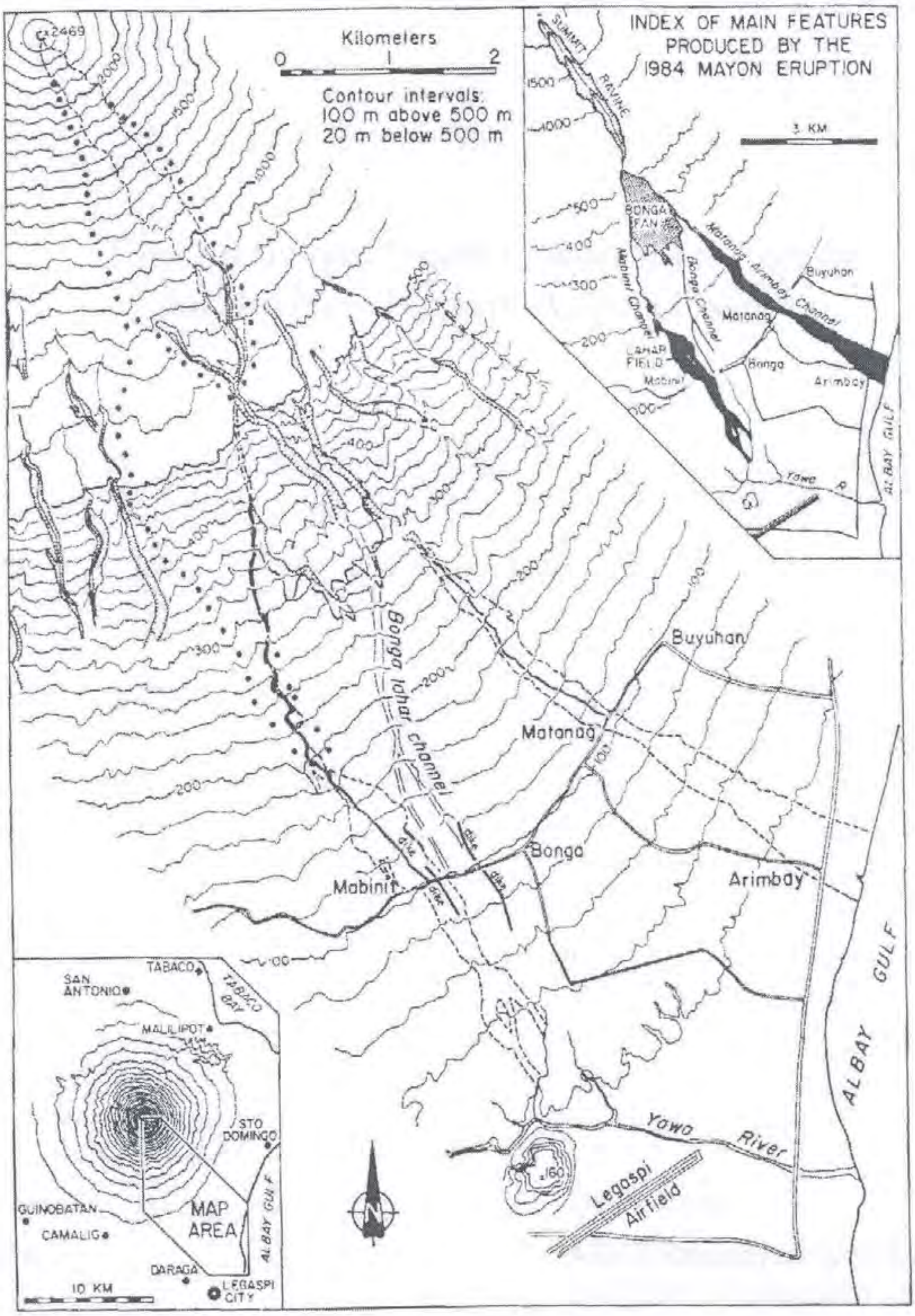

Fig. 2.5-4 Pre-eruption Topography of the Summit Ravine Bonga Fan sector of Mayon Volcano

Ashfalls during eruptions of the volcano are generally experienced in the municipalities of Camalig, Guinobatan and Ligao in the southwest, and in Tabaco in the northeast (**Figure 2.5-5**). This phenomenon is caused by the predominant wind drift around the volcano in the NE direction during the months of October to June, and in the SW direction during the months of July to September. However, Legaspi City experienced considerable ashfalls during past eruptions, particularly in the 1897, 1984 and 1993 eruptions.

2.5.3 Noise

In the absence of a definitive noise standards for aircraft operations in the Philippines, USFAA Regulation (FAR 150), identifies compatible land uses based on day-night sound levels. It specifies a yearly day-night average sound level of less than 65 dB for residential, schools and hospitals. For comparison, a jet aircraft taking-off nearby registers at least 140 dB, which is more than the human threshold of 120 dB for pain but lower than 150 dB which is known to rupture the human eardrum.

The noise pollution that will be generated by the landing and take-off of aircraft will be a critical issue in the future since the areas within the immediate vicinity of the airport is experiencing steady growth in population and commercial activities. Over a period of eight years (1990-1998), an average of 37 hectares of agricultural land per year were converted to urban use. Barangay Bagtang with many residential structures and where Rwy 06 is located will be most affected by aircraft noise.

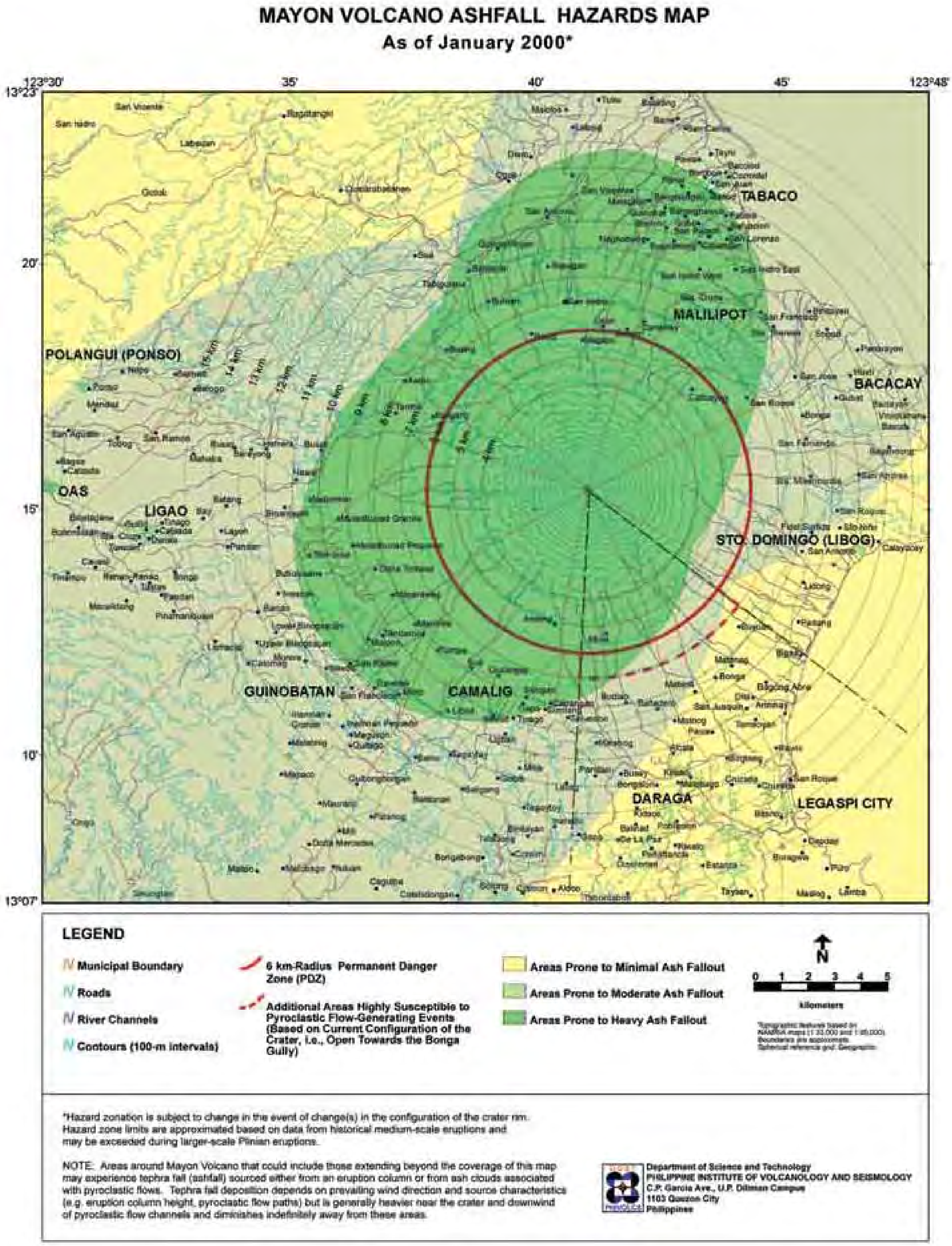

Fig. 2.5-5 Mayon Volcano Ashfall Hazard Map (January 2000)

Chapter 3 AIR TRAFFIC DEMAND FORECAST

3.1 INTRODUCTION

3.1.1 Previous Studies

The most recent attempt to forecast the magnitude of aviation activities in Legaspi Airport was the study done by ECFA in 1997. The result of the forecasting exercise done is summarized in **Table 3.1-1**, indicating an estimated passenger volume of more than 270,000 and a cargo volume of 1,500 tons for year 2000.

Table 3.1-1 Previous Forecast of Air Traffic Demand

Year	PHI		LEG	
	Passenger	Cargo (tons)	Passenger	Cargo (tons)
2000	18,496,000	258,100	276,000	1,500
2005	25,192,000	329,400	375,000	1,900
2010	30,885,000	400,800	460,000	2,300
2015	36,073,000	472,200	537,000	2,700

Source: ECFA Study 1997

Historical records, however, have shown that the passenger movement at the existing Legaspi Airport has decreased to 100,000 in the year 2000 from 174,000 in 1997. The performance in air cargo has shown a similar trend (**Table 3.1-2**). Both passenger and cargo forecasts have not shown the rates of increase anticipated in the earlier study. This highlights the need to update the forecast, taking into consideration the recent trends and developments.

Philippine Airlines is currently providing one daily, plus three additional return flights, per week between Manila and Legaspi, using B737 aircraft at one-way air fare of PhP2,418. Meanwhile, two daily services costing PhP 300 to 380 are provided by the Philippine National Railways and more frequent bus services are available at a one-way cost of approximately PhP 400. Competition with land transportation partly explains the observed trends in traffic.

Table 3.1-2 Actual Passenger Volumes

Year	PHI		LEG	
	Passenger	Cargo (tons)	Passenger	Cargo (tons)
1990	8,197,482	347,117 (1991)	142,179	470 (1991)
1995	10,853,335	488,366	154,623	939
2000	12,921,728	553,159	100,098	428

Source: ATO

In 2001, DOTC commissioned a nationwide survey, which resulted in, among others, an estimate of dominant trip directions using air transportation. The Origin–Destination Survey conducted during that year highlighted the predominant travel directions in the Bicol Region, confirming the importance of Albay (site of Legaspi Airport) as the main origin and destination within the Region. In terms of trip desires, Albay is followed by Camarines Sur, where Naga Airport is situated. **Table 3.1-3** indicates that, apart from Manila and possibly Cebu, there is no other significant origin and destination associated with Legaspi Airport.

Table 3.1-3 Trip Origin-Destination (Percentage)

O/D		DESTINATIONS									
		1	2	3	4	5	6	7	8	9	TOTAL ORIGINS
ORIGINS	1. Manila		7.58		0.33	0.38	0.07	0.15	0.05	28.42	36.98
	2. Cebu	12.33			0.10	0.02				6.61	19.06
	3. C.Norte									0.02	0.02
	4. C.Sur	0.08								0.05	0.13
	5. Albay	0.92								0.20	1.12
	6. Sorsogon	0.17	0.02							0.02	0.20
	7. Masbate	0.02									0.02
	8.Catanduanes									0.02	0.02
	9. Total Other Provinces	25.67	4.34		0.10	0.25		0.02	0.03	12.05	42.46
	TOTAL DESTINATIONS	39.19	11.93	0.00	0.53	0.65	0.07	0.17	0.08	47.38	100.00

3.1.2 Forecast Methodologies

The performance of various forecasting methodologies applied in the past is summarized in **Table 3.1-4**. Among the various projections, the NAASP Forecast using Econometric Modeling appears to have closely predicted the actual traffic, although a systematic underestimation is clearly evident. It seems that both complex econometric models and simple trend projections used in the past have resulted in about the same level of prediction performance.

Table 3.1-4 Comparison of Forecast Methodologies

YEAR	CAMP (1992)	NTPP (1980)	JAC (MACTAN MODEL)	ECFA (1997)	NAASP (1979)	ACTUAL
1980					70,498	69,791
1986					82,650	131,788

YEAR	CAMP (1992)	NTPP (1980)	JAC (MACTAN MODEL)	ECFA (1997)	NAASP (1979)	ACTUAL
1990	175,343	163,545	136,132		94,832	142,179
1995	246,601	221,550	253,447			154,623
2000	317,827	279,556	472,081	276,000		100,098
Method	Time-Series Decomposition	Trend Projection	Econometric Model (GRDP, Population)	Econometric Model	Econometric Model	
Mean Absolute Deviation	114,290	89,250	154,920	175,902	33,030	
Mean Square Error	18,988,573,607	12,380,301,016	49,391,367,158	30,941,513,604	1,660,459,058	
Mean Absolute Percentage Error	100.11%	79.20%	146.59%	175.73%	24.37%	

The forecasting methodology adopted in the current exercise recognizes the past trend as well as the overall role of Legaspi in the regional and national network of airports. It involves a three-step process requiring first a prediction of the national and regional passenger volume as input to a paired passenger movement estimate to and from Legaspi. The share of potential Legaspi Airport passenger traffic is then estimated as a fraction of the total national or regional estimate of passenger traffic volume, estimated using econometric models. Finally, the peak-hour passenger and aircraft movement is estimated by analyzing the daily traffic record over the last two years.

The various graphs of Legaspi's passenger share shown in Chapter 2 indicate that the long-term variation can be assumed to represent a stationary time series focused around a particular value. A stationary time series is characterized by observations that can be represented by a constant plus a random fluctuation. In essence, each time series datum of traffic volume at any time, designated as $\boldsymbol{V_t}$, can be represented by two components, to wit:

$$\boldsymbol{V_t} = \mu + \varepsilon_t$$

Where μ = unknown constant corresponding to the mean of the series, and

ε_t = random error

Instead of utilizing an estimated passenger share based on an average over the past, an exponential smoothing equation is used to adjust a previous forecast by a fraction of the previous forecast error to obtain the current forecast. The exponential smoothing equation is given by

$$F_t = F_{t-1} - \alpha\varepsilon_{t-1},$$

Where, F_t = forecast in period t

F_{t-1} =forecast in period t-1

α = smoothing constant

ε_{t-1} = observed forecast error at time t-1

The passenger volume for the entire domestic and NCR (the most significant airport pair for Legaspi, refer to Inception Report Feb 2002) are estimated using econometric models. A summary of the model-building exercise is provided in the Annex.

3.2 ANNUAL PASSENGER TRAFFIC FORECAST

3.2.1 Forecast Air Passenger Volume at Legaspi Airport

The estimated total domestic passenger traffic volumes for NCR and the entire Country are shown in **Table 3.2-1**. Based on an extensive review of past modeling exercises, it seems that the most significant variable to explain the variation in air passenger traffic has been the population of the airport hinterland. The current modeling exercise looked into a wide range of variables and finally opted to limit consideration to population as the explanatory variable, due to problems on statistical data multicollinearity and the issue of model parsimony. Using a 20-year time series data beginning in 1980, the resulting models in shifted forms are:

For MNL : PAX = 1.23(POPNCR – 5,053,341.41), Multiple R = 0.96

For PHI : PAX = 0.34(POPPHI-36,118,392.47), Multiple R = 0.97.

Table 3.2-1 Forecast Of Domestic Air Passenger Volumes (NCR and Philippines)

YEAR	DOMESTIC NCR	TOTAL DOMESTIC
2000	5,959,595	13,346,697
2005	6,996,760	15,519,780
2010	7,912,460	17,436,360
2015	8,738,510	19,219,060
2020	9,492,980	21,011,610
2025	10,108,390	22,719,660

For Legaspi Airport, the forecast of low, medium and high air passenger volume estimates are shown in **Table 3.2-2**. Under the medium forecast, it is estimated that Legaspi may be serving a potential volume of 217,080 passenger movements in 2015.

Table 3.2-2 Forecast of Domestic Air Passenger Volumes at Legaspi

YEAR	LOW	MEDIUM	HIGH
2005	146,930	175,300	183,360
2010	166,160	196,950	206,010
2015	183,510	217,080	227,070
2020	199,350	237,330	248,250
2025	212,280	256,620	268,430

3.2.2 Allocated Sector Passenger Forecast

As shown in the preceding section, the most significant origins and destinations associated with Legaspi Airport are Manila and Cebu. Using a gravity model with population and sector distance as the parameters, the total estimated passenger movements in Legaspi were allocated to the Legaspi-Manila and Legaspi-Cebu routes. The mathematical form of the allocation model is expressed as:

$$V_{ij} = \lambda\, V^{LGP} \frac{[(P_i / \Sigma P_m) \times (P_j / \Sigma P_m)]}{D_{ij}^{\theta}}, \quad m = i,j$$

Where :

V_{ij} = Air passenger volume between Airport i and Airport j

V^{LGP} =Estimated total air passenger volume at Legaspi for each analysis year

$P_{i,j}$ = Population at hinterland I and j

D_{ij} = Sector distance between I and j

λ,θ = Estimated parameters

The calibrated model results in the route-allocation are summarized in **Table 3.2-3**.

Table 3.2-3 Route-Allocated Annual Air Passenger Traffic Forecast

Year	Population			Sector Air Traffic Volume	
	NCR	Cebu	Albay	MLA-LGP	CEB-LGP
2005	10,737,419	3,251,166	1,287,725	155,444	18,863
2010	11,481,317	3,431,904	1,364,343	173,382	21,226
2015	12,152,388	3,599,851	1,436,547	190,322	23,435
2020	12,765,312	3,772,311	1,514,066	208,623	25,684
2025	13,256,262	3,936,338	1,592,712	227,761	27,867

3.3 ANNUAL AIR CARGO FORECAST

Using the same approach employed in defining the passenger forecast as outlined in the preceding section, the forecast cargo traffic at the Legaspi Airport was derived as a percentage share of the nationwide airport system cargo traffic. Historical data (**Table 3.3-1**) were similarly utilized to define an econometric model with value of domestic production as the explanatory variable.

Table 3.3-1 Historical Cargo Traffic (tons)

YEAR	PHI	NCR	Region V	LEG
1991	347,117	93,036	1,549	470
1992	381,139	82,520	1,473	444
1993	415,639	92,412	1,825	775
1994	428,204	68,512	2,351	936
1995	488,366	89,791	2,230	939
1996	526,277	108,685	2,898	1,013
1997	678,765	115,356	3,089	862
1998	504,096	97,322	2,419	758
1999	510,630	87,107	2,195	771
2000	553,159	125,872	1,501	428

Under the medium-level estimate, Legaspi Airport is anticipated to handle about 2,000 tons of cargo in year 2015 (**Table 3.3-2**).

Table 3.3-2 Forecast Cargo Traffic (tons)

Year	PHI	LEGASPI		
		Low	Medium	High
2005	840,390	870	1,030	1,210
2010	1,182,300	1,230	1,440	1,700
2015	1,609,190	1,670	1,970	2,310
2020	2,163,150	2,250	2,640	3,110
2025	2,882,020	2,990	3,520	4,150

3.4 PEAK-HOUR AIR TRAFFIC VOLUMES

The design of airport facilities is normally based on the volume occurring during the peak-hour on an average day of the peak month. Adjustment factors are derived to translate the forecasted two-way annual air traffic into the design hourly volume.

Using data provided by ATO-Legaspi for the last two years (2000-2001), the peak month was determined to be consistently occurring during the month of May. The average day traffic of the peak month was computed to be 0.375 percent of the annual air passenger volume.

Considering the prevailing flight patterns in Legaspi Airport, the peak hour traffic on an average day of the peak month is about 57.5 percent of the total daily traffic.

The design of airport facilities is based on one-way directional traffic volume considering the direction with the higher percentage of passenger movement. The heavier direction constitutes about 51 percent of the total hourly traffic.

Finally, the design hourly volume is determined by adjusting the one-way peak-hour traffic using a load factor to account for the utilization of available seats. For Legaspi Airport, a load factor of 85 percent is assumed for better utilization of available seating capacity. The computed design hourly volume is shown in **Table 3.4-1**.

Table 3.4-1 Peak-Hour Air Passenger Traffic Forecat

Year	Two-way Air Passenger Traffic	Peak-Month Average Daily Traffic	Peak-Hour Traffic	One-way Directional Traffic	Design Hourly Volume
		ADF=0.00375	PHF=0.575	DF=0.510	Load Factor = 0.85
2005	175,297	657	378	193	227
2010	196,945	739	425	217	255
2015	217,081	814	468	239	281
2020	237,328	890	512	261	307
2025	256,620	962	553	282	332

3.5 FORECAST OF AIR TRAFFIC MOVEMENT

The aircraft fleet of Philippine Airlines (PAL) over the last three (3) years is summarized in **Table 3.5-1**. During the period, increments were noted in the number of B737-300, B737-400, A340-300 and B747-200.

Table 3.5-1 Aircraft Fleet of PAL

Aircraft Model	Sept 1999	Aug 2000	Feb 2001
B747-400	4	4	4
B747-200	0	3	3
A340-300	2	4	4
A330-300	8	8	8
A320-200	3	3	3
B737-400	0	0	3
B737-300	7	9	9
TOTAL	24	31	34

In domestic operations, A330, A320 and B737 will continue to serve as PAL's main fleet. In Legaspi Airport, the short- to medium-term passenger demand will be in the range to be served by medium-sized jet aircraft such as A320-200 and B737. This is reflected in PAL's development requirements over the short-term. **Table 3.5-2** summarizes the indicative timetable of PAL's Airport Development requirements over the short- term period.

Table 3.5-2 PAL Airport Development Requirements

Design Aircraft	Schedule				
	Immediate	1999	2000	2002	2004
A330	Davao Pto.Princesa Gen.Santos			Bacolod(New) Iloilo(New)	C.de Oro Zamboanga
A320	Bacolod(exist) Davao Kalibo **Legaspi**	Cotabato Dumaguete Roxas	Butuan Dipolog		
B737	Naga Tagbilaran				

Until 1996, PAL operated along routes connecting Legaspi to Masbate, Virac, Cebu and Manila. Thereafter all routes, except those connecting Legaspi with Manila and Cebu were discontinued for reasons of declining route profitability. In 1998, PAL eventually discontinued the Legaspi-Cebu leg for similar reasons.

New airlines, however, have started to serve many routes abandoned by PAL. Asian Spirit has been serving similar routes abandoned by PAL using smaller aircraft. This report anticipates that the route connecting Cebu with Legaspi will represent less than 12 percent of the total potential volume of the air passenger traffic in Legaspi (**Table 3.5-3**). It is assumed that this will be served by other airlines.

Table 3.5-3 Air Passenger Volume Per Route

Year	Peak-hour Air Passenger Volume Per Route (One way)			Annual Air Passenger Volume Per Route (Two-way)	
	Total	MLA-LEG	CEB-LEG	MLA-LEG	CEB-LEG
2005	227	203	24	155,444	18,863
2010	255	227	28	173,382	21,226
2015	281	250	31	190,322	23,435
2020	307	273	34	208,623	25,684
2025	332	296	36	227,761	27,867

The aircraft movement is estimated assuming that passenger traffic volumes between 30,000 to 300,000 will be served by small jets in the mold of B737 or A320. Lower volumes will be served by turbo prop aircraft with a seating capacity of about 50-54 passengers. A summary of the forecast annual aircraft movements is given in **Table 3.5-4**.

Table 3.5-4 Forecast Aircraft Movement

Year	Aircraft Type	Seat Capacity	Route Allocated Passenger Movement		Cargo (tons)
			MLA-LEG	CEB-LEG	
2005	Passenger Volume		155,444	18,863	1,030
	SJ	130	1,407		
	TP	54		412	
	Total		1,819		
2010	Passenger Volume		173,382	21,226	1,440
	SJ	130	1,569		
	TP	54		463	
	Total		2,032		
2015	Passenger Volume		190,322	23,435	1,970
	SJ	130	1,723		
	TP	54		511	
	Total		2,234		
2020	Passenger Volume		208,623	25,684	2,640
	SJ	130	1,888		
	TP	54		560	
	Total		2,448		
2025	Passenger Volume		227,761	27,867	3,520
	SJ	130	2,061		
	TP	54		607	
	Total		2,668		

Chapter 4 AIRPORT FACILITY REQUIREMENT

4.1 SUMMARY

In accordance with the relevant provisions of ICAO guidelines and using planning parameters derived from previous projects of the Consultant, the requirements for various facilities were established to optimally address the medium and long-term requirements of Legaspi Airport. Any major improvement for the Legaspi Airport will entail a substantial amount of time for project preparation and implementation. The design year for medium-term development is, therefore, assumed to be at year 2015, allowing at least six (6) years after project completion. Design for long-term development is based on projected requirements for year 2025. A summary of the planning criteria and parameters for the horizontal components of the airport is given in **Table 4.1-1**. The corresponding requirements for vertical components are summarized in **Table 4.1-2.**

Table 4.1-1 Planning Criteria and Parameters (Horizontal Components)

Components	Present Condition	Future Requirements	
	Year 2000	Year 2015	Year 2025
1. Annual Passengers ('1000)	100	217	257
2. Annual Cargo (tons)	400	1,970	3,520
3. Annual Commercial Aircraft Movements	404 (2001)	2,234	2,668
4. Peak-Hour Passengers (2 ways)	285	562	664
5. Peak Hour Aircraft Movements (2 ways)	1	2	3
6. Largest Aircraft	B737	A320	A320
7. Longest Haul	MNL-LEG	ditto	ditto
8. Aerodrome Reference Code	4C	4C	4C(4E)
9. Operational Category	Non-Instrument	Precision Cat. I	Precision Cat. I
10. Runway – Length – Width	2280 m 36 m	2000 m 45 m	2000 m (2,500m) 45 m
11. Runway Strip – Length – Width	2380 m 150 m	2120 m 300 m	2120 m 300 m
12. Taxiway – System – Width	2 stub taxiways	1 stub taxiway 23 m	1 stub taxiway 23m
13. Aircraft Parking Stand	3	2(3)	3

Table 4.1-2 Planning Criteria and Parameters (Vertical Components)

Components	Future Requirements	
	Year 2015	Year 2025
1. Passenger Terminal Building	5,620 sq.m.	6,640 sq.m.
2. Cargo Terminal Building	200 sq.m.	400 sq.m.
3. Administration Building	1,800 sq.m.	1,800 sq.m.
4. Fire Station Building	270 sq.m.	270 sq.m.
5. Access Road	Two-way, Two Lane	Two-way, Two Lane
6. Car Park	6,000 sq.m.	7,000 sq.m.
7. Air Navigation Systems	Cat I ILS	Cat I ILS
8. Rescue and Fire Fighting		
– Category	6	6
– Fire Vehicles	min 2	min 2
9. Public Utilities		
– Power Supply	1200 KVA	1200 KVA
– Water Supply	150 cu.m./day	150 cu.m./day
– Sewage Disposal	150 cu.m./day	150 cu.m./day
– Solid Waste Disposal		
– Telephone Trunk line	75 extensions, 25 trunkline	75 extensions, 25 trunkline
10. Fuel Supply	25 Kl Storage Capacity	50 Kl Storage Capacity

4.2 PLANNING PARAMETERS

4.2.1 General

The physical characteristics of airports to satisfy internationally accepted standards for operational efficiency and safety are prescribed under ICAO Annex 14, among other references. ICAO Annex 14 specifies the minimum configuration and physical characteristics of runway, taxiway and apron in accordance with an aerodrome reference code and approach category of the airport runway.

A set of interrelated planning criteria needs to be considered in determining the required parameters for the airport physical plan. These criteria consist of:

a) design aircraft
b) aerodrome reference code
c) runway dimensions
d) approach category of runway

The aerodrome reference code is a function of the design aircraft that the runway is intended to serve. Approach category of the runway is determined on the basis of anticipated weather conditions (occurrences of low visibility conditions) and intended service grade (acceptable level of flight cancellations and delay) for an airport.

4.2.2 Design Aircraft

In domestic operations, A330, A320 and B737 will continue to serve as PAL's main fleet. At Legaspi Airport, the short to medium-term passenger demand will be in the range to be served by medium-sized jet aircraft such as A320-200 and B737.

A320, which is slightly bigger than B737 should be chosen as the design aircraft for the short- to medium-term development period. However, to provide for unconstrained long-term development, a larger aircraft in the mold of A330 should be considered for airside separation distance requirements. **Table 4.2-1** provides a comparison among these three (3) aircraft models.

Table 4.2-1 Technical Comparisons among Design Aircraft for Legaspi Airport

Criteria	Aircraft Model		
	A320-200	B737-400	A330-300
Max Take-off Weight	67 t	63 t	212 t
Seating Capacity	160-170	150-160	300
Overall Length	37.6 m	36.4 m	63.7 m
Wing Span	34.1 m	28.9 m	60.3 m
Tail Height	11.9 m	11.2 m	17.62 m
Wheel Base	12.64 m	14.3 m	22.1 m
Wheel Track	7.6 m	5.2 m	10.7 m

4.2.3 Aerodrome Reference Code

Table 4.2-2 outlines the provisions of aerodrome reference code of ICAO Annex 14. A320-200 aircraft is categorized as reference code 4C under ICAO Annex 14. The short- to medium-term development plans for the Legaspi Airport should satisfy the minimum requirements for this reference code. For long-term requirements, particularly to provide for operation of larger aircraft such as A330 and B747, airside separation distance requirements of reference code 4E should be taken into account.

A basic runway length of 2,000-m and width of 45-m to cater to the operations of A320 class aircraft should be provided. The possibility of future expansion to 2,500-m may also be examined.

Table 4.2-2 Aerodrome Reference Code of ICAO Annex 14

Code Number	CODE ELEMENT 1 Aeroplane Reference Field Length	Code Letter	CODE ELEMENT 2 Wingspan	 Outer Main Gear Wheel Span
1	Less than 800 m	A	Up to but not including 15m	Up to but not including 4.5m
2	800m up to but not including 1,200m	B	15m up to but not including 24m	4.5m up to but not including 6m
3	1,200m up to but not including 1,800m	C	24m up to but not including 36m	6m up to but not including 9m
4	1,800m and over	D	36m up to but not including 52m	9m up to but not including 14m
		E	52m up to but not including 65m	9m up to but not including 14m
		F	65m up to but not including 80m	14m up to but not including 16m
AERODROME REFERENCE CODE FOR LEGASPI AIRPORT FOR SHORT-TERM DEVELOPMENT : CODE 4C FOR LONG-TERM DEVELOPMENT : CODE 4E				

4.2.4 Approach Category of Runway

Runways are categorized into instrument and non-instrument runways, with the latter intended for aircraft operation using visual approach procedures. Instrument runways are further categorized into:

a) Non-precision Approach Runway
b) Precisions Approach Runway (Categories I to III)

Legaspi Airport is categorized under the Civil Aviation Master Plan as a trunkline airport. Within Region V, it functions as the main airport access, accounting for about 50 % of the total regional passenger volume. In view of this, the airport should be capable of providing efficient, reliable service and for such purpose, one end of the runway should be precision approach equipped with Instrument Landing System (ILS), while the other end may be non-precision instrument approach with directional guidance provided by

VOR/DME. The main and precision approach runway is determined on the basis of prevailing wind direction and occurrences of low visibility conditions.

The wind rose analysis for Legaspi City made by PAGASA based on the data summarized in **Table 4.2-3** indicates the following:

Annual prevailing wind direction is northeasterly, consisting of the North-East (NE, 36.9%) followed by the East-North-East (ENE, 15.6%) and the East (E,15.0%);

Southwest to westerly wind directions account for approximately 25% of the annual occurrences of wind directions; and

Existing runway orientation of 06/24 is confirmed to be optimal in terms of the usability factor determined by wind speeds and direction.

The wind speeds shown are daily averages observed from 5:00 AM to 6:00 PM and every three hours for a period of 10 years. Thus, the occurrence of wind speeds exceeding 8 m/s (approximately 15 knots) may be more frequent than 0.4%. As such, it should not be construed that 99% of the usability factor (wind coverage in case of cross-wind component limitation of 15 knots) would be achievable regardless of the runway orientation.

Table 4.2-3 Wind Direction and Speed Distribution (Legaspi City, 1987-1996)

Speed (m/s)	DIRECTION								
	NNE	NE	ENE	E	SSW	SW	WSW	W	Others	Total
Calm										0.0
1-4	1.2	31.6	14.7	14.8	0.3	8.5	7.8	6.2	4.2	89.1
5-8	1.3	5.2	0.9	0.2	0.0	1.1	1.1	0.4	0.3	10.5
>8	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.4
Total	2.6	36.9	15.6	15.0	0.3	9.7	9.0	6.7	4.5	100.0

Source: PAGASA

In the absence of recorded data regarding the cloud base and visibility, monthly rainy days are correlated with the frequency of wind direction. During the wettest season from October to January (shown in **Table 4.2-4**), the prevailing wind direction is northerly to easterly. It is expected that under low visibility condition the approaches of landing aircraft would be from the southwest (existing Rwy 06). In view thereof, precision approach should be established from the southwest.

Table 4.2-4 Monthly Weather Data (Rainy Days and Frequency of Wind Directions)

Month	Number of Rainy Days	Rainfall (mm)	Frequency of Northerly to Easterly Winds (%)	Frequency of Southerly to Westerly Wind (%)
January	21	321.9	99.3	0.3
February	15	209.7	99.7	0.3
March	16	185.0	98.8	0.3
April	15	161.0	95.9	2.3
May	14	170.5	74.1	21.0
June	17	259.5	54.0	43.1
July	19	179.0	29.4	65.4
August	18	236.1	20.2	73.1
September	19	261.6	27.6	67.9
October	22	353.8	61.5	33.4
November	22	486.3	89.8	6.0
December	24	562.5	96.6	2.2
Annual	222	3,487.0	70.5	26.6

4.3 RUNWAY STRIP AND OBSTACLE LIMITATION SURFACES

4.3.1 Runway Strip

Following ICAO standards, the dimensions of a runway strip for a precision approach runway code number 4 shall, wherever practicable, be made to extend laterally at least to 150 meters on each side of the centerline of the runway. It should extend before the threshold and beyond the end of the runway by at least 60 m. Any object situated on the runway strip, which may endanger aircraft, should be regarded as an obstacle and should, as far as practicable, be removed. Except for visual aids required for air navigation purposes, no fixed object shall be permitted on a runway strip within 60 m of the runway centerline.

4.3.2 Runway End Safety Area

A runway end safety area should be provided at each end of the runway strip. The runway end safety area should extend from the end of runway strip by at least 90 m. The width of the runway end safety area should be at least twice that of the associated runway (i.e., 90 m for the case of Legaspi). An object situated within a runway end safety area, which may endanger aircraft, should be regarded as an obstacle and should, as far as practicable, be removed.

4.3.3 Obstacle Limitation Surfaces

The following obstacle limitation surfaces shall be established, in accordance with ICAO standards, for a precision approach runway category I:

a) Conical surface;
b) Inner horizontal surface;
c) Approach surface;
d) Transitional surfaces; and
e) Take-off climb surface

The following obstacle limitation surfaces are also recommended to be established by ICAO for a precision approach runway category I:

a) Inner approach surface;
b) Inner transitional surfaces;
c) Balked landing surface:

It is recommended that existing objects above these surface should, as far as practicable, be removed except when an object is shielded by an existing immovable object, or the object would not adversely affect the safety or regularity of aircraft operation. The dimensions of obstacle limitation surfaces are shown in **Figure 4-3-1**.

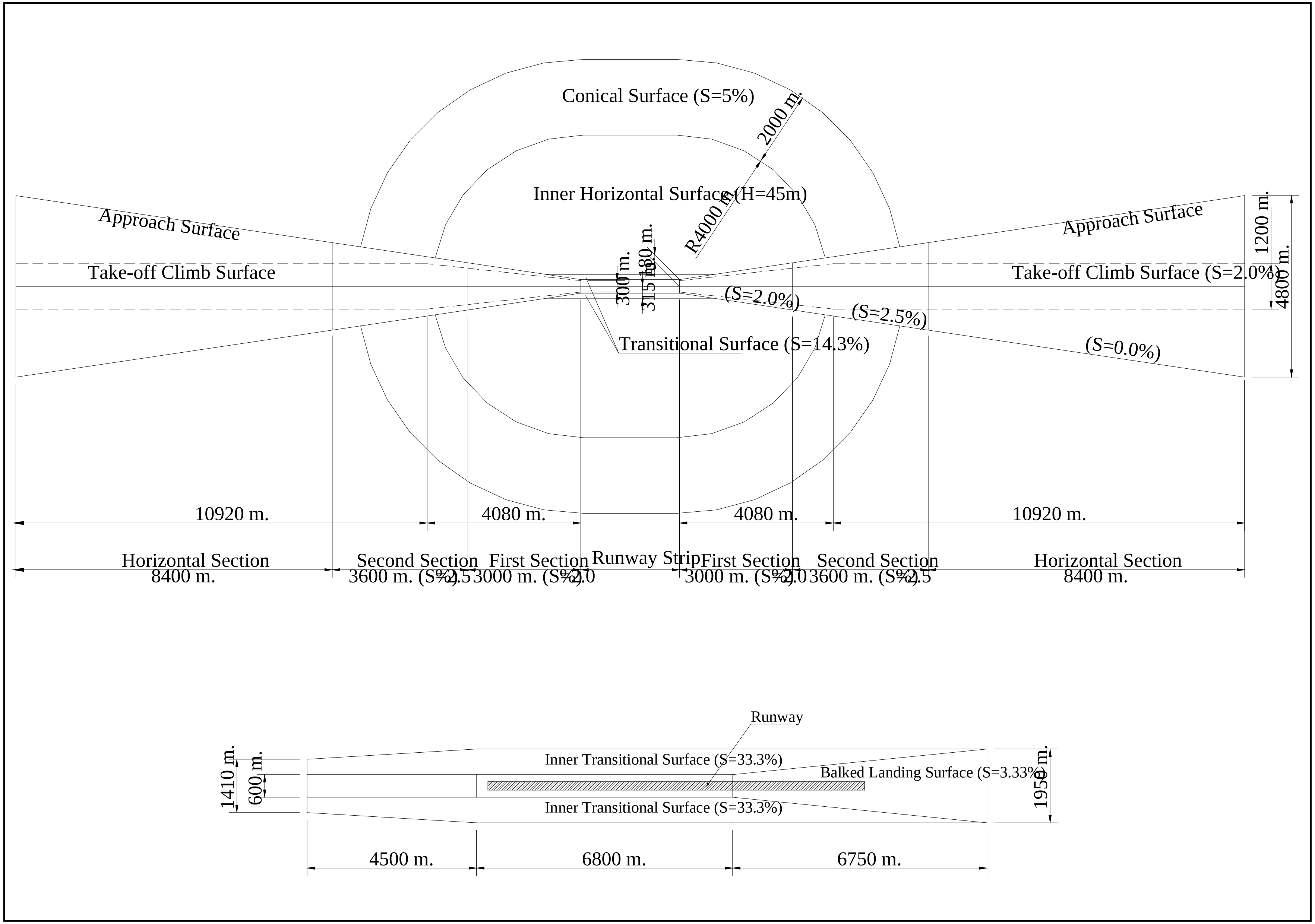

Fig. 4-3-1 Obstacle Limitation Surface

4.4 RUNWAY, TAXIWAY AND APRON

4.4.1 Runway

The number and orientation of runway(s) at an airport should be such that the usability factor of the airport is not less than 95% with a crosswind component of no more than 20 knots.

As seen in **Table 4.4-1**, the present runway length of 2,280 m at the existing Legaspi Airport is more than sufficient for use by B737 and A320. The runway width should be increased to 45 m with 7.5-m wide shoulders on both sides in accordance with relevant recommendations of ICAO.

Table 4.4-1 Standard Runway Length Requirements for Domestic Operation in Japan

Design Aircraft	Runway Length Requirement
Large Jet Aircraft such as B747, B777, MD-11, etc.	2,500 m
Medium to Small Jet Aircraft such as A300, B767, MD-81, MD-87, MD-90, B737, A320	2,000 m
Turbo Prop. Aircraft such as YS-11	1,500 m
Small Prop. Aircraft such as DO-228, DHC-6, N24A, BN2A	800 m to 1,000m

Source: Design Standards for Airport Civil Facilities, Japan

4.4.2 Taxiway and Taxiway Strip

A complete parallel taxiway is not economically desirable when the number of instrument approaches does not reach landings during the peak hour. Hence, it is not foreseen to be required at Legaspi for the identified planning periods.

4.4.3 Apron

The required number of aircraft parking stands with sufficient allowance for aircraft overstaying is estimated based on the following formula:

$$S = \frac{1.2 \times N \times T}{60}$$

Where,

S= Number of aircraft parking stands

N= Number of aircraft landings

T= Turn-around time (60 minutes for SJ & TP)

The width and depth of the aircraft parking stands have been determined based on the dimension and required clearances for the design aircraft, in this case A320.

4.5 PASSENGER AND CARGO TERMINAL BUILDINGS

4.5.1 Passenger Terminal Building

The floor area required for the passenger terminal building is calculated by multiplying the number of peak-hour passengers and the required unit floor area per passenger. A unit floor area of 10 sq.m. per peak-hour passenger has been adopted for passenger terminal based on a planning practice in the Philippines.

4.5.2 Cargo Terminal Building

The floor area of the cargo terminal building is estimated based on the annual cargo volume and unit cargo handling capacity. A handling capacity of 15 tons per sq.m. is adopted for estimating the cargo handling area based on experience from other similar projects.

4.6 OTHER BUILDINGS

4.6.1 Control Tower Building

The control tower should be high enough to enable the controller to observe the surface of runway threshold with an angle of depression not less than 35 minutes. The approximate minimum eye level of controllers will be about 23 m above the ground. The floor area of the control tower will be about 300 sq.m. to accommodate air traffic controllers, control consoles, staircase, and others.

4.6.2 Administration Building

The floor space required for administrative and operational functions will be about 660 sq.m. to accommodate 11 functional units composed of the following :

a) Executive Office

b) Assistant Executive Office

c) Executive Staff

d) Legal Staff

e) Internal Audit

f) Security Unit

g) Medical Unit

h) Airways Navigation/Air Traffic

i) Aviation Safety

j) Administrative Division

k) Finance

Each functional unit is assumed to be manned by an average of 10 persons. For planning purposes each individual is provided with 5 sq.m. of floor space and an additional 20 percent for circulation and provision for common areas.

4.6.3 Fire Station Building

The floor space required for fire station building will be about 270 sq.m. based on the requirement of fire fighting vehicles and the minimum space requirement for Design Category 6.

4.7 ROAD AND CARPARK

4.7.1 Access Road

The number of road lanes and width should be established on the basis of anticipated volume of traffic to be accommodated. A two-lane, two-way road can handle 2,500 vehicles per hour, while a four-lane road with a divider can handle up to 8,800 vehicles per hour. The characteristics of the site, including the functional role of the access road, should be ascertained before a final access road design can be formulated. Whether or not the access road will be part of a by-pass road facility should be considered in the design.

4.7.2 Car Park

The parking demand for vehicles is estimated based on the number of two-way peak-hour passengers and unit parking demand per hourly passenger. It is assumed that each departing or arriving passenger will need on the average about 0.3 vehicle parking space for planning of the car park. A unit space of 35 sq.m. per vehicle is used to estimate the required area for the car park (see **Fig. 4.7-1**).

FAA Advisory Circular 150/5360-13 recommends 31.5 to 36 sq.m. should be provided for each parked vehicle. This unit space includes parking space, driveways, sidewalks, green areas and islands within a car park.

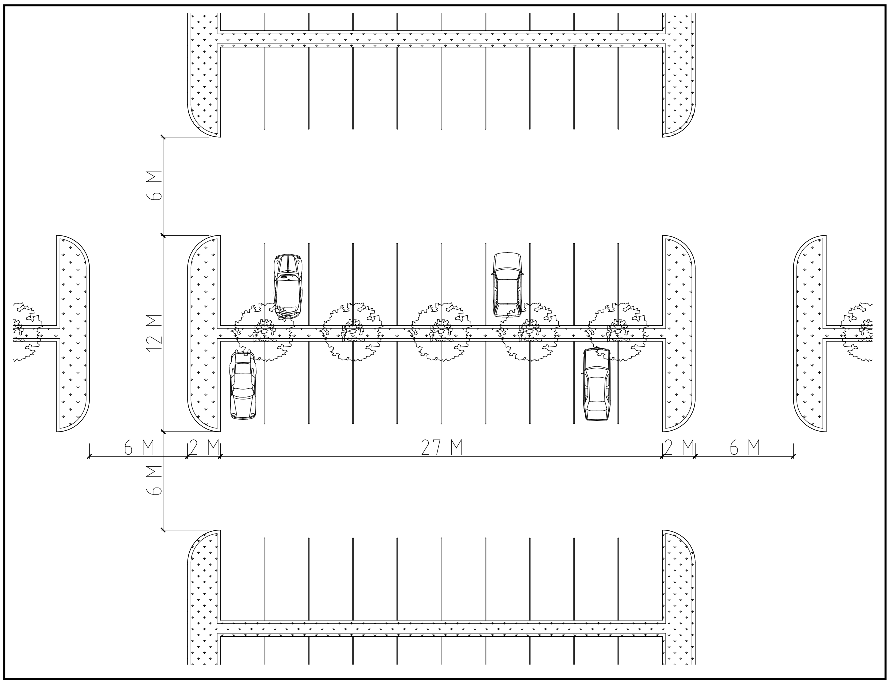

Fig. 4.7-1 Typical 20-Vehicle Capacity Parking Module Configuration

For a module of 20 parking space:

A = L x W

A = 37 m x 18 m

A = 666 sq.m.

Unit space = 666 sq.m./ 20 vehicles

Unit space = 33.3 sq.m./vehicle

or 35 sq.m./vehicle to include sidewalks, green areas, etc.

4.8 AIR NAVIGATION

Air navigation systems, including radio navigation aids, aeronautical ground lights, meteorological observation systems, air traffic control (ATC) and aeronautical telecommunication systems should be provided to allow for precision approach category I operations. The following equipments are required for Legaspi Airport:

Radio Navigation Aids

a) Category I Instrument Landing System (ILS) for main approach direction
b) VHF Omnidirectional Range (VOR) / Distance Measuring Equipment (DME)
c) Navaids Monitoring and Control System

Aeronautical Ground Lights

a) Precision Approach Category I Lighting System (PALS Cat-I) including its light plane for main approach direction
b) Simple Approach Lighting System (SALS) including its light plane for secondary approach direction
c) Precision Approach Path Indicators (PAPI) for both runway approaches
d) Runway Edge Lights, Runway Threshold and Wing Bar Lights, Runway End Lights, Stopway Lights, and Taxiway Edge Lights
e) Aerodrome Beacon, Apron Flood Lights, Illuminated Wind Direction Indicators, and Obstacle Lights
f) Aeronautical Ground Light Monitoring and Control System

Meteorological Observation System

a) Transmissiometers (Runway Visual Range) and Ceilometers for both approach directions
b) Automatic Weather Observation, Data Collection, Recording and Display System
c) Communication Facilities for Meteorological Services, etc.

ATC and Aeronautical Telecommunication System

a) VHF and HF Radio Communication Facilities and Multi-Channel Magnetic Tape Recorder as existing
b) PCs inclusive of associated software for ALS & AFTN linkages
c) VSAT
d) Handheld transceivers
e) Binoculars
f) Signaling lamp (Air Traffic Light Gun)
g) Siren

4.9 RESCUE AND FIRE FIGHTING SERVICES

The level of protection for rescue and fire fighting is determined based on the dimensions of aircraft using the airport in accordance with "Airport Service Manual Part I - Rescue and Fire Fighting" (ICAO). The category for A320 design aircraft is 6. The minimum usable amounts of extinguishing agents and fire fighting vehicles required for category 6 are as follows:

Table 4.9-1 Minimum Usable Amount of Extinguishing Agents & Fire Fighting Vehicles

Requirements for Category 6	
Min. Number of Rescue and Fire Fighting Vehicles	2
Min Storage of Extinguishing Agents Water (liters) Discharge Rate (Foam Solution/min)	 11,800 6,000
Complementary Agents Dry Chemical Powder (kgs.)	 225

4.10 AIRPORT UTILITIES

The demand for airport utilities is estimated based on the average unit demands of airports and summarized in **Table 4.10-1.**

Table 4.10-1 Unit Demand for Utilities for Planning Purposes

Utilities	Area of Application	Unit Demand
Water and Sewage	Passenger Terminal Building	23 liters/sq.m./day
	Cargo Terminal Building	3 liters/sq.m./day
	Administration Building and Other Buildings	10 liters/sq.m./day
Solid Waste	Passenger Terminal Building	0.07 kgs/sq.m./day
	Cargo Terminal Building	0.14 kgs/sq.m./day
	Administration Building and Other Buildings	0.14 kgs/sq.m./day
Electricity	Passenger Terminal Building	100 VA/sq.m.
	Cargo Terminal Building	60 VA/sq.m.
	Administration Building and Other Buildings	80 VA/sq.m.
Telephone	Passenger Terminal Building	0.005 extension/sq.m.
	Cargo Terminal Building	0.005 extension/sq.m.
	Administration Building and Other Buildings Trunk Lines	0.025 extension/sq.m 25 lines

Basis : Average Unit Demand from Mactan, Manila and Narita Airports

Note: Generated Sewage is assumed at 100 % of Water Consumption

Secondary power supply will be estimated to provide emergency power to essential facilities and equipment at the airport to maintain operation during power failure.

4.11 AVIATION FUEL SUPPLY SYSTEM

Fuel consumption is estimated by multiplying the trip fuel and the number of departing flights for each aircraft type. The trip fuel for small jet and turbo prop aircraft can be approximated by the following formulae:

Small Jet : TF = 0.0041 x SD + 0.75

Turbo Prop : TF = 0.0010 x SD + 0.60

where,

TF : Trip fuel (kl)

SD : Sector distance (km)

The required fuel storage capacity is determined based on the requirement that the airport should have a storage capacity sufficient to provide for seven days of consumption. The tank capacity has been planned to be 1.25 times of the storage requirement.

Table 4.11-1 Estimated Weekly Fuel Consumption and Required Tank Capacity

Requirements	2015	2025
Weekly Fuel Consumption (kl)	22	30
Tank Capacity (kl)	1 x 25	2 x 25

4.12 WORLD GEODETIC SURVEY 1984 (WGS-84)

Realizing that accurate coordinates are critical to flight safety, the International Civil Aviation Organization (ICAO) recommend that WGS 84 (World Geodetic Survey 1984) be used as a standard datum for all international flight operations. The ICAO goal was to provide safer air transportation by using an accurate, consistent, and universally recognized geodetic reference frame for air travelers.

4.12.1 Geodetic Control Stations

Number of Stations: Each airport must have one Primary Airport Control Station (PACS) and at least two Secondary Airport Control Stations (SACS). Establishing three SACS is highly recommended.

Location: The PACS and SACS shall be located within the airfield property and placed appropriately to support classical/conventional survey observations. The geometric figure of an equilateral quadrilateral with sides of approximately 1 kilometer should be used as a model. Consideration should be given to stability, permanence, and utility (accessibility, visibility, and potential sources of interference with GPS signals).

Station Monuments: Different types of monuments will be appropriate for different locations and ground conditions on the aerodrome/heliport and it is for the surveyor, with the guidance of ATO or other legitimate authority, to decide on the most appropriate type. Additionally, investigation should be made prior to the installation of survey monuments to ensure that underground cables and services will not be affected by the installation. In order of preference, the choices for monuments of PACS and SACS are:

- On bed rock
- On a concrete platform or pillar
- A stainless steel rod driven to refusal
- A one meter spike

Name: Each survey station must be assigned (and preferably labeled or stamped with) a unique name such that there is no doubt as to its provenance or identity. An unambiguous numbering system, identifying the aerodrome/heliport, year and station number should be used. The recommended naming convention is to use the last three letters of ICAO designation code and a sequential number. For example, the ICAO identifier for Ninoy Aquino International Airport is RPLL. The PACS and SACS would be named “PLL1”, “PLL 2”, and “PLL 3”. If this naming convention already exists at the airfield, the next number in the sequence should be used for newly established stations. However, guidance provided by ICAO, the ATO, or other appropriate authority should be judiciously considered in the naming process and conditions such as the use of pre-existing marks or the preferences of the entity controlling the airfield may dictate that another naming convention be used. In all cases the surveyor should avoid the practice of establishing new monuments solely to satisfy a naming convention.

Labels: Uniform labels (e.g. stamped disks) may be used at individual aerodrome/heliport for all survey stations. Existing survey marks if appropriately located (*refer to Location*) may be used, but no changes should be made to their labeling. Any substantial topographic surface feature may also be used as a survey monument, provided the feature is clearly marked to identify the exact point of survey. All stations should be defined to within ± 0.002 meter and the station name should be clearly evidenced in stamping, durable paint or other durable medium.

4.12.2 Airfield Features

Runway Points: The 3-dimensional positions of runway ends, threshold ends, overrun (stopway) ends, the touchdown zone elevation (TDZE) and a vertical profile of the runway must be determined. Generally 4 points along the centerline of the runway (at a separation of not less than 10% of runway length) produces and adequate runway vertical profile as long as the plane of the vertical gradient between any two adjacent published runway points does not depart by more than one foot from the runway surface.

Instrument Landing System (ILS): The 3-dimensional positions of all ILS components must be determined. The ILS normally consists of the following electronic components: Localizer, Glide Slope (GS), Outer Marker, Middle Marker, Inner Marker and Compass Locator. **NOTE:** The point of survey for an end fire type glide slopes is different from that of traditional glide lopes. End fire type glide slopes are primarily used along the coastline, as they take into account tidal effects. These glide slopes are considerably larger than traditional glide slopes.

Microwave Landing System (MLS): The 3-dimensional positions of all MLS components must be determined.

Terminal Navigation Aids: The 3-dimensional positions of all Terminal Navigation Aids will be surveyed.

Visual NAVAIDs: The latitude and longitude of all Visual NAVAIDSs must be determined.

The position of a “plot point(s)” shall be determined for certain electronic and visual NAVigational AIDs (NAVAIDs). The term “plot point” is understood to be a unique coordinate position that is determined by either geodetic survey of by photogrammetric means. The “plot point” may be the center of the NAVAID, or when the NAVAID is composed of more than one unit, the center of the array, or in the case of an approach light systems, the first and last lights. A position, and sometime an elevation, depending on the NAVIAD, shall be determined for the selected electronic NAVAIDs associated with the airport. The horizontal and vertical plot point for electronic NAVAIDs are listed in Plot Points of NAVAIDs Table (Annex E).

Plot points shall be collected for all required visual NAVAIDs; NAVAIDs and their "plot points" are identified in Plot Points of NAVAIDs Table. Reminder: Elevations are **not required** for visual NAVAIDs.

Glide Slope Abeam Point: The abeam point is a calculated location. It is defined as the point on the runway centerline at which the physical location of the pint on the runway centerline at which the physical location of the point survey on the Glide Slope device lies perpendicular to the runway centerline. The height of this point will be interpolated from the runway end, threshold, and/or profile information as appropriate.

Runway Crown and Airport Elevation: The highest point on each runway and the highest point of all the usable runway surfaces must be determined.

Obstructions/Obstacles: the 3-dimensional position of objects limiting or impending non-precision area navigation approach and departure must be determined. Diagram of the areas of concern surrounding the runway and the arbitrary heights of obstacles must be presented. The controlling obstructions/obstacles must be surveyed to the absolute accuracy specified in Precision Table (Annex F) and the relative accuracy specified in the Accuracy Table (Annex G). All other objects/obstructions shall be surveyed.

4.12.3 Frangible Objects

All **frangible objects** are **not covered** under this program. Frangible objects are objects designed to breakaway such as, runway marker signs, taxiway signs, wind socks, anemometers, approach light systems, etc. **Do not** survey frangible navigational aids (except those in Airfield Features), meteorological apparatus, parked aircraft, and mobile or temporary objects (i.e. construction equipment, dirt/debris piles, etc.).

4.12.4 Survey Accuracy and Precision

Accuracy: The accuracy requirements are expressed (root sum square of the accumulated process errors), per component (latitude, longitude, and ellipsoid height), 90% confidence region, to include the accuracy of the NIMA recognized WGS 84 fiducial station. (Accuracy Table)

Precision: The precision requirements are expressed (root sum square of the accumulated process errors less the absolute accuracy estimate of the PACS) per component (latitude, longitude, and ellipsoid height), 90% confidence region, with respect to the PACS. (Precision Table)

4.12.5 Survey Data Acquisition Report/Publication

A document containing the final results relating to any surveyed portion of the project must be produced ad should contain the following information:

1) A table containing the results for each object positioned during the project.

   Note: All accuracy values are estimates of absolute accuracy with respect to WGS 84. The table shall include the following information:

   a) A unique point identifier (name)

   b) An abbreviated description of the object positioned

   c) The WGS 84 latitude (DD MM SS.SSS)

   d) The Latitude hemisphere (N/S)

   e) The WGS 84 Longitude (DDD MM SS.SSS)

   f) The Longitude hemisphere (E/W)

   g) The WGS 84 Ellipsoid height (meters) (MMMM.MMM)

   h) The WGS 84 Ellipsoid height (feet) (FFFF.FF)

   i) The EMG96 Orthometric height (meters) (MMMM.MMM)

   j) The EMG96 Orthometric height (feet) (FFFF.FF)

   k) The Latitude accuracy (WGS 84 absolute accuracy mmm.mmm)

   l) The Longitude accuracy (WGS 84 absolute accuracy mmm.mmm)

   m) The Ellipsoid height accuracy (mmm.mmm)

2) A narrative containing the following information:

   a) The method used to establish WGS 84 control including the names of WGS 84 control stations used.

   b) A description of the method(s) used to extend control to all other points.

   c) Describe the equipment, procedures, and software used in the performance of the survey.

   d) If GPS, describe the collection scenarios, and epoch intervals used.

   e) Events or conditions witnessed during the data acquisition phase that may bear on the validity of the data.

3) A description of the computational process including:

   a) A comprehensive account of the GPS vector processing or classical/conventional surveying calculations. The software name, version number, and relevant optional settings should be discussed.

   b) A comprehensive account of the least square adjustment process including analysis of the variance/covariance matrices. The software name, version number, weighting and weighting rationale should be discussed.

   c) An accounting of precision values with respect to the PACS (as specified by FAA or ICAO as applicable) is required. The information may be presented in the form of certification that all precision requirement were met, by exception, or in tabular format as appropriate.

   d) Other technical, historical, administrative, logistical or other information bearing on the quality of the data or the completion of the project. Sketches, diagrams, detailed station descriptions, photographs, maps, electronic files (the installation GIS for example) and other documents should be provided if acquired during the course of the project.

4) A copy of all raw data collected on the project and copies of all intermediate files produced during the process.

4.13 AERODROME DATA

Aerodrome data in accordance with ICAO Annex 15, Doc. 8126, and the Aeronautical Information Publication (AIP) including associated charts (Aerodrome Obstacle Chart ICAO Type A/B/C, Aerodrome Chart, Aerodrome Ground Movement Chart and Aircraft parking/Docking Chart) shall be provided in written and electronic form (hard/soft copy). Charts shall be in AutoCAD file.

Chapter 5 DEVELOPMENT STRATEGY AND SELECTION OF NEW AIRPORT SITE

5.1 REVIEW OF DEVELOPMENT STRATEGIES

5.1.1 General

Considering the planning parameters and prevailing conditions detailed in the preceding sections of the Report, the emerging development strategies are the following:

a) **Option I** : Improving the Existing Legaspi Airport Facilities

b) **Option II** : Developing a New Airport to Serve both Legaspi and Naga City (**New Southern Luzon Airport**); and,

c) **Option III** : Developing a New Legaspi Airport.

Option I involves improving the existing facilities at Legaspi Airport to upgrade its level of service in accordance with ICAO requirements for Precision Approach Runway Code 4C for the short-term. Option I recognize the operational restrictions prevailing at Naga Airport and should be treated separately. Naga Airport is experiencing dramatic decrease in traffic demand on account of stiff competition with road transportation after the completion of Quirino Highway. Necessarily, the requirements of Naga Airport should be established in a separate study if Option I is pursued.

Option II recognizes simultaneously the operational restrictions in both Legaspi and Naga Airports. By developing a new airport midway between the existing facilities in Legaspi and Naga, it aims to save on development cost arising from two separate improvement activities. Option II involves a small-scale development of Sorsogon airport to make it more responsive to unserved demand from the southern part of Region V once the existing Legaspi Airport is decommissioned.

Option III envisions the relocation of the existing Legaspi Airport, independent of the requirements of Naga Airport. Similar to Option I, it also recognizes the need for a separate consideration of the requirements of Naga Airport.

5.1.2 Implications of Option I (Improving the Existing Legaspi Airport Facilities)

This strategy requires the doubling of the existing runway strip and shifting the aircraft-parking apron together with the terminal facilities to satisfy the requirements of the precision approach runway. A possible scheme for general development, while keeping the airport operational, is shown in **Figure 5.1-1.**

The existing runway at the Legaspi Airport is more than enough to accommodate domestic operation of A320, and B737 if obstacles surrounding the airport are removed. Improving the runway for precision approach may be undertaken by shortening the runway to 2,000-m so that the 300-m wide runway strip, together with the localizer area and runway end safety area could be established without diverting the nearby Yawa river. However, a portion of the Bagtang river and the road located at the southern end of the airport need to be diverted, together with other roads in the vicinity. The terminal facilities including aircraft parking apron would need to be redeveloped beside the existing terminal area with adequate separation distance from the runway centerline.

The precision approach will be established for Rwy 06, and one (1) set of Instrument Landing System (ILS), consisting of localizer and glide path/DME should be installed. In order to ensure adequate signal performance of the equipment, the localizer (to be located at the northern end of the runway) and glide path critical areas should be provided and properly graded. Rwy 24-end should be displaced to the south by 300-m to accommodate the localizer critical area and avoid diversion of the Yawa river. The glide path critical area would be provided along the southwestern part of the expanded runway strip. However, due to the existing alignment of the Manila-Legaspi railway, the length of the precision approach lighting system would be limited to approximately 500-m which could result in operational limitation of the ILS approach procedure.

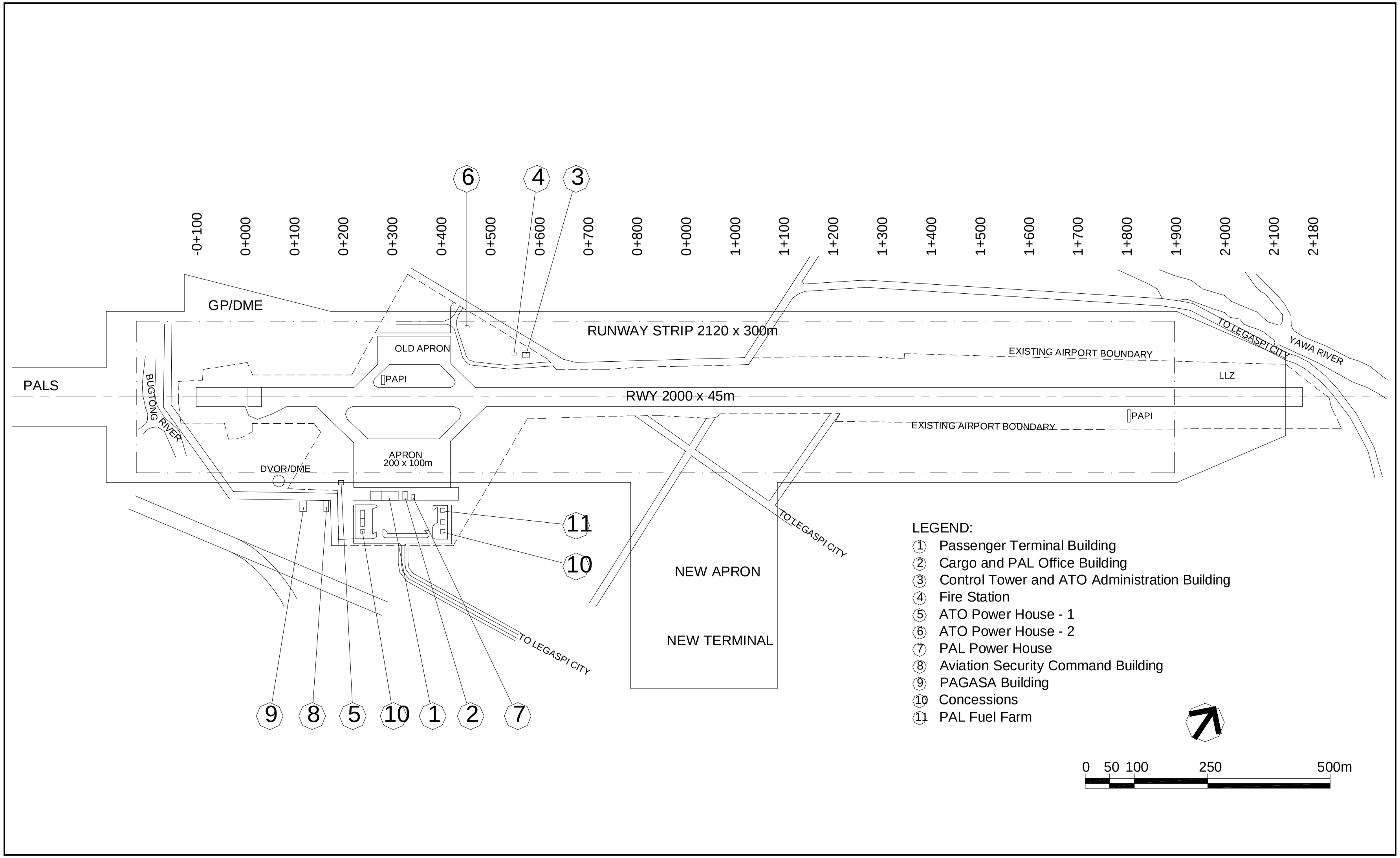

Fig. 5.1-1 Alternative Development Option: Existing Airport

5.1.3 Implications of Option II (Developing the New Southern Luzon Airport)

The potential sites are located in the provinces of Camarines Sur and Albay, bounded by several mountains such as Mt. Isarog, Mt. Iriga, Mt. Masaraga and Mt. Mayon, with the highest elevations all exceeding 1,000-m AMSL. Along the western coast from south of Pamolano to the north of Pio Duran, are hilly terrains with elevations of up to around 500-m AMSL. In between these mountains and hilly terrains are low and flat flood plains near the vicinity of Lake Baao and Lake Bato, some rivers, creeks and rice paddies (around the municipalities of Baao, Nabua, Bato and Libon). Flat areas with relatively higher elevations (30 to 40-m AMSL) can be found near the boundary of Nabua and Bato. Another flat area exists near the boundary of Guinobatan and Pio Duran, which however is considered inaccessible from both Legaspi and Naga. Shown in **Figure 5.1-2,** the potential sites identified in the previous study and confirmed under the present study are located in:

a) Site 1 - Barangay Salvacion, Iriga City;
b) Site 2 - Barangay Cotnogan, Libon; and
c) Site 3 - Barangay Balangiban, Polangui.

Because of the mountains and volcano located on the northeast and southeastern part of Bicol Region, the eastern airspace is not usable at all for the proposed New Southern Luzon Airport. In addition, to satisfy obstacle clearance requirements, runway orientation needs to be directed from the northwest to southeast, which is very likely to be totally inconsistent with the prevailing wind direction of northeast to southwest. Thus, a completely crosswind runway will result under this condition. **Table 5.1-1** summarizes the result of the evaluation of these three (3) sites.

The distribution of active faults in the Bicol Region is shown in **Figure 5.1-3**. An active fault called “Lake Bato Lineament” lies along the western coast where hilly terrain exists. Another fault is located further down along the southwestern coastline of Albay and Sorsogon Provinces. While most of the alternative sites are outside the potential effect of Mayon Volcano, they are near the two identified major faults and, therefore, within seismic sensitive areas.

Fig. 5.1-2 Potential Sites for Alternative Development Option II

Table 5.1-1 Evaluations of Potential Sites for Development Option II

Criteria	Potential Sites		
	Salvacion, Iriga City	Cotnogan, Libon	Balangiban, Polangui
Air Space	The horizontal surface is free from obstacles. About 12 km. northeast of the site is Mt. Iriga with an elevation of 1,100 AMSL. The runway will be oriented towards northwest-southeast direction to avoid obstacle on the approach and take-off surfaces.	The presence of Mt. Iriga (1, 100 AMSL), Mt. Malihao (1,458 AMSL) and Mt. Masaraga (1,328 AMSL) on the northeastern part of the site limits the runway orientation to northwest-southeastern direction. Horizontal inner surface will be free from obstruction, however, holding track pattern will be limited on the southwestern side of the runway.	Several hills in the northeastern part of the site pose an obstruction to aircraft operation. To avoid those obstacles, the runway orientation will be northwest-southeast direction. Holding track pattern will be on the southwestern side of the runway, as those hills protrudes on the northeastern part of the inner horizontal surface.
Wind Direction	The prevailing wind in the site was observed to be northeast- southwest direction. The desired orientation of the runway will be perpendicular to the prevailing wind direction.	The runway orientation on this site is perpendicular to the prevailing wind on the area. This is considered to be a crosswind direction.	During the site reconnaissance, the prevailing wind in the site is similar with Site 1 and 2; this is considered a crosswind direction.
Topography	The site is basically a flat land, gradually sloping to the north where the Iriga river system is located. Due to relatively high elevation of 35 AMSL, the site was said to be free from flood in the past. Expected volume of earthworks will be minimal	The area was observed to be rolling with difference in elevation approximately 20 m due to relatively high with average elevation of 75 AMSL, the probability of flooding is Low. This site will require massive volume of earthwork.	The general topography of the site is relatively flat with elevation ranging from 16 m to 18 m. The site was noted to be part of the area considered lowland and prone to floods.
Accessibility	The site is approximately 60 km. from Legaspi City and 50 kms. from Naga City by road. Travel time to the site is about 70 minutes from Legaspi and 60 minutes from Naga Cities via the well- paved National Highway No. 1	The site is approximately 50 km. from Legaspi City and 60 kms. from Naga City by road. Travel time would be about 60 minutes and 20 minutes respectively via the well- paved National Highway No. 1.	The site is approximately 40 km. from Legaspi City and 20 km. from Naga City. The site can be reached via the well-paved road National Highway No. 1 in 45 minutes and 25 minutes time from Legaspi City and Naga City respectively.

Table 5.1-1 Evaluations of Potential Sites for Development Option II (Cont'd)

Criteria	Potential Sites		
	Salvacion, Iriga City	Cotnogan, Libon	Balangiban, Polangui
Land Use	Prevailing land uses in the area was noted to be agricultural, i.e., mostly planted with rice and coconut. The area is irrigated and considered to be a prime land.	The site was observed to be agricultural, (mostly planted with coconut) and graze land for cattle raising.	The area is an agricultural land principally planted with rice. It is also fully irrigated. Therefore, the area is considered a prime agricultural land.
Environmental Factor	Necessary relocation will be required for some houses along the Iriga-Bato highway and farmers housed at the site, which will be directly affected by airport construction. No aircraft noised influence is expected for major urban centers.	Several houses and school will be affected by the airport construction, thus; needs to be relocated. No aircraft noise influence is expected from major urban centers	Some houses will be directly affected by airport construction. Due to the desirable runway orientation and its proximity to town proper of Polangui, Aircraft noise influence is expected.
Others	A portion of the Bato-Iriga highway including power line will have to be diverted. Some irrigation canal will also need to be diverted	The barangay road (macadam surfaced) will need to be diverted or relocated as it will be directly affected by the airport construction	A substantial cost will be required for the diversion of existing two series or power line that run across the site. Some irrigation canals will also need to be diverted.

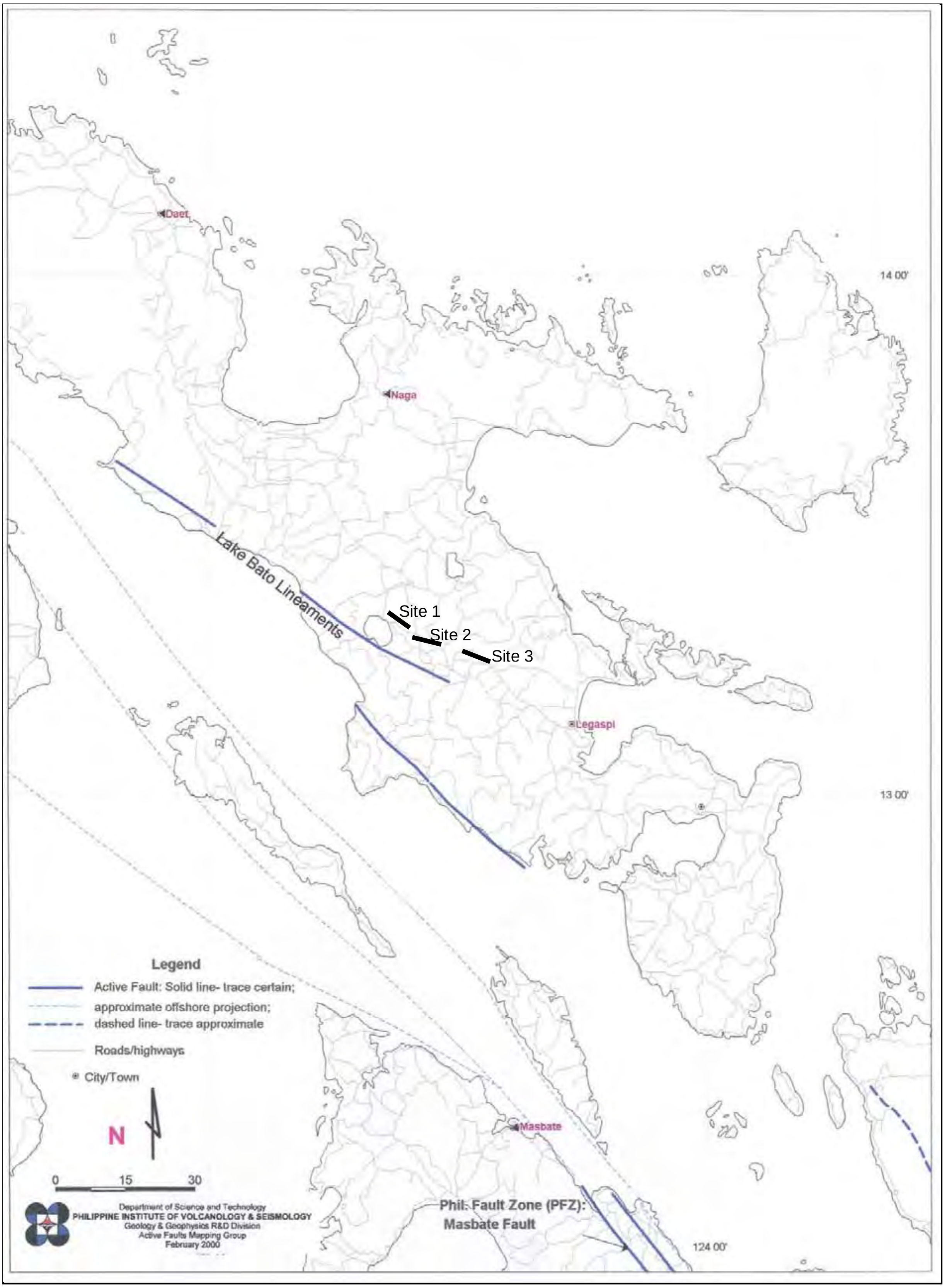

Fig. 5.1-3 Distribution of Active Faults in Bicol Region

5.1.4 Implication of Option III (Developing a New Legaspi Airport)

The development of a New Legaspi Airport envisions the decommissioning of the existing facility and relocating to a new site, where the operational restrictions in the existing airport can be most economically addressed, with minimum social dislocation. In the reconnaissance survey, the four (4) sites identified in the previous study were confirmed to be feasible areas for development considering a multi-objective selection process. The location of potential areas for development, shown in **Figure 5.1-4**, were identified to be in:

a) Site 4 - Barangay Alobo, Daraga City
b) Site 5 – Barangay Villahermosa, Daraga City
c) Site 6 – Barangay Bariis, Legaspi City
d) Site 7 – Barangay Borabod, Castilla

A brief assessment of these sites is summarized in **Table 5.1-2**. On the basis of the selection criteria enumerated in **Table 5.1-2**, the two most desirable sites emerged to be in Barangay Alobo and Barangay Bariis. The comparison between the two sites is covered in more detail in the succeeding section.

Fig. 5.1-4 Potential Sites for Development Option III

Table 5.1-2 Evaluations of Potential Sites for Development Option III

Criteria	Potential Sites			
	Alobo, Daraga, Albay	Villahermosa, Daraga, Albay	Bariis, Legaspi City	Borabod, Castilla, Sorsogon
Air Space	No obstacles for approach and take-off surfaces. The northwestern part of the horizontal surface is obstructed by hilly terrain, but no adverse effect on aircraft operation if the holding track pattern is established on the southeastern side. A hill with a 30-m. tower and antenna protrudes upon the southeastern portion of the conical surface by about 110 m.	There are no obstacles on approach and take-off surfaces. The hilly terrain on the northwestern part poses an obstruction on the inner horizontal surface but there will be no adverse effect on aircraft operation if the holding track pattern is established on the southeastern side of the runway.	There are no obstructions on approach and take-off surfaces. The inner horizontal surface is free from obstacles. The hilly terrain protrudes the conical surface on the northeastern part of the runway but no significant influence to aircraft operation by establishing the holding track pattern on the western side of the runway	There are no obstacles for approach and take-off surfaces. However, there are several hills protruding upon both the eastern and western parts of horizontal surface
Wind Direction	Northeast to southwest runway orientation will be adequate for the prevailing wind direction.	Runway orientation will be adequate for the prevailing wind direction in the area.	The runway orientation is adequate for the prevailing wind in the area.	The runway orientation will be adequate for prevailing wind
Topography	The site is basically flat with an average elevation. of about 90 AMSL. Considerable volume of earthwork will be needed for airport construction.	The terrain is undulated with varying elevations of up to15 m. in difference. This will require a large volume of earthwork but cut and fill can be balance. With an average elevation of about 20 AMSL, the probability of flooding is low.	The general topography of the site is undulated with varying elevations of up to 15 m. difference. This will require a substantial volume of earthwork, but cut and fill can be balance at site. The site is about 130 m. AMSL, with minimal probability of flood.	The site is generally flat with an average elevation of almost 50 AMSL. The probability of flood is low.
Accessibility	Site is 12 km. by road from Legaspi City, approximately 20 minutes drive via Daraga town proper. Road distance from Sorsogon City is approximately 48 kms. or a 60- min trip.	The distance from Legaspi City is 19 km. by road and from Sorsogon City is 35 km. Travel time is approximately 25 mins. and 40 mins. from Legaspi City and Sorsogon City, respectively.	The road distance from Legaspi City is 27 km, approximately a 35 -minute drive. From Sorsogon it is also 35 km by road (or a 35-minute drive)	The site is 34 km. by road from Legaspi City, approximately a 40-minute drive. From Sorosogon City it is 25 km away (or a 30-minute drive)

Table 5.1-2 Evaluations of Potential Sites for Development Option III (Cont'd)

Criteria	Potential Sites			
	Alobo, Daraga, Albay	Villahermosa, Daraga, Albay	Bariis, Legaspi City	Borabod, Castilla, Sorsogon
Land Use	The existing land use in the area is agricultural and devoted to rice plantation. Reports stated that a study for irrigation on the area was previously conducted. However, during the site reconnaissance the area was noted to be not irrigated.	The area is devoted to coconut plantation and covered by Comprehensive Agrarian Reform Program. (CARP).	The land use prevailing in the area is a mixed coconut and grass the area is also covered by Comprehensive Agrarian Reform Program (CARP).	The land use prevailing in the area is agricultural, and devoted to rice land. The irrigation system on the area is not functioning
Environmental Factor	Some houses will be directly affected by airport construction and need to be relocated. No aircraft noise influence is expected on major urban centers.	Minimal resettlement is required since the area is thinly populated. No aircraft noise influence is expected to major urban centers	The social impact from resettlement is minimal as it was noted that the area is thinly populated. No aircraft noise problem on urban centers is expected. However, a relocation site is located near the north portion of the approach. Actual extent of relocation site needs confirmation.	Several houses will be directly affected by airport construction, requiring a large-scale resettlement plan. No aircraft noise problem is expected on major urban centers
Others	The runway crosses the barangay road, diversion is required. The site is complementary to future urban expansion of Metro Legaspi.	The runway will cross an existing power line; necessary diversion of the power line is required.	The runway will run across an existing road; thus, diversion is required.	Diversion of existing power line on the northern part of the site is required. The runway will cross-existing waterways and needs to diverted

5.2 EVALUATION OF ALTERNATIVE STRATEGIES

5.2.1 Development Option I

In summary, the implementation of Option I as a development strategy will involve:

a) Shortening of the existing runway to accommodate localizer and runway-end safety area;

b) Diversion of Bagtang river and the national road;

c) Relocation of terminal facilities and apron to provide adequate separation distance from the runway centerline;

d) Acquisition of about 65.81 hectares of prime urban land valued at PhP3.29 billion (at estimated prevailing market value of PhP 5,000 per sq.m. for land and on-site developments, to be validated); and

e) Removal of obstacles for unconstrained approach procedure involving 22 million cu.m. of earthworks valued at approximately PhP 2.2 billion (PhP100.00 per cu.m.)

Option I will have to contend with the noise pollution imposed on a heavily built-up urban center around the airport, characterized by mixed developments of commercial, residential, academic and other institutions. In addition, on the basis of hazards zoning by PhiVolcs, hazards due to the Mayon Volcano have already covered the boundaries of Legaspi Airport and is projected to further grow and intensity in magnitude.

Finally, since the precision approach lighting system is limited to only about 500m, its reliability will be jeopardized.

5.2.2 Development Option II

Development Option II is deemed to be technically undesirable on account of the surrounding geographic constraints. The topographic features of the general area render the eastern air space unusable for air navigation. If obstacle clearances are satisfied, a completely crosswind runway configuration will result, which is not an optimal orientation from the viewpoint of safety and operational efficiency. Lastly, the airport will be located in seismic sensitive areas due to the presence of active faults along the western coast.

5.2.3 Development Option III

Option III provides a technical solution to the limitations present in Option I and Option II. As it involves relocating to a new site, more flexibility is accorded to the extent that the chosen site will allow. Option III entails the following:

a) About 48.69 hectares of land made available for urban development (estimated value of PhP3.9 Billion @ PhP8,000 / sq.m., to be validated);

b) Acquisition of about 160 hectares of raw land (estimated value of PhP 16 million @ PhP10 / sq.m., to be validated); and

c) Development of new airport facilities of international standards.

In view of the foregoing reasons, Option III (The New Legaspi Airport Project) is the development strategy proposed for implementation. The choices among the potential sites were narrowed down to two (2), namely: Barangay Alobo in Daraga and Barangay Bariis in Legaspi City.

5.3 COMPARATIVE ANALYSIS OF SELECTED SITES FOR NEW LEGASPI AIRPORT

The sites in Barangay Alobo, Daraga City and Barangay Bariis, Legaspi City are both capable of accommodating a runway orientation adequate for the prevailing wind, along the northeast-southwest direction.

5.3.1 Barangay Alobo, Daraga, Albay

<u>Location and Accessability</u>

The site is about 12 kms west of Legaspi City, in the Municipality of Daraga. The proposed runway's southwest end would be located close to the boundary of the municipalities of Daraga and Camalig. The northeast end would be proximate to the national highway linking Barangays De La Paz and Burgos.

From Legaspi City, access to the site is via a two-lane provincial road of about eight (8) kilometers in length, passing through Daraga town proper and then through Barangay Penafrancia. The provincial road gets off to a partially paved eight-kilometer national road, passing through Barangays Gapo and Inarado before leading to the site.

Site Topography and Drainage

The site topography is generally flat with mean elevation of about 90m AMSL. It is planted with rice, with some patches of fruit-bearing trees and coconut. The area is drained by the Abagao River to the north, Abagao River to the west and Jovellar River to the south.

Land Use and Proximity to Built-Up Areas

The site is an agricultural, rain-fed rice land. There is no irrigation in the site and its productivity is low. There are about 20 to 30 nipa houses, presumably owned by farmers/caretakers of the rice field within the proposed site. The nearest community is about a kilometer north of the proposed area in Barangay Dela Paz.

Obstacle Assessment for Airspace Utilization

At the site in Barangay Alobo, small portions of hilly terrain protrude along the approach surface, as well as the inner horizontal and conical surfaces. The obstructions on the approach surfaces, however, can be excavated and utilized as borrow materials for site development works. The holding track pattern may have to be limited to the southern side of the aerodrome due to obstructions on the northern side. A small obstruction is also found along the northeastern side of the aerodrome (**Figure 5.3-1**).