORGANIZATION PLAN

4.1 INTRODUCTION

The key to efficient airport operation is the development of an effective, clearly defined organization plan. The plan should be flexible to accommodate the changing needs of the airport—as airports grow a more sophisticated organizational structure is required.

In order to develop an organization plan for the new airport at Laguindingan the organization of the two existing Corridor airports, Cagayan de Oro and Iligan, were examined.

4.2 ORGANIZATION STRUCTURE OF THE CAGAYAN DE ORO AIRPORT

The Cagayan de Oro Airport is classified by the Air Transportation Office (ATO) as a trunkline airport. Commercial service is provided by Philippine Airlines with a weekly total of 29 flights. The airport is operated from sunrise to sunset with a total work force of 56 regular and 39 casual employees, based on the organization structure shown in Figure 4-1.

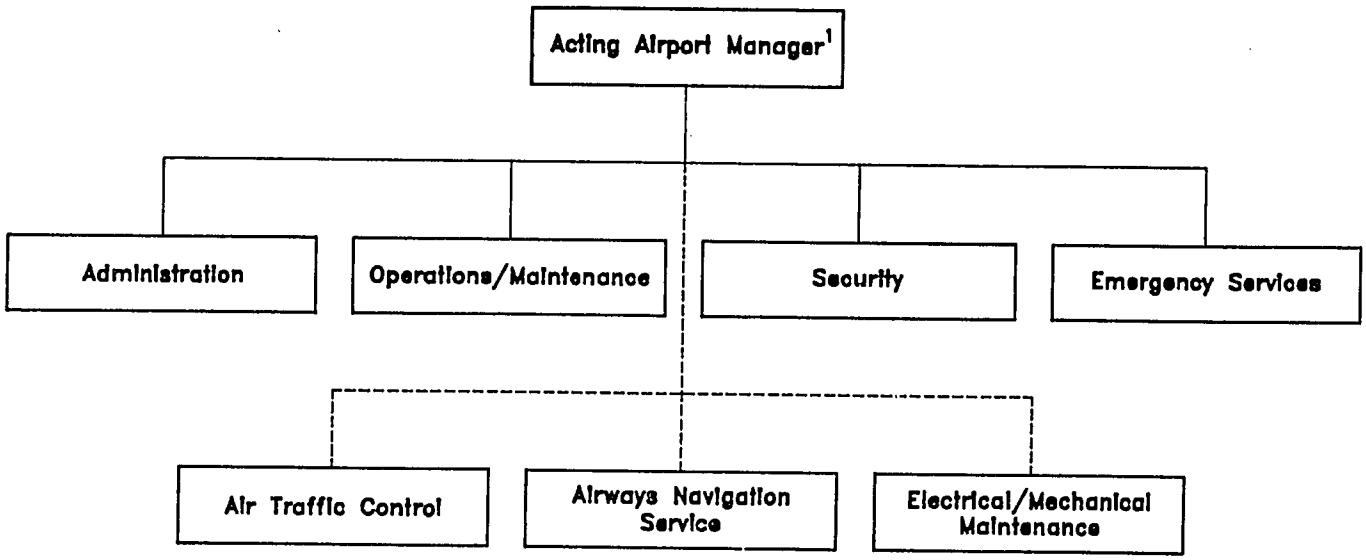
The Chief Air Traffic Controller of the airport is also the Acting Airport Manager, and has been for the past 20 years. In the past, this situation was probably the result of the salary structure for the positions (the Airport Manager receives ₱3,200/month while the Chief Air Traffic Controller's monthly salary is ₱10,135); however, with the 1989 Salary Standardization Act a trunkline Airport Manager's pay grade was made the same as that of the Chief Air Traffic Controller. Even with the adjustment in salary the double-duty situation still exists.

Although the organization of the Cagayan de Oro Airport is divided into functional units, the divisions do not perform daily operations without the direct input from the Acting Airport Manager. The Airport Manager directs all operations of the airport, that is everyone reports to the Airport Manager directly.

4.3 ORGANIZATION STRUCTURE OF THE ILIGAN AIRPORT

The Iligan Airport is classified by the ATO as a secondary airport. Philippine Airlines presently services the airport with 14 weekly flights to Cotabato. The airport operates from sunrise to sunset (although the last commercial flight is at 10:30 am) with a total of 3 regular and 23 casual employees, based on the organization structure shown in Figure 4-2.

97

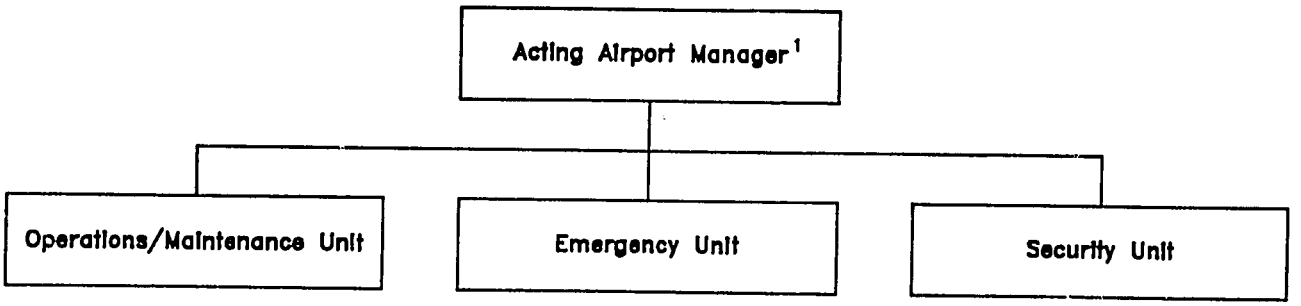


[1] *The Acting Airport Manager is the Chief Air Traffic Controller.*

Note: Although the organization structure appears to be delineated by function, actual operation has all personnel reporting directly to the Acting Airport Manager.

Source: Air Transportation Office

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 4-1
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	ORGANIZATION STRUCTURE CAGAYAN DE ORO AIRPORT	



[1] *The ATO has not established an Airport Manager position for Iligan. The Acting Airport Manager is the most senior of the Firefighter I.*

Note: Although the organization structure appears to be delineated by function, actual operation has all personnel reporting directly to the Acting Airport Manager.

Source: Air Transportation Office

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 4-2
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	ORGANIZATION STRUCTURE ILIGAN AIRPORT	

For the Iligan Airport, the ATO has not established an airport manager position; the management of the airport is handled by the most senior firefighter. The indication is that the low level of operations at the Iligan Airport does not justify the need for an airport manager. And in fact, the low level of responsibility with little chance of advancement within the ATO, would make the position hard to fill.

The Iligan Airport functions on a daily basis, with little long range planning done on the local level; major operations and maintenance functions are planned and administered by the ATO in Manila. Although the Acting Airport Manager does a good job in keeping the airport in operation with available resources, he does not appear to have substantial input in the overall management process. For example, although there are six firefighters (1-regular and 6-casual) employed at the airport, there has not been a Crash-Fire-Rescue vehicle assigned to the airport since 1987.

4.4 PROPOSED ORGANIZATION STRUCTURE OF THE LAGUINDINGAN AIRPORT

As airports grow, the need arises to develop a more sophisticated organizational structure (not just everybody reporting directly to the airport manager). To establish the organization, the responsibilities of operating the airport must be sub-divided into functional areas. One way of sub-dividing these functions is as follows:

- Administration
- Facilities Management
- Operations

This division allows tasks requiring similar skills and training to be combined in a single part of the organization for more efficient resource utilization. (For example, a single worker can probably perform a variety of jobs within the administration area—personnel, office management, etc.—but would probably not be able to function effectively in technical area, such as maintenance). The division of functions provides the flexibility to allow the organization to grow incrementally.

The organization does not have to spring into existence all at once, a well planned organization structure should provide the flexibility to expand to meet the growing needs of the operation of the airport. For example, the Airport Manager might initially appoint a Facility Manager (to direct maintenance operations) but continue to direct operations and administrations himself. Then, as the airport grows further, an Operations Manager could be appointed later.

The key to the organization issue is that as the organization grows a single individual cannot effectively manage the entire operation—a structured hierarchy of subordinates is required. Otherwise, resources are not effectively used (nobody can effectively schedule the time of 50 subordinates) and some important aspects of the airport will not receive sufficient attention (for example, if the Airport Manager does not have a technical background, maintenance issues may tend to be overlooked).

The operation and maintenance of the Laguindingan Airport requires an organizational structure free of the limitations and problems inherent in the present structure of the Cagayan de Oro and Iligan airports. There should be adequate manpower to meet the demands of the functional units of the new airport. There should also be adequate resources (supplies, materials and equipment) for the efficient operation of the airport. The organization structure proposed for the Laguindingan Airport is shown in Figure 4-3.

4.4.1 Staffing

The majority of the technical personnel of the Cagayan de Oro and Iligan airports can be transferred to the Laguindingan Airport; however, careful evaluation and screening must be performed to assure that the necessary skills are available. Training should be provided to bring the level of expertise up to that required at the new airport.

4.4.2 Training

The proper training of personnel in the operation and maintenance of the airport is considered essential to its efficient operation. In-house training of personnel can be conducted by on-site senior staff members. More extensive training is available at the Civil Aviation Training Center (CATC) in Manila which presently offers a comprehensive range of training programs.

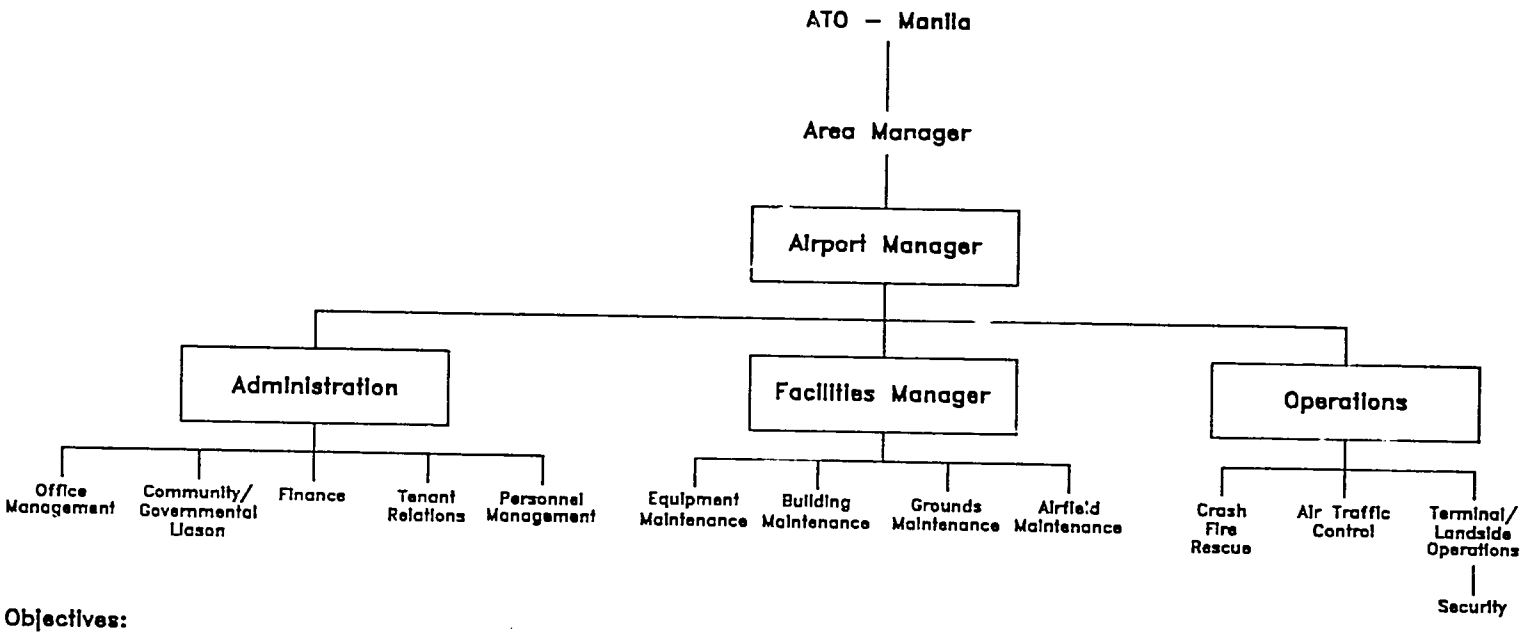
For training not currently available at the Manila CATC (such as advanced firefighting and avionics courses), the Singapore or Bangkok CATC could be utilized.

4.5 AREA MANAGER CONCEPT

In 1989 the Department of Transportation and Communications implemented an airport clustering scheme, whereby eight airport area centers were established under which all national airports are grouped. An area manager was assigned to each center to oversee the operations of the satellite airports.

The ATO concept of establishing area managers appears to be a valuable idea; providing potential for regional cooperation and coordination, and facilitating effective communication between individual airports and Manila ATO headquarters.

In order for an area manager to play an effective role, however, a clear objective for the position must be defined, and appropriate resources committed.



Objectives:

Effective communication and coordination with Manila ATO
Effective personnel utilization – applies skills to related jobs
Establish priorities

Note: Enclosed boxes represent individuals, other titles indicate functions – staffing of functions varies with the size of operation

Finance function depends on the degree of centralization of financial affairs in Manila

Engineering, planning, and budgeting functions performed by ATO–Manila

Source: Consultant

PHILIPPINE ASSISTANCE PROGRAM SUPPORT UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT CONTRACT NO.: 492-0452-C-00-0099-00	CAGAYAN DE ORO-ILIGAN AIRPORT PROJECT	FIGURE 4-3
LOUIS BERGER INTERNATIONAL, INC. LOCKWOOD GREENE INT'L, INC. TRANS-ASIA (PHILS.) INC. GLOBETROTTERS ENG'G CORP. ERNST & YOUNG CONSULTANT MANAGEMENT SERVICES, INC.	PROPOSED ORGANIZATION STRUCTURE LAGUINDINGAN AIRPORT	

Observations have indicated two important problems which the *"Area Manager concept"* has the potential to address:

- The individual airports, particularly the smaller ones, lack the professional resources to identify airport technical and operational needs and to perform airport development and maintenance planning.

  (As an example, the Iligan Airport's lack of an operational fire fighting vehicle for over four years is a serious problem, but there is a lack of understanding at the local level of how to deal with the problem.)

- The individual airports have both a perceived and real problem in communicating effectively with the Manila ATO headquarters. They tend to feel isolated and they are not confident that Manila understands their true needs.

The Area Manager could play an important role in addressing these problems by:

- Assisting individual airports in determining individual training, planning, development, and capital improvement needs.
- Facilitating communication between the airports, so they can learn from the experience of others and coordinate their efforts—give the individual managers a feeling of being part of a team, rather than lonely individuals.
- Developing regional priorities, for communication to Manila. Since the Area Manager will have more *"clout"* in Manila than the individual airport managers (in most cases), and will better understand the ATO bureaucratic procedures, the individual airport managers can feel that their interests are better represented at Manila headquarters.

In order for the Area Manager concept to meet these needs, however, three changes will have to occur:

- Appropriate resources will have to be assigned. Technical staff, to assist the individual airports, will be required. Engineers, planners, business development specialists, operations specialists, etc. could be of great assistance to the local airports in defining and meeting their needs. The technical staff could, perhaps, be provided to the areas on a rotating basis so that large increases in staff will not be required to meet this need.

- The Area Manager must be perceived by the individual airports as being *"on their side"*—in other words, if the Area Manager is perceived as being simply another unnecessary layer in the bureaucratic hierarchy (as seems to be the case presently), the objectives of the program will not be met. He must perform a useful function for the airports (such as helping them convince the Manila headquarters of their needs or helping them define and obtain needed resources) if he is to gain acceptance. The effective manager must perceive the meeting of his subordinates' needs as one of his primary responsibilities.

- The Area Manager must be a full-time position. The area manager positions are presently filled by designating one of the airport managers in the region as Area Manager. Thus, former peer relationships (for example between Davao and Cagayan de Oro managers) are suddenly redefined as a supervisor-subordinate relationship. This is bound to cause friction and confusion as to ones opportunities within system, for example:

  Future Assignments. The question of future assignments becomes difficult. For example, if the Davao Airport Manager, who is also the regional Area Manager, is replaced by a new man, will this new man automatically become Area Manager, with supervisory responsibility over other, possibly more experienced managers, such as the Cagayan de Oro Airport Manager. Can the other airport managers in a region ever hope to advance in the hierarchy—must the Cagayan de Oro manager transfer to Davao in order to have a chance to become the Area Manager?

  Representation. Since the Area Manager is also a manager of one of the airports, will the other airport managers within the region trust him to fairly represent their interests, or will he be suspected of favoritism of his own airport?

  Work Load. Will the Area Manager really be able to do much of a job when he already has a full-time job as an airport manager?

  Ability. Just because an individual is a successful airport manager does not necessarily indicate that he will be a good Area Manager—different skills are required.

Ideally, the area manager position should be separated from that of the airport manager which would: allow the individual to devote the required time to the job; allow other airport managers the opportunity to advance to that position based on their abilities; and provide full, unbiased representation of the regional airports needs. Adequate resources and staff should be devoted so that the Area Manager could successfully perform his assigned responsibilities.

CHAPTER 5

IMPLEMENTATION PLAN

5.1 INTRODUCTION

This study presents a proposed airport development program for the Cagayan de Oro-Iligan Corridor, the basis of which is the construction of a new airport at Laguindingan. This section of the report outlines the steps which must be taken to implement the airport project.

5.2 ELEMENTS OF THE IMPLEMENTATION PLAN

Implementation of the Laguindingan Airport will require an integrated, multi-disciplinary effort. This effort must be carefully coordinated by the Department of Transportation and Communications (DOTC) and the Air Transportation Office (ATO) in order to ensure maximum efficiency. The effectiveness of the implementation plan has an important effect on the cost and schedule of the project, as well as on the extent of economic benefits related to the project, as presented in the economic feasibility study (Volume I, Chapter 7).

The airport implementation plan consists of five coordinated elements:

- Engineering
- Administrative/technical
- Operational planning
- Planning coordination
- Financial planning

Each of these elements is described in this chapter, along with their interactions with the other elements.

5.3 ENGINEERING

5.3.1 Engineering Tasks

Since preliminary designs have already been prepared for the new airport, as presented in this report, three engineering steps remain in the implementation program: detailed surveys; final design; and, construction. Because they result in the physical realization of the airport, these engineering tasks form the heart of the implementation program.

5.3.1.1 Detailed Surveys

These surveys will provide the detailed technical data required for the final design process. The surveys include:

- topographical surveys of the airport site, to guide facility siting and grading and drainage design;
- meteorological data collection, including wind and visibility information, required to confirm planned runway orientation and NAVAIDS; and,
- soils investigations, to guide the design of pavements and structure foundations.

5.3.1.2 Final Design

The final design process, based on the preliminary designs already produced, involves the preparations of plans, specifications, and cost estimates to guide the construction of the airport. The final design process is also guided by applicable national and international codes and standards. Final design products include:

- plans (drawings), which represent a graphic description of the scope and details of the construction effort;
- specifications (General Conditions), which present the contractual conditions governing the construction effort;
- specifications (Special Conditions), which represent a written description of construction procedures and materials requirements; and,
- cost estimates, which provide input to the project's programming and financial planning.

5.3.1.3 Construction

The construction process involves the building and installation of the airport's physical facilities, in accordance with the final design. Elements of the construction effort include:

- construction of site improvements, such as pavements, site drainage, and grading;
- construction of buildings, such as the terminal building, operations center, and control tower; and,
- installation of special equipment, such as lighting systems, NAVAIDS, terminal equipment, and air traffic control equipment.

5.3.2 Key Participants in the Engineering Tasks

Key governmental agencies and private organizations involved in the engineering work will include:

- the Department of Transportation and Communications (DOTC);
- the Air Transportation Office (ATO);
- the General Engineering Consultant (GEC), and any engineering subcontractors, such as architects, geotechnical, etc.; and,
- construction contractor(s), working under GEC supervision.

5.3.3 Coordination of Engineering Tasks with Other Implementing Elements

The engineering tasks must be coordinated with other elements of the airport implementation program. In particular, cost and schedule information developed during both the preliminary and final design will guide project programming and phasing, which in turn, will be integrated with the financial planning of the project. The programming requirements of the financial plan will guide the phasing of the design and construction work.

5.3.4 Contractual Arrangements for Engineering Work

The DOTC and the ATO will select the preferred contractual arrangements for the project engineering work. Factors affecting this decision will include departmental work loads, scheduling requirements, budget status, and governmental policies.

It is likely that a large portion of the engineering work will be performed under contract in order to avoid the requirement for governmental agencies to excessively expand their own professional staffs.

Three general approaches to the engineering implementation of the project are possible:

- Design-Build, under which a single contractor is selected to both design and build the project;
- Design-Award-Construct, the traditional approach under which the final design is performed under one contract and then a competitive selection of construction contractors is made, based on the final design; and,
- Fast Track, under which construction is begun prior to the completion of the final design (can be applied to either the design-build or the Design-Award-Construct approaches).

Given the scale of the airport project, the likely budgetary constraints, and the schedule requirements, as well as normal governmental contracting practices, the traditional design-award-construct approach is likely to be the preferred method of implementation.

A variety of contractual arrangements are possible under the design-award-construct approach. Again, based on the specific characteristics and requirements of the project, the preferred contractual approach is likely to be the selection of a General Engineering Consultant (GEC), to perform detailed surveys and final design under the general supervision of the DOTC/ATO. The GEC would supervise the construction of the airport, to be performed by a separate contractor, or contractors, with the GEC providing all quality control and contract administration services. As described in the following sections, the GEC can also be used to perform a variety of other functions during the implementation program.

5.4 ADMINISTRATIVE/TECHNICAL

5.4.1 Administrative/Technical Tasks

Administrative/technical tasks are those which involve organization of the implementation program to ensure that all elements contribute effectively to the overall success of the program. Administrative/technical tasks include the following:

- **Project programming statement**

  Project programming is the development of the project scope, schedules, and phasing to balance available technical, policy, and financial resources with the project requirements. The project programming statement guides all other elements of the implementation program.

- **Implementation program role assignments**

  The variety of elements in the airport implementation program will require a coordinated effort between several governmental agencies, each acting in its area of responsibility. An inter-agency coordinating committee, chaired by the DOTC, should be organized to ensure that the required tasks are accomplished according to the program schedule.

- **Land acquisition**

  Land required for the airport must be acquired prior to construction. The form of control required for the land (government ownership, lease, private ownership) will be determined in coordination with the project program and financial plan. If, for example, private participation is incorporated into the implementation program, it may not be necessary for the government to purchase all the land required for the airport.

- **Staffing for operation and maintenance of the new airport**

  Personnel requirements for operations and maintenance of the new airport must be determined, and the appropriate personnel provided. A recommended staffing organization is presented in Chapter 4. The staffing plan will be formulated in consideration of ATO policies and the present staffing at the existing Corridor airports.

5.4.2 Key Participants in Administrative/Technical Tasks

Key governmental agencies and private organizations involved in the administrative/technical work will include:

- the Department of Transportation and Communications;
- the Air Transportation Organization;
- other governmental agencies, appointed to the inter-agencies coordinating committee;
- landowners; and,
- the GEC, for assistance in preparing the project programming statement.

5.4.3 Coordination of Administrative/Technical Tasks with Other Implementation Elements

The administrative/technical tasks must be carefully coordinated with the other elements of the implementation program. This is particularly true for the engineering and financial elements. Development of the project programming statement, which is the basic coordination document for the entire airport program, is an administrative/technical task, and will require input from all other implementation elements.

5.4.4 Contractual Arrangements for Administrative/Technical Work

Most of the administrative/technical tasks will be performed by DOTC/ATO personnel, and by personnel of other governmental agencies. This work is directly guided by government policy, and this policy implementation is most efficiently guided by government personnel.

Certain elements of the work could, however, be contracted to others. The GEC, for example, could perform staff functions in the land acquisition and project programming tasks, under the direct guidance of the DOTC/ATO. Since the engineering tasks will form the framework for the entire program schedule, and the engineering costs will form the bulk of the overall program cost, it is likely that the GEC could prepare the project programming statement very efficiently.

5.5 OPERATIONAL PLANNING

5.5.1 Operational Planning Tasks

Operational planning involves the preparations for the transition from the present operations at the two existing Corridor airports, Cagayan de Oro and Iligan, to consolidated commercial air operations at the new airport. Specific tasks will include:

- **Identification of airport roles**

  It is assumed that all air carrier operations will be consolidated at the new airport. The continuing operational roles, if any, of the existing airports following the opening of the new airport, must be determined and the DOTC and ATO roles identified. These continuing roles, if any, will, in turn, determine the full scope of operations to be accommodated at the new airport. For example, the extent to which existing military operations at Cagayan de Oro and general aviation operations at Iligan will be transferred to the new airport at Laguindingan will affect the facilities required at the new airport.

- **Coordination with airport users**

  The facility requirements of future users of the Laguindingan Airport, which have been estimated for the purposes of the preliminary design and master plan, must be confirmed. The key issue is determination of the airline facility requirements, but the needs of other airport users must also be identified.

- **Planning of operational transition**

  The physical transfer of aviation operations from the existing airports to the new airport will require detailed planning to promote efficiency and continued safety of aviation operations. Specific tasks will include the transfer of air traffic control, security, and fire-fighting personnel; transfer of airline operations; and public notification.

5.5.2 Key Participants in Operational Planning Tasks

Key governmental agencies and private organizations involved in the operational planning include:

- the Department of Transportation and Communications;
- the Air Transportation Office;
- ATO technical departments (air traffic control, airport operations, etc.);
- Philippine Airlines;
- other airport users; and,
- the GEC, to provide technical support to the DOTC/ATO staff.

5.5.3 Coordination of Operational Planning Tasks with Other Implementation Elements

The operational planning tasks must be closely coordinated with the engineering tasks, since the operational planning work will help determine the scope of the facilities required at the new airport--particularly those related to aviation operations other than commercial air carriers. In addition, the operational planning work must be integrated with the financial planning work in order to ensure that the identified facility requirements are balanced by the appropriate financial mechanisms.

5.5.4 Contractual Arrangements for Operational Planning Work

Since it is directly related to government aviation policy and national transportation requirements, most of the operational planning work will be performed by DOTC/ATO personnel. Some of the work should also be performed either by, or in close cooperation with, the airlines proposing to serve the new airport.

Certain elements of the work could, however, be contracted to others. The GEC, for example, could perform staff operational planning functions under the direct guidance of the Air Transportation Office.

5.6 PLANNING COORDINATION

5.6.1 Planning Coordination Tasks

The key planning coordination tasks have been identified and described in the preceding sections and the preliminary issues have been addressed. However, as the airport program proceeds toward final implementation, many of these issues will need to be addressed in greater detail. These tasks include:

- **Re-zone land required for airport use**

  The Laguindingan airport site is presently designated as agricultural land. Prior to use by the airport the land's zoning must be reclassified from agricultural to industrial/transportation use, in accordance with Housing and Land Use Regulatory Board requirements.

- **Coordinate airport development with overall Corridor development programs**

  The economic benefits to the Corridor and the national economy resulting from the new airport can be maximized if the airport program is coordinated with other economic development programs for the Corridor. For example, the airport and the services it can provide should be included in the Corridor's Industrial Master Plan, which is presently being prepared.

- **Coordinate the new airport's ground access system with the Corridor's transportation system**

  The new airport is conveniently located to serve the entire Corridor, but is farther from Cagayan de Oro City than the existing Lumbia Airport. Efficient ground transportation services will, therefore, be essential to the success of the new airport. These services will be highway-based and, because such systems are flexible, planning will be relatively straight-forward.

  Planning work will include the assignment of responsibilities for providing services and the planning of facilities at the airport to accommodate the services.

- **Coordinate development of compatible land use in the airport vicinity**

  As described in Chapter 2, the development and operation of the Laguindingan Airport will affect the surrounding activities. Environmental impacts, such as noise, safety, drainage, ground traffic volume, and other effects, can be minimized through appropriate planning. this is particularly true in the Corridor's situation because the proposed airport is not located within a heavily developed area.

  Since the new site allows over-water approaches to both ends of the runway, noise and safety impacts will be limited.

  Land use plans for areas near the airport should be coordinated with the airport master plan to ensure that any adverse impacts of the airport's development and operation are minimized.

- **Coordinate airways requirements for the new airport with the national system**

  No major revisions in the national enroute airway system will be required to accommodate the new airport. Depending on the future status of the existing facilities, such as the Cagayan de Oro VOR, some minor changes may be needed.

- **Coordinate airport utility requirements with Corridor systems**

  Planned expansion of the MORESCO power grid will be capable of meeting the airport's requirements for electrical service. Further investigation is required to determine potable water sources. Detailed arrangements for provision of these services, and the future provision of telephone service, must be made with the responsible agencies.

- **Coordinate development programs for all Corridor airports**

  Development plans and five-year budgets have already been approved for the existing Corridor airports: Cagayan de Oro and Iligan. Certain developments have also been proposed for the Linamon site. Once a schedule for implementation of the new airport has been established, policies concerning further development of the existing airports must be formulated.

If, for example, the first phase of the new project, including air carrier and passenger terminal facilities, is to be implemented in the near future, it may be judged uneconomical to make further significant government investments in commercial air carrier-related facilities at the existing airports. Projects such as the new passenger terminal at the Cagayan de Oro Airport, or runway widening and lengthening both the Cagayan de Oro and Iligan airports, may be less beneficial in light of their shorter expected economic life.

Other airport improvement projects involving equipment which could be relocated, such as the purchase of fire trucks or the installation of an Instrument Landing System at Cagayan de Oro, could remain justified in anticipation of future relocation to the new Laguindingan Airport.

5.6.2 Key Participants in Planning Coordination Tasks

Key governmental agencies and private organizations involved in the planning coordination work will include:

- the Department of Transportation and Communications;
- the Air Transportation Office;
- ATO technical departments (air traffic control, facility planning);
- Corridor Industrial Master Plan agencies;
- utility companies;
- Corridor local government and planning agencies; and,
- GEC, to provide technical support to the DOTC/ATO staff.

5.6.3 Coordination of Planning Coordination Tasks with Other Implementation Elements

The planning coordination work must be coordinated with other elements of the implementation program, and in particular with the engineering tasks. This work will determine the external connections between the airport itself and its surrounding environment, including utility connections, ground transport links, and integration into the airways system. These external links will affect the final design of the airport facilities.

5.6.4 Contractual Arrangements for Planning Coordination Work

Since it is directly related to government policy and national transportation requirements, most of the planning coordination work will be performed by DOTC/ATO personnel. Certain elements of the work could, however, be contracted to others. The GEC, for example, could perform staff planning functions and general coordination work under the direct guidance of the ATO staff.

5.7 FINANCIAL PLANNING

5.7.1 Financial Planning Tasks

Although the financial feasibility of the Laguindingan airport program has been established in Volume I, Chapter 7, a specific financial plan must be developed for the airport implementation program. The financial plan must provide the required amounts of funds at the proper times, in accordance with the project programming statement. Specific financial planning tasks include:

- **Identify participants in project financing**

  Alternative financial approaches, including methods of incorporating private financial participation in the project, should be explored. Participation by present landowners may prove attractive.

- **Identify potential funding sources**

  Sources of governmental financing, including foreign donors, will be explored, as well as any private sources identified above.

- **Establish funding requirements**

  Project funding requirements and time will be established, in accordance with the project programming statement.

- **Formulate program financial program**

  Synthesize the financial program, through the balancing of funding requirements and the funding sources.

5.7.2 Key Participants in Financial Planning Tasks

Key governmental agencies and private organizations involved in the financial planning work will include:

- the Department of Transportation and Communications;
- the Air Transportation Office;
- government budget agencies;
- domestic and international lending agencies;
- private firms involved in project financing;
- airport concessionaires, if any; and,
- the GEC, to provide technical support to the DOTC/ATO.

5.7.3 Coordination of Financial Planning Tasks with Other Implementation Elements

The financial planning work must be integrated with the engineering and, especially, the project programming work. The project programming statement will balance funds available with the engineering requirements to determine project phasing and timing.

5.7.4 Contractual Arrangements for Financial Planning Work

The DOTC and the ATO will direct the financial planning work. Government policy will form a key guide to the formulation of the financial plan. It is likely that much of the staff work, including estimation of funding requirements and identification and evaluation of funding sources, will be performed under contract, either with the GEC and/or a separate financial planning consultant.

5.8 IMMEDIATE ACTION PROGRAM

The preliminary engineering program for the Laguindingan Airport's implementation includes approximately one year for final design and 34 months for construction. Most of the implementation elements described in the preceding section must be completed during the first year of the program.

Since they will guide the design process, many of the key elements must be completed early in the first year. These elements include the engineering and geotechnical surveys, the project programming statement, financial planning, and portions of the operational planning and planning coordination.

Although the implementation program work will, therefore, be very concentrated during the early months of the project, certain portions of the work can be initiated immediately expediting the overall program. Items identified for this *"Immediate Action Program"* are those which are on the overall programs critical path and which involve relatively limited cost and commitment on the part of the government agencies.

5.8.1 Elements of the Immediate Action Program

The following elements of the airport implementation program are considered candidates for the Immediate Action Program, to be initiated by the DOTC and the ATO immediately.

5.8.1.1 Engineering Tasks

(a) Formulate engineering contracting strategy

The government can immediately begin selection of a strategy for obtaining engineering services for the airport design and construction. As described in Section 5.3.4, a variety of approaches is possible. The General Engineering Consultant (GEC) approach offers certain benefits under a program of this type, however, other approaches which involve DOTC/ATO personnel in a more direct project management role are also possible.

Once the contracting approach has been identified, a Terms of Reference and Scope of Work (SOW) for the selection of engineering consultant(s) can be prepared (a draft SOW is included in Annex C). Preparatory work of this nature will allow a rapid start of the project work.

(b) Monitor airport site meteorological conditions

Meteorological conditions are generally uniform throughout the coastal areas of the Corridor, and it has therefore been assumed that the conditions at the Laguindingan airport site are similar to those at the Cagayan de Oro Airport, where weather data are collected by the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA). It would be prudent, however, to collect as much data at the site as possible, prior to final design. Wind data is particularly important because of its impact on the optimal runway orientation. It is possible that local topographical conditions affect wind direction at the proposed site in an unforeseen way.

A monitoring station should be established at the site as soon as possible, recording wind speed and direction, precipitation, barometric pressure, and temperature, by time of day. A method of recording horizontal visibility and ceiling height, if feasible, would also be advisable.

5.8.1.2 Administrative/Technical Tasks

(a) Prepare for airport land acquisition

The DOTC/ATO can begin exploring issues related to acquisition of land for the new airport. Owners should be identified and preliminary discussions held so that alternative methods of acquisition (purchase, lease, continued private ownership) can be evaluated.

5.8.1.3 Operational Planning Tasks

(a) Coordination with airport users

The DOTC/ATO can initiate discussions with Philippine Airlines and other users of the Corridor airports, including the military, to identify key issues for consideration during the final design.

5.8.1.4 Planning Coordination Tasks

(a) Initiate re-zoning of airport land

Since the proposed airport site is presently zoned for agricultural use, re-zoning of the land must be completed prior to construction. The re-zoning process may prove very time consuming, so it may be wise to initiate the process as soon as possible so it does not become a scheduling constraint later in the implementation program.

(b) Coordinate airport plan with regional development plans

The new airport must be coordinated with other development plans for the Corridor if economic benefits of the project are to be maximized. For example, the airport's development should be included in the Corridor's industrial master plan. The DOTC/ATO can initiate efforts to update relevant regional plans to incorporate the airport.

(c) Preliminary coordination with utility companies

Contact should be made with Corridor utility companies to present preliminary concepts of airport service locations and capacities. In this way, the utility companies will have additional time to adjust their own development plans to accommodate the airport's needs.

(d) Evaluate development plans of the existing Corridor airports

The five-year development plans for the existing Corridor airports include some major projects designed to accommodate increased levels of passenger and cargo service. If the new airport, which will consolidate all scheduled passenger and cargo service, is to be implemented in the near future some of these plans may have lower levels of economic justification, because of the facilities' shorter economic life. The DOTC/ATO should review these development plans as appropriate.

5.8.1.5 Financial Planning Tasks

(a) Preliminary financial planning

Preliminary concepts for financing the of the new airport, including potential participation by private interests, have been presented in Volume I, Chapter 7. The DOTC/ATO can begin to explore these concepts with government agencies and private organizations, in order to determine which appear viable for further study.

Table A-1
SUMMARY OF TEST RESULTS ON TEST PITS AND AUGER HOLES

Station (km)	Sample No.	Depth (m)	Soils Description	Soil Class AASHTO	Grain Size Analysis							Atterberg Limit			Compaction			CBR 95% MDD	CBR at Blows			Swell		
					2"	1"	3/8"	#4	#10	#40	#200	LL	PL	PI	%	MDD AASHTO T-99 (g/cc)	OMC %		10 %	30 %	65 %	10 %	30 %	65 %
3+500	TP-1	0.00-0.30	Chocolate Brown Clay	A-7-5 (17)					100	99	98	69	37	32	41									
		0.00-0.30	Reddish Brown Fat Clay and Coral Limestone	A-7-5 (20)						100	99	61	31	30	43									
		0.80-1.50	Reddish Brown Fat Clay and Coral Limestone	A-7-5 (17)				100	99	99	98	62	39	23	54	1.24	45.0	12.70	8.39	16.23	19.59	0.78	0.28	0.26
3+440	AH-1	0.00-0.40	Chocolate Brown Lean Clay	A-6 (16)				100	98	97	93	39	10	29	48									
		0.40-1.30	Reddish Brown Sandy Fat Clay with Traces of Gravel Size Corals	A-7-5 (11)		100	75	71	68	65	61	51	31	20	32									
3+290	TP-2	0.00-0.20	Dark Brown Fat Clay	A-7-5 (18)						100	98	62	36	26	58									
		0.20-1.70	Mottled Brown and Reddish Brown Fat Clay and Coral Limestone	A-7-5 (17)						100	98	65	43	22	60	1.25	36.5	9.10	2.80	7.84	8.95	1.66	1.29	0.87
3+205	AH-2	0.00-0.30	Reddish Brown Lean Clay	A-7-6 (14)			100	98	98	98	97	49	29	20	42									
		0.30-0.50	Reddish Brown Fat Clay	A-7-6 (20)					100	99	98	63	24	39	44									
		0.50-1.30	Reddish Brown Fat Clay with Traces of Gravel Size Corals	A-7-5 (20)			100	99	98	97	95	69	38	31	47									
3+305	TP-3	0.00-1.00	Reddish Brown Lean Clay	A-6 (10)					100	99	99	34	18	16	42									
		1.00-1.50	Reddish Brown and Light Yellowish Brown Clayey Coral Limestone													1.225	41.0	13.30	6.72	14.55	17.35	1.00	0.92	0.46
2+950	AH-3	0.00-0.20	Reddish Brown Fat Clay	A-7-5 (18)					100	99	97	61	36	25	40									
		0.20-0.60	Reddish Brown Fat Clay	A-7-5 (19)						100	98	65	38	27	43									
		0.60-1.20	Reddish Brown Lean Clay	A-7-5 (10)				100	96	95	92	47	35	12	41									
2+785	TP-4	0.00-0.80	Chocolate Brown Fat Clay	A-7-5 (20)						100	97	65	36	29	50									
		0.80-1.50	Mottled Brown and Reddish Brown Fat Clay and Coral Limestone	A-7-5 (20)			100	97	96	94	91	73	37	36	52	1.26	37.0	3.70	2.07	4.47	6.2	1.57	1.52	1.46
2+700	AH-4	0.00-0.40	Mottled Brown and Reddish Brown Loan Clay	A-7-6 (12)					100	99	98	46	28	18	25									
		0.40-0.70	Reddish Brown Fat Clay	A-7-5 (15)					100	99	99	55	35	20	42									
		0.70-1.25	Reddish Brown lean Clay with some Gravel Size Corals	A-7-5 (10)		100	82	80	78	77	75	48	37	11	27									

Table A-1 (Cont'd)
SUMMARY OF TEST RESULTS ON TEST PITS AND AUGER HOLES

Station (km)	Sample No.	Depth (m)	Soils Description	Soil Class AASHTO	Grain Size Analysis							Atterberg Limit			Compaction			CBR 95% MDD	CBR at Blows			Swell		
					2"	1"	3/8"	#4	#10	#40	#200	LL	PL	PI	%	MDD AASHTO T-99 (g/cc)	OMC %		10 %	30 %	65 %	10 %	30 %	65 %
2+580	TP-5	0.00-0.15	Brown Fat Clay	A-7-5 (17)					100	99	99	60	37	23	35									
		0.15-0.30	Reddish Brown Fat Clay with Coral Gravel	A-7-5 (18)		100	96	85	80	79	78	65	39	26	32									
		0.70-1.50	Reddish Brown Fat Clay with Traces of Coral Gravel/Coral Limestone													1.25	37.0	10.60	7.08	10.07	10.82	2.07	1.07	0.98
2+450	AH-5	0.00-0.30	Mottled Brown and Reddish Brown Clayey Silt with Traces of Gravel & Tree Roots	A-5 (9)			100	98	98	97	94	46	36	10	40									
		0.30-1.15	Reddish Brown Sandy Fat Clay with Taces of Gravel Size Corals	A-7-5 (10)		100	93	78	71	64	56	59	39	20	28									
2+330	TP-6	0.00-0.40	Brown Fat Clay with Traces of Coral Gravel	A-7-5 (20)					100	99	98	69	36	33	50									
		0.40-0.70	Reddish Brown Clayey Coral Gravel/Coral Limestone	A-2-7 (2)		100	62	44	36	33	29	51	26	25	19									
		0.70-1.50	Mottled Brown and Reddish Brown Clayey Coral Gravel/Coral Limestone	A-2-7 (3)		100	73	55	42	37	31	45	16	29	16	1.52	26.0	16.80	9.51	19.59	17.35	0.33	0.17	0.11
	AH-6	0.00-0.35	Chocolate Brown Fat Clay with Gravel Size Corals	A-7-5 (8)		100	59	50	46	45	43	73	42	31	24									
		0.35-0.70	Mottled Brown and Reddish Brown Clayey Gravel Size Corals	A-2-7 (1)		100	50	40	33	29	23	42	22	20	18									
		0.70-1.35	Mottled Brown and Reddish Brown Lean Clay and Gravel Size Corals	A-6 (1)		100	96	81	63	51	39	30	18	12	15									
2+080	TP-7	0.00-0.15	Chocolate Brown Fat Clay with Traces of Coral Gravel	A-7-5 (16)				100	99	99	97	70	39	31	54									
		0.15-0.50	Brown Clayey Coral Limestone Gravel	A-2-6 (1)		100	51	37	29	26	23	40	21	19	19									
		0.50-1.00	Mottled Brown and Reddish Brown Clayey Coral Limestone Gravel	A-2-6 (1)		100	82	58	39	29	22	35	17	18	16	1.58	20.5	4.10	2.53	3.53	5.55	0.22	0.26	0.22
		1.00-1.50	Mottled Brown, Light Brown and Reddish Brown Clayey Limestone	A-2-7 (1)	100	79	69	55	40	29	20	46	19	27	17									
1+950	AH-7	0.00-0.25	Dark Brown Fat Clay with Traces of Gravel and Tree Roots	A-7-5 (18)		100	96	93	91	89	86	71	46	25	35									
		0.25-0.75	Brown Clayey Sandy Gravel Size Coral	A-2-6 (0)		100	69	48	32	26	19	40	23	17	14									
		0.75-1.50	Mottled Brown and Reddish Brown Clayey Sandy Gravel Size Corals	A-7-6 (8)		100	88	75	64	55	45	51	27	24	28									
1+835	TP-8	0.00-0.30	Chocolate Brown Fat Clay w/ Gravel Size Corals	A-7-5 (20)		100	94	93	88	85	81	68	32	36	46									
		0.30-0.60	Mottled Brown and Reddish Brown Fat Clay with Traces of Gravel	A-7-5 (17)		100	92	84	76	71	66	76	36	40	40									
		0.60-1.50	Mottled White, Light Brown and Reddish Brown silty Coral Limestone	A-2-4 (0)		100	35	25	20	14	9	22	13	9	9	1.84	13.5	17.00	2.70	12.23	27.30	0.11	0.06	0.04

Table A-1 (Cont'd)
SUMMARY OF TEST RESULTS ON TEST PITS AND AUGER HOLES

Station (km)	Sample No.	Depth (m)	Soils Description	Soil Class AASHTO	Grain Size Analysis							Atterberg Limit			Compaction			CBR 95% MDD	CBR at Blows			Swell		
					2"	1"	3/8"	#4	#10	#40	#200	LL	PL	PI	%	MDD AASHTO T-99 (g/cc)	OMC %		10 %	30 %	65 %	10 %	30 %	65 %
1+710	AH-8	0.00-0.20	Mottled Brown and Reddish Brown Fat Clay with Gravel Size Corals	A-7-5 (5)		100	64	55	49	45	40	60	35	25	27									
		0.20-0.60	Brown Clayey Gravel Size Corals	A-2-7 (1)		100	66	49	38	30	22	46	26	20	25									
		0.60-1.35	Brown Clayey Sandy Gravel Size Corals	A-2-7 (0)		100	56	36	26	19	12	51	31	20	17									
1+585	TP-9	0.00-0.20	Dark Brown Fat Clay with Sandy and Traces of Gravel Size Coral & Tree Roots	A-7-5 (19)			100	98	95	90	85	62	35	27	34									
		0.20-0.70	Mottled Brown and Reddish Brown Sandy Coral Gravel and Clay with Tree Roots/Coral Limestone	A-7-6 (3)		100	77	60	46	39	36	48	27	21	26									
		0.70-1.50	Mottled Light Yellowish Brown & Brown Clayey Coral Gravel/coral Limestone	A-2-6 (2)		100	89	75	51	38	30	42	21	21	11	1.44	27.5	11.2	3.36	9.51	15.67	4.86	2.79	2.2
1+460	AH-9	0.00-0.25	Chocolate Brown Fat Clay w/ Tree Roots	A-7-6 (19)					100	99	96	64	26	38	51									
		0.25-0.85	Brown Fat Clay with Traces of Gravel Size Corals	A-7-5 (18)			100	96	95	94	93	67	32	35	53									
		0.85-1.15	Mottled Dark Brown and Reddish Brown Fat Clayey Coral and Limestone	A-7-5 (12)		100	68	61	56	53	50	85	38	47	23									
1+325	TP-10	0.00-0.25	Chocolate Brown Fat Clay	A-7-5 (16)						100	99	57	36	21	44									
		0.25-0.60	Mottled Brown Reddish and White Corral Limestone																					
		0.60-1.50	Mottled Brown and Dark Brown Fat Clay	A-7-5 (20)					100	99	99	71	38	33	53	1.23	39.0	4.30	1.01	2.78	5.81	3.12	3.03	2.05
1+160	AH-10	0.00-0.25	Chocolate Brown Fat Clay with some Gravel Size Corals and Tree Roots	A-7-5 (15)		100	82	68	63	61	58	65	34	31	31									
		0.25-0.60	Chocolate Brown Fat Clay	A-7-5 (20)				100	99	98	95	63	34	29	52									
		0.60-1.50	Mottled Brown and Dark Brown Fat Clay	A-7-5 (20)			100	97	96	96	94	78	43	35	52									
1+085	TP-11	0.00-0.30	Chocolate Brown Lean Clay	(14)		100	94	93	93	92	91	46	42	22	31									
		0.30-0.60	Mottled Brown and Reddish Brown Coral Gravel	A-1-9 (0)	100	54	22	15	10	9	8	NIL	NIL	NP	8									
		0.60-1.00	Reddish Brown and White Clayey Coral Limestone	A-2-5 (1)		100	54	32	25	23	22	65	33	32	15									
		1.00-1.50	Mottled White and Reddish Brown Clayey Coral Gravel/Coral Limestone	A-2-6 (0)		100	54	36	25	19	15	28	14	14	8	1.76	16.0	12.90	6.72	17.91	25.74	0.83	0.46	0.28

Table A-1 (Cont'd)
SUMMARY OF TEST RESULTS ON TEST PITS AND AUGER HOLES

Station (km)	Sample No.	Depth (m)	Soils Description	Soil Class AASHTO	Grain Size Analysis							Atterberg Limit			Compaction			CBR 95 % MDD	CBR at Blows			Swell		
					2"	1"	3/8"	#4	#10	#40	#200	LL	PL	PI	%	MDD AASHTO T-99 (g/cc)	OMC %		10 %	30 %	65 %	10 %	30 %	65 %
0+965	AH-11	0.00-0.25	Chocolate Brown Fat Clayey with Traces of Gravel Size Corals	A-7-5 (18)			100	99	93	88	78	62	38	24	38									
		0.25-0.60	Dark Brown Sandy Fat Clay with Traces of Gravel Size Corals	A-7-5 (11)		100	71	69	65	60	51	61	34	27	30									
		0.60-1.50	Dark Brown Sandy Fat Clay with Gravel Size of Corals	A-7-6 (10)		100	82	76	66	59	49	56	29	27	29									
0+840	TP-12	0.00-0.30	Mottled Reddish Brown and Brown Fat Clay with Traces of Coral Gravel	A-7-5 (20)			100	98	94	92	90	64	33	31	28									
		0.30-0.80	Mottled Brown and Yellowish Brown Clayey Coral Gravel	A-2-6 (0)		100	85	57	39	25	12	38	22	16	14									
		0.80-1.50	Mottled Brown and Reddish Brown Clayey Coral Gravel/Coral Limestone	A-2-6 (0)		100	63	50	38	29	20	33	18	15	15									
0+710	AH-12	0.00-0.80	Reddish Brown Flat Clay with Tree Roots	A-7-5 (17)					100	99	98	68	36	32	45									
		0.80-1.50	Reddish Brown Fat Clay	A-7-5 (20)					100	99	98	74	36	38	45									
0+590	TP-13	0.00-0.30	Reddish Brown Fat Clay	A-7-5 (17)					100	99	98	60	37	23	31									
		0.30-0.60	Reddish Brown Fat Clay	A-7-5 (20)					100	9	99	66	33	33	37									
		0.60-1.00	Reddish Brown Fat Clay with Traces of Fine to Coarse Sand	A-7-5 (20)				100	98	97	96	65	36	29	44									
		1.00-2.50	Reddish Brown Fat Clay	A-7-5 (18)				100	98	97	96	64	39	25	43	1.26	36.0	6.10	1.68	3.92	11.19	0.50	0.16	0.12
0+465	AH-13	0.00-0.50	Reddish Brown Fat Clay	A-7-5 (17)					100	99	98	57	32	25	38									
		0.50-1.50	Reddish Brown Fat Clay	A-7-6 (18)						100	99	56	29	27	38									
2+080	TP-14	0.00-0.15	Chocolate Brown Clayey Coral Gravelly Clay	A-7-5 (5)		100	74	58	51	43	39	66	42	24	26									
		0.15-1.00	Mottled Brown and Reddish Brown Clayey Coral Gravel	A-2-6 (1)		100	74	54	40	34	28	39	19	20	16									
		1.00-1.50	Reddish Brown Clayey Coral Gravel	A-2-6 (0)		100	66	45	31	25	19	29	15	14	13	1.75	17.0	7.8	3.02	7.58	9.28	0.22	0.09	0.04
2+080	AH-14	0.00-0.55	Brown Clayey Sandy Gravel Size Corals	A-2-6 (1)		100	61	50	45	40	34	39	26	13	12									
		0.55-1.50	Mottled Brown and Reddish Brown Clayey Sandy Gravel Size Corals	A-2-7 (3)		100	68	50	45	40	32	44	19	25	18									

Table A-2
SUMMARY OF TEST RESULTS FOR AGGREGATE SOURCES

Name of Source	Materials Description	Sieve Analysis														Atterberg Limit			Specific Gravity		Absorption, %		Unit Weight				Los Angele Abrasion (%)	Soundness Organic	
		3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	LL	PL	PI	FA	CA	FA	CA	Loose (g/cc)		Rodded (g/cc)				
																							FA	CA	FA	CA		FA	CA
Agusan	Light Gray sandy gravel and cobbles/boulders sub-angular to subrounded	100	87	77	61	51	44	39	30	21	15	12	7	4	3	NIL	NIL	NP	2.7	2.55	3.43	2.6	1.55	1.5	1.61	1.69	32.48	2.71	0.73
Omalag	Light brownish gray sandy gravel and cobbles/boulders sub-rounded to well-rounded	100	80	75	63	54	46	42	34	27	14	7	3	1	1	NIL	NIL	NP	2.99	2.64	6.04	3.55	1.53	1.5	1.64	1.69	28.32	6.85	1.38
Mandulog	Light gray sandy gravel and cobbles/boulders sub-rounded to well-rounded	100	86	55	54	54	54	54	48	36	23	15	6	2	1	NIL	NIL	NP	2.64	2.71	3.71	1.12	1.63	1.39	1.69	1.5	25.63	6.8	0.00
Tagoloan	Light to dark gray sandy and cobbles/boulders sub-rounded to well-rounded	100	86	75	63	53	44	38	27	19	15	11	5	3	1	NIL	NIL	NP	2.88	2.71	3.65	1.38	1.6	1.59	1.67	1.77	29.32	2.71	1.23
Iponan	Light gray sandy gravel and cobbles/boulders sub-rounded to well-rounded	100	96	91	74	55	39	35	31	28	24	19	11	10	10	NIL	NIL	NP	2.84	2.68	2.23	2.2	1.43	1.48	1.53	1.65	33.49	2.33	0.89
Taguanao	Light gray sandy gravel and cobbles/boulders sub-rounded to well-rounded	100	87	63	38	32	26	22	18	14	8	5	2	1	1	NIL	NIL	NP	2.95	2.68	3.54	2.21	1.52	1.55	1.59	1.73	30.61	1.61	0.2
Pagatpat	Light brownish gray sandy gravel and cobbles/boulders rounded to subrounded	100	83	67	61	55	48	42	35	31	27	25	22	21	20	30	18	12	2.65	2.72	3.91	0.99	1.32	1.42	1.43	1.62	28.76	2.03	1.01
Ala-e	Light gray sandy gravel and cobbles/boulders sub-rounded to well-rounded	100	94	77	56	51	42	37	30	25	19	14	7	4	3	NIL	NIL	NP	2.67	2.49	6.63	1.18	1.55	1.45	1.66	1.61	27.86	1.44	0.37

ANNEX B

BASIS OF COST ESTIMATE

B.1 INTRODUCTION

In order to prepare the cost estimate required for the economic and financial analysis of the proposed Laguindingan Airport, preliminary facility designs were developed (Volume II, Chapter 3).

The basis of the cost estimate for these facilities are presented in this annex.

B.2 LIST OF REFERENCES

- Equipment Rates: Acel Equipment Guidebook 1989 and Acel Rate Adjustment, Acel89A1
- DPWH Standard Specifications, Vol. II 1988 for Highways, Bridges and Airports
- Estimating Construction Costs - 4th Edition (by P.J. Peurifoy)
- Dodge Manual 1979, Guide on Labor and Equipment Output
- United Architects of the Philippines, Ace Program - Estimating Guide

B.3 UNIT COST DEVELOPMENT

Base cost of construction materials were obtained from actual field verification. For construction materials not available within the corridor, Manila prices were used.

Labor rates used are from the Corridor.

Equipment available in the area are from equipment list submitted by the leading contractors (Class A) in the Corridor.

B.4 CLEARING AND GRUBBING

1.	Equipment	1 D8 Dozer (per hour)	₱760
		1 Chain Saw (per hour)	₱50
2.	Crew	1 LM (per hour)	₱14
		3 Labor (3 x ₱13.75/h)	₱41
			₱865

@ an output of 300 m^2/h

Unit cost/ha. = $\frac{865/ha}{300\ m^2}$ x 10,000 m^2/ha = ₱28,842/ha, say 28,900/ha

B.5 STRIPPING - UP TO 0.15 M (6") OF NATURAL GRADE

1.	Equipment	1 Dozer (per hour)	₱760
		1 Dump Truck (per hour)	₱50
2.	Crew	1 LM (per hour)	₱14
		3 Labor (per hour)	₱41
			₱865

@ an output of 250 m^2/h

Unit cost/m^3 = ₱2,152 = ₱58/m^3
(250 m^2 x 0.15 m)

B.6 CUT (EXCAVATION)

1.	Equipment	1 Dozer (per hour)	₱760
		Backhoe w/ pavement breaker 718/h x 1.30%	₱934
		1 Dump Truck (per hour)	₱527
2.	Crew	1 Foreman (per hour)	₱19
		1 LM (per hour)	₱14
		6 Labor (per hour)	₱83

@ an output of 25 m^3/h

Unit cost/m^3 = $\frac{₱2,337/ha}{25\ m^3}$ = ₱94/m^3

B.7 BORROW FILL

1.	Equipment	1 Wheel Loader (per hour)	₱193
		2 Dump Truck (1.5 m^3/h)	₱1,114
2.	Crew	1 LM (per hour)	₱14
		2 Labor (per hour)	₱28

@ an output of 10 m^3/h

$$\text{Unit cost} = \frac{₱1{,}949/h}{10\ m^3/h} = ₱195/m^3$$

B.8 SUB-GRADE PREPARATION, LEVEL AND COMPACT

1.	Equipment	1 Grader (per hour)	₱422
		1 Compactor (per hour)	₱274
2.	Labor	1 LM (per hour)	₱14
		2 Spotter (per hour)	₱28

@ an output of 200 m^2/h

$$\text{Unit cost} = \frac{₱738/h}{200\ m^2/h} = ₱4/m^2$$

B.9 SELECT FILL

1.	Materials	Delivered cost @ Corridor (m^3)	₱320
2.	Equipment	1 Grader (per hour)	₱422
		1 sheepfoot roller (per hour)	₱51
3.	Crew	1 LM (per hour)	₱14
		5 Laborer (per hour)	₱69

@ an output of 20 m^3/h

$$\text{Unit cost (Equipment + Labor)} = \frac{₱556/h}{20\ m^3/h} = ₱28$$

Total = Materials + (Equipment + Crew) = ₱350/m^3

B.10 PCC PAVEMENT

(a) Concrete Mix

1.	Materials Class "AAA" (m^3)		₱2,022
	Cement	13.44 Bags/m^3 x ₱100/bag	₱1,344
	Sand	0.51 m^3 x 430/m^3	₱219
	Aggregate	1.02 m^3 x 450/m^3	₱459
2.	Equipment		
2.1	Batch Plant (Assume, 20 mos. concreting)		
	MOB/DEMOB Cost - Hauling - 30 km city proper to site		₱9,940.32
	Trailer 8 hrs. (4 hrs./way) x ₱915/h		₱7,320
	1st Crane 4 hrs. (2 hrs load/unload) x 437/h		₱1,748
	Labor Cost, 8 men x 8 hrs ea x 13.63/h		₱872
2.2	Other Equipments		₱9,804,354
	3 Transit Mixers	3 x 20 mos. x ₱121,200/mo.	₱7,272,000
	1 Pump Crete	1 x 3 mos. x ₱35,500/mo.	₱106,500
	12 Concrete Vibrators	12 x 20 mos x ₱5,000/mo.	₱1,200,000
	1 Concrete Paver	1 x 18 mos. x ₱68,103/mo.	₱1,225,854

Direct Cost

(Materials + Equipment Cost) at a total volume of 77,000 m^3 required

$$\frac{\text{Equipment Cost}}{\text{Total Volume}} = \frac{₱9{,}804{,}354}{77{,}000\ m^3} \qquad ₱127$$

Total Direct Cost = Material + Equipment (per m^3) ₱2,150

Indirect Cost

Indirect Cost (20% of Direct Cost)	₱411
Applicable Cost/m^3	₱2,561

(b) Concrete Mix - Class "A" for Roads, Parking Area, and others

1.	Materials		₱1,359
	Cement	8 bags x ₱100	₱800
	Sand	0.42 m^3 x ₱430	₱181
	Aggregate	0.84 m^3 x ₱450	₱378
2.	Equipment Cost {same as item (a)}		₱127
3.	Indirect Cost - add 20% to 1 and 2		₱297
		Total Cost/m^3	₱1,783

(c) Cement Stabilized Crushed Sub-base

1.	Materials		₱730
	Cement	@ ₱100/bag x 2.80 bag/m^3	₱280
	Crushed aggregate	@ ₱450/m^3	₱450
2.	Indirect Cost, add 20%		₱146
	Cost/m^3		₱876

(d) Double Bituminous Surface Treatment

1. Materials

Bituminous materials	
(1 mt covers 8 m^2 pavement, 0.05 thick or 0.43 m^3)	
₱10,200/t x 0.005 t/m^2	₱51
Aggregate 19 mm thick @ ₱12.50/m^2	₱13
12.5 mm thick	

2. Equipment

Bituminous Paver (per hour)	₱683
Roller (per hour)	₱274

3. Labor Crew

1 LM (per hour)	₱14
6 Labor (per hour)	₱83

Output 300 m^2/h

$$\text{Unit Cost /m}^2 = \frac{1{,}054/h}{300\ m^2/h} + ₱64/m^2 = ₱67/m^2$$

B.11 AIRSTRIP PAVEMENTS

(a) Runway, 45 m wide x 2,500 m long

1. PCC Pavement, Vol. Total x ₱2,561/m^3 — ₱91,668,922

V1 = 0.37 x 15 x 2,500	=	13,875 m^3
V2 = 0.35 x 15 x 2,500	=	11,813 m^3
V3 = 0.26 x 15 x 2,500	=	9,750 m^3
V4 = 982 x 0.37	=	364 m^3

2. Cement Stabilized Crushed Sub-base, Vol. Total x ₱876/m^3 — ₱20,426,568

V1 = 0.15 x 15 x 2,500	=	5,625 m^3
V2 = 0.205 x 15 x 2,500	=	7,688 m^3
V3 = 0.26 x 15 x 2,500	=	9,750 m^3
V4 = 982 x 0.26	=	255 m^3

3. Double Bituminous Surface Treatment, Area x ₱67/m^2 — ₱2,512,500
   Area = 15 m x 2,500 m = 37,500 m^2

4. Uncrushed Gravel Base Course, Vol. x ₱450/m^3 — ₱5,062,500
   = 0.30 m x 15 m x 2,500 m = 11,250 m^3

5. Runway Markings (Estimated Area - 2,500 m^2)

   - Paint Materials @ ₱1,400/gal @ 20 m^2/gal. (Includes other incidentals) — ₱175,000
   - Labor, 80% of materials — ₱140,000
   - Unit Cost/m^2 = $\frac{₱315,000}{2500}$ = ₱126/m^2

6. Miscellaneous, Dowels and Sealant B (per lot) — ₱250,000

Total — ₱120,255,490

(b) Taxiway, 23 m wide

1.	PCC Pavement 0.37 x 23 m x 413 x ₱2,561/m³	₱9,000,967
2.	Cement (Stabilized Crushed Sub-base) 0.15 x 23 m x 413 x ₱876/m³	₱1,248,169
3.	Double Bituminous Surface Treatment, 15 m x 826 m x ₱67/m²	₱830,130
4.	Uncrushed Gravel Base Course 0.30 m x 15 m x 826 m x ₱450/m³	₱1,672,650
5.	Markings for 40 m² @ ₱126/m²	₱5,040
6.	Miscellaneous, Dowels and Sealants (per lot)	₱35,000
	Total	₱12,791,956

(c) Apron (Area = 125 m x 200 m = 25,000 m²)

1.	PCC Pavement, 0.37 x area x ₱2,561/m³	₱23,689,250
2.	Cement (Stabilized Crushed Sub-base) 0.15 x area x ₱876/m³	₱3,285,000
3.	Double Bituminous Surface Treatment, 7.5 m x 420 m x ₱67/m²	₱211,050
4.	Uncrushed Gravel Base Course 0.30 m x 7.5 m x 400 m x ₱450/m³ 0.20 m x 2,704 x 450	₱668,610
5.	PCC Pavement, 0.15 m thick x 2,704 x ₱2,561/m³	₱1,038,742
6.	Markings, for 900 m² @ ₱126/m²	₱113,400
7.	Miscellaneous, Dowels and Sealants (per lot)	₱60,000
	Total	₱29,066,052

B.12 SITE IMPROVEMENT

(a) Drainage Line

1. Runway

Box Culvert 3.0 m wide x 3.5 m hige x 200 m long 0.50 thick walls @ ₱8,720/lm	₱1,744,000
RCP's, 1.20 m 0 x 330 m @ ₱2,870/lm	947,100
Sub-Total	₱2,691,100

2. Access Roads

Box Culvert 3.0 m wide x 3.5 m high x 40 m long 0.30 thick wall @ ₱6,240/lm	₱1,744,000
RCP's, 1.20 m 0 x 56 m @ ₱2,870/lm	₱160,720
1.07 m 0 x 36 m @ ₱1,725/lm	₱62,100
0.91 m 0 x 45 m @ ₱1,380/lm	₱62,100
Excavation, 1,360 m^3 @ ₱94/m^3	₱127,840
Backfill, 650 m^3 @ ₱195/m^3	₱126,750
Sub-total	₱534,520
Total	₱3,225,620

(b) Access Roads, 7.3 m wide

1. PCC Pavement

0.20 m thick x 7.3 m wide x 13,000 m long x ₱1,784/m^3		₱33,860,320
Uncrushed Gravel	0.20 x 11 x 13,000 x ₱250/m^3	₱7,150,000
Shoulder	0.15 x 3.6 x 13.000 x ₱250/m^3	₱1,755,000

2. Land Acquisition Cost

₱3,000 m long x 15 m wide right of way @ ₱300,000/ha	₱1,350,000

* Unit Cost/km = ₱3,393,486

Total	₱44,115,320

(c) Service Roads, 6.10 m wide

PCC Pavement	
0.20 thick x 6.1 wide x 900 Long x ₱1,784	₱1,958,832
Uncrushed gravel	
0.15 x 3.6 x 900 long x ₱250	₱121,500
Unit Cost/km = ₱1,872,299	
Total	₱2,080,332

(d) Perimeter Fence - 9,730 lm

Front	-	Chainlink with 3 runs of barbed wire =	1,630 lm
Rest	-	Barbed wires 4 runs of concrete post =	8,100 lm

1.	Concrete Post @ 3 m distance	
	0.20 m x 0.20 m x 9,730 lm/3 m x ₱2,010/m^3	₱782,292
	(reinforcing bars included)	
2.	Chainlink Portion	
	1,630 x ₱250/m - chainlink	₱407,500
	3 x 1,630 x ₱20/m - barbed wire	₱97,800
3.	Barbed Wire Portion	
	4 x 8,100 lm ₱20/m	₱648,000
4.	Add, 30% Labor	₱580,677
	Unit cost/lm = ₱258.61	
	Total.	₱2,516,269

(e) Landscaping/Turfing

1.	Landscaping @ ₱150/m^2		₱1,665,450
	Parking Area,	8,560 m^2	
	Terminal Building	1,966 m^2	
	Truck Parking	253 m^2	
	CFR Building	324 m^2	
2.	Turfing @ ₱8.00/m^2		₱1,280,000
	Airfield	160,000 m^2	
	Total		₱2,945,450

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(f) *Parking Area*

1.	PCC Pavement 0.15 m x 8,200 m² x ₱1,784	₱2,194,320
	Uncrushed Gravel 0.15 x 8,200 m² x ₱250	₱307,500
2.	Add, 30% labor	₱750,546
	Total	₱3,252,366

B.13 UTILITIES

(a) *Power Supply*

1.	Relocation of Electric Poles/Lines (per lot) Affected, installed new lines	₱300,000
2.	Sub-station Equipment, Protective (per lot)	₱1,200,000
3.	Labor Charges 30% of item 2	₱360,000
	Total	₱1,860,000

(b) *Water Supply*

1.	Lump Sum Cost for constructing deep well, storage tanks and pipe lines	₱1,200,000
2.	Materials cost of water pumps (2 ea)	₱280,000
	Total	₱1,480,000

(c) *Sewerage*

(per lot) ₱400,000

B.14 NAVAIDS/AIRPORT LIGHTING

Reference/Sources:

- ANF 5-yr. Development Plan (CY 1990-1994) from the office of the DOTC
- Other (various) information provided by the ATOs Air Navigation Service branch
- Tariff and Customs Code of the Philippines, 1991 (for taxes)

A. VOR (for relocation only)

Labor cost (per lot)	₱300,000
shelter, new 9 m floor area	₱120,000

B. ILS (for relocation only)

Labor cost (per lot)	₱450,000

C. PAPI (new)

Material cost ($110,000)	₱3,080,000
plus taxes @ 20%	₱616,000
Installation Cost	₱100,000

D. Runway/Taxiway Lights (new)

Material cost (per lot)	₱4,800,000
Taxes	₱960,000
Installation Cost	₱400,000

E. Approach Lights, both ends (new)

Material cost/lot	₱3,500,000
Installation cost	₱300,000

F. Lighted Wind Cone, 2 each (new)

Material Cost	₱80,000
Taxes	₱16,000
Installation Cost	₱20,000

B.15 BUILDINGS

Based on plans/drawings and design presented in Volume II, Chapter 3.

(a) Terminal Building

		Area/Qty	Amount	Unit Cost
1.	Flooring - Including finishes	2,400 m²	₱5,477,862	₱2,282/m²
2.	Concrete column, Costing	77 ea	₱2,992,343	₱38,862/ea
3.	Walls and Partitions	-	₱2,804,194	N.A.
4.	Ceiling	3,584 m²	₱4,382,040	₱1,223/m²
5.	Roofing	3,840 m²	₱4,147,200	₱1,080/m²
6.	Doors, Various Types	-	₱767,728	N.A.
7.	Structural Framing	3,584 m²	₱6,798,439	₱1,897/m²
8.	Finish Carpentry	1 lot	₱802,000	N.A.
9.	Electrical	1 lot	₱800,000	N.A.
10.	A/C /Ventilation	1 lot	₱2,540,000	N.A.
11.	Painting	2,200 m²	₱396,000	₱180/m²
12.	Plumbing	1 lot	₱530,000	N.A.
13.	Other Features	1 lot	₱6,392,960	N.A.
14.	Miscellaneous	1 lot	₱713,916	N.A.
	Total			₱39,232,682

A. Terminal Building Floor Area = 2,400 m² Unit cost/m² ₱16,347

(Note: Only significant items are listed herein.)

1. Flooring

1.a	Sub-base (0.15 m thick)	
	0.15 x 2,400 x ₱450/m³ x 1.20% (compact)	₱194,400
1.b	PCCP, 0.15 m thick x 2,400 @ ₱1,784/m³	₱642,240
	Rebars, @ 130 kg/m³ x ₱22/kg	₱1,029,600
1.c	Vinyl Finish, Offices - 530 m² @ ₱650/m²	₱344,500
1.d	Marble Finish, 1,870 m² @ ₱900/m²	₱1,683,000
1.e	Pebble Washout, 800 m² @ ₱400/m²	₱320,000
1.f	Add 30%, indirects	₱1,264,122
Sub-total		₱5,477,862

2. Concrete Cols./Footing - 60 x 60 x 7.8 m

2.a	Concrete footing 1.80 x 1.80 x 0.40 x 77 ea @ 1,784/m^3	₱178,029
2.b	Concrete 0.6 x 0.6 x 7.8 x 77 ea x ₱1,784/m^3	₱385,729
2.c	Rebars @ 250 kg/m^3 x ₱22/kg	₱1,738,044
2.d	Add, 30%	₱690,541
Sub-total		₱2,992,343

3. Walls

3.a	Cement Plastered Finish 850 m^2	₱510,694
	- Wall Footing 0.60 x 0.60 x 30 x ₱1,784/m^3	₱57,802
	Rebars @ 250 kgs/cum x ₱22/kg	₱178,750
	- CMU, 12 pieces/m^2 @ ₱12 ea	₱144
	- Mortar 0.03 m^3/m^2 @ ₱1,783/m^3	₱54
	- Rebars, 2.3 kg/m^2 @ ₱22/kg	₱51
		₱248
	Add 30% Indirects	₱74
		₱323
3.b	Tempered Glass - 340 m^2 @ ₱3,600/m^2	₱1,224,000
3.c	Plywood Partitions, DBL Wall, Marine Ply 310 m^2 @ ₱3,000/m^2	₱930,000
3.d	Arch - Reinforced Concrete vol. 30 m^3 @ ₱1,784/m^3 plus reinforcements	₱139,500
Sub-total		₱2,371,022

4. Ceiling

4.a	Acoustical Finish 600 m^2 @ ₱700/m^2	₱420,000
4.b	Plywood with textured spray 1,800 m^2 @ ₱850/m^2	₱1,530,000
4.c	Spandrel Type Metal 1,184 m^2 @ ₱1.200/m^2	₱1,420,800
4.d	Add, 30%	₱1,011,240
Sub-total		₱4,382,040

5. Roofing (3,840 m^2)

5.a	Long Span, pre-painted @ ₱600/m^2	₱2,304,000
5.b	Insulation, Blanket @ ₱480/m^2	₱1,843,200
Sub-total		₱4,147,200

6.	Doors		
	6.a	Aluminum Roll-up Doors, 6 m x 2.4 m, 9 ea @ 3,600/m²	₱466,560
	6.b	Hollow Core Doors, 12 ea @ ₱5,000	₱60,000
	6.c	Glass Doors, 7 ea @ ₱9,200	₱64,000
	6.d	Add, 30% Indirect	₱177,168
	Sub-total		₱767,728
7.	Structural Framing (110 tons)		₱ 6,798,439
	7.a	Fabricate/Install, @ 31 kg/m² for 3,584 m² @ ₱60/kg	₱6,666,240
	7.b	Painting/Coating @ 350 sq.ft/ton paint coverage for 110 ton @ ₱1,200/m²	₱132,199
8.	Finish Carpentry Counters x shelves (per lot)		₱802,000
9.	Electrical 2,400 m²) C.O. @ 0.60/m² @ ₱200/c.o.		₱800,000
10.	A/C		₱1,740,000
	10.a	cu.ft. of space for airconditioning = 50,000 cu.ft.	
	10.b	BTU H/cu.ft. = 58,000 cu.ft. x 12 BTU Tons refrigeration = $\frac{58,000}{12,000}$ BTU/cu.ft = 58 tr @ ₱30,000/ton ref x 58	
	Ventilation		₱800,000
11.	Painting - Walls 2,200 m²		
	11.a	Rate of 25 m²/gal @ x 2 coats ₱1,250/m²	₱220,000
	11.b	Add labor cost 80%	₱176,000
	Sub-total		₱396,000
12.	Plumbing (materials includes installation cost)		
	12.a	No. of Fixtures @ ₱36,000/fixture x 12	₱432,000
	12.b	Water System (per lot)	₱98,000
	Sub-total		₱530,000

13. Other Features

13.a	Security Check Counters/X-ray detectors (per lot)	₱1,200,000
13.b	PA System/Intercom (per lot)	₱1,192,960
13.c	Fire Protection System (per lot)	₱2,000,000
13.d	Conveyors for baggage (per lot)	₱2,000,000
Sub-total		₱6,392,960

14. Miscellaneous (per lot)

14.a	Form works	
14.b	Ceramic tile finish on toilets	
14.c	Toilet partitions	
14.d	Windows	
14.e	Signage	
14.f	Building Septic Vault	
Sub-total		₱713,916

(b) Cargo Terminal Building (360 m²)

(Note: Some unit cost here were the same as the terminal building)

1.	Flooring 360 m² @ ₱2,800/m²	₱1,008,000
2.	Walls 950 m² @ ₱600/m²	₱570,000
3.	Roofing (same material as walls) ₱960 m²	₱576,000
4.	Structural Framing 360 m² @ ₱2,728/m²	₱982,000
5.	Electrical 250/m²	₱90,000
6.	Aluminum Doors 3.2 x 5.6 3 m high x 4 ea @3,600/m²	₱260,000
7.	Other Features, weigh scale, bin racks freezer/cooler, telephone system	₱600,000
8.	Miscellaneous	₱120,000
9.	Sprinkler System (per lot)	₱800,000
Sub-total		₱5,007,000

Unit cost/m² ₱13,908

(c) Operations Buildings (525 m²)

This building, less special features of Cargo Terminal, @ ₱11,800/m²

₱6,195,100

(d) *CFR Building (2 storey, 450 m²)*

This building, 1st storey @ 18 m x 18 m,
2nd storey, 7 x 18 m @ ₱11,800/m² ₱2,950,000

(e) *Control Tower (325 m²)*

5-storey building with control cab @ the top level.
15 m x 15 m 1st level, 5 m x 5 m rest.

Structure, 325 m² @ ₱11,800/m² ₱3,385,000

Equipment, Purchase of

- Weather Instrument ₱2,500,000
- Communication Equipment, 8 CHL voice logging 4 transmitter VHF and 4 ea receiver, 2 ea High Frequency SSB Transceiver, 1-set intercom ₱700,000

Sub-total ₱7,035,000

(f) *Power Plant Building (60 m² @ ₱11,800/m²)*

Reinforced concrete roof slab ₱708,000

Plus equipments (generator, pump, switch gear) ₱200,000

Sub-total ₱908,000

Table B-1
SUMMARY OF UNIT RATES

Item No.	Item Description	Unit of Measure	Foreign Component		Local Component						Financial Cost	
					Labor		Taxes		Others			
			%	Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost
I.	Earthworks											
	Clearing/Grubbing	ha	39	11,271	20	5,780	20	5,780	21	6,069	100	28,900
	Stripping	cu.m.	37	21	23	13	18	10	22	13	100	58
	Excavation	cu.m.	39	37	19	18	20	19	22	21	100	94
	Borrow Fill	cu.m.	38	74	28	55	19	37	15	29	100	195
	Sub-grade Preparation	sq.m.	38	2	20	1	19	1	23	1	100	4
II.	Runway, 45 m wide	LM	40	19,240	19	9,139	20	9,620	21	10,101	100	48,102
III.	Apron, 125 m x 200 m	sq.m.	40	465	19	221	20	222	21	244	100	1,163
IV.	Taxiway, 23 m	LM	40	12,389	19	5,885	20	6,194	21	6,504	100	30,973
V.	Control Tower											
	Building, 5 storey	sq.m.	37	4,366	30	3,540	18	2,124	15	1,770	100	11,800
	Equipment	Lot	41	1,312	25	800	20	640	14	448	100	3,200
VI.	NAVAIDS											
	VOR (Relocation only)	Lot			70	294	18	76	12	50	100	420
	ILS (Relocation Only)	Lot			70	315	18	81	12	54	100	450
	PAPI	Lot	43	1,632	25	949	20	759	12	456	100	3,796
VII.	Airfield Visual Aids											
	Runway Edge Lights	Lot	43	2,649	25	1,540	20	1,232	12	739	100	6,160
	Approach Lights	Lot	43	1,634	25	950	20	760	12	456	100	3,800
	Lighted Wind Cone	ea	43	25	25	15	20	12	12	7	100	58
VIII.	CFR Facilities											
	Building	sq.m.	37	4,366	30	3,540	18	2,124	15	1,770	100	11,800
	Equipment	Lot	41	3,280	12	960	20	1,600	27	2,160	100	8,000
IX.	Airport Buildings											
	Terminal Building	sq.m.	37	6,048	30	4,904	18	2,942	15	2,452	100	16,347
	Operations Building	sq.m.	37	4,366	30	3,540	18	2,124	15	1,770	100	11,800
	Cargo Terminal	sq.m.	37	5,146	30	4,172	18	2,504	15	2,086	100	13,908
	Power Plant	sq.m.	37	4,316	30	3,500	18	2,100	15	1,750	100	11,666
X.	Site Improvements											
	Drainage Lines	Lot	37	1,288	13	452	20	696	30	1,044	100	3,480
	Access Roads, 2-Lane, 7.30 m wide	km	37	1,255,590	19	644,762	20	678,697	24	814,437	100	3,393,486
	Service Roads, 6.10 m, wide	km	37	855,248	19	439,181	20	462,296	24	554,755	100	2,311,480
	Perimeter Fence	LM	25	65	23	60	19	49	33	85	100	259
	Landscaping/Turfing	Lot	10	295	29	854	20	589	41	1,207	100	2,945
XI.	Automobile Parking	sq.m.	37	147	19	75	20	79	24	95	100	397
XII.	Utilities											
	Power Supply	Lot	32	595	19	353	18	335	31	577	100	1,860
	Water Supply	Lot	32	474	19	281	18	266	31	459	100	1,480
	Sewer Line	Lot	32	128	19	76	18	72	31	124	100	400
XIII.	Land Acquisition	ha					10	30,000	90	270,000	100	300,000
XIV.	Relocation Cost	ea					20	1,860	80	7,440	100	9,300

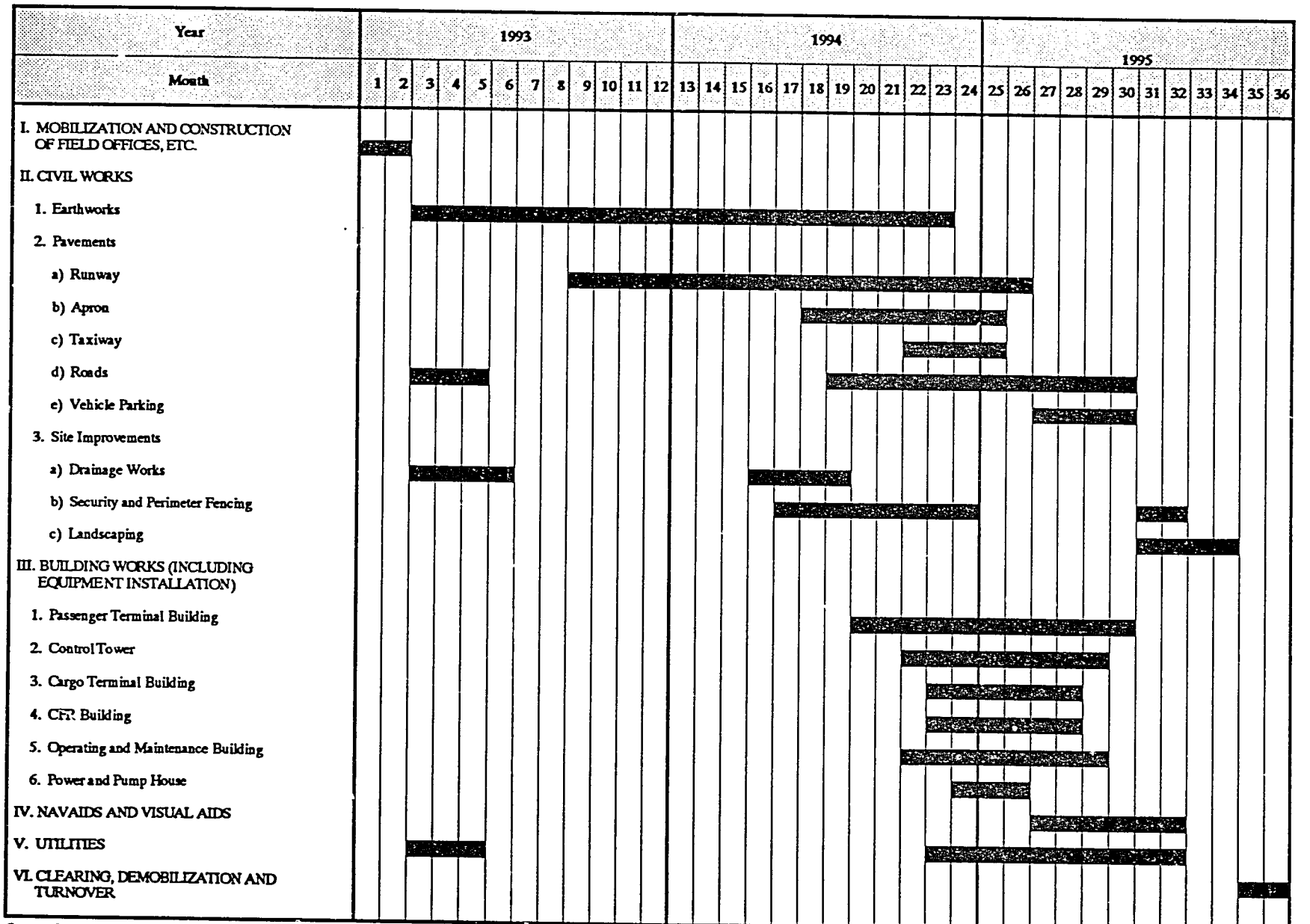
Source: Consultant's estimates

Table B-2
CONSTRUCTION COST ESTIMATE
LAGUINDINGAN SITE
(Financial Costs in Thousands of Pesos)

Item	Description	Unit	Quantity	Cost Components			Financial less Taxes	Financial Cost
				Foreign	Local	Taxes		
1.	Earthworks							
	• Clearing/grubbing	ha	85	958	1,008	491	1,966	2,457
	• Stripping	m^3	36,610	769	972	382	1,741	2,123
	• Excavation	m^3	1,891,910	69,413	72,596	34,339	142,009	176,348
	• Borrow fill	m^3	458,359	33,918	38,860	16,602	72,778	89,380
	• Sub-grade preparation	m^2	201,950	303	343	162	646	808
2.	Runway, 45m wide	lm	2,500	46,225	46,227	23,113	92,452	115,565
3.	Apron, 125m x 200m	m^2	25,000	14,675	14,665	7,335	29,340	36,675
4.	Taxiway, 23m wide	lm	413	4,796	4,796	2,398	9,592	11,990
5.	Control Tower							
	• Building, 5 storey	m^2	325	1,419	1,726	690	3,145	3,835
	• Equipment	lot	1	1,312	1,248	640	2,560	3,200
6.	NAVAIDS							
	• VOR (relocation)	lot	1	0	344	76	344	420
	• ILS (relocation)	lot	1	0	369	81	369	450
	• PAPI	lot	1	1,630	1,407	759	3,037	3,796
7.	Airfield Visual Aids							
	• Runway edge lights	lot	1	2,649	2,279	1,232	4,928	6,160
	• Approach lights	lot	1	1,634	1,406	760	3,040	3,800
	• Lighted wind cone	ea	2	50	42	24	92	116
8	CFR Facilities							
	• Building	m^2	250	1,092	1,327	531	2,419	2,950
	• Equipment	lot	1	3,280	3,120	1,600	6,400	8,000
9	Airport Buildings							
	• Passenger terminal	m^2	2,400	14,515	17,657	7,061	32,172	39,233
	• Operations	m^2	525	2,292	2,788	1,115	5,080	6,195
	• Cargo terminal	m^2	360	1,853	2,253	901	4,106	5,007
	• Power plant	m^2	60	259	315	126	574	700
10.	Site Improvements							
	• Drainage	lot	1	1,288	1,496	696	2,784	3,480
	• Access road, 7.3m wide	km	13	16,323	18,969	8,823	35,292	44,115
	• Service roads, 6.1m wide	km	1	770	894	416	1,664	2,080
	• Perimeter fence	lm	9730	632	1,411	477	2,043	2,520
	• Landscaping/turfing	lot	1	295	2,061	589	2,356	2,945
11.	Vehicle Parking	m^2	8,200	1,205	1402	648	2,607	3,255
12.	Utilities							
	• Power supply	lot	1	595	930	335	1,525	1,860
	• Water supply	lot	1	474	740	266	1,214	1,480
	• Sewer	lot	1	128	200	72	328	400
	Total Construction Cost			224,752	243,851	112,740	468,603	581,343
	Contingencies, 10%			22,475	24,385	11,274	46,860	58,134
	Engineering & Supervision, 8%			17,980	19,508	9,019	37,489	46,507
	Land Acquisition	ha	167		45,090	5,010	45,090	50,100
	Relocation Cost	ea	190		1,414	353	1,414	1,767
	Total Amount			265,207	334,248	138,396	599,456	737,582

Source: Consultant's estimates

Table B-3
GENERAL CONSTRUCTION SCHEDULE



Source: Consultant's estimates

ANNEX C

DRAFT SCOPE OF WORK

DETAILED DESIGN SERVICES AND CONSTRUCTION SUPERVISION CAGAYAN DE ORO-ILIGAN AIRPORT

C.1 BACKGROUND

C.1.1 It is the policy of the Government of the Philippines (GOP) to spread industrialization to rural areas with high potential for the development. In keeping with this policy the GOP approved the Cagayan de Oro Special Development Project which aims to contribute to regional development by attracting new industries and investments to Region X, Northern Mindanao.

One of the essential infrastructure necessary for the development of the Cagayan de Oro-Iligan Corridor into an industrial/agro-industrial center is the construction of a new airport at Laguindingan to accommodate the anticipated air traffic, both passenger and cargo, and at the same time ensure safe and efficient aircraft operation.

C.1.2 The 1991 Cagayan de Oro-Iligan Airport Feasibility Study and Master Plan was conducted to identify and select a technically feasible, economically justified, socially sound and cost effective implementation plan for improving and upgrading the airport facilities serving the Cagayan de Oro-Iligan Corridor. The Final Report showed the need for implementation/construction of the following:

- Runway - 2,500m x 45m, expandable to 3,000m
- Taxiway - two 206m x 23m
- Apron - 125m x 200m
- Access Roads - 13 km
- Vehicle Parking/Circulation - 240 spaces
- Passenger Terminal Building - 40m x 60m
- Cargo Terminal Building - 18m x 18m
- CFR Building - 18m x 18m
- Operations and Maintenance Building - 15m x 35m
- Control Tower (CAB) - 15m x 15m (5m x 5m)
- Power and Pump House - 6m x 10m

- Elevated Concrete Water Tank - 10,000 gallons
- Aircraft Fuel Farm - 40,000 gallons, w/hydrant system
- NAVAIDS - VOR, ILS (Category 1), SALS, RVR, PAPI, DME, Lighted Windcone

C.1.3 Location of the Project

The project location is in the Municipality of Laguindingan, Misamis Oriental Province, Northern Mindanao, approximately 30 kilometers NNW of Cagayan de Oro City.

C.1.4 Proponent Agency

The Department of Transportation and Communications, Air Transportation Office, hereinafter referred as "DOTC/ATO", is the proponent agency for this project.

C.2 SCOPE OF SERVICES

In the implementation of the activities outlined in Section C.1.2 above, the Consultant for the detailed design and construction supervision, hereinafter referred to as "Consultant", is responsible in the performance of the following activities:

C.2.1 Detailed Design Services

C.2.1.1 Review and Update of Feasibility Report

The Consultant shall review and, if necessary, revise the findings and recommendations embodied in the 1991 Cagayan de Oro-Iligan Airport Feasibility Study Final Report. The Consultant shall be solely responsible for the analysis and interpretation of all data contained therein, and for its findings, conclusions and recommendation resulting therefrom.

C.2.1.2 Topographic Surveys

Preliminary topographic surveys were conducted in early 1991, the result of which is included in the 1991 Cagayan de Oro-Iligan Feasibility Study Final Report. The data contained therein may be applied to the preliminary engineering designs, however, the Consultant is required to conduct a thorough topographic and drainage survey on which to base the detailed design and the proposed airport construction.

C.2.1.3 Soils Investigation and Testing

The Consultant shall perform extensive seismic and subsurface soils surveys of the Laguindingan site. The Consultant shall perform a thorough analysis of the soil characteristics on the airport site for the planning of the grading, drainage and subdrainage systems and for designing pavements and base courses. The Consultant shall determine and consider the effects of any expansive clays and solution cavities in the design and their resulting cost implications.

C.2.1.4 Detailed Engineering

A. Design

Upon completion of the review of available data and information relating to the design of the airport facilities, the Consultant shall prepare and submit for DOTC/ATO approval the preliminary design proposals prior to working on the detailed design of any of the airport facilities. For this purpose, the Consultant shall submit a Preliminary Design Report which shall include findings of the Consultant based on field investigation, design criteria, layout plan of the facilities, and alternative designs analyzed, as well as the recommended designs and comparative cost estimates.

Upon DOTC/ATO approval of the Preliminary Design, the Consultant shall perform detailed engineering designs and prepare contract plans, and documents in sufficient detail as to form a reasonable basis for competitive international bidding and the actual construction of the airport facilities. This shall include, but not limited to, preparation of detailed layout, designs, cost estimates, plans and drawings for all airport facilities.

The Consultant, in coordination with the DOTC/ATO, shall prepare property acquisition plans showing the limits of the necessary right-of-way.

The design of the structures shall take into full account and provide adequate resistance against the likely seismic level in the project area.

B. Technical Specifications

The Consultant shall prepare the complete technical specifications for the project. The specifications shall consider the most economical, effective and widely accepted engineering concepts and standards consistent with the need for efficient operation of the airport.

C. Quantity and Cost Estimates

The Consultant shall prepare a detailed Bill of Quantities based on the final scheme approved by DOTC/ATO. The cost of construction, broken down into foreign exchange and local currency costs shall be prepared. The unit price for each item shall be established through a detailed analysis of the cost of equipment, materials, labor, overhead, etc. required to complete each work item.

The foreign currency component shall include the cost of:

1. acquisition of imported materials, equipment and supplies
2. identifiable foreign component of domestic materials to be used
3. wages of expatriate personnel, and
4. overhead and profit of foreign firms.

The local currency component shall include the cost of:

1. right-of-way acquisition
2. domestic materials and supplies
3. taxes
4. wages of domestic personnel, and
5. overhead and profit of local firms.

The total foreign and local currency requirement for each year (broken down into quarterly expenditures) over the expected duration of the project shall be prepared by the Consultant.

D. Schedules

The Consultant shall prepare a construction schedule for the project. Where items of work are divided into several contract packages, a detailed schedule for each contract package shall be prepared by the Consultant. The construction schedule shall include, but not be limited to, the procurement schedule of major materials and equipment.

The Consultant shall take into account the climatic conditions in the project area in the preparation of construction schedules.

E. Tender Documents

The Consultant, subject to the approval of DOTC/ATO, may divide the project into several contract packages.

The Consultant shall prepare all necessary tender documents, including detailed drawings to illustrate all construction details for the construction of the airport facilities, and the required tender documents for the execution of the construction of such facilities, as well as the procurement of necessary equipment and materials.

The tender documents shall include, but not be limited to, the following:

1. Instruction to Bidders: general information, list of minimum equipment required, work schedule, form of guarantees;
2. tender form;
3. general conditions of contract;
4. form of contract;
5. special conditions of contract, if any;
6. technical specifications for the execution of the works, and;
7. schedule of bid items including work and materials.

In addition to the preparation of necessary designs and tender documents for the execution of the project, the Consultant shall provide the necessary services for the prequalification of contractors for each contract package, including the preparation of necessary documents for the invitation of applications and questionnaires for such prequalification, and the evaluation of such applications with recommendations regarding the capability of prospective bidders to undertake the construction of the required works for the project.

A Draft Prequalification Document including the invitation and questionnaires shall be prepared and submitted by the Consultant to the DOTC/ATO for review and approval. The Final Prequalification Document which appropriately incorporated the comments of DOTC/ATO shall be the one handed down by the Consultant to the prospective bidders. The final decision regarding the acceptability of each tenderer rests with the DOTC/ATO.

F. Tendering

The Consultant, subsequent to the prequalification of contractors shall, upon receipt of the authorization to proceed from DOTC/ATO, provide necessary services for the invitation of tenders, evaluation of tenders and recommendations for the award of contract(s) to the most deserving bidder(s). The Consultant shall prepare and submit to the DOTC/ATO a detailed Tender Evaluation Report and the recommendation for the award of contract within one month of the closing date of tenders. The authorized representative of DOTC/ATO shall be present during the opening of bids. The DOTC/ATO retains the right of final decision in the acceptance of any tender.

The Consultant shall assist DOTC/ATO during contract negotiations and, in coordination with DOTC/ATO, prepare and finalize all contracts relating to the carrying out of works for the project.

C.2.2 Construction Supervision

During the construction stage of the project, the Consultant shall perform the following:

C.2.2.1 Provide necessary services for the supervision of the construction of the project facilities and the procurement and installation of equipment and materials to ensure completion of all works within the time allowed in each contract and to ensure that the conditions of the contracts are satisfactorily adhered too.

C.2.2.2 Review and/or approve, as appropriate, manufacturer's drawings and/or contractor's proposals relating to the construction of the project facilities and the procurement of equipment and materials.

C.2.2.3 Prepare all necessary work orders authorizing changes in the work, including altering plans and specifications, negotiating new or revised unit prices, and other related activities, for approval by DOTC/ATO.

C.2.2.4 Review, evaluate, and make recommendation to the DOTC/ATO on all proposals for changes by the Contractors.

C.2.2.5 Prepare any further designs and supply all necessary working drawings to the contractors for satisfactory execution of the works including those made necessary as a result of any modifications and/or alterations in the original tender documents.

C.2.2.6 Review as necessary, the location and alignment of all works as laid out by the construction contractors and recommend acceptance or rejection of the works as constructed and equipment/materials procured.

C.2.2.7 Recommend acceptance or rejection of the materials to be used or incorporated into the works, to test such materials and to verify, if necessary, manufacturers certificates as presented by the contractors.

C.2.2.8 Issue interim payment certificates, certificates of completion, final payment certificates and maintenance certificates in accordance with the conditions of the contract.

C.2.2.9 Assist in settling disputes or differences in opinion which may arise between the client and the contractors, excepting litigation and arbitration.

C.2.2.10 Perform all other duties as necessary and incidental to the satisfactory execution of the Project.

C.2.2.11 Deliver to DOTC/ATO upon completion of the works all job records, reproducible "as built" drawings and the instructions necessary for the satisfactory operation and maintenance of the works.

C.2.2.12 The Consultant shall provide any additional services related to the project upon request, subject to the approval of DOTC/ATO, on the basis of justifiable and mutually acceptable billing rates/costs.

C.2.3 Other Related Activities

C.2.3.1 Monthly Progress Reports

The Consultant shall keep DOTC/ATO fully informed on all matters relating to the implementation of the project at all stages, including at the time of investigations, preparation of design and tender documents, construction supervision, etc., through Monthly Progress Reports and other special reports as necessary, Monthly Reports shall be submitted as early as possible and in no case later than the first week of the following month.

C.2.3.2 Contract Completion and Project Completion Reports

Within one month after the issuance of the completion certificates for each contract, the Consultant shall submit a Contract Completion Report. At the completion of the project, the Consultant shall prepare a Project Completion Report providing details of project implementation, costs, benefits and relevant information in a format acceptable to DOTC/ATO. One year after project completion, the Consultant shall submit a Maintenance Completion Report summarizing the conditions of the facilities and any remedial measures which need to be taken.

C.3 RESPONSIBILITY OF THE CONSULTANT

The Consultant shall be responsible for all decisions relating to the suitability of the proposed designs, drawings and specifications of works for the project facilities, including supervision during construction of such works, and administrative and technical control of all relating contracts. DOTC/ATO, however, reserves the right to override the decision of the Consultant in any matter relating to the execution of the Project; and for all such overriding decisions shall bear the related legal and/or financial responsibility.