社会開発調査部報告書

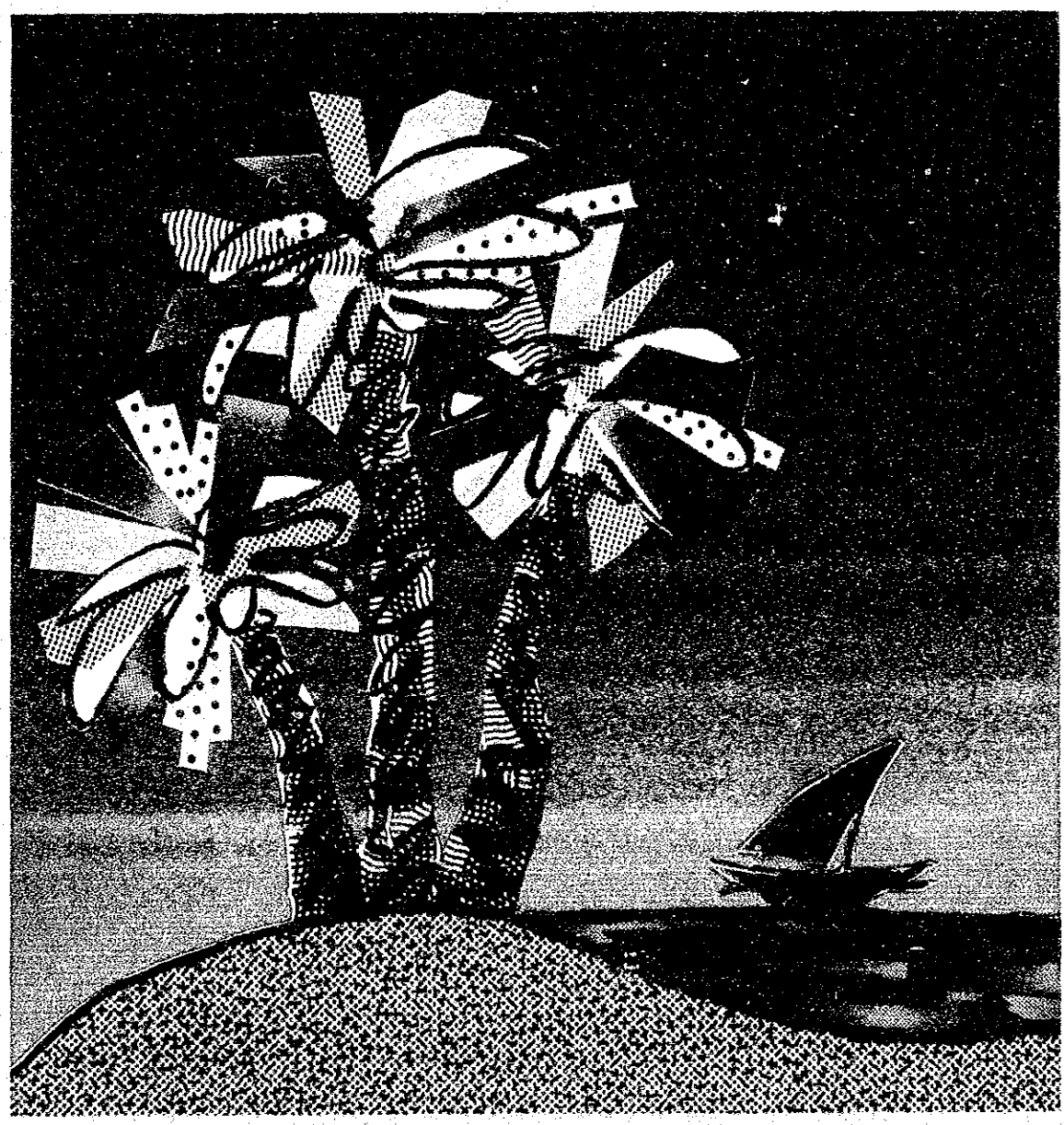
No. 153

THE KINGDOM OF THAILAND OFFICE OF EASTERN SEABOARD DEVELOPMENT COMMITTEE

THE MASTER PLAN STUDY FOR THE DEVELOPMENT OF PHATTHAYA AREA

Final Report

JUNE 1990



JAPAN INTERNATIONAL COOPERATION AGENCY

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"The Master Plan Study for the Development of Phatthaya Area, Final Report, June 1990"

THE KINGDOM OF THAILAND

THE MASTER PLAN STUDY FOR THE DEVELOPMENT OF PHATTHAYA AREA

FINAL REPORT

JUNE 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a master plan study for the Development of Phatthaya Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kingdom of Thailand a survey team headed by Mr. Teruo Yoshimatsu, Nippon Koei Co., Ltd. composed of members from Nippon Koei Co., Ltd. and Yachiyo Engineering Co., Ltd., on several occasions between June 1989 and March 1990.

The team held discussions with concerned officials of the Government of the Kingdom of Thailand, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned, of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

June, 1990

Kensuke Yanagiya

President

Japan International Cooperation Agency

MASTER PLAN STUDY
FOR
THE DEVELOPMENT OF PHATTHAYA AREA

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

June 1990

Dear Sir,

Letter of Transmittal

We are pleased to submit herewith the Final Report for the Master Plan Study for the Development of Phatthaya Area. This Report proposes the development framework and integrated development plan toward 2006 for the sound and sustainable growth of the Area and for contributing to the national economy as an internationally well-reputed resort and the center of the Eastern Seaboard region.

The Report presents priority projects and their implementation plan as the solution to the prevailing problems in Phatthaya at present with the target year of 1996. The Report also presents legal, institutional and financial recommendations with a view to bringing the proposed integrated development plan and the priority projects into reality.

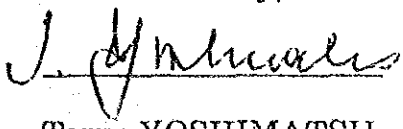
The Report comprises :
- Main Report (English)
- Summary Report (English)
- Summary Report (Japanese)

The Summary Report briefs the findings, plans and recommendations made in the Study. The Main Report contains full description of the Study results including findings, analyses, projections, plans and recommendations.

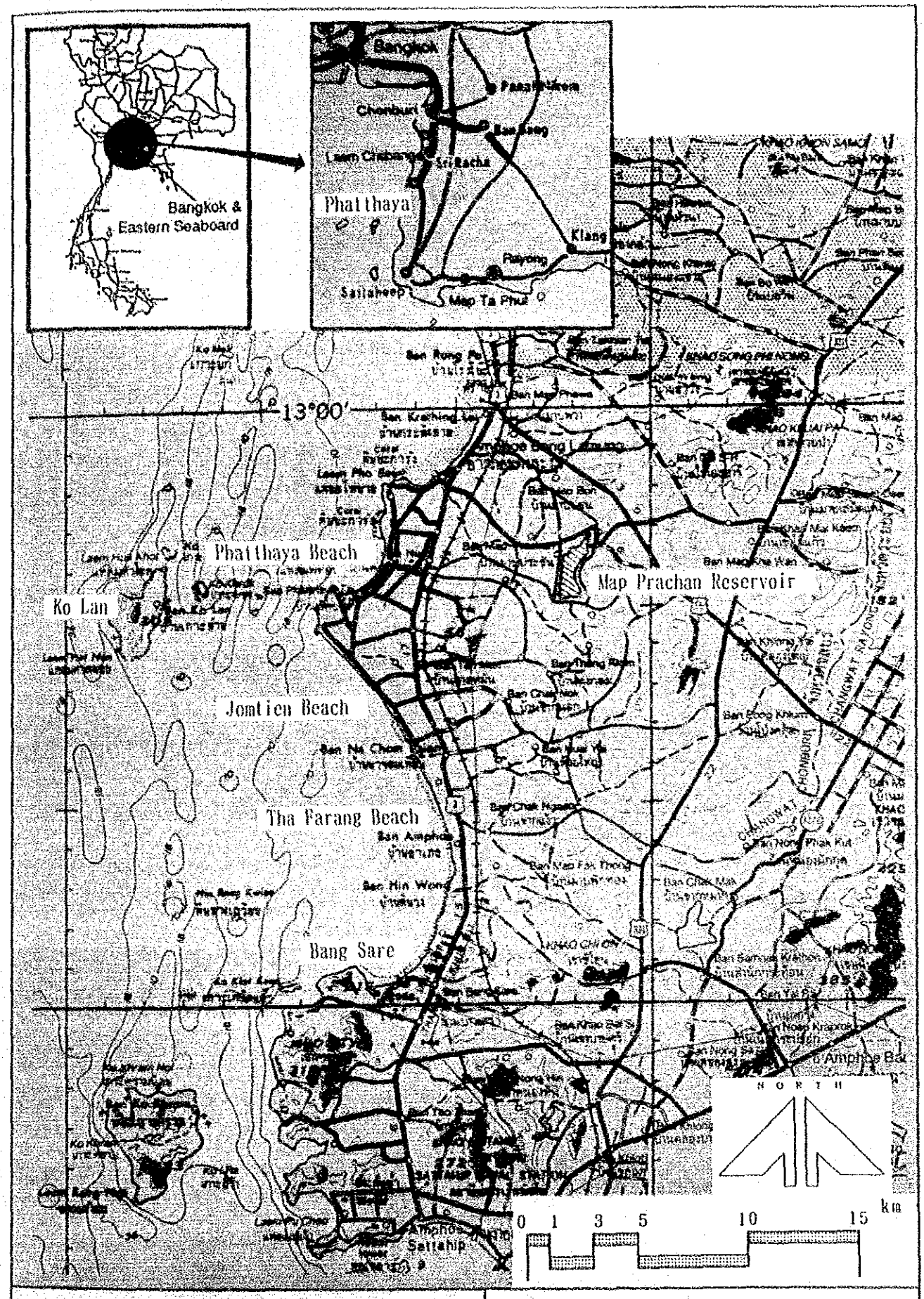
The Study Team would like to express sincere gratitude to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, Ministry of Transport and Embassy of Japan to the Kingdom of Thailand, as well as Steering Committee and Working Group for the Study, Office of Eastern Seaboard Development Committee and other officials and personnel concerned, for their assistance.

The Study Team sincerely hopes that the Study results will contribute to the development and public welfare of the Phatthaya Area as well as to the enhancement of the national economy of Thailand.

Yours sincerely,



Teruo YOSHIMATSU
Team Leader



THE MASTER PLAN STUDY FOR THE DEVELOPMENT OF PHATTHAYA AREA

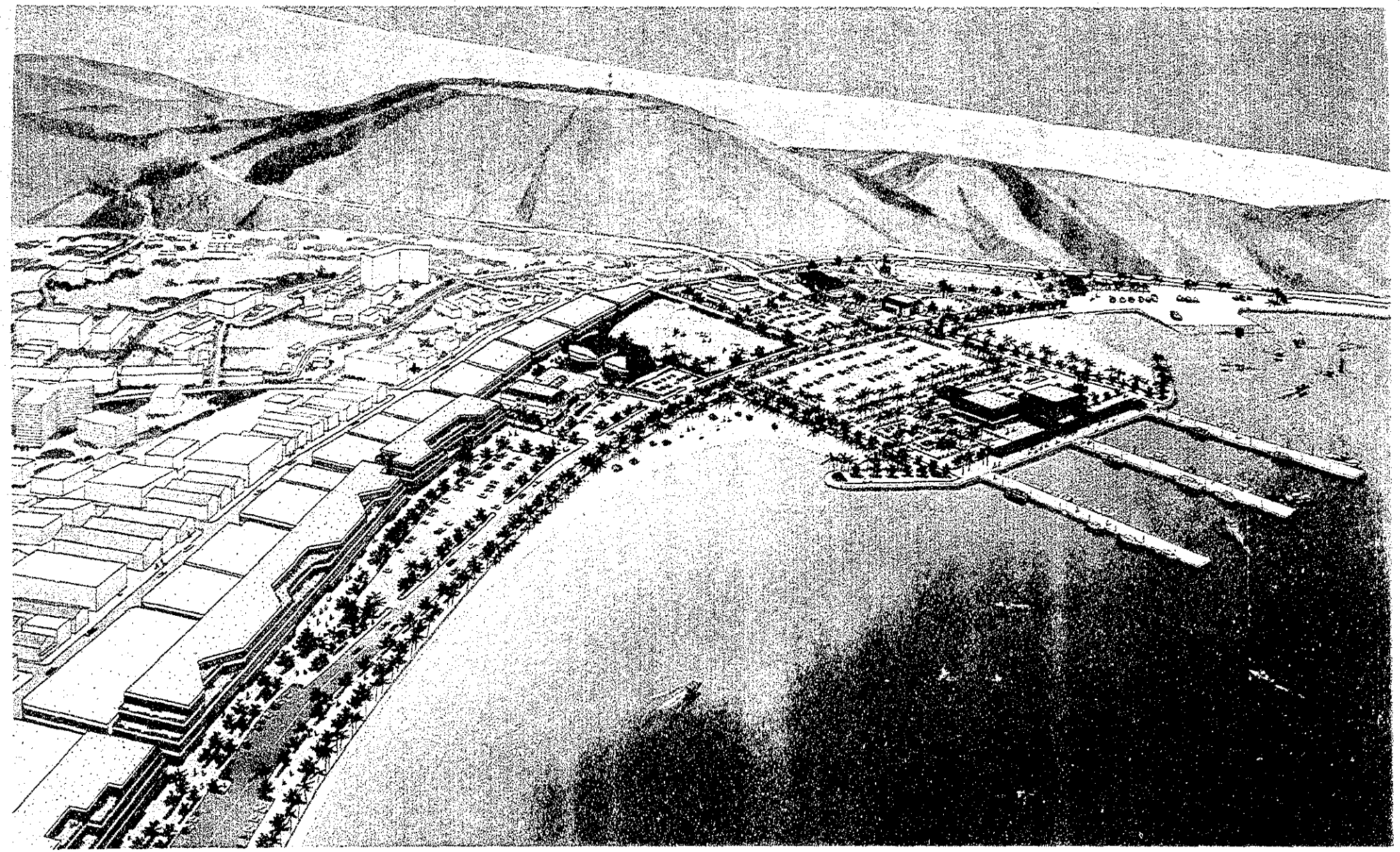
Study Area

(Area covering Phatthaya Municipality including Ko Lan and its southern coastal area down to Bang Sare)

A View of Study Area (From Phatthaya hill)

Phatthaya Beach

Water Contamination is serious in southern part of Phatthaya Beach



Development of South Phatthaya Land Reclamation

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LIST OF TABLES

LIST OF FIGURE

ABBREVIATIONS

Governmental Offices and Agencies

CAT	:	Communication Authority of Thailand
DOH	:	Department of Highway
DOLA	:	Department of Local Administration
DTCP	:	Department of Town and Country Planning
EGAT	:	Electricity Generating Authority of Thailand
HOD/HD	:	Harbour Department
IEAT	:	Industrial Estate Authority of Thailand
LD	:	Land Department
MOAC	:	Ministry of Agriculture and Cooperatives
MOC	:	Ministry of Communications
MOF	:	Ministry of Finance
MOI/MOINT	:	Ministry of Interior
MOIND	:	Ministry of Industry
NEA	:	National Energy Administration
NEB	:	National Environmental Board
NESDB	:	National Economic and Social Development Board
NHA	:	National Housing Authority
OESB	:	Office of Eastern Seaboard
PCH/PCG	:	Phatthaya City Hall
PEA	:	Provincial Electricity Authority
PWA	:	Provincial Waterworks Authority
PWD	:	Public Work Department
RID	:	Royal Irrigation Department
RTG	:	Royal Thai Government
TAT	:	Tourism Authority of Thailand
TOT	:	Telephone Organization of Thailand
JICA	:	Japan International Cooperation Agency

Others

BMA	:	Bangkok Metropolitan Area Bangkok Metropolitan Administration
BMR	:	Bangkok Metropolitan Region
ESB	:	Eastern Seaboard Development Committee
APCA	:	Administration of Phatthaya City Act

Abbreviation of Measurements

Length	mm	:	millimeter
	cm	:	centimerter
	m	:	metre
	km	:	kilometer
Area	sq cm	:	square centimeter
	sq m	:	square metre
	sq km	:	square kilometer
	km^2	:	square kilometer
Volume	l	:	liter
	cu m	:	cubic metre
	MCM	:	million cubic metre
Weight	mg	:	Milligram
	kg	:	Kilogram
	T	:	Tonne (metric ton)
Time	s	:	second
	min	:	minute
	h	:	hour
	d	:	day
	y	:	year

Derived measures

m^3/s	:	cubic metre per second
cu m/s	:	cubic metre per second
cu m/h	:	cubic metre per hour
cu m/d	:	cubic metre per day
MCM/y	:	million cubic metre per year
lcd	:	litre per capita per day
mg/ℓ	:	milligram / liter (ppm)
%	:	per cent

Others

BOD	:	Biochemical Oxygen Demand
RBC	:	Rotating Biological Contactor
O&M	:	Operation and Maintenance
F/S	:	Feasibility Study
D/D	:	Detailed Design
HWL	:	high water level
LWL	:	low water level
MSL	:	mean sea level
AMSL	:	above mean sea level
v	:	volume
q	:	discharge

Electrical measures

V	:	volt
A	:	ampere
Hz	:	hertz (cycle)
W	:	watt
kW	:	kilowatt
MW	:	megawatt
GW	:	gigawatt
kWh	:	kilowatt hour
kVA	:	kilovolt ampere
MVA	:	megavolt ampere

1. INTRODUCTION

1.1 Background of the Study

The Government of Thailand aims at establishing a semi-industrialized country during the Sixth National Economic and Social Development Plan (1986/87-1991/92) mainly through export promotion, foreign exchange earning and improvement of economic efficiency. In line with this policy, the Government has launched a national development plan for the "Eastern Seaboard (ESB) region" as a priority area in order to solve the problem of excess accumulation of population and industrial activities in the Bangkok Metropolitan area as well as to rectify the regional economic imbalance. The tourism industry, the single highest foreign exchange earner in the Thai economy, has been growing rapidly attracting 4-2 million foreign tourists in 1988 after a vigorous campaign "Visit Thailand Year" in 1987.

Phatthaya is the second biggest tourist destination in Thailand only next to Bangkok. In 1987, 1,417 thousand tourists visited Phatthaya out of which 1,012 thousand were from overseas. Phatthaya also has come before the footlight as the natural center of the growing ESB region for research, commercial and business activities as well as for residential development. Its development has been accelerated in these years as the development of Laem Chabang and Map Tha Phut were set on their ways. However, due to the lack of proper regulation and guidance for land development and use and inadequate provision of infrastructures, problems including water supply, water pollution, traffic congestion and disorderly land development arose and are becoming acute.

In 1978 and 1979, JICA (Japan International Cooperation Agency) conducted Phatthaya Infrastructures Development Master Plan and Feasibility Study ("Previous JICA Study"). Many projects and measures proposed by the Previous JICA Study, however, are yet to be implemented. After 10 years, various problems arose and development environment has significantly changed. New roles and functions including the role as multifunctional area and regional center of ESB region are needed in the Phatthaya Area also.

Considering the above, the Government of Thailand reached the conclusion that a master plan study should be conducted for the development of Phatthaya Area and made a request to the Government of Japan for the Study. In response to the request,the Government of Japan dispatched a JICA preliminary study team and agreed on the Scope of work on the Study on December 20th, 1988.

1.2 Objective and Study Area

1.2.1 Objective of the Study

The objective of the Study is: "to formulate a master plan (target year 2006) for the development of Phatthaya Area with a view to promoting social and economic development of the Area, considering the radical development in recent years."

1.2.2 Study Area

Study Area is defined basically as "the area of Phatthaya City including Ko Lan and its southern coastal area down to Bang Sare" as defined by the Scope of Work (SW).

However, from the viewpoint of improving unbalanced distribution of economic activities, particularly the excessive concentration of activities in coastal area, a need arose to look into areas outside the study area as defined by the SW, especially the hinterland area of Phatthaya.

Considering this situation, the Study Team has dealt with development issues outside the Study Area flexibly and to the extent possible. In the event that analysis was made for an area outside the Study Area, the area for analysis was determined considering direct influence of Phatthaya and also needs and characteristics of each sector.

The following list shows areas to be covered or considered by the Study for each sector.

Category A : Inland boundary is approximately 500 meter from Sukhumvit highway to the east.

Category B : Areas covered by category A plus areas further to the east.

Category C : Area including these under categories A and B plus ESB region as well as BMR.

Sector	Planning Boundary	Planning Horizon
Regional development plan	C	
Land use plan	A	
Tourism plan	B	(C)
Tourism facilities plan	B	
Legal, organizational and financial aspects	C	
Demand forecast	A	(C)
Transport plan	A	(B)
Stormwater drainage	B	
Water supply plan	B	
Sewerage plan	A	
Coastal and sea use plan	A	
Public facilities plan	A	(B)
Environmental aspect	A	(B)
Socio-economic aspect	A	(C)
Low income housing	B	

2. PHATTHAYA TODAY

2.1 Introduction

The situation of Phatthaya today is critical. There is no disagreement among concerned people on this matter. Water supply shortage has been so serious that many hotelliers have resorted to buy water from venders bringing in water by trucks. Many of them are resigned enough to advise their guests not to swim in the beach because of high level of pollution. Crime and traffic congestion are also often cited as unpleasant characteristics of Phatthaya city. Some have even started talking about the decline of Phatthaya as an international resort.

The situation is indeed serious as presented in this Chapter. It is, however, not at all without hope. Tourists themselves seem to have more optimistic attitude than hotel liers or travel agents. Present conditions of Phatthaya in the latter half of 1989 were surveyed. Problems were identified and their cruise were sought. This chapter presents the results of examinations on Phatthaya today.

2.2 Natural and Physical Settings

2.2.1 Geography and Natural Conditions

1) Topography

Topographical features of the whole study area may be characterized by two parts. Those are, the beach are namely Phatthaya town, Jomtien and southern beach, and the upland area in Ong Phra hill.

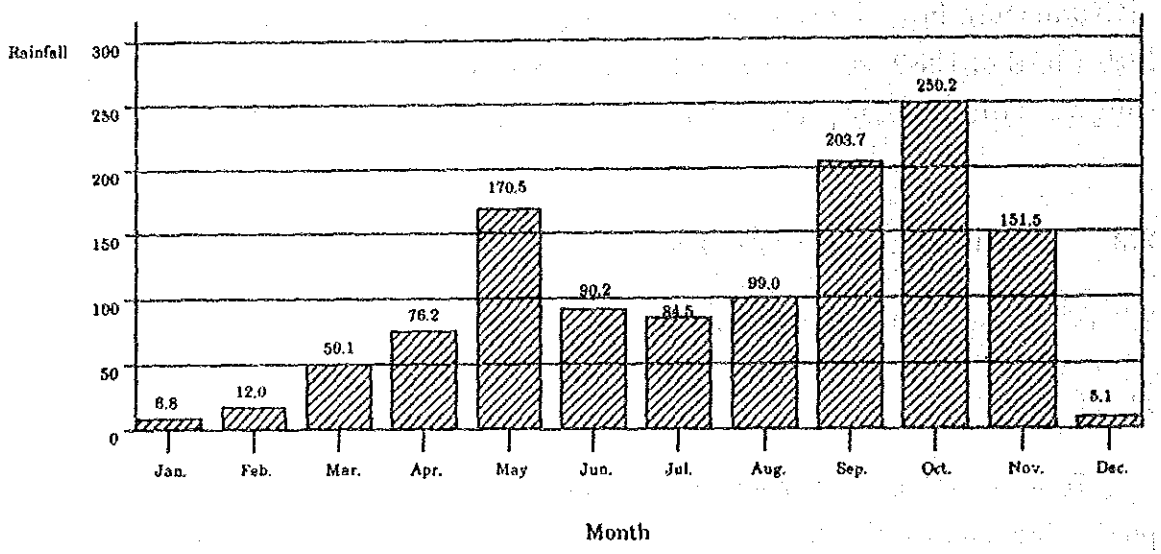
The beach area is generally flat with gentle slope extending from its hinterland to seashore. However, narrow strip of flat land, elevation of 5m or less, is formed along the seashore and is slightly higher than its hinterland. The town and developed areas are grown on the strip of land.

The upland area is located in the south of Phatthaya town and is jutted to into the sea with a plain sloping from top of Ong Phra hill (about 100m above the sea level) to the sea.

The area behind the flat land along seashore forms the lowlands where swamps are distributed in some places. The lowlands have a function of temporary retardation ponds for rain water coming down from the uplands. Behind the lowlands, Sukhumvit road and railway on raised embankment run generally parallel to beach line. These also have a function of like levee for flood from the uplands.

2) Climate

The study area is in a tropical forest zone with the climate divided into dry (December - April) and wet (May - November) seasons. Eight years records of an observation station in Phatthaya present information about rainfall as shown in the figure below.



Monthly Mean Rainfall (PHATTHAYA)
[unit: mm/month]

The annual average rainfall is about 1200 mm, ranging from 815 mm to 1630 mm, of which more than 80% of annual rainfall occurs during wet season. The amount of rainfalls in Phatthaya is somewhat less than other areas in Thailand.

The annual average temperature is around 27 degrees C, highest in April and lowest in December with small difference from the average.

Typhoons, in most cases, originate in South China Sea during June to December and pass through the northern part of Thailand from June to

September and its southern part from October to December. The east coast of Gulf of Thailand has seldom suffered from the damage of typhoon.

The average wind velocity ranges from 2.5 m/s to 7.0 m/s with the direction of south-westery from May to September, and northery and north-eastery from October to January.

3) Geology

The beach and estuarin deposit being mainly composed of sand forms a seashore dune on which developed and southern beach areas are built. Behind the seashore dune, the alluvium deposit ranges in low land area. Ong Phra hill is mainly composed of granite, extending to form an inland terrace.

2.2.2 Land Use and Sea Use

1) Land Use

The total area of Phatthaya City is 50.29 km^2. Areas by land use types in 1987 are shown in Table 2.2.1 and Fig. 2.2.1. As for the land use classification, it is indicated that 75.2% are for agricultural area; 10.7% for residential area; 5.3% for commercial area; 3.4% for transportation route; 1.4% for religious area and 1.1% for open-space. But, actually, the agricultural areas are mostly unused, and perhaps, already committed for sale for other use in the future.

In particular, many commercial and business facilities, such as hotels, condominiums, shop houses and offices are located in the seaboard. Commercial facilities, like shop houses are concentrated in the both sides of main roads which include "Phatthaya Beach Road", "Phatthaya 2nd Road", "Na Klua Road", "Central Phatthaya Road" and "South Phatthaya Road".

There exist many private investment activities from Phatthaya City to Bang Sare. Especially construction of hotels, condominiums and so on, spreads along the seaboard. A great change of land use in some areas took place between 1987 and 1989. Indeed, not only the areas along the main roads, but also some of the inland areas have been the subject of the high-pace construction rush of hotels, condominiums, shop houses and so on. Consequently disorderly land development has been in progress; urban sprawl has rapidly progressed; and many ponds and swamps which provide the water storage function are disappearing by landfill.

Although the construction rush of hotels and condominiums spills over the southern boundary of Phatthaya City toward Bang Sare, there still exist much more "open-spaces" as well as "rural and agricultural areas" in this area than in the Phatthaya City.

Generally speaking, in the inland area, east of Sukhumvit Road, housing estates and condominiums are under construction within about 1 km from Sukhumvit road; but, the areas further east of Sukhumvit Road still remain mostly as open-space or rural and agricultural areas.

The study area can be divided into seven sub-areas, each with distinctive landuse characteristics. Figure 2.2.2 shows the subareas. The following is an overview of existing landuse characteristics of the subareas.

(1) Phatthaya Beach Area

Na Klua Town Zone:

It is bordered by the northern boundary of Phatthaya City, Soi Na Klua 13, and Sukhumvit road. An old downtown with Na Klua market as its core exists. The majority of residents are found on the banks of Na Klua river and the vicinity. In addition, many squatters reside around swamps near the sea.

Industrial establishments such as tapioca factories, repair shops for vehicles, furniture factories, sawmills as well as building materials factories exist along the western side of Sukhumvit road. In between such establishments, there are Djittabhawan college, temples, schools, and public facilities, like a tax office, a fire station and a police station.

North Phatthaya Zone:

With boundaries of Soi Na Klua 13, Central Phatthaya Road and Sukhumvit Road, this zone contains many tourist facilities, such as hotels, restaurants, souvenir stores, which are concentrated in the southern beach front part, enclosed by Beach Road and Phatthaya 2 Road.

Along both sides of Central Phatthaya Road, a series of shop houses is formed. Currently, high grade commercial facilities and business facilities are under construction or planning.

In addition, the construction of housing estates and shop houses is being extended to the inner areas from main roads in this zone.

South Phatthaya Zone:

Its boundaries consist of Central Phatthaya Road, Tappraya Road, Thep Prasit road and Sukhumvit Road. There are hotels, restaurants, beer-bars and night clubs concentrated along Beach Road and Phatthaya Road in this zone. It features the night tourism of Phatthaya. Again, the construction of residential units and shop houses is extended to the inner areas of this zone.

(2) Khao Phatthaya Area

Its boundaries consist of Tappraya Road, and the coastal line. It has hotels of top class; is very near to the downtown of Phatthaya City but keeps well its own neatly isolated characteristics providing beautiful beaches. It is fit for being honored as an international resort.

(3) Jomtien Beach Area

Its boundaries consist of Thep Prasit Road, and the southern boundary of Phatthaya City, and Sukhumvit Road. A construction rush of hotels, condominiums and shop houses is now found along Jomtien Beach Road.

Still, many open-spaces remain in the inner areas within a distance of 100 to 200 meters from Jomtien Beach Road.

(4) Tha Farang Beach Area

It belongs to the western part of Sukhumvit Road, the northern and southern boundaries are formed with Phatthaya City and Ban Hua Hin respectively. There are some scattered hotels, condominiums and housing estates along the shore, under the conditions of either having been constructed, or being constructed. The remaining part is entirely of "open-space" or "rural & agricultural area".

(5) Bang Sare Area

It is the southern most part of the planning area of the Study Area. The fishery villages in Bang Sare is the core of this area. At present, DTCP prepared a Sanitary District Plan for this area. Accordingly, its

residential and commercial activities are all concentrated in the fishery villages of Bang Sare. In addition, in the eastern side of Sukhumvit Road are found scattered housings.

(6) Ko Lan Area

It is Ko Lan Island itself; and has beaches of Ta-Van, Tien, Sa Mae and Nuan. Currently, Nuan beach has the Hotel Koh Larn Island Resort. And Hotel Island Inn, which is located at a distance of 400 meters south of Bang Ko Lan, is under expansion work of its buildings.

The whole island well conserves natural conditions except in the vicinities of Nuan Beach's hotel and Bang Ko Lan.

But, Ta-Van beach, the main beach, contains many shop houses, and is inevitably disordered. On the other hand, there are less shop houses in Tien beach, and accordingly, the beach still keeps its calmness.

(7) Inland Area

This is the area east of Sukhumvit Road. Residential areas, shop houses and factories are currently concentrated within about 1 km from Sukhumvit Road. The area beyond about 1 km from Sukhumvit Road is almost entirely of "open-space" or "rural & agricultural area", except for scattered villages.

2) Beach and Sea Use

(1) Introduction

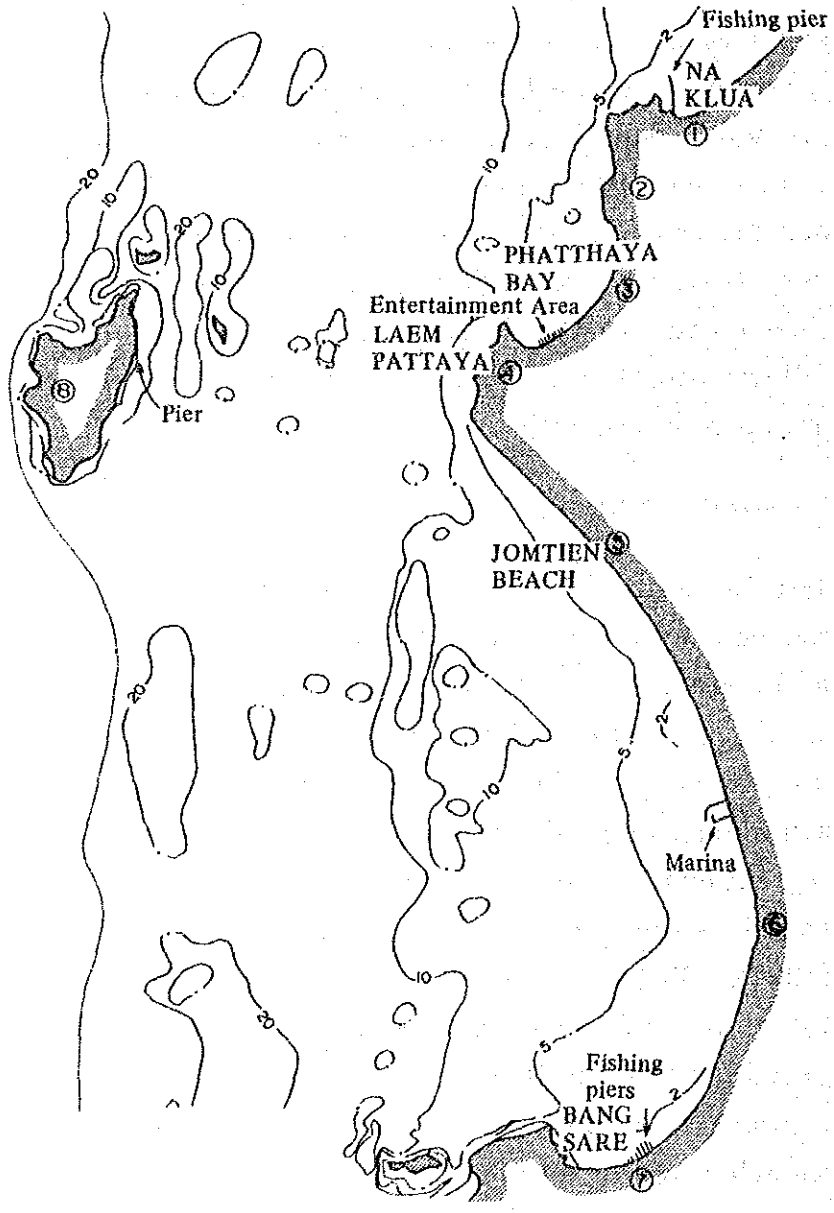
Beach and sea use at Phatthaya today is dominated by tourism and recreation, with commercial fishing now restricted to the north and south limits of the study area. Phatthaya has developed from a small fishing port to its present position as a major tourist resort in a brief period of 30 years, during which rapid development has taken place. Intensive land development without effective planning controls has had an adverse effect on the coastline and beaches, creating immediate problems and also others with serious long-term effects. An immediate problem recognized by the authorities and beach users is the utilization of the sea by an increasing number of visitors which leads to conflicts between various activities, poor safety conditions and risk of serious accidents. Another problem, with long-term consequences which are not yet sufficiently recognized, is encroachment of construction on to the beaches causing permanent loss of beach sand and coastal erosion. The very features which first attracted visitors to Phatthaya are thus threatened. In the description of existing beach and sea use which follows, attention is drawn to areas where such problems already occur or appear imminent.

(2) Existing Conditions

Within recent years leading to the current situation at Phatthaya, there has been a steady increase in the use of beach and sea areas for tourism and recreation. Phatthaya originally was a small fishing village at the south corner of Phatthaya bay. Its development as a recreation area led progressively to the use of the north and central parts of the bay by swimmers, and sailing and powered craft for sea sport. Fishing and recreational activities co-existed, and conflicted, for some years. This was the situation prevailing at the time of the JICA Master Plan Study (1977). Since then there has been a gradual separation of these two functions. A fishing pier was built at Na Klua in 1983. Fishing vessels previously at Phatthaya have moved to Na Klua and activities at Phatthaya are now mainly recreational. The current situation is that the whole of the mainland study area, except at Na Klua and Bang Sare at the north and south extremities respectively, is used for recreation – swimming, water sports and excursion trips. These activities have

spread from Phatthaya to Jomtien and further south. Ko Lan also is primarily an island for recreation. The fishing industry operates from Na Klua and Bang Sare, and at both these locations there are small boat-repair and boat-building yards.

The Study Area:- The study area extends from Na Klua to Bang Sare, a total distance of 34 km measured along the coastline. Also included is Ko Lan island, 9 km west of Phatthaya. The study area is divided into sub-areas for describing beach and sea use, which are indicated on the figure below.



① Na Klua:- The nearshore area is a mudflat which is not attractive to swimmers, and Na Klua has retained its role as a fishing base. A fishing pier 850 m long which extends northwards from the coastline is used by local vessels. However, the water depth alongside at low tide is 1 m or less, which is insufficient for vessels to operate efficiently. A boat-repair and building yard, which has two slipways, is located to the west of the root of the fishing pier. This yard's principal activity is the repair of timber excursion and fishing vessels.

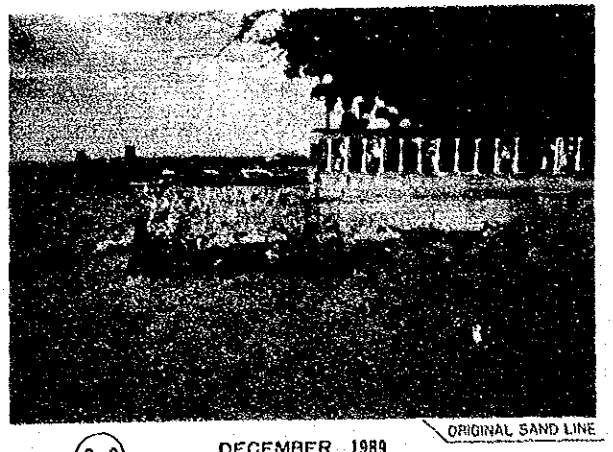
② Headland between Na Klua and Phatthaya:- This headland has one large and two small bays with narrow beaches. Buildings on the coastline are mainly small (holiday bungalows etc.) but recently a few high-rise condominiums have been built. The siting of boundary walls of new developments too close to the shoreline suggests that coastal erosion is likely to be a growing problem.

③ Phatthaya Bay and Beach:- Phatthaya bay and beach are extensively used for recreation and there is much congestion and conflict of activities - which are sunbathing, swimming, various water sports and departing for, or returning from, excursion trips. The boats in the bay are mainly excursion vessels, speed boats, water scooters and pedal boats. (Sailing yachts and surf boards have largely moved south towards Jomtien.) The Phatthaya "entertainment area" comprising restaurants, bars and night clubs is at the south end. It is built over the water on timber piling. Other structures are simple timber piers and small concrete boat ramps, but there is no proper facility for berthing of the large number of excursion vessels. Visual inspection indicates that the beach is eroding in South Phatthaya in front of a restaurant terrace which encroaches on to the beach, and generally along the sea wall in front of the Phatthaya Beach Road/South Phatthaya Road junction (see photographs 2.1 to 2.3).

④ Laem Phatthaya:- South of the tip of the headland there are three small beaches used by wealthier visitors staying at the Royal Cliff and other hotels or private beach houses and by members of the Royal Varuna Yacht Club. This area has good sea breezes and is favoured by sailing yachts and wind-surfers.

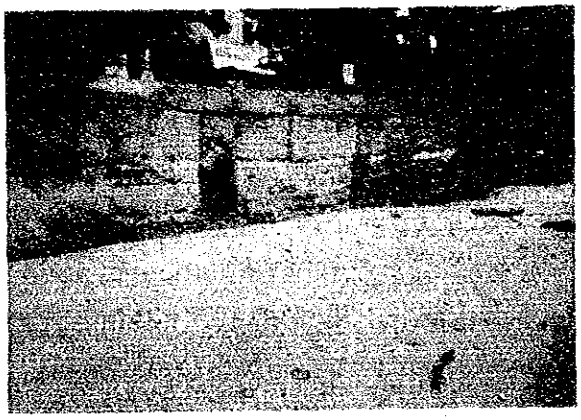
⑤ Jomtien Beach:- Development, which now extends about 7½ km along the coast, consists of hotels, bungalows, high and low rise condominiums,

(2.1) JULY 1989



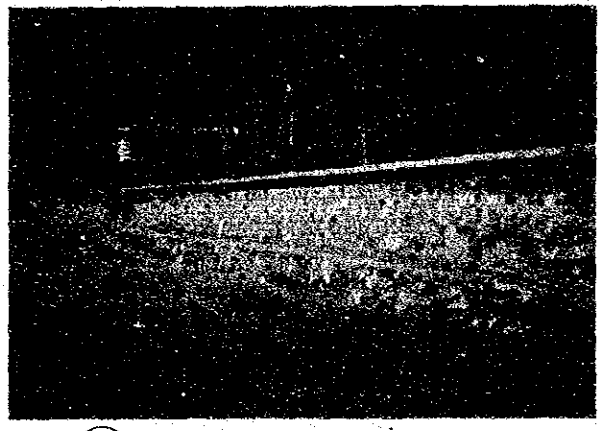
(2.2) DECEMBER 1989

SOUTH PHATTHAYA



(2.3) JULY 1989

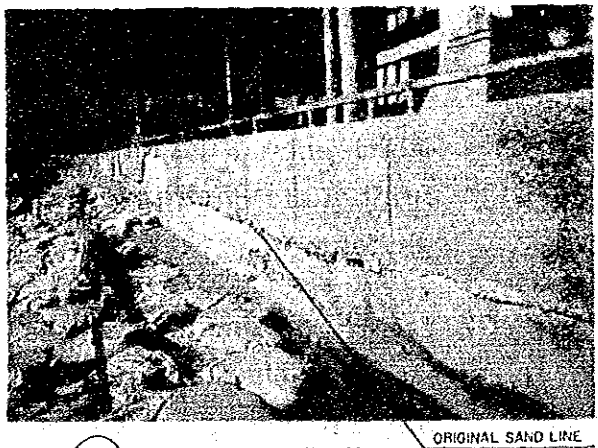
SOUTH PHATTHAYA



(2.4) DECEMBER 1989

SOUTH JOMTIEN

(2.5) JULY 1989



(2.6) DECEMBER 1989

AMBASSADOR CITY

COASTAL EROSION IN STUDY AREA

shops, etc. Swimming and water sports are the main activities. At the north end of Jomtien at Phatthaya Park, trees have been planted and beachside facilities spaciously laid out. A short distance south there is still a beach of adequate width with some vegetation cover. Progressing along the coastal road, however, developments appear to be following those at Phatthaya, in that the coastal road and sea wall have been constructed too close to the shore, storm waves will be reflected and erosion with loss of beach sand will follow. Early signs of this are already evident at the south end of the coastal road (see photograph 2.4). The coastal road stops just north of a tidal inlet at Ban Pak Khlong.

⑥ Coastline between Jomtien and Bang Sare:- This area (Tha Farang Beach) is now being developed but, as there is no coastal road, it is relatively unspoilt with irregularly spaced new developments and old fishing settlements. Most of new structures are set back from the shore, with three exceptions – the Ambassador City Hotel Complex, a privately owned marina for sailing yachts and powered boats comprising a small harbour basin (capacity 700 vessels) protected by two breakwaters, and a small beach resort with timber/thatch cottage accommodation. The terrace of the Ambassador City Hotel is the most serious example of construction encroachment causing coastal erosion observed in the study area. Photographs 2.5 (28 July 1989) and 2.6 (11 Dec. 1989) illustrate the major change which occurred in less than 5 months.

⑦ Bang Sare:- This is a fishing village pursuing its traditional role with limited, simple facilities for visitors. Boats can be hired for fishing or scuba-diving. Fishing vessels operate from four main timber/concrete piers about 250 m long and a number of smaller ones. A small boat-repair yard serves some of the local vessels.

⑧ Ko Lan Island:- This island is the popular destination for day-trips from Phatthaya, attracting visitors by its relative tranquility, white sandy beaches and coral reefs. Most activities are beach and sea-oriented. They include swimming, snorkelling, scuba-diving and viewing the coral reefs from glass-bottomed boats. Environmental damage to the coral reefs has been reported by careless casting of vessels' anchors, solid waste, oil and grease discharged by boats, illegal collection of coral pieces as souvenirs or (in the past) use of explosives for fishing.

The popular beaches (Ta Van, Tien and Sa Mae) are on the west side of the island, but there are no piers here for passenger embarkation and disembarkation. The only fixed facility is a concrete pier 110 m long on the east side which is of inadequate length for access at low water. Ko Lan is the home port for some of the excursion vessels operating from Phatthaya.

Summary of Current Beach and Sea use
● Fishing, boat repair and boat building at Na Klua.
● Recreational use (swimming and water sports) of about 28 km of coastline extending from just south of Na Klua through Phatthaya Bay to the south end of Jomtien beach. Excursion vessels within this area operate from Phatthaya Bay.
● Isolated recreational facilities south of Jomtien
● Well established fishing centre at Bang Sare
● Recreational use (swimming, water sports and coral viewing) at Ko Lan

(3) Institutional Arrangements

Three bodies are responsible for regulation and control of beach and sea activities, and marine matters generally, at Phatthaya - Harbour Department, Phatthaya City Administration and Marine Police.

The Harbour Department is responsible on a national basis for marine matters. In the context of Phatthaya the significant duties are protection of the marine environment, registration and licensing of boats and crew, approval of structures extending from the shoreline and of scheduled passenger services. The study area is controlled by a new sub-office in Phatthaya, opened in 1988, which reports to Harbour Region No. 6 at Chachoengsao. Phatthaya sub-office carries out inspections for the above-mentioned matters – its principal concerns are safety checks on boats and structures and inspection of lifesaving equipment. Particular attention is paid to passenger – carrying commercial vessels. The office does not own a boat, has a limited budget and few staff, and thus is hampered in its inspection duties.

Phatthaya City Administration (acting through the Coast Guard) is responsible for zoning and control of beach and sea areas allocated to various activities (see Fig. 2.2.3) – swimming, water sports involving

boats, mooring of boats and passenger transfer. The current regulations were issued in 1984. The administrative departments of PCA are also concerned with construction approval of marine structures (following approval in principle by the Harbour Department). Marine structure design is carried out by PWD on behalf of PCA. PCA's jurisdiction is restricted to the administrative boundaries of Phatthaya from Na Klua to Jomtien, and Ko Lan. The Coast Guard (employed by the City Administration) enforce the zoning regulations, provide sea rescue services and general assistance to sea users. The Coast Guard has 17 employees and 5 small boats.

The Marine Police, which is part of the national police department controlled by the Ministry of Interior, is responsible for policing infringements of the law and for the security of all sea users. The Marine Police has 20 staff, two medium sized boats and one small boat.

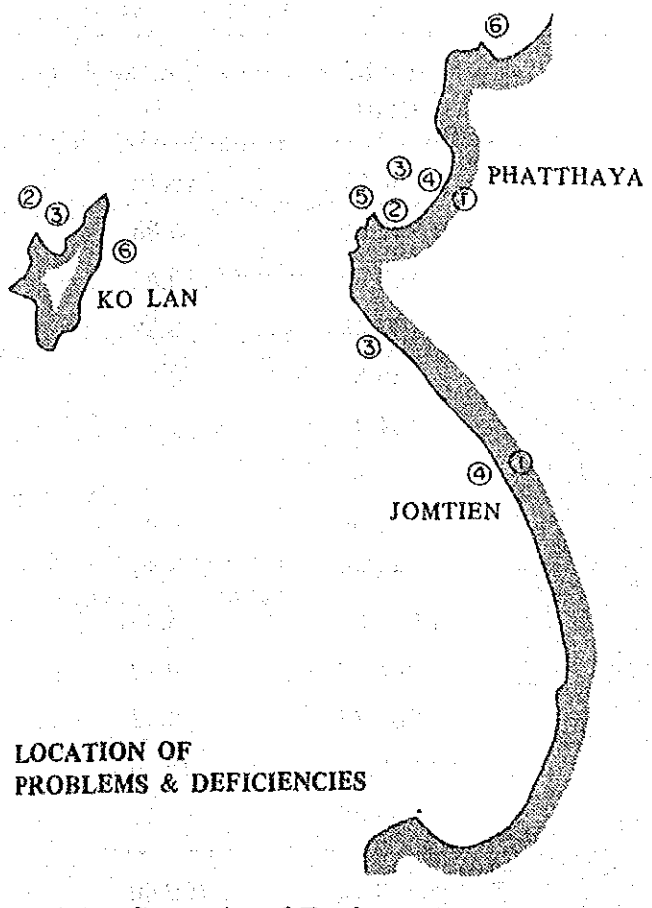
(4) Current Problems and Deficiencies

Generally
- Encroachment of construction beyond the natural shoreline, interfering with the beach's natural coastal protection function and leading to erosion (examples – at South Phatthaya, south end of Jomtien beach road, Ambassador City Hotel - see photographs 2.1 to 2.6)

Phatthaya
- Overutilisation of sea areas within the bay and ineffective demarcation between activities, leading to severe congestion, potential conflict and risk of accidents. Problems are compounded by excursion boats embarking, disembarking and transferring passengers via the beach.
- Lack of convenient, efficient and safe fixed facility for embarking and disembarking passengers arriving or departing by sea on excursion boats and other vessels
- Narrow beach which appears to be eroding progressively – insufficient space for relaxation and recreation
- Lack of waterfront land in south Phatthaya for a coastal road, promenade and essential facilities. Waterfront

	occupied by unauthorised piers, restaurants etc. of entertainment area
Jomtien	• Rapid development with inadequate planning and control which could result in similar problems as at Phatthaya – both on the beach and sea surface
	• No provision for promenade, tree-planting or other coastal vegetation at south end of beach road
Na Klua	• Pier of insufficient length for fishing vessels to operate efficiently
Ko Lan	• Lack of facilities for passenger embarkation and disembarkation – no piers on west side of island and pier of insufficient length (unsuitable at low tide) on east side
	• Risk of damage and degradation to coral reefs and beach pollution, as tourist activity increases
Regulation and Control	• Limited powers of enforcement and inadequate penalties for breaches of marine use zones and safety regulations.
	• Lack of effective action by building control authorities to prevent construction encroachment on to the beaches which causes coastal erosion.
	• Inadequate equipment and financial resources for effective supervision and control of marine activities.

The figure below shows the location of the principal physical problems and deficiencies.



Key

① Encroachment & Erosion

② No piers for excursion boats

③ Congestion of sea area

④ Narrow beach

⑤ No terminal for passenger sea transport

⑥ Pier length insufficient

(5) Committed Projects

A tourist port is to be constructed at Phatthaya, funded by an OECF loan. The implementing agency is the Tourist Authority of Thailand. The feasibility study was to commence in January 1990, followed by detailed design and construction over a total period of 45 months.

On behalf of PCA, PWD has prepared a design and cost estimate for a pier at Ta Van beach on the west side of Ko Lan Island but the execution programme is uncertain.

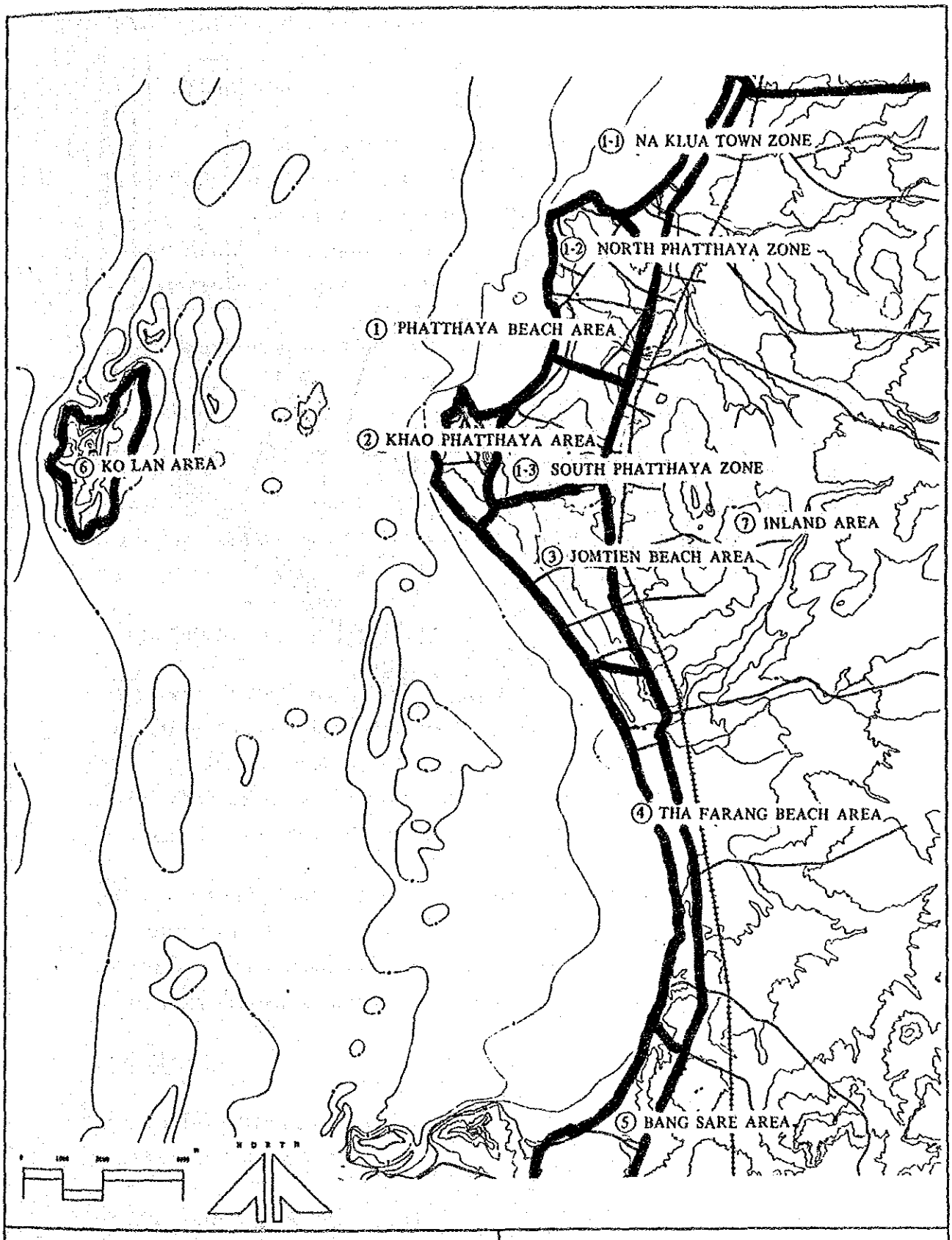
Table 2.2.1 LAND USE OF PHATTHAYA CITY IN 1987

No.	Classification of Land Use	Area (Rai)	Share (%)
1	Residential Area	3,466.87	10.72
2	Commercial Area	1,725.00	5.33
3	Institutional Area	145.62	0.45
4	Industrial Area	167.50	0.52
5	Warehouse	65.63	0.20
6	Religious Area	464.91	1.44
7	Infrastructure Area	---	---
8	Recreation Area	12.50	0.04
9	Cattle Area	45.93	0.14
10	Road	1,084.51	3.36
11	School	251.25	0.78
12	River & Canal	236.25	0.73
13	Rural & Agricultural area	24,297.15	75.16
14	Others	365.63	1.13
	Total	32,328.75	100.00

Source: Survey Division, DTCP.

THE MASTER PLAN STUDY FOR
THE DEVELOPMENT OF PHATTHAYA AREA

Fig. 2.2.1 Land Use in 1987

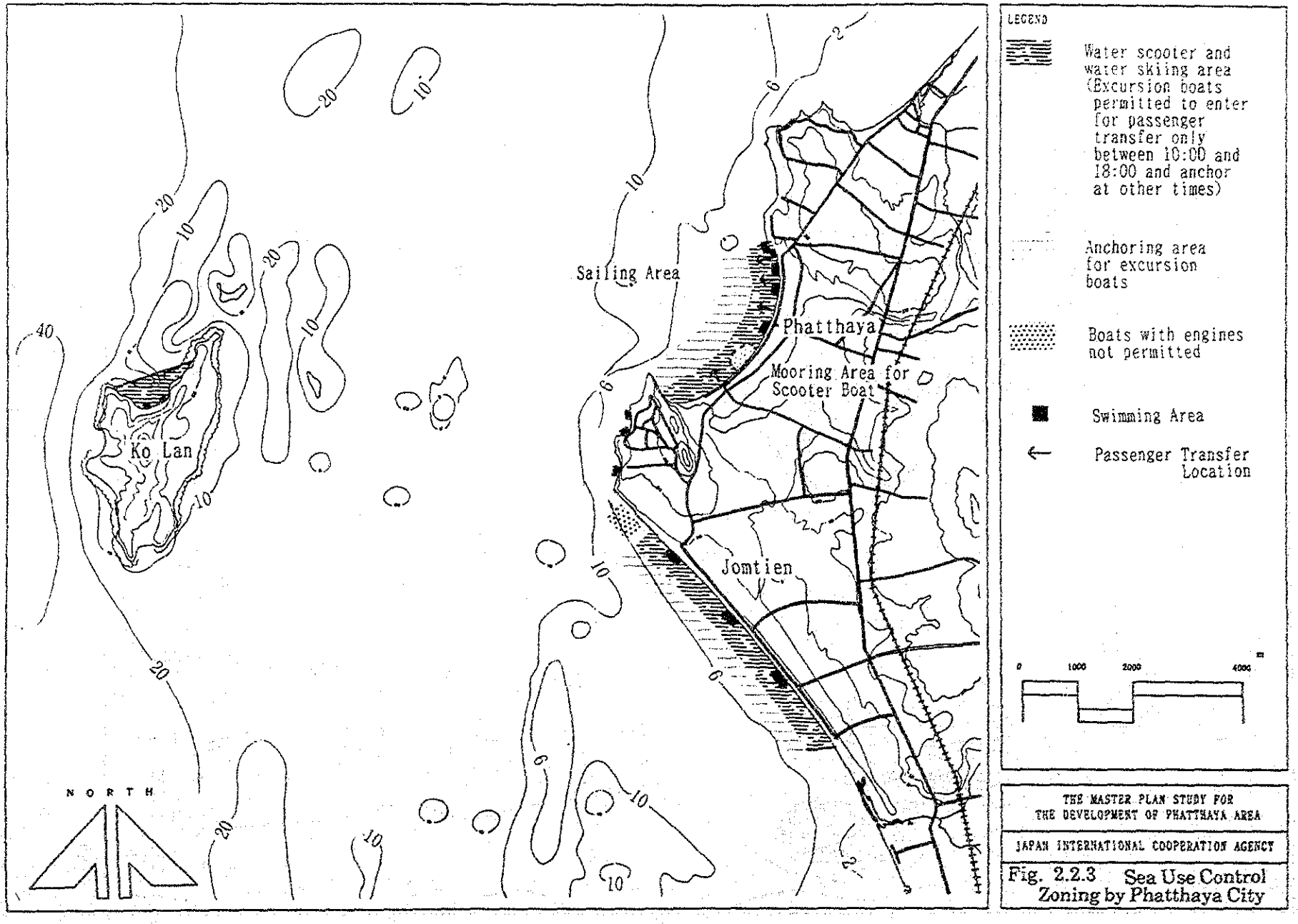


LEGEND

THE MASTER PLAN STUDY FOR
THE DEVELOPMENT OF PHATTHAYA AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 2.2.2
Zoning of the Study Area



THE MASTER PLAN STUDY FOR THE DEVELOPMENT OF PHATTHAYA AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 2.2.3 Sea Use Control Zoning by Phatthaya City

2.2.3 Environment & Water Quality

1) Urban Environment

Urban environment together with natural environment form an attractive area of Phatthaya area. Unfortunately both environments have been degraded rapidly and any visitors may observe the differences every year. Tourism growth has brought about fast urbanization in Phatthaya accompanied by pollution problem generated by human activities.

Present problems of urban environment are listed as follows:

a) Water supply:

Shortage of public water supply in Phatthaya area and lack of natural groundwater strata results in exploitation of shallow-well water regardless of its quality. Raw water of poor to moderate quality is carried by trucks and sold at 40-50 Baht/m^3.

b) Wastewater and drainage system:

Toilet waste in each household is handled by septic tank - seepage pit unit while other wastewater generated will be discharged through public drains either natural or sewer pipe. Secondary treatment for wastewater is provided by major establishments. All natural drains and sewers discharge into the sea as their only ultimate disposal, thus polluting marine ecosystem.

Lack of or inadequate proper drainage systems are known to all existing communities within the project area. Filling of lowland which used to serve as retarding basin always leads to floodings in the surrounded area. The case will be worse in urban area where drainage sewers are not yet provided.

c) Solid Waste:

Garbage collection in Phatthaya City is not capable to cover all solid waste generated within the city.

Existing Phatthaya solid waste dumping site poses severe health problems to nearby communities. Groundwater has been contaminated following the first rainy season after the site has been dumped by solid waste in 1982.

Suction tankers provided by Phatthaya City to empty septage (in septic tank) are inadequate and there are tankers "illegally" operated by private sector.

Disposal of septage are haphazard. No disposal sites are designated and the septage is frequently spread over ground of plantation areas without retaining pond provided.

d) Public Facilities:

Slaughter House: Present condition of slaughter house which belong to Phatthaya town is unhygenic and improperly managed. No treatment system is provided for wastewater generated from slaughtering process, which eventually being discharged into adjacent private land. The buildings are more than 10 years old, yet there is no piped water supply. Water is drawn from shallow wells within the premises regardless of contamination caused by slaughtered waste.

Next to the slaughter house a low income Muslim communities has emerged and seems to grow fast.

Market: Existing market in Na Klua is deteriorating seafront environment which is designated to be public recreation area. While other markets are in better conditions, they are not up to satisfactory standard either.

Transportation: No regular bus route has been set up in Phatthaya and local transportation by mini-truck are said to be expensive. Traffic are heavy in certain times of the day particularly during weekend. Public parking spaces are also limited.

Transportation to and from Bangkok depends mostly on road system which is very congested, particularly during weekend. Rail connection is not popular and at present does not fully utilized.

e) Air Pollution & Noise:

Air pollution is not major threat in the Study Area, at least at present. Major sources of air pollution are from road vehicles which also generate noise nuisance, particularly motor-bikes. Sensitivity to air and noise pollution

varies widely from person to person and some tourists may regard it very unpleasant situation.

f) Socio-economic Impact

Being a tourist center and heavily dependent upon service business, Phatthaya attracts and invites people from most parts of Thailand. As a consequence, cost of living in Phatthaya is relatively high which has to be born inevitably by local people including those not involved in tourist business.

2) Marine Environment

In case of Phatthaya tourism development, coral reef and sea water quality are two important factors to be discussed. Major threats to marine environment is given in Figure 2.2.4.

a) Coral Reef:

Coral resources are scattered around Ko Lan. Some of these have been destroyed by human activities such as fishing, tourism, use of explosive, anchoring of boats. The remaining coral reef, however, is still valuable tourism spot for Phatthaya area.

b) Sea Water Quality:

Sea water was sampled mostly 50 m offshore at 9 stations (See Fig. 2.2.5), on three periods:

- July 29 - 30, 1989 - transition season
- September 23 - 24, 1989 - wet season
- December 2 - 3, 1989 - dry season

Results of analysis are given in Table 2.2.2 (1)~(3). Comparison of seawater standards is made to some parameters set by NEB for Karon Bay in Phuket.

It is apparent that sea waters in the vicinity of Ko Lan were all complied with NEB standard. Sub-standard sea waters in terms of suspended solids and total coliform were found along the coasts line. Large amount of total coliform indicated pollution caused by human activity.

3) Water Quality

In addition to sea water, sampling at major drains are made as well as shallow wells in the study area. These samplings serve specific purposes which shall be illustrated in following chapter.

a) Drains:

Water sampled from major drains in the study area were made in 11 stations (Fig. 2.2.5) including

- 4 street drains in Phatthaya City
- 7 natural drains of which 2 stations were located about 5 km upstream

Results of water analysis is given in Table 2.2.3 (1)~(3) whereas comparison with some parameters of NEB standard for Domestic Effluent Guidelines are made.

It is obvious that degraded street drains from Phatthaya city are contaminating sea water, confirming the inefficiency of existing wastewater treatment plant to cope up with wastewater generated. Major drains serving as receivers of household waste (D2, D8) are also in bad conditions. Other natural drains give indication of being contaminated by human activities, in spite of some upstream locations.

All these drains ultimately and continuously discharge into the sea, thus contaminating the most important tourism resource of their origin.

b) Shallow Wells:

Two groups of shallow wells have been sampled (See Fig. 2.2.6).

- 3 household shallow wells belong to local people near solid waste dumping site
- 3 shallow wells being used as sources of raw water supply for hotels in Phatthaya, and a well serving as water supply for Phatthaya slaughter house, and a well in Ko Lan.

Table 2.2.4 (1)~(3) gives the findings on water quality of the wells, compared with some parameters of Groundwater Quality Standards for Drinking Purpose issued by Ministry of Industry in 1978.

Shallow wells utilized by local people within vicinity downstream of the existing solid waste dumping site are heavily contaminated, and unsuitable at all

for household use. Illness caused by water consumption were reported during the investigations. The wells had been used as the only source of water supply (usually unboiled for drinking purpose) for local people until 1987 when the solid waste started dumping into the area. Water quality began to be polluted since the following rainy season.

The existing solid waste site also pose a threat, on public health point of view, to the proposed RID's Huai Chak Nok Reservoir (Fig. 2.2.7) as the solid site is located at the reservoir's catchment boundary.

Water sampled from shallow wells utilized by some hotels in Phatthaya give lower water quality than that required for drinking purpose. However, after being treated the water has been supplied to guest without any reports on negative response.

The shallow wells being used as water supply for Phatthaya Slaughter House is not hygenic. It is evident that the well is contaminated by slaughtering process as well as by nearby communities. Water quality of the shallow well at Haad Samae, Ko Lan is not complied with the proposed water quality standard either.

Table 2.2.2 (1) SEAWATER QUALITY SAMPLED/1 ON 29~30 JULY 1989

Parameter	Unit	Standard/2	S1	S2	S3	S4	S5	S6	S7	S8	S9
PH	–	6.5~8.3	8.3	8.3	8.3	8.25	8.3	8.2	8.2	8.2	8.3
DO	mg/ℓ	≮4.0	6.0	6.2	5.8	6.8	6.3	6.2	6.3	6.3	6.0
Turbidity	NTU	–	0.7	0.5	0.5	3.9	6.5	2.7	6	18	10.5
BOD	mg/ℓ	–	1.5	0.2	0.4	1.8	1.4	0.9	1.1	0.3	1.7
COD/3	mg/ℓ	–	148	133	126	155	133	148	140	148	126
S.S	mg/ℓ	≯20	0.4	<0.4	0.8	13	18	6	58	32.5	43
Coliform, total	#/100mℓ	≯1000	<2	<2	2	<2	9	<2	<2	<2	4

Remarks: /1 Average Temp. of Water Samples was 29.7°C (Range 28~32°C)
/2 Coastal Water Quality Standards for swimming in Karon Bay, Phuket, by NEB
/3 COD by Potassium Dichromate method
S1 = Ko Lan West Coast, Ban Ta Waen Beach, ~50 m offshore
S2 = Between Ko Lan and Ko Sak
S3 = Ko Lan East Coast, Ban Ko Lan Pier, ~50 m offshore
S4 = Ban Na Klua Fishing Pier, ~500 m offshore
S5 = North Phatthaya, ~50 m offshore
S6 = South Phatthaya, ~50 m offshore
S7 = Ban Na Cham Thian, ~50 m offshore
S8 = Ban Amphoe, ~50 m offshore
S9 = Bang Sare fishing Pier, ~200 m offshore

Table 2.2.2 (2) SEAWATER QUALITY SAMPLED /1 ON 23~24 September 1989

Parameter	Unit	Standard/2	S1	S2	S3	S4	S5	S6	S7	S8	S9
PH	–	6.5~8.3	8.4	8.5	8.45	8.4	8.35	8.4	8.4	8.35	8.4
DO	mg/ℓ	≮4.0	5.3	5.6	5.3	5.1	6.6	5.9	6	5.7	6
Turbidity	NTU	–	0.4	0.4	0.4	1	2.1	1.5	1.5	1.9	1.9
BOD	mg/ℓ	–	0.4	0.5	0.2	0.1	0.1	0.7	0.3	0.5	0.4
COD/3	mg/ℓ	–	120	113	105	128	98	128	120	82.5	97.5
S.S	mg/ℓ	≯20	1	0.6	1	1	6.6	3.6	3	6.4	5
Coliform, total	#/100mℓ	≯1000	240	130	33	79	81	>2400	240	>2400	7.8

Remarks: /1 Average Temp. of Water Samples was 29.2°C (Range 28.8~30.0°C)
/2 Coastal Water Quality Standards for swimming in Karon Bay, Phuket, by NEB
/3 COD by Potassium Dichromate method
S1 = Ko Lan West Coast, Ban Ta Waen Beach, ~50 m offshore
S2 = Between Ko Lan and Ko Sak
S3 = Ko Lan East Coast, Ban Ko Lan Pier, ~50 m offshore
S4 = Ban Na Klua Fishing Pier, ~500 m offshore
S5 = North Phatthaya, ~50 m offshore
S6 = South Phatthaya, ~50 m offshore
S7 = Ban Na Cham Thian, ~50 m offshore
S8 = Ban Amphoe, ~50 m offshore
S9 = Bang Sare fishing Pier, ~200 m offshore

Table 2.2.2 (3) SEAWATER QUALITY SAMPLED/1 ON 2~3 December 1989

Parameter	Unit	Standard/2	S1	S2	S3	S4	S5	S6	S6/1	S7	S8	S9
PH	–	6.5~8.3	8.1	8.1	8.15	8.15	8.1	8.1	8.0	8.2	8.1	8.1
DO	mg/ℓ	≮4.0	5.8	5.9	6.2	6.4	6.2	5.0	4.2	4.2	5.0	6.0
Turbidity	NTU	–	0.6	0.4	1.0	0.5	0.6	1.3	3.6	0.8	0.6	3
BOD	mg/ℓ	–	0.3	0.1	0.2	0.1	0.6	0.3	0.3	0.7	0.8	1.2
COD/3	mg/ℓ	–	331	279 (1.2/4)	154	235	242 (0.6/4)	198	272	198	323 (1.2/4)	250
S.S	mg/ℓ	≯20	1.3	9	0.6	2	1	1	4	2	0.5	28
Coliform, total	#/100mℓ	≯1000	610	4.5	200	20	1,600	6,800	23,000	7.8	<2,000	280

Remarks /1 Average Temp. of Water Samples was 25.8°C (Range 24.5~26.5°C)
/2 Coastal Water Quality Standards for swimming in Karon Bay, Phuket, by NEB
/3 COD by Potassium Dichromate method
/4 COD by Potassium Pernanganate method
S1 = Ko Lan West Coast, Ban Ta Waen Beach, ~50 m offshore
S2 = Between Ko Lan and Ko Sak
S3 = Ko Lan East Coast, Ban Ko Lan Pier, ~50 m offshore
S4 = Ban Na Klua fishing Pier, ~500 m offshore
S5 = North Phatthaya, ~50 m offshore
S6 = South Phatthaya, ~50 m offshore
S6/1 = South Phatthaya, ~5 m offshore
S7 = Ban Na Cham Thian, ~50 m offshore
S8 = Ban Amphoe, ~50 m offshore
S9 = Bang Sare fishing Pier, ~200 m offshore

Table 2.2.3.(1) WATER QUALITY OF MAJOR DRAINS SAMPLED/1 ON 29~30 JULY 1989

Parameter	Unit	Standard/2	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
PH	–	5~9	7.6	7.0	7.2	–	–	–	–	7.0	7.4	8.2	7.5
DO	mg/ℓ	–	8.8	0.8	7.0	1.8	1.4	2.4	0.8	0.9	4.2	9.2	5.4
Turbidity	NTU	–	6.6	4.7	2500	–	–	–	–	4.5	3	14	10.5
BOD	mg/ℓ	20/3	2.5	24	0.5	14.3	12.7	36	6.4	40.5	1.1	5.5	1.3
COD/4	mg/ℓ	–	103	138	126	96	66	175	59	175	30	140	66
S.S	mg/ℓ	30	43	31	2,760	18	28	41	31	22	11	53	24
Coliform, total	#/100mℓ	–	70	>2,400	280	>2,400	60	60	>2,400	>2,400	>2,400	2	1,600

Remarks: /1 Average Temp. of Water Samples was 30.8°C (Range 28~36°C)
/2 Domestic Efficient Guidelines for Community (>2,500 persons), by NEB
/3 BOD of Water Sample after allow setting 30 minutes
/4 COD by Potassium Dichromate method
D1 = Klong Bang Lamung at Highway #3
D2 = Klong Na Klua outlet
D3 = Klong Na Klua upstream of Ban Map Bon
D4~D7 = Phatthaya City street drains
D8 = Klong South Phatthaya
D9 = Huai Chak Nok Upstream at Ban Huai Yai
D10 = Huai Chak Nok at Highway #3
D11 = Klong Huai Tu at Highway #3

Table 2.2.3.(2) WATER QUALITY OF MAJOR DRAINS SAMPLED/1 ON 23~24 September 1989

Parameter	Unit	Standard/2	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
PH	–	5~9	7.4	7.7	–	–	–	–	–	7.3	7.3	7.1	7.25
DO	mg/ℓ	–	5.6	0.6	–	0.4	0.4	3.4	2.2	0.5	5.6	5.4	4.2
Turbidity	NTU	–	16	26	–	–	–	–	–	10	52	80	34
BOD	mg/ℓ	20/3	1.3	48.7	–	41.3	27	90	47	16	0.9	1.5	1.2
COD/4	mg/ℓ	–	75	135	–	127	105	127	53	83	23	23	38
S.S	mg/ℓ	30	50	42	–	28	18	17	57	15	30	39	17
Coliform, total	#/100mℓ	–	$>2.4\times10^3$	$>240\times10^3$	–	$>240\times10^3$	$>240\times10^3$	$>240\times10^3$	$>240\times10^3$	160×10^3	9.5×10^3	1.6×10^3	13×10^3

Remarks: /1 Average Temp. of Water Samples was 28.0°C (Range 25.5~30.0°C)
/2 Domestic Efficient Guidelines for Community (>2,500 persons), by NEB
/3 BOD of Water Sample after allow setting 30 minutes
/4 COD by Potassium Dichromate method
D1 = Klong Bang Lamung at Highway #3
D2 = Klong Na Klua outlet
D3 = Klong Na klua upstream of Ban Map Bon (No flow at time of sampling)
D4~D7 = Phatthaya City street drains
D8 = Klong South Phatthaya
D9 = Huai Chak Nok Upstream at Ban Huai Yai
D10 = Huai Chak Nok at Highway #3
D11 = Klong Huai Tu at Highway #3

Table 2.2.3 (3) WATER QUALITY OF MAJOR DRAINS SAMPLED/1 ON 2~3 December 1989

Parameter	Unit	Standard/2	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
PH	–	5~9	7.9	7.1	7.6	–	–	–	–	6.8	7.4	7.3	7.0
DO	mg/ℓ	–	7.0	0.6	8.2	0.6	2.2	1.3	3.9	0.6	7.2	6.6	4.8
Turbidity	NTU	–	4.1	1.6	16	–	–	–	–	4	470	17	2.6
BOD	mg/ℓ	20/3	0.1	23.4	2.7	110	8.4	10.8	12.6	9.2	1.6	4.5	0.2
COD/4	mg/ℓ	–	200	180	20	253	66.7	127	80	260	66.7	120	267
S.S	mg/ℓ	30	12	11	5	84	5	26	8	6	1,560	10	200
Coliform, total	#/100mℓ	–	2×10^{3}	1.6×10^{8}	1.6×10^{3}	1.6×10^{8}	1.7×10^{6}	3.5×10^{7}	9.2×10^{7}	$>2.4\times10^{7}$	4.6×10^{4}	1.7×10^{3}	5.4×10^{5}

Remarks: /1 Average Temp. of Water Samples was 24°C (Range 22~26°C)
/2 Domestic Efficient Guidelines for Community (>2,500 persons), by NEB
/3 BOD of water sample after allow setting 30 minutes
/4 COD by Potassium Dichromate method
D1 = Klong Bang Lamung at Highway #3
D2 = Klong Na Klua outlet
D3 = Klong Na klua upstream of Ban Map Bon
D4~D7 = Phatthaya City street drains
D8 = Klong South Phatthaya
D9 = Huai Chak Nok Upstream at Ban Huai Yai
D10 = Huai Chak Nok at Highway #3
D11 = Klong Huai Tu at Highway #3

Table 2.2.4 (1) WATER QUALITY OF SHALLOW WELLS SAMPLED ON 29-30 July 1989

Parameter	Unit	Standard /2		W1	W2	W3	W4	W5	W6	W7
		Suit	Max							
PH	—	7.8 - 8.5	6.5 - 9.2	7.6	7.2	7.2	6.9	6.2	5.2	6.0
DO	mg/ℓ	—	—	6.6	4.2	2.8	4.0	4.6	4.6	4.4
Turbidity	NTV	5	20	0.7	33	74	3.7	73	4.4	2.1
BOD	mg/ℓ	—	—	0.4	1	1	1.5	4.7	0.6	0.5
COD /3	mg/ℓ	—	—	14.8	37	59	81	177	7.4	14.8
SS	mg/ℓ	—	—	<0.4	7	18	1	40	3	<0.4
Coliform, total	#/100mℓ	2.2	—	50	2	17	1600	>2400	<2	>2400
Dissolved Solids	mg/ℓ	750 /4	1500 /4	694	571	654	1193	2808	125	144
Lead, total	mg/ℓ Pb	none	0.05	—	—	—	—	0.006	<0.005	0.008
Chromium, total	mg/ℓ Cr	—	—	—	—	—	—	<0.015	<0.015	<0.015
Zinc, total	mg/ℓ Zn	5	15	—	—	—	—	0.04	<0.02	0.04
Mercury, total	mg/ℓ Hg	none	0.001	—	—	—	—	<0.0004	<0.0004	0.0004

Remarks :
/1 Average Temp. of water samples was 28.7 °C (Range 28 - 29.5 °C)
/2 Groundwater quality standards for drinking purpose, Ministry of Industry
/3 COD by Potassium Dichromate method
/4 Standard in terms of total solids

W1 = Orchid Lodge Hotel (North Phatthaya)
W2 = Nipa Lodge Hotel (Central Phatthaya)
W3 = Siam Bayshore Hotel (South Phatthaya)
W4 = Phatthaya Slaughter House
W5 = Khuan Phien's house, ~ 30m from solid waste dumping site
W6 = Khuan Nii's house, ~ 40m from solid waste dumping site
W7 = Khuan Chamnong's house, ~ 700m from solid waste dumping site

Table 2.2.4 (2) WATER QUALITY OF SHALLOW WELLS SAMPLED ON 23-24 September 1989

Parameter	Unit	Standard /2		W1	W2	W3	W4	W5	W6	W7	W8
		Suit	Max								
PH	—	7.0 - 8.5	6.5 - 9.2	7.8	7.2	7.7	6.95	7	5.65	6	5.95
DO	mg/ℓ	—	—	5.6	2.6	5	1.9	1.2	7.2	3.8	1
Turbidity	NTV	5	20	0.5	1.1	43	1.1	110	16	49	31
BOD	mg/ℓ	—	—	0.5	0.8	0.7	1.5	55.5	0.6	0.1	0.8
COD /3	mg/ℓ	—	—	75	75	36	53	338	15	15	52.5
SS	mg/ℓ	—	—	0.4	18	3	2	100	9	1.5	16
Coliform, total	#/100mℓ	2.2	—	130	31	$>240\times10^3$	11×10^3	2.3×10^3	$<2.4\times10^3$	21×10^3	920
Dissolved Solids	mg/ℓ	750 /4	1500 /4	794	482	479	1522	3162	75	164	1204
Lead, total	mg/ℓ Pb	none	0.05	—	—	—	—	<0.005	<0.005	<0.005	—
Chromium, total	mg/ℓ Cr	—	—	—	—	—	—	0.045	<0.01	<0.01	—
Zinc, total	mg/ℓ Zn	5	15	—	—	—	—	<0.02	0.33	0.055	—
Mercury, total	mg/ℓ Hg	none	0.001	—	—	—	—	<0.0004	<0.0004	<0.0004	—
Iron, total	mg/ℓ Fe	0.5	1.0	—	—	—	—	39	1.9	0.43	—

Remarks:
/1 Average Temp. of water samples was 28.9 °C (Range 28 - 30 °C)
/2 Groundwater quality standards for drinking purpose, Ministry of Industry
/3 COD by Potassium Dichromate method
/4 Standard in terms of total solids

W1 = Orchid Lodge Hotel (North Phatthaya)
W2 = Nipa Lodge Hotel (Central Phatthaya)
W3 = Siam Bayshore Hotel (South Phatthaya)
W4 = Phatthaya Slaughter House
W5 = Khuan Phien's house, ~ 30m from solid waste dumping site
W6 = Khuan Nii's house, ~ 400m from solid waste dumping site
W7 = Khuan Chamnong's house, ~ 700m from solid waste dumping site
W8 = Haad Samae, Ko Lan, ~ 50m form the beach

Table 2.2.4 (3) WATER QUALITY OF SHALLOW WELLS SAMPLED ON 2-3 December 1989

Parameter	Unit	Standard /2		W1	W2	W3	W4	W5	W6	W7	W8
		Suit	Max								
PH	—	7.0 - 8.5	6.5 - 9.2	7.9	7.2	6.9	6.2	6.5	5.0	5.6	3.6
DO	mg/ℓ	—	—	7.2	4.8	5.4	1.5	1.3	3.0	4.7	1.8
Turbidity	NTV	5	20	0.8	3.3	10	2.7	96	0.3	3.8	80
BOD	mg/ℓ	—	—	0.1	1.7	1.8	3.2	18.6	0.2	0.1	0.3
COD /3	mg/ℓ	—	—	46.7	53.4	73.4	60	213	20	33.4	93.4
SS	mg/ℓ	—	—	0.6	3	3	0.5	10	0.5	1	10
Coliform, total	#/100mℓ	2.2	—	350	920	2	3700	200	<2000	2000	<20
Dissolved Solids	mg/ℓ	750 /4	1500 /4	645	405	341	1633	962	47.5	79	1000
Lead, total	mg/ℓ Pb	none	0.05	—	—	—	—	0.014	<0.005	<0.005	—
Chromium, total	mg/ℓ Cr	—	—	—	—	—	—	0.065	<0.015	<0.015	—
Zinc, total	mg/ℓ Zn	5	15	—	—	—	—	0.085	0.095	0.1	—
Mercury, total	mg/ℓ Hg	none	0.001	—	—	—	—	0.011	<0.0008	0.001	—

Remarks:
/1 Average Temp. of water samples was 27.3 °C (Range 28 - 30 °C)
/2 Groundwater quality standards for drinking purpose, Miniutry of Industry
/3 COD by Potassium Dichromate method
/4 Standard in terms of total solids

W1 = Orchid Lodge Hotel (North Phatthaya)
W2 = Nipa Lodge Hotel (Central Phatthaya)
W3 = Siam Bayshore Hotel (South Phatthaya)
W4 = Phatthaya Slaughter House
W5 = Khuan Phien's house, ~ 30m from solid waste dumping site
W6 = Khuan Nii's house, ~ 400m from solid waste dumping site
W7 = Khuan Chamnong's house, ~ 700m from solid waste dumping site
W8 = Haad Samae, Ko Lan, ~ 50m form the beach

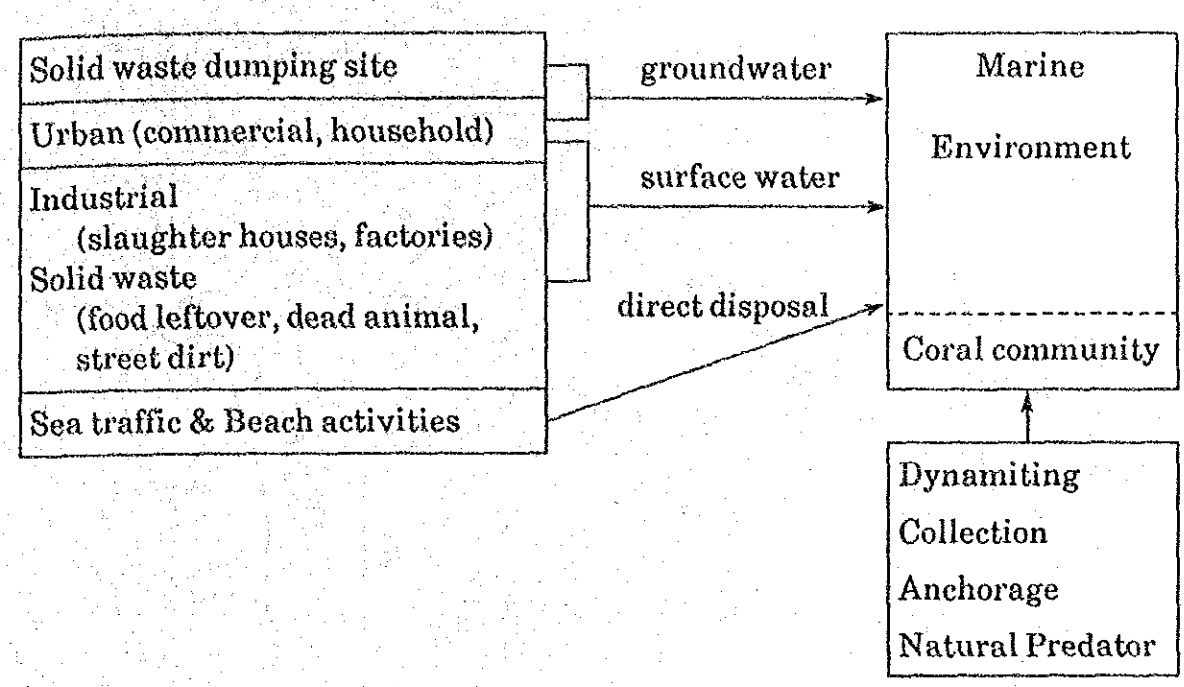
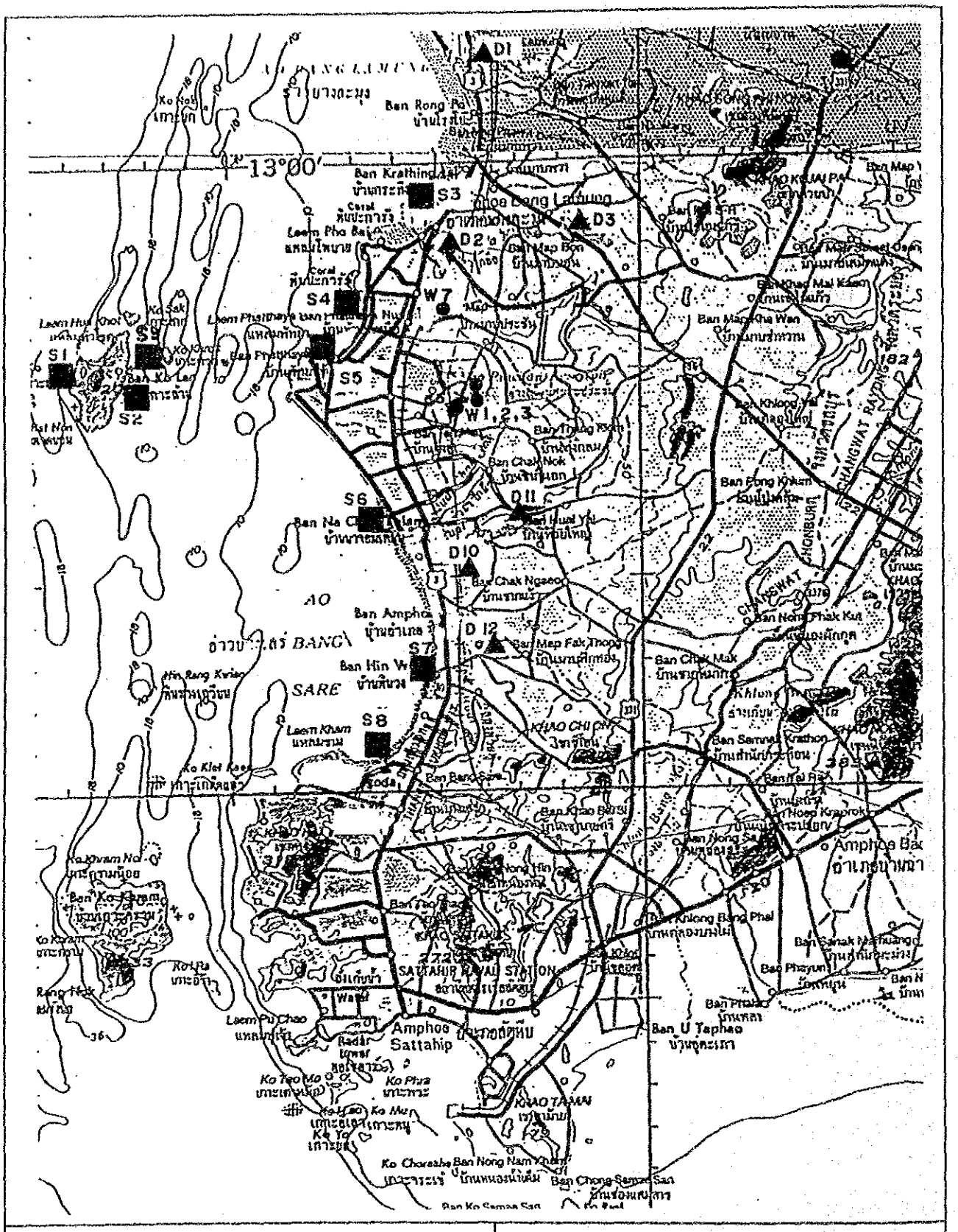


Fig. 2.2.4 Major Threats to Marine Environment in Phatthaya Area



LEGEND

W Shallow Well

D Drain

S Sea water

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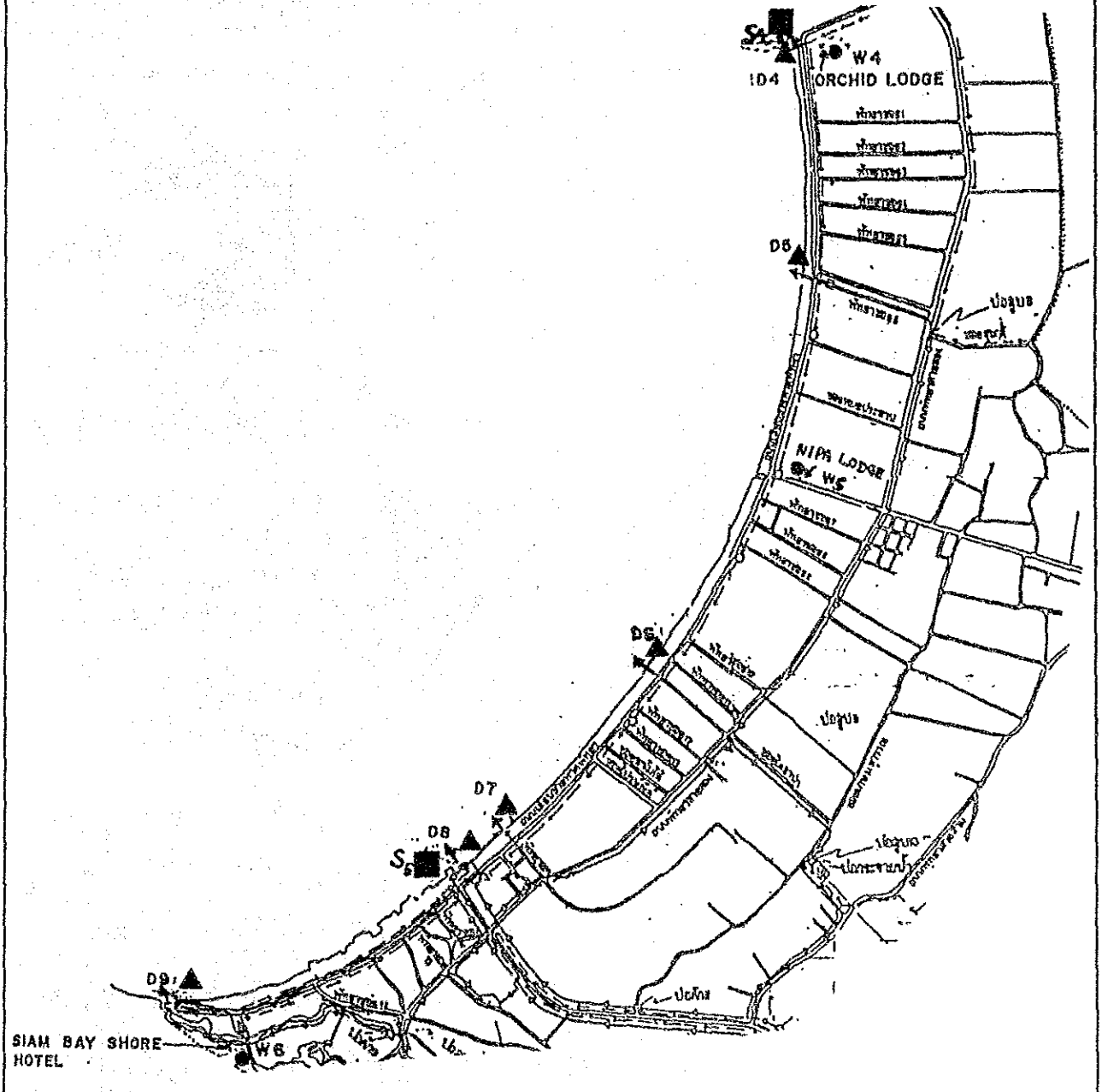
Fig. 2.2.5

Water Sampling Locations



LEGEND

W Shallow Well

D Drain

S Sea water

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Fig. 2.2.6

Water Sampling Locations

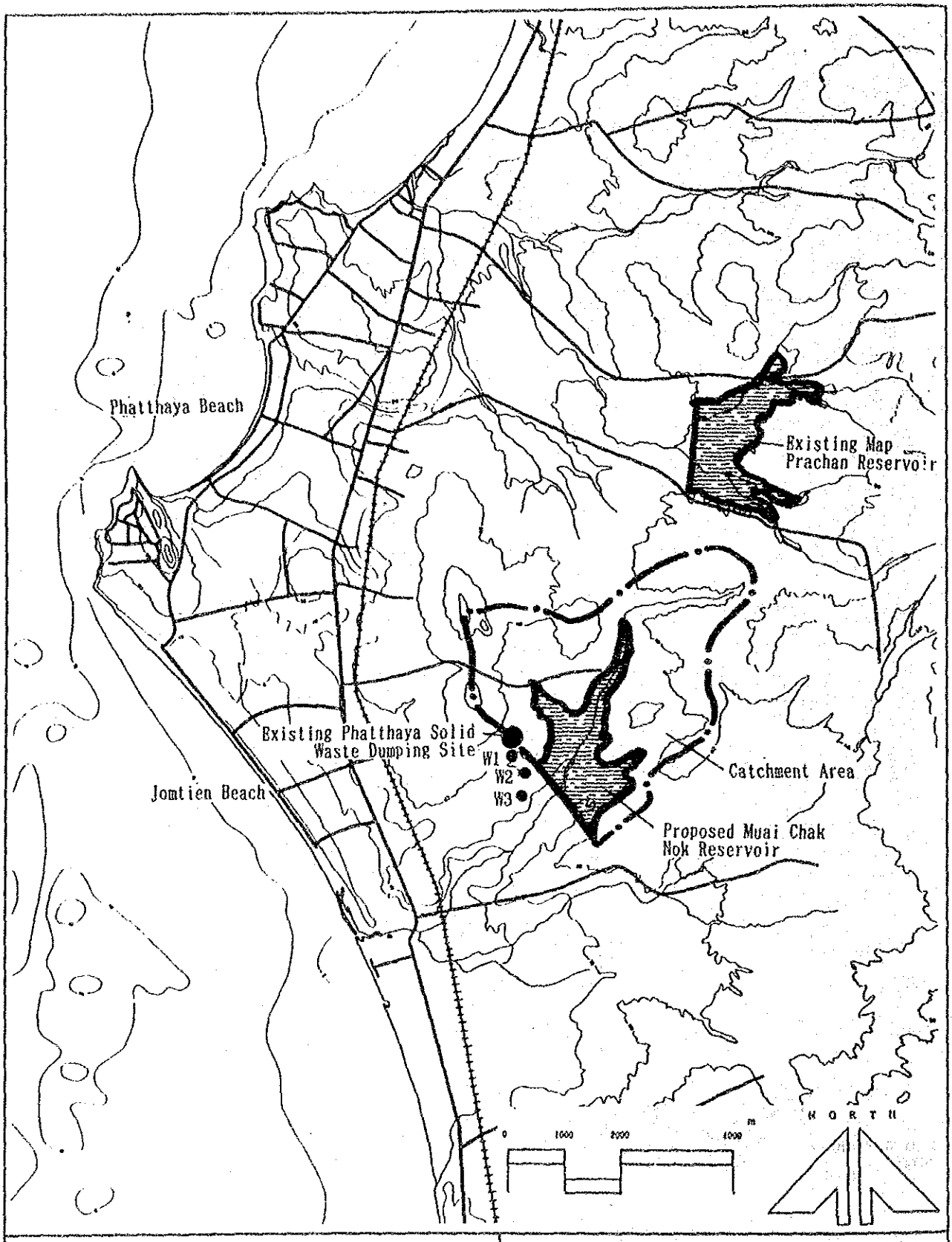

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	Fig. 2.2.7 Proposed Huai Chak Nok Reservoir