6.5 Airport Layout Plan

Fig. 6.5.1 shows the airport layout plan for the redevelopment of the existing Nozha airport, and the concept for layout is explained hereinafter.

6.5.1 Runway

Runway 22 is planned to extend by 800 m toward the northeast on the former marine airport. This extension will require land acquisition of about 5.2 ha and reclamation from the former marine airport which is estimated to cover an area of about 21 ha. and require an earth volume of about 1 million cu.m. Fish pond, marine club, buildings, etc. should be removed for the extension of the runway.

6.5.2 Taxiway

The instrument approaches will exceed four flights during the peak hour after year 2000. According to ICAO Master Planning Manual, a complete parallel taxiway will be necessary in Phase-I.

The parallel taxiway is located at 180 m from the center line of the runway in accordance with ICAO standards.

The location and number of the perpendicular exit taxiways are planned considering the distance of various aircraft, the location of the existing taxiways, the location of apron and cost-effectiveness as shown in Fig. 6.5.1.

A part of runway 18/36 and the existing taxiway at runway 22 threshold will be overlaid and used for a portion of a new exit taxiway.

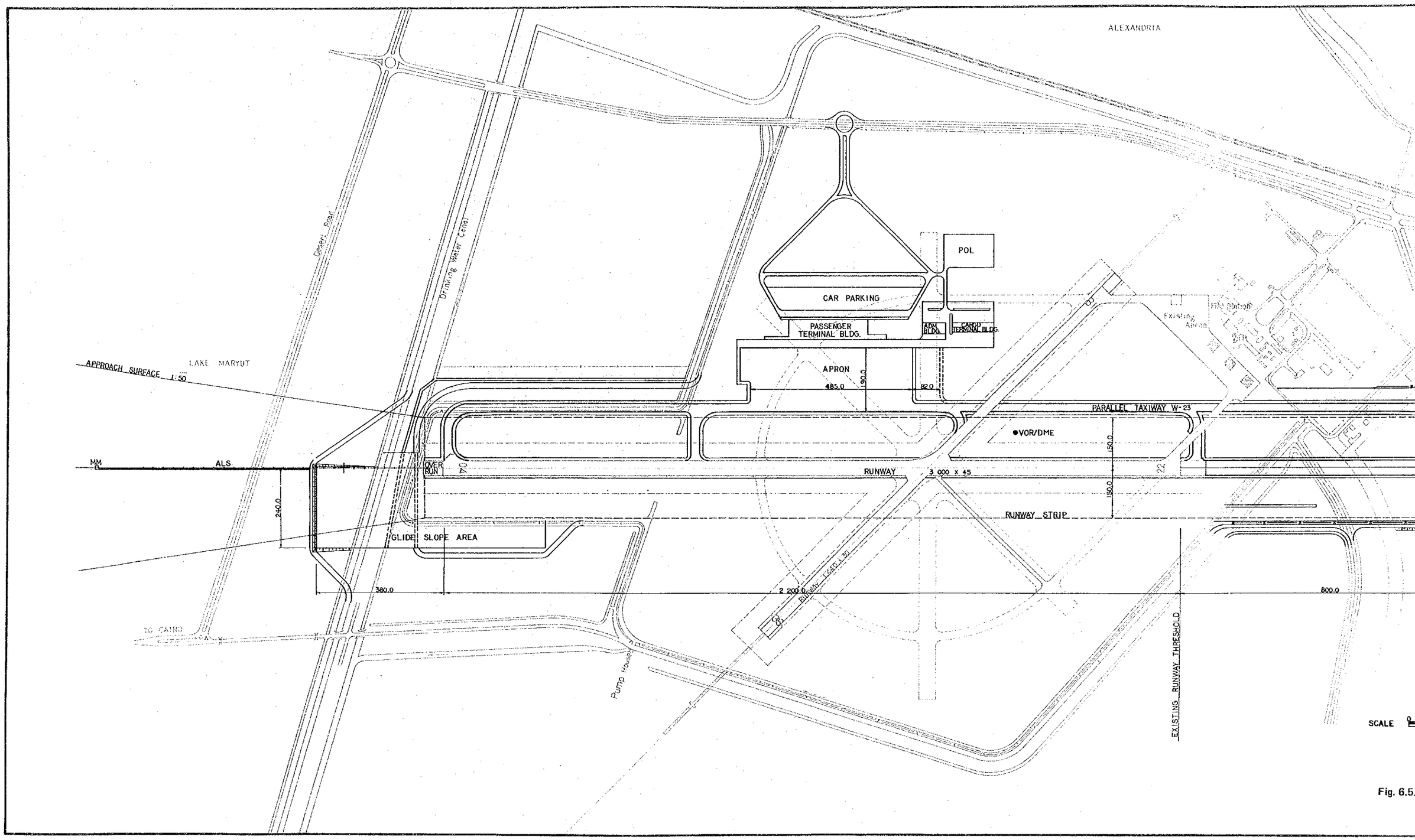

ALEXANDRIA
Desert Road
Drinking Water Canal
LAKE MARYUT
APPROACH SURFACE 1:50
POL
CAR PARKING
PASSENGER TERMINAL BLDG.
ADM. BLDG.
CARGO TERMINAL BLDG.
APRON
485.0
190.0
82.0
Existing Apron
Fire Station
PARALLEL TAXIWAY W-23
VOR/DME
150.0
MM
ALS
OVER RUN
RUNWAY
3 000 x 45
RUNWAY STRIP
240.0
GLIDE SLOPE AREA
380.0
2 200.0
800.0
TO CAIRO
Pump House
EXISTING RUNWAY THRESHOLD
SCALE

Fig. 6.5

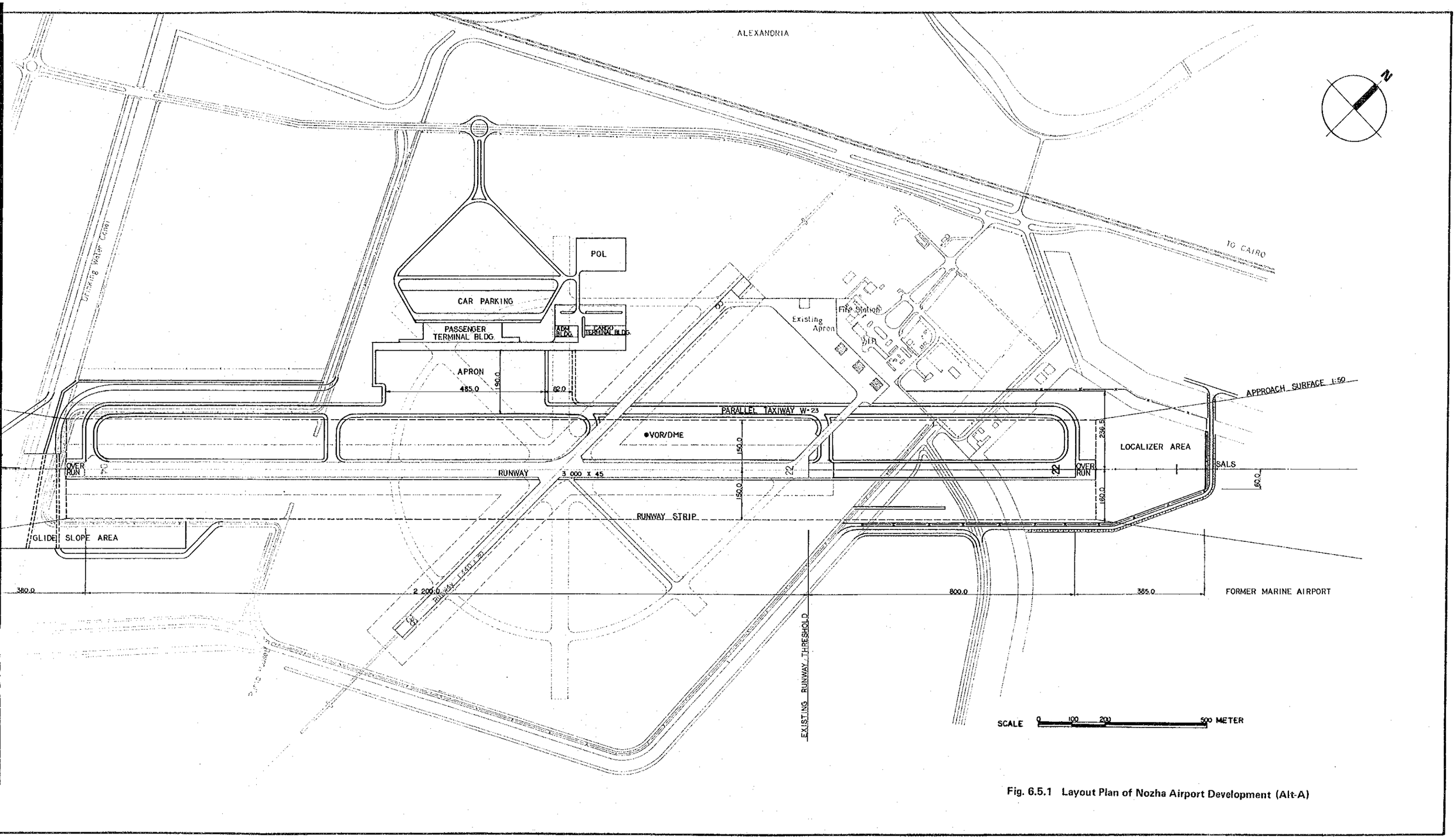


Fig. 6.5.1 Layout Plan of Nozha Airport Development (Alt-A)

6.5.3 Apron

The aircraft parking configuration is planned to be a linear concept for the least pavement area. Boarding bridges will be equipped for better passenger services. The apron layout plan is shown in Figs. 6.5.2 and 3.

6.5.4 Passenger Terminal Building

The passenger terminal building is considered to be a linear concept building with both international passenger and domestic passenger processing facilities. Boarding bridges are planned for enplaning and deplaning of passengers. The airside of the building will be 2 storeys separating departing and arriving passengers, and the landside 1 storey.

6.5.5 Cargo Terminal Building

Cargo terminal building is located as shown in Fig. 6.5.1 considering the phased development of the apron and passenger terminal building and their respective expansion area.

6.5.6 Administration Building and Control Tower

The administration building and control tower is located separately from the passenger terminal building and near the gravity center of the runway to facilitate in control of air traffic.

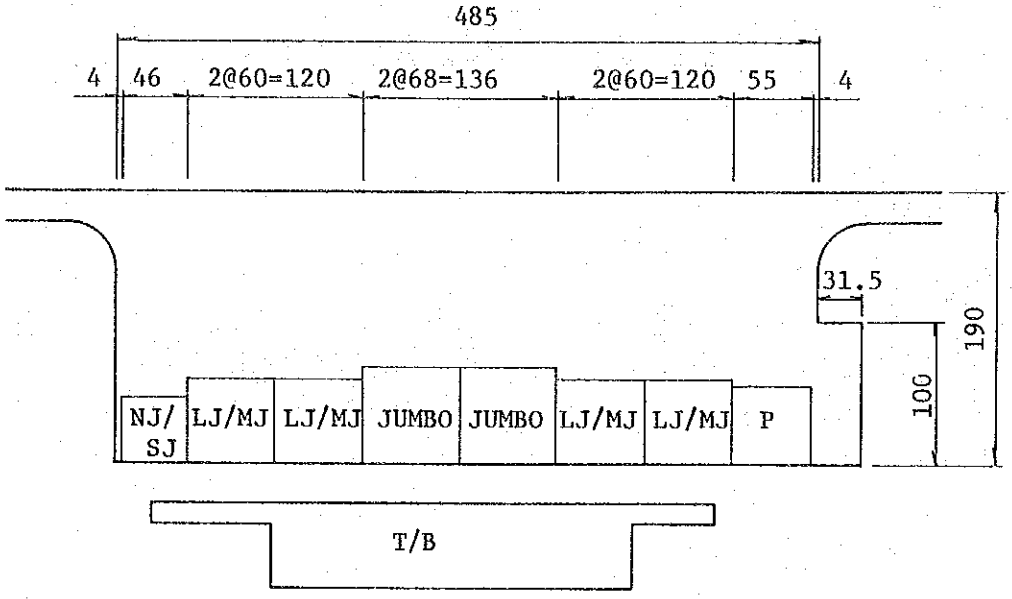


Fig. 6.5.2 Apron Layout for Phase I

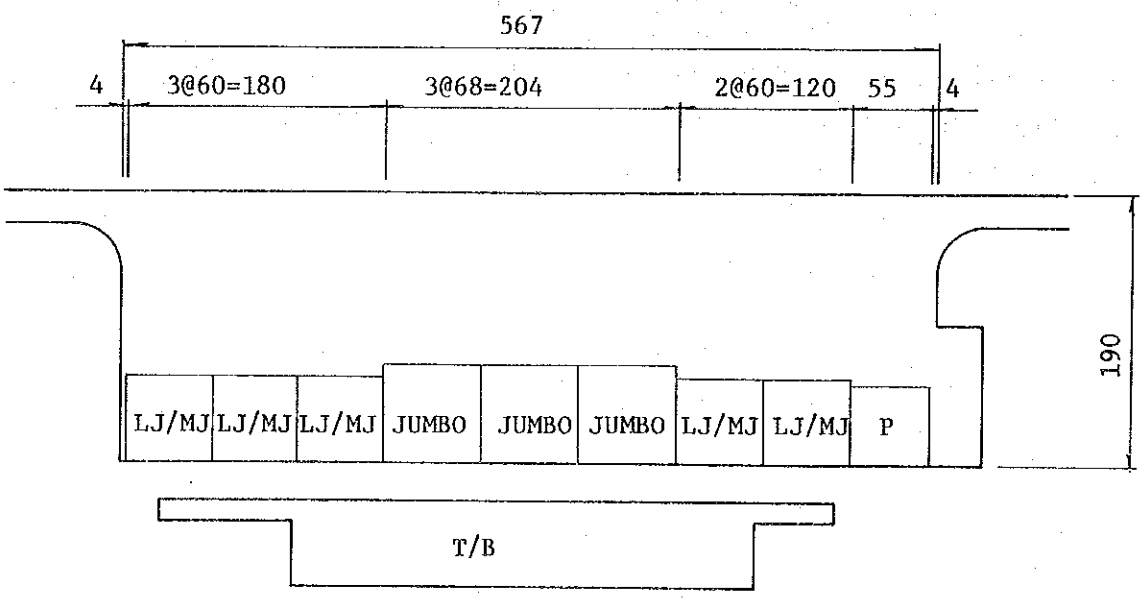


Fig. 6.5.3 Apron Layout for Phase II

6.6 Outline of Airport Facilities

Airport facilities have been preliminarily planned as the basis of the preliminary cost estimate for the comparison between the alternatives: Alt-A, B and C.

6.6.1 Runway Profile and Grading Plan

The runway profile in the reclaimed area is planned as shown in Fig. 6.6.1 so that the elevation of the runway will be at least 2 m above the water level of the former marine airport, or the pavement of the runway will be at least 1 m above the water level. As a result, the runway slope is planned to be 0.5 percent upward toward the extended runway 22 threshold as shown in Fig. 6.6.1. The existing runway will require pavement overlays of 18 cm thick before Phase I, 32 cm for Phase I, and 8 cm for Phase II.

Typical cross section is shown in Fig. 6.6.2.

The sand volume required for the reclamation is estimated to be 1.5 times as much as the volume calculated based on the cross-section taking into account a sinkage of dumped sand in the very soft silty clay.

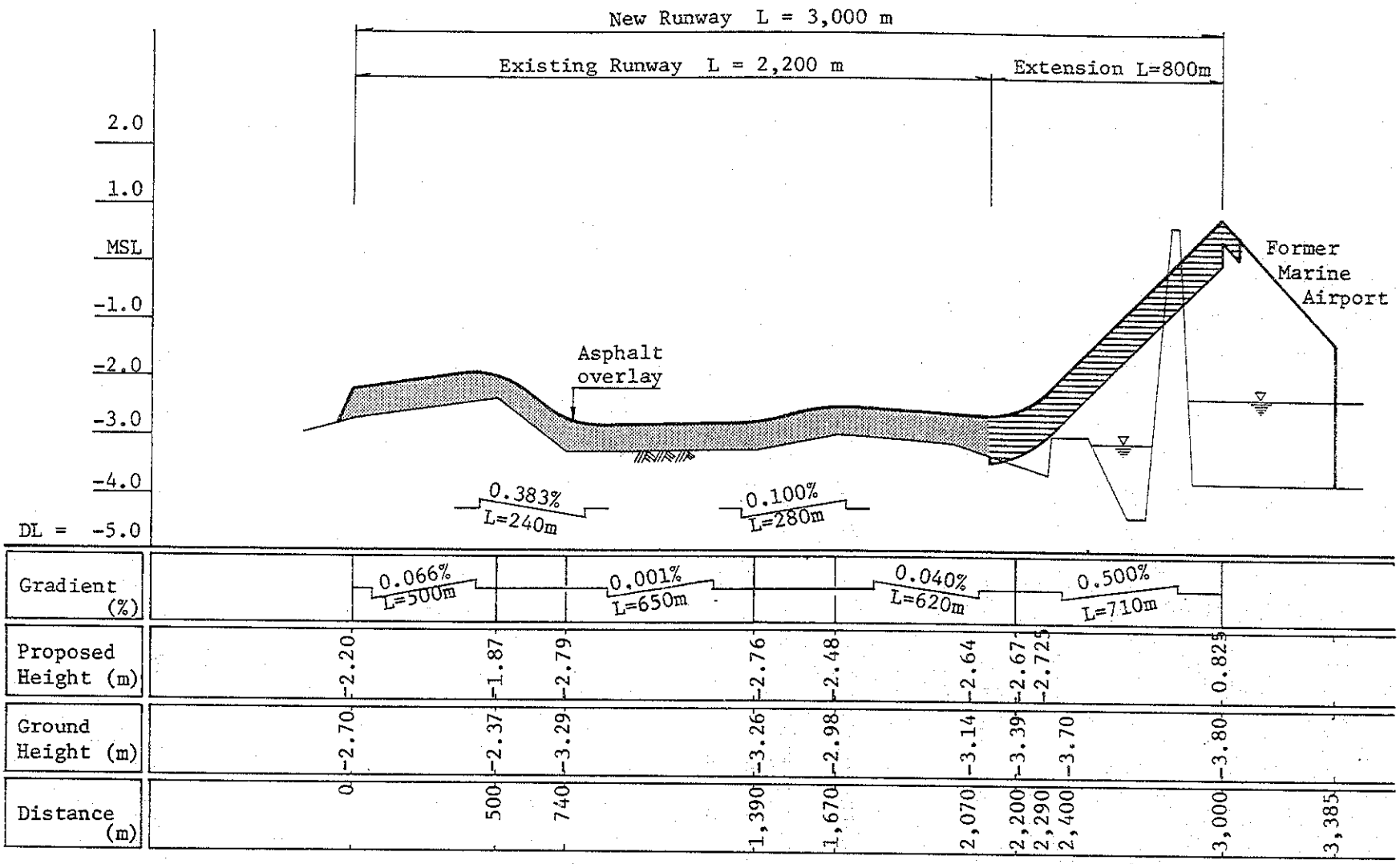


Fig. 6.6.1 Proposed Runway Profile

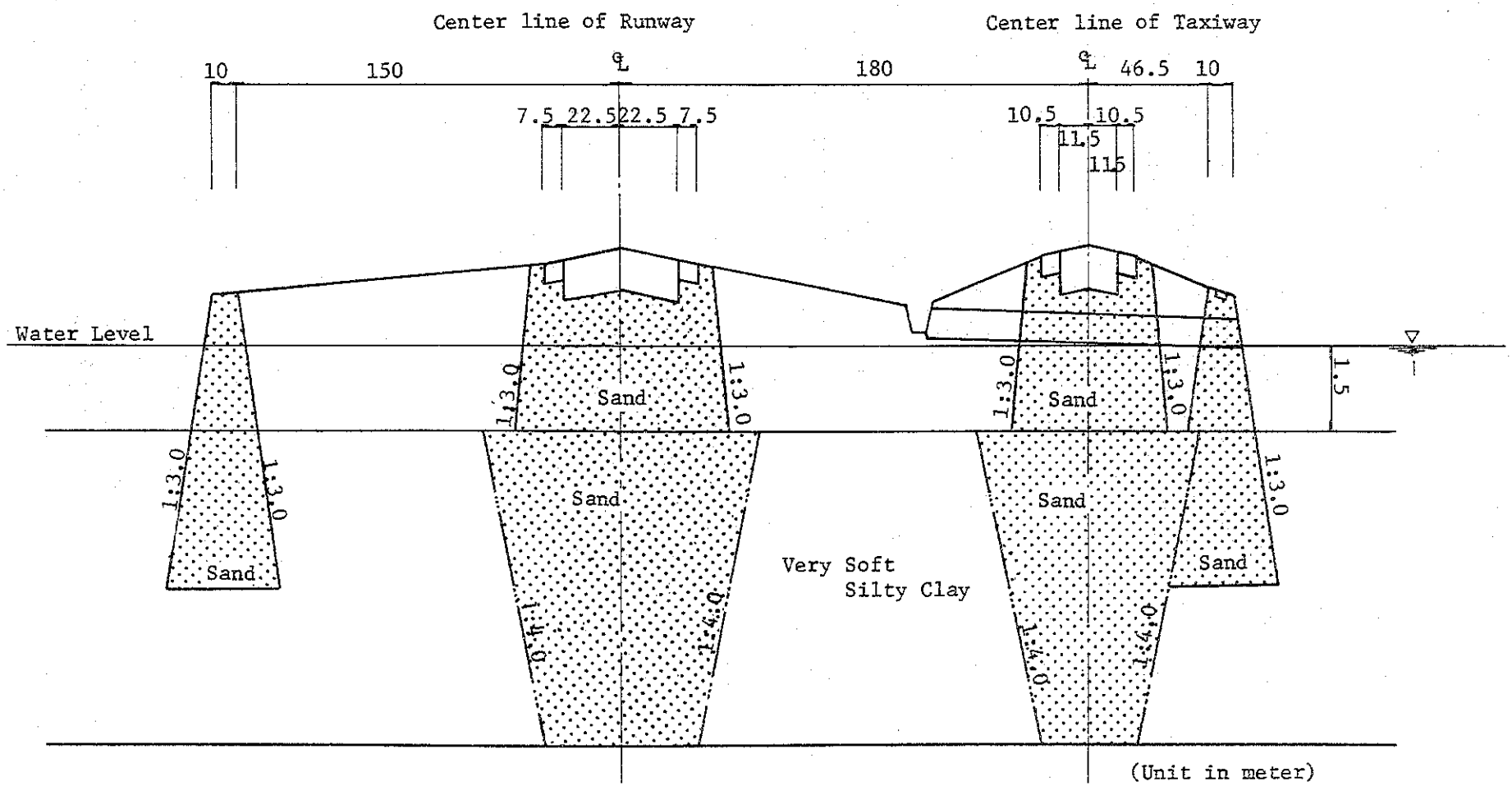


Fig. 6.6.2 Typical Cross Section at Nozha

6.6.2 Pavement Structures

(1) Improvement of Subgrade Soil

The existing land of Nozha airport was reclaimed from Lake Maryut by dredging soil, and the ground water table is very high (about 0.5 to 0.7 m below ground level). According to the previous study (NACO), it is reported that very soft clay (qc = 1 to 3 Kg/cm^2) of 6 m thick lies below the ground. This was confirmed by N-value of 0 to 2 obtained from soil investigation performed by JICA.

It is obvious that movements of large jet aircraft will cause significant uneven settlement due to the construction of the foundation if pavement is constructed on weak foundation without any countermeasures. Hence, the improvement of subgrade soil is mandatory and improvement by sand drain is planned because of the thickness of weak soil stratum, i.e. 6 m as shown in Fig. 6.6.3. The sand-drain is applied for acceleration of consolidation settlement. By this improvement, CBR value of 10 percent and K75 of 5 Kg/cm^3 will be obtained on the subgrade.

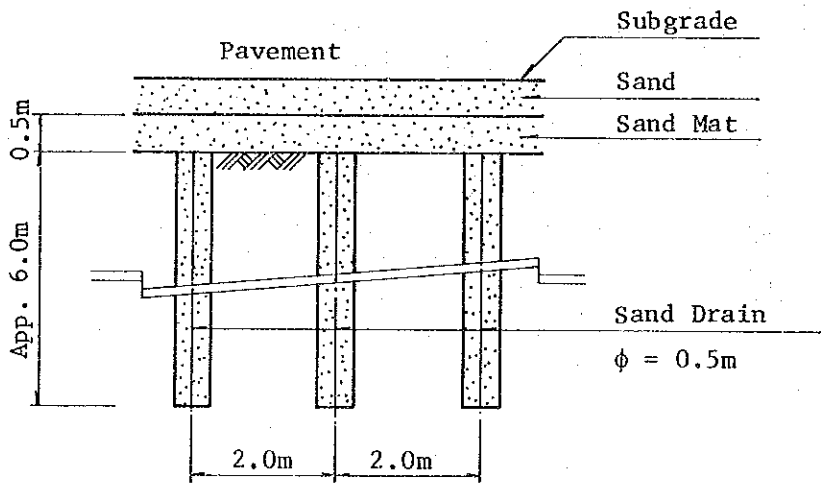


Fig. 6.6.3 Typical Corss-Section of Sand Drain

(2) Types of Pavement

There are two types of pavement: namely, rigid pavement (cement concrete) and flexible pavement (asphalt concrete).

Flexible pavement is considered suitable for this project except for the passenger loading apron where rigid pavement is preferred due to fuel spillage and possible subsequent rutting or defacement of the flexible pavement surface.

(3) Pavement Thickness

The thickness of flexible and rigid pavements are determined based on the Corps of Engineers Method and PCA Method, respectively.

The applied design criteria and standard pavement thickness are as follows:

i) Phase I Development

Design aircraft : B-747-200B

Repetition of design load : 3,000 times

a) New runway and taxiway

Subgrade CBR value : 10%

Component	Thickness
Bituminous surface course	4 cm
Bituminous binder course	5 cm
Ditto	5 cm
Graded aggregate base course	30 cm
Crusher-run subbase course	36 cm
Total	80 cm

b) Overlay on existing runway 04/22

Subgrade CBR value : 3%

Thickness of bituminous overlay : 32 cm

c) New Apron

Subgrade K value : K_{75} = 5.5 Kg/cm^3

Base course K value : K_{75} = 7.0 Kg/cm^3

Component	Thickness
Cement concrete slab	34 cm
Graded aggregate base course	30 cm
Total	64 cm

ii) Phase II

Design aircraft : B-747-200B

Repetition of design load : 5,000 times

a) Overlay on runway 22 end portion of 800 m and all taxiways

Subgrade CBR value : 10%

Thickness of bituminous overlay : 3 cm

b) Overlay on runway 04/22 other than the above (L = 2,200 m)

Subgrade CBR value : 3%

Thickness of bituminous overlay : 8 cm

c) New extended apron

Subgrade K value : K_{75} = 5.5 Kg/cm^3

Base course K value : K_{75} = 7.0 Kg/cm^3

Component	Thickness
Cement concrete slab	38 cm
Graded aggregate base course	30 cm
Total	68 cm

d) Overlay apron

Subgrade K value : K_{75} = 5.5 Kg/cm^3

Base course K value : K_{75} = 7.0 Kg/cm^3

Thickness of cement concrete overlay : 13 cm

6.6.3 Drainage

According to meteorological data (1964-1983) at Nozha airport, the annual minimum rainfall is 47.5 mm (1982); the maximum, 148.5 mm (1974); and the annual mean, 81 mm. The daily maximum rainfall is 31 mm (Oct. 1973) and there is generally little rainfall from May to September. Meteorological Authority reports that the hourly rainfall intensity is less than 8 mm per hour. The existing terrain at the airport property area is mostly flat, thus it is difficult to drain to the existing drainage. However, it is judged that no special drainage facility is required since the amount of rainfall is very small and infiltration of water into the ground can be expected because of the permeable soil.

In the light of the high ground water level and the continuous settlement of the airport area, it should be necessary to review the existing overall drainage system when the Nozha airport to be redeveloped.

6.6.4 Buildings

The structure of the buildings is planned to be of reinforced concrete. Due to the weak foundation, pile foundation is necessary for the passenger terminal building, administration building, and control tower. Four piles with a diameter of 300 mm (500 mm for control tower) and 12 m long will be necessary per 100 sq.m.

6.6.5 Air Navigation Systems

The air navigation systems required for category-I operation have been planned for Phase-I development as listed in Table 6.6.1. Replacement of these equipment should be necessary in Phase-II, since lifetime of the electronic equipment is generally, at maximum, around 10 years if the necessary maintenance work is carried out. The maximum use of the existing equipment is considered in the redevelopment plan.

Table 6.6.1 Air Navigation Systems Plan

Equipment	Outline	Remarks
RADIO NAVAIDS		
ILS	ILS RWY 04, category - I	
Locator	at outer marker station	
VOR/DME	Replacement of the existing equipment.	
MLS	Replacement of the ILS above.	
NDB	Replacement of the existing equipment.	
Navaids monitor and control equipment.		
ATC/COM		
Tower console		
VHF air/ground radio	5 frequencies. Replacement of the existing equipment.	
UHF air/ground radio		
VHF link	Between outer marker station.	
AFTN teletype		
ISB radio	For AFTN TTY and ATS direct speech.	Back-up for commercial carrier
Tape recorder	Relocation of the existing tape recorder.	
Master clock and Interphone	ATC use.	
LIGHTING		
Approach lighting systems	RWY 04, Category - I	Supporting structure on the lake
Simple approach lighting system	RWY 22.	Ditto
Runway edge lights	Extension of the existing lights.	
Runway threshold/end lights	Relocation of the existing fixture.	
PAPI	Relocation of the existing lights.	

Table 6.6.1 Air Navigation Systems Plan (Cont.)

Equipment	Outline	Remarks
Taxiway edge lights	For parallel taxiway.	
Apron flood lights	For new apron.	
Illuminated wind indicater	Relocation of the existing lights.	
Aerodrome beacon	Relocation of the existing lights.	
Air traffic light gun	For air traffic control tower.	
Power supply system		
MET		
Surface sensors	Surface wind, temperature, dew point rainfall.	
Data collecting equipment	Automated data collection and recording.	
Runway visual range equipment	RVR measurement.	
Ceilometer	Cloud height measurement	
Weather teletype		
HF receiver		
OTHERS		
Measuring equipment and spare parts		

6.6.6 Land Acquisition and Compensation

Land aquisition and compensation as tabulated in Table 6.6.2 are required for the redevelopment of Nozha airport.

Table 6.6.2 Items of Land Acquisition and Compensation

Land Acquisition

Description	Quantity	Remarks
Paddy field	52,000 m^2	RWY 22 extension area

Removal

Description	Quantity	Remarks
Boat house	1,300 m^2	RWY 22 extension area
Marine club	2,400 m^2	Ditto
Bldg. beside fish pond	200 m^2	Ditto
Houses	10,000 m^2	Ditto
Lamp posts	8	Desert road

Diversion

Description	Quantity	Remarks
Drainage Canal	350 m	RWY 22 extension area
Road	1,400 m	Ditto
Drainage canal	600 m	RWY 04 extension area
Potable water canal	800 m	Ditto
Road	800 m	Ditto

6.7 Aircraft Noise Influence

The aircraft noise contour is preliminarily calculated and the noise influence is assessed in this Section in order to compare environmental impact for the alternative airport development concepts. Figs. 6.7.1 and 6.7.2 show the aircraft noise contours for various runway directions both at present and year 2000 in WECPNL.

The area covered by aircraft noise contours, excluding the airport property area, the former marine airport and Lake Muryut, is as follows:

Above WECPNL 70 = Approx. 600 ha
Above WECPNL 75 = Approx. 230 ha
Above WECPNL 80 = Approx. 90 ha

Although the area expected to be covered by WECPNL 75 to 80 and above 80 are planned to be agricultural area and industrial area in the future land use in Alexandria respectively, many houses and small buildings (about 10,000 people live in the residential area of approx. 60 ha now) exist to the north of the airport boundary near runway 04 threshold and on the northeast of the airport entrance.

From the above, aircraft noise problems are foreseen when take-off and landing operations of large jet aircraft become more frequent.

The following countermeasures will become necessary:

i) Relocation of houses
ii) Land acquisition
iii) Sound proof construction

The land use controls for the airport vicinity in other countries are shown in Table 6.7.1.

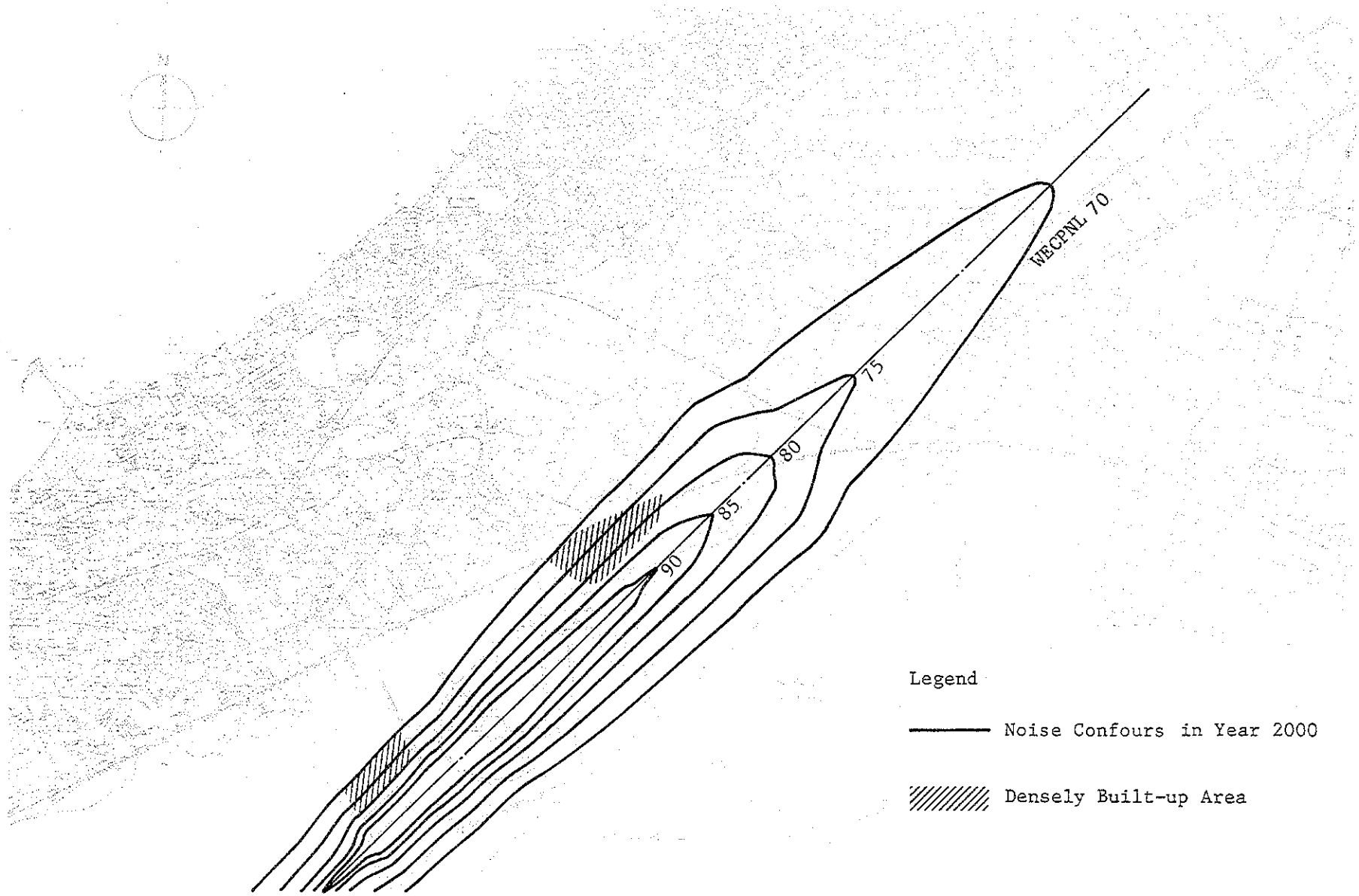


Fig. 6.7.1 Area Affected by Aircraft Noise
(Nozha Airport) s = 1:50,000

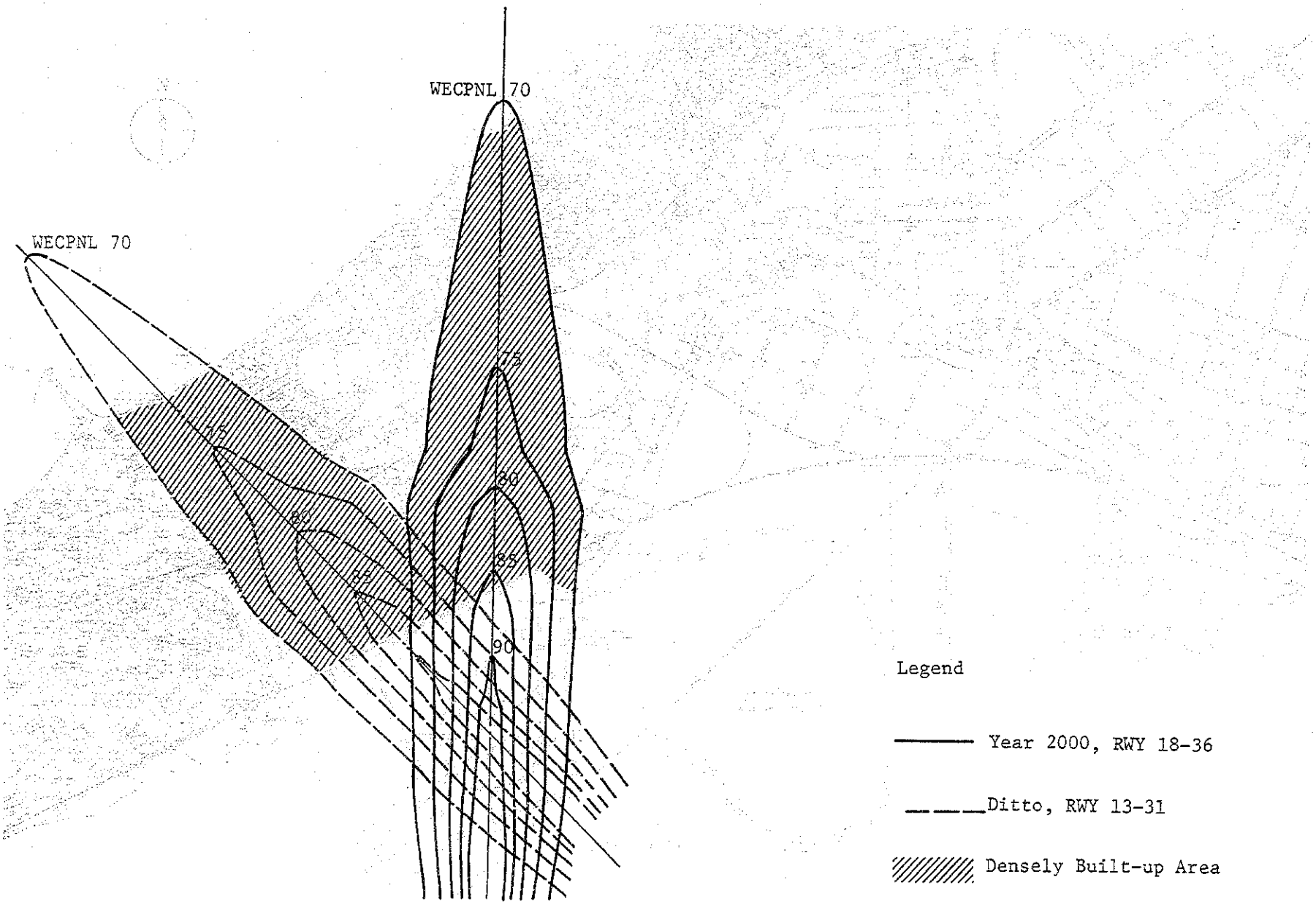


Fig. 6.7.2 Area Affected by Aircraft Noise
(Nozha Airport) s = 1:50,000

Table 6.7.1 Land Use Controls for Noise

Conversion: WECPNL = NEF + 48 = N-10

Japanese		U S A		French	
WEC-PNL	Standard	NEF	Standard	N	Standard
More than 70	No construction of schools, hospitals, etc. is permitted	Less than 30	Necessary noise reduction measures, required for schools, hospitals and churches. Compatible with residential, commercial, hotel, offices, outdoor recreational, industrial.	Less than 84	No building restrictions.
More than 75	No construction of residences is permitted.			More than 84	New residential development to be avoided.
More than 80	Noise proof construction for existing residences is necessary.	More than 30	Compatible with commercial, outdoor recreational and industrial. Schools, hospitals, churches, theaters, etc. are not permitted.	More than 89	No school, hospital residential building public building permitted.
More than 90	Compensation for removal of the existing residences.	More than 40	Outdoor recreational (non-spectator) is only compatible. Necessary noise reduction measures for industrial and commercial bldg.	More than 96	No building permitted.

6.8 Construction Schedule and Cost Estimates

6.8.1 Construction Schedule

The Construction Schedule of Alt-A is planned as indicated in Table 6.8.1. The construction period for Phase I development is estimated to be about 3 years. After completion, half a year is required for flight check, test operation for various navaids, maturity flight, etc., before opening the flight operation on extended runway.

Meanwhile, about two years are required for topographic survey, soil investigation, detailed design and tender evaluation after completion of this Feasibility Study. Therefore, inauguration of fullscale construction after land acquisition and compensation will be set around mid 1988 and completion around mid 1991.

The opening of extended runway with 3,000 m length will be scheduled around beginning of 1992.

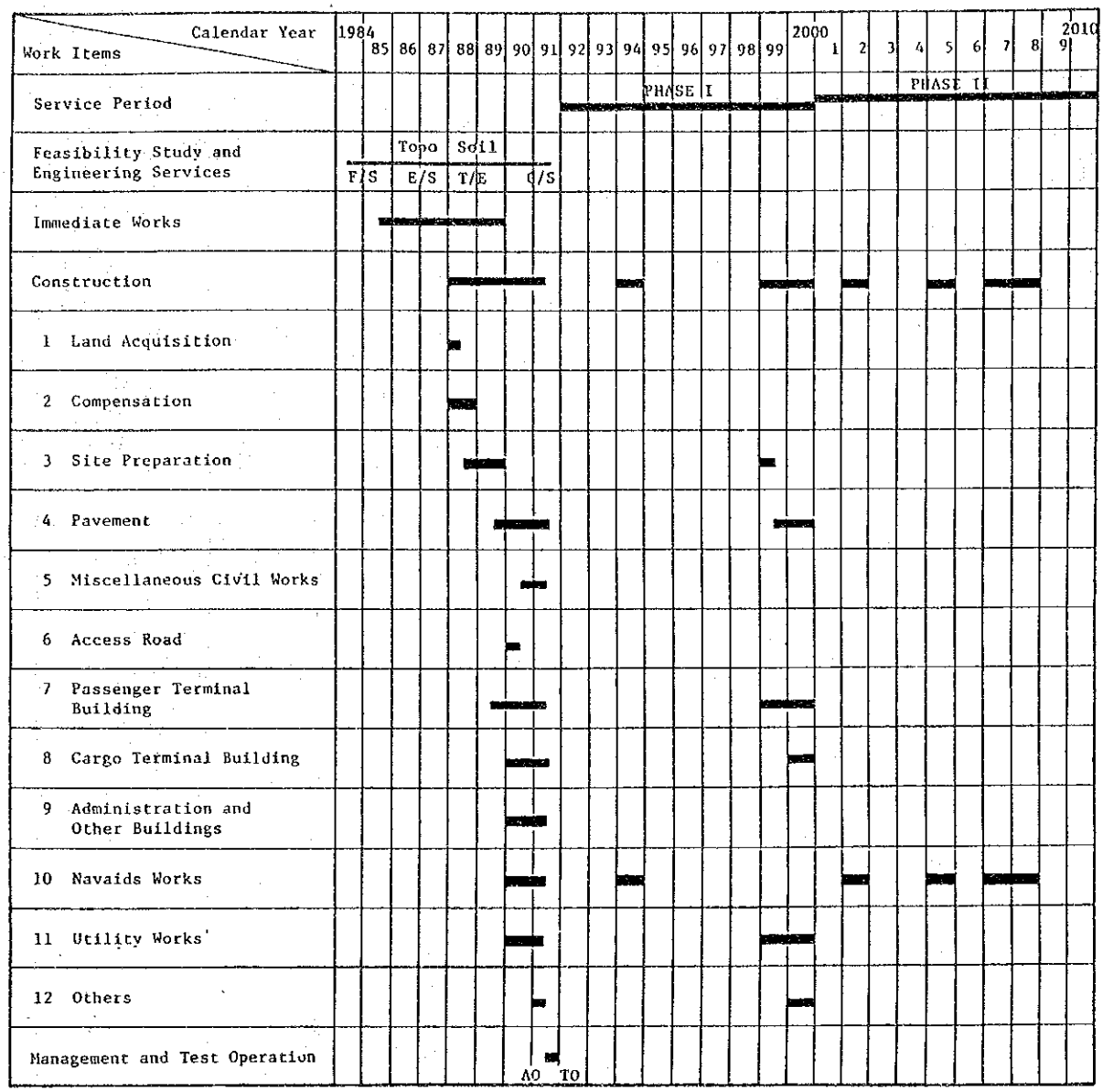
6.8.2 Cost Estimates

The construction cost is estimated by work and phase as tabulated in Table 6.8.2. The cost estimates are based on the following assumptions:

- The unit construction prices used in the cost are estimates based on the information collected from ECAA during the Study Team's stay in Cairo.
- Exchange rates are set at US$1 = 0.82 and E1.00 = 300 Japanese Yen
- When the construction takes place in the restricted area, closing the runway in the day or night to permit work after final flight will be necessary. The unit construction cost of the night work is assumed to be 1.5 times of that of daytime work. However, for the purpose of comparison with the development plan of the new airport, all of the construction cost are estimated as daytime work.

The required construction cost for Phase I development is estimated at about 76 million Egyptian Pounds.

Table 6.8.1 Construction Schedule for Alt-A (Nozha Airport)



F/S Feasibility Study

Topo Topographical Survey

Soil Soil Investigation

E/S Detail Design and Tender Document

T/E Tender Evaluation

C/S Construction Supervision

AO Establishment of Airport Organization

TO Test Operation, Various Flight Checks, etc.

Table 6.8.2 Estimated Construction Cost for Alt-A (Nozha Airport)

(Unit : 1,000£E)

Work Item \ Phase of Construction		Phase I 1992-2000	Phase II 2001-2010	Total
Land Acquisition and Compensation	Land Acquisition	78		78
	Compensation	4,546		4,546
	Sub Total	4,624		4,624
Civil Works	Site Preparation	17,694	367	18,061
	Pavement Works	13,245	4,697	17,942
	Miscellaneous	160		160
	Access Road	123		123
	Sub Total	31,222	5,064	36,286
Building and Equipment Works	Passenger Terminal Building	18,093	7,683	25,776
	Cargo Terminal Building	1,875	1,425	3,300
	Administration/Tower and Other Buildings	1,921		1,921
	Sub Total	21,889	9,108	30,997
Navaids Works	Radio Navaids, Telecommunications, Air-Traffic Control, Meteorological and Lighting Works	6,072	3,782	9,854
Utilities Works	Power Supply, Water Supply Sewage and Incinerator	3,439	2,626	6,065
Special Services Facility Works	Boarding Bridge	1,750	350	2,100
Total of Construction Works		68,996	20,930	89,926
Contingency (10%)		6,900	2,093	8,993
GRAND TOTAL		75,896	23,023	98,919

CHAPTER 7 DEVELOPMENT PLAN OF NEW AIRPORT

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7.1 General

The study of development plan for New Alexandria International Airport at the reserved site located about 45 km southwest side Alexandria City, and redevelopment and utilization of existing Nozha airport are main objectives in this chapter.

Two selected study cases are summarized as follows:

Alt-B: Domestic and international flights are handled at New Alexandria International Airport, and the passenger handling service at Nozha airport is closed.

Alt-C: Nozha airport will serve domestic flights, and New Alexandria International Airport will serve international flights and limited domestic passengers for New Ameriyah City.

Airport layout plan, facility plan and construction costs and schedules are studied in the sections which follow.

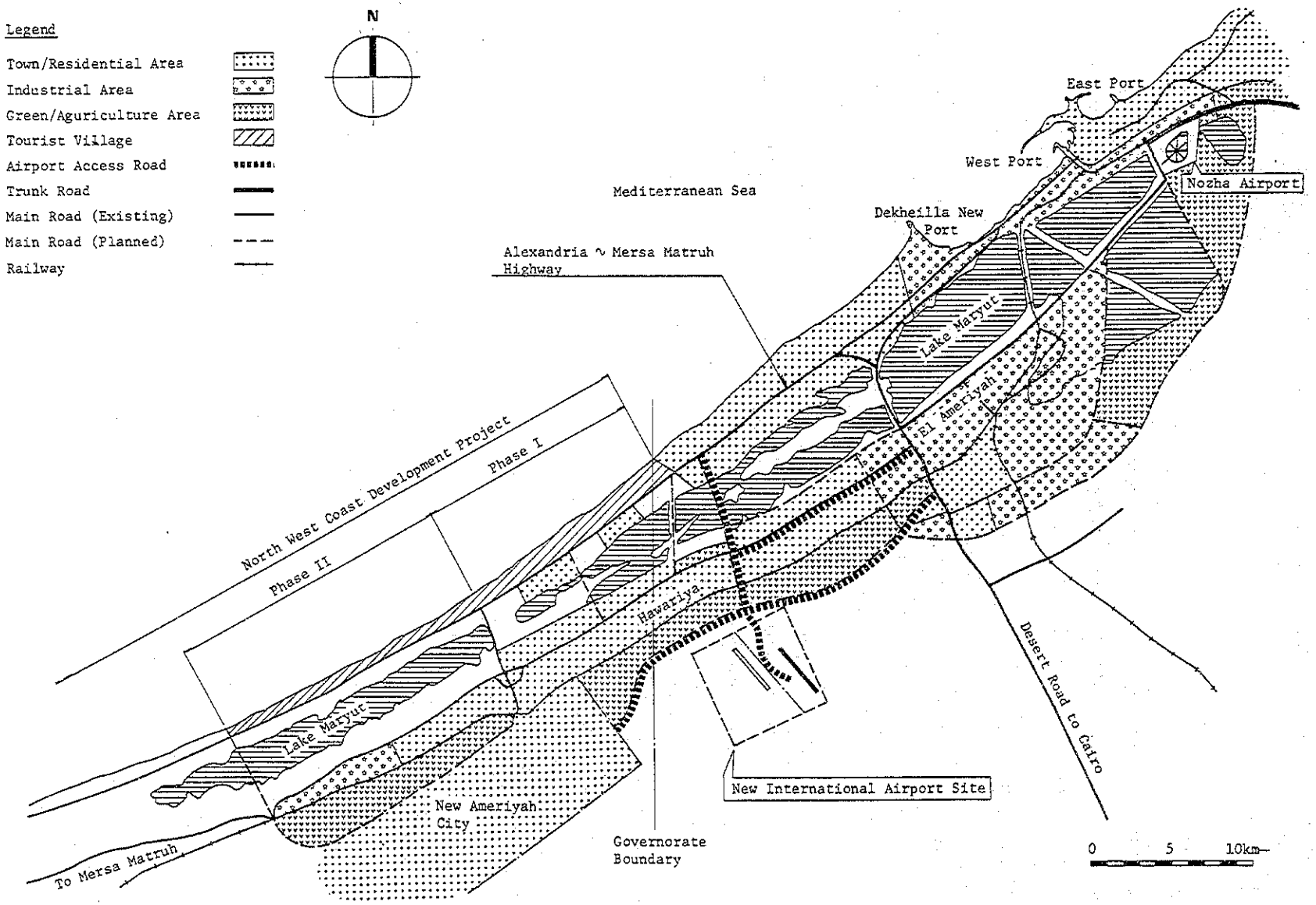


Fig. 7.1.1 Land Use Plan of Airport Vicinity

7.2 Construction Site of New Airport

7.2.1 Construction Site of New Airport

As shown in Fig. 7.1.1, the new airport site is located in desert area near Hawariya about 40 km southwest from Alexandria city, and also 11 km southwest from Desert Road between Alexandria and Cairo. The trip time by car from Alexandria city to the new airport site takes 40 minutes. In this site, an area of 36 km^2 (6 km x 6 km) was originally reserved for new airport construction in 1971. However, it is ascertained as a result of site reconnaissance that about two thirds of the above area has already been occupied by the military for their new airfield which is now under construction. Therefore, new airport development is studied within the area in the east part of the 6 km by 6 km area as shown in Fig. 7.2.1.

However, it is considered that this area allocated to the civil airport is still sufficient even for future unexpected demand change. This site is located approximately 10 km south of the Mediterranean coastline. The site lies on undulating terrain with an average elevation of approximately 50 m above mean sea level.

The site is capable of providing the required airspace for the establishment of preferable flight procedures.

7.2.2 Land Use and Development Plan Around the Construction Site

In the surrounding area of the new airport, a trunk road connecting Alexandria to Mersa Matruh runs along the Mediterranean coast, and a national railway line connecting Alexandria to Mersa Matruh and Salum runs along the south shore of Lake Maryut.

North West Coast development along the coastline is underway as shown in Fig. 7.1.1. This development includes industrial and free zone area along the road between Desert Road and Hawariya in the east of the airport, and New Ameriyah city project in the west. The new airport is to be located at the center of the regional development area and will play an important role as not only the northern gateway of Egypt but as the gateway to the North West Coast including Alexandria city and New Ameriyah city, if the new airport is developed.

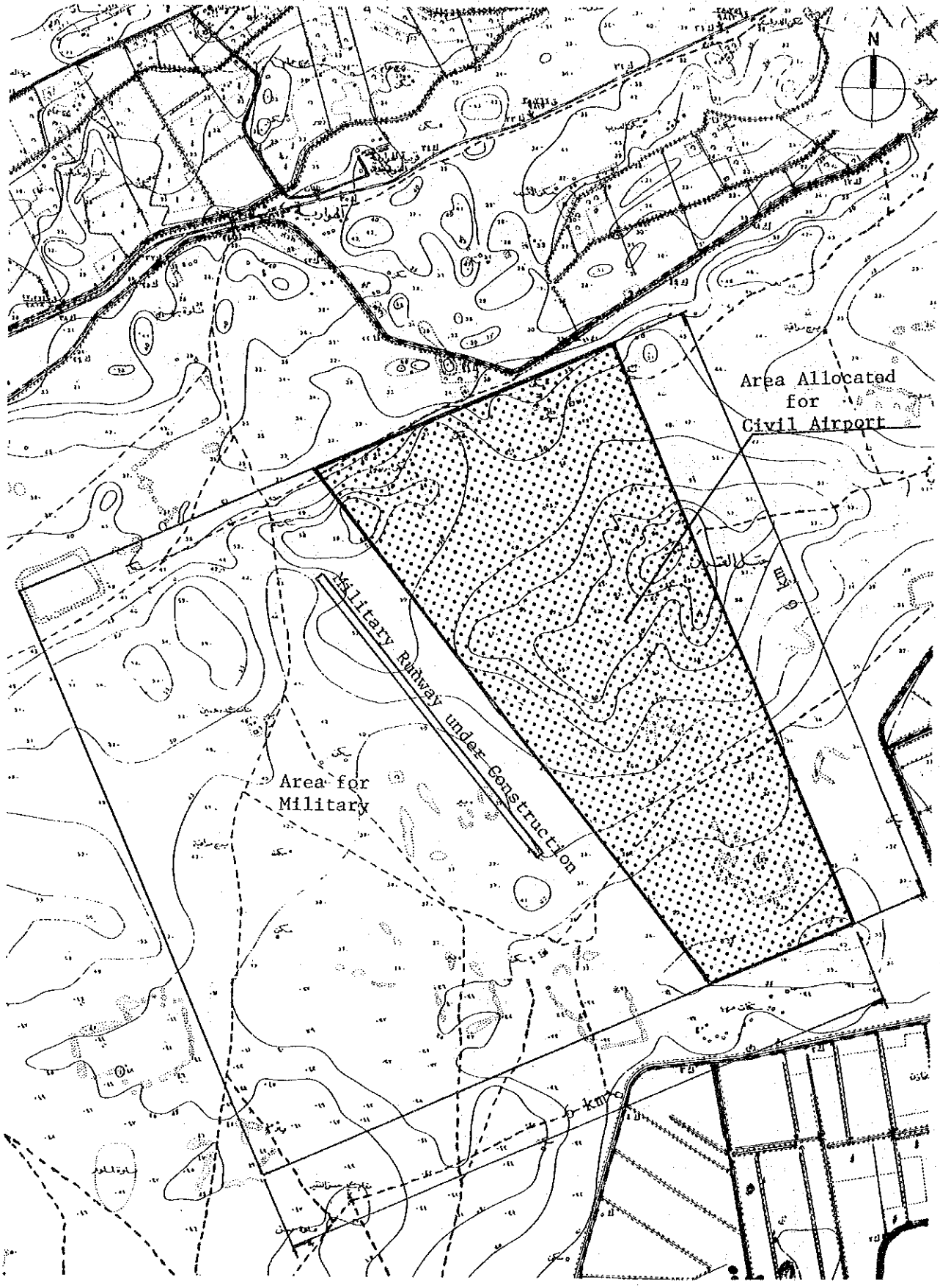


Fig. 7.2.1 Area Allocated for New Alexandria International Airport

S = 1:50,000

7.2.3 Climate Condition

Weather observation was performed in this survey to collect data since there was no weather data at the construction site. Collected data over a period of 2 months at the site was analyzed in comparison with the existing data of Nozha and Dekheilla airports because of difficulty to observe at site for a longer period.

The method of the site observation is described in detail in the report on "Site survey of natural conditions."

The outline of weather data of the construction site and Nozha and Dekheilla are compared below.

- Data collection point and observed period.

Construction site:	Aug. to Sep. 1984 (2 months)
Nozha airport:	Jan. 1981 to Dec. 1983 (3 years)
Dekheilla airport:	Jan. 1981 to Dec. 1983 (3 years)

- Observation items
  - Wind rose and velocity
  - Temperature
  - Humidity
  - Amount of rainfall (only Nozha airport)

Weather observation at the site is now continuing beyond September, 1984.

(1) Temperature

The authorized aerodrome reference temperature at Nozha airport is 30.6 °C as indicated in AGA 2-1, Aeronautical Information Publications (AIP), Arab Republic of Egypt. This reference temperature is based upon the average aerodrome reference temperature of about 40 years (1942 - 1980) at the meteorological office in Nozha airport (Source: Meteorological Authority). The observed monthly mean of daily maximum temperature at the new site was 31.0 °C for August, 1984 (August is usually the hottest month of the year in Alexandria).

Since no significant difference between the authorized aerodrome reference temperature has been found, the authorized aerodrome reference temperature is used for the planning of the new airport.

However, the temperature (30.6°C) applied for the new airport in the study should be reviewed based on the observation data for the longest period available when the project is implemented.

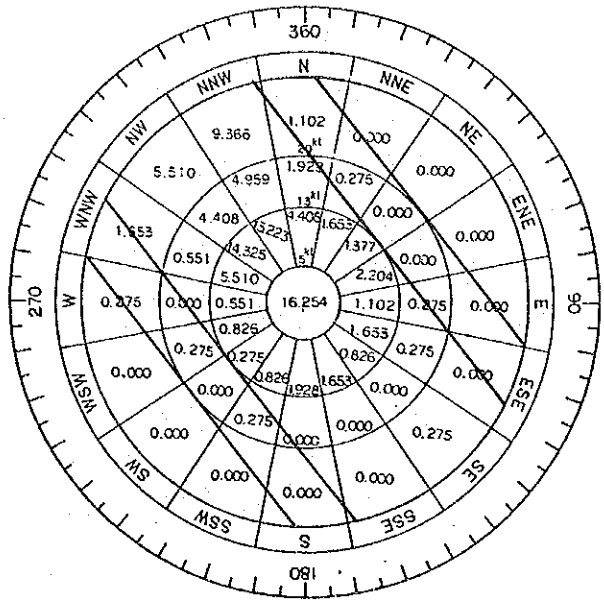
(2) Wind Rose and Velocity

The rose at the new airport (18 Aug. - 2 Oct. 1984) is compared to the wind rose at Nozha airport (18 Aug. - 2 Oct. 1984). The distribution of wind components is very similar and the prevailing wind is northwest in both roses, as shown in Figs. 7.2.2 through 4.

Since Nozha airport and the new airport site are not different from each other in wind conditions, the wind-rose of the existing Nozha airport is applied for the planning of the new airport.

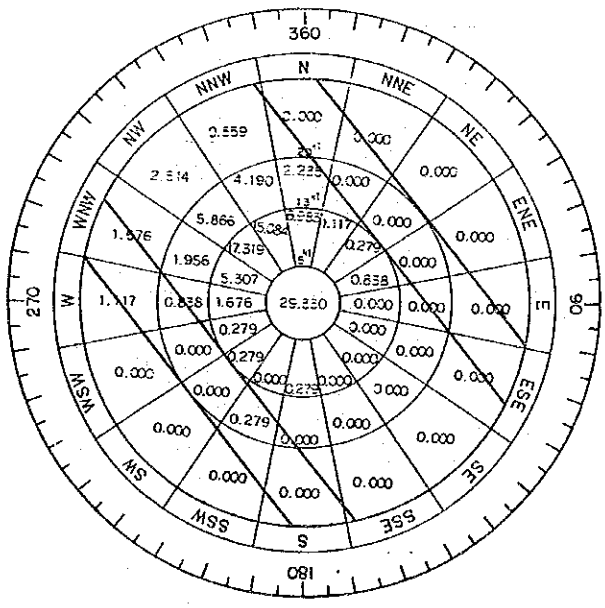
(3) Wind Coverage of New Runway

The cross-wind coverage has been calculated for the new runway (N142 E, true north) using the wind rose of Nozha airport. Fig. 7.2.4 shows the cross-wind coverage. The cross-wind coverage is 96.3 percent for cross-wind components less than 13 kt and 99.4 percent for 20 kt. Fig. 7.2.5 shows, for reference, the cross-wind coverage of the new runway based on the wind rose of Dekheilla airport. Figs. 7.2.6 and 7 show the cross-wind coverage for any orientation, and these figures indicate that the orientation (N142 E, true north) of the planned runway is the optimum one.



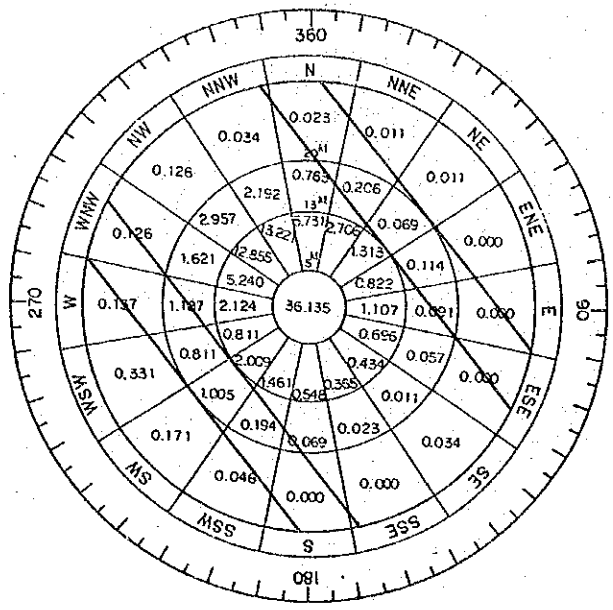
Location: New airport site
Period : 1984/8/18-1984/10/2 (46 days)
RWY Direction: N 142°E
Wind coverage: 97.14% (cross wind 13kt)
99.79% (cross wind 20kt)

Fig. 7.2.2 Wind Rose Observed at New Airport



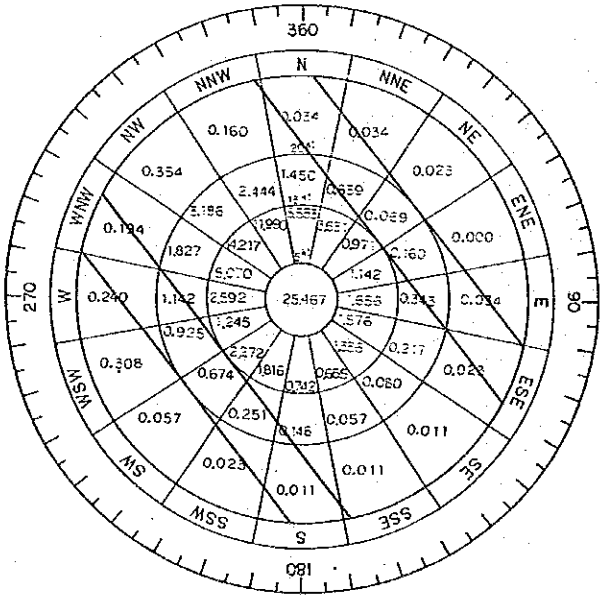
Location: Nozha airport
Period : 1984/8/18-1984/10/2 (46 days)
RWY Direction: N 142°E
Wind coverage: 97.34% (cross wind 13kt)
99.48% (cross wind 20kt)

Fig. 7.2.3 Wind Rose Observed at Nozha Airport



Data source: Nozha airport
Period : 1981-1983 (3 years)
RWY Direction: N 142°E
Wind coverage: 96.3% (cross wind 13kt)
99.4% (cross wind 20kt)

Fig. 7.2.4 Cross-Wind Coverage for the New Runway



Data source: Dekheilla airport
Period : 1981-1983 (3 years)
RWY Direction: N 142°E
Wind coverage: 95.9% (cross wind 13kt)
99.5% (cross wind 20kt)

Fig. 7.2.5 Cross-Wind Coverage for the New Runway

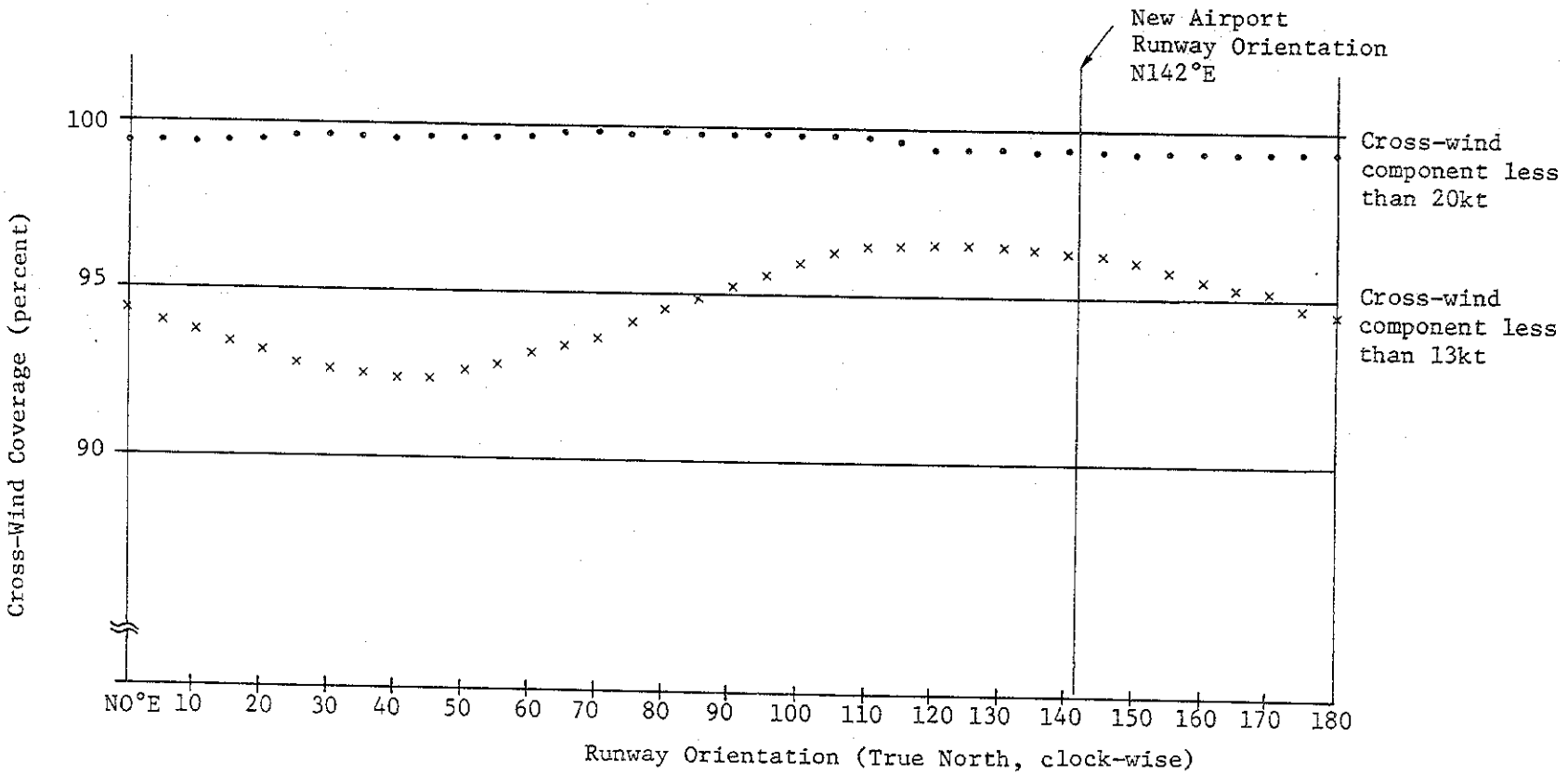


Fig. 7.2.6 Runway Orientation vs. Cross-Wind Coverage (1)
(Data Source: Nozha Airport, 1981-1983)

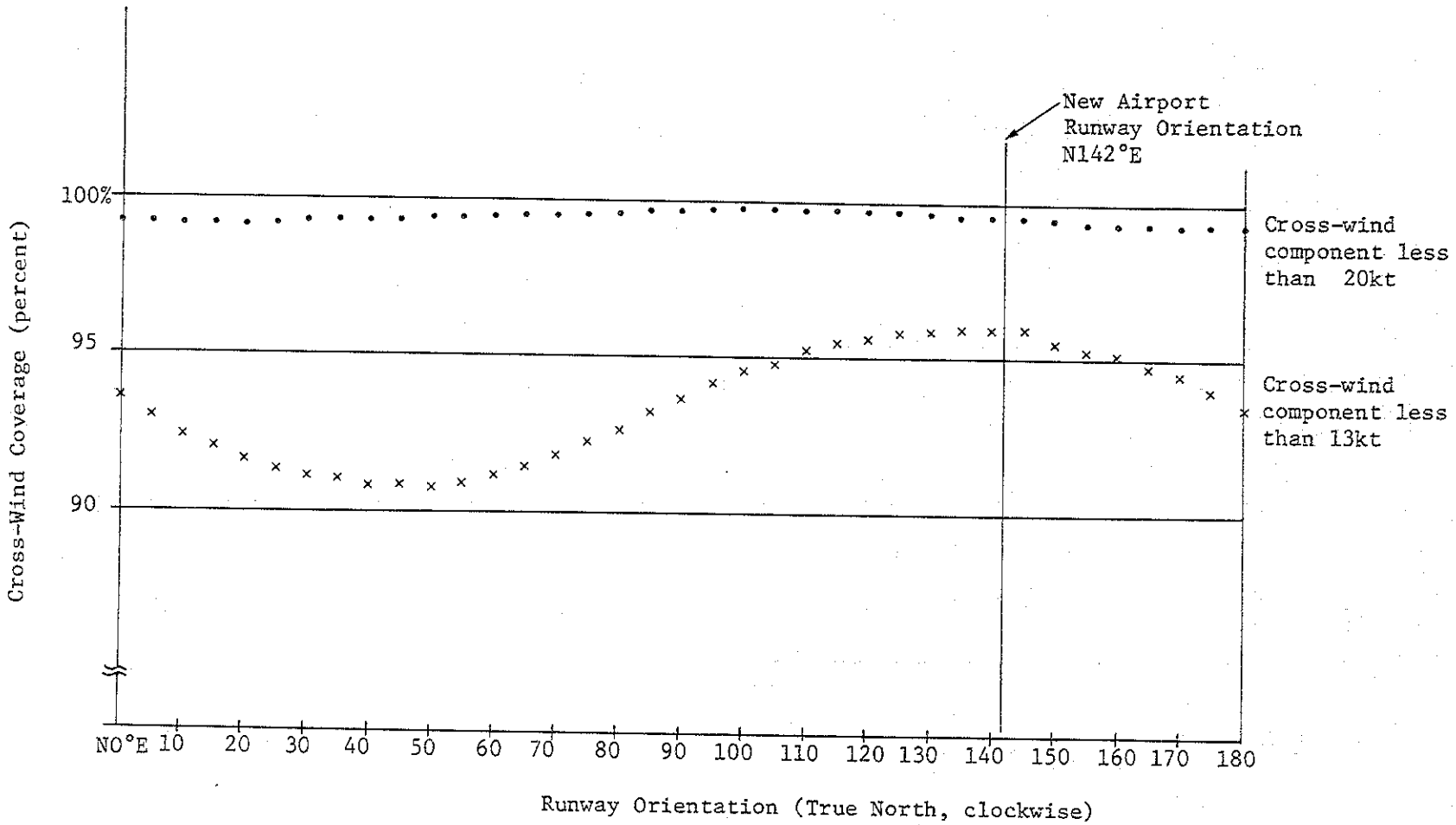


Fig. 7.2.7 Runway Orientation vs. Cross-Wind Coverage (2)
(Data Source: Dekheilla Airport, 1981-1983)

7.2.4 Geographical Features

The geographical features of the construction site are based on the existing map of scale 1:25,000. This map, however was published during the 1940s, and does not cover recent conditions.

The confirmation of geographical features in this feasibility study was done by the topographic survey. The detailed survey method is described in the report on "Site survey of natural conditions." The outline of survey results is described below.

(1) Outline of Survey Results

The topographic survey has been completed for an area of about 460 ha. as shown in Fig. 7.2.8. The survey area was determined based on the discussions with Egyptian Civil Aviation Authority. The runway of the new airport was tentatively located parallel to the military runway with a separation of 2,000 m.

Survey items are as follows:

i) Establishment of principal points
ii) Traverse survey
iii) Center-line survey
iv) Profile leveling (Scale V=1:100, H=1:5,000)
v) Cross-section leveling (Scale V=1:100, H=1:1,000)
vi) Plane table survey (Scale 1:25,000)

(2) Outline of Site Conditions

No man-made structures such as buildings, roads, etc. nor plants other than small weeds, are found in the survey area. The average ground elevation along the surveyed center line is about 50 meters above sea level.

There are hills with top elevation of 60 to 73 m at the centre of the survey area running from south to north. The terrain descends towards both west and south side with about 1.2 percent slope along the center line of the runway. The terrain condition is, however, nearly flat without remarkable variation. The east side of the site is especially level.

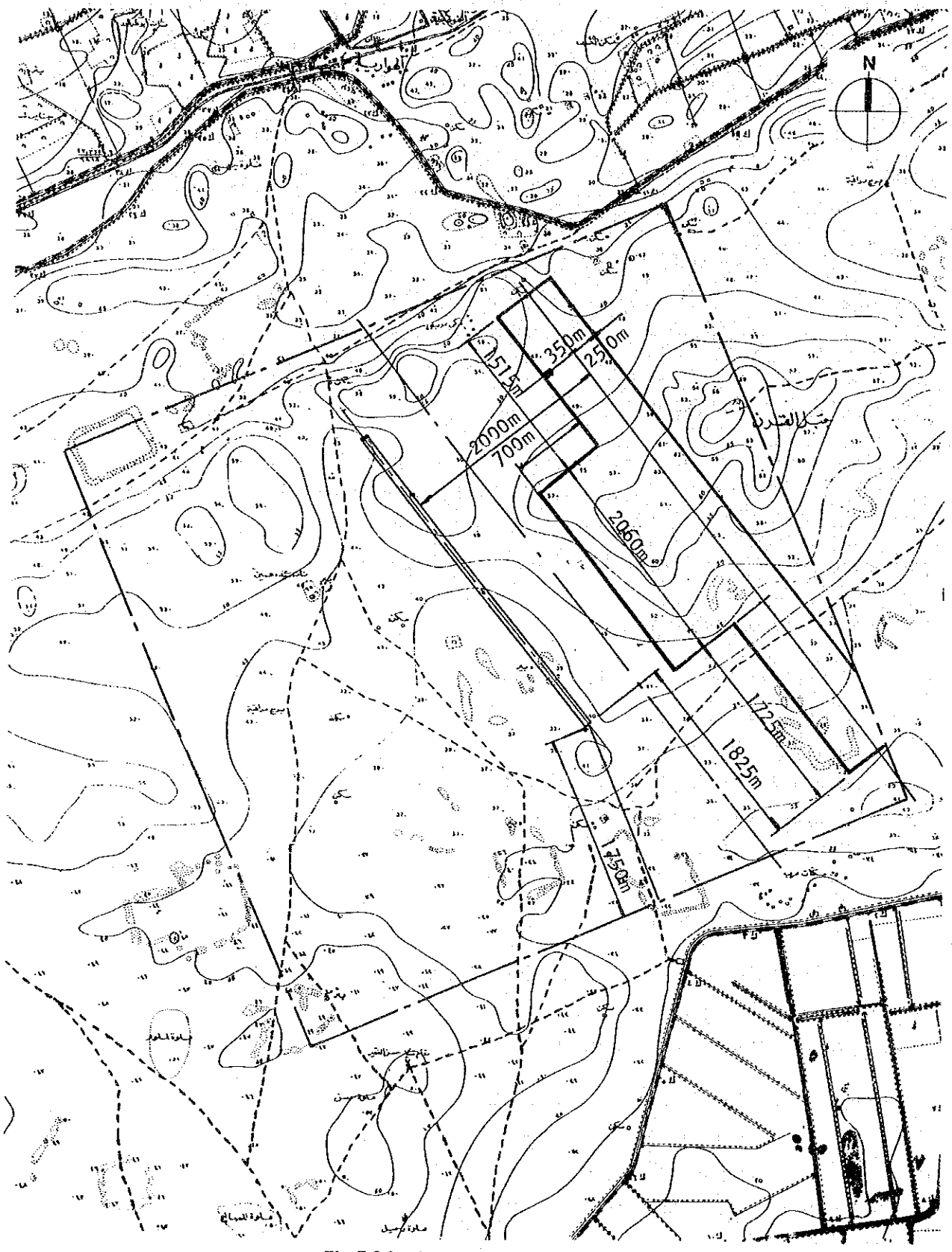


Fig. 7.2.8 Area of Topographical Survey

7.2.5 Soil Condition

The land surface of the construction site is covered with fine silty clay, and hills have limestone and mudstone of 5 to 10 cm thickness. Soil survey was performed in order to check quality of soil, distribution and strength for the pavement bed. The details are described in the report on "Site survey of natural conditions" and outlined below:

(1) Outline of Soil Investigation

Soil investigations as follows have been performed for the new airport site during August and September:

Mechanical Boring:	3 places
Test Pit:	5 places
Standard penetration test:	40 tests
Plate bearing test:	1 test
Laboratory Test:	1 L.S

(2) Survey Results

Very hard silty or clayey sediments with N-value of 20-80 were confirmed by borings and test pits. Some of them with higher N-value are considered to be "marl" which is an argillaceous calcium carbonate deposit. Platey limestone is observed at terrace higher than about 50 m in elevation. These sediments are considered to be classified in the formation of late tertiary. In the construction site of the military runway, bulldozer, scraper and ripper are used for the earth work. Limestone is hard enough for use as aggregate.

Cut portion shows 20% of the CBR test results to be fit for pavement bed, but banking portion is 5% of the CBR test results. These results are due to the existence of consolidated mudstone and limestone at cutting portion, and piled silty clay on the surface of banking portion judging from N-values.

7.3 Development Plan of the New Airport and Utilization of Nozha Airport

The development plan of the new airport shall also consider the utilization of Nozha airport at the same time.

The selection of the most feasible plan shall be based not only economic factors but also on effective utilization of the existing airport property to meet the target demand levels of air traffic.

The study result for the utilization of Nozha airport is described in the following sections.

7.3.1 Study on the Development Plan of the New Airport and the Utilization of Nozha Airport

Following factors were studied for the utilization of Nozha airport after completion of the new airport:

- Accessibility to Alexandria city which is the centre of traffic demand
- Effective utilization of about 350 ha of existing airport property
- Control of the water level at the airport area to minus 0.5 to 0.7 m by a pumping facility since the property is about minus 3 m elevation and about 1 m below the level of Lake Maryut.
- Harmonization with the green belt area along the property excluding the north side adjoining the city based upon the year 2005 plan by Alexandria Governorate
- Improving airport capacity to annually handle about 700,000 passengers after completion of the immediate plan for year 1991. This capacity is the nearly same as about 730,000 annual domestic passengers of Phase II development plan.

To attain these targets, the following alternative plans for utilization of Nozha airport after completion of the new airport are considered.

(I) Utilize as an airport with limited service	(a) General aviation and VIP's airport (b) Domestic airport
(II) Convert into land for other use	(a) Residential, agricultural or industrial area after land reclamation (b) Part of the green belt around Alexandria City (c) Public space such as a sports centre or public park.

7.3.2 Selection of Alternative Plan

Selection of alternative plan for detailed study from the abovementioned 5 alternatives for the utilization of Nozha airport was based not only on economic analysis but also on harmonization with the city development plan for Alexandria.

Therefore, Alt-B, which is to utilize the existing airport property for other purpose and handle all flights including domestic and international at the new airport was selected from 5 alternatives. Alt-C, which is to utilize existing Nozha airport for domestic and handle the international flights at the new airport was also selected for the following reasons;

(a) It is preferable to maximize utilization of the existing airport facility of Nozha for scheduled flights

(b) Nozha airport offers greater convenience for domestic passengers than the new airport because the load center of domestic demand is Alexandria City.

(c) When the existing Nozha airport is utilized for domestic service after immediate development work, it is possible to cope with the forecast air traffic demand during the project life up to the year 2010.

(d) When Nozha airport is utilized for domestic use, domestic demand from New Ameriyah city and Northwest Coast Development area can be accommodated in the new airport.

(e) Whenever the demand becomes larger than the handling capacity of Nozha airport and it is required to expand the airport facility on a large scale, it will be possible to replace Nozha airport by the new airport.

7.4 Airport Layout Plan

The layout plan for the new airport is based on the following two alternatives:

Alt-B: Construction of the new airport for international and domestic flights.

Alt-C: Construction of the new airport for international flights and use of Nozha airport for domestic flights.

The facility requirements of these alternatives are shown in Tables 4.1.1 to 4.1.3 of Chapter 4, and the major items are summarized in Table 7.4.1.

Runway location and layout plan of Alt. B is shown in Figs. 7.4.1 and 7.4.2, and layout plan of Alt-C is shown in Figs. 7.4.5 and 7.4.6.

The factors as explained hereinafter have been considered in the preparation of the airport layout plan.

Table 7.4.1 Comparative Table of Major Facilities for Alt-B & Alt-C

Facilities \ Plans		ALT - B New Airport (Int'l + Dom)	ACT-C New Airport + Nozha Airport	
			New Airport (Int'l)	Nozha Airport (Dom)
1. Runway		3,250 m	3,250 m	2,200 m
2. Parallel Taxiway	Year 2000	Required	None	None
	Year 2010	Required	Required	None
3. Apron (Spot)	Year 2000	JUMBO 2 LJ/MJ 4 NJ/SJ 1 P 1	JUMBO 2 LJ/MJ 4 P 1	NJ 2 P 1
	Year 2010	JUMBO 3 LJ/MJ 5 P 1	JUMBO 3 LJ/MJ 5	LJ/MJ 2 P 1
4. Int'l Pax. Terminal (m^2)	Year 2000	25,800	25,800	-
	Year 2010	36,000	36,000	-
5. Dome Pax. Terminal (m^2)	Year 2000	3,400	500	3,300
	Year 2010	5,600	1,300	5,100
6. Car Parking (m^2)	Year 2000	31,000	26,000	8,700
	Year 2010	44,000	37,000	14,000

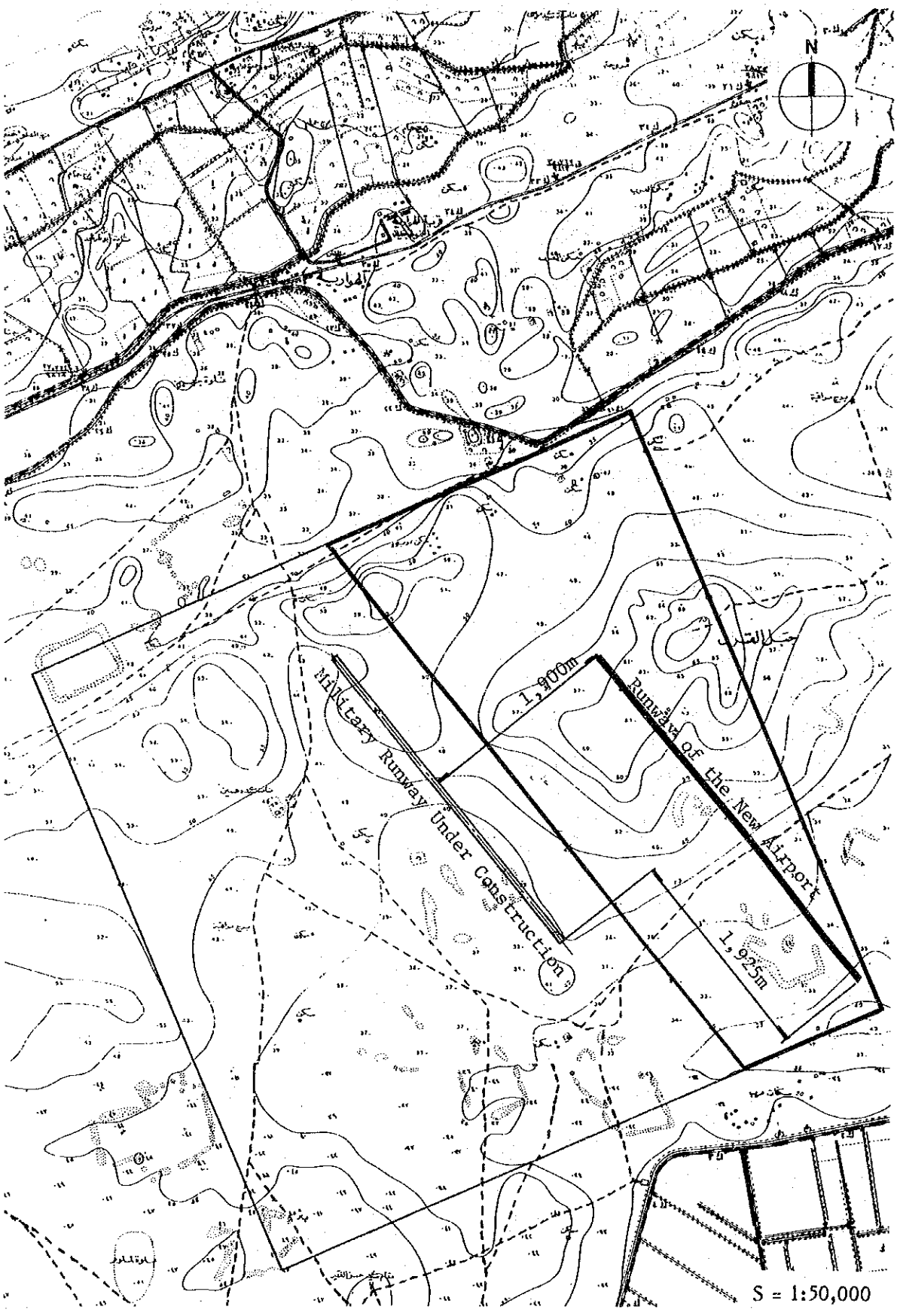
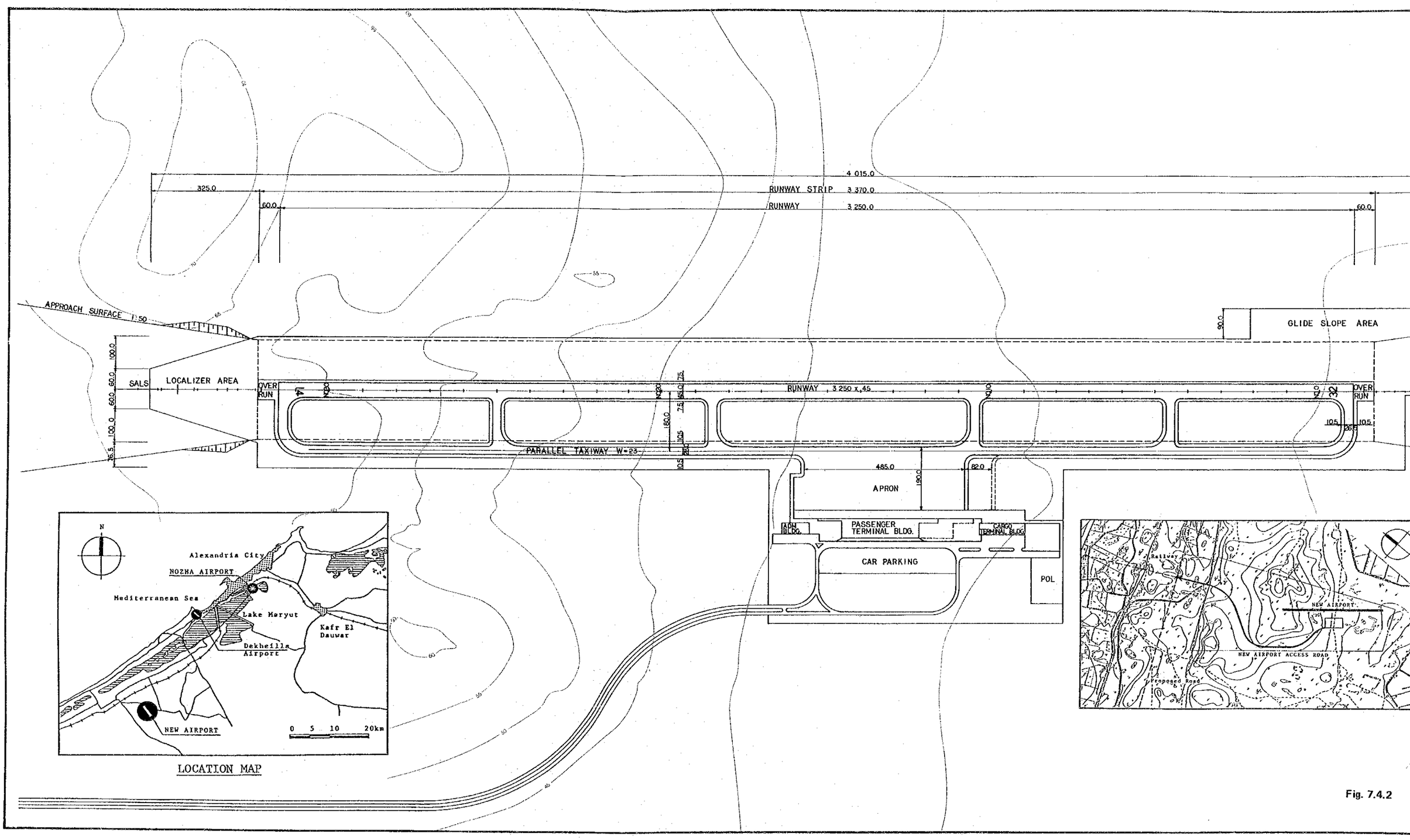


Fig. 7.4.1 Location of Runway for New Alexandria International Airport (Alt–B & Alt–C)



LOCATION MAP

Fig. 7.4.2

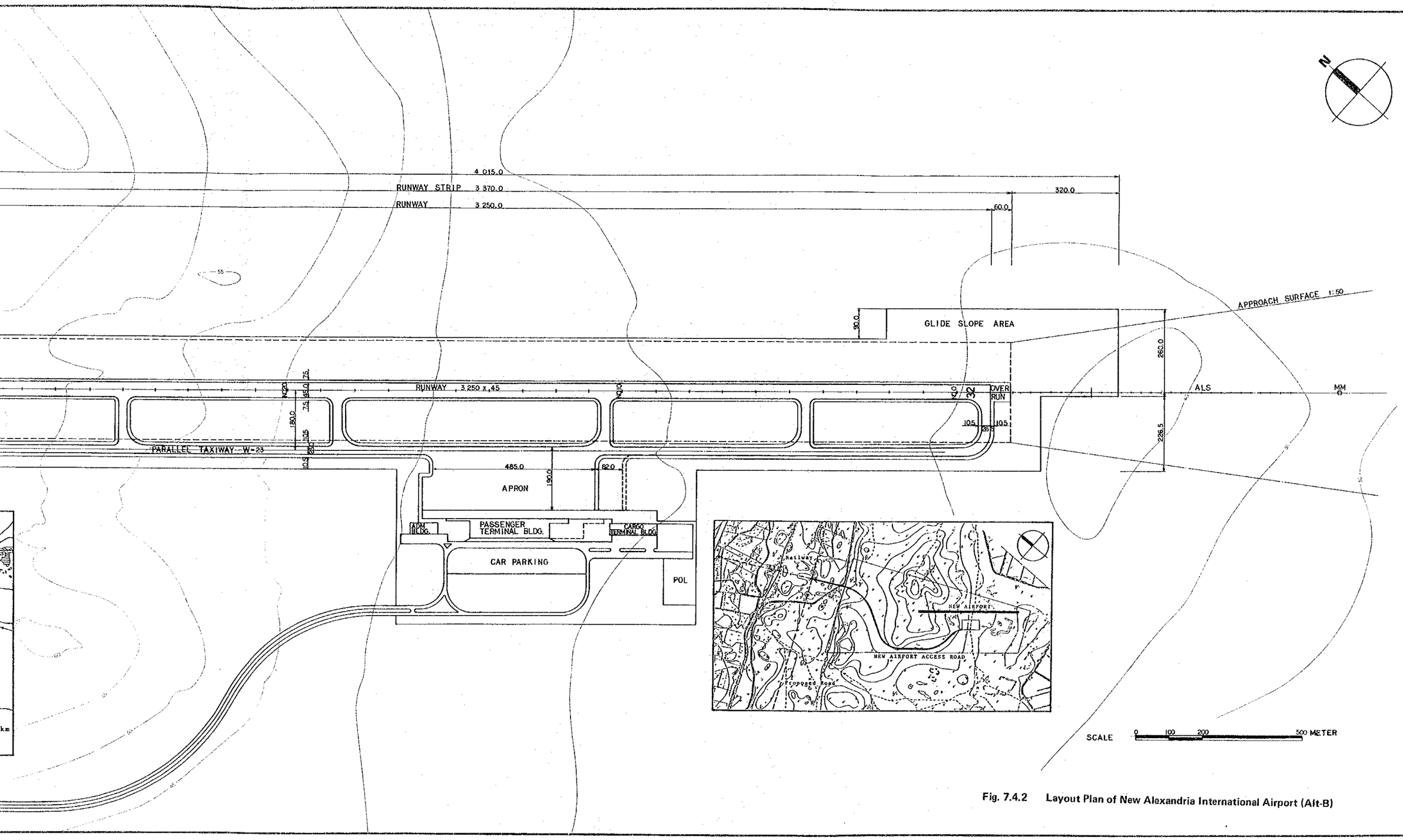


Fig. 7.4.2 Layout Plan of New Alexandria International Airport (Alt-B)

7.4.1 Development of New Airport (Alt-B)

(1) Runway, Taxiway and Apron Configuration

a) Runway Orientation

The orientation of the runway was determined to be N 142 E (RWY 14/32) and parallel with the adjacent military runway with a separation of 1,900 m considering wind coverage and safety and simultaneous aircraft operations at both airports without disruption

The cross-wind coverage of runway 14/32 is 96.3 percent for cross-wind less than 13 kt and 99.4 percent of 20 kt, based on the 3 years observation data at Nozha airport. The wind observation during 18th Aug. - 2nd Oct. 1984 at the new airport indicates that the cross-wind coverage is 97.1 for cross-wind less than 13 kt. (Refer to subsection 7.2.3).

The runway orientation is, accordingly, considered good for the wind conditions. For reference, the cross-wind coverages of runway 14/32 are respectively 95.9% and 99.5% for less than 13 kt and 20 kt cross-wind components based on observation data during the last 3 years at Dekheilla airport.

b) Separation of Two Runways *

Prior to the topographic survey, the runway configuration was discussed with Egyptian Civil Aviation Authority and determined to be parallel to the military runway with a separation of 2,000 m. However this separation was reduced to 1,900 m for less earth work volume after several grading trials to achieve the least and balanced cut and fill volume. A runway separation of 1,900 m is also considered to be acceptable for the following reasons:

i) Simultaneous aircraft operations are possible for runways separated more than 1,300 m.
ii) There is still ample space for terminal facilities between the boundary of military airport and the new runway, even if demand should rise unexpectedly.

c) Longitudinal Location of the Runway *

The longitudinal location of the runway is determined to be staggered by situating the southern threshold 1,925 m south from the southern threshold of

Note: * modified in 9.3.2

the military runway so that the least earth work volume can be achieved within the limit of the reserved land. However, an area for middle marker, approach lighting system and a part of ILS glide slope facility is located beyond the limit of the reserved land in order to reduce the earth work volume. As a result, about 11 ha of additional land will be required.

d) Establishment of Main Approach Direction

The prevailing wind is from the northwest and the main approach direction is determined to be runway 32 (toward the northwest). Hence, ILS, approach lighting system, etc., for precision approach Category-I is planned for runway 32 approach.

e) Taxiway and Apron Configuration

The layout of taxiway of the new airport in Alt-B is basically the same as the layout of Nozha airport by Alt-A. Full parallel taxiway is, therefore, planned with exit taxiways.

Apron shall be considered in the layout plan of terminal facility. Taking the topographic condition along the planned runway and property boundary shown in Fig. 7.4.1 into consideration, the terminal area is located at the west side of the runway and therefore involves less earthwork volume. The preferred location of apron is to be as near the centre of the runway as possible from the point of view of connection with the runway. Taking account of the above-mentioned points, the new terminal area including apron is planned as shown in Fig. 7.4.2.

f) Obstacle Limitation Surface

There is nothing in the planned area to infringe upon the obstacle limitation surfaces nor to limit the establishment of aircraft operations as shown in Fig. 7.4.3.

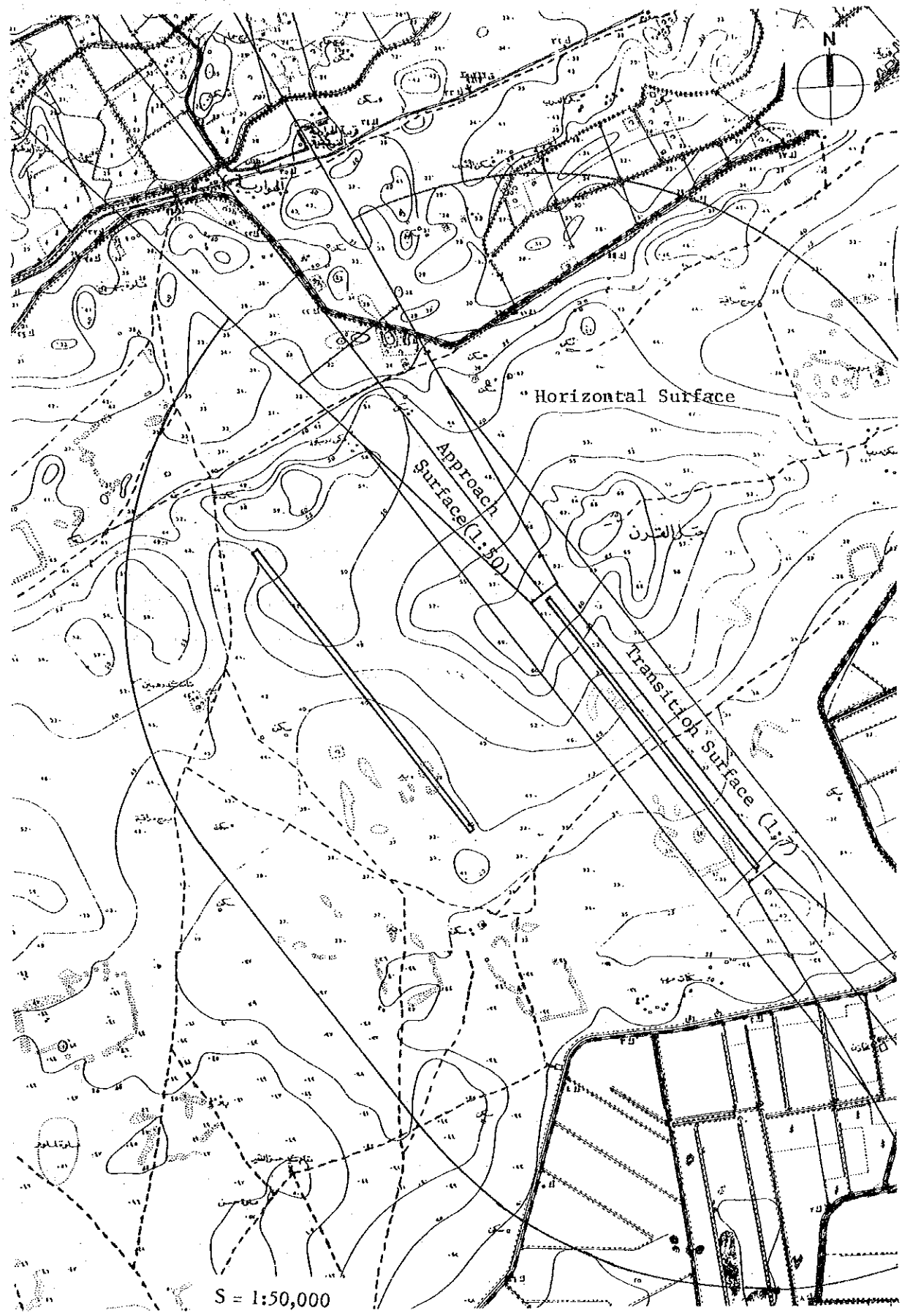


Fig. 7.4.3 Obstruction Limitation Surfaces for New Alexandria International Airport

(2) Terminal Facility

The basic concept of terminal facility layout plan is the same as the redevelopment plan of Nozha airport of Alt-A.

The passenger terminal building follows the linear concept with passenger and cargo terminal buildings, administration facility and fire station in a line facing the apron. The car parking area is at the land side with space reserved for fuel yard and catering facility. Necessary space for the terminal area including apron is about 40 ha with a width of 900 m and depth of 450 m as shown in Fig. 7.4.2.

(3) Access Road

The most convenient access road to the new airport would be a road connected to the Coastal Highway, linking Alexandria and Mersa Matruh as shown in Fig. 7.1.1.

The coastal Highway is now being expanded from 2-lanes to 4-lanes, and is scheduled to be completed by the beginning of the 1990. New Ameriyah city will be linked with the airport by the 2-lane road which is planned by Alexandria Governorate.

The connection road with Coastal Highway, however, is required to be about 14 - 15 km long and must cross Lake Maryut with large scale work involved.

The access road, therefore, is planned to link with a proposed road between Desert Road and New Ameriyah City as shown in Fig. 7.4.4.

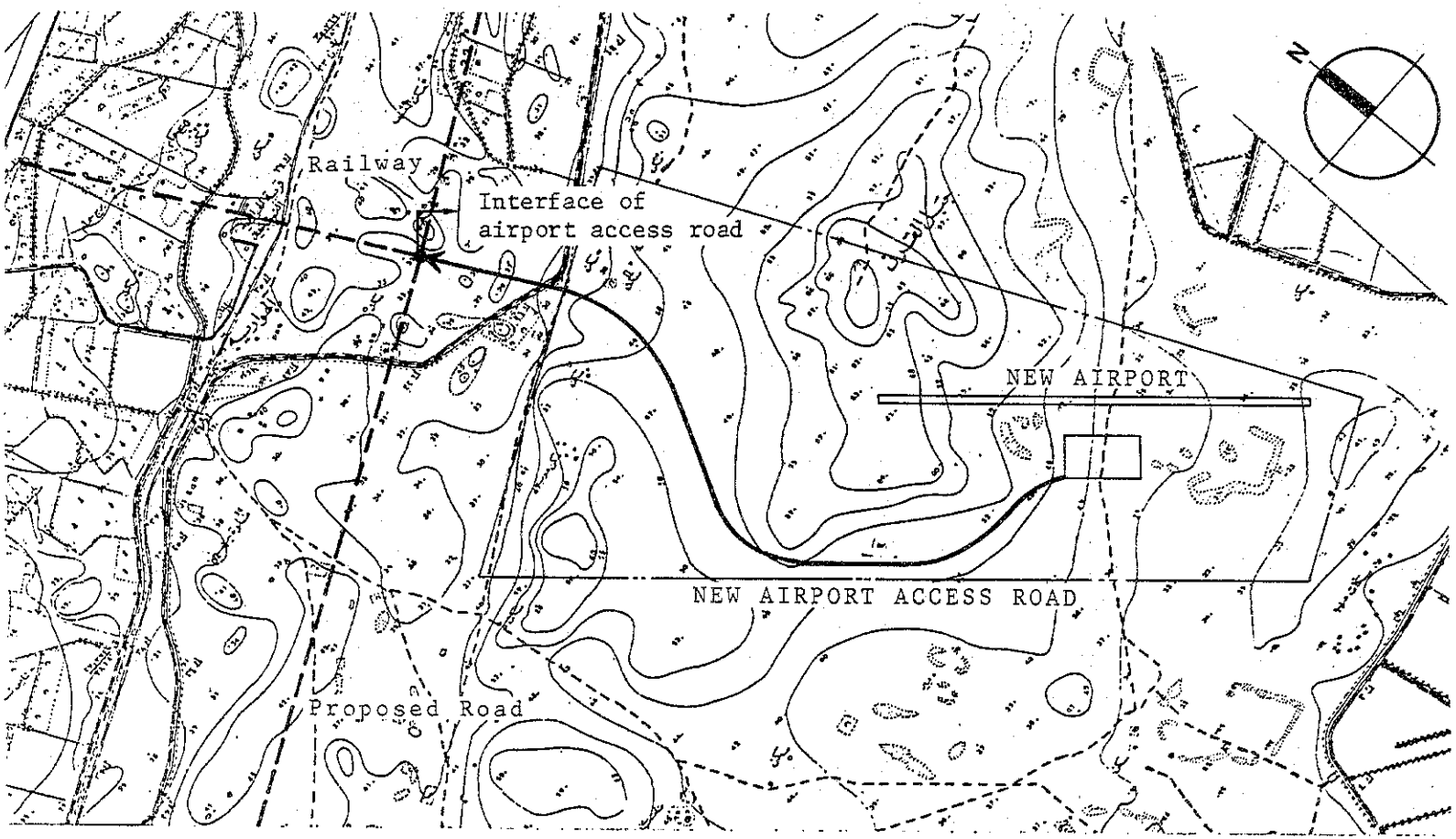


Fig. 7.4.4 Plan of Airport Access Road

S = 1:50,000

7.4.2 Development of New Airport and Nozha Airport (Alt-C)

Alt-C consists of the following features:

- New airport for use of international and limited domestic flights.
- Nozha airport for use only by domestic flights.

(1) Plan of the New Airport

Airport layout plan of the new airport by Alt-C is basically the same as in Alt-B. Requirements for the terminal facilities, however, are smaller than Alt-B as shown in Table 7.4.1. The parallel taxiway is planned to be constructed in Phase II development because the number of instrument landings at peak hour is too small: 3.6 and 4.1 in the year 2000 and 2010, respectively. Two exit taxiways, therefore, are planned to be constructed at the connecting point with apron in Phase I development. Turning pads shall be considered at both ends of the runway in order to cope with 180° turning by wide body aircraft due to lack of construction of parallel taxiway in Phase I development. The layout plan is shown in Fig. 7.4.5.

(2) Redevelopment of Nozha Airport

Alt-C is to use Nozha airport for a domestic airport after completion of the new airport, with the condition that the development works for Nozha airport are to be carried out in the immediate plan by the year 1986 as shown in Table 5.9.6.

The number of passengers will decline sharply due to the diversion of international flight services to the new airport in the year 1992. However, Phases I and II development are required in order to cope with the traffic demand of the years 2000 and 2010.

The development plan of each facility is described in the following Sections and general layout plan is shown in Fig. 7.4.6.

a) Runway, Taxiway and Apron

Runway, taxiway and apron are shown in Fig. 7.4.6. They can serve in the Phase II development plan without expansion of existing facilities. Pavement overlay work, however, will be required by the increasing air traffic volume.

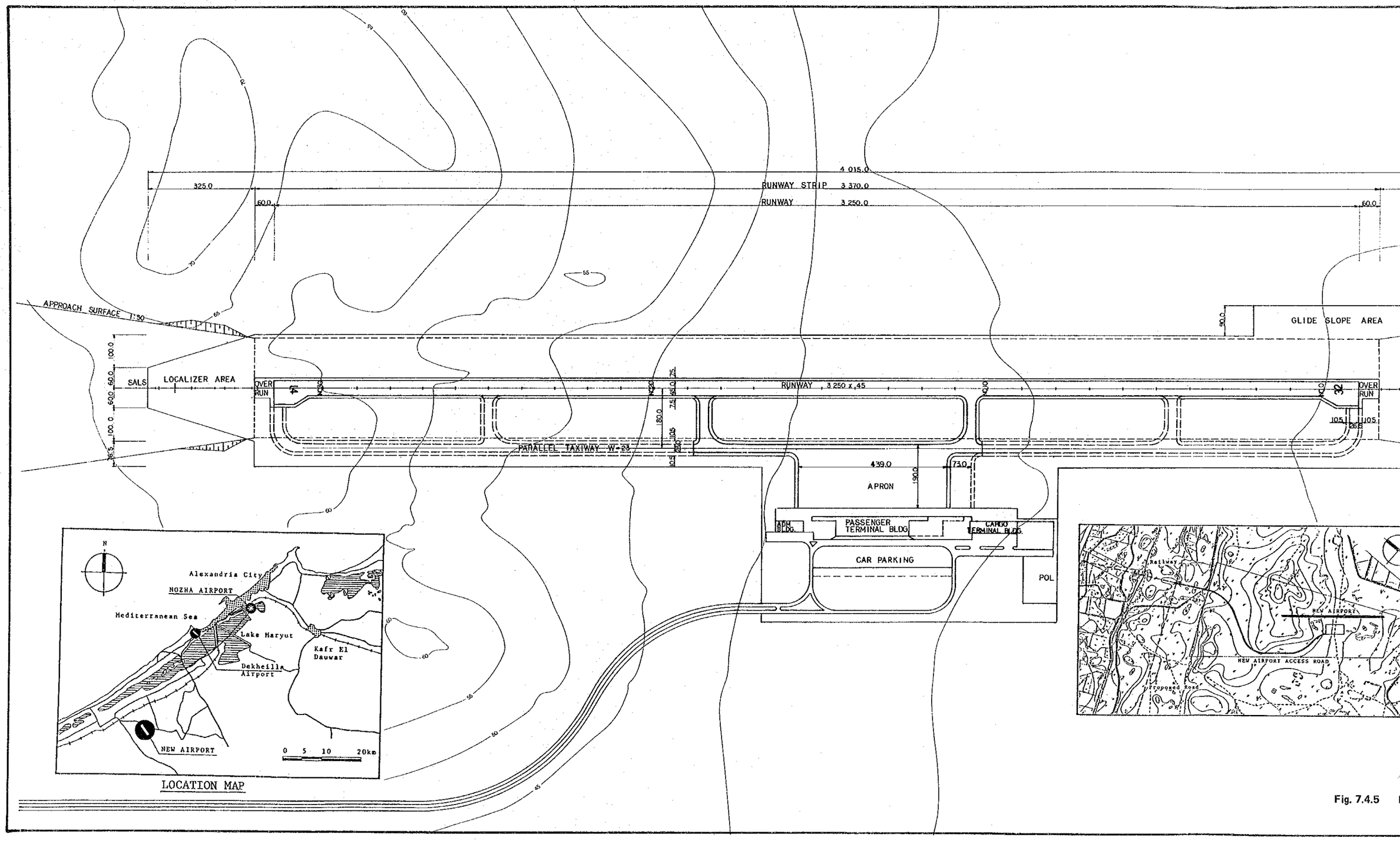

4 015.0
325.0
RUNWAY STRIP 3 370.0
RUNWAY 3 250.0
60.0
60.0
APPROACH SURFACE 1:50
50.0
GLIDE SLOPE AREA
100.0
60.0
60.0
100.0
SALS
LOCALIZER AREA
OVER RUN
RUNWAY 3 250 x 45
OVER RUN
PARALLEL TAXIWAY W-23
180.0
439.0
73.0
APRON
190.0
ADM BLDG.
PASSENGER TERMINAL BLDG
CARGO TERMINAL BLDG.
CAR PARKING
POL
N
Alexandria City
NOZHA AIRPORT
Mediterranean Sea
Lake Maryut
Kafr El Dauwar
Dekheila Airport
NEW AIRPORT
0 5 10 20km
LOCATION MAP
Railway
NEW AIRPORT
NEW AIRPORT ACCESS ROAD
Proposed Road

Fig. 7.4.5

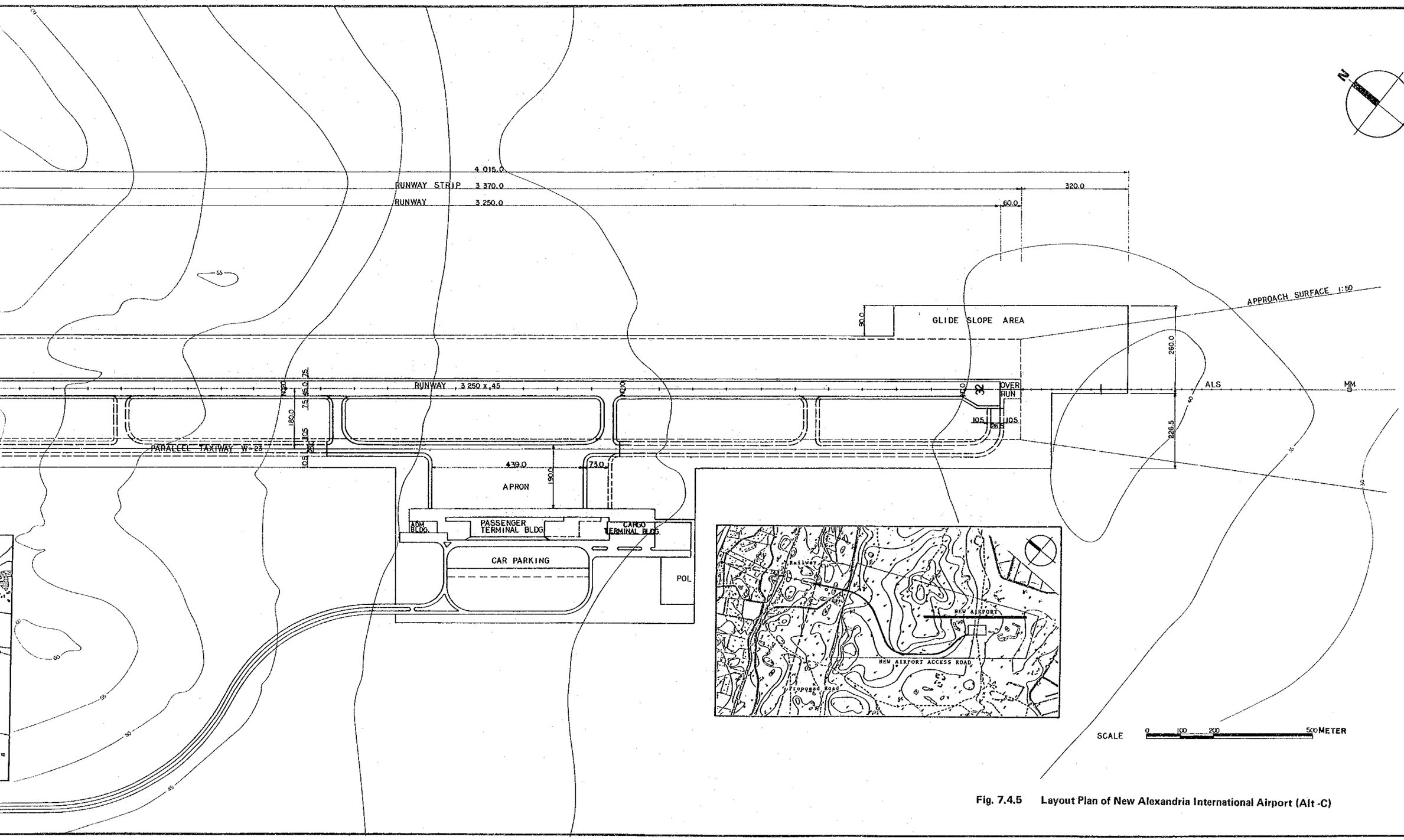


Fig. 7.4.5 Layout Plan of New Alexandria International Airport (Alt -C)

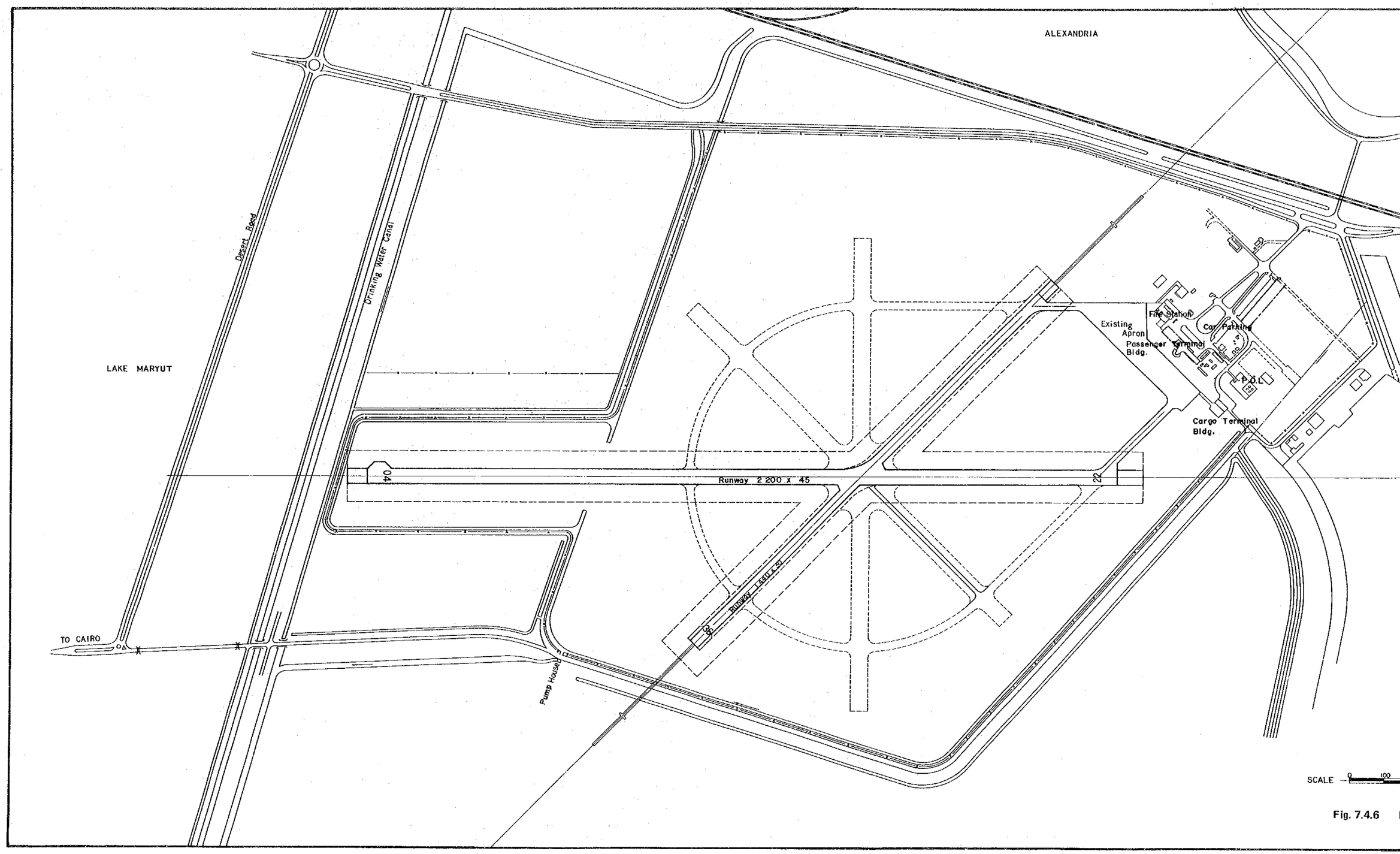

ALEXANDRIA
LAKE MARYUT
Desert Road
Drinking Water Canal
Fire Station
Car Parking
Existing Apron
Passenger Terminal Bldg.
P.O.L.
Cargo Terminal Bldg.
04
Runway 2 200 x 45
22
Runway 1 440 x 30
TO CAIRO
Pump House
SCALE 0 100

Fig. 7.4.6

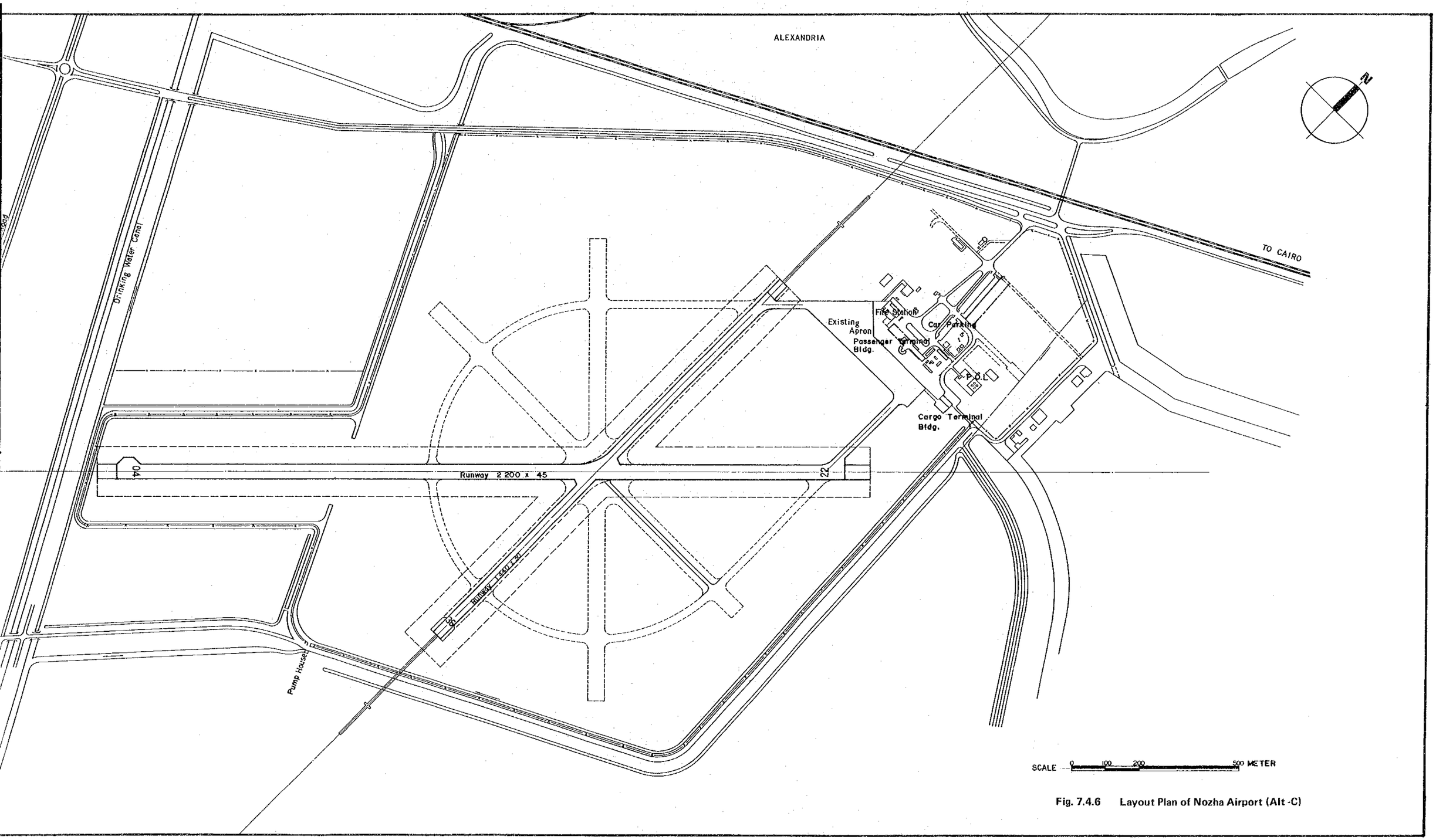


Fig. 7.4.6 Layout Plan of Nozha Airport (Alt -C)

b) Passenger Terminal Building

In Phase I development, expansion work of 300 sq.m is required based upon the basic assumption of 10 sq.m per peak hour-passenger studied in Chapter 4. The expansion of passenger terminal building from 3,300 sq.m to 5,100 sq.m is planned in Phase II development. The expansion site is beside the existing VIP building, and the VIP building shall also be relocated maintaining it's current scale at that time.

c) Other facilities

- Cargo terminal building

  Cargo terminal building is to be developed with 900 sq.m of floor space in the immediate development plan. By the diversion of international flights after the 1992, the facility will have spare capacity of 850 sq.m and 790 sq.m in Phase I and Phase II development, respectively. This space can be converted into a general aviation hangar.

- Car parking

  The car park for 350 vehicles which is to be expanded by the immediate development work is nearly the same as the required capacity of 340 vehicles by the year 2005. In Phase I development the pavement work of about 1,600 sq.m for the remaining area is therefore required. The total area of the car park is required to be expanded to 14,000 sq.m as Phase II development work. Expansion area for this is planned to be as near as possible to the passenger terminal building taking user's convenience into consideration.

7.5 Outline of Airport Facilities

7.5.1 Development of New Airport (Alt-B)

(1) Grading Plan

The grading plan for the airport is generally established so as to achieve the least and a balanced earth work volume. The profile of the centerline of the runway and the typical cross section of the airfield are shown in Figs. 7.5.1 and 2 respectively. The total earth work volume for the total airport construction is estimated to be about 1,000,000 cu.m of cut volume. The major planning criteria and policies in accordance with ICAO recommendations are summarized as follows:

a) The new airport is planned on the southern slope of the hill with a gradient of about 1.2 percent.* Therefore, the longitudinal slope for the central portion of the runway is planned to be 1.2 percent for construction economy. However, 0.8 percent is adopted for the first and the last quarter of the runway in accordance with ICAO Annex 14.

b) A transverse slope for the runway and taxiway is planned to be 1.3 percent considering the tolerance of the pavement works and to facilitate overlay works in the future.

c) The area to be cleared and graded for the runway strip is basically as shown in Fig. 7.5.3.

d) Within the above area, cross-section is planned with down slopes of 1.0% and 2.5% toward the outside for cut and fill sections respectively in order to minimize the earth work volume and to facilitate an adequate water flow.

e) The allowable maximum transverse slope of 5% is basically adopted for the area beyond the above-mentioned cleared and graded area, in order to minimize the earth work volume.

Note: * revised in Chapter 9. 9.3

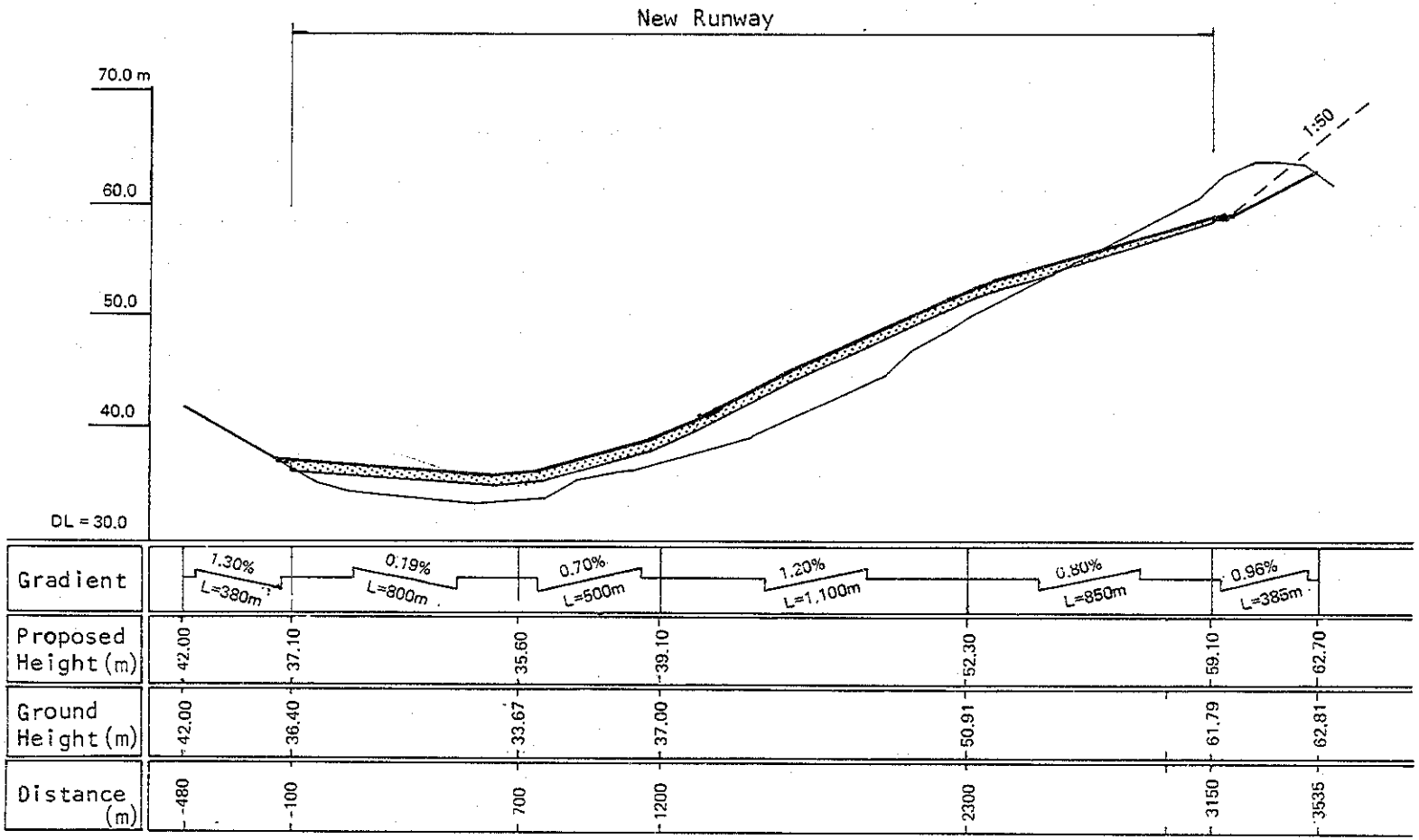


Fig. 7.5.1 Runway Profile of New Alexandria International Airport

(Revised in Chapter 9)

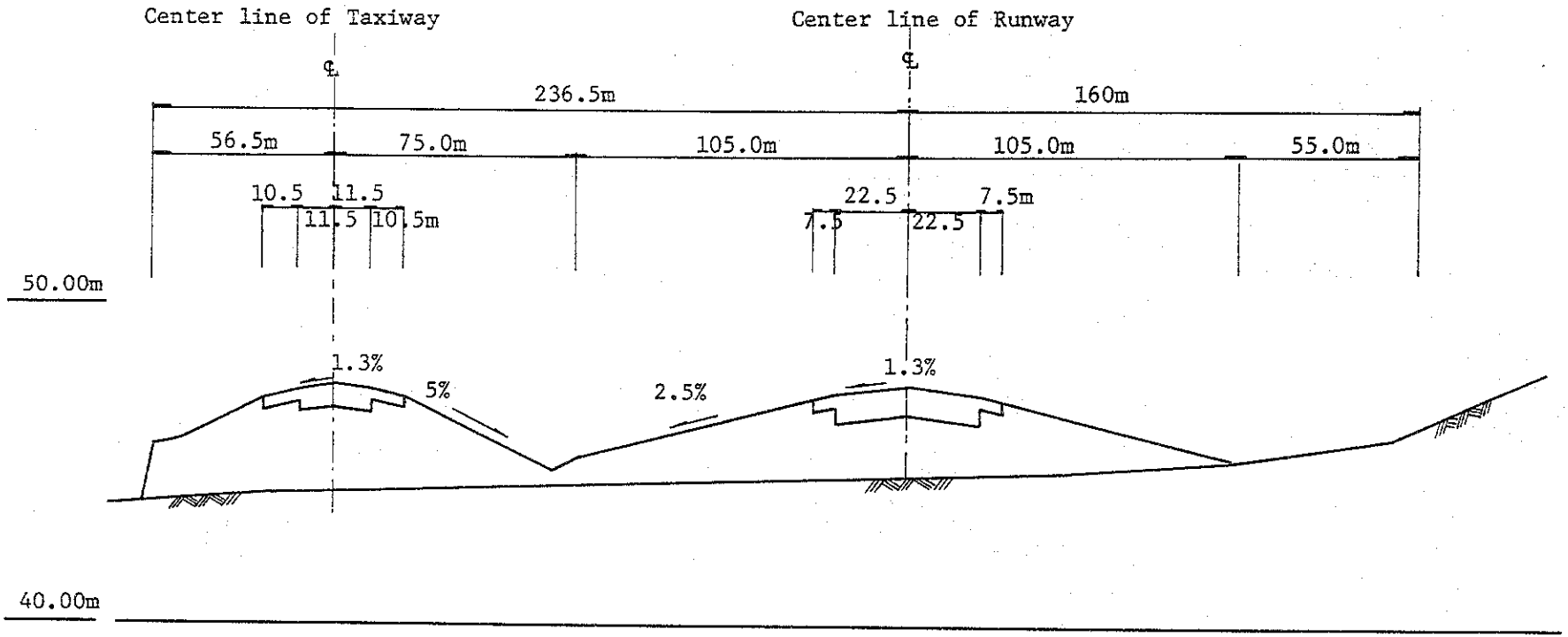
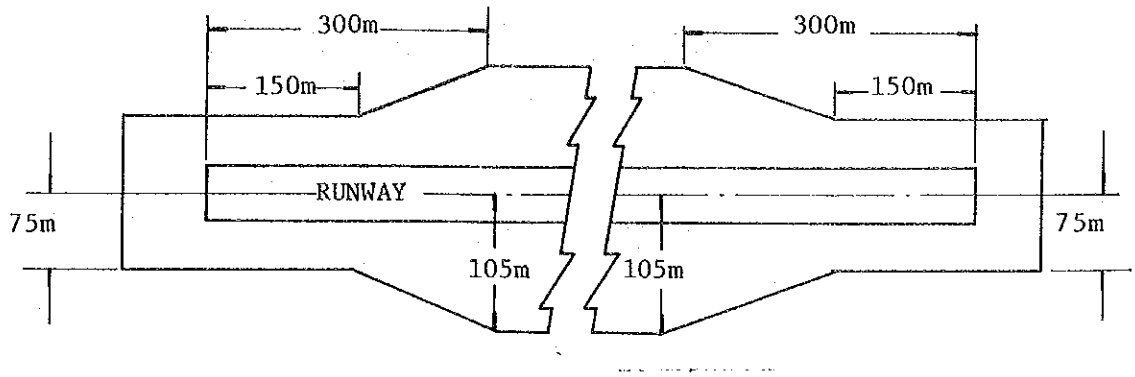


Fig. 7.5.2 Typical Cross Section of New Alexandria International Airport



Source: ICAO ANNEX 14 ATTACHMENT A.

Fig. 7.5.3 Area to be Cleared and Graded

(2) Pavement

a) Subgrade Bearing Strength

The site is classified into cut area and fill area. The subgrade of cut area consists of very hard layer sediments or limestone with N-value of 20 -80. Therefore, subgrade CBR for design is estimated as 20%. With regard to fill area, material of fill is fine silty clay hauled from cut area. The modified CBR of this material is about 5% based on laboratory testing. The cement stabilization method* is adopted in order to increase the subgrade CBR for design from 5% to more than 10% for economic reasons.

Note: * revised in Section 10.4.4

b) Types of Pavement

As mentioned in Section 6.6.2 flexible pavement is planned for the runway and taxiways except passenger loading apron where rigid pavement will be adopted.

c) Pavement Thickness

The pavement thickness is planned as follows based on the JCAB Method.

i) Phase I

Design Aircraft	:	B-747
Design period	:	9 years
Repetition of design load	:	3,000 times

- Runway and taxiway (Cut area)

  Subgrade CBR Value : 20%

Component	Thickness
Bituminous surface course	4 cm
Bituminous binder course	5 cm
Ditto	5 cm
Graded aggregate base course	25 cm
Crusher-run subbase course	15 cm
Total	54 cm

- Runway and Taxiway (Filled area)

  Subgrade CBR Value : 10%

Component	Thickness
Bituminous surface course	4 cm
Bituminous binder course	5 cm
Ditto	5 cm
Graded aggregate base course	30 cm
Crusher-run subbase course	36 cm
Total	80 cm

- Apron (Filled area)

  Subgrade K value : $K_{75} = 5.5$ kg/cm^3

  Subbase K value : $K_{75} = 7.0$ kg/cm^3

Component	Thickness
Cement concrete slab	34 cm
Graded aggregate base course	30 cm
Total	64 cm

ii) Phase II

Design aircraft : B-747

Design Period : 10 years

Repetition of Design load : 5,000 times

- Existing Runway and Taxiway (Filled area)
  Thickness of Bituminous overlay: 3 cm

- New Apron (Filled area)

Component	Thickness
Cement concrete slab	38 cm
Graded aggregate base course	30cm
Total	68 cm

- Existing Apron overlay
  Thickness of cement concrete 13 cm

(3) Drainage System Plan

According to meteorological data from 1964 to 1983, maximum daily rainfall during the last 20 years at Nozha and Dekheilla is 65 mm and 64 mm respectively. Rainfall intensity of 60 minutes is about 8 mm according to Meteorological Authority in Cairo. Therefore, storm water drainage will be basically by evaporation and infiltration in the new airport except for the terminal area where necessary drainage facilities consisting of catch basin, drain pipe, U-shaped channel, etc. will be planned.

(4) Air Navigation Systems

The air navigation systems required for category-I operation have been planned as shown in Table 7.5.1. The life of the electronic equipment is about 10 years if necessary maintenance is carried out. The replacement of the equipment is accordingly required thereafter.

Table 7.5.1 Air Navigation Systems Plan

Equipment	Outline	Remarks
NAVIAIDS		
ILS	RWY 32, Category-I	
Locater	at outer marker station	
MLS	Replacement of ILS above	
VOR/DME	Conventional type	Terminal VOR/ DME
NDB		Terminal NDB
Navaids monitor and control		
ATC/COM		
ASR/SSR		
Tower console		
VHF air/ground radio	5 frequencies	
UHF	air/ground radio	
VHF link	Between outer marker station	
AFTN teletype		
ISB radio	AFTN/ATS direct speech	Back up for common carrier
Tape recorder		
Master clock and interphone	ATC use	
LIGHTS		
Approach lighting system	RWY32, Category-I	
Simple approach lighting system	RWY14	
Runway edge lights		

Table 7.5.1 Air Navigation Systems Plan (Cont'd)

Equipment	Outline	Remarks
Runway threshold/end lights		
PAPI	RWY 14/32	
Taxiway edge lights		
Apron flood lights		
Illuminated wind indicater		
Aerodrome beacon		
Power supply and control equipment		
Air traffic light gun		
MET		
Surface sensors	surface wind, temp, dew point, rain fall	
Data collecting equipment	Automated data collection and recording	
Runway visual range equipment	RVR measurement	
Ceilometer	Cloud height measurement	
Weather facsimile		
Weather teletype		
HF receiver		
Others		
Measuring equipment and spare parts.		

(5) Airport Utilities

Airport utilities (especially power and water supply) have to interface with the regional network.

The power supply system and water supply system have preliminarily been planned and the construction cost has been preliminarily estimated based on the following conditions: (Refer to Fig. 7.5.4)

a) Power supply system

The construction cost has been estimated for the power supply system (main substation, underground distribution lines, substations) necessary for the new airport.

It is assumed that transmission lines connecting the airport main substation to the regional transmission network will be constructed in the other related project by the authority concerned. Hence, the construction cost for the transmission lines is excluded.

b) Water supply system

As for the water supply system, the cost for distribution lines outside the reserved area for the new airport has been excluded.

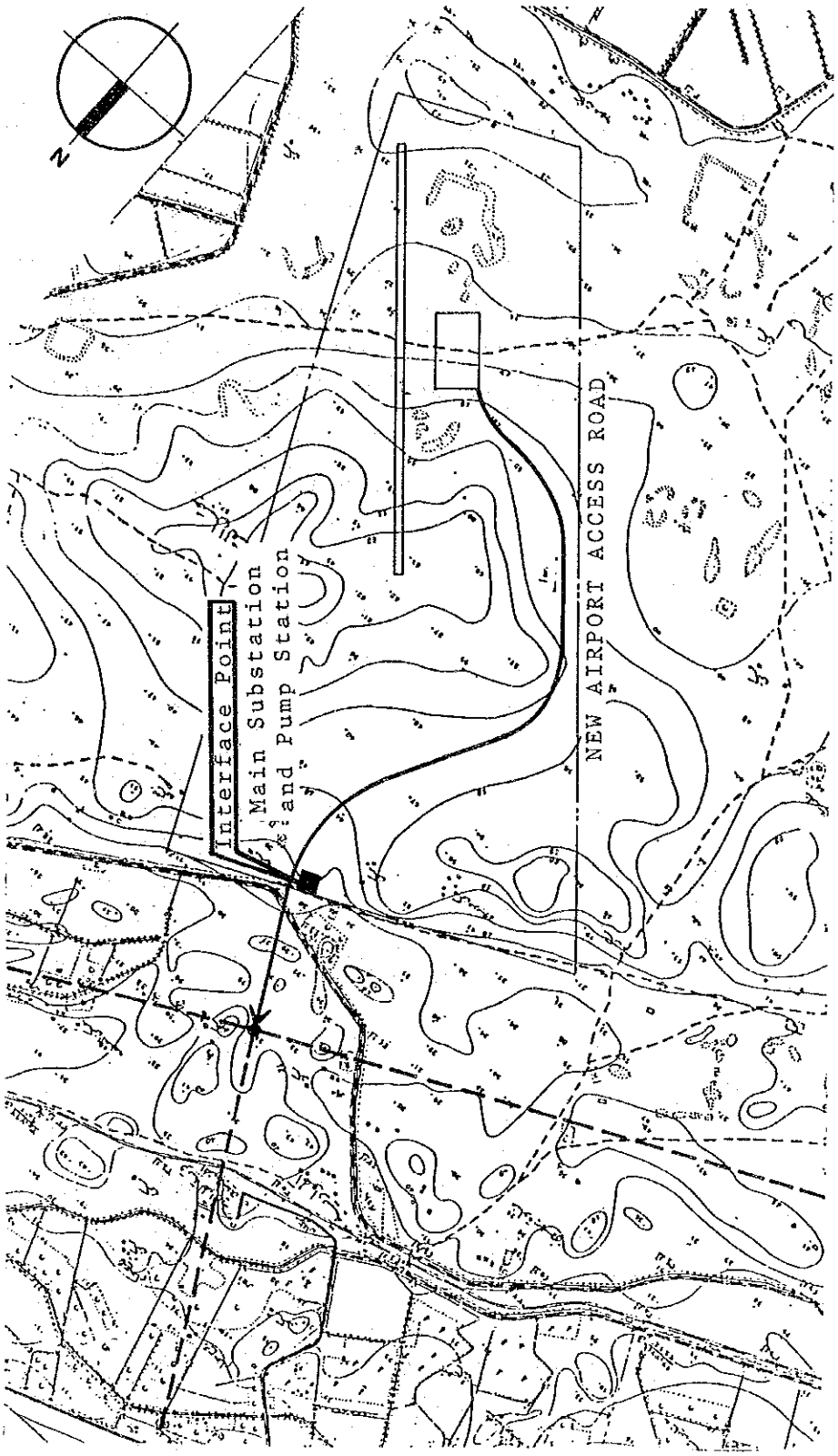


Fig. 7.5.4 Interface Point of Airport Utilities

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7.5.2 Development of New Airport and Nozha Airport (Alt-C)

(1) Development Plan of New Airport

Facilities planning of Alt-C is basically the same as for Alt-B except for the following facilities:

- Pavement:

  Domestic aircraft movements in Alt-C are less than Alt-B, however the input for design including repetition of design load of Alt-C is the same as for Alt-B. Only the pavement required for parallel taxiway and perpendicular exit taxiways at Phase II are planned differently as follows:

  Design aircraft : B-747
  Design Period : 10 years (Phase II)
  Repetition of design load : 5,000 times

- Taxiway (Cut area)

  Subgrade CBR Value : 20%

Component	Thickness
Bituminous surface course	4 cm
Bituminous binder course	5 cm
Ditto	5 cm
Graded aggregate base course	25 cm
Crusher-run subbase course	15 cm
Total	54 cm

- Taxiway (Filled area)

  Subgrade CBR Value : 10%

Component	Thickness
Bituminous surface course	4 cm
Bituminous binder course	5 cm
Ditto	5 cm
Graded aggregate base course	30 cm
Crusher-run subbase course	42 cm
Total	86 cm

(2) Redevelopment Plan of Nozha Airport

Main works of redevelopment for Phase I and Phase II are overlays of the pavement, renewal of Navaids and expansion of the passenger terminal building.

a) Pavement

- Phase I

  Overlay with 3 cm thickness is required for runway 04/22, runway 18/36 (only section used for connecting taxiway to apron), taxiway and apron.

- Phase II

  The following overlay is planned for Phase II.

Area	Thickness
Runway 18/36 (only the section abovementioned)	10 cm
Runway 04/22 and taxiway	12 cm

b) Passenger Terminal Building

In the case of Alt-C, an additional floor area of 300 sq.m will be required for the passenger terminal building in Phase I and Phase II, respectively, in the direction of existing VIP building which will be relocated. The cost estimate of the expansion of the building is based on the assumption that the structure and the interior of the new expanded building is the same as the old building in consideration of achieving a balance between both buildings.

7.6 Aircraft Noise Influence

7.6.1 Existing Land Use of New Airport Site

The new airport is located in desert area dotted with only a few Bedouin houses. There are agricultural lands to both the north and the south of the new airport site. There are dozens of houses near Hawariyah Station and along the paved road with two lanes in the north of the new airport site. It is judged from the above present condition that the new airport can be developed compatible with the existing land use in the airport vicinity.

7.6.2 Noise Influence and Future Land Use

Green zone and agricultural zone with width of about 2 km each is planned in the north of the new airport according to the comprehensive plan "Alexandria 2005", issued by the Alexandria Governorate. Residential area and tourist villages are also planned between the National railway and Mediterranean sea in "Alexandria 2005."

The aircraft noise contour WECPNL 70 for Alt-B will extend to Lake Maryut and the planned residential area will be influenced by aircraft noise as shown in Fig. 7.6.1.

In case of Alt-C the noise contour coverage would be smaller than that of Alt-B. However, noise pollution is foreseen to be the same problem as in the case of Alt-B.

Therefore, the planned residential area should be changed to green belt, agricultural land or industrial area and new residential development should be avoided at the earliest possible date when the new airport construction is finalized.

7.6.3 Noise Influence at Nozha Airport in Alt-C

Nozha airport will be used for domestic services in Alt-C, so influence of aircraft noise must be also assessed based on aircraft movements and mix.

Aircraft movements of Alt-C, however, are less than one fourth of those of Alt-A. Therefore it is expected that the aircraft noise influence for Alt-C is small.

Moverover Alt-C has the merit that airport services can be moved to the new airport before the noise problem becomes serious because Alt-C takes maximum advantage of the capacity of Nozha airport with small investment. Precise assessment will be completed in Chapter 12.

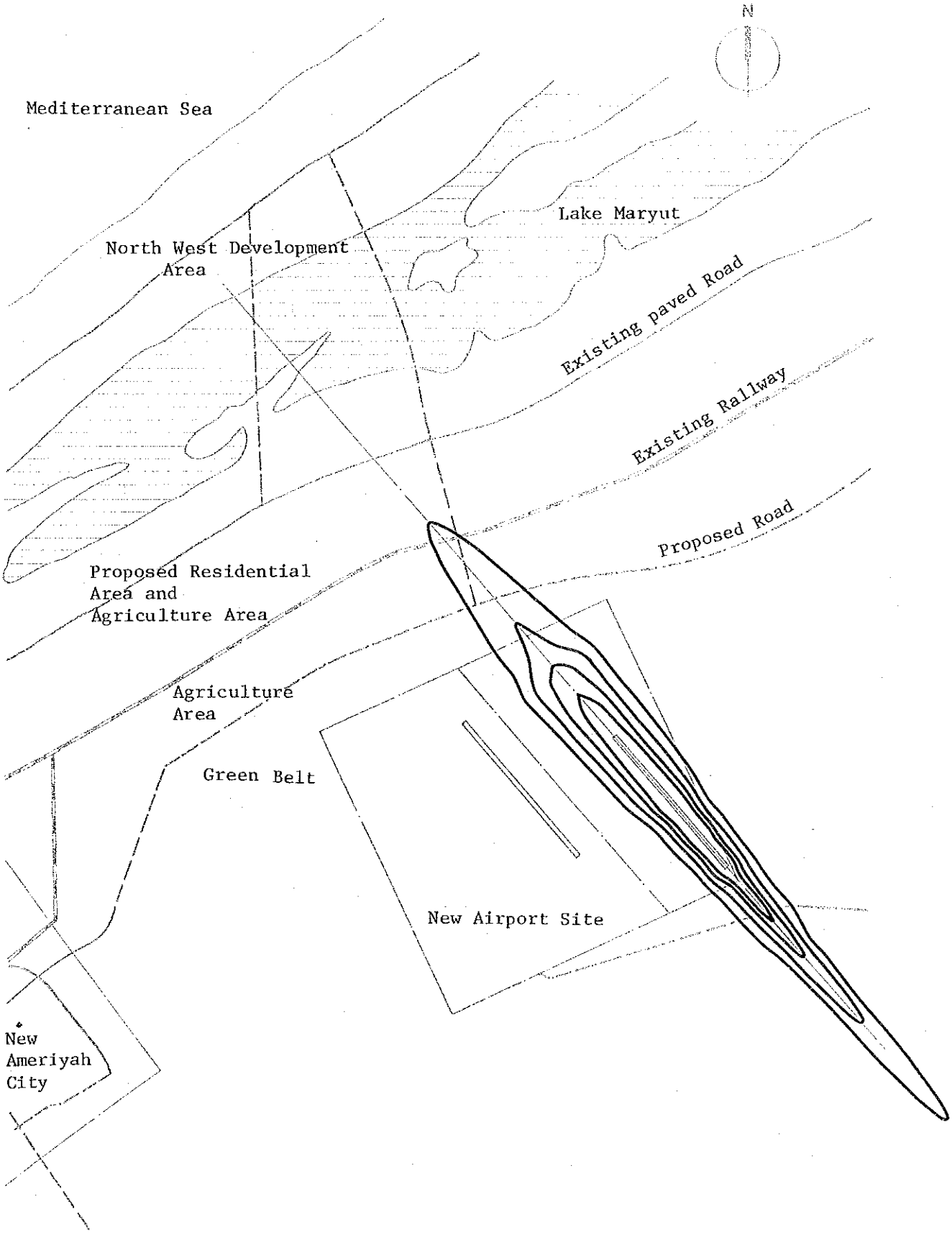


Fig. 7.6.1 Area Affected by Aircraft Noise (New Airport)

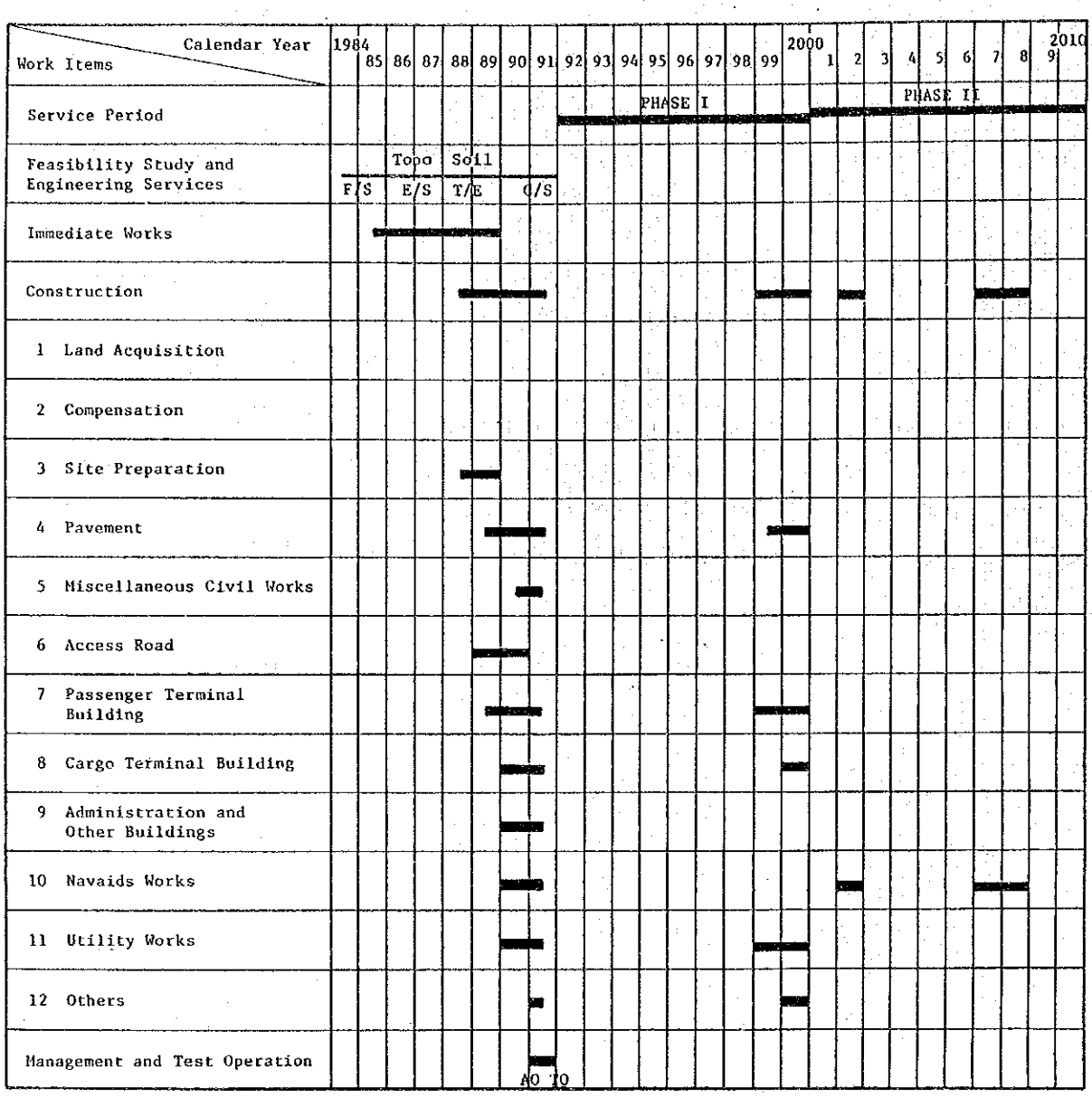
7.7 Construction Schedule and Cost Estimates

7.7.1 Construction Schedule

Construction schedules for Alt-B and Alt-C are summarized in Tables 7.7.1 and 2 respectively. As regards Alt-B, about 3 years are required for the completion of Phase I construction. On the other hand, concerning Alt-C, about 1 additional year is required for construction of new airport (3 years) and redevelopment of Nozha airport (1 year). In both cases, after completion, six months are required for flight check, test operation for various navaids, maturity flight, etc. as in Alt-A mentioned in section 6.8.

Meanwhile, about 2 years are required for topographic survey, soil investigation, detailed design and tender evaluation after completion of this Feasibility Study. Therefore, inauguration of construction will be set around July, 1988 and completion around June 1991. The opening of the new airport will be scheduled around January, 1992.

Table 7.7.1 Construction Schedule for Alt-B (New Airport)



F/S Feasibility Study

Topo Topographical Survey

Soil Soil Investigation

E/S Detail Design and Tender Document

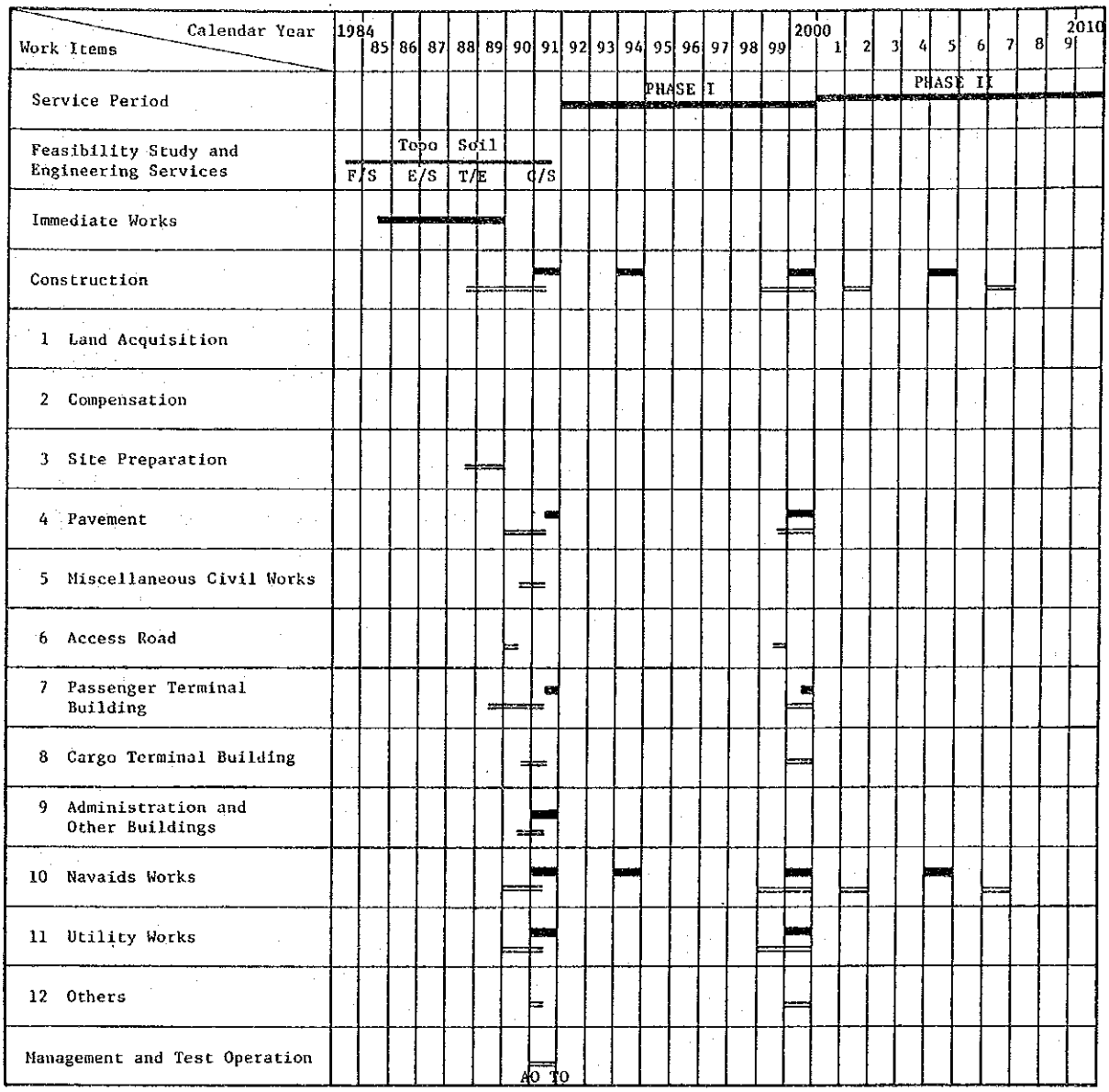
T/E Tender Evaluation

C/S Construction Supervision

AO Establishment of Airport Organization

TO Test Operation, Various Flight Checks, etc.

Table 7.7.2 Construction Schedule for Alt-C (Nozha Airport & New Airport)



F/S Feasibility Study

Topo Topographical Survey

Soil Soil Investigation

E/S Detail Design and Tender Document

T/E Tender Evaluation

C/S Construction Supervision

AO Establishment of Airport Organization

TO Test Operation, Various Flight Checks, etc.

Nozha

New Airport

7.7.2 Construction Cost Estimate

The construction costs for Alts-B and C are estimated by item and year, as tabulated in Tables 7.7.3 and 4 respectively. Cost estimates are based on the following assumptions:

- Unit construction prices are based on the information collected from ECAA during the Study team's stay in Cairo.
- Exchange rates are set at 1US$ = £E 0.82 and £E 1 = 300 Yen.
- Construction cost of access road is estimated for the section from the terminal area of new airport to the planned trunk road between New Ameriyah City and Desert Road.
- Construction cost of utilities is estimated as the required cost for introduction from northern boundary of new airport site within area of 6 km x 6 km to the terminal area.

Construction costs for Phase I of Alt-B and Alt-C are estimated to be about 63 million Egyptian Pounds and about 57 million Egyptian Pounds respectively.

Table 7.7.3 Estimated Construction Cost for Alt-B (New Airport)

(Unit : 1,000£E)

Work Item \ Phase of Construction		Phase I 1992-2000	Phase II 2001-2010	Total
Land Acquisition and Compensation	land Acquisition	-	-	-
	Compensation	-	-	-
	Sub Total	-	-	-
Civil Works	Site Preparation	4,895	-	4,895
	Pavement Works	13,809	3,089	16,898
	Miscellaneous	258	-	258
	Access Road	1,976	-	1,976
	Sub Total	20,938	3,089	24,027
Building and Equipment Works	Passenger Terminal Building	17,520	7,440	24,960
	Cargo Terminal Building	1,875	1,425	3,300
	Administration/Tower and Other Buildings	1,975	-	1,975
	Sub Total	21,370	8,865	30,235
Navaids Works	Radio Navaids, Telecommunications, Air-Traffic Control, Meteorological and Lighting Works	9,084	5,662	14,746
Utilities Works	Power Supply, Water Supply Sewage and Incinerator	3,768	2,626	6,394
Special Services Facility Works	Boarding Bridge	1,750	350	2,100
Total of Construction Works		56,910	20,592	77,502
Contingency (10%)		5,691	2,059	7,750
GRAND TOTAL		62,601	22,651	85,252

Table 7.7.4 Estimated Construction Cost for Alt-C (New Airport and Nozha Airport)

(Unit : 1,000£E)

Work Item \ Phase of Construction		Phase I 1992-2000			Phase II 2001-2010			GRAND TOTAL
		Nozha Airport	New Airport	Sub Total	Nozha Airport	New Airport	Sub Total	
Land Acquisition and Compensation	Land Acquisition	-	-	-	-	-	-	-
	Compensation	-	-	-	-	-	-	-
	Sub Total	-	-	-	-	-	-	-
Civil Works	Site Preparation	-	4,811	4,811	-	156	156	4,967
	Pavement Works	520	10,242	10,762	1,726	5,601	7,327	18,089
	Miscellaneous	-	258	258	-	-	-	258
	Access Road	-	988	988	-	988	988	1,976
	Sub Total	520	16,299	16,819	1,726	6,745	8,471	25,290
Building and Equipment Works	Passenger Terminal Building	100	15,780	15,880	720	6,600	7,320	23,200
	Cargo Terminal Building	-	1,875	1,875	-	1,400	1,400	3,275
	Administration/Tower and Other Buildings	800	1,975	2,775	-	-	-	2,775
	Sub Total	900	19,630	20,530	720	8,000	8,720	29,250
Navaids Works	Radio Navaids, Telecommunications, Air-traffic Control, Meteorological and Lighting Works	775	8,635	9,410	1,850	5,887	7,737	17,147
Utilities Works	Power Supply, Water Supply Sewage and Incinerator	499	3,100	3,599	656	2,293	2,949	6,548
Boarding Bridge		-	1,750	1,750	-	350	350	2,100
Total of Construction Works		2,694	49,414	52,108	4,952	23,275	28,227	80,335
Contingency (10%)		269	4,941	5,210	495	2,328	2,823	8,033
GRAND TOTAL		2,963	54,355	57,318	5,447	25,603	31,050	88,368

CHAPTER 8 ECONOMIC AND FINANCIAL ANALYSES FOR THE SELECTION OF ALTERNATIVES

CHAPTER 8 ECONOMIC AND FINANCIAL ANALYSES FOR THE SELECTION OF ALTERNATIVES

8.1 General

The preliminary economic and financial analyses in this Chapter are carried out to select the most economically and financially feasible scheme among three airport development alternatives.

The result of economic analysis indicates that the economic internal rate of return (EIRR) of Alt-C is 12.3%* which is the highest among EIRR for other alternatives and that this alternative is economically feasible. Alt-A is clearly inferior to other alternatives since it has an EIRR of 10.5%.

The financial analysis is also carried out in this Chapter in order to compare Alt-B and Alt-C in terms of the present value of total expenditure for the project because Alt-C will require the duplication of airport operations which is not required by Alt-B. All costs are discounted at the prime rate of 13% in Egypt and compared at the present value. Although Alt-C requires operation and maintenance costs of about 0.4 million Egyptian Pounds more than Alt-B, Alt-C requires 1.5 million Egyptian Pounds less in total expenditure including construction, operation and maintenance costs for Phases I and II. It is considered that the higher operation and maintenance costs in Alt-C are offset by the lower present value of the construction cost.

Therefore, it is concluded that Alt-C is superior to other alternatives from economic and financial standpoints.

Note: * revised in Chapter 14

8.2 Economic Analysis

8.2.1 Objectives

The objectives of the PART III are to select of the most economically feasible alternative among three alternatives and to complete the preliminary evaluation of the project.

The objectives of an economic analysis are to identify and estimate the costs and benefits arising from a project from the economic viewpoint of the nation or the region in which the project is planned in order to assess the net contribution to the national or regional economy. The economic costs and benefits must be valued at economic prices. The economic analysis is made through a comparison of the costs and benefits of two cases, i.e., "with project" case and "without project" case ("WOP"). This is because the additional benefits to the national economy, which are firstly realized by investing or utilizing the additional capital, are measured through the comparison with "WOP" case.

8.2.2 Methodology

(1) Definition of "Without Project"

Most of the existing facilities of Nozha airport will reach their capacity during the period from 1986 to 1988, with the exception of the passenger terminal building which is already in a saturated state. In Section 5.9, an immediate improvement plan including pavement overlay of the runways and apron, and expansion and remodeling of the terminal building etc., was proposed in order to expand the existing airport capacities for use until the completion of Phase I development.

By this short term improvement, Nozha airport will be able to accommodate unrestrained domestic passengers (250,000 annual passengers) and international passengers (400,000 annual passengers) of the limited routes in 1991. In this study, this is specified as the "without project" (WOP) case. The construction cost for the above improvement is estimated at 3.5 million Egyptian Pounds.

(2) Economic Prices

As mentioned earlier, the costs and benefits of the project must be valued in terms of economic prices. In most developing countries, prices are distorted compared with prices determined by the competitive market due to various systems, price policies, etc. Therefore, measurement and evaluation of the costs and benefits of the project based on financial prices (prices used in actual transactions) will include price distortion, and will make it impossible to evaluate the project from the viewpoint of the optimal allocation of resources in the national economy.

However, in this Chapter, the financial prices are used for the estimation of the costs and benefits of the project. The reasons for this are as follows:

a) The differences between the three alternatives are relatively small in terms of the ratio of foreign and local currency portion.

b) The principal benefits are common to all alternatives.

Therefore, the distortions of price are also common to all alternatives and have no effect on the selection of the most favorable alternative.

In PART IV, Chapter 14, a detailed study will be made on the selected alternative at economic prices.

(3) Project Life

Although project life of 19 years (from the year 1992 up to 2010) is considered for the comparative evaluation of the airport development concepts in this Chapter, the project life will be extended to the longer period in Chapter 14.

8.2.3 Alternatives

The alternatives have already been described, but are explained again below.

Alt-A: Redevelopment plan of the existing Nozha airport for domestic and international services.

Alt-B: Development plan of a new airport for domestic and international services as replacement of Nozha airport. The following two cases can be considered for this alternative:

Alt-B-1: Development plan of a new airport with sale of the existing airport property area.

Alt-B-2: Development plan of a new airport with the conversion of Nozha airport into one for VIPs, general aviation (GA) or heliport, etc.

Alt-C: Development plan of Nozha and a new airport.
Nozha airport is to be used for domestic services and general aviation, and the new airport for international and limited domestic services.

8.2.4 Costs

(1) Summary of Costs of Project

The costs of the project will include the following:

a) Construction cost
b) Deduction in economic value by sale of the existing airport property area
c) Operation and maintenance costs
d) Construction, operation and maintenance costs saved at Cairo airport
e) Operation and maintenance costs saved at Nozha airport

Although items b), d) and e) above are considered to be benefits, these items are deductions from the costs which are defined as the government expenditure for the project. Therefore, these are classified in cost items in this study.

The breakdown of the costs by alternative is summarized in Table 8.2.1.

Table 8.2.1 Project Costs by Alternative

Alternative / Timing of construction of parallel taxiway / Cost Items	Alt. A	Alt. B		Alt. C	Remarks
		Alt. B - 1	Alt. B - 2		
	· Redevelopment of existing Nozha airport	· Construction of a new airport. · Sale of existing airport property area.	· Construction of a new airport. · Conversion of Nozha airport into one for VIPs, general aviation or heliport, etc.	· Construction of a new airport for international and limited domestic service. · Redevelopment of Nozha airport for domestic service and general aviation.	· Commencement of the new airport service is in 1992.
	Phase I	Phase I		· New airport: Phase II · Nozha airport: No Construction	
Construction Cost	Phase I: 75.9 mil LE Phase II: 23.0 mil LE Total : 98.9 mil LE	Phase I : 62.6 mil LE Phase II : 22.7 mil LE Total : 85.3 mil LE		Phase I: 57.4 mil LE (New 54.4, Nozha 3.0) Phase II: 31.0 mil LE (New 25.6, Nozha 5.4) Total : 88.4 mil LE (New 80.0, Nozha 8.4)	
Deduction in economic value by sale of the existing airport property area		Economic price of the existing airport property area -8.8 mil LE			Assumed to use the existing airport property area as agricultural land 2.5 LE/m^2, 350 ha.
Operation and Maintenance cost	Personnel cost, Materials and Utilities, Maintenance and Repair cost. (1) Personnel cost ..... Calculated based on personnel plans. (2) Materials and Utilities ..... Various materials necessary for airport management and administration and utilities. Calculated as equal value as personnel cost. (4) Maintenance and Repair cost ..... Civil and Building works : 1% of construction cost of the facilities. Equipment : 5% of purchasing cost of the equipment.				
Construction cost and operation and Maintenance cost saved at Cairo airport	In WOP case, the overflowing passengers (international passengers and domestic passengers between Alexandria and Upper Egypt) will use Cairo airport, resulting in an additional investment and operation and maintenance cost at Cairo airport. In with Project case, these costs can be saved. [Phase I] Apron: 2 berth(B747) [Phase II] Apron: 3 berth(B747) Passenger terminal building: 9,000m^2 Passenger terminal building: 14,600m^2				-
Savings on operation and Maintenance cost necessary for existing airport	In with project case, the operation and maintenance cost necessary for Nozha airport can be saved.				

(2) Construction Cost

The construction costs for the alternatives are estimated in the previous chapters as follows.

Table 8.2.2 Construction Costs by Alternative

(1984. Million £E)

	Alt-A	Alt-B	Alt-C
Phase I	75.9	62.6	57.4 (New: 54.4, Nozha: 3.0)
Phase II	23.0	22.7	31.0 (New: 25.6, Nozha: 5.4)
Total	98.9	85.3	88.4 (New: 80.0, Nozha: 8.4)

The total construction costs of Phases I and II of Alt-A are 10.5 and 13.6 million Egyptian Pounds higher than Alt-C and Alt-B, respectively.

Alt-C costs 3.1 million Egyptian Pounds more than Alt-B in total construction cost including Phase II development. However, the parallel taxiway in Alt-C is to be constructed in Phase II. The initial investment is, therefore, 5.2 million Egyptian Pounds less than Alt-B.

(3) Deduction in Economic Value by Sale of the Existing Airport Property Area

In Alt-B, consideration could be given to the economic value of the airport property area of the existing Nozha airport. Various possible uses are conceivable for the existing airport property area such as housing, greenery (parks), farmland, or industrial sites. Since it is difficult to evaluate the economic value without carrying out a case study for each land use, it is assumed for reference in this analysis that the existing airport property area will be used as farmland and will be sold for total 8.8 million Egyptian Pounds (2.5 Egyptian Pounds per sq.m).

(4) Operation and Maintenance Costs

Operation and Maintenance costs comprise personnel cost, material and utility costs, and maintenance and repair costs.

a) Personnel Cost

Based on the airport organization plans given in section 4.8, the average personnel expenses are calculated based on an average annual salary of 2,100 Egyptian Pounds per person.

b) Materials and Utilities Costs

Materials and utilities costs consist of various consumables for airport operation and administration, and utility charges for power, water etc. These costs are estimated to be equal to personnel cost.

c) Maintenance and Repair Costs

The annual maintenance and repair costs for the facilities are calculated as follows:

Civil and Building facilities	:	1% of the construction costs of the facilities
Equipment	:	5% of the purchasing cost of the equipment

(5) Construction and O & M Costs Saved at Cairo Airport

In "WOP" case, the overflowing passengers (passengers of international and domestic routes between Alexandria and Upper Egypt) will use Cairo airport. Additional investment, and operation and maintenance costs will be required for Cairo airport in order to handle the overflowing passengers. In case of "with project", these costs will be saved.

The scale and construction costs of the saved facilities are shown in Table 8.2.3. Calculation of the facility requirements is based on peak characteristics of Cairo airport.

Table 8.2.3 Construction Costs Saved at Cairo Airport

Facility \ Phase		Phase I	Phase II
Facilities requiring expansion	Apron (berths)	2 (B747)	3 (B747)
	Passenger terminal building (m^2)	9,000	14,600
Construction costs (million Egyptian Pounds)		6.6	10.7

The operation and maintenance costs saved at Cairo airport in "with project" case are calculated by the same method as the above-mentioned paragraph (4). Regarding personnel cost, it is estimated that the following number of personnel will be saved at Cairo airport taking into account merit of scale of Cairo airport.

Table 8.2.4 Number of Personnel Reduced at Cairo Airport

Year	1991	1995	2000	2005	2010
Number of personnel saved at Cairo airport	50	55	70	85	100

(6) Operation and Maintenance Costs Saved at Existing Nozha Airport

In the case of "with project", operation and maintenance costs required for Nozha airport in the "WOP" case (0.7 million Egyptian Pounds/year) will be saved.

8.2.5 Benefits

(1) Summary of Benefits of Project

The benefits given to the national economy by this project are shown in Fig. 8.2.1. These are divided into direct benefits directly caused by the project and indirect benefits indirectly caused as a result of implementation of the project. Each of these are further broken down into tangible benefits and intangible benefits from the viewpoint of possibility or impossibility of measurement.

In evaluating the net contribution of this project to the national economy, the benefits adopted are the direct and tangible benefits. These consist of the following items which are tabulated by alternative in Table 8.2.5.

a) Benefit due to accommodation of overflowing Egyptian international passengers

b) Benefit due to accommodation of overflowing domestic passengers

c) Benefit due to accommodation of overflowing international cargo

d) Benefit due to reduction of passenger processing time at the airport

e) Benefit to the airline by permitting introduction of larger aircraft

f) Additional access cost in case of the new airport (disbenefit)

g) Benefit to provide an alternate airport to Cairo

h) Benefit due to accommodation of overflowing foreign international passengers.

In this Chapter, only items from a) to f) are quantified in the comparative evaluation of the alternative airport development concepts.

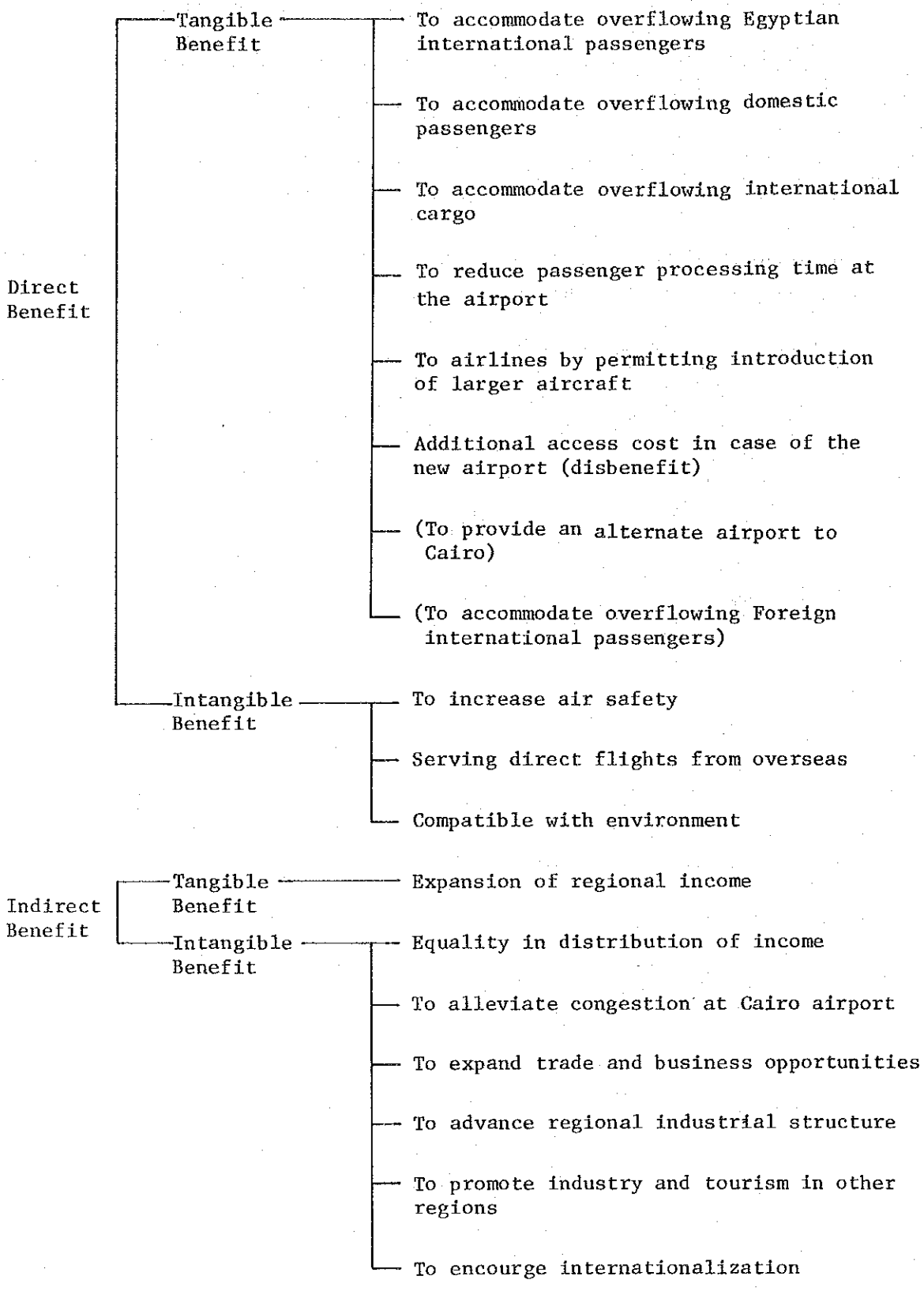


Fig. 8.2.1 Benefits of Project

Table 8.2.5 Project Benefits of Alternatives

Alternative / Benefit Items	Alt - A	Alt - B		Alt - C	REMARKS
		Alt - B - 1	Alt - B - 2		
	· Redevelopment of existing Nozha airport	· Construction of a new airport · Sale of the existing airport property area	· Construction of a new airport · Conversion of Nozha airport into one for VIPs, GA or heliport, etc.	· Construction of new airport for international and limited domestic service · Redevelopment of the existing airport for domestic service and GA.	Commencement of the new airport service is in 1992
To accommodate overflowing Egyptian international passengers	In "WOP" case, overflowing passengers must travel via Cairo. In "with project" case, additional amounts of surface transportation cost and time value, and air fares paid to foreign airlines needed in "WOP" case will be saved and measured as a benefit.				· Overflowing passengers
To accommodate overflowing domestic passengers	Benefits per passenger are measured as the difference between air fare and surface transportation fare. The benefit is calculated by the multiplication by the number of overflowing domestic passengers.				· Overflowing passengers
To accommodate overflowing international cargo	In "WOP" case, overflowing air cargo shall be transported via Cairo. In With Project case, for the cargo owned by Egyptians, additional amounts of surface transportation cost and the air fare paid to foreign airlines needed in WOP case will be saved.				· Overflowing cargo
To reduce passenger processing time at the airport	Passenger processing time is expected to be reduced by average half an hour through improvement of the airport facilities. The benefit is measured after conversion of the time saved into monetary terms.				· "WOP" case passengers
To reduce airlines' operation cost by permitting the introduction of larger aircraft	The introduction of larger aircraft is possible through the airport development, resulting in reduction of aircraft operation cost per passenger. Egypt Air shares the reduction. The benefit is measured based on WOP case passengers.				· "WOP" case passengers
Additional access cost in case of the new airport (disbenefit)		The "WOP" case passengers, international and domestic passengers who will have used Nozha airport must pay the additional access cost.		International passengers who will have used Nozha airport in "WOP" case must pay additional access cost.	· "WOP" case passengers
Other benefits	i) Benefit to provide an alternate airport to Cairo Although Luxor Airport is designated as the alternate airport of Cairo Airport, the following benefits will arise after development of Alexandria Airport as compared with the "WOP" case: - To accommodation of foreign carriers which will divert to other countries in "WOP"case - To reduce operation cost of Egypt Air to divert to Luxor airport in "WOP" case ii) Benefit due to accommodate foreign international passengers Assuming that 50 percent of foreign international passengers who will visit Alexandria by air in "with project" case, will not visit Alexandria in "WOP" case. The difference in the foreign currency expenditure between the foreign passengers with the longer stay in Egypt in case of visiting Alexandria (WP) and the shorter stay in Egypt without visiting Alexandria "WOP" is estimated as a benefit.				These benefits were not included in the comparative evaluation of the alternative schemes in this report.

(2) Benefit due to Accommodation of Overflowing Egyptian International Passengers

In "with project" case the overflowing passengers are able to travel overseas directly from/to Alexandria. The benefit can be quantified in comparison with travelling by way of Cairo in case of "WOP".

a) Savings of access cost to/from the airport

Total savings consist of savings in surface transportation cost and travelling time value. The savings of surface transportation cost and those of time value by alternative are shown in Tables 8.2.6 and 8.2.7, respectively.

Table 8.2.6 Travelling Cost Saved on Surface Transportation

(Unit: £E/pax.)

	Alexandria ⇄ Cairo airport	Alexandria ⇄ Nozha airport	Alexandria ⇄ New Airport	Total
Alt-A	7.3	-0.2		7.1
Alt-B, C	7.3		-1.0	6.3

Source: Estimated based on Egypt National Transport Study, ABC World Airways Guide and Statistical Year Book.

Table 8.2.7 Travelling Time Value Saved on Surface Transportation

(Unit: £E/pax.)

	Alexandria ⇄ Cairo airport	Alexandria ⇄ Nozha airport	Alexandria ⇄ New Airport	Total
Alt-A	2.4	-0.1		2.3
Alt-B, C	2.4		-0.4	2.0

Source: Estimated based on Statistical Year Book

The saving of surface transportation will apply to all Egyptian overflow passengers, while the time saving value to 80%, assuming 20% were on overseas sightseeing trips (based on information from Egypt Air). The time value of an Egyptian is estimated as 0.6 Egyptian Pounds/hour based on Statistical Year Book.

b) Saving of air fares

Additional air fares which will be paid to foreign airlines in "WOP" case as compared with "with project" case are saved and can be measured as a benefit. The savings in air fares paid to foreign carriers are estimated as shown in Table 8.2.8 by destination group. Herein, the share of foreign airlines in international aircraft movements (67%) is assumed to remain unchanged (Annual Statistical Report).

Table 8.2.8 Savings of Air Fare

Europe/USA Countries	8.3 £E/Passenger
Middle East Countries	3.3
Other Countries	5.8

Source: Egypt National Transport Study, Statistical Year Book and ABC World Airways Guide

(3) Benefit due to Accommodation of Overflowing Domestic Passengers

Through the use of air transportation, Egyptian domestic air passengers should receive benefits. Further, foreign domestic air passengers contribute to the Egyptian GDP through the use of domestic airlines. That is, for Egyptians, the air fare - surface transportation fare = benefit. For foreigners, the contribution to the GDP is also measured by the difference between air fare and surface transportation fare. The average benefit per passenger is 9 Egyptian Pounds/pax. for Egyptians and 22 Egyptian Pounds/pax. for foreigners (estimated based on air fare and train fare). Egyptian domestic passengers are assumed to be 50% of the total.

(4) Benefit due to Accommodation of Overflowing International Cargo

In "WOP" case, overflowing international cargo will be handled through Cairo. It is assumed that 50% of cargo presently handled is Egyptian.

Without the project, additional surface transportation cost and additional air fares will be needed as compared with direct transportation from/to Alexandria. These additional costs will be saved in "with project" case. Savings on surface transportation between Alexandria and Cairo is estimated to be 11.8* Egyptian Pounds/ton.

Note: *Estimated from Egypt National Transport Study and Annual Statistical Report.

Moreover savings on air fare are estimated by destination group as indicated in Fig. 8.2.9.

Table 8.2.9 Savings on Cargo Air Fare

Europe/USA Countries	59.4 £E/ton
Middle East Countries	20.6
Other Countries	40.0

Source: Egypt National Transport Study, Statistical Year Book and ABC World Airways Guide

(5) Benefit due to Reduction of Passenger Processing Time at the Airport

In "with project" case, passenger travel time is expected to be reduced by 0.5 hour/passenger by introducing more efficient check-in and baggage handling procedures. Benefit is valued at 0.3 Egyptian Pounds/passenger. It should be noted, however, that this benefit will be realized only for the traffic of Egyptian domestic passengers in "WOP" case and not for the overflowing passengers.

(6) Benefit to Airline by Permitting Introduction of Larger Aircraft

In "with project" case, airlines will be able to introduce larger aircraft into operation. As a result, the operation cost per passenger which includes personnel, fuel, and capital depreciation will be reduced. From the viewpoint of the national economy, the reduction of operation cost of Egypt Air is evaluated as a benefit of this project.

This benefit is calculated by the difference between the average operation cost of "WOP" case and the "with project" case and multiplying it by the number of international and domestic passengers using Egypt Air in "WOP" case. Operation costs per passenger in "WOP" case and "with project" case are shown in Table 8.2.10.

Table 8.2.10 Average Aircraft Operation Costs

(Unit: £E/Passenger)

International Flight

Year	"WOP" Case	"With Project" Case
1992	91.41	91.41
1995	ditto	91.13
2000	ditto	90.66
2005	ditto	90.23
2010	ditto	89.86

Domestic Flight

Year	WOP" Case	"With project" Case
1992	38.44	38.44
1995	ditto	38.24
2000	ditto	38.04
2005	ditto	37.98
2010	ditto	37.82

Source: Estimated based on the data of several airlines in Japan.

(7) Additional Access Cost in Case of the New Airport (Disbenefit)

The distance from the center of Alexandria to the existing Nozha airport is 7 kilometers, while the distance from Alexandria to the new airport is 45 kilometers. For this reason, passengers who use Nozha airport in "WOP" case, will have to make an extra 38 kilometer trip. The total additional time and fuel cost (1.1 Egyptian Pounds/pax) are evaluated as the disbenefit of the new airport. The passengers affected by this disbenefit by alternative are as follows.

Alt-B: Egyptian international and domestic passengers in "WOP" case
Alt-C: Egyptian international passengers in "WOP" case

8.2.6 Cash Flow

The costs and benefits of each alternative are shown in Tables 8.2.11 to 8.2.14.

Table 8.2.11 Case Flow of Alt-A (thousand £E, 1984)

YEAR	COST					BENEFIT						
	CONST. COST	O & M COST	SAVE AT CAIRO	SAVE AT NOZHA	TOTAL COST	INT'L PAX	DOM. PAX	INT'L CARGO	TIME SAVE	AIRLINE BENEFIT	ADD. ACCESS	TOTAL BENEFIT
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	1460.0	0.0	0.0	0.0	1460.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	2910.0	0.0	0.0	0.0	2910.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	10160.0	0.0	0.0	0.0	10160.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	20420.0	0.0	0.0	0.0	20420.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	26450.0	0.0	-3310.0	0.0	23140.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	18950.0	0.0	-3310.0	0.0	15640.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	2060.0	-280.0	-690.0	1090.0	4470.0	160.0	400.0	40.0	0.0	0.0	5060.0
1993	0.0	2090.0	-290.0	-690.0	1110.0	5660.0	470.0	470.0	40.0	30.0	0.0	6670.0
1994	1160.0	2120.0	-290.0	-690.0	2300.0	7100.0	780.0	540.0	40.0	50.0	0.0	8510.0
1995	0.0	2150.0	-300.0	-690.0	1160.0	8670.0	1090.0	590.0	40.0	90.0	0.0	10480.0
1996	0.0	2180.0	-310.0	-690.0	1180.0	9150.0	1400.0	630.0	40.0	110.0	0.0	11330.0
1997	0.0	2210.0	-320.0	-690.0	1200.0	9800.0	1710.0	680.0	40.0	140.0	0.0	12370.0
1998	1380.0	2240.0	-330.0	-690.0	2600.0	10390.0	2020.0	710.0	40.0	160.0	0.0	13320.0
1999	8280.0	2280.0	-5680.0	-690.0	4190.0	10990.0	2330.0	750.0	40.0	180.0	0.0	14290.0
2000	11950.0	2310.0	-5690.0	-690.0	7880.0	11700.0	2640.0	800.0	40.0	200.0	0.0	15380.0
2001	0.0	2610.0	-480.0	-690.0	1440.0	12360.0	2950.0	850.0	40.0	210.0	0.0	16410.0
2002	2080.0	2650.0	-500.0	-690.0	3540.0	12970.0	3410.0	910.0	40.0	230.0	0.0	17560.0
2003	0.0	2680.0	-510.0	-690.0	1480.0	13710.0	3880.0	970.0	40.0	250.0	0.0	18850.0
2004	0.0	2710.0	-520.0	-690.0	1500.0	14300.0	4340.0	1030.0	40.0	260.0	0.0	19970.0
2005	810.0	2750.0	-540.0	-690.0	2330.0	15020.0	4810.0	1090.0	40.0	270.0	0.0	21230.0
2006	0.0	2790.0	-550.0	-690.0	1550.0	15770.0	5270.0	1160.0	40.0	290.0	0.0	22530.0
2007	640.0	2830.0	-560.0	-690.0	2220.0	16530.0	5740.0	1240.0	40.0	310.0	0.0	23860.0
2008	640.0	2870.0	-570.0	-690.0	2250.0	17260.0	6360.0	1310.0	40.0	330.0	0.0	25300.0
2009	0.0	2920.0	-590.0	-690.0	1640.0	17990.0	6820.0	1390.0	40.0	350.0	0.0	26590.0
2010	0.0	2960.0	-600.0	-690.0	1670.0	18890.0	7440.0	1450.0	40.0	360.0	0.0	28180.0

DISCOUNT RATE = 5. % B/C RATIO = 1.7088 NPV = 53402.30

DISCOUNT RATE = 10. % B/C RATIO = 1.0865 NPV = 4598.42

DISCOUNT RATE = 15. % B/C RATIO = 0.7170 NPV = -11196.20

EIRR = 10.960 %

Table 8.2.12 Cash Flow of Alt-B-1 (thousand £E, 1984)

YEAR	COST					BENEFIT						
	CONST. COST	O & M COST	SAVE AT CAIRO	SAVE AT NOZHA	TOTAL COST	INT'L PAX	DOM. PAX	INT'L CARGO	TIME SAVE	AIRLINE BENEFIT	ADD. ACCESS	TOTAL BENEFIT
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	1260.0	0.0	0.0	0.0	1260.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	2500.0	0.0	0.0	0.0	2500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	2700.0	0.0	0.0	0.0	2700.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	11670.0	0.0	0.0	0.0	11670.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	30820.0	0.0	-3310.0	0.0	27510.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	21170.0	0.0	-3310.0	0.0	17860.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	-8800.0	1990.0	-280.0	-690.0	-7780.0	4170.0	160.0	400.0	40.0	0.0	-470.0	4300.0
1993	0.0	2020.0	-290.0	-690.0	1040.0	5270.0	470.0	470.0	40.0	30.0	-470.0	5810.0
1994	0.0	2050.0	-290.0	-690.0	1070.0	6620.0	780.0	540.0	40.0	50.0	-470.0	7560.0
1995	0.0	2080.0	-300.0	-690.0	1090.0	8070.0	1090.0	590.0	40.0	90.0	-470.0	9410.0
1996	0.0	2110.0	-310.0	-690.0	1110.0	8530.0	1400.0	630.0	40.0	110.0	-470.0	10240.0
1997	0.0	2140.0	-320.0	-690.0	1130.0	9120.0	1710.0	680.0	40.0	140.0	-470.0	11220.0
1998	1360.0	2170.0	-330.0	-690.0	2510.0	9670.0	2020.0	710.0	40.0	160.0	-470.0	12130.0
1999	7080.0	2210.0	-5680.0	-690.0	2920.0	10220.0	2330.0	750.0	40.0	180.0	-470.0	13050.0
2000	10710.0	2240.0	-5690.0	-690.0	6570.0	10890.0	2640.0	800.0	40.0	200.0	-470.0	14100.0
2001	0.0	2450.0	-480.0	-690.0	1280.0	11490.0	2950.0	850.0	40.0	210.0	-470.0	15070.0
2002	4330.0	2490.0	-500.0	-690.0	5630.0	12060.0	3410.0	910.0	40.0	230.0	-470.0	16180.0
2003	0.0	2520.0	-510.0	-690.0	1320.0	12750.0	2880.0	970.0	40.0	250.0	-470.0	16420.0
2004	0.0	2550.0	-520.0	-690.0	1340.0	13300.0	4340.0	1030.0	40.0	260.0	-470.0	18500.0
2005	0.0	2590.0	-540.0	-690.0	1360.0	13960.0	4810.0	1090.0	40.0	270.0	-470.0	19700.0
2006	0.0	2630.0	-550.0	-690.0	1390.0	14660.0	5270.0	1160.0	40.0	290.0	-470.0	20950.0
2007	950.0	2670.0	-560.0	-690.0	2370.0	15370.0	5740.0	1240.0	40.0	310.0	-470.0	22230.0
2008	950.0	2710.0	-570.0	-690.0	2400.0	16040.0	6360.0	1310.0	40.0	330.0	-470.0	23610.0
2009	0.0	2760.0	-590.0	-690.0	1480.0	16720.0	6820.0	1390.0	40.0	350.0	-470.0	24850.0
2010	0.0	2800.0	-600.0	-690.0	1510.0	17560.0	7440.0	1450.0	40.0	360.0	-470.0	26380.0

DISCOUNT RATE = 5. % B/C RATIO = 2.0021 NPV = 58878.40

DISCOUNT RATE = 10. % B/C RATIO = 1.2943 NPV = 11943.50

DISCOUNT RATE = 15. % B/C RATIO = 0.8632 NPV = -4069.61

EIRR = 13.130 %

Table 8.2.13 Cash Flow of Alt-B-2 (thousand £E, 1984)

YEAR	COST					BENEFIT						
	CONST. COST	O & M COST	SAVE AT CAIRO	SAVE AT MOZHA	TOTAL COST	INT'L PAX	DOM. PAX	INT'L CARGO	TIME SAVE	AIRLINE BENEFIT	ADD. ACCESS	TOTAL BENEFIT
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	1260.0	0.0	0.0	0.0	1260.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	2500.0	0.0	0.0	0.0	2500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	2700.0	0.0	0.0	0.0	2700.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	11670.0	0.0	0.0	0.0	11670.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	30820.0	0.0	-3310.0	0.0	27510.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	21170.0	0.0	-3310.0	0.0	17860.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	1990.0	-280.0	-690.0	1020.0	4170.0	160.0	400.0	40.0	0.0	-470.0	4290.0
1993	0.0	2020.0	-290.0	-690.0	1040.0	5270.0	470.0	470.0	40.0	30.0	-470.0	5810.0
1994	0.0	2050.0	-290.0	-690.0	1070.0	6620.0	780.0	540.0	40.0	50.0	-470.0	7560.0
1995	0.0	2080.0	-300.0	-690.0	1090.0	8070.0	1090.0	590.0	40.0	90.0	-470.0	9410.0
1996	0.0	2110.0	-310.0	-690.0	1110.0	8530.0	1400.0	630.0	40.0	110.0	-470.0	10240.0
1997	0.0	2140.0	-320.0	-690.0	1130.0	9120.0	1710.0	680.0	40.0	140.0	-470.0	11220.0
1998	1360.0	2170.0	-330.0	-690.0	2510.0	9670.0	2020.0	710.0	40.0	160.0	-470.0	12130.0
1999	7080.0	2210.0	-5680.0	-690.0	2920.0	10220.0	2330.0	750.0	40.0	180.0	-470.0	13050.0
2000	10710.0	2240.0	-5690.0	-690.0	6570.0	10890.0	2640.0	800.0	40.0	200.0	-470.0	14100.0
2001	0.0	2450.0	-480.0	-690.0	1280.0	11490.0	2950.0	850.0	40.0	210.0	-470.0	15070.0
2002	4330.0	2490.0	-500.0	-690.0	5630.0	12060.0	3410.0	910.0	40.0	230.0	-470.0	16180.0
2003	0.0	2520.0	-510.0	-690.0	1320.0	12750.0	2880.0	970.0	40.0	250.0	-470.0	16420.0
2004	0.0	2550.0	-520.0	-690.0	1340.0	13300.0	4340.0	1030.0	40.0	260.0	-470.0	18500.0
2005	0.0	2590.0	-540.0	-690.0	1360.0	13960.0	4810.0	1090.0	40.0	270.0	-470.0	19700.0
2006	0.0	2630.0	-550.0	-690.0	1390.0	14660.0	5270.0	1160.0	40.0	290.0	-470.0	20950.0
2007	950.0	2670.0	-560.0	-690.0	2370.0	15370.0	5740.0	1240.0	40.0	310.0	-470.0	22230.0
2008	950.0	2710.0	-570.0	-690.0	2400.0	16040.0	6360.0	1310.0	40.0	330.0	-470.0	23610.0
2009	0.0	2760.0	-590.0	-690.0	1480.0	16720.0	6820.0	1390.0	40.0	350.0	-470.0	24850.0
2010	0.0	2800.0	-600.0	-690.0	1510.0	17560.0	7440.0	1450.0	40.0	360.0	-470.0	26380.0

DISCOUNT RATE = 5. % B/C RATIO = 1.8177 NPV = 52915.40

DISCOUNT RATE = 10. % B/C RATIO = 1.1753 NPV = 7833.60

DISCOUNT RATE = 15. % B/C RATIO = 0.7870 NPV = -6949.62

EIRR = 11.955 %

Table 8.2.14 Cash Flow of Alt-C (thousand £E, 1984)

YEAR	COST					BENEFIT						
	CONST. COST	O & M COST	SAVE AT CAIRO	SAVE AT NOZHA	TOTAL COST	INT'L PAX	DOM. PAX	INT'L CARGO	TIME SAVE	AIRLINE BENEFIT	ADD. ACCESS	TOTAL BENEFIT
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	1150.0	0.0	0.0	0.0	1150.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	2290.0	0.0	0.0	0.0	2290.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	2620.0	0.0	0.0	0.0	2620.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	8730.0	0.0	0.0	0.0	8730.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	26260.0	0.0	-3310.0	0.0	22950.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	22440.0	0.0	-3310.0	0.0	19130.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	2410.0	-280.0	-690.0	1440.0	4170.0	160.0	400.0	40.0	0.0	-340.0	4420.0
1993	0.0	2440.0	-290.0	-690.0	1460.0	5270.0	470.0	470.0	40.0	30.0	-340.0	5940.0
1994	660.0	2460.0	-290.0	-690.0	2140.0	6620.0	780.0	540.0	40.0	50.0	-340.0	7690.0
1995	0.0	2490.0	-300.0	-690.0	1500.0	8070.0	1090.0	590.0	40.0	90.0	-340.0	9540.0
1996	0.0	2510.0	-310.0	-690.0	1510.0	8530.0	1400.0	630.0	40.0	110.0	-340.0	10370.0
1997	0.0	2540.0	-320.0	-690.0	1530.0	9120.0	1710.0	680.0	40.0	140.0	-340.0	11350.0
1998	1860.0	2570.0	-330.0	-690.0	3410.0	9670.0	2020.0	710.0	40.0	160.0	-340.0	12260.0
1999	9290.0	2590.0	-5680.0	-690.0	5510.0	10220.0	2330.0	750.0	40.0	180.0	-340.0	13180.0
2000	17070.0	2620.0	-5690.0	-690.0	13310.0	10890.0	2640.0	800.0	40.0	200.0	-340.0	14230.0
2001	0.0	2910.0	-480.0	-690.0	1740.0	11490.0	2950.0	850.0	40.0	210.0	-340.0	15200.0
2002	4330.0	2940.0	-500.0	-690.0	6080.0	12060.0	3410.0	910.0	40.0	230.0	-340.0	16310.0
2003	0.0	2970.0	-510.0	-690.0	1770.0	12750.0	3880.0	970.0	40.0	250.0	-340.0	17550.0
2004	0.0	3010.0	-520.0	-690.0	1800.0	13300.0	4340.0	1030.0	40.0	260.0	-340.0	18630.0
2005	570.0	3040.0	-540.0	-690.0	2380.0	13960.0	4810.0	1090.0	40.0	270.0	-340.0	19830.0
2006	0.0	3070.0	-550.0	-690.0	1830.0	14660.0	5270.0	1160.0	40.0	290.0	-340.0	21080.0
2007	1650.0	3090.0	-560.0	-690.0	3490.0	15370.0	5740.0	1240.0	40.0	310.0	-340.0	22360.0
2008	0.0	3120.0	-570.0	-690.0	1860.0	16040.0	6360.0	1310.0	40.0	330.0	-340.0	23740.0
2009	0.0	3140.0	-590.0	-690.0	1860.0	16720.0	6820.0	1390.0	40.0	350.0	-340.0	24980.0
2010	0.0	3170.0	-600.0	-690.0	1880.0	17560.0	7440.0	1450.0	40.0	360.0	-340.0	26510.0

DISCOUNT RATE = 5. % B/C RATIO = 1.7545 NPV = 51234.70

DISCOUNT RATE = 10. % B/C RATIO = 1.1891 NPV = 8466.65

DISCOUNT RATE = 15. % B/C RATIO = 0.8249 NPV = -5529.41

EIRR = 12.319 %

8.2.7 Comparison of the Alternatives and Evaluation of the Project

The economic internal rate of return, the cost benefit ratio and the net present value of each alternative are calculated to evaluate the alternatives based on the cash flows described in Section 8.2.6 and are summarized in Table 8.2.15.

Table 8.2.15 Summary of Economic Analysis

Alternatives / Items	Alt-A	Alt-B		Alt-C
		Alt-B-1	Alt-B-2	
EIRR %	11.0	13.1	12.0	12.3
At discount rate 12% NPV (million £E) 1984	-4.0	3.4	-0.1	0.9
B/C ratio	0.92	1.10	1.00	1.02

Alt-A is inferior to other alternatives in all above evaluation items. The higher construction cost of more than 10 million Egyptian Pounds makes Alt-A least desirable in spite of the merit of the least access cost to the airport from the center of the demand.

The best results in all the evaluation items are indicated in Alt-B-1. The economic value of 8.8 million Egyptian Pounds of the sale of the existing airport property area leads the better results. However, there is a great assumption behind the results that the land will be sold and efficiently used for other purposes just in 1992 when the new airport is opened. Unless Nozha airport is used for other purposes with an economic value of the above amount immediately after the inauguration of the new airport, it is difficult to consider Alt-B-1 as an alternative to be compared with other alternatives.

Therefore, the selection is made between Alt-B-2 and Alt-C which has a possibility to sell Nozha airport property in the future.

The EIRRs of alternative Alt-B-2 and Alt-C are 12% and 12.3% respectively. Alt-C has only a slight advantage over Alt-B-2. The EIRR in Alt-C is slightly higher than the opportunity cost of capital of 12% in Egypt and Alt-C is judged to be an economically feasible alternative.

For Phase I investment program, the construction cost of Alt-C is 5.2 million Egyptian Pounds cheaper than that of Alt-B-2. Therefore, it can be said that Alt-C will benefit the national economy by the reduction of the initial investment and give the Government greater flexibility in the airport development coping with the demand change. The results of the economic analysis are summarized as follows:

a) Alt-C is the most economically favourable among the alternatives and also an economically feasible alternative because the EIRR of Alt-C is greater than the opportunity cost of capital in Egypt.

b) The results of the economic analyses on Alt-B and Alt-C are close to each other. The combined judgement on the selection between Alt-B and Alt-C will be done in the following Chapter 9, taking into account the results of the financial analyses on the alternatives and other factors.

c) Alt-A is inferior to other alternatives in all the economic evaluation items.