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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
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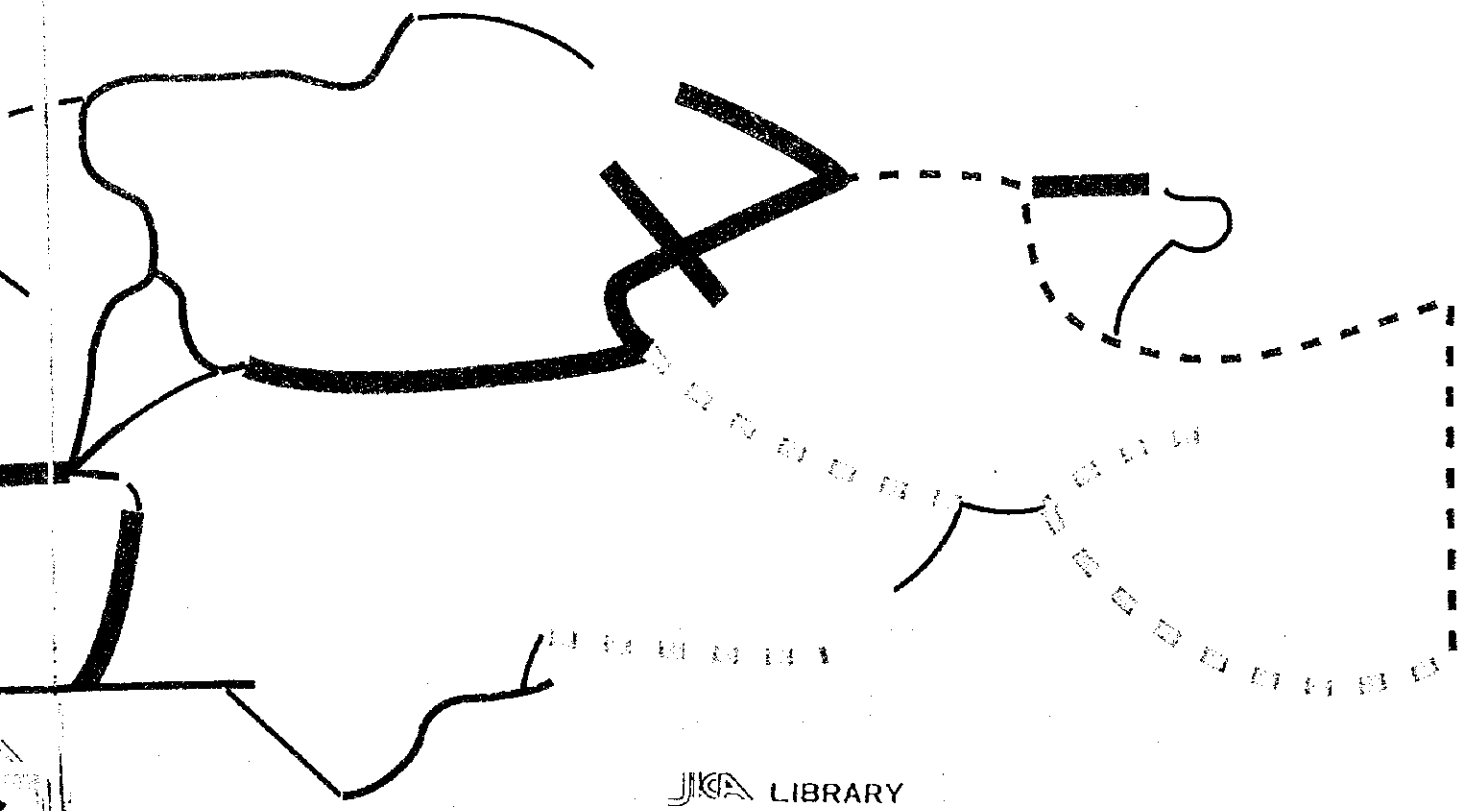
FINAL REPORT
THE DEVELOPMENT STUDY ON THE NATIONWIDE FERRY SERVICE ROUTES(STAGE II) IN THE REPUBLIC OF INDONESIA

VOLUME 2
PART3: SHORT-TERM DEVELOPMENT PLAN

OCTOBER 1998



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PACIFIC CONSULTANTS INTERNATIONAL (PCI)

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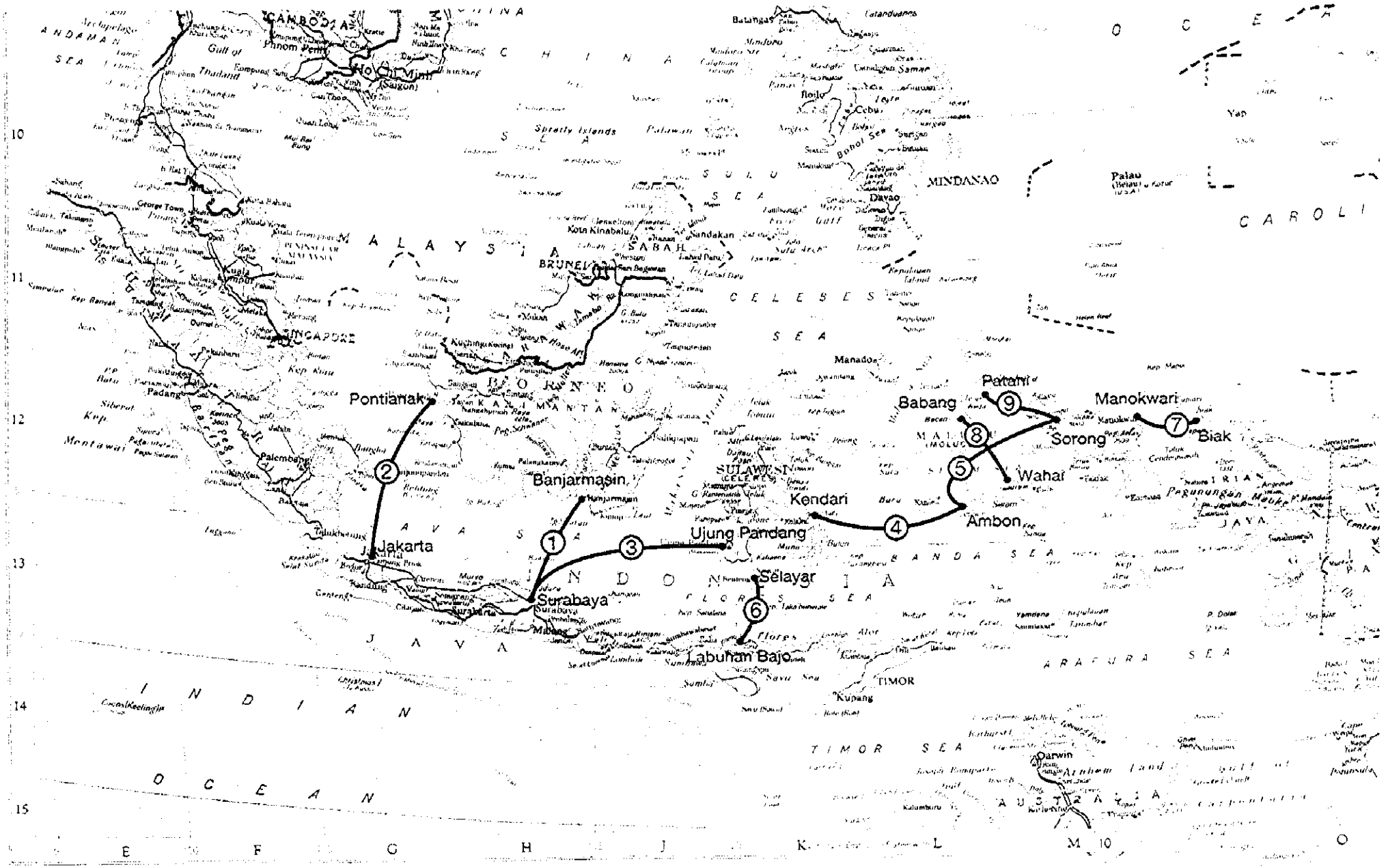
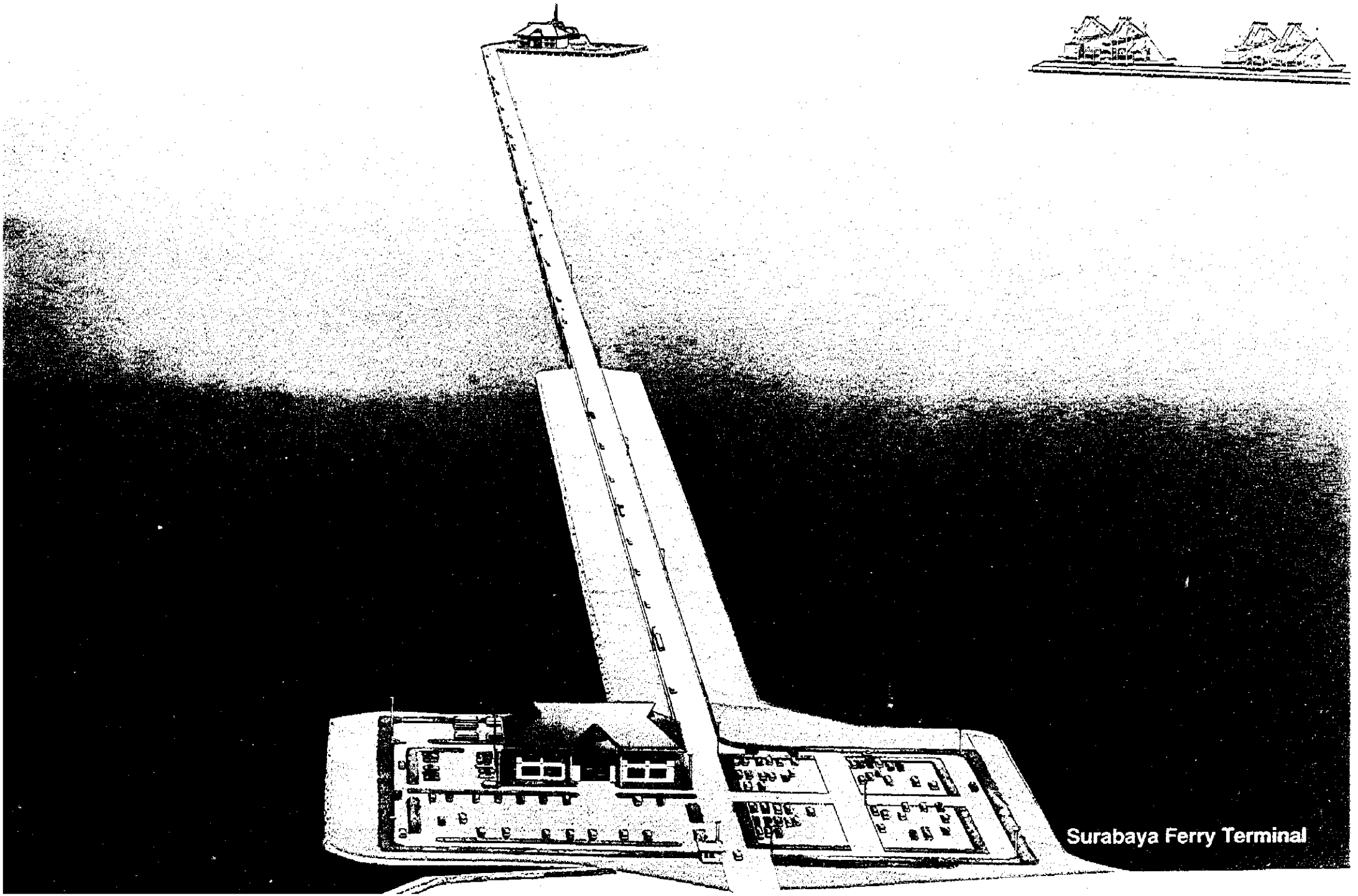
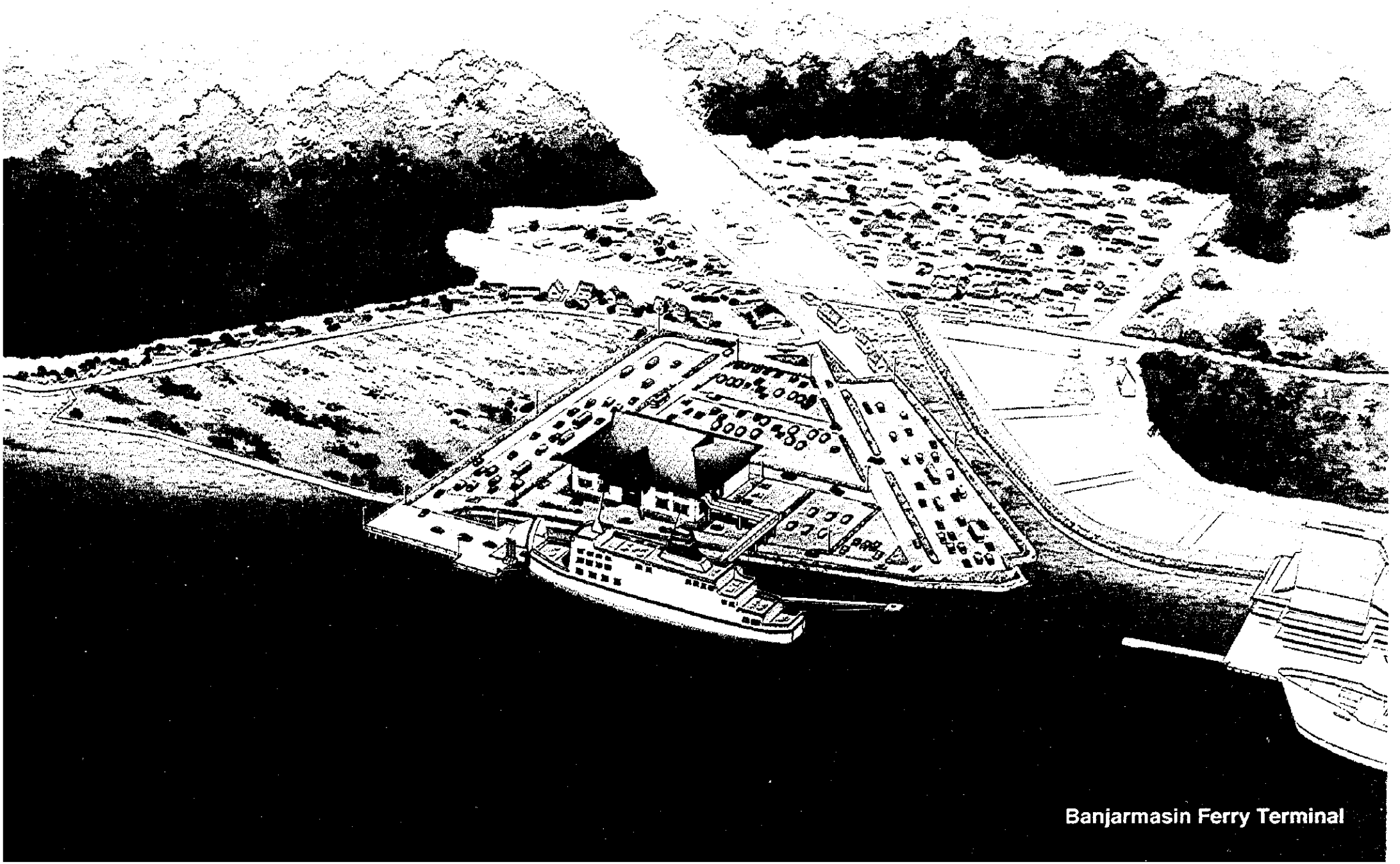
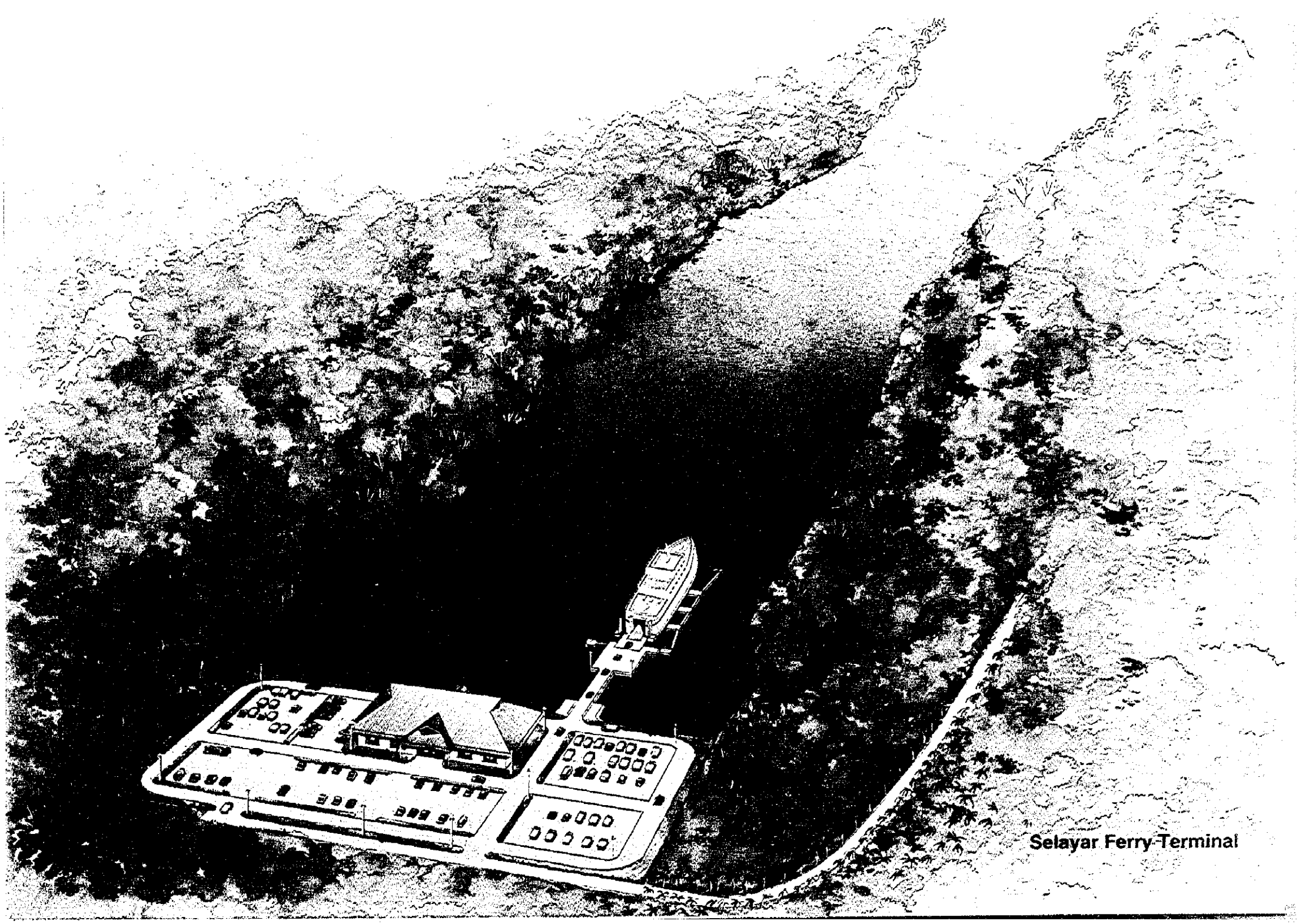
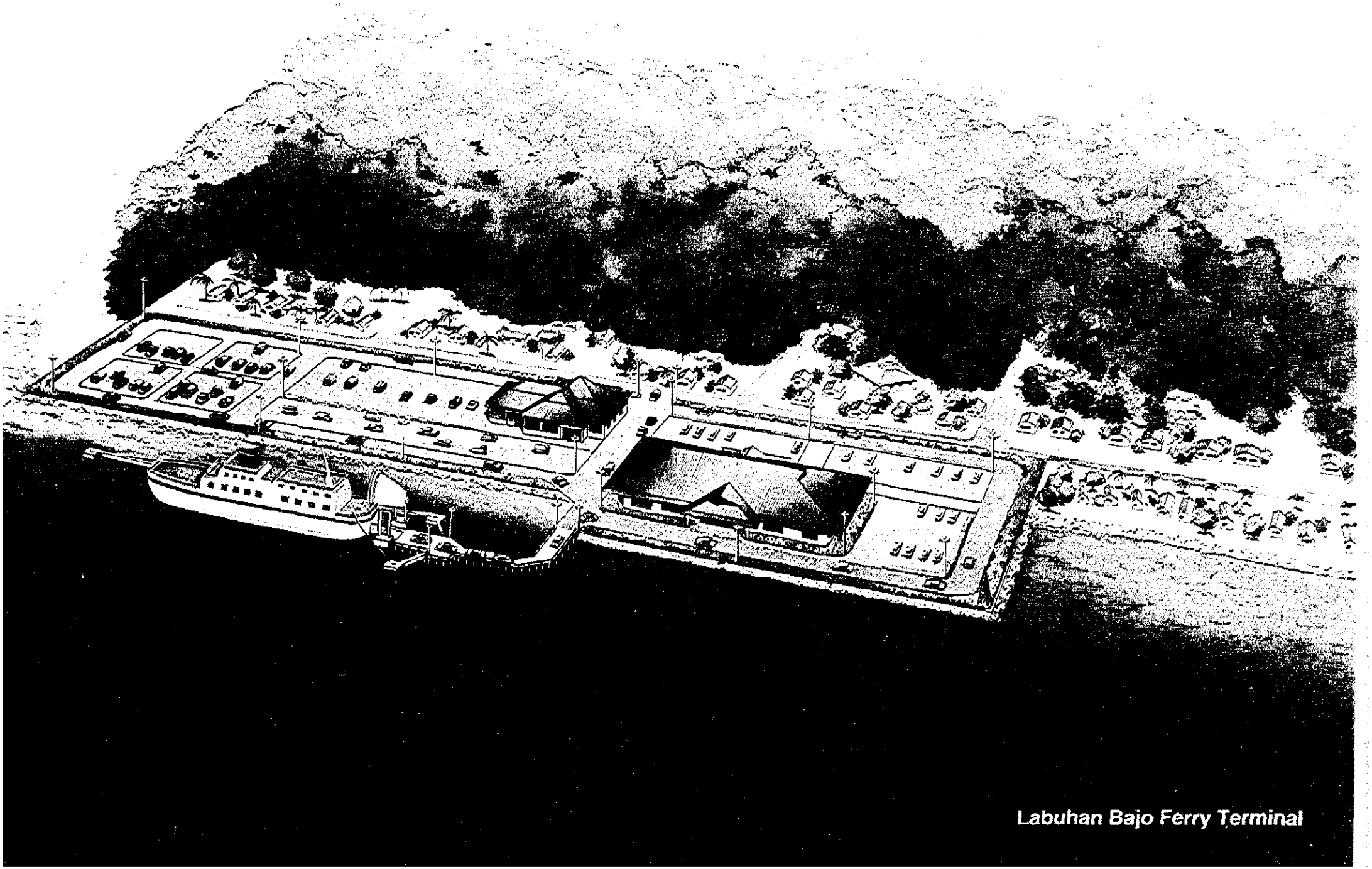

Pontianak
Jakarta
Banjarmasin
Ujung Pandang
Surabaya
Selayar
Labuhan Bajo
Kendari
Ambon
Babang
Patani
Sorong
Manokwari
Biak
Wahai
1
2
3
4
5
6
7
8
9
Location Map of Study Routes

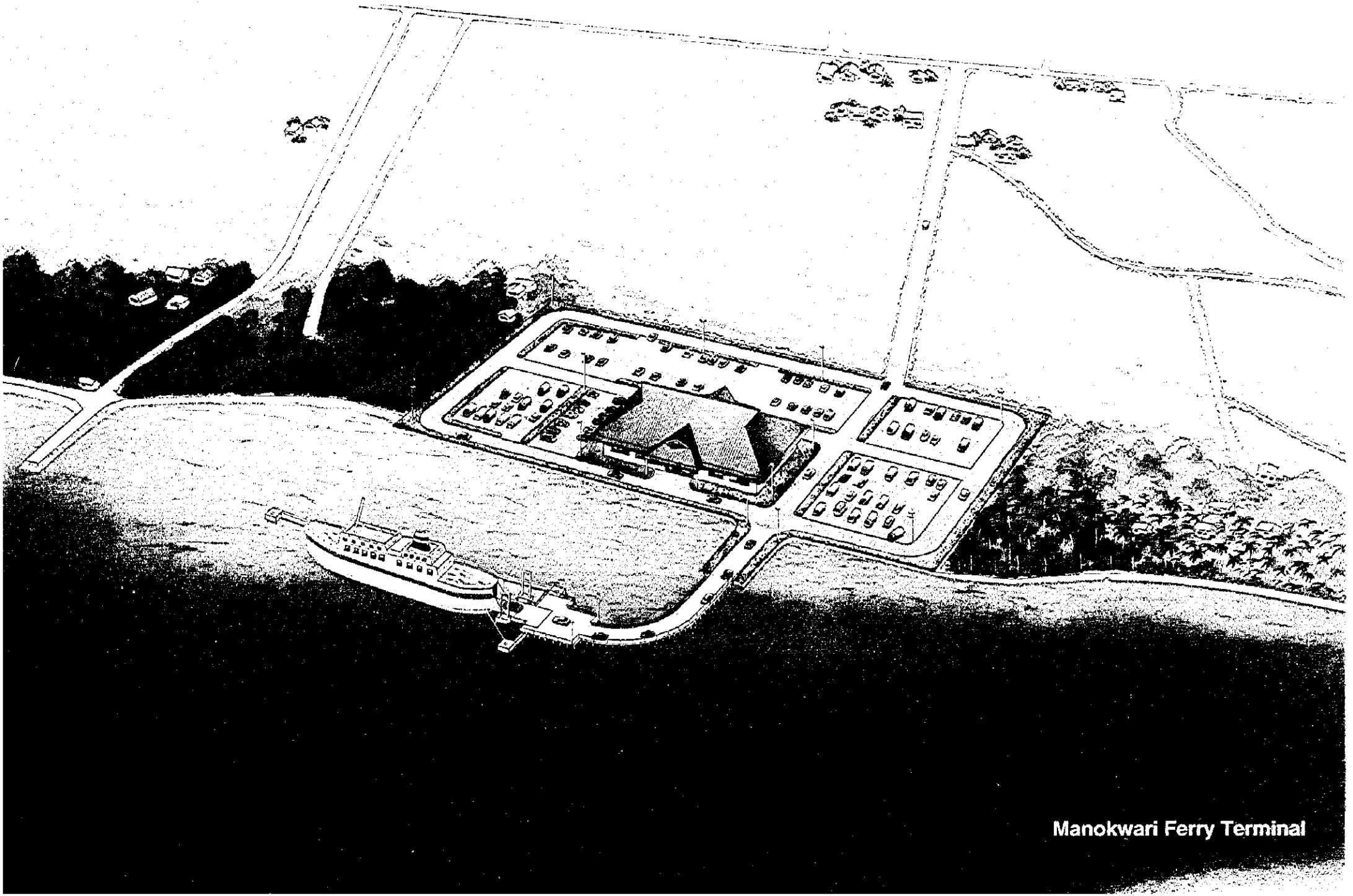

Surabaya Ferry Terminal

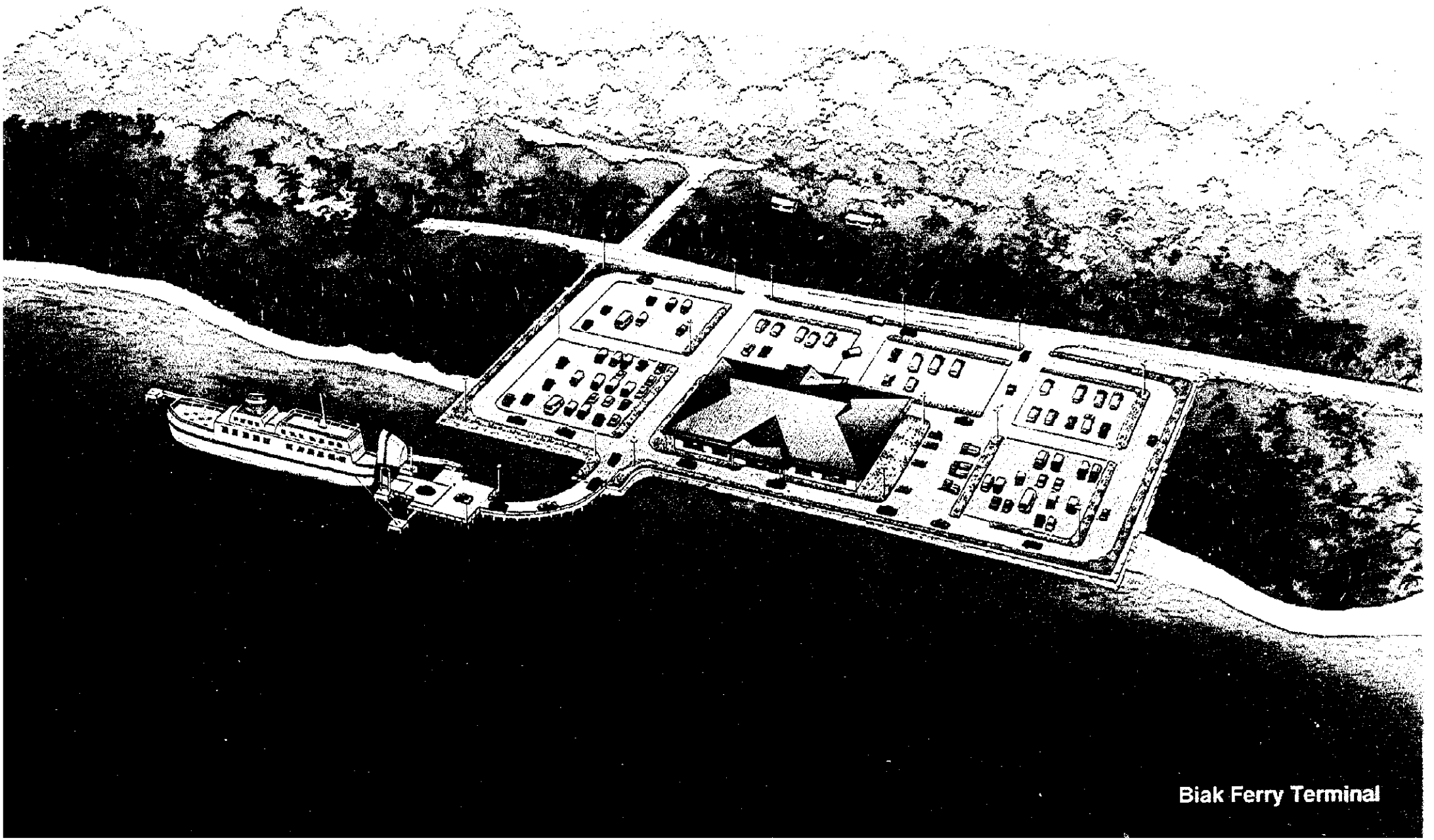

Banjarmasin Ferry Terminal

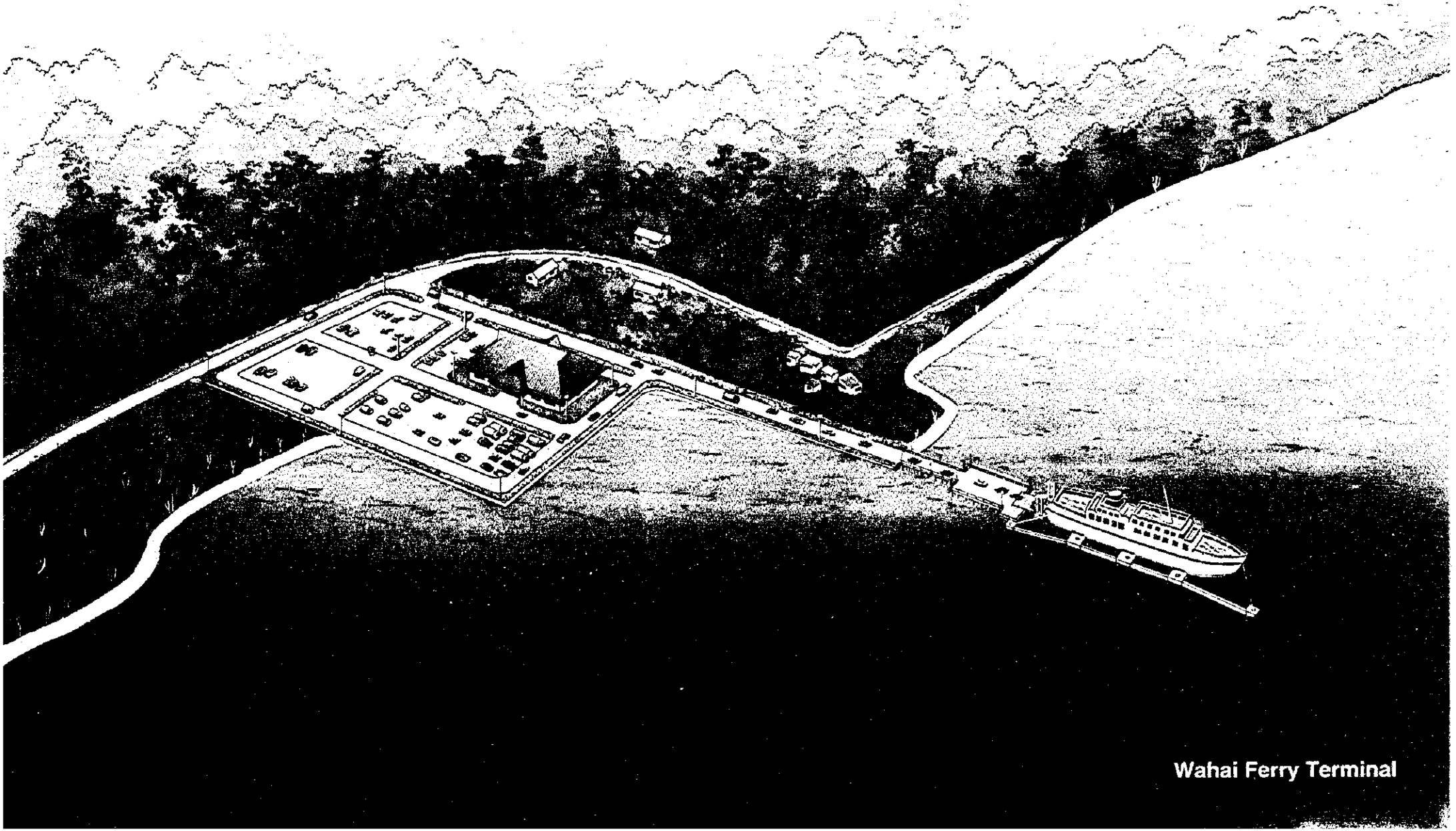


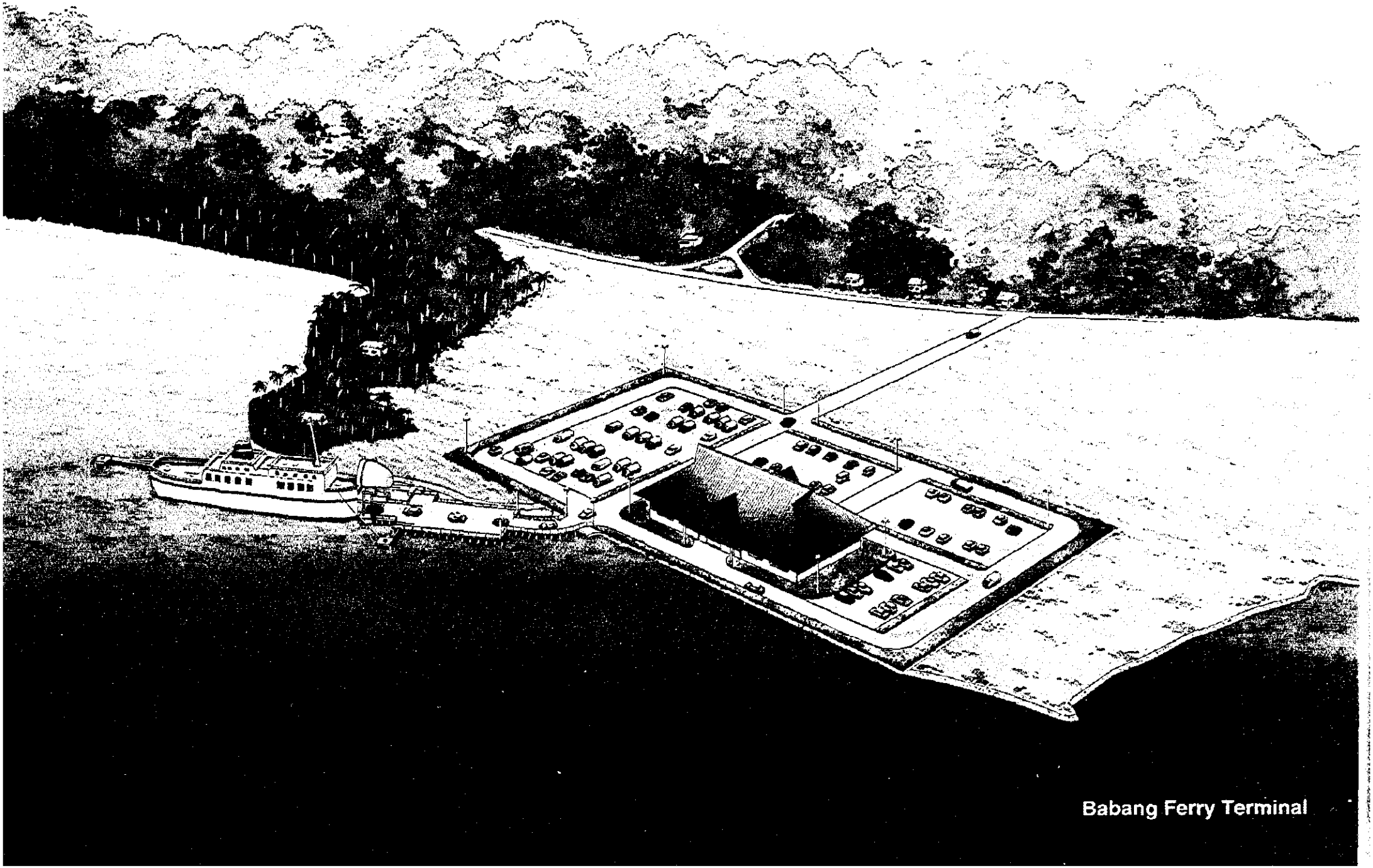
Selayar Ferry Terminal


Labuhan Bajo Ferry Terminal


Manokwari Ferry Terminal


Biak Ferry Terminal


Wahai Ferry Terminal


Babang Ferry Terminal

LIST OF ABBREVIATIONS

A		
	ADB	Asian Development Bank
	AMDAL	Environmental Impact Analysis
	ASDF	ASDP's antecedent project
	ASDP	State-owned Ferry Terminal Company
B		
	BAPEDAL	Environmental Impact Management Agency
	BAPENAS	National Development Planning Agency
	BAPPEDA	Provincial Development and Planning Board
	BKN	Province Treasurer
	BM.	Bench Mark
	BOT	Build Operate Transfer
	BPS	Central Bureau of Statistics
C		
	CBR	California Bearing Ratio test
	CFC	Conversion Factor for Consumption
	CIF	Cost, Insurance of Freight
	CONV	Conventional type boat
D		
	DIK	Activity of Filler List
	DEPKEN	Ministry of Finance
	DGAC	Directorate General of Air Communication
	DGLT	Directorate General of Land Transportation and Island Waterways
	DGSC	Directorate General of Sea Communication
	DL	Datum Level
	DUK	Activity of Proposal List
	DWT	Dead Weight Tonnage
E		
	EIA	Environmental Impact Assessment
	EIRR	Economic Internal Rate of Return
F		
	FOB	Free on Board
G		
	GDP	Gross Domestic Product
	GPS	Global Positioning System

	GRDP	Gross Regional Domestic Products
	GRT	Gross Registered Tonnage
H		
	HHWS	Highest High Water Spring
	HWS	High Water Spring
I		
	IBRD	International Bank for Reconstruction and Development
	IEE	Initial Environmental Examination
	ITCZ	Inter-tropical Convergence Zone
J		
	JICA	Japan International Cooperation Agency
K		
	KANWIL	Provincial Office
	KM	Decree of the Minister
	KVA	Kilo Volt Ampere
L		
	LCT	Landing Craft Transport
	LLAJ	Directorate of Highway Transportation
	LLAK	Directorate of City Transportation
	LLASDP	Directorate of River, Lake and Ferry Transportation
	LLJREL	Directorate of Railway Transportation
	LLWS	Lowest Low Water Spring
	LOA	Length over All
	LSL	Local Surface Level
	LWS	Low Water Spring
M		
	MOC	Ministry of Communications
	MOF	Ministry of Finance
	MSL	Mean Sea Level
N		
	NM	Nautical Mile (1852m)
	NPV	Net Present Value
O		
	OCC	Opportunity Cost of Capital
	OD	Origin and Destination
	OECF	Oversea Economic Cooperation Fund, Japan
P		
	PASS	Passenger vessel

	Pax.	Passenger
	P.C.	Precast Concrete
	PELINDO	Indonesian Sea Port Cooperation
	PELNI	Indonesian National Shipping Company
	PIANC	Permanent International Association of Navigation Congress
	PT.	Limited Company
R		
	RC	Reinforced Concrete
	REPELITA VI	Five Year National Development Plan in the Sixth
	Ro-Ro	Roll on Roll off type vessel
	Rp.	Rupiah
S		
	SCF	Standard Conversion Factor
	SMB	Srendrup Munk Bretschneider
T		
	T.A	Truk Air (non motor boat)
	TTM	Monthly Average Exchange Rate
U		
	UPT	Technical Implementation Unit
	USAID	United States Agency for International Development
	USD	US Dollar
V		
	VAT	Value Added Tax

CONTENTS

LIST OF TABLES

PART 3 SHORT-TEERM DEVELOPMENT PLAN

LIST OF FIGURES

PART 3 SHORT-TEERM DEVELOPMENT PLAN

LIST OF TABLES IN APPENDICES

PART 3 SHORT-TEERM DEVELOPMENT PLAN

LIST OF FIGURES IN APPENDICES

PART 3 SHORT-TEERM DEVELOPMENT PLAN

PART 3

SHORT-TERM DEVELOPMENT PLAN

Chapter 1 Selection of Ferry Routes for the Short-term Development Plan

1.1 Traffic Demand Forecast for the Short-term Development Plan

1. Traffic demand for the short-term development plan is forecasted in the same manner as the traffic demand forecast for the long-term development plan.

2. The target year of the short-term development plan is 2004. In addition, the traffic demands in the years of 2008 and 2013 are forecasted as the midterm numerical values.

3. Ferry traffic demands of Category-1 and -2 ferry routes in the year of 2004 are estimated based on the passenger and cargo OD tables. The forecasts in the year of 2008 and 2013 are calculated based on the assumption that the demands increase every year from 2004 to 2019 at the same increase rate.

4. Traffic demands of Category-3 are forecasted using the same equation as that for the long-term development plan.

5. The projection of ferry passengers, cargoes, four-wheel vehicles and two-wheel vehicles for selection of the short-term development plan is shown in Table 1.1.1.

1.2 Evaluation of Ferry Routes for the Long-term Development Plan

1.2.1 Basic Premise for Selection of Ferry Routes

6. In order to select the ferry routes for the short-term development plan, the selected nine routes in the long-term development plan are categorized into the long distance routes and the middle and short distance routes.

7. The long distance routes are located on the trunk lines connecting main regions, which are regarded as the interregional routes. The middle and short distance routes connects the islands of eastern part of Indonesia, especially in Maluku and Irian Jaya.

1.2.2 Evaluation Items of Ferry Routes

8. In the selection of Ferry routes for short-term development plan, it is necessary to examine profitability and urgency of the ferry routes taking into consideration

Table 1.1.1 Demand Forecast for the Short-term Development Plan

		PASSENGER				CARGO				4 WHEEL-VEHICLE				2 WHEEL-VEHICLE			
		2004	2008	2013	2019	2004	2008	2013	2019	2004	2008	2013	2019	2004	2008	2013	2019
									unit : ton								
Long Distance Route																	
Surabaya	Banjarmasin	559,800	770,700	1,149,300	1,856,500	166,300	250,500	414,900	750,000	63,550	90,460	140,110	234,960	5,740	7,910	11,790	19,040
Jakarta	Pontianak	254,000	339,600	488,200	754,700	75,400	110,400	176,200	304,900	28,830	39,870	59,500	95,520	2,530	3,380	4,860	7,520
Surabaya	U Pandan	168,500	234,100	353,200	578,500	50,000	76,100	127,500	233,700	19,110	27,480	43,060	73,210	1,670	2,320	3,510	5,740
Kendari	Ambon	126,000	182,200	289,100	502,900	37,400	59,200	104,400	203,200	14,300	21,380	35,250	63,660	1,260	1,830	2,900	5,040
Ambon	Sorong	74,800	103,300	154,700	251,200	22,200	33,600	55,800	101,500	8,490	12,130	18,840	31,800	750	1,040	1,560	2,530
Middle and Short Distance Route																	
Selayar	L Bajo	84,500	119,800	185,400	313,000	16,700	26,700	47,100	91,100	9,550	13,360	20,390	33,950	930	1,310	2,030	3,430
Manokwari	Biak	72,600	101,500	154,300	255,200	14,400	22,600	39,200	74,300	8,230	11,310	16,970	27,670	790	1,100	1,680	2,770
Wahai	Babang	47,700	71,900	120,000	222,100	9,400	16,000	30,500	64,600	5,370	8,010	13,200	24,090	510	760	1,270	2,350
Patani	Sorong	44,600	68,100	115,400	217,500	8,800	15,200	29,300	63,300	5,030	7,610	12,680	23,590	470	720	1,230	2,310

		TRUCK				BUS				SEDAN,PICKUP				LARGE TRUCK AND BUS			
		2004	2008	2013	2019	2004	2008	2013	2019	2004	2008	2013	2019	2004	2008	2013	2019
Long Distance Route																	
Surabaya	Banjarmasin	34,970	49,750	77,060	1,298,230	9,540	13,570	21,020	35,240	19,070	27,140	42,030	70,490	28,930	41,160	63,750	106,910
Jakarta	Pontianak	15,860	21,930	32,720	52,530	4,320	5,980	8,930	14,330	8,650	11,960	17,850	28,660	13,120	18,140	27,070	43,460
Surabaya	U Pandan	10,510	15,120	23,680	40,270	2,870	4,120	6,460	10,980	5,740	8,240	12,920	21,960	8,700	12,500	19,590	33,310
Kendari	Ambon	7,860	11,760	19,380	35,010	2,150	3,210	5,290	9,550	4,290	6,410	10,580	19,100	6,510	9,730	16,040	28,970
Ambon	Sorong	4,670	6,670	10,360	17,490	1,270	1,820	2,830	4,770	2,550	3,640	5,650	9,540	3,860	5,520	8,570	14,470
Middle and Short Distance Route																	
Selayar	L Bajo	5,250	7,340	11,210	18,670	960	1,340	2,040	3,400	3,340	4,680	7,140	11,880	4,030	5,640	8,610	14,340
Manokwari	Biak	4,530	6,220	9,330	15,230	820	1,130	1,700	2,770	2,880	3,960	5,940	9,690	3,480	4,780	7,170	11,700
Wahai	Babang	2,950	4,410	6,970	13,240	540	800	1,320	2,410	1,880	2,800	4,620	8,420	2,270	3,380	5,580	10,170
Patani	Sorong	2,770	4,190	6,980	12,970	500	760	1,270	2,360	1,760	2,660	4,440	8,260	2,130	3,220	5,360	9,970

Source : Study Team

investment cost, natural conditions and environmental influence.

9. The ferry demand volumes of passengers/ vehicles/ cargoes should be most important items for the evaluation of ferry service. Indonesian Government's policy to develop the economically less developed regions should also be taken into account. Accordingly the following items are selected for easy comparison and evaluation among the selected nine routes.

1) Ferry transport demand
   - Passenger volume in 2004 and 2019
   - Four-wheel vehicle volume in 2004 and 2019
     (these volumes are subdivided into truck, bus and sedan & pickup)
   - Cargo volume in 2004 and 2019
2) Construction cost for ferry terminal on each route in 2019
   - Construction cost of the new ferry terminal including offshore and on shore facilities
3) Ferry boats operation cost for each route in 2004 and 2019
   - Procurement cost and operation costs of new or used ferry boats to be engaged on the routes
4) Demand efficiency
   - Tariff income potential of ferry transportation; total person-miles, vehicle numbers -miles, tons-miles
   - Ratio of ferry terminal construction cost per one passenger, vehicle and ton
   - Ratio of ferry boats operation cost per one passenger, vehicle and ton
5) Urgency of ferry route development
   - Necessity of urgent ferry route development considering the Indonesian Government's eastern region development plan

1.3 Selection of Ferry Routes for the Short-term Development Plan

1.3.1 Selection of Ferry Routes

10. Five long distance and four middle and short distance routes have been evaluated separately according to the above mentioned evaluation items.

11. The demand potential and ratio of ferry terminal construction cost and ferry boats operation cost are calculated by the following formulas.

- Tariff income potential = Ferry transport demand (passenger, vehicle and cargo) × Distance

- Ratio of ferry terminal construction cost = $\frac{\text{Ferry terminal construction cost}}{\text{Ferry transport demand (Passenger, Vehicle and cargo)}}$

- Ratio of ferry boats operation cost = $\frac{\text{Ferry boats operation cost}}{\text{Ferry transport demand (Passenger, vehicle and cargo)}}$

12. The results of selection are as follows.

13. Regarding the selection of the long distance routes, Surabaya - Banjarmasin route is most superior among the five routes from the point of view of the development efficiency.

14. Concerning the middle and short distance routes, Selayar - Labuhan Bajo route is most superior among the four routes from the point of view of the development efficiency, while, Patani - Sorong route is clearly inferior to the Manokwari - Biak and Wahai - Babang routes.

15. Comparing the routes of Manokwari - Biak and Wahai - Babang, both routes are evaluated highly, especially in the terms of ratio of ferry terminal construction cost.

16. Table1.3.1 shows the selection of ferry routes for the short-term development plan including those which the Indonesian government suggested the study team to include. The evaluation ranks are shown in Appendices A1.3.1.

1.3.2 Proposed Routes for the Short-term Development Plan

17. According to the above mentioned evaluation items and evaluation, the proposed routes for the Feasibility Study are as follows.

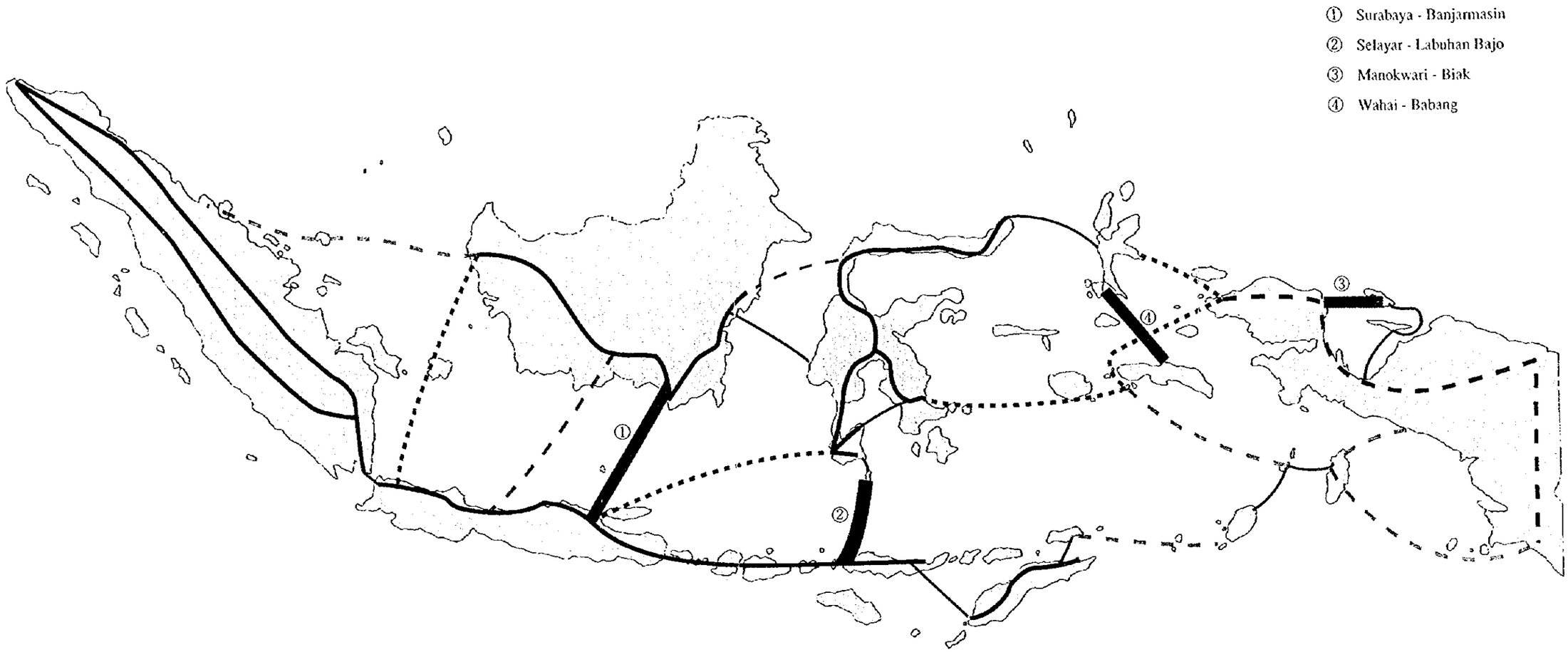
Long distance route:	Surabaya - Banjarmasin
Middle and short distance route:	Selayar - Labuhan Bajo
	Manokwari - Biak
	Wahai - Babang

18. The ferry routes proposed for the short-term development plan are shown in Figure1.3.1.

Table 1.3.1 Selection of Ferry Routes for the Short-term Development Plan

		Demand Volume						Dis-tance	Cost (Million Rp.)			Evaluation Items and Evaluation															Urgency of Ferry Develop-ment	Route Selection for Short-term Development Plan	
		2004			2019				Terminal Construc-tion	Ferry boats Operation		Development Efficiency																
												Tariff Income Potential ('000,000)						Ratio of Terminal ('000 Rp.)			Ratio of Ferry boats ('000 Rp.)							
												2004			2019						2004			2019				
		Passenger	Vehicle	Cargo	Passenger	Vehicle	Cargo	(NM)		2004	2019	Passeng.	Vehicle	Cargo	Passeng.	Vehicle	Cargo	/Pers.	/Car	/Ton	/Pers.	/Car	/Ton	/Pers.	/Car	/Ton		Steering Committee	Study Team
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(1)*(7)	(2)*(7)	(3)*(7)	(4)*(7)	(5)*(7)	(6)*(7)	(8)/(4)	(8)/(5)	(8)/(6)	(9)/(1)	(9)/(2)	(9)/(3)	(10)/(4)	(10)/(5)	(10)/(6)			
Long Distant Routes																												
Route A																												
Surabaya	Banjarmasin	559,800	63,550	166,300	1,856,500	234,860	750,000	256	167,868	21,075	55,602	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	○	◎	◎	◎	◎		◎	◎
Route B																												
Jakarta	Pontianak	254,000	28,830	75,400	754,700	95,480	304,900	417	90,633	14,979	44,284	◎	○	○	○	○	◎	○	○	◎	△	△	○	△	△	○			
Route C																												
Surabaya	Ujung Pandang	168,500	19,110	50,000	578,500	73,190	233,700	445	115,850	10,905	29,913	○	△	○	○	○	◎	△	△	△	△	△	△	△	○	○			
Route D																												
Kendari	Ambon	126,000	14,290	37,400	502,900	63,620	203,200	362	46,708	5,325	20,473	△	△	△	△	△	○	◎	◎	◎	○	○	◎	○	○	○			
Route E																												
Ambon	Sorong	74,800	8,490	22,200	251,200	31,780	101,500	337	40,751	2,592	9,821	△	△	△	△	△	△	△	△	△	◎	◎	◎	◎	◎	◎			
Middle and Short Distant Routes																												
Route a																												
Selayar	Labuhan Bajo	84,500	9,550	16,700	313,000	33,950	91,100	135	26,525	2,032	3,959	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎		◎	◎
Route b																												
Manokwari	Biak	72,600	8,230	14,400	255,200	27,670	74,300	144	26,846	2,060	3,997	◎	○	◎	○	○	○	○	○	○	◎	◎	◎	○	○	○	◎	◎	◎
Route c																												
Wahai	Babang	47,700	5,370	9,400	222,100	24,090	64,600	178	25,267	2,154	2,676	○	△	○	○	○	○	○	△	○	○	○	△	◎	◎	◎	◎	◎	◎
Route d																												
Patani	Sorong	44,600	5,030	8,800	217,500	23,580	63,300	173	27,836	2,145	2,657	△	△	○	○	○	○	○	△	△	○	△	△	◎	◎	◎			

Note : ◎ First priority, ○ Second priority, △ Third priority



Legend

- Proposed Ferry Routes for the Short-term Development Plan
- Proposed Ferry Routes for the Long-term Development Plan
- Ferry Routes in Future
- Existing Ferry Routes
- Ferry Routes under construction

Figure 1.3.1 Ferry Routes for the Short-term Development Plan

Chapter 2 Natural Conditions

2.1 Location

1. The locations of each terminal of the study routes are shown below.

Table 2.1.1 Terminal Location

Route	Site	Coordinate	Regency	Province
Surabaya - Banjarmasin	Surabaya (Lamong Bay)	112° 42′ 16″ E 7° 13′ 31″ S	(Municipal) Surabaya	East Java
	Banjarmasin (Public Port)	114° 32′ 38″ E 3° 16′ 0″ S	(Municipal) Banjarmasin	South Kalimantan
Labuhan Bajo - Selayar	Labuhan Bajo	119° 52′ 32″ E 8° 29′ 27″ S	Manggarai	East Nusa Tenggara
	Selayar (Patumbukan)	120° 29′ 32″ E 6° 23′ 34″ S	Selayar	South Sulawesi
Wahai – Babang	Wahai	129° 29′ 34″ E 2° 47′ 54″ S	Central Maluku	Maluku
	Babang	127° 34′ 38″ E 0° 37′ 20″ S	North Maluku	Maluku
Manokwari - Biak	Manokwari (Sowi)	134° 02′ 24″ E 0° 54′ 19″ S	Manokwari	Irian Jaya
	Biak (Mokmer)	136° 18′ 55″ E 1° 11′ 54″ S	Biak	Irian Jaya

2.2 Topographic Conditions

2. A series of topographic surveys was carried out for each terminal (except Biak – Mokmer site which was surveyed in the previous study) from January to March 1998 using the following criteria.

1) Mapping Scale: 1:1,000 (Surabaya: 1:4,000)
2) Contour Interval: 1m
3) Datum Level: Lowest Low Water Spring (LLWS) was established by the result of tide observation at each terminal site and was used as datum level (DL) for mapping work.
4) Survey Method: Traverse survey and height difference measurement.
5) Bench Marks: At least two benchmarks were established for each terminal site. The location and elevation of each

benchmark is listed in the following table (See Table 2.2.1).

3. A series of hydrographic surveys was conducted simultaneously with the topographic surveys following the criteria below.

1) Mapping Scale: 1:1,000 (Surabaya: 1:4,000)
2) Contour Interval: 1m
3) Datum Level: LLWS
4) Survey Method: Measurement of water depth by echo sounder and positioning by GPS.

Table 2.2.1 Benchmarks

Site	Bench Mark	Local Coordinates		Elevation (DL, m)
		East	North	
Surabaya	BM I	10,000.000	10,000.000	+4.270
	BM II	9,973.599	10,195.222	+4.239
Banjarmasin	BM I	226,837.000	9,749,232.000	+3.076
	BM II	226,855.065	9,749,237.459	+3.909
Labuhan Bajo	BM I	816,525.613	9,060,312.302	+3.684
	BM II	816,557.902	9,060,146.645	+3.194
Selayar (Patumbukan)	BM IA	222,571.000	9,292,756.000	+2.704
	BM II	222,536.296	9,292,763.294	+4.735
	BM I	222,527.893	9,292,689.781	+3.695
	BM IIA	222,513.087	9,292,767.452	+6.363
Wahai	BM I	554,782.000	9,690,683.000	+2.143
	BM II	554,808.106	9,690,747.959	+2.414
Babang	BM I	341,677.000	9,929,362.000	+2.238
	BM II	341,623.370	9,929,311.759	+2.929
Manokwari (Sowi)	BM I	342,805.374	9,900,051.965	+4.427
	BM II	393,217.000	9,900,014.000	+2.609

4. The results of the topographic and hydrographic survey are shown in Figures A2.2.1 to A2.2.7 in Part 3 of the Appendices.

2.2.1 Surabaya

5. The survey site is located in the Lamong Bay between Surabaya City and Gresik

City, about 2.5km west of the commercial port Tanjung Perak. The slope of seabed in Lamong Bay is extremely gentle and six rivers flow into this bay area.

6. The proposed project site is actually on alluvial tidal flat with mud bottom and is about 3km from the shoreline of low water (LWS). The water area of water depth over 5m below LWS is obtained around 2 - 3km offshore.

2.2.2 Banjarmasin

7. The proposed site is located on the left bank of the Barito River approximately 30km upstream from the river mouth and belongs to tidal compartment of the river. The tidal range is observed about for 2.8m at the site. Waves will not pose a major problem to ferry services.

8. The site is separated from the public port of Banjarmasin (Trisakti Port) by a small creek of 15m width. The access roads to the site from the center of the Banjarmasin City do not have sufficient width and traffic capacity.

2.2.3 Labuhan Bajo

9. The proposed site is the existing ferry port with facilities of 500GRT ferry berthing jetty and movable bridge, which was constructed in 1995/96. The water depth at the end of the jetty is observed to be about DL-6m.

10. The topography of land in the vicinity of the port is rather flat. Some permanent buildings such as PT. ASDP office, staff housing, warehouses and so on are found around the port.

11. The water area in front of the existing port is surrounded by several islands and thus waves will not pose any problem to ferry operation.

2.2.4 Selayar (Patumbukan)

12. The proposed site is located at the head of an inlet about 42km south of Benteng City, the regional capital city of Selayar Island. The land topography is rather uneven, while seaside is characterized by mangrove in relatively shallow water.

13. The inlet is approximately 120m in width and 700m in length and both sides of

this inlet are steep slopes of the mountainous terrain. The influence of waves from the Flores Sea is negligibly small all through the year.

14. Access to the site from the main road, Benteng - Apatana, is through an unpaved road of 3m width, and some semi-permanent houses owned by new settlers are found at the site.

2.2.5 Wahai

15. The proposed site is situated on the seashore in a hidden bay and is located about 250m south of the Wahai Public Port. The branch office of DGSC, office building, staff houses, small shops and so on are found in the vicinity.

16. The seaside of the proposed area is covered by bush, coconut trees and mangrove. Wave are not considered to pose any problem to ferry services.

2.2.6 Babang

17. The proposed site is located on the East Coast of Bacan Island and is about 400m northwest from the Babang Public Port. Babang is about 16km from Labuha Town, the major port town of the island.

18. The proposed site, which is empty and covered by grass presently, is an abandoned reclaimed area.

19. The land side topography is flat, while sea side topography is rather steep and the contour of DL-5m is from only 10 - 20m from shoreline.

2.2.7 Manokwari (Sowi)

20. The proposed site is located on the bayside approximately 5km southwest of Manokwari Town. The access road is in fairly good condition, that is, a part of the road from Manokwari is asphalt paved though another part is still unpaved.

21. The vicinity of the proposed site is flat and is presently empty and covered by bush. Seaside topography is relatively steep and the contour of DL-5m is about 50 - 60m from shoreline.

2.2.8 Biak (Mokmer)

22. The proposed site is the ferry terminal now being constructed by DGLT and is located approximately 20 minutes from Biak Town by vehicle. The size of the ferry terminal area still under construction is approximately 100m x 60m and located at the center of Mokmer village. Fishponds are located on both sides of the ferry terminal now under construction.

23. The water depth at the end of the jetty is estimated to be approximately 5m below LWS. The site is open to SW waves. The maximum height of waves is assumed to be about two meters. The difference between HWS and LWS is about 1.6m.

2.3 Tide

24. Tide observations were carried out continuously for 15 days and nights at each terminal site from January to February 1998. Based on the observed data, harmonic analysis was executed to determine the tidal constituents, amplitude and phases. The significant tide levels in each terminal site are as follows.

Table 2.3.1 Tide Elevations in Each Terminal Site

(DL+, m)

Terminal	HHWS (m)	MSL (m)	LLWS (m)	Remarks
Surabaya (Lamong Bay)	2.74	1.37	0.00	Existing Data
Banjarmasin (Port Site)	2.97	1.48	0.00	
Selayar (Patumbukan)	2.39	1.19	0.00	
Labuhan Bajo	2.70	1.35	0.00	
Wahai	1.92	0.96	0.00	
Babang	1.35	0.67	0.00	
Manokwari (Sowi)	2.22	1.11	0.00	
Biak (Mokmer)	1.55	0.92	0.00	Phase I Report

25. In the case of Lamong Bay (Surabaya), necessary data for sounding and topographic survey were obtained from existing tidal observation station of the Tanjung Perak Port. The tidal condition of Mokmer site (Biak) is quoted from the report of the Phase I Study.

26. Based on the observed data and harmonic analysis, the tidal constituents of each terminal site are as shown in Table 2.3.2.

Table 2.3.2 Tidal Constituents in Each Terminal Site

(Unit in meter)

Constituents	M_2	S_2	N_2	K_1	O_1	M_4	MS_4	K_2	P_1
Surabaya	0.35	0.24	0.04	0.44	0.30	0.03	0.03	0.07	0.14
Banjarmasin	0.34	0.05	0.06	0.74	0.30	0.04	0.02	0.01	0.24
Patumbukan	0.43	0.15	0.12	0.34	0.15	0.03	0.01	0.04	0.11
Labuhan Bajo	0.43	0.17	0.28	0.20	0.29	0.00	0.01	0.05	0.09
Wahai	0.34	0.18	0.10	0.20	0.15	0.00	0.01	0.05	0.06
Babang	0.16	0.14	0.04	0.21	0.13	0.00	0.00	0.04	0.07
Manokwari	0.35	0.24	0.17	0.19	0.16	0.01	0.01	0.06	0.06
Biak *	0.42	0.11	0.05	0.21	0.13	0.00	0.01	0.03	0.07

* Source: Phase I Report, March 1993.

27. Tide is classified as diurnal, semi-diurnal and mixed semi-diurnal according to the number which is defined by the ratio: $(K_1 + O_1)/(M_2 + S_2)$.

Semi-diurnal type: Form Number < 0.25
Mixed Semi-diurnal type: 0.25 < Form Number < 1.25
Diurnal type: Form Number > 1.25

The tidal types at each terminal site are described as follows.

Table 2.3.3 Tidal Form Type

Location	Form Number	Tidal Form Type
Surabaya	1.254	Diurnal
Banjarmasin	2.667	Diurnal
Patumbukan	0.845	Mixed Semi-diurnal
Labuhan Bajo	0.817	Mixed Semi-diurnal
Wahai	0.673	Mixed Semi-diurnal
Babang	1.133	Mixed Semi-diurnal
Manokwari	0.593	Mixed Semi-diurnal
Mokmer	0.642	Mixed Semi-diurnal

2.4 Current

28. The objective of current measurement is to obtain information of possible current speed and direction that will affect maneuvering of vessels in the vicinity of the proposed ferry terminal site. Observations of the current were executed at each terminal site according to the following criteria.

1)	Point of Survey:	One offshore point at each terminal site.
2)	Layer:	Two layers (surface layer and bottom layer) at each survey point.
3)	Timing of Observation:	Around the time of spring tide.
4)	Period of Observation:	25 hours continuously.
5)	Method of Observation:	Self-recording current meter. (Aanderra RCM7, Valeport BFM105) Two minutes measurement at intervals of 10 minutes.

29. The maximum speeds of the observed current at each terminal site are presented in the table below. The results of observations verify that maneuverability of vessels at all the terminal sites is not adversely affected by the current.

Table 2.4.1 Current Speed and Direction

Location	Tide	Max. Speed (m/sec)	Direction
Surabaya (Lamong Bay)	Flood	0.27	W – WNW
	Ebb	0.25	E - ESE
Banjarmasin (Barito River)	Flood	0.68	NNE (upstream)
	Ebb	0.80	SSW (downstream)
Selayar (Patumbukan)	Flood	0.20	SE – E
	Ebb	0.18	W - WSW
Labuhan Bajo	Flood	0.44	SSW
	Ebb	0.23	N
Wahai	Flood	0.12	W – NW
	Ebb	0.14	SE - ESE
Babang	Flood	0.13	SE
	Ebb	0.36	NNW
Manokwari (Sowi)	Flood	0.23	N
	Ebb	0.10	S
Biak* (Mokmer)	Flood	0.65	ENE
	Ebb	0.50	WSW

* Source: Phase I Report, March 1993.

2.5 Wave

(1) Wave hindcast

30. The ferry operation in the following three proposed sites, among others, was

considered to be affected by waves, but there were no observed wave data available for each terminal site. Therefore wave hindcast in those sites was conducted using the latest wind data over a period of more than five years.

Patumbukan (Selayar Island, South Sulawesi)
Babang (Bacan Island, Halmahera, North Maluku)
Manokwari (Irian Jaya)

31. The applied method for wave hindcast was SMB (Sverdrup-Munk-Bretschneider) method, in which offshore waves (wave height, period, and direction of incidence) were calculated.

32. Summary tables of frequency of occurrence of wind (the combined distributions of frequency of wind direction and wind speed) and wave (the combined distributions of frequency of wave direction and wave height) for each of the three terminal sites are shown in the Tables 2.5.1 – 2.5.3.

(2) Selayar (Patumbukan)

33. The tables show the relatively calm characteristics of waves at the three terminal sites. According to Table 2.5.1(2), the directions of wave incidence to the Patumbukan (Selayar Island) site are limited to the range between NE – E – SE and the days with calm wave conditions (with wave height less than 0.3 meters) show a frequency of more than 95%. The frequency of occurrence of the waves with height 0.3 – 0.9 meters occupies 4.7% and the probability of the days with wave height greater than 1 meter is calculated as 0.7 days in a year (around once in 1.5 years).

(3) Babang

34. According to Table 2.5.2(2), the range of directions of wave incidence to the Babang (Bacan Island) site is rather wide. About 20% of waves come from N and NE and these waves are considered to be generated in the Molucca Sea area and to propagate to Halmahera, while about 18% of waves come from S and SE and those waves are seen to be generated in the Seram Sea area.

35. The days with calm wave conditions (with wave height less than 0.3 meters) show a frequency of more than 90%. The frequency of occurrence of the waves with height 0.3 – 0.9 meters occupies 9.7% and the probability of the days with wave height greater than 1 meter is calculated as 0.17 days in a year (around once in 6 years).

Table 2.5.1(1) Frequency of Occurrence of Wind (Hasanuddin)

Station: Hasanuddin - Ujung Pandang; 1987 - 1990 & 1994 - 1997

Speed (m/s)	Calm	1 - 3	3 - 5	5 - 7	7 - 9	9 - 11	11 -	Total
Direction	26,106 37.4%							26,106 37.38%
N		3,398 4.87%	1,122 1.61%	300 0.43%	37 0.05%	12 0.02%	13 0.02%	4,882 6.99%
NE		2,396 3.43%	515 0.74%	146 0.21%	19 0.03%	0	2 0.00%	3,078 4.41%
E		6,726 9.63%	688 0.99%	187 0.27%	30 0.04%	6 0.01%	2 0.00%	7,639 10.94%
SE		7,284 10.43%	507 0.73%	108 0.15%	17 0.02%	6 0.01%	0	7,922 11.34%
S		2,985 4.3%	574 0.8%	441 0.6%	127 0.2%	43 0.06%	9 0.01%	4,179 6.0%
SW		2,092 3.00%	300 0.43%	65 0.09%	8 0.01%	2 0.00%	1 0.00%	2,468 3.53%
W		4,096 5.87%	2,114 3.03%	603 0.86%	33 0.05%	9 0.01%	4 0.01%	6,859 9.82%
NW		4219 6.04%	1,932 2.77%	501 0.72%	30 0.04%	15 0.02%	6 0.01%	6,703 9.60%
Total	26,106 37.38%	33,196 47.53%	7,752 11.10%	2,351 3.37%	301 0.43%	93 0.13%	37 0.05%	69,836 100.00%

Table 2.5.1(2) Frequency of Occurrence of Wave (Patumbukan)

Location: Patumbukan - Selayar Island; 1987 - 1990 & 1994 - 1997

Height (cm)	Calm	1 - 30	31 - 60	61 - 90	91 - 120	121 - 150	150 -	Total
Direction	47,018 67.3%							47,018 67.33%
N		0	0	0	0	0	0	0 0.00%
NE		2,396 3.43%	515 0.74%	146 0.21%	19 0.03%	0	2 0.00%	3,078 4.41%
E		6,726 9.63%	688 0.99%	187 0.27%	30 0.04%	6 0.01%	2 0.00%	7,639 10.94%
SE		7,284 10.43%	507 0.73%	108 0.15%	17 0.02%	6 0.01%	0	7,922 11.34%
S		2,985 4.27%	574 0.82%	568 0.81%	43 0.06%	9 0.01%	0	4,179 6.0%
SW		0	0	0	0	0	0	0
W		0	0	0	0	0	0	0
NW		0	0	0	0	0	0	0
Total	47,018 67.33%	19,391 27.77%	2,284 3.27%	1,009 1.44%	109 0.16%	21 0.03%	4 0.01%	69,836 100.00%

Table 2.5.2(1) Frequency of Occurrence of Wind (Babullah)

Station: Babullah - Ternate; 1989 - 1997 & 1992 - 1997

Speed (m/s)	Calm	1 - 3	3 - 5	5 - 7	7 - 9	9 - 11	11 -	Total
	19,045							19,045
Direction	31.0%							30.96%
N		3,198	4,435	2,162	424	109	309	10,637
		5.20%	7.21%	3.51%	0.69%	0.18%	0.50%	17.29%
NE		1,015	723	59	9	0	0	1,806
		1.65%	1.18%	0.10%	0.01%			2.94%
E		1,888	1,443	145	10	1	28	3,515
		3.07%	2.35%	0.24%	0.02%	0.00%	0.05%	5.71%
SE		1,864	1,852	426	44	14	2	4,202
		3.03%	3.01%	0.69%	0.07%	0.02%	0.00%	6.83%
S		2,520	2,085	1,382	391	142	88	6,608
		4.1%	3.4%	2.2%	0.6%	0.23%	0.1%	10.7%
SW		3,533	245	85	16	2	3	3,884
		5.74%	0.40%	0.14%	0.03%	0.00%	0.00%	6.31%
W		1,977	454	130	21	2	13	2,597
		3.21%	0.74%	0.21%	0.03%	0.00%	0.02%	4.22%
NW		2584	3,538	2,304	573	145	70	9,214
		4.20%	5.75%	3.75%	0.93%	0.24%	0.11%	14.98%
Total	19,045	18,579	14,775	6,693	1,488	415	513	61,508
	30.96%	30.21%	24.02%	10.88%	2.42%	0.67%	0.83%	100.00%

Table 2.5.2(2) Frequency of Occurrence of Wave (Babang)

Location: Babang - Bacan Island; 1989 - 1990 & 1992 - 1997

Height (cm)	Calm	1 - 30	31 - 60	61 - 90	91 - 120	121 - 150	150 -	Total
	34,740							34,740
Direction	56.5%							56.48%
N		7,633	2,695	309	0	0	0	10,637
		12.41%	4.38%	0.50%				17.29%
NE		1,015	782	9	0	0	0	1,806
		1.65%	1.27%	0.01%				2.94%
E		1,888	1,443	155	1	28	0	3,515
		3.07%	2.35%	0.25%	0.00%	0.05%		5.71%
SE		3,716	470	16	0	0	0	4,202
		6.04%	0.76%	0.03%				6.83%
S		6,520	88	0	0	0	0	6,608
		10.6%	0.1%					10.7%
SW		0	0	0	0	0	0	0
W		0	0	0	0	0	0	0
NW		0	0	0	0	0	0	0
Total	34,740	20,772	5,478	489	1	28	0	61,508
	56.48%	33.77%	8.91%	0.80%	0.00%	0.05%	0.00%	100.00%

Table 2.5.3(1) Frequency of Occurrence of Wind (Manokwari)

Station: Rendani - Manokwari; 1987 - 1997

Speed (m/s)	Calm	1 - 3	3 - 5	5 - 7	7 - 9	9 - 11	11 -	Total
	22,229							22,229
Direction	69.2%							69.20%
N		812	676	225	36	34	60	1,843
		2.53%	2.10%	0.70%	0.11%	0.11%	0.19%	5.74%
NE		168	105	16	2	0	4	295
		0.52%	0.33%	0.05%	0.01%		0.01%	0.92%
E		493	380	104	16	12	0	1,005
		1.53%	1.18%	0.32%	0.05%	0.04%		3.13%
SE		1,624	1,106	344	62	26	5	3,167
		5.06%	3.44%	1.07%	0.19%	0.08%	0.02%	9.86%
S		421	209	47	14	2	1	694
		1.3%	0.7%	0.1%	0.0%	0.01%	0.0%	2.2%
SW		151	100	23	3	2	1	280
		0.47%	0.31%	0.07%	0.01%	0.01%	0.00%	0.87%
W		446	272	93	24	10	3	848
		1.39%	0.85%	0.29%	0.07%	0.03%	0.01%	2.64%
NW		730	611	285	75	41	19	1,761
		2.27%	1.90%	0.89%	0.23%	0.13%	0.06%	5.48%
Total	22,229	4,845	3,459	1,137	232	127	93	32,122
	69.20%	15.08%	10.77%	3.54%	0.72%	0.40%	0.29%	100.00%

Table 2.5.3(2) Frequency of Occurrence of Wave (Manokwari)

Location: Sowi - Manokwari; 1987 - 1997

Height (cm)	Calm	1 - 30	31 - 60	61 - 90	91 - 120	121 - 150	150 -	Total
	25,118							25,118
Direction	78.2%							78.20%
N		1,783	60	0	0	0	0	1,843
		5.55%	0.19%					5.74%
NE		289	6	0	0	0	0	295
		0.90%	0.02%					0.92%
E		493	484	16	12	0	0	1,005
		1.53%	1.51%	0.05%	0.04%			3.13%
SE		1,624	1,106	344	62	26	5	3,167
		5.06%	3.44%	1.07%	0.19%	0.08%	0.02%	9.86%
S		421	256	14	3	0	0	694
		1.31%	0.80%	0.04%	0.01%			2.2%
SW		0	0	0	0	0	0	0
W		0	0	0	0	0	0	0
NW		0	0	0	0	0	0	0
Total	25,118	4,610	1,912	374	77	26	5	32,122
	78.20%	14.35%	5.95%	1.16%	0.24%	0.08%	0.02%	100.00%

(4) Manokwari

36. According to Table 2.5.3(2), the directions of wave incidence to the Manokwari range between N – E -- S, and about 7% of waves come from N and NE and these waves are considered to be generated in the Pacific Ocean and to propagate to Irian Jaya, while about 15% of waves come from S and E and those waves are seen to be generated in Cenderawasih Bay.

37. The days with calm wave conditions (with wave height less than 0.3 meters) show a frequency of more than 92.5%. The frequency of occurrence of the waves with height 0.3 -- 0.9 meters occupies 7.1%, and the probability of the days with wave height greater than 1 meter is calculated as 1.2 days in a year (around once in 0.8 years).

(5) Summary and maximum wave height

38. From the above wave conditions, the proposed terminal sites can be considered to be calm enough to have operative and serviceable days over 90% of a year. And it is also considered that construction of breakwater is not necessary for these sites. The possible maximum waves hindcast from the wind conditions for the three sites are as follows.

Table 2.5.4 Possible Maximum Wave Height

Site	Wave Height $H_{1/3}$ (m)	Wave Period $T_{1/3}$ (s)	Direction
Sclayar	2.3	6.6	E
Babang	1.8	5.6	E
Manokwari	2.3	6.6	SE

2.6 Subsoil Conditions

39. In order to survey and confirm the subsoil conditions of proposed terminal sites, one boring for the onshore development area and another boring for the offshore facility area were executed at each terminal site. The subsoil profiles acquired from the borings at each site are shown in Figures A2.6.1 -- A2.6.7 in Part 3 of the Appendices. The following is an outline of subsoil conditions at each survey site (Also see Table 2.6.1 for a summary of Soil Investigation results).

(1) Surabaya (Lamong Bay)

40. At BM.I, the upper layers up to -4m below local surface level (LSL) formed top soil in the form of organic matter with an N value of 0. The layers between -4m to -56m are loam layers with silt sand and shell fragments being inserted in the depth of -12m to 16m and 36m to 38m. At BM.II, the upper layers consist of silty clay or clay and the N values are relatively low. At about DL-59m there exists clayey stone layer.

(2) Banjarmasin (Near Public Port Site)

41. At BM.I, the upper layer is fine sandy clay and the lower layer is clayey to fine sand and the N values are relatively low. The layer between 4m – 22m below LSL formed silty loam layer with N values from 2 to 14. At BM.III, the upper layer is clayey silt and the lower layer is clayey fine sand and the N values are relatively low. The layer between 22m – 30m below LSL formed silty sand layer with N values from 8 to 32.

(3) Selayar (Patumbukan)

42. At BM.I, the upper layer is fine, gravelly and clayey sand and the lower layer is clayey sand. The N values are relatively low up to DL-17m (N=5 – 16). At BM.II, the upper layer is medium to fine sand and the middle layer is very soft mud and the lower layers are sandy clay or clay. The layer between DL-20 to -30m formed sandy loam and loam with N values of 4 – 6. At about DL-32.5m, there exists a gravel layer with N value over 50.

(4) Labuhan Bajo

43. Both BM.I and BM.II, the upper layers are medium to fine sand with shell fragments, characteristics of which are very loose to loose with N values between 1 – 12.

Meanwhile the layer of the depth 7 – 12m from local surface level generally consist of sand layer to gravel sand and gravel clay with N value around 9 – 31. At about DL-26m, there exists an Andesite Layer with N value over 60.

(5) Wahai

44. At BM.I, the upper layer consists of mainly silt, clay and fine sand and the N values are relatively low (N=4 – 7). The layer between 6m and 20m below LSL consists of silt, silt and sand with N values 6 – 31. The deeper layer between 22m and 28m below LSL consists of loam, silt and gravel sand with N values 3 – 6. Further the depth between 28m and 30m below LSL is the layer of sandy silt to gravel sand with N values from 6 to 56. At BM.II, the upper layer is fine sand and the lower layer is silt and the N values are relatively low.

(6) Babang

45. At BM.I, the upper layer consists of gravelly sand and shell fragments with N value over 50. The middle layers are clay or silt with shell fragments and N values are relatively low. The lower layer is gravelly coarse sand and the N values show over 50 again. At BM.II, the upper layers are silt or sandy silt with shell fragments and the N values are relatively low, while the lower layers are sand or silty sand with shell fragments.

(7) Manokwari (Sowi)

46. At BM.I, the upper layer consists of mainly silt and sand with average N value of about 30. A shell fragment of one meter thickness was found at about 6 – 8m below seabed. The lower layers below DL-16m commonly are silt and sand with N value over 50. At BM.II, the upper layer is gravelly sand with shell fragment and N value is over 50, while the middle layer is silt and sand with N values between 20 – 60. The layer below DL-14m is clay and shell fragments and is very hard with N value over 50.

Table 2.6.1 Summary of Soil Investigation

No.	Site Location	Boring	Depth (DL, m)	Average N	Cohesive Soil	Non-cohesive Soil
1	Surabaya	BM. I	0 - 4	0	Soft	-
			4 - 60	33	Hard	-
		BM. II	0 - 11	1	Soft	-
			11 - 12	5	Medium	-
			12 - 60	35	Hard	-
2	Banjarmasin	BM. I	0 - 19	1	Soft	-
			19 - 22	14	Hard	-
			22 - 30	12	-	Medium
		BM. II	0 - 16	1	Soft	-
			16 - 19	5	Medium	-
			19 - 20	14	Hard	-
		BM. III	0 - 14	2	Soft	-
			14 - 24	7	Medium	-
			24 - 32	19	-	Medium
3	Selayar (Patumbukan)	BM. I	0 - 3	3	Soft	-
			3 - 12	6	-	Soft
			12 - 20	18	-	Medium
			20 - 22	60	-	Hard
		BM. II	0 - 6	3	-	Soft
			6 - 20	0	Soft	-
			20 - 27	5	Medium	-
			27 - 29	10	Hard	-
			29 - 30	50	-	Hard
4	Labuhan Bajo	BM. I	0 - 7	3	-	Soft
			7 - 19	12	-	Medium
			19 - 30	57	-	Hard
		BM. II	0 - 5	4	-	Soft
			5 - 11	16	-	Medium
			11 - 30	57	-	Hard
5	Wahai	BM. I	0 - 10	6	-	Soft
			10 - 14	12	-	Medium
			14 - 18	8	-	Soft
			18 - 20	31	-	Hard
			20 - 27	5	-	Soft
			27 - 30	50	-	Hard
		BM. II	0 - 6	4	-	Soft
			6 - 30	5	Medium	-
6	Babang	BM. I	0 - 3	60	-	Hard
			3 - 11	13	-	Medium
			11 - 14	12	Hard	-
			14 - 19	16	-	Medium
			19 - 22	56	-	Hard
		BM. II	0 - 7	6	-	Soft
			7 - 13	12	Hard	-
			13 - 27	18	-	Medium
			27 - 30	38	-	Hard
		BM. III	0 - 5	6	-	Soft
			5 - 14	21	-	Medium
			14 - 20	55	-	Hard
7	Manokwari (Sowi)	BM. I	0 - 7	30	-	Medium
			7 - 18	50	-	Hard
		BM. II	0 - 16	50	-	Hard
			6 - 14	35	-	Medium
			14 - 20	50	-	Hard

Notes	Cohesive Soil	Non-cohesive Soil	Remarks
N value	0 - 4	0 - 10	Soft
	4 - 8	10 - 30	Medium
	N > 8	N > 30	Hard