Table 6.12.2 Dimension and Slopes of Obstacle Limitation Surfaces for Take-Off Runways

Surface and dimensions[a]	Code number 1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

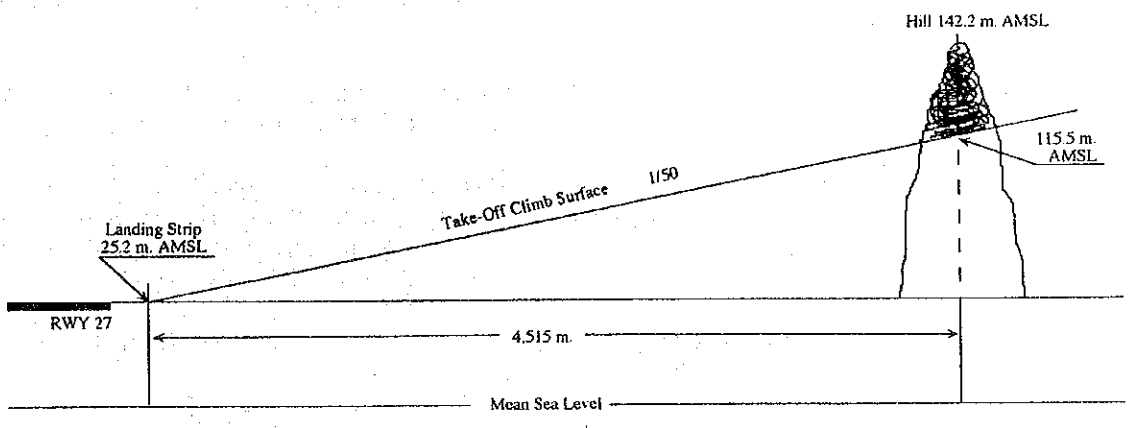

Figure 6.12.4 Diagram in Relationship to Take-Off Climb Surface for Take-Off Runway 09 and 142.2 m High Hill

6.13 AIR NAVIGATION SYSTEMS

Air Navigation Aids at Phuket International Airport are maintained and operated by the following three (3) different organizations :

1. Airports Authority of Thailand (AAT)

   - Terminal Building Facilities
   - Airfield Lighting System

2. Aeronautical Radio of Thailand LTD (AEROTHAI)

   - Radio Navigation Aids
   - Air Traffic Control System
   - Aeronautical Telecommunication System

3. Department of Meteorology

   - Meteorological Observation System

The conceptual diagram of the existing Air Navigation Systems is shown in **Figure 6.13.1**. Layout plan of the Air Navigation Aids is shown in **Figure 6.13.2** and the inventory list for the equipment is shown in **Table 6.13.1**.

6.13.1 Radio Navigation Aids

Radio Navigation Aids consist of ILS, DVOR/DME and NDB, and are maintained in good condition. However, NDB has exceeded its practical life.

(1) ILS/DME

Instrument Landing System (ILS) consisting of two (2) frequencies Glide Slope (GS), Localizer (LLZ) and Middle Marker (MM), which were installed in 1989, are operating for the Runway 27 approach. Since Runway 09 threshold is very close to the shore, LLZ is not installed in the normal position.

Off-set LLZ collocated DME are installed at a point 245 m inside from Runway 09 threshold and 120 m away from the runway center line.

Off-set angle of LLZ is set at 1.9316 degrees and center line of LLZ beam intercepts the runway center line at a distance of 803 m from Runway 27 threshold. Although installation of LLZ in the normal position is desirable, it should be noted that this shore area is designated as a National Park.

Glide Slope angle is 3.2 degrees due to the obstruction (Ban Laem Sai 142.2 m) of the Runway 27 approach surface.

Middle Marker is located 803 m from Runway 27 threshold on the extended runway center line.

ILS collocated DME was installed in 1989 and are operating in good condition.

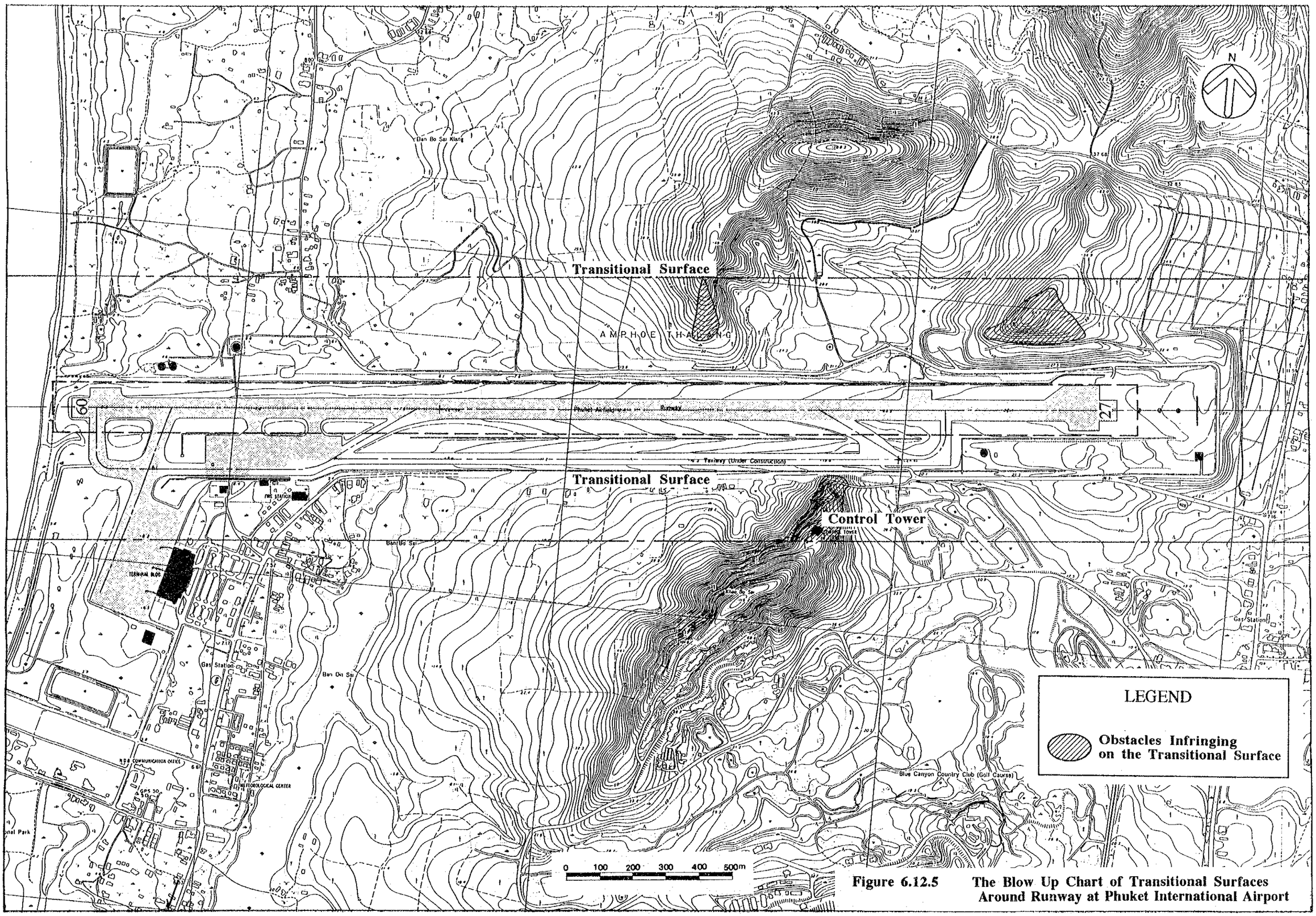

Figure 6.12.5 The Blow Up Chart of Transitional Surfaces Around Runway at Phuket International Airport

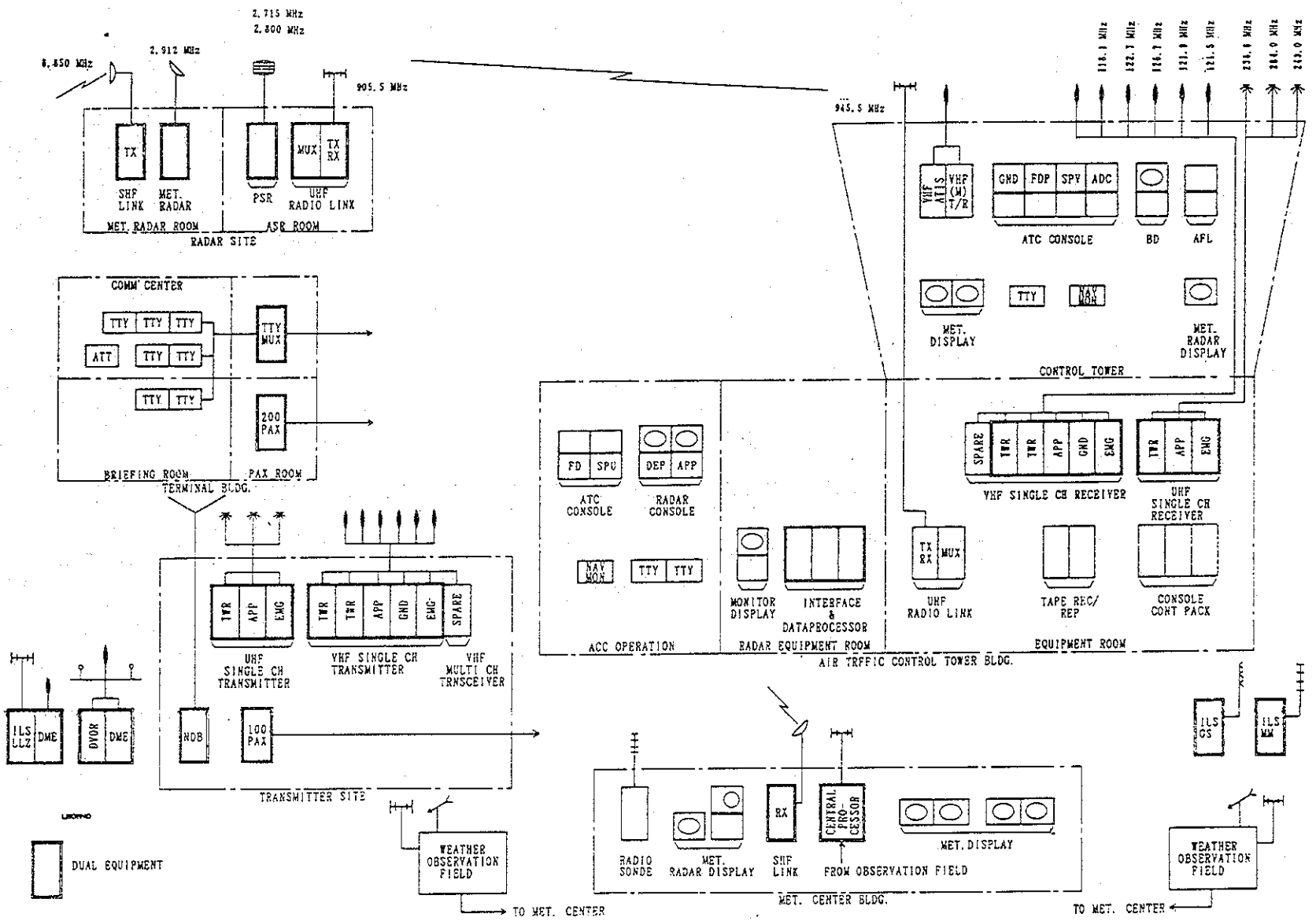

Figure 6.13.1 Air Navigation System Conceptual Diagram

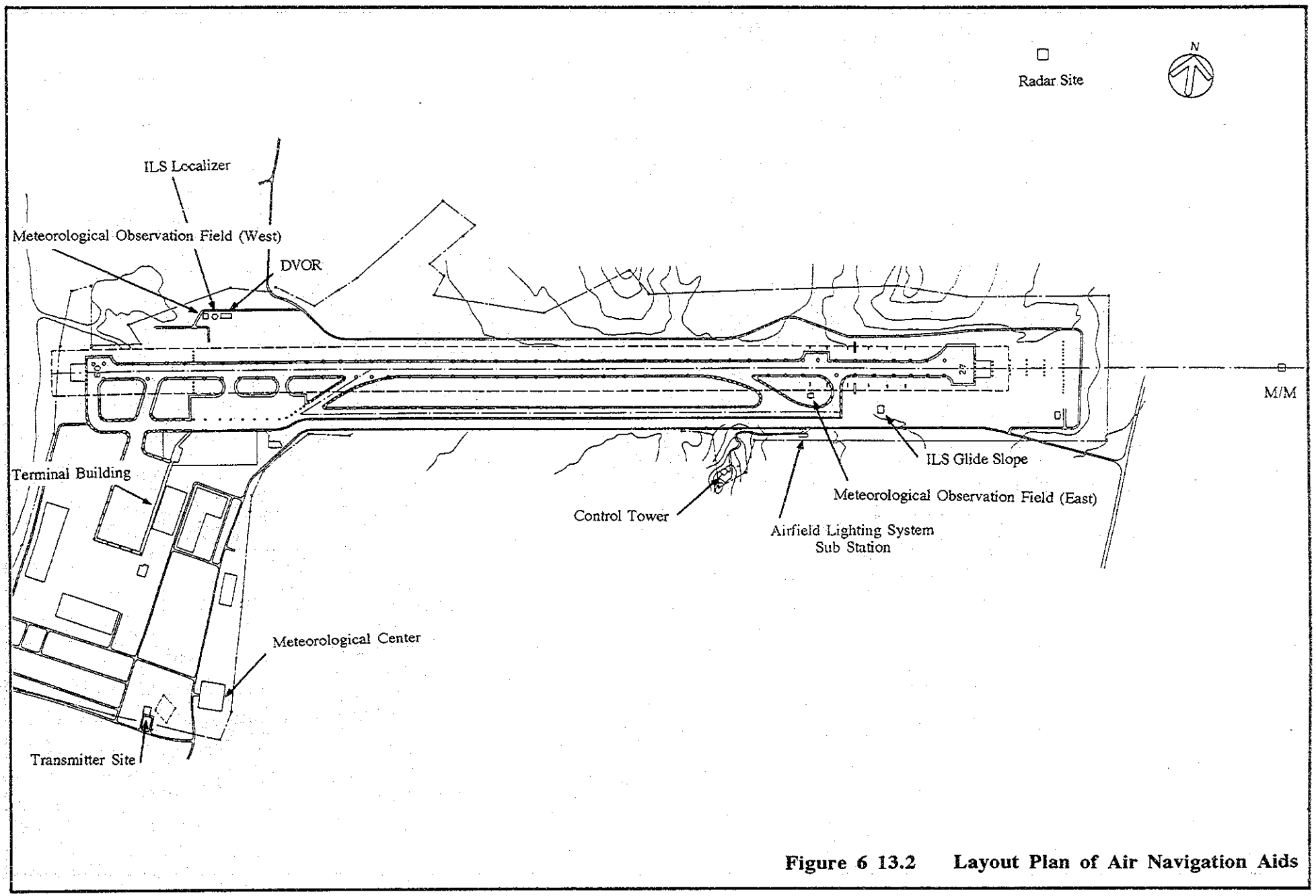

Figure 6 13.2 Layout Plan of Air Navigation Aids

Table 6.13.1 Inventory List

ITEM	SPECIFICATION	Q'ty	YEAR OF MANUFACTURE	MANUFACTURER	CONDITIONS
ILS (LLZ/GS/MM)	2 freq./15W/5W/2W	1	1989	Norsn Marconi	Good
DVOR	50 W	1	1989	Toshiba	Good
DME	1 KW	1	1987	NEC	Good
DME	100 W	1	1989	DELCOM	Good
NDB	1 KW/500W	1	1978	DELCOM	Need replacement
ASR (PSR)	500KW 60NM	1	1989	Toshiba	Good
VHF (TX/RX)	25 W single channel	11		PEA	Good
VHF (TX/RX)	15 W multi channel	2		PEA	Good
UHF (TX/RX)	25 W single channel	3		PEA	Good
Tape Recorder	40 track	1			Good
Reproducer	40 track	1			In repair shop
Comm. Console	Console, Comm. Rack	1			Good
UHF Radio Link	6 channels	1		Toshiba	Good
PABX	116 lines	1			Good
PABX	200 lines	1	1991	Northern Telecom	Good
Teletype Multiplex	12 channel	1			Good
Teletypewriter	Keyboard/Printer	1			Good
Teletypewriter	Printer	10			Good
Teletypewriter	75B Keyboard/Printer	1			Good
Engine Generator	220/380 V	6	1981 ~ 1992	Cummins/Marathon	Good
Engine Generator	220/240 V	3	1987	Cummins/Marathon	Good
UPS	30 KVA 30 min.	1	1990	Emerson	Good
Ceilometer		2			Good
RVR		2			Good
Anemometer	Prop type	6			Good
Temperature/RH		2			Good
Pressure Sensor		2			Good
Precipitation Gauge		2			Good
Data Processor		1		Climatronics Corp.	Good
Data Display		4		Climatronics Corp.	Good
Weather Radar	500 KW 480/120 km	1	1990	Enterprise Electronics	Good
Microwave Radio Link	6650 MHz	1	1990	MAC Inc.	Good

(2) DVOR/DME

DVOR/DME was installed in 1987 and are operated in good condition.

(3) NDB

NDB (1 kW) installed at transmitter site was manufactured in 1978. The equipment is barely maintaining half of the nominal performance in terms of output power. AEROTHAI is promoting the NDB replacement plan.

6.13.2 Air Traffic Control System

(1) Control Area and Control Zone

Phuket Air Traffic Control provides Approach Control service (APP) and Aerodrome Control service (ADC) within an area of 30 NM radius and 5 NM radius from the airport respectively.

Primary Surveillance Radar (PSR), which has a 60 NM coverage range for APP, is installed on top of a mountain (253.3 m) about 3 km from the Control Tower.

UHF radio link, connecting the radar site and Control Tower, is operated to transmit radar signal with 6 channel capacity.

Secondary Surveillance Radar (SSR) is installed at Surat Thani, 75 NM distance from PSR.

The radar signal of the PSR and SSR are integrated by radar data processor which is installed at the radar equipment room in the Control Tower.
Radar display consoles and bright display console are provided in the ATC operation room and Control Tower cabin.

(2) Telecommunication Console

Communication consoles are provided for approach control and departure control positions in the ATC operation room, aerodrome control and ground control positions at the Control Tower cabin.

Flight Data Processing console and Supervisory console are also provided in both control rooms.

All consoles are controlled from the communication control rack installed in the equipment room. The equipment is operated in good condition.

Fixed communication and mobile communication are made by pressing a button down on the console except for emergency communication. In case of emergency, communication between Control Tower and related offices such as the fire station will be provided by mobile handy transceiver network.

(3) Voice Logging Recorder and Reproducer

All telecommunications are recorded by dual track voice logging recorder which has a 40 channel recording capacity. However, stand-by recorder for maintenance is not provided.

6.13.3 Aeronautical Telecommunication

(1) Mobile Telecommunication

Five (5) VHF channels and three (3) UHF channels are allocated for air to ground, ground to ground mobile telecommunication services. A dual radio transmitter (single channel) and a dual radio receiver (single channel) are provided for each frequency. Spare radio transmitter sets and radio receiver sets are provided.

Multi channel radio transceivers which cover all service frequencies, are provided in the transmitter station and Control Tower cabin. Radio transmitter equipment is installed at the transmitter station and radio receiver equipment is installed in the equipment room of the Control Tower.

The equipment is maintained in good condition.

(2) Fixed Telecommunication

Direct speech telephone circuit and domestic teletype circuit are provided between Phuket and Bangkok. Direct Speech Network is shown in **Figure 6.13.3**.

Signal for domestic teletype circuit from/to Bangkok is divided in 12 teletype channels by audio frequency shifting keyer (Speech Plus) installed at Communication Center in the Terminal Building.

Teletype terminals (keyboard and/or printer) are provided in the Communication Center, Briefing Room, Approach Control, Control Tower cabin, AAT and Met Center.

All telephone and teletype communications are installed by over head telephone cable within the airport. Telecommunications to outside of the airport are connected by land line or microwave radio link to Thalang TOT (Telephone Organization of Thailand) Station or Mt. Tosea microwave radio relay station which is controlled by CAT (Communication Authority of Thailand).

Communication cable diagram is shown in **Figure 6.13.4**.

6.13.4 Airfield Lighting System

The following Airfield Lighting Systems currently operated are:

- Simple Approach Lighting System (SALS) for Runway 27
- VASIS for Runway 27
- PAPI for Runway 09
- Runway Edge Lights
- Runway Threshold and End Lights
- Runway Threshold Identification Lights for Runway 09
- Taxiway Edge Lights
- Illuminated Wind Direction Indicators
- Guidance Signs
- Aerodrome Beacon
- Apron Floodlights
- Obstruction Lights

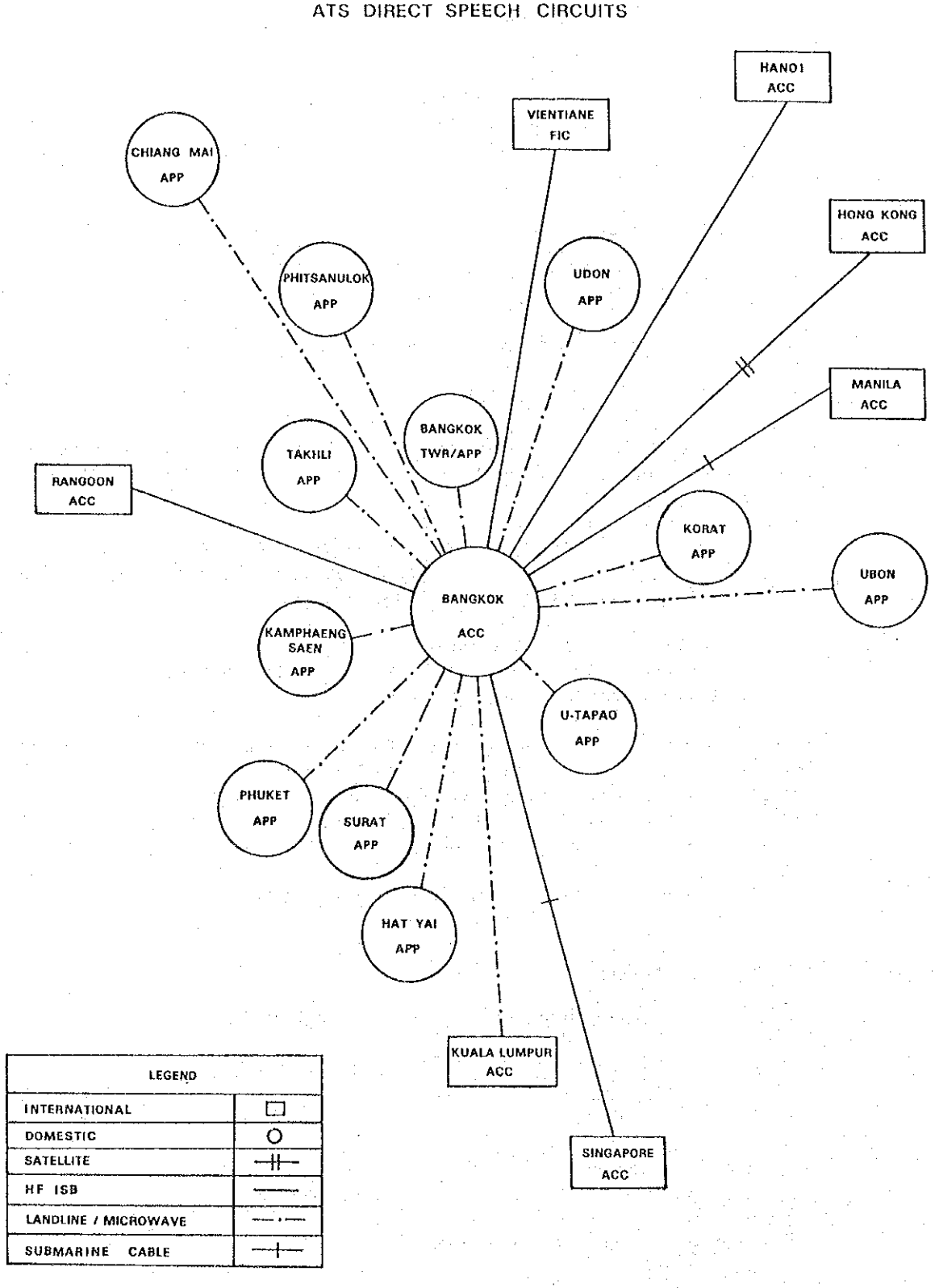

Figure 6.13.3 Direct Speech Network

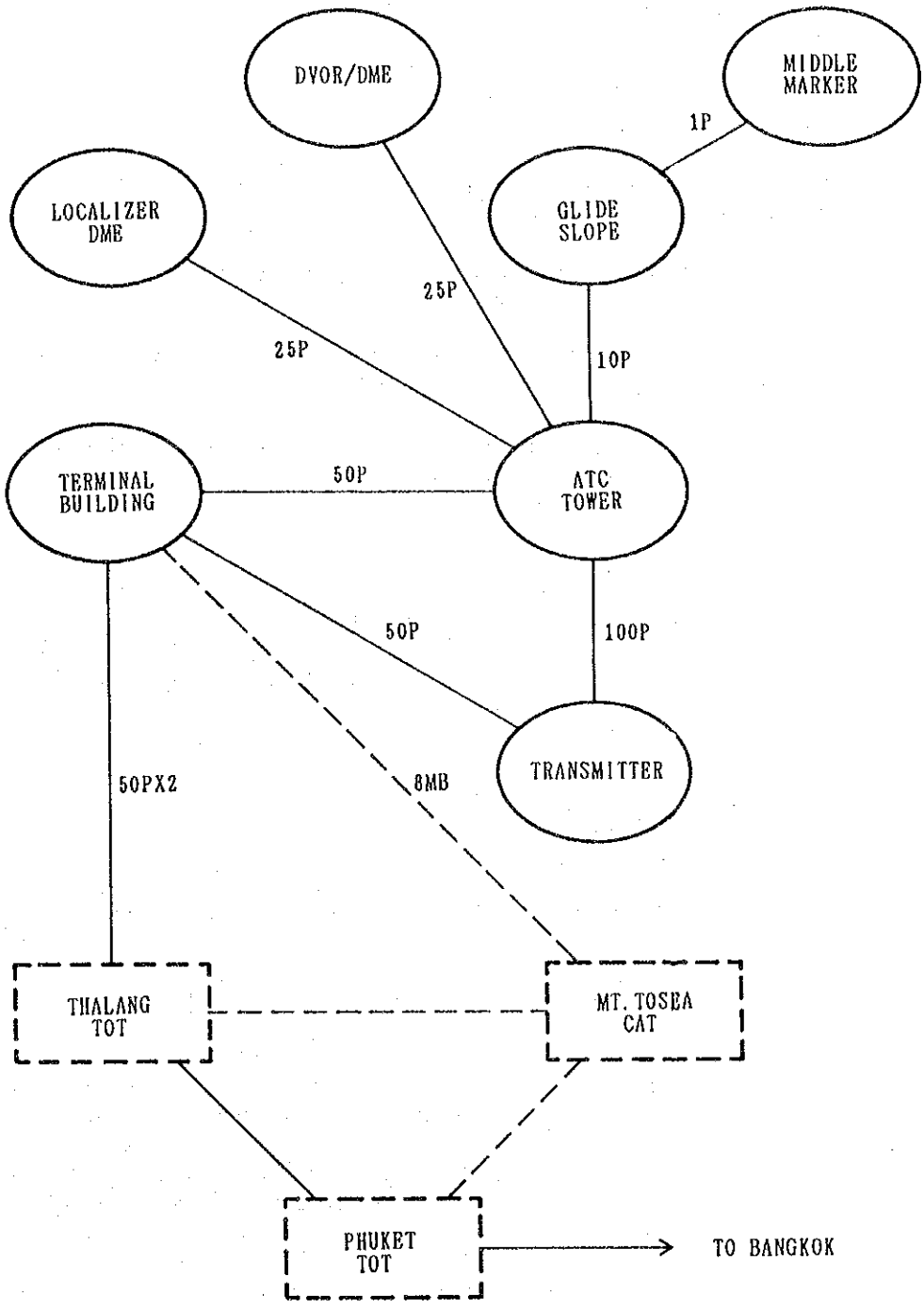

Figure 6.13.4 Communication Cable Diagram

The parallel taxiway (Taxiway P) is equipped with taxiway edge lights and holding position lights.

The existing VASIS for Runway 27 approach was also be replaced with PAPI in this construction stage.

Electric power is supplied from AFL substation controlled by CCR and switching relay panel.

Lighting intensity is controlled in 3 or 5 stage brilliancy by CCR mentioned above.

AFL control console, which can control lighting brilliancy, is installed in the Control Tower cabin. Local control is provided as well.

Obstruction Lights are installed on artificial obstructions around the airport such as radar tower, but not on the hills.

6.13.5 Meteorological Observation System

(1) Automatic Weather Observation System

The following sensors are provided for the weather observation field:

- Anemometer
- Temperature sensor
- Relative Humidity sensor (RH)
- Pressure gauge
- Precipitation gauge
- Ceilometer
- Runway Visual Range (Transmissometer and Background Light)

Weather observation field areas are provided near the touch down point of both ends of the runway.

The current observing data except ceilometer data are collected and converted to series data format at the weather observation fields.

All of the observing data, which are transmitted from the field via land line or radio link, are gathered at the central processor installed at the Meteorological Center.

Processed weather observation data are provided to monitor displays which are installed at Met. Center, Briefing Room, ATC operation room and Control Tower cabin. The system is operating in good condition.

(2) Weather Radar

Weather radar, which performs observation of cloud and rain intensity within 480 km radius, is provided adjacent to PSR. Cloud velocity is detectable within 120 km radius.

Radar video signal is transmitted to Met. Center by microwave radio link.

Processed radar video signal is provided to the radar console at Met. Center and monitor displays which are installed in the Met. Center, Briefing Room and Control Tower cabin.

Met. radar and PSR are operated in the same frequency band and the same with distance of about 30 m. However, no interference has been recognized between both radar systems.

6.13.6 Evaluation

The following items should be considered in this project:

(1) Approach Lighting System (ALS) and the Middle Marker Location

The existing Simple Approach Lighting System (SALS) for Runway 27, which consists of four (4) barrette lights and one (1) cross bar light, should be replaced in the Approach Lighting System.

Under the condition of off-set LLZ approach, sufficient visual guidance aids is required to align aircraft axis on the runway center line at the intercepting point.

According to ICAO Annex 10, Middle Marker should be installed at 1050 m. ± 150 m on the extended runway center line from the approach runway threshold. Relocation of the Middle Marker to the new site may perform without serious obstruction in geographical condition.

(2) Airport Surveillance Radar (ASR)

The maximum range of radar coverage of ASR (PSR/SSR) in Thailand FIR is shown in **Figure 6.13.5.**

Phuket approach control area is covered by Phuket PSR and Surat Thani SSR radar coverage. Both radar signals are integrated in one radar signal and established as digital radar symbol on the Phuket radar console.
However, at the low altitude in the SSR coverage in Phuket control area is not sufficient for radar surveillance and control due to geographical condition from Surat Thani SSR.
Additional SSR to Phuket PSR should be considered.

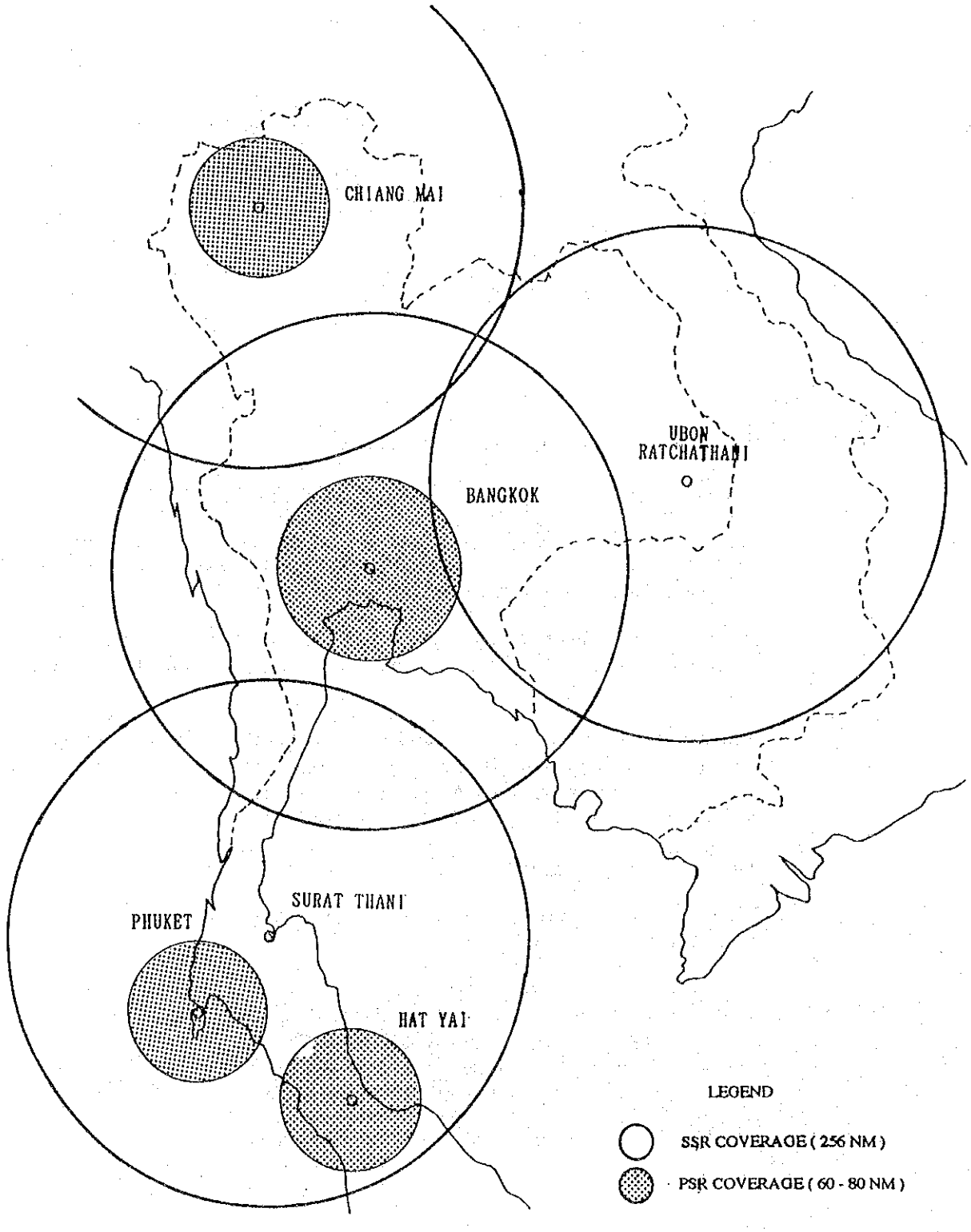

Figure 6.13.5 Layout of Radars in Thailand FIR

6.14 RESCUE AND FIRE FIGHTING SERVICES

6.14.1 Category for Services

The current airport is being operated by the following aircraft.

A-300	:	480 flights per month
B-737	:	140 flights per month
DHC-8/ATR 42	:	120 flights per month

The airport category for rescue and fire fighting services will be determined by the overall length of the longest aeroplane and their maximum fuselage normally using the airport, and the movements in the busiest consecutive 3 months of the year shall also be considered in compliance with ICAO recommendation.

The airport category for the services is determined as Category 8, based on the above-mentioned condition in compliance with the ICAO recommendation.

The notification on crash protection category of the airport by AIP-Thailand is Category 8.

The type and number of vehicles are as follows:

Fire fighting vehicle	:	2 nos.
R I V	:	1 no.
Tank car	:	1 no.
Ambulance	:	1 no.
Engine boat	:	1 no.

6.14.2 Capacity of Extinguishing Agents

The current capacity of the facility provided at the airport is as follows:

Foam tank car x 2	AFFF	1211 x 2	=	2,422 l
	Water	9463 x 2	=	18,926 l
Rapid intervention vehicle	Dry foam		=	492 l

The minimum usable amounts of extinguishing agents for AFFF (Aqueous Film Forming Foam) is recommended 18,200 l's of water for airport Category 8 in

Airport Service Manual of ICAO and amount of dry chemical as complementary agents for the same airport category is 450 l.

6.14.3 Evaluation

All vehicles have been provided since 1987 and it is considered that there are no troubles on the number of personnel, stock of chemical agents, etc.

6.15 AIRPORT UTILITIES

6.15.1 Power Supply System

Major airport facilities are supplied with 33 KV high voltage power line from PEA (Provincial Electricity Authority) individually.

System Diagram is shown in **Figure 6.15.1**

All facilities are provided with emergency engine generators except Met. Center.

Capacity of the engine generator for the terminal building is insufficient. AAT has a plan to install an additional generator.

Six month's data of power supply from PEA to Phuket International Airport shows 18 power interruptions per month with 5 minutes average interrupting time.

As shown in this data, stable power supply system, which is backed up by engine generators, are required at Phuket International Airport so as to continue operation without interruption if PEA supply is interrupted.

Status of supply power should also be monitored and controlled at a central power station.

- Terminal Building and AFL Sub Station

  Although additional engine generator to Terminal Building is planned by AAT, additional engine generators will be required for maintenance. Additional emergency engine generator for AFL will also be required as a spare for maintenance.

- Control Tower

  Power distribution system for radio navigation aids at Control Tower should be rearranged so that all radio navigation aids and communication systems are provided with power from this station.

- Meteorological Center

  The equipment for airport operation such as observation data processor, weather radar and microwave radio link should be supported by emergency power supply system.

6.15.2 Telephone System

Two (2) telephone PAX (Private Automatic Exchange) are provided in the Terminal Building and Transmitter Building. One of the telephone exchange systems, which has 200 capacity, is maintained and operated by AAT to provide service to facilities within the Terminal Building area. Seven (7) commercial telephone lines from Thalang TOT (Telephone Organization of Thailand) are accommodated in this telephone exchange trunk.

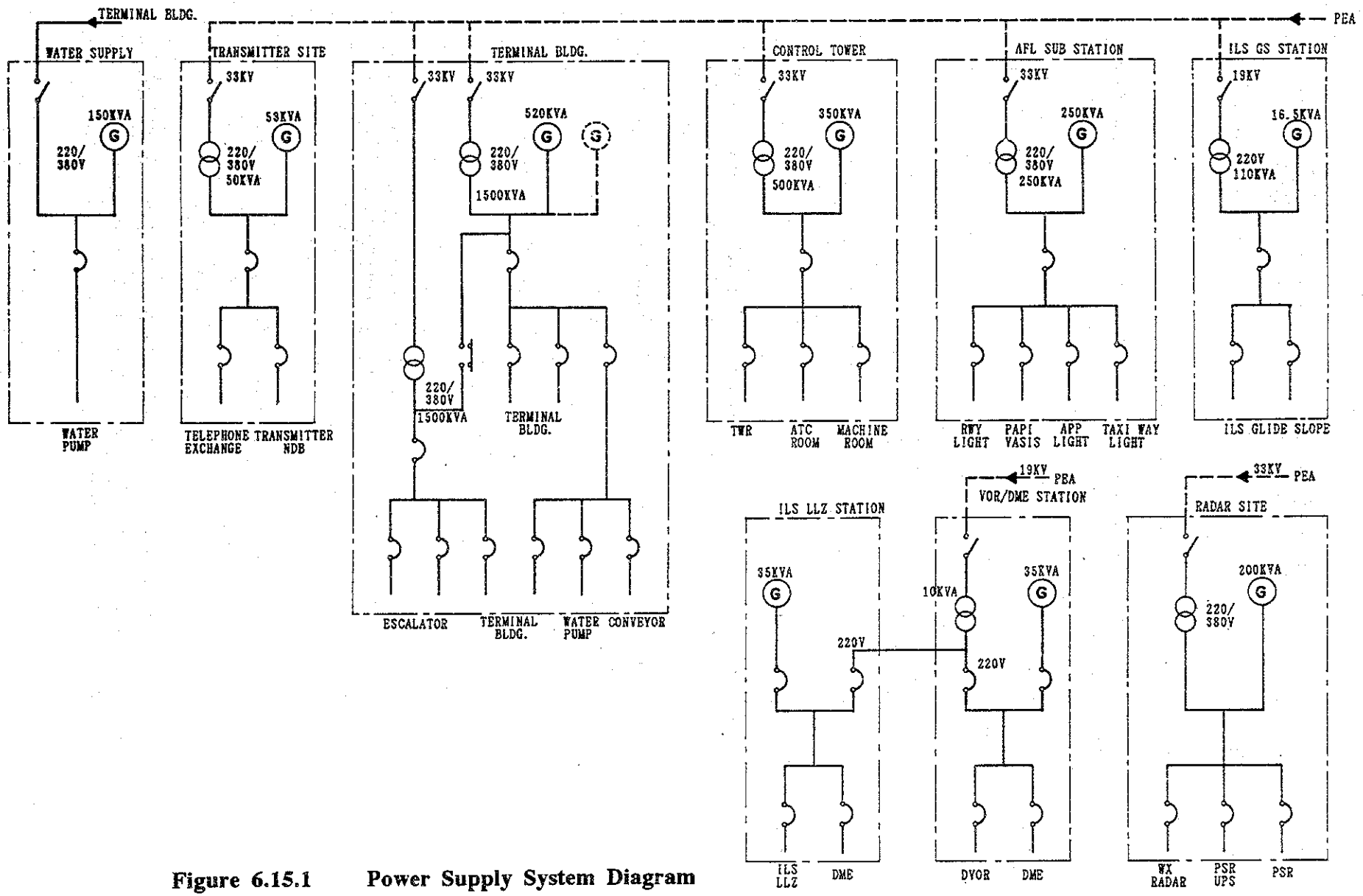

Figure 6.15.1 Power Supply System Diagram

Another telephone exchange system having 116 capacity is maintained and operated by AEROTHAI to provide administrative service to ATC facilities.

Sixteen (16) commercial telephone lines from Thalang TOT are accommodated in this telephone exchange trunk.

Both telephone systems are connected with one(1) pair of tie line.

It is considered that there is no problem on the operational condition of the system in the present condition.

6.15.3 Water Supply System

Outline of the system is as follows:

- Source of water : By 7 deep wells
- Total capacity : 300 ton/day
- Consumption : Average 250 ton/day

The existing water supply system has no problem for the present demand.

6.15.4 Sewage Disposal

Sewage disposal is treated by the oxidation pond, which is located at the west side of terminal apron and close to the beach. Maximum treated volume is about 250 ton/day.

An additional oxidation pond is about tobe completed near the existing one as of May 1993.

6.15.5 Solid Waste Disposal

Solid waste from the airport is collected and treated by an agent outside.

6.16 FUEL SUPPLY SYSTEM

The apron fuel hydrant system for Jet A-1 was applied at Apron C, however the number of hydrant pits is three in spite of four parking spots. It is operated by Petroleum Authority of Thailand (PAT).

Outline of the facilities is as follows:

- Storage tank for JET A-1	4	tanks	538,000 l
- Storage tank for Avgas	1	tank	3,000 l
- Servicer	4	nos.	12,000 l
- Tank truck	3	nos.	15,000 l

It is considered that there is no problem on the existing facility under the current operational condition. Also, there are some future extension plans being accompanied with the expansion of apron.

CHAPTER 7

BASIC DEVELOPMENT POLICY FOR AIRPORT MASTER PLANNING

CHAPTER 7 BASIC DEVELOPMENT POLICY FOR AIRPORT MASTER PLANNING

7.1 OBJECTIVE OF AIRPORT MASTER PLAN

This chapter explains the alternative airport master plans of Phuket International Airport in order to study the development policy for the future through the comparison study. Airport master plans are prepared for the long-term development based on the airport facility requirements analysis described in Chapter 5, the evaluation of the existing airport facility in Chapter 6, and the environmental consideration in Chapter 11. The phased development plan will be studied in line with this airport master plan.

The main objective of the airport master plan is to provide guidelines for the future development which will satisfy traffic demand and will be compatible with the community development and environmental conditions of the surrounding area. For this purpose, development alternatives are prepared and carefully studied in order to extract the most appropriate development plan for the Phuket International Airport.

Airport master plan should also be established in consideration of the preservation of the environment circumstances as mentioned in Section 11.4 "Environmental Evaluation ".

Figure 7.1.1 shows the flowchart of the Airport Master Planning.

7.2 TARGET YEAR

The phases of the airport development is set forth as follows:

Short-term development : Design target year 2000

Long-term development : Design target year 2010

7.3 CONCEPT OF DEVELOPMENT ALTERNATIVES

Three development alternatives as explained below are prepared for the long term development. Two alternatives are established for the existing airport development in consideration of two different concepts for development i.e. expansion and upgrading. In consideration of fundamentally different measure for the existing problem, one alternative for a new airport development will be established.

Alternative-1 : Expansion of the existing airport

In order to cope with the traffic demand of the target year, the facilities of the existing airport will be expanded and will have sufficient capacity for the future increasing traffic demand.

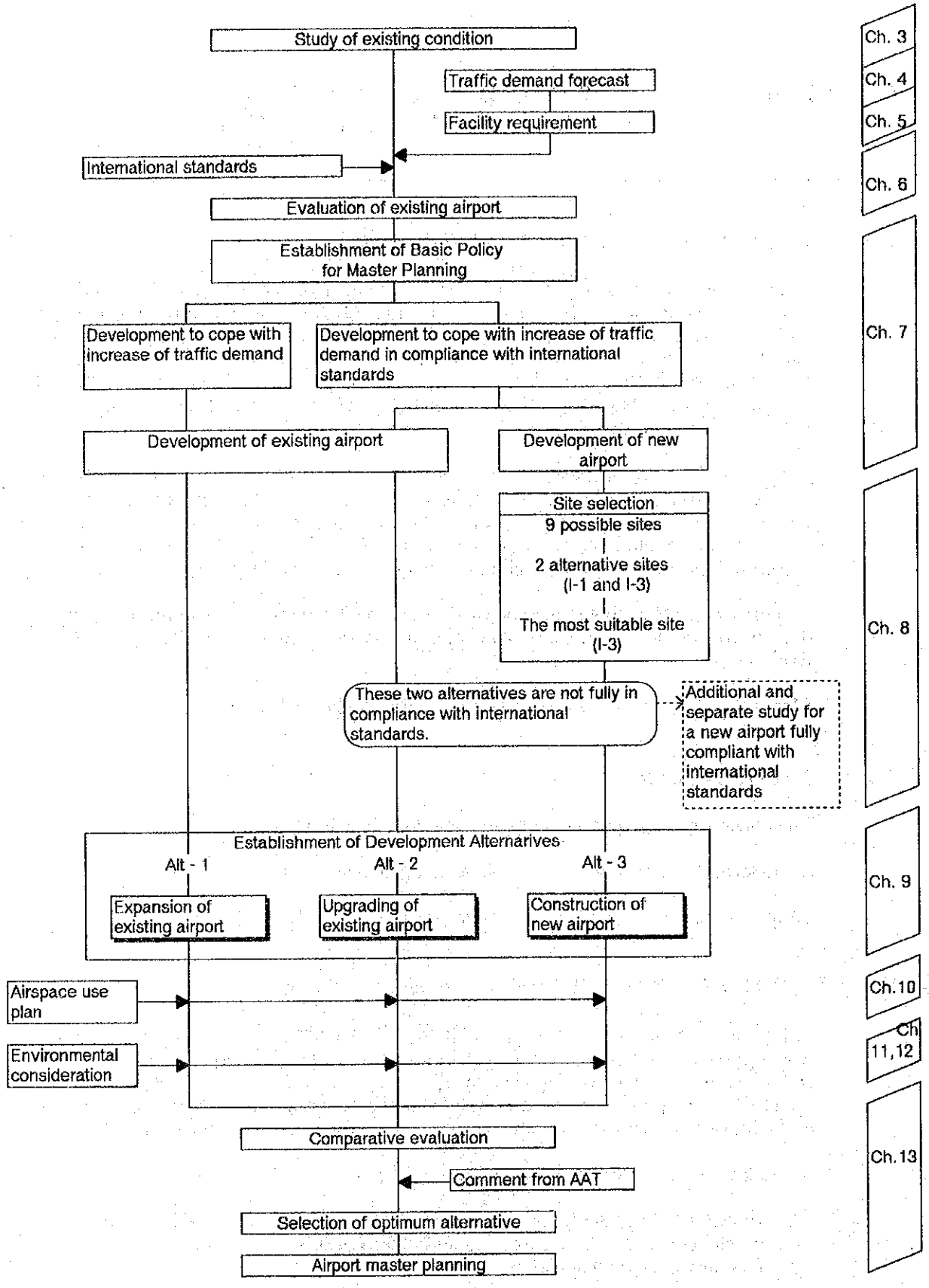

Figure 7.1.1 Flowchart of Airport Master Planning

Alternative-2 : Upgrading of the existing airport

For further development of the airport in compliance with the international standard in addition to the development of Alternative-1, the existing airport will be improved in compliance with the ICAO standards and recommendations taking into consideration the cost and benefit of each work item.

Alternative-3 : New airport development

Due to the constraint of the existing airport for future development, another alternative will be established instead of the upgrading or expansion of the existing airport by the new airport construction. The new airport shall be planned in compliance with the ICAO standards and recommendations in order to be free from the various constraint experienced at the existing airport. For the completion of a new airport, it is considered to take many years, and for this reason short-term development will be temporarily required at the existing airport.

Above three alternatives will be studied in the following.

CHAPTER 8

SELECTION OF NEW AIRPORT SITE

CHAPTER 8 SELECTION OF NEW AIRPORT SITE

8.1 GENERAL

This chapter explains the selection of a suitable site for a new airport which will be one of the Airport Development alternatives. The procedure for site selection is summarized in the flow chart as shown in **Figure 8.1.1**. Major points are as follows:

(1) Establishment of Possible Sites on the Map

Several sites which satisfy the requirements for a new airport site can be found on the map. (In this Study, nine sites were established.)

(2) Selection of Alternative Sites

Two alternative sites are selected from the possible sites considering the results of field survey and data collection.

(3) Selection of a New Airport Site

The most suitable site for a new airport development is selected from the two alternative sites through the further detailed study.

The study area for site selection is the whole area of Phuket Island and the adjacent area in the main land.

8.2 REQUIREMENT FOR NEW AIRPORT SITES

The preliminary study, which was provided by JICA, on the site selections of new airport was carried out on the map of Scale 1:50,000 as the part of preparatory works in Japan. The conditions for this preliminary study are as followed:

(1) 3500 m runway length with single runway system.

(2) 300 m runway strip width in compliance with instrument approach runway by ICAO recommendation.

(3) Maintaining of approach surface and inner horizontal surface for instrument runway in compliance with Obstacle Limitation Surface by ICAO Annex 14.

(4) Airport land space for maintaining minimum separation distance between runway and full parallel taxiway by targeted aircraft of B-747 in compliance with ICAO recommendation.

(5) Consideration of 500 m depth of terminal area.

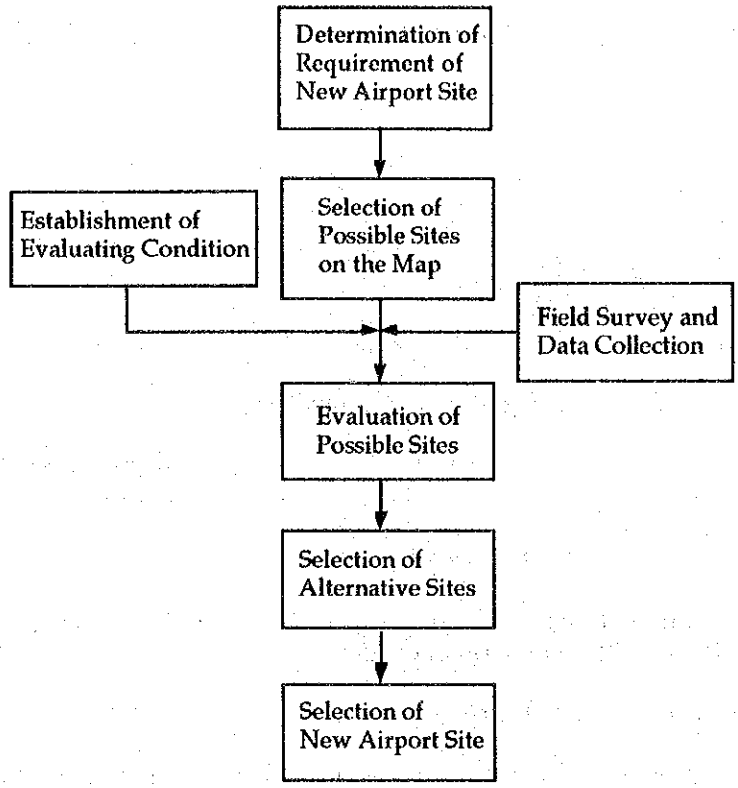

Figure 8.1.1 Flow Chart of New Airport Site Selection

(6) Consideration of 1000 m width of terminal area for maintaining of 500,000 m^2 of total terminal area.

(7) The space for LLZ and ALS at both runway ends is considered. In case of the provision of ALS, the site considered will not only be on the land but also in the sea.

These above mentioned condition are settled by the following considerations.

a) The existing runway length of 3000 m is considered suitable to accommodate the direct flights to London with some weight restriction. However, a 3500 m runway length will be required for the full load operation by B-747 due to the increase of future air traffic demand.

Therefore 3500 m runway length is considered in the study.

b) The main reason for the requirement of new airport will be the release from the current constraints on the existing airport for items not complying with ICAO Standard, etc.

Accordingly, the possible new airport sites will meet the conditions for runway strip, approach surface and other items recommended by ICAO.

c) Separation distance between the runway centerline and the parallel taxiway centerline is considered to be 182.5 m to comply with ICAO Aerodrome reference code E (B-747 class aircraft).

d) The detailed configuration of taxiway system and terminal area layout plan will be studied in the following stage.

The basic shape of the airport property for the study is drawn as shown on **Figure 8.2.1.**

8.3 BACKGROUND OF THE STUDY AREA

8.3.1 Geographic Condition

Most of Phuket Island is low land less than 60 meters above sea level and some parts along the west coast is hilly areas. Relatively flat area is situated in the central part and northern end of the island where Phuket town is located and remaining areas are mainly hilly and mountainous areas. Small coastal plains are also located mainly along the east coast of the island. Many small islands are found mainly offshore of the eastern and northern coasts.

Due to the limit in the availability of the vast and flat land being suitable for an airport construction, possible sites for a new airport are limited to the following area of the island:

a) Central and northern plains
b) Coastal plains
c) Small islands around the Main Island

There are many undulations in the hilly areas, and suitable sites cannot be found in the hills.

8.3.2 Socio-Economic Condition

The total land of 543 square kilometers in Phuket is classified into five major categories; urban lands, mining areas, agricultural lands, forest areas and coastal ecosystems, according to its land use.

Land tenure is a crucial determinant for the development projects in the Island. In Phuket, more than a half of the island is in private ownership, about 40% is in some type of preserved area, and the remainder belongs to the land for public ownership. Furthermore, as the expansion of urban areas and the increase of tourism facilities have pushed up land prices considerably in Phuket Island, land acquisition has become very difficult at present.

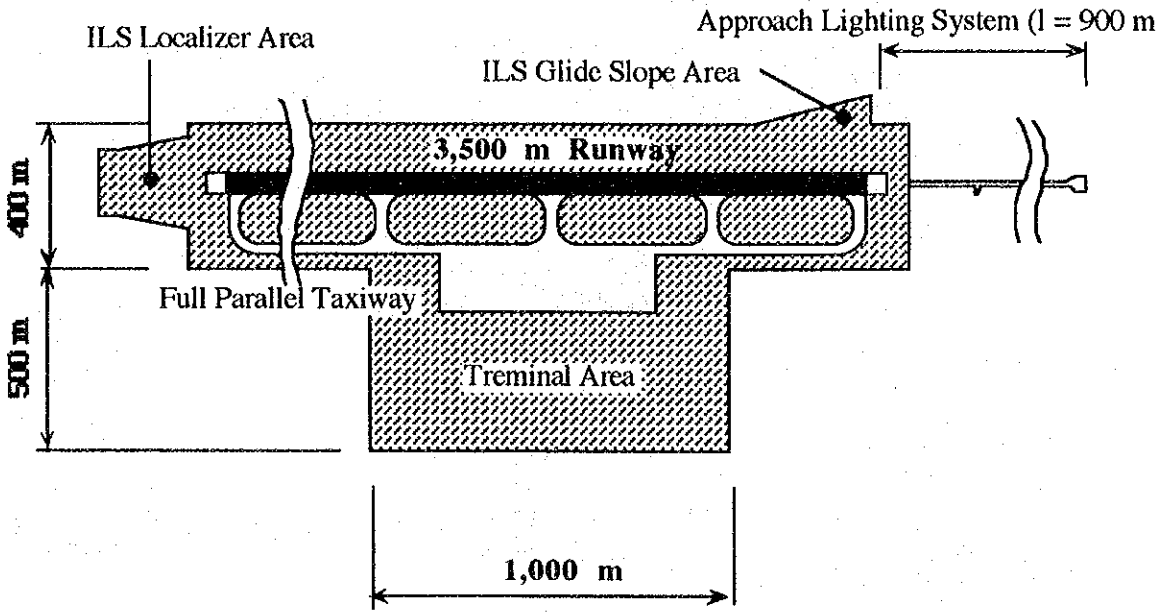

Figure 8.2.1 Layout of New Airport

Agricultural areas cover almost 50 % of the land preserves of Phuket Island. In the vicinity of Phuket Town, the expansion of urbanized areas is remarkable, where several new housing developments are in progress. The tourist accommodations, which started to increase rapidly during the late 1980's, are concentrated along the southern beaches on the west side of the island until recently. However, along Bang Tao Beach located in the middle on the west coast, new hotel developments are currently proceeding. The northern part on the west coast, Mai Khao and Nai Yang Beaches, are preserved as a National Marine Park, and a few bungalows are available. On the area of 3,000 rai at the northern part of the Island, Royal National Park Project started on October 1991 and will be completed on September 1993, according to the resolution of the Cabinet.

8.3.3 Environmental Conditions

Environmental conditions are explained in Chapter 11.

8.4 EVALUATION CRITERIA

Following criteria are established for the evaluation of the possible new airport sites.

8.4.1 Aircraft Operational Condition

(1) Obstacle Limitation Surfaces

The selecting condition for candidate sites of new airport are based on the international standards and recommended practices described in Annex 14, Aerodromes, ICAO. Candidate sites were studied on the assumption for 4E of aerodrome reference code and precision approach category I for runways.

The obstacle limitation surfaces which are the most fundamental subject for establishment of a new runway are shown in **Figure 6.12.1**. Detailed dimensions are given in **Table 6.12.1**.

The obstacle limitation surface for take-off are also shown in **Figure 6.12.1** and detailed dimensions are given in **Table 8.4.1**.

Precision approach procedures for candidate sites are not studied in detail, but it is considered that there is a possibility for establishment of precision approach and departure procedures in accordance with the PANS-OPS (Procedures for Air Navigation Services, Aircraft Operations, DOC 8168-OPS/611, ICAO). if no obstacles project above the obstacle limitation surfaces for the intended runway.

The orientation of runway of each candidate site was studied so as to align on the east-west or similar direction considering the weather data at Phuket International Airport and prevailing wind direction in Phuket Island which was informed to be east to west.

Table 8.4.1 Dimension of Take-off Climb Area and Obstacle Limitation Surfaces for Take-off

Surface and dimensions[a]	Code number 1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

(2) Wind Coverage

According to the analysis of meteorological data, distribution of wind direction and velocity is as shown in **Figures 8.4.1** to **8.4.3** and it indicates that the prevailing wind direction is a westerly wind in Phuket Island . Therefore, in case that the new runway direction is north-south, wind coverage is, as shown below, lower than that of the existing airport (east-west, 85-265 deg.).

N-S	E-W (85-265 deg.)	
95.32 %	99.77%	(Cross Wind 13 kt)
99.42%	99.97%	(Cross Wind 20 kt)

Especially in the rainy season from May to October, they fall to the following figures:

92.01% (cross wind 13 kt)
98.90% (cross wind 20 kt)

The lowest coverage occurs in September and the values are:

89.76% (cross wind 13 kt)
97.64% (cross wind 20 kt)

8.4.2 Environmental Conditions

Environmental conditions are explained in Chapter 11.

8.4.3 Construction Conditions

In general, construction of the new airport will be accompanied by large-scale civil works such as a large amount of cut and embankment works and huge amount of pavement works. Especially, if high embankment or cutting of mountains and hills are required, earth works may sometimes dominate the construction cost and period.

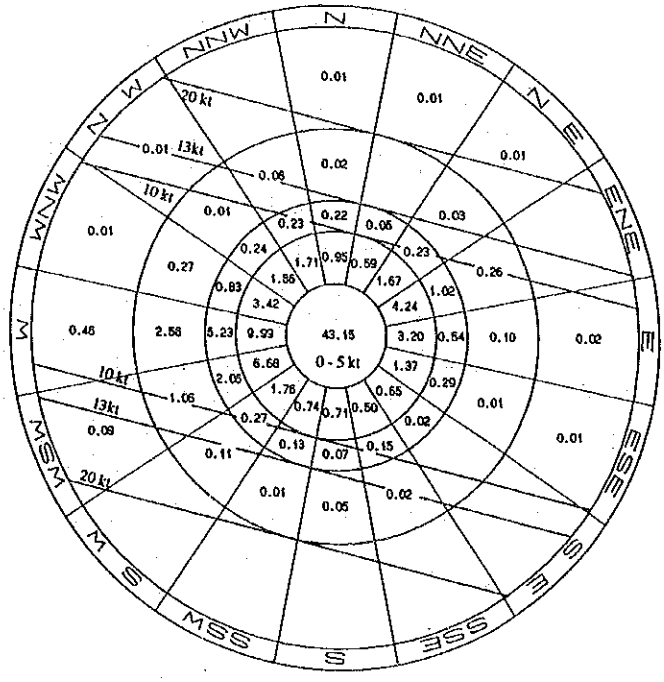

Figure 8.4.1 Wind Rose (All Seasons)

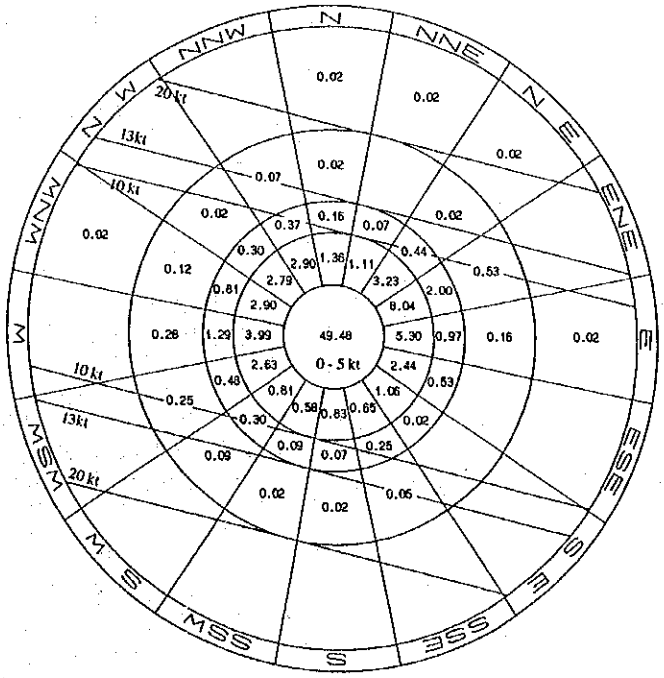

Figure 8.4.2 Wind Rose (Dry Season)

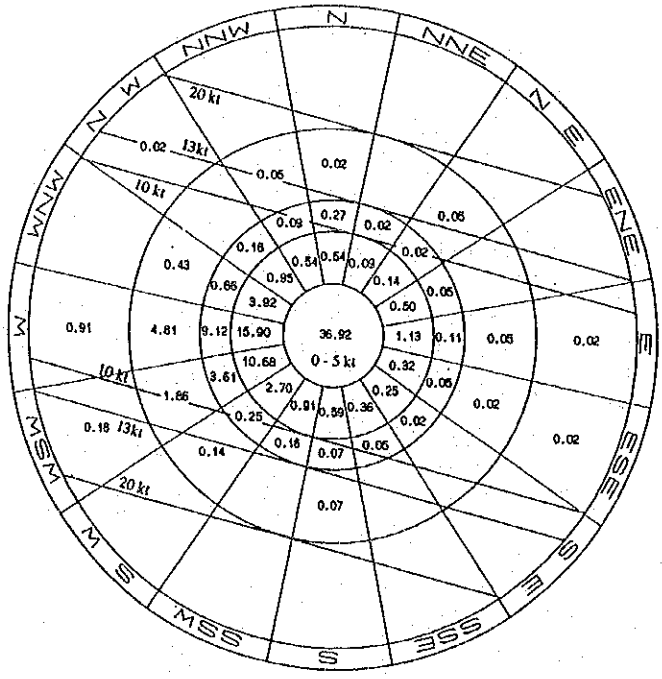

Figure 8.4.3 Wind Rose (Rainy Season)

In the case of a marine airport or some sort of coastal airport, reclamation and revetments will be required. Construction conditions of access road and utilities such as electricity and telephone will be variable from place to place since it depends on the required extent of construction or improvement works, in order to connect with the existing utilities.

Future expansion is evaluated from the viewpoint of difficulties for construction of runway extension and terminal area expansion.

8.4.4 Other Conditions

Phuket Island is a small island and highly populated. There are many tourism resources and resort developments. The difficulty of land acquisition is, therefore, expected from the existing land use conditions.

In Phuket Island main access demand for tourism industry occurs in the southern part of the Island, such as Phuket Town, Patong and Karon Beach. Accessibility is, therefore, represented by distance of access routes from Phuket town.

8.5 SELECTION OF ALTERNATIVE SITES

8.5.1 The Process for Selection of a Suitable Site for the Airport

The process for selection of a suitable site for the new airport is as follows.

(1) Theoretical Selection Method

Using the 1 : 50,000 scale topographic map obtained for the study, 9 sites were selected as shown in **Figure 8.5.1** based on the basic conditions previously described in Section 8.2, due to the main aspects of Airport Development, Construction, Aircraft Operation, and Environment in the office.

(2) Verification of Theoretical Studies by Field Investigations

The 9 proposed sites selected in the office were examined by further field studies to check their adequacy to comply with the required conditions. Of the 9 sites, the information obtained from the maps were outdated and Sites I-1 and I-3 were confirmed to have a new bypass road and a resort area under development, etc., and would require some shifting from the original site selected. By making further studies, Site I-3 was changed by moving it closer to Site I-1 as shown in **Figure 8.5.2.**

From this field study, it was decided to restudy the 9 sites placing emphasis on Aircraft Operation and the Environment.

Table 8.5.1 shows the comparative evaluation of the nine possible new airport sites detailed in Section 11.3.

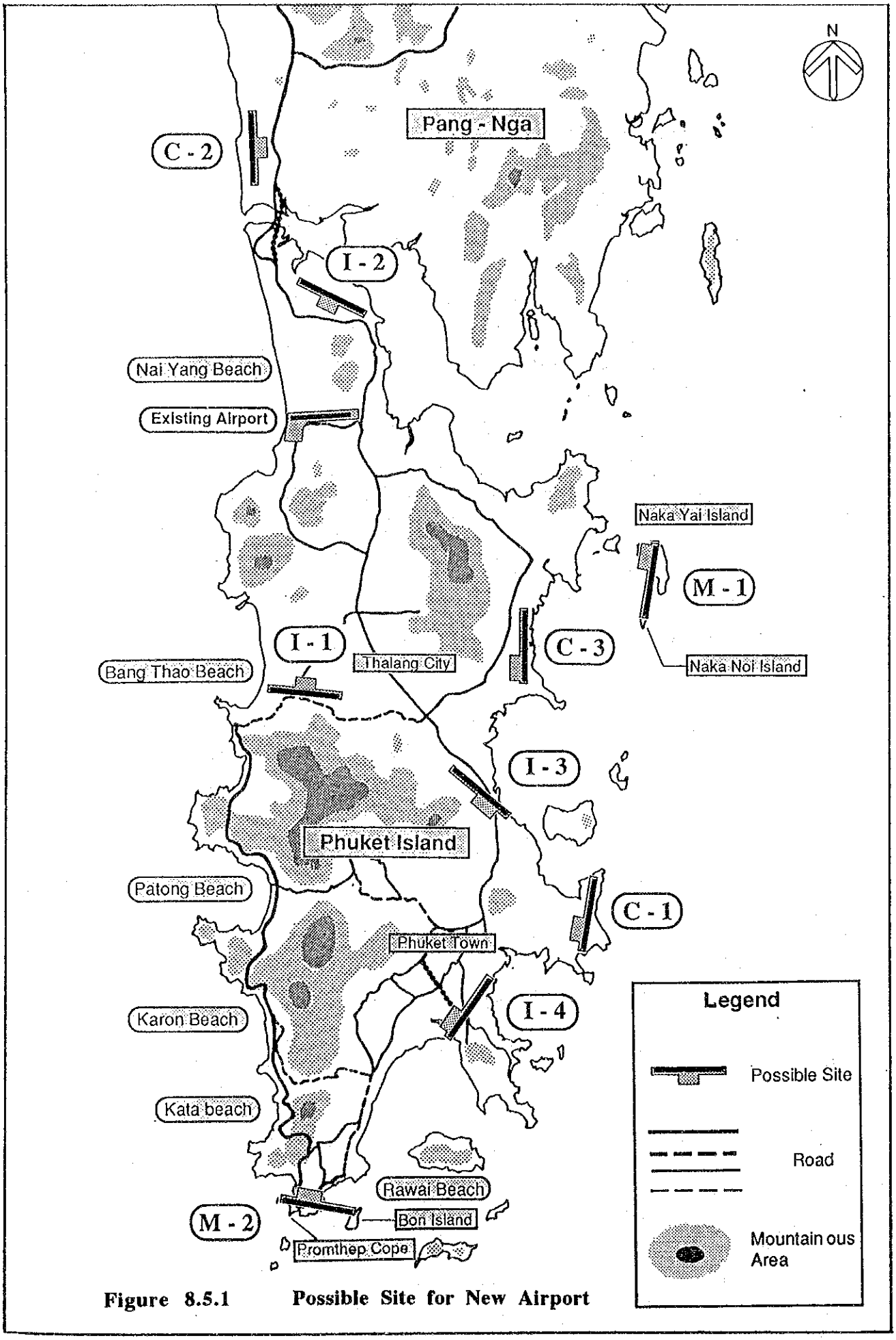

Figure 8.5.1 Possible Site for New Airport

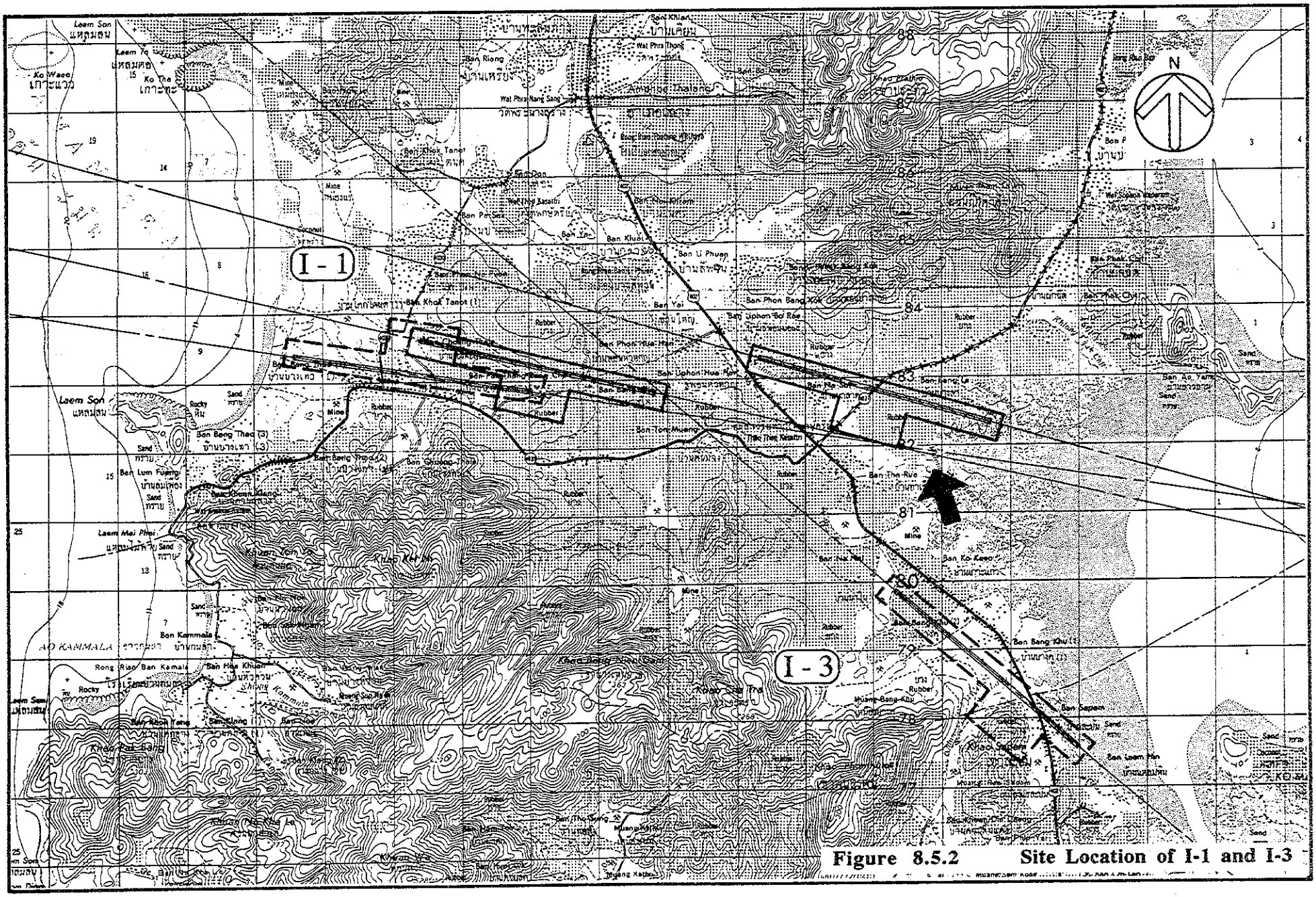

Figure 8.5.2 Site Location of I-1 and I-3

Table 8.5.1 Evaluation of Airport Sites

	INLAND											
Alt. No.	**I-1**			**I-2**			**I-3**			**I-4**		
1 Site Condition												
– Location			Central plain of the Island, near to Bang Thao beach			Northern end of the Island, near Khlong Tha Nun strait			East end of the central plain of the Island, 10 km north of Phuket Town			South-east of the Island, 4km south of Phuket Town
– Runway orientation			E - W			SEE - NWW			E - W			NE - SW
– Surrounding condition			Rice field, plantation area, village and abandoned mine on flat terrain			Rubber plantation area and village on flat hill			Swampy area and relatively flat terrain			Plantation and mangrove area
2 Airport Development Aspect												
– Extensibility of runway		A	Extensible, One side		C	Poor		B	Partial reclamation		C	Reclamation
– Extensibility of terminal		A	Expansible		A	Expansible		A	Expansible		A	Expansible
– Accessibility	A			B			A			B		
Distance from Phuket Town			27 km			43 km			13 km			6 km
Main access route		B	Routes 402 & 4025		B	Route 402		A	Route 402		A	Routes 4021 & 4023
New access road			3.3km			0.8km			0.2km			0.3km
Special access way			None			None			None			None
3 Construction Aspect												
– Special civil work required	A	A	None	A	A	None	A	B	Rerouting of Route 4027	C	C	Long rerouting of Route 4023
– Need for land reclamation		A	None		A	None		A	None		C	Partly Swampy Area
– Availability of utilities (Elec., tel., etc.)		A	No problem		A	No problem		A	No problem		A	No problem
4 Aircraft Operational Aspect												
– Obstacle Limitation Surface												
Approach * ◊		A	Clear		A	Clear		A	Clear		A	Clear
Horizontal * ◊	B	C	Hill on N (160m) Mountain on S (450m)	A	C	Hill on NNE (30m) Mountain on SSW (220m)	B	C	Mountain on N (340m) Mountain on S (80m)	B	C	Mountain on N (140m) Hill on SE (180m)
Transitional ◊		A	Clear		A	Clear		A	Clear		A	Clear
– Establishment of OPS procedure ◊		B	Possible		A	No problem		B	Possible		C	Problematic
– Wind Coverage ◊		A	Good		A	Good		A	Good		A	Good
5 Environmental Impact												
(Detailed evaluation is shown in Table 11.4.2)												
– Social Environment ◊		B	Fair		B	Fair		A	Few		B	Fair
– Natural Environment ◊	A	A	Few	B	B	Fair	A	B	Fair	C	B	Fair
– Quality of Life ◊		B	Fair		B	Fair		B	Fair		C	**Significant**
Comprehensive Evaluation	(A)			B			(A)			C		
Remarks (Main Disadvantages)				– Royal Park						**- Noise Pollution to Phuket Town**		

◊ : priority evaluation items

Bold letters indicate the decisive points of disadvantages

Evaluation
A : Excellent
B : Fair
C : Poor

MARINE						COAST									REMARKS
M-1			M-2			C-1			C-2			C-3			
North-east offshore of the Island, Nakha Yai and Naka Noi Islands in Phang Nga Bay N - S Two small islands in relatively shallow sea			South end of the Island, Partly off shore of the coast, and Man and Bon Islands E - W Rocky cape and small island			South-east of the Island, 4km east of Phuket Town, Coast of a cape N - S Plantation area between 200 and 130 meter high hills			Opposite shore of Phuket Island, West coast of Malay Pen. N - S Plantation area along undeveloped beach, and village			East of the central part of the Island, Along the coast of Phang Nga Bay N - S Plantation and mangrove area			
B	C	Large reclamation Reat Is. can be used	C	C	Large reclamation Large scale earth work	C	C	Poor Large scale earth work	B	A	Good Expansible	C	C	Partial reclamation Expansible	
	B			C			C			A			A		
	B	37 km Route 402 & 4027 7.2km Marine access		B	14 km Routes 4021 & 4024 1.5km Marine access		A	4 km Existing road 3.0km Marine access		C	55 km Route 402 0.5km None		C	24 km Routes 402 & 4027 1.0km None	
C	C	New access road includes 1,000m and	C	C	Large scale earth work for site preparation	C	C	**Large scale earth work for site preparation**	A	A	None	A	B	Detour of river	
	C	Large Scale		C	Large Scale		A	None		A	None		A	None	
	C	Problematic		B	Problematic		A	No problem		A	No problem		A	No problem	
B	C	Island on N (60m)	A	A	Clear	B	A	Clear	B	A	Clear	C	C	**Hill on N (10m)**	*Figure in ( ) shows obstacle height above surface
	B	Clear Hill on W (30m)		B	Clear Hill on N (300m)		B	Clear on E Island on W (160m)		C	Clear on W Hill on E (10m)		C	**Clear on E** **Mountain on W (440m)**	
	A	Clear		A	Clear		A	Clear		A	Clear		C	**Terrain on E**	
	A	No problem		A	No problem		B	Possible		A	No problem		C	Problematic	
	B	Possible		A	Good		B	Possible		B	Possible		B	Possible	
B	B	Fair	C	C	**Significant**	B	B	Fair	A	B	Fair	B	B	Fair	
	B	Fair		C	**Significant**		B	Fair		A	Few		B	Fair	
	A	Few		A	Few		B	Fair		A	Few		B	Fair	
B			**C**			**C**			**B**			**C**			
– Wind coverage - Environment Problems			**– Environment Problems**			**– Large Scale Earth Work**			– Wind coverage – Tourism Development			**– Obstacles (Hill and Mountain)**			

The evaluation was made on the special points to be considered which were explained in Section 8.4. Among those points, aircraft operational conditions and environmental conditions have been regarded as important in order to secure the safety of aircraft operation and to preserve the natural environmental conditions on the surrounding area. Therefore, these two conditions have been reflected more to the total evaluation of each possible site.

From the results of the restudy, evaluation results meeting with the requirements were obtained for Sites I-1, I-2, I-3, M-1 and C-2.

(3) Detailed Studies for Other Requirements

Based on the data and information collected in the field, further detailed studies were made for selection of two alternative sites from the five sites selected in the previous section. The major reason for selection are as follows:

a) For Site I-2, objection was raised by the Client that the approach lighting facility would be over the Royal Park area being developed by the Thai Royal Family. **Figure 8.5.3** shows the location of Royal Park Project.

Construction of the Royal Park will be started very soon in the northern end of Phuket Island, which is adjacent to Site I-2. The new airport is planned outside of the proposed park area, and a part of approach lighting system has to be constructed in the park area. It is very difficult to shift the new airport eastward in the limited land so as to avoid this conflict with the Park. Through further discussions with AAT, it was concluded that construction of structures such as approach lights would be impossible in the park area. Therefore, Site I-2 is eliminated from the candidate sites.

b) Site M-1 will not be recommendable in this Study because of the following reasons:

i) According to the meteorological data of last three years at the existing airport, the wind coverage for the runway of north-south direction is more than 95 % of ICAO recommendation as shown below.

99.4 %	(crosswind 20 kt)
95.3 %	(crosswind 13 kt)

However, actual wind coverage for proposed runway direction at Site M-1 is unknown since the condition of the wind on the sea will be different and may be stronger than that of the existing airport on the land.

Furthermore, the activity of the small aircraft such as general aviation occupies about 30 percent of the total aircraft movements in Phuket International Airport. Therefore, 13 kt crosswind will be considered as the important factor for the site selection on the sea.

ii) It is difficult to foresee the impact on environmental conditions caused by large scale reclamation work for construction of a new airport on the sea.

Therefore, Site M-1 is not selected only from the available information in this Study.

c) Site C-2 is eliminated from the compatibility with tourism development of the site and crosswind condition is mentioned below.

The wind coverage for the runway of north-south direction is more than 95 % as already explained, however in the rainy season from May to October, they will decrease to the following values:

98.9 %	(crosswind 20 kt)
92.0 %	(crosswind 13 kt)

Since the activities of general aviation occupies about 30 percent of the total aircraft movement in Phuket International Airport, 13 kt crosswind will be considered as the important factor for the site selection. Therefore, the wind coverage smaller than 95 percent which is less than the recommendation in ICAO Annex 14 is not suitable for a new airport site.

(4) Selection of Alternative Sites

From the reasons stated in the above, the proposed sites were narrowed down to the two Alternative Sites of I-1 and I-3. **Figure 8.5.2** shows the location of Sites I-1 and I-3.

8.5.2 Obstacle Limitation Surfaces at Alternative Sites

Obstacle limitation surfaces for landing and taking-off at the two alternative sites of I-1 and I-3 are preliminary studies as shown in **Figure 8.5.4** to **5**.

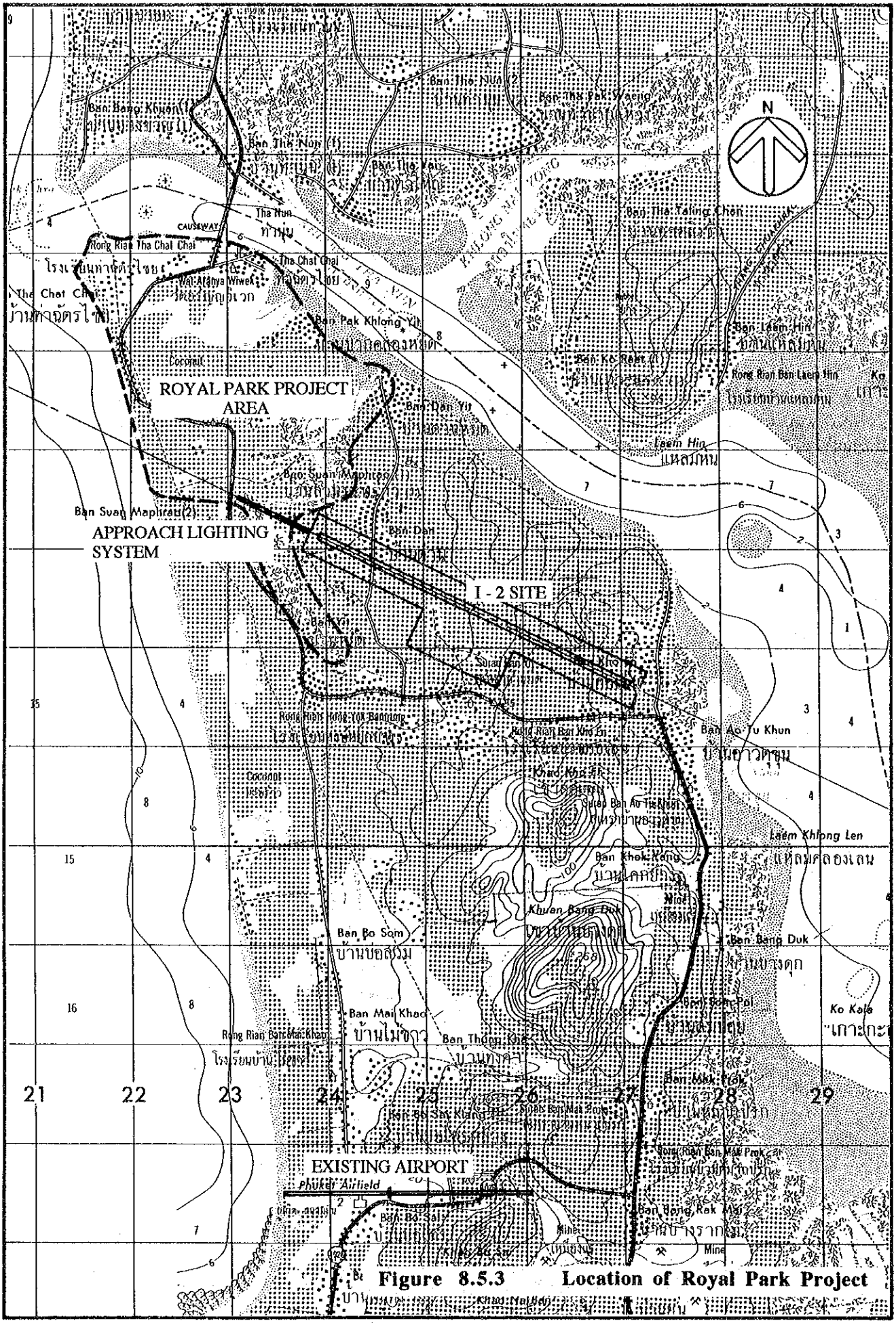

Figure 8.5.3 Location of Royal Park Project

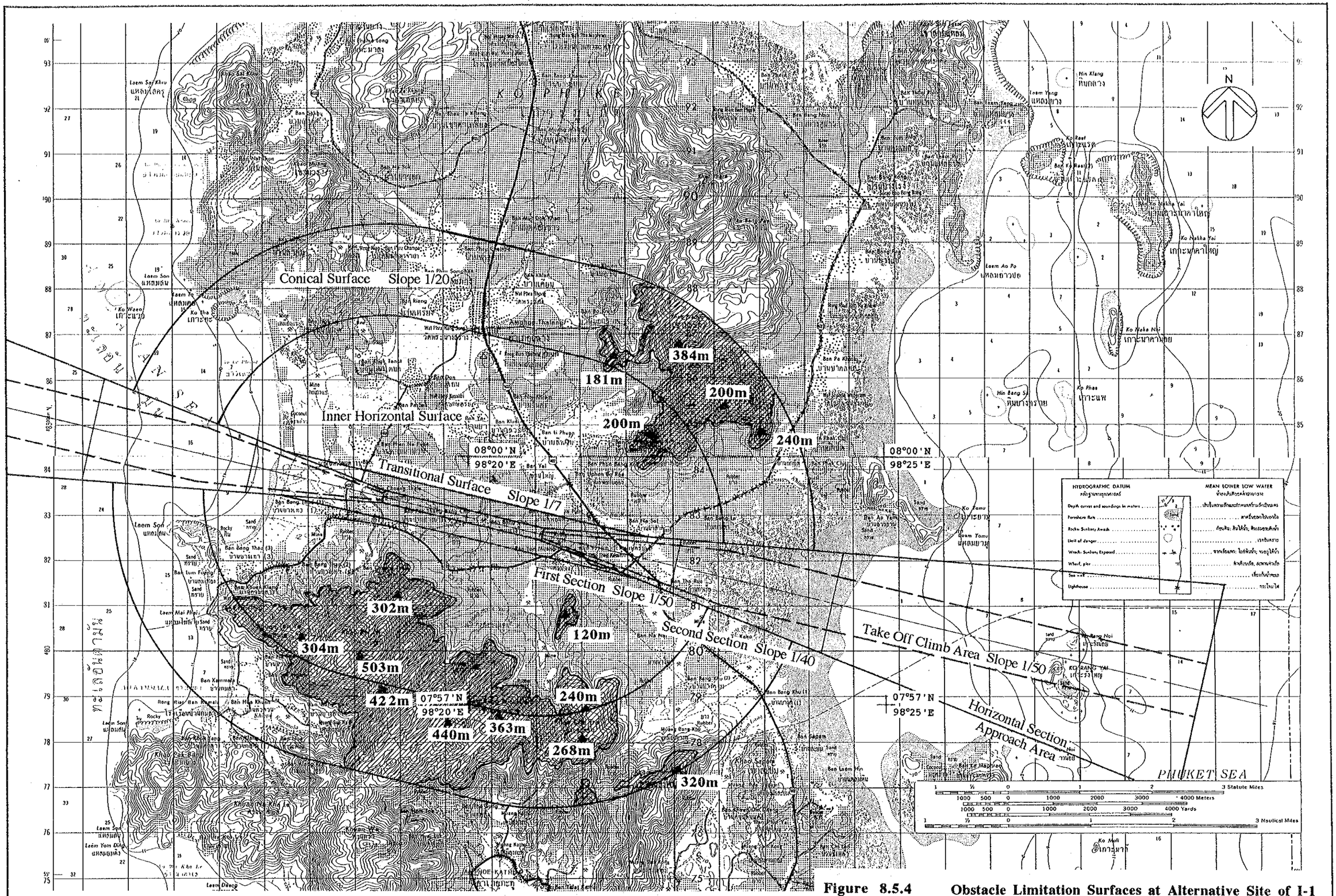

Figure 8.5.4 **Obstacle Limitation Surfaces at Alternative Site of I-1**

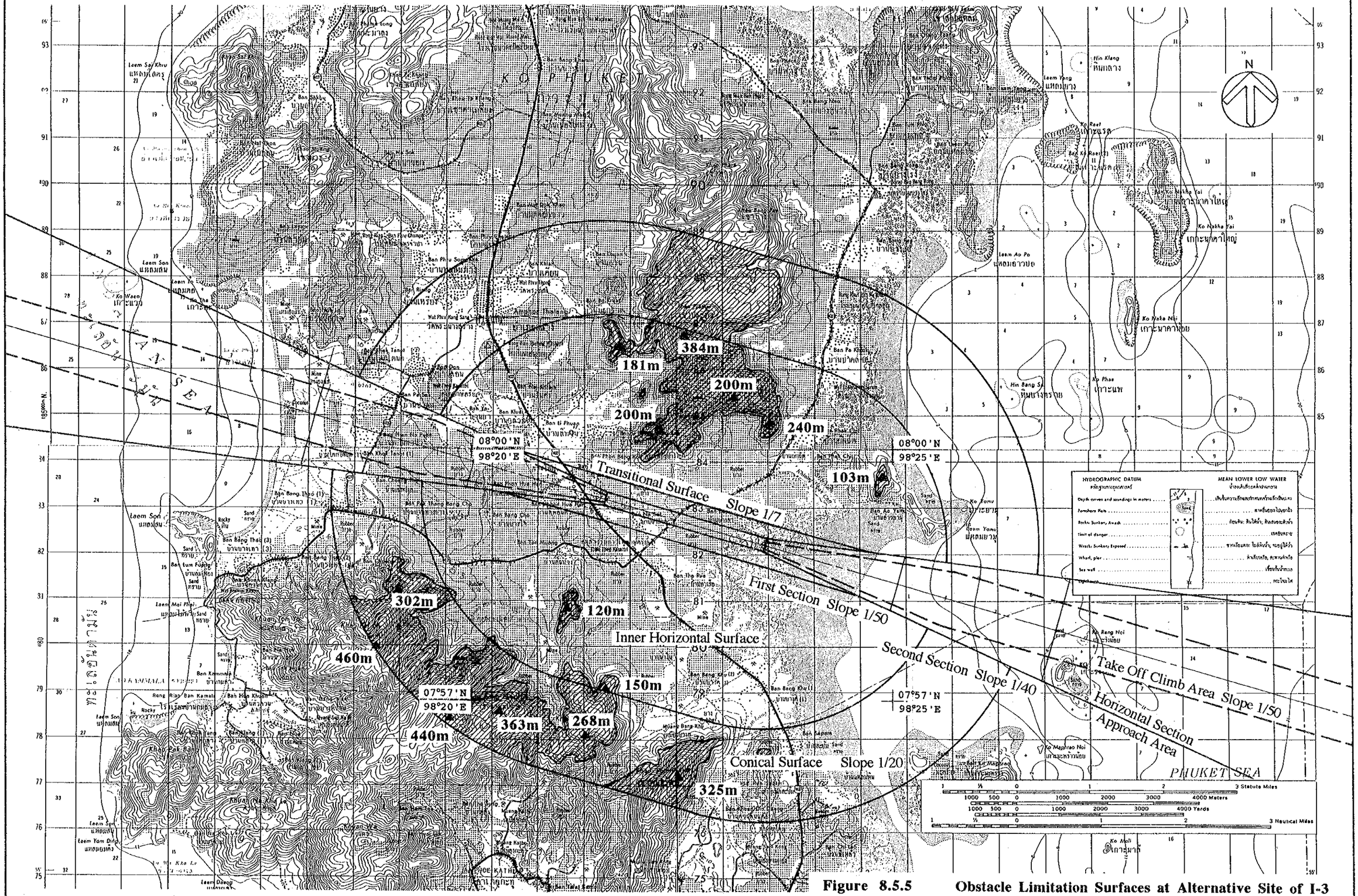

Figure 8.5.5 **Obstacle Limitation Surfaces at Alternative Site of I-3**

8.6 SELECTION OF A NEW AIRPORT SITE

A new topographic map was prepared to the scale of 1 : 10,000 for the sites selected for Sites I-1 and I-3 from the topographical map of 1 : 50,000 to make the detailed study for final selection such as earth moving and the relation to the existing trunk road systems.

The comparative study of Sites I-1 and I-3 was compared to make the final selection of the optimum site as described in the following.

(i) Airport Operational Aspect

In consideration of the airspace utilization and existence of obstructions, it was determined that there was no big difference between the two sites on the aspect of the establishment of departure and arrival procedure by straight - in procedure.

(ii) Construction Aspects

Site I-1 is situated on an area with rolling hills with some undulations of 15 meters, whereas Site I-3 is situated in an area where approximately 80% of the site is located on similar type of rolling hills and 20% of the area is located over an area with mangrove trees adjacent to the coastline and there are maricultural ponds for fish raising. From the point of construction aspect, Site I-1 will require normal earth moving operations, whereas Site I-3 will require earth moving operations on the coastline and approach light systems would have to be constructed over swamp lands in mangrove forests. The cut-and-fill earthworks operations would be about the same for both sites of approximately 30,000 m^3.

The construction techniques required would be about the same for both sites and there will be no special civil works required, however Site I-3 will have problems of relocating existing major road systems, and both sites would have about the same type of construction work requirements.

(iii) Environmental Aspects

The area around Site I-1 has many Islamic colonies and is noted for the number of the Muslim quarters on Phuket Island. There are also some Muslim quarters in Site I-1, and the Muslims are well known for opposing any relocation required in connection with construction projects, and have exhibited a strong resistance to any human meddling to the natural surroundings and vegetations in-and-around their dwellings. For these reasons it will not be easy to obtain the cooperation of the local residents in procuring land property for the proposed airport site.

In the case of Site I-3, it will be necessary to develop a part of mangrove forests for the airport site. As a general rule, the transplanting of mangrove trees is considered very difficult, and in addition ecologists are promoting a movement to protect the existing mangrove trees. Therefore, it will not be desirable to move large tracts of mangrove trees from the aspect of protection of the natural habitat. The mangrove tree requires a fresh supply of sea water for its existence. If the swampland is removed and the waterways are lost or the circulation of fresh sea water is obstructed by the airport construction, it can be

assumed that the mangrove forests in the vicinity of the proposed airport would perish due to lack of fresh sea water. At present however, there are already some 20% to 30% of mangrove forests converted to maricultural ponds, and the remaining mangrove trees are maintained in the original condition at the present time.

In either case, regardless of which area is finally selected, there will be problems with social and environmental nature for Sites I-1 and I-3. However, the problem of religion will be a very sensitive social problem, and it will be a very complicated problem which will no doubt present a large problem before it can be amicably resolved. In either case, it will not be easy to determine which of the two sites will be the better decision from the viewpoint of environment of religion, but it would seem that Site I-3 could be easier of the two because of the high possibility for obtaining the countermeasure technically.

(iv) Other Related Problems

Other related matters are given in a comparative list in **Table 8.5.2**. There are no other matters outstanding for the two proposed sites.

(v) Selection of the New Airport Site

In making the selection of the new airport, safe aircraft operation will be of prime consideration, with the least impact on the environment, with construction conditions, convenience of access, future expandability and cost of construction next in line. For the new Phuket Airport, when the two alternate sites are compared, the problem of environment will make the big difference with other matters following.

From the construction viewpoint, Site I-1 seems to be the easier of the two, however, Site I-3 does not present a large problem, and there seems to be very little difference between the two proposed sites.

It is considered that there is no big difference on the convenience of accessibility. However, from the point of expandability Site I-3 will require land reclamation of swampy areas and special consideration for the conservation of mangrove forests will be required.

In the selection of the best suited site for the new airport, Site I-3 is considered to be the most suitable site from the following reasons: (i) it will be easier to obtain local cooperation and the minimum adverse impact will be made to the adjacent areas if the correct precautionary measures are taken in advance, (ii) countermeasures can be taken technically for the preservation of mangrove forests around the new airport site, and (iii) the airport with the scope desired can be constructed.

It is noted that Site I-3 and other sites in the island are not fully in compliance with ICAO recommendations since inner horizontal surfaces are not established due to the existence of the obstructions.

A new airport site completely free from obstructions for approach, transitional and horizontal surfaces recommended by ICAO could not be found in Phuket Island due to the mountainous terrain of the Island. Therefore, an ideal site for a new airport fully in compliance with international standards may be found in Phuket Island including in the sea or on the adjacent mainland by an additional and separate study, if necessary.

In case it is required to find a suitable site in the sea, the following items should be studied in detail at the possible sites including Site M-1 to confirm the possibility of a new airport construction.

- Meteorological condition such as wind direction and velocity
- Marine condition such as tidal current, wave height, etc.
- Environment conditions in the reclamation area

Table 8.5.2 Comparison of Alternative Airport Sites

Item \ Site	I-1	I-3
1. General Conditions		
- Runway Direction	- N103° E	- N106° E
- Elevation	- 16.0 m	- 8.8 m
- Land Use	- Rubber plantation 68% - Post Mined Land 25% - Others 7%	- Rubber plantation 54% - Mangrove Forest 23% - Shrimp Farm 7% - Paddy Field 5% - Others 11%
- Population density of Tumbon	- 200-300 person/km2 (Chieng Thalae) - 100-200 person/km2 (Srisunthons)	- 300-400 person/km 2 (Ko Kao)
2. Constructional Aspects		
- Land Acquisition	- Land cost will be higher than Site I-3	- Will be no difficulty - Land cost will be lower than Site I-1
- Land tenure	- Mostly private ownership	- Private ownership and public ownership by RFD and MOI
- Resettlement	- Muslim village will be subject	- No problem
- House Relocation (houses)	120	110
- Required special constrution method	- None	- Require land improvement on swampy area
- Main civil work	- Cut and Embankment	- Reclamation of swampy area and Cut/ Embankment
- Earth Work Volume		
Cut	2.8 mil cu.m	2.8 mil cu.m
Embankment	3.0 mil cu.m	3.2 mil cu.m
- Access road construction	- Easy to connect to existing road	- New construction of access road will be required
- Road Diversion	0.6 km	0 km
- Compatible with existing utility and facilities	1.0km	2.5 km
• Road network	- No affection	- Detour of Route 4027
• Public utilities	- No problem by existing facilities	- No problem by existing facilities
- Compatibility with development plan surrounding the airport	- New hotel development to the west of site (3 hotels, 980 rooms in total)	- No problem
- Expansibility of Runway and Taxiway	- No problem (extension from 3,500 m. to 4,000 m.)	- Diversion of trunk road or land improvement of swampy area will be required. (extension from 3,500 m. to 4,000 m.)
3. Operational Aspects after Completion		
- Obstacle Limitation Surface		
• Approach Surface	- Both approach surfaces are cleard of obstacles	- Both approach surfaces are clear of obstacles
• Inner Horizontal Surface	- Mountains (200-500 m.) at south are obstacles - 180 m. mountain at north-east side is obstacle.	- 200-334 m. mountain at north side are obstacles. - South side will be free of obstacles
• Conical Surface	- 200-400 m. mountains at south, and 384 m. mountain at north side are obstacle.	- 200-300 m. mountainus at north, south side are obstacles.
• Take-Off Climb Surface	- Both side surfaces at east and west are clear of obstacles	- Same as Site I-1 (No obstacle)
- Obstacle in basic ILS surface	- No obstacle in basic ILS surface	- Same as I-1
- Airspace utilization	- Only straight-in and out is establishable	- Same as I-1
- Establishment of STAR and SID	- No problem	- No problem
- Acessibility	- Easy access from Phuket City and outside of island	- Same as I-1
	- Location will be in the center of Island of resort area on west, east and south	- Will be more convenient than Site I-1
4. Environmental Aspects		
- Social environment		
• Resettlement	- Muslim village will be the subject of resettlement	- Small villages will be subject of resettlement
• Land Use	- Near the hotels, muslim villages	- Rubber plantations, Mangrove Forests
- Natural environment		
• Topography/geology	- Flat area and low hills	- Flat area and low hills
• Flora and Fauna	- Rubber plantations	- Partly in the mangrove forest
• Aesthetic	- Near the group of hotels	- Partly in the mangrove forest
- Quality of life		
• Air pollution	- None	- None
• Water pollution	- None	- For mangrove forest
• Noise pollution	- Influence affecting to hotels	- None
5. Others		
TOTAL EVALUATION		**Recommended**

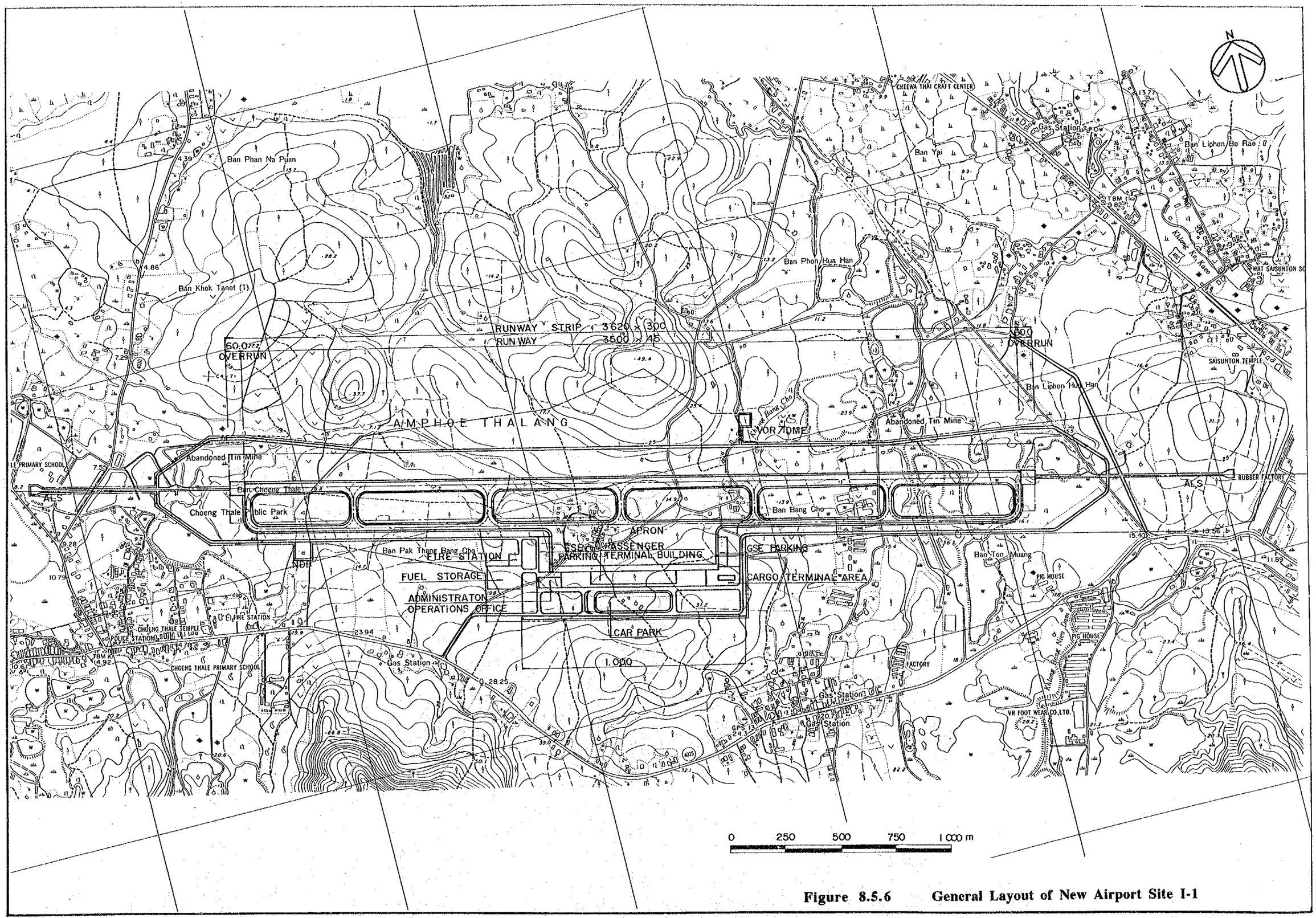

Figure 8.5.6 General Layout of New Airport Site I-1