(3) Ground water, public waterworks and swamp

Quality of ground water was examined using the existing wells near the proposed treatment plants, and data were prepared regarding the anticipated effects of stabilization ponds on ground water after operation of such treatment plant is begun.
With respect to the quality of ground water, the presence of ammoniac nitrogen in the existing wells seems to suggest pollution due to nightsoil. Since planning was made on the assumption that the quality of ground water would be as BOD_5 5mg/lit., this quality means that the water was quite unfavorable as water for public waterworks.

(4) River and sea area

Pattaya River and Na Klua River showed very high BOD_5. As mentioned in the report entitled Environmental Survey of Pattaya, this is due to the fact that sewage is directly discharged into Pattaya River from homes, hotels and restaurants.
Na Klua River is probably contaminated mainly by sewage from tapioca factories and houses.
Considerable unpleasant smell occurs at the estuary of both rivers, and thus improvement of the sewerage system seems to be essential for ameliorating the living environment of the residents.

3.5.3 Topographic Survey

For the design of the sewerage system, surveys were carried out at points where bridges cross the Na Klua and Pattaya Rivers. The survey results will aid in the design of the Planned culverts and pipe construction for carrying wastewater across the rivers.

3.5.4 Direct Interviews

The results of the direct interviews with residents, hotel managers and others are summarized as follows.

Interviews were carried out at the following 45 spots as shown in Fig. 3.5.9.

Hotels	11	
Restaurants, shops	5	
Bangalows	5	
Houses		
Houses using public waterworks	5	
Houses not using public waterworks	5	Na Klua Area
Houses in inland areas	5	
Houses in Pattaya downtown	5	
Tapioca factories		
First Grade Factory	1	
Second Grade Factory	3	
Total	45	

According to the survey, most hotels are equipped with some kind of sewage treatment facilities. However, there are problems with the maintenance and management, and there were few hotels showing good results. The treated water permeates into the subsoil at 4 hotels, is sprayed onto the lawns at 5 hotels, and is discharged into rivers directly by 2 hotels. Septic tanks are used by restaurants and shops for the treatment of nightsoil, while various effluents are directly discharged into public water body. Such septic tanks are cleaned once a year by the use of "Vacuum car." The restaurants and shops interviewed also hope to see the construction of public sewage facilities.

Bungalows are also using septic tanks. However, there is no treatment equipment for the tanks except in one case where there is a "purifying tank" for the treatment of nightsoil. An owner of a bungalow says that sufficient treatment can be made by septic tank alone. The treated water is discharged by natural permeation into the ground. 25 houses investigated were using septic tanks for the treatment of nightsoil.
These are cleaned once a year in the inland area, while the dwellers in the area along the river do not feel the need for a periodic cleaning of tanks.

As for tapioca factories, stabilization ponds are used in 3 out of the 4 factories checked in the current survey. However, only one factory has a satisfactory stabilization pond, and others have only a very small pond. The surveyed First Grade tapioca factory wishes to see further construction of large stabilization ponds. The sewage from the tapioca factories is discharged into the public water body.

Wastewater Quality Survey at a Hotel in Pattaya

FIG 3.5.9 LOCATION OF DIRECT INTE

FIG 3.5.9 LOCATION OF DIRECT INTERVIEW

3.6 Estimated Amount of Sewage

3.6.1 Management of Industrial Wastewater

In the study area, the tapioca factories give rise to the largest problem of industrial wastewater, followed by slaughterhouses and concrete factories.

As compared with other industrial wastewater, that from the tapioca factories contributes most to environmental pollution in both quantity and quality, and this is one of the most important matters to be solved in order to maintain Pattaya as a resort.

At present, there are 22 tapioca factories in the study area, only 2 factories are First Grade, the others are Second Grade. Among the factories of First Grade, the one located along Na Klua River already has stabilization ponds to treat wastewater, and its cleaning function is clarified in the present investigation on water quality by JICA.

According to the investigation results on water quality, the existing stabilization pond does not meet the requirements of the standards set by the Ministry of Trade and Industry of Thailand. Because very high contents of BOD_5 and SS are contained in the sewage from starch production, it seems very difficult to treat the sewage up to 20-60 mg/l of BOD_5. However, according to data provided by the Thai Industrial Environment Control Division, some times the treated sewage ultimately reveals a BOD5 less than 60 mg/l. The government of Thailand intends to adopt strict regulations to enforce the sewage treatment standards.

As compared with Second Grade factories, First Grade ones are producing more than 10 times of the starth; thus, their sewage is also more than 10 times as great. First Grade factories seem capable of being equipped with treatment facilities to meet the requirements of the government regulations. Therefore, in the present project for a sewerage system, it was planned that the First Grade factories shall treat their sewage by themselves, while the sewage from Second Grade factories shall be poured into the public sewerage system.

However, if First Grade factories should be unable to construct the facilities to meet the requirements of the standards, their sewage must also necessarily be put into the public sewerage system. Therefore, piping plans and treatment plant plans are made so as to be able to meet these possible requirements.

As for the treatment plant in Na Klua Area, plans call for obtaining the necessary land to construct a plant capable of handling the maximum estimated amount of sewage in 1996. As for the piping plan, the First Grade factories in question are at the opposite side of the Na Klua Area from the treatment plant. Thus the part of the piping plant. This is directly influenced by sewage from the factories is an extension of about 300m of ∅800 inflow pipe from the road to the treatment plant. This is included in the piping plan to provide in advance for the possible flows of sewage from the First Grade tapioca factories.

Since the quality of industrial sewage poured into the public sewerage system must be less than 300 mg/l of BOD_5, sewage would have to be pre-treated at each tapioca factory individually in order to meet the requirements of the Thai regulations.

3.6.2 Unit Discharge and Quality of Sewage

Sewage volumes were calculated from volume of water supplied to 5 types of recipients as follows: hotels and bungalows, residents, day trippers restaurants, and factories.

This report will now consider, first, the volume of water supplied and then the volume of water supply amount discharged into the proposed sewerage system.

(a) Hotels and Bungalows

1) Water supply volumes (daily average)

Daily water supplies per room are calculated assuming a 100% operation rate, with 1.6 guests per room and 1.5 hotel employees per room.

Hotel-lodging guests	250 lit./guest/day
Employees	80 "
Restaurants (in hotels)	40 "
Cleaning	160 "
Water supply for pool	100 "
Water supply for air-conditioning	240 "
Total	870 lit./guest/day

Thus volume of water supplied per room (1.6 guests) is obtained by the following equation.

870 l/guest/day x 1.6 guests/room = 1,392 l/room/day
= 1.4 m^3/room/day

Breakdown is as follows:*

(1) Lodging guests at hotels

Western style bath:
125 lit./time x 1 time/day = 125 lit./day
Toilet seat:
13.5-16.5 lit./time x 4 times/day = 54-66 lit./day
Hand-washing:
3 lit./time x 4 lit./day = 12 lit./day
Face-washing:
10 lit./time x 2 times/day = 20 lit./day
Shower:
24-60 lit./time x 1 time/day = 24-60 lit./day

Total: 235-283 lit./day

Average: about 250 lit./day

(2) Employees

Toilet seat:
13.5-16.5 lit./time x 2 times/day = 27.0-33.0 lit./day
Hand-washing:
3 lit./time x 2 times/day = 6 lit./day
Face washing:
10 lit./time x 1 time/day = 10 lit./day
Shower:
24-60 lit./time x 1 time/day = 24-60 lit./day

Total: 67~103 lit./day

Average: about 88 lit./day

Water supply volume is calculated from the figures per hotel guest, by the following equation (if one assumes 1.5 employees per room):

$$88 \text{ lit./day} \times \frac{1.5}{1.6} = 82.5 \doteqdot 80 \text{ lit./day}$$

Note: Since hotel employees are included as residents, their in-hotel water supply needs were calculated as less than they would be in the case if they lived full time in the hotels.

* Japanese book on air-conditioning, hygienic equipments, and operational data written by Yokota et al.

(3) Restaurants in hotels

According to the master plan, it is estimated that one hotel-lodging guest takes meals 2.1 times per day at the hotel restaurant, and 20 lit. of water is estimated as being necessary for each meal.*

Thus the water supply needed for one person per day is

$$20 \text{ lit./once} \times 2.1 \text{ times/day} = 42 \text{ lit./day} \doteqdot 40 \text{ lit./day}$$

* Manual of Air Conditioning and Sanitary Engineering Vol. 11

(4) Cleaning

The total amount of hotel bed linens, etc., to be cleaned is 4kg (dry weight) per day per bed*. Water used for cleaning is 40 lit. per kg. Thus, the water used per day per bed is 40 lit. x 4kg = 160 lit./day

* Manual of Air Conditioning and Sanitary Engineering Vo. 11

(5) Water supply for pools

Swimming pool: Planning is made on the basis of existing condition in the various hotels.

Replacement water is estimated at 5% per day.
The current number (quantity) of rooms and pool capacities are summarized in the following table.

Table 3.6.1 Number of Hotel Rooms and Pool Capacities

Name of Hotel	No. of Rooms	Volume of Pool
Orchid Lodge	177	597 m^3
Weekender	120	639
Holiday Inn	340	600
Regent	276	200
Nipa Lodge	140	597
Ocean View	115	412
Royal Cliff	520	2,074
Asia Pattaya	266	1,620
Total	1,954	6,739 m^3

The capacity of pool per room of existing hotels is 3,449m³/room.

$6,739m^3 \div 1,954$ rooms $= 3,449m^3$/room

If water replacement is 5%, the needed water supply is $0.172m^3$/room/day. If lodging guests per room are 1.6 persons, the water supply per lodging guest can be calculated as approximately $0.100m^3$/guest/day, according to the following formula:

$0.172m^3$/room/day $\div$ 1.6 = $0.107m^3$/guest/day $\fallingdotseq$ $0.100m^3$/guest/day

(6) Water supplies for cooling

A replacement rate of about 2% of the circulating water is considered "standard" in Japan. Circulatory water in a refrigerator of turbo-type cooling system is 13 lit./min/RT. Ton per refrigerator per one square meter, in hotel standards in the United States is 0.019-0.027; therefore, the water needed for cooling $1m^2$ is 0.006 lit./min.*

0.019-0.027 x 13 lit./min/RT x 0.02(2%) = 0.0049-0.007 lit./min.m^2
Average 0.006 lit./min.m^2

The operation time per day is taken as 24 hours.
The area per room averages $45m^2$ (according to local investigation).
Thus, the water needed for cooling one room is as follows:

0.006 lit./min.m^2 x 60 min x 24 hr x 45 m^3/room
= 388.8 lit./room/day

If lodging guests per room are 1.6 persons, it can be calculated that one lodging person requires the following amount of water.

388.8 lit./room/day $\div$ 1.6 guests/room $\fallingdotseq$ 240 lit./guest/day

* Kūki Sekkei Gaisūchi (Approximate Values for Air Conditioning)
Osaka Electric Heating Co. Ltd.
Guidebook for construction equipment

2) Sewage volume (daily average)

Daily average volume of sewage from the hotel shall be the value derived by deducting the volume used for air-conditioning and pool from the total volume of water supplied.

Water supplies to pool :	100 lit./guest/day
Water supplies to air-conditioning:	240 lit./guest/day
Total	340 lit./guest/day

Assuming the amount of water supplied per hotel-lodging guest is 870 lit./day.

870 lit./guest/day - 340 lit./guest/day = 530 lit./guest/day

Sewage volume per hotel-room is as follows:

530 lit./guest/day x 1.6 guest/room $\fallingdotseq$ 850 lit./room/day

3) Relations between daily average volume of sewage and daily maximum volume of sewage

The daily average volume of sewage per hotel room is calculated assuming 1.6 lodging guests per room, while the daily maximum amount of sewage is calculated assuming 2.0 lodging persons per room and further multiplying the derived figures by 1.5.
Therefore, the daily maximum volume of sewage is calculated as follows:

$$850 \text{ lit./room/day} \times \frac{2.0 \text{ persons}}{1.6 \text{ persons}} \times 1.5 = 1.59 \text{ m}^3\text{/room/day}$$

(b) Residents

1) Volume of water supplied

The volume of water supplied to residents is obtained by dividing supplies into "water for living" and "water for public use."

(1) In calculating "water for living" per day per person (daily average) , Japanese standards were adopted.

For the water for living, the following values can be considered.

Cooking	6 lit./person/day
Boiling	6 "
Washing of tablewares (by hand)	6 "
Shower	24-60 " (42 lit./person/day)
Laundry (by hand)	20 "
Hand-washing	3 lit. x 4 = 12 lit./person/day
Face-washing	10 lit./person/day
Toilet (Hotels use a different structure of toilet)	25 "
Sweeping	[7]
Miscellaneous uses	[8]

(Mean volume of water used) 127 lit./person/day
(Excepting water for sweeping and miscellaneous uses)

(Mean volume of water used) 142 lit./person/day
(Including the above uses)

(2) Water for public use

Water for business is obtained in accordance with the master plan as follows. Although in the following table the area of each facility in question is that of land area, the floor area of the building was assumed as 25% of the land area.

Table 3.6.2 Volume of Water Used in Various Public Establishments

	1981				1996			
	Land area m^2	Calculated* floor area m^2	Water supply** per unit floor area $l/m^2.day$	Water supply l/day	Land area m^2	Calculated* floor area m^2	Water supply** per unit floor area $l/m^2.day$	Water supply l/day
Post Office	350	87.5	6.5	569	800	200	6.5	1,300
Police Station	500	125	15.8	1,975	1,660	415	15.8	6,557
Administrative Facilities	28,000	7,000	6.8	47,600	28,000	7,000	6.8	47,600
Fire Station	500	125	15.8	1,975	1,500	375	15.8	5,925
Hospital	-	-	25.5	0	14,000	3,500	25.5	89,250
Primary School	78,000	19,500	13.7	267,150	249,000	62,250	13.7	852,825
Junior High School	16,000	4,000	11.6	46,400	64,000	16,000	11.6	185,600
Total				365,669				1,189,057

* 25% x Land area

** Japan Waterworks Association, Design Criterion for Waterworks Facilities, 1977

The primary schools have a land area of 16,000m^2 per school, and calculation were made assuming 2,000 pupils per school. According to the criteria used in calculating the number of persons to be served in the various buildings*, the average number of pupils in primary school buildings is taken to be 1/4 of those who could be simultaneously accommodated at the maximum.

Also, based on the data*, water supply per pupil per day average 81.1 lit. The water supply to primary schools was thus calculated as follows:

2,000 pupils x 1/4 x 81.1 lit./pupil/day = 40,550 lit./day/school

In the master plan, 5 primary schools are planned in 1981, thus the total water supply will be 202,750 lit./day. Comparing this figure with the figure of 1,068,600 lit./day obtained from calculations on the basis of land area, it is about 19% of the latter. Therefore, the water for public use is assumed, as a conservative value, to be 25% of the value obtained from land area consideration. The population to be supplied with water is estimated to be 42,300 persons in 1981 and 80,200 persons in 1996. Thus, the water supply per person can be calculated as follows:

1981: 365,669 lit./day ÷ 42,900 persons ≒ 10 lit./person/day
1996: 1,189,057 lit./day ÷ 80,200 persons ≒ 15 lit./person/day

* Japan Construction Center, Structural Standards of Nightsoil Purifying Tanks and Detailed Explanations of Them.

(3) Estimated daily average water supply

Water for living and water for public use are added as follows.

Water for living + Water for public use
= 137 lit./person/day (1981) -
157 lit./person/day (1996)

(4) Relation between estimated volume of daily average and daily maximum water supply

The maximum water supply is assumed to be 50% more than the planned daily average, in accordance with design standards used in Japan.

Planned maximum water supply
= 1.5 x (137 lit./person/day - 157 lit./person/day)
≒ 210 lit./person/day - 240 lit./person/day

Planned water supplies:

	1981	1986	1991	1996
Daily average	137	144	150	157
Daily maximum	210	220	230	240

Unit: lit./person/day

2) Planned unit volume of sewage

The unit for residents shall be the same as that of water supplies.

Planned sewage volumes:

	1981	1986	1991	1996
Daily average	137	144	150	157
Daily maximum	210	220	230	240

Unit: lit./person/day

(c) Day Trippers

1) Unit demand of water supply

Planned daily water demand of day trippers is calculated below. Sites where such guests use water are to be restaurants, parks and amenity core.

Toilet seat	(13.5 lit./time - 16.5 lit./time) x 2 = 27-33 lit./person/day
Hand-washing	3 lit./time x 2 = 6 lit./person/day
Meal (restaurants)	(10-20 lit./time) x 1 = 10-20 lit./person/day
Total	43-59 lit./person/day
Average	50 lit./person/day

Among them, supposing that the meals would be taken at restaurants, this amount would be duplicated, thus 20 lit./person/day is deducted and 30 lit./person/day of unit demand is obtained for planned daily average water supply.

Planned daily average water supply: 30 lit./person/day
Planned daily maximum water supply: 45 lit./person/day

2) Sewage volume

The volume shall be the same as those of water demand.

Planned daily average sewage: 30 lit./person/day
Planned daily maximum sewage: 45 lit./person/day

(d) Restaurants

1) Water volume

The unit of planning daily average water demand:
20 lit./person/day

The unit of planning daily maximum water demand:
30 lit./person/day

2) Sewage volume

The volume shall be the same as those of water demand:

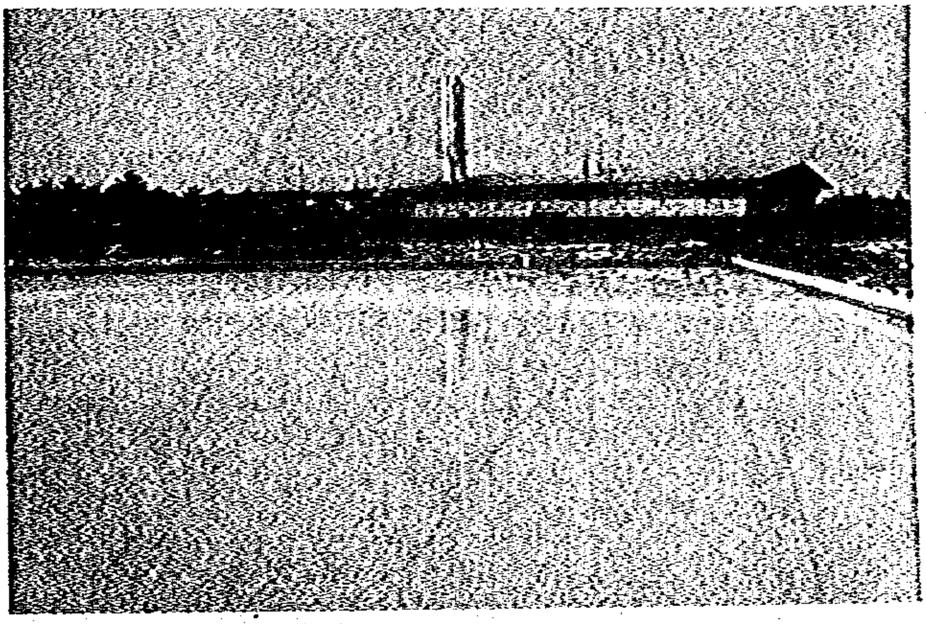
Planned daily average sewage: 20 lit./person/day
Planned daily maximum sewage: 30 lit./person/day

(6) Industrial Wastewater

It is mostly composed of wastewater from tapioca factories. Thus, planning was made on the basis of the wastewater from such factories.

The sites of factories are shown in Fig. 3.6.1. The volume of sewage was calculated as 4,640m^3/day, but this includes the sewage from factories that have since then stopped operations. In the above volume, 2,400m^3/day is sewage from First Grade factories.*

The volume of sewage from each factory is shown in Table 3.6.3.



A First Grade Tapioca Factory and its Stabilization Ponds in Na Klua. (Factory No. 11 on Fig. 3.6.1)

---

* Data of Tapioca Factories in Bang Lamung
Works Factory Control Division, Department of Industry,
Ministry of Industry.

Fig. 3.6.1 Location of Tapioca Factories

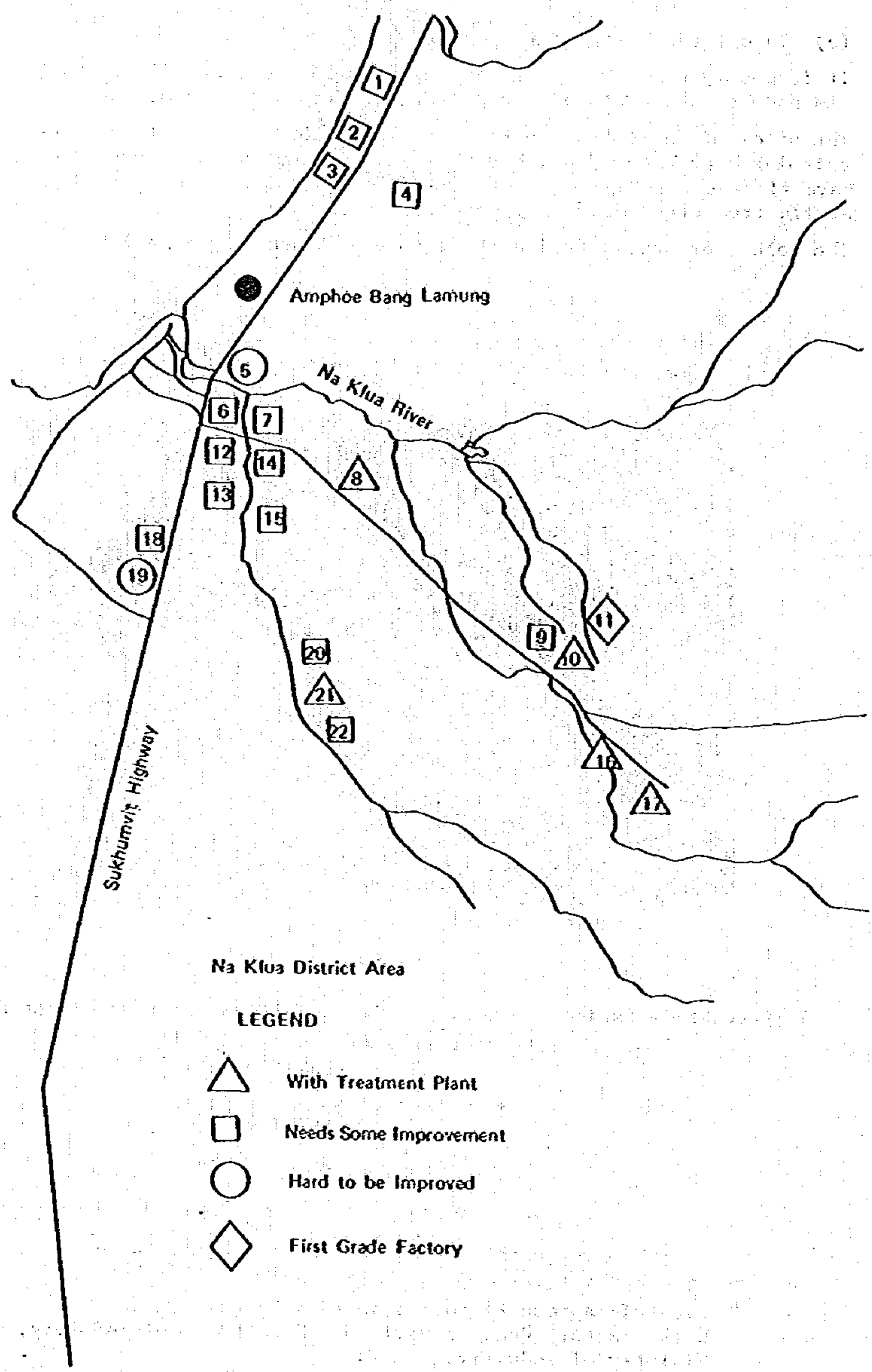


Table 3.6.3 Wastewater from Tapioca Factories

Number	Name of Factory	Production (ton/day)	Wastewater (m^3/day)	BOD-loading kg/day	Total area (rai)	Existing Treatment Plant area (rai)	Required Treatment Plant area (rai)	Remarks
1	Tang Tai Heng	8	160	800	25	Stabilization Pond: 5 Ponds 2 rai	12 - 16	
2	Loog Feng	8	160	800	20	Stabilization Pond: 4 Ponds 3 rai	12 - 16	
3	Lee Mine	8	160	800	16	Stabilization Pond: 5 Ponds 1 rai	12 - 16	
4	Sa Ka Kaed	5	100	500	18	Stabilization Pond: 2 Ponds 3 rai	8 - 10	Stop
5	Thai Yuen Yong	5	100	500	10	Stabilization Pond: 1 Pond 1 rai	8 - 10	Stop
6	Yoong Sai Ha	5	100	500	8	Stabilization Pond: Pond 4 rai	8 - 10	Stop
7	Kuo Heng	4	80	400	21	Stabilization Pond: Pond 4 rai	6 - 8	Stop
8	Yong Heng	5	100	500	30	Stabilization Pond: 4 Ponds 5 rai	8 - 10	Stop
9	Jing Hua Tai	4	80	400	13	Stabilization Pond: 3 Ponds 2 rai	6 - 8	Stop
10	Chang Fah	8	160	800	55	Stabilization Pond: 7 Ponds 15 rai	12 - 16	
11	Kew Chang Fah	60	2,400	12,000	167	Stabilization Pond: 15 Ponds 105 rai	90 - 120	
12	Sijpaisan	5	100	500	23	Stabilization Pond: 2 Ponds 3 rai	8 - 10	
13	Yong Heng	5	100	500	30	Stabilization Pond: 4 Ponds 4 rai	8 - 10	
14	Kuai Lee	5	100	500	10	Stabilization Pond: 3 Pond 5 rai	8 - 10	
15	Seng Lee	5	100	500	30	Stabilization Pond: 3 Ponds 3 rai	8 - 10	
16	Jareon Heng Heng	12	240	1,200	45	Stabilization Pond: 5 Ponds 15 rai	18 - 24	
17	Nguan Heng	2	40	200	20	Stabilization Pond: 5 Ponds 12 rai	3 - 4	
18	Kai Tee	5	100	500	21	Stabilization Pond: 4 Ponds 4 rai	8 - 10	Stop
19	Sin Heng Huak	1	20	100	4	Stabilization Pond: 2 Ponds 0.5 rai	1 - 2	Stop
20	Sa Klea Tapioca Factory	-	-	-	-	-	-	Stop
21	Yu Heng	4	80	400	13	Stabilization Pond: 5 Ponds 5 rai	6 - 8	
22	Leng Heng	8	160	800	15	Stabilization Pond: 6 Ponds 6 rai	12 - 16	
	Total	172	4,640	23,200				

(f) Quality of Sewage

1) Hotels and bungalows

The water quality of sewage from hotels and bungalows was estimated as BOD_5 200 mg/lit. and SS 150 mg/lit., on the basis of water quality surveys.

2) Residents

(1) Pollution load per person in Japan is as follows.

Table 3.6.4 Standard Values of Pollution Load per Person

(Unit: g/person/day)

Item	1970	1990	Remarks
BOD_5	44	64 - 84	Increasing at the rate of 1-2 g/person/day, every year
SS	40	58 - 76	SS:BOD = 0.9:1

Table 3.6.5 Pollution Load per Person, Divided into Water for Miscellaneous Uses and Nightsoil

(Unit: g/person/day)

Item	1970		1990		Remarks
	Night-soil	Water for miscellaneous uses	Night-soil	Water for miscellaneous uses	
BOD_5	13	31	13	51 - 71	Values in 1970 were based on the Survey by Ministry of Construction
SS	10	30	10	48 - 66	

* Japan Sewage Works Association, Design Criterion for Sewage Works Facilities.

(2) The quality of domestic-sewage can be calculated by dividing the standard value of pollution load per person by the maximum sewage volume per person per day. In Japan, the ordinary BOD_5 and SS are about 200 mg/lit.

From the above calculations of pollution load per person, an estimate is made about the pollution load of the present project area and the quality of water for domestic use is calculated.

These figures correspond to the figures applicable to Japan around the year 1965.

Table 3.6.6 Pollution Load per Person

(Unit: g/person/day)

Item	Nightsoil	Water for miscellaneous uses	Total
BOD_5	13	*1 23	36
SS	10	*2 22	32

*1: 31 - 1.5 x 5 = 23

*2: SS:BOD = 0.9:1

SS 36 x 0.9 ≑ 32 32 - 10 = 22

Planned water quality of domestic sewage:

The quality is calculated from the above unit of pollution, with the volume of sewage estimated as 240 lit./person/day.

BOD_5 : 36 ÷ 240 x 10^3 = 150 mg/l

SS : 32 ÷ 240 x 10^3 = 133 mg/l

Although the above values are obtained, planning was made with BOD_5 = 200 mg/lit. and SS = 150 mg/lit.

3) Day Trippers

Pollution load was calculated with the same values as that of residents:

BOD_5 = 200 mg/lit.
SS = 150 mg/lit.

4) Restaurants

Tests of water quality of sewage from restaurants revealed the water to be highly polluted. The tested BOD_5 values were especially high since the tested wastewater was stored in tanks after having been used for washing. If this wastewater was mixed with other wastewater, its BOD_5 load could reach 200 mg/lit. and SS, 150 mg/lit.

5) Wastewater from factories

As mentioned in 3.6.1, planning was made on the basis of sewage from tapioca factories with BOD_5 = 300 mg/lit. and SS = 200 mg/lit.

3.6.3 Annual Amount of Wastewater

The annual amount of wastewater was calculated by classifying its sources into:

(a) Hotels and bungalows
(b) Residents
(c) Day trippers
(d) Restaurants
(e) Industry

The procedure for calculating the amount of wastewater is shown in Fig. 3.6.2.

(a) Hotels and Bungalows

1) Prevalence ratio of sewage

In the present plan 100% of the hotels and bungalows will have sewage treatment facilities. Presently, 2 or 3 hotels possess sewage treatment facilities which are operating satisfactorily. It is assumed that hotels with such facilities will gradually change by discharging their treated water into the public sewerage system. The present plan assumes that by 1986 the wastewater of all hotels will be treated by the public system.

With regard to the bungalows located along the low-lying beach area between Na Klua rnd Pattaya, the collection of wastewater therein is very difficult, and it would be necessary to install pumping stations in order to pump up the wastewater to the treatment plants.

Thus, in the present plan it is assumed that the bungalows will treat their wastewater individually. However, the treatment plant will be provided with an area and capacity sufficient to treat wastewater from the bungalows. With regard to the piping of wastewater to the treatment plant, the diameter of the pipes will not be significantly influenced because the volume of wastewater from bungalows will be insignificant. The pipes have been designed, taking into consideration the possibility of accommodating the wastewater from the bungalows.

2) Distribution of rooms

In the distribution of rooms of hotels and bungalows, 3,600 rooms of the actually existing hotels are taken into consideration. The number of rooms (700 rooms) to be added in Phase I (1986) are assumed to be distributed in the area where hotels already exist, and 4,400 rooms (hotels-3,000 rooms, (bungalows-1,400 rooms) to be added in Phase II (1996) are assumed to be constructed in the hotel and bungalow zones in the South.

The number of hotel rooms in 1986 and 1996 is shown in the following Table 3.6.7.

Fig. 3.6.2 Sources of Sewage

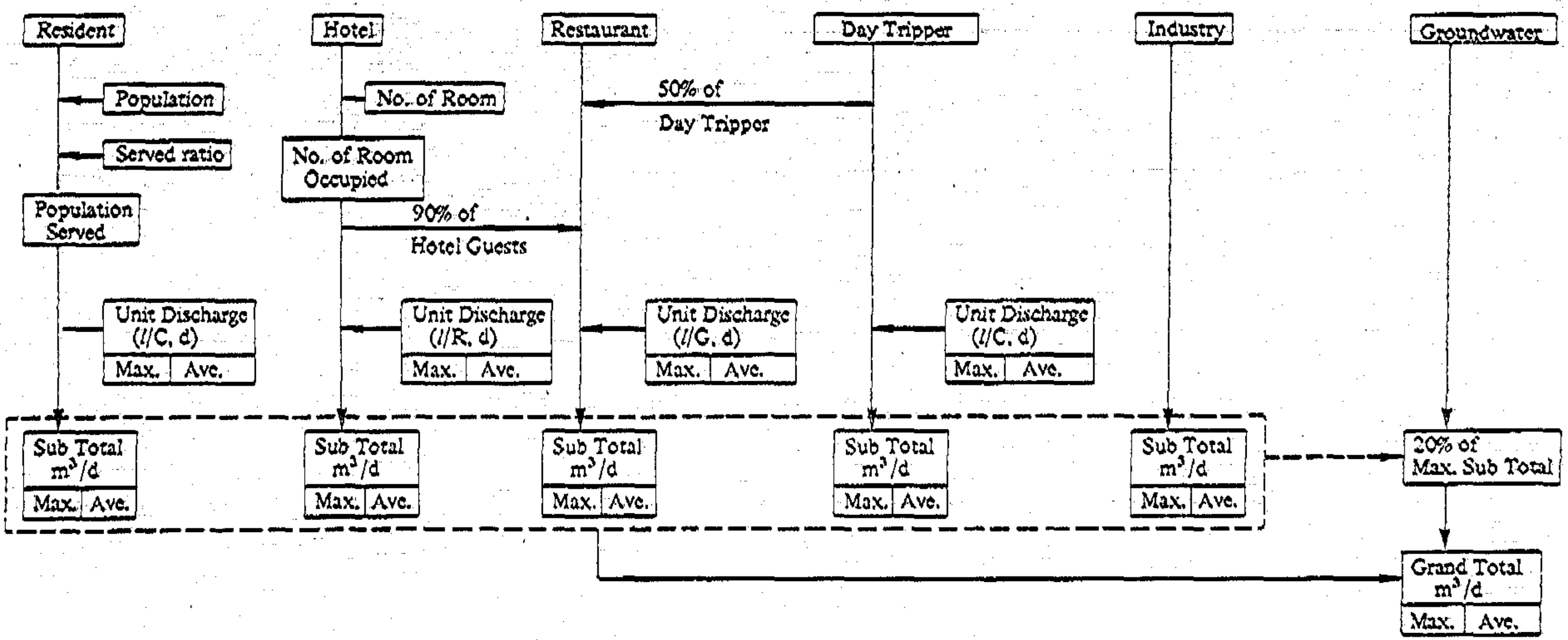


Table 3.6.7 Number of Hotel Rooms

Year	Situation	A Area	B Area	C Area	Ko Lan Island	Total
		room	room	room	room	room
1981	Existing	90	2,260	1,170	80	3,600
	Future	-	-	-	-	-
	Total	90	2,260	1,170	80*	3,600
1986	Existing	90	2,260	1,170	-	3,600
	Future	-	430	100	250	700
	Total	90	2,690	1,270	250	4,300
1991	Existing	90	2,260	1,170	-	3,600
	Future	-	430	2,400	250	3,000
	Total	90	2,690	3,570	250	6,600
1996	Existing	90	2,260	1,170	-	3,600
	Future	-	430	4,500	250	5,100
	Total	90	2,690	5,670	250	8,700

* By 1986, the 80 rooms on Ko Lan Island will be used as residences of employees.
Areas A, B and C are shown in Figure 3.6.3.

With regard to the distribution of rooms, existing hotels with 100 or more rooms shown seperately, are assumed to retain their present number of rooms, and the other rooms being alloted to the bungalow areas. With the exception of Tropicana Hotel where 200 rooms will be added in their expansion plan.

Fig. 3.6.3 Hotel and Bungalow Areas Dividing Plan

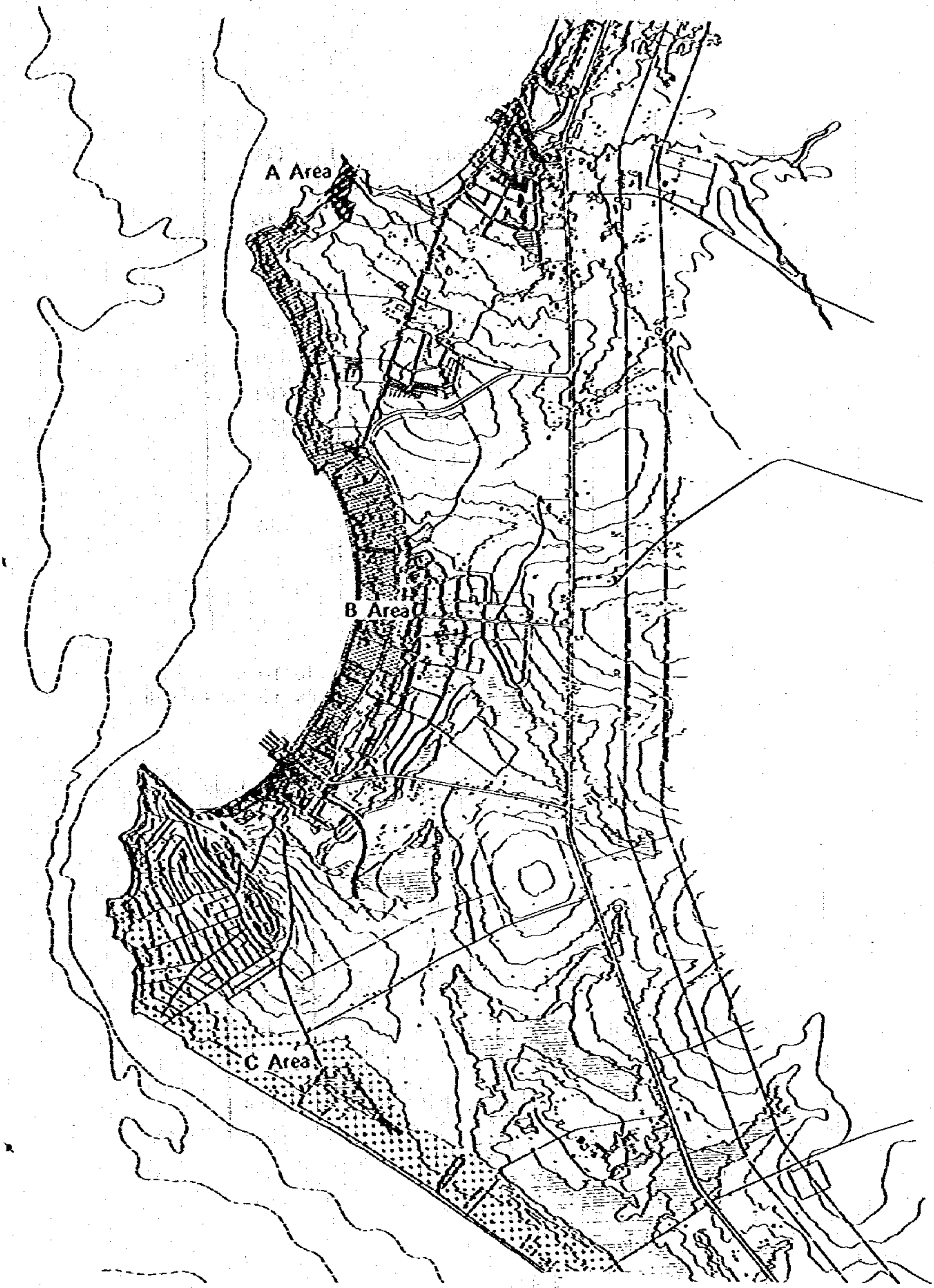


Table 3.6.8 Present Distribution of Hotel Rooms

(TOT, 1978)

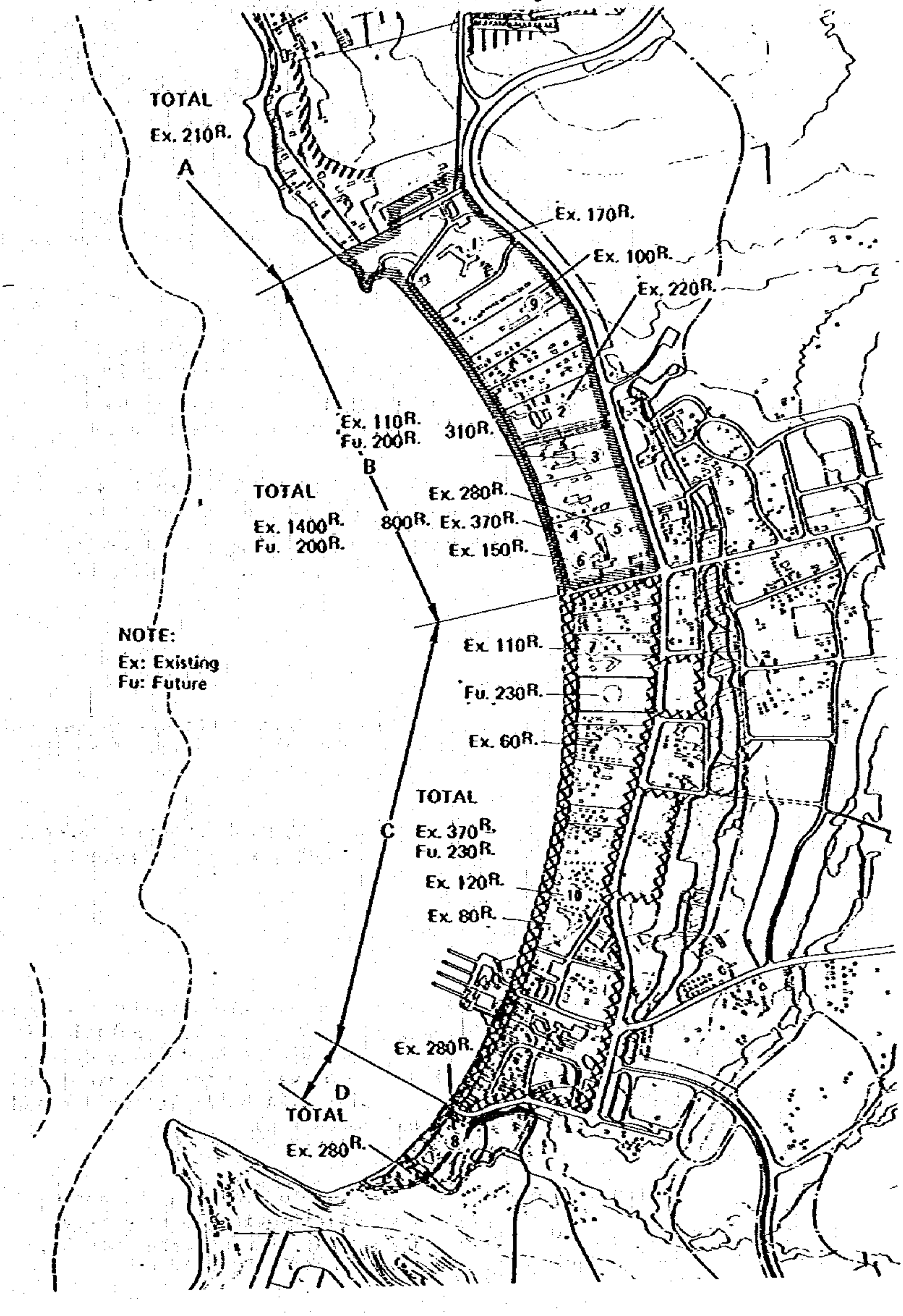
Number	Accommodation in Pattaya No.	Name	No. of Rooms
1	19	Orchid Lodge	170
2	9	Hyatt Pattaya	220
3	41	Tropicana	110
4	10	Holiday Inn	370
5	27	Regent Pattaya	280
6	16	Nipa Lodge	150
7	18	Ocean View	110
8	31	Siam Bayshore	280
9	45	Weekender Hotel	100
10	26	Royal Garden Hotel	120
11	25	Royal Cliff	650
12	1	Asia Pattaya	270
Total			2,830

The distribution of rooms in hotels and bungalows is as follows. Table 3.6.9 shows the distribution of the existing and new rooms in the hotels in the blocks (A) (B) (C), and (D) in Figure 3.6.4.

Table 3.6.9 Distribution of Rooms in Hotels and Bungalows

Situation	B Area				
	(A)	(B)	(C)	(D)	Total
Existing	210	1,400	370	280	2,260
Future	-	200	230	-	430
Total	210	1,600	600	280	2,690

Fig. 3.6.4 Distribution of Hotel and Bungalow Room Number



For the detailed distribution in respective blocks, the number of rooms of the large-scale hotels mentioned before is first determined. The distribution of the remaining rooms is obtained from the number of bungalows counted from a 1/2000 scale map and data provided by the T.O.T. Pattaya Office.

(A) block: The existing 210 rooms are distributed as shown in the attached figure.

(B) block: The existing 1,400 rooms all belong to the large hotels. The new 200 rooms to be added will belong to the Tropicana Hotel.

(C) block: Of the 360 existing rooms, 230 belong to the existing two large hotels, and the remaining 140 rooms to be allocated to two hotels as shown in the attached figure considering the distribution of bungalows.

The new 230 rooms to be added are assumed to be distributed in A block which was determined optimum in the Master Plan.

(D) block: The existing 280 rooms will belong to a single large hotel.

The existing and the new rooms of hotels were distributed as described above, and the quantity of influent wastewater to each sewer pipe was calculated.

(b) Residents

1) Prevalence rate of sewage

A 100% prevalence rate of sewage facilities among the residents is assumed. Although in the master plan, a prevalence rate of 100% is assumed in the planned residential areas, and 70% is assumed in the areas where the existing situation will be retained.

The present plan assumes a prevalence rate of 100%, with sewage treatment facilities to treat the whole quantity of wastewater from the project area.

2) Na Klua Town A, B and Northern New Town

(1) Phase I

In Phase I, the population density in respective blocks will be calculated based upon the land use plan. First, in Phase I, population is allocated into respective blocks, based on population density determined by the land use plan. Total volume of wastewater is calculated by each block accordingly, and Phase I plan will be implemented based on the unit discharge obtained per unit area (ha).

Na Klua Town A:-

In Phase I, Na Klua Town A will be divided into blocks A, B, and C, as shown in Fig. 3.6.5. The population distribution in respective blocks are shown in table 3.6.10. The amount of wastewater per ha. is calculated accordingly as shown in Table 3.6.10.

Table 3.6.10 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Block	Population density person/ha	Quantity of Wastewater		
		Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec.ha
A	78.1	0.000434	0.000043	0.000477
B	58.8	0.000327	0.000033	0.000360
C	139.9	0.000778	0.000078	0.000856

Na Klua Town B:

As shown in Fig. 3.6.6, Na Klua Town B is divided into blocks A and B. The population distribution in these two blocks and the amount of wastewater therein are shown in Table 3.6.11.

Table 3.6.11 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Block	Population density person/ha	Quantity of Wastewater		
		Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec.ha
A	86.3	0.000479	0.000048	0.000527
B	96.5	0.000536	0.000054	0.000590

Northern New Town:

In Phase I, the Northern New Town is divided into three blocks, namely, A, B and C, as shown in Figure 3.6.7.

Table 3.6.12 shows the amount of wastewater, calculated as in the preceding cases.

Table 3.6.12 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Block	Population density person/ha	Quantity of Wastewater		
		Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec.ha
A	77.4	0.000430	0.000043	0.000473
B	79.7	0.000443	0.000044	0.000487
C	98.9	0.000549	0.000055	0.000604

(2) Phase II

The areas covered in Phase II are the same as in Phase I. Since some of the details regarding the roads and streets are still unclear, subdivision is made to those roads and streets already known.

Na Klua Town A:

As shown in Fig. 3.6.5, Na Klua Town A will be divided into two blocks D and E. Population is distributed to each block according to the land area calculated by land use plan (including areas for public use) as shown in the attached table. The volume of wastewater per hectare is obtained based on population density as shown in the table below.

Table 3.6.13 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Block	Population density person/ha	Quantity of Wastewater		
		Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec.ha
D	95.1	0.000528	0.000053	0.000581
E	116.3	0.000646	0.000065	0.000711

Northern New Town:

The Northern New Town is divided into blocks D, E and F, as shown in Fig. 3.6.7. The amount of wastewater per ha. (caluclated as in the preceding cases) is presented in Table 3.6.14.

Table 3.6.14 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Block	Population density person/ha	Quantity of Wastewater		
		Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec.ha
D	110.8	0.000616	0.000062	0.000678
E	103.1	0.000573	0.000057	0.000630
F	104.1	0.000578	0.000058	0.000636

3) Hotel area

In the hotel area (including the east side of the Road T-1; refer to Fig. 3.6.8) the population of 8,000 inhabitants is assumed to be distributed uniformly over the hotel area, the commercial area, and the "amenity core."

The hotel area:

Amenity core	Main	25.5 ha
	Northern	7.4 ha
	Sub total	32.9 ha
Commercial area	3.1 + 3.7 =	6.8 ha
Hotel area		
34.2+19.4+31.9+3.6+9.3+9.3 =		107.7 ha
Total		147.4 ha

Population: 8,000 inhabitants
Average population density: 54.3 inhabitants/ha

Table 3.6.15 Amount of Wastewater per ha.

(Maximum hourly quantity of wastewater)

Population density person/ha	Quantity of Wastewater		
	Domestic m^3/sec.ha	Groundwater m^3/sec.ha	Total m^3/sec/ha
54.3	0.000302	0.000030	0.000332

4) Area to be maintained in its present condition

In the area to be maintained in its present condition, the volume of residential wastewater which will be discharged into public severage system was calculated by allocating the residences to the nearest trunk sewage lines.

Fig. 3.6.5 Population Density in Each Area of Na Klua Town 'A'

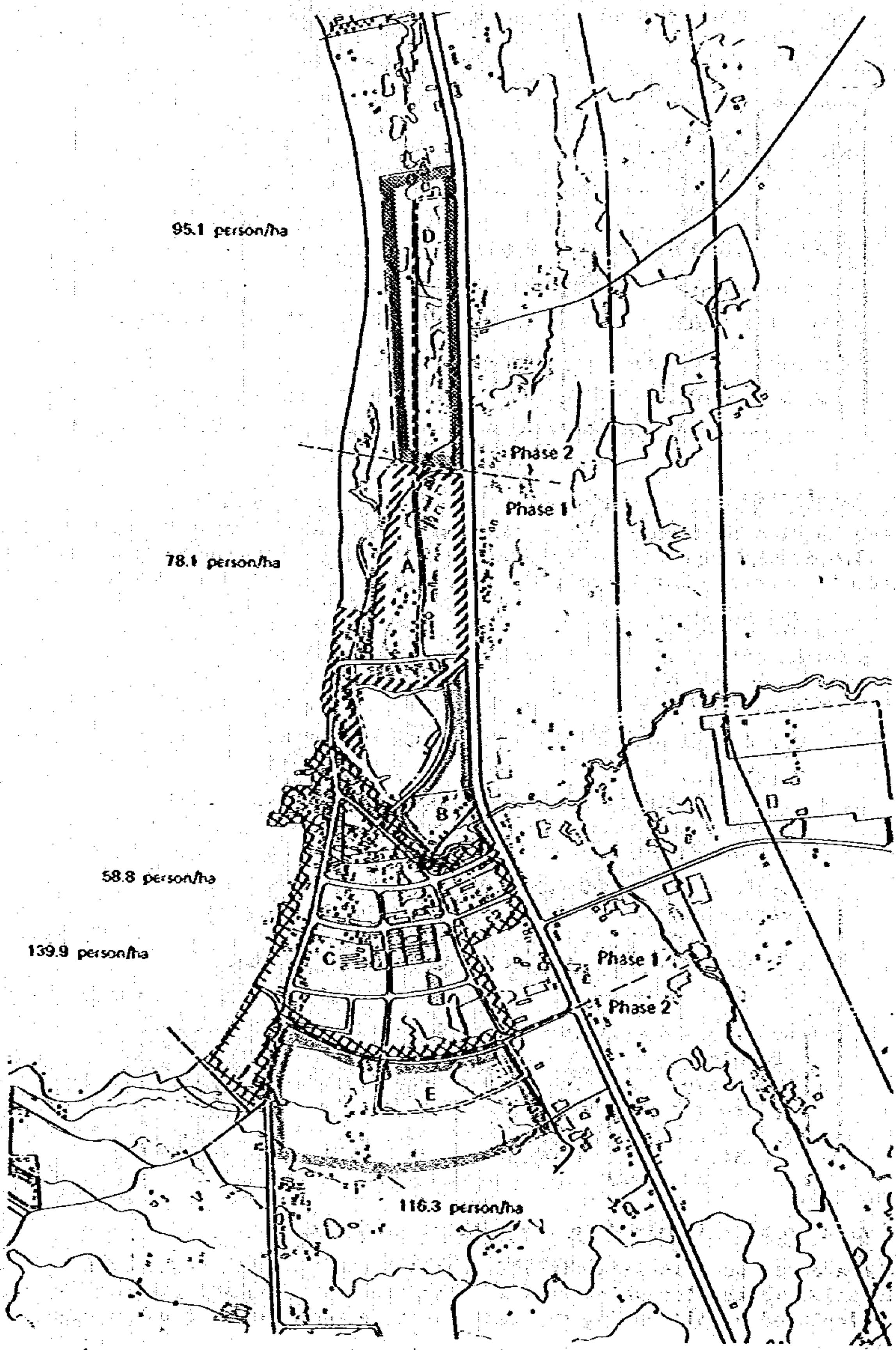


Fig. 3.6.6 Population Density in Each Area of Na Klua Town 'B'

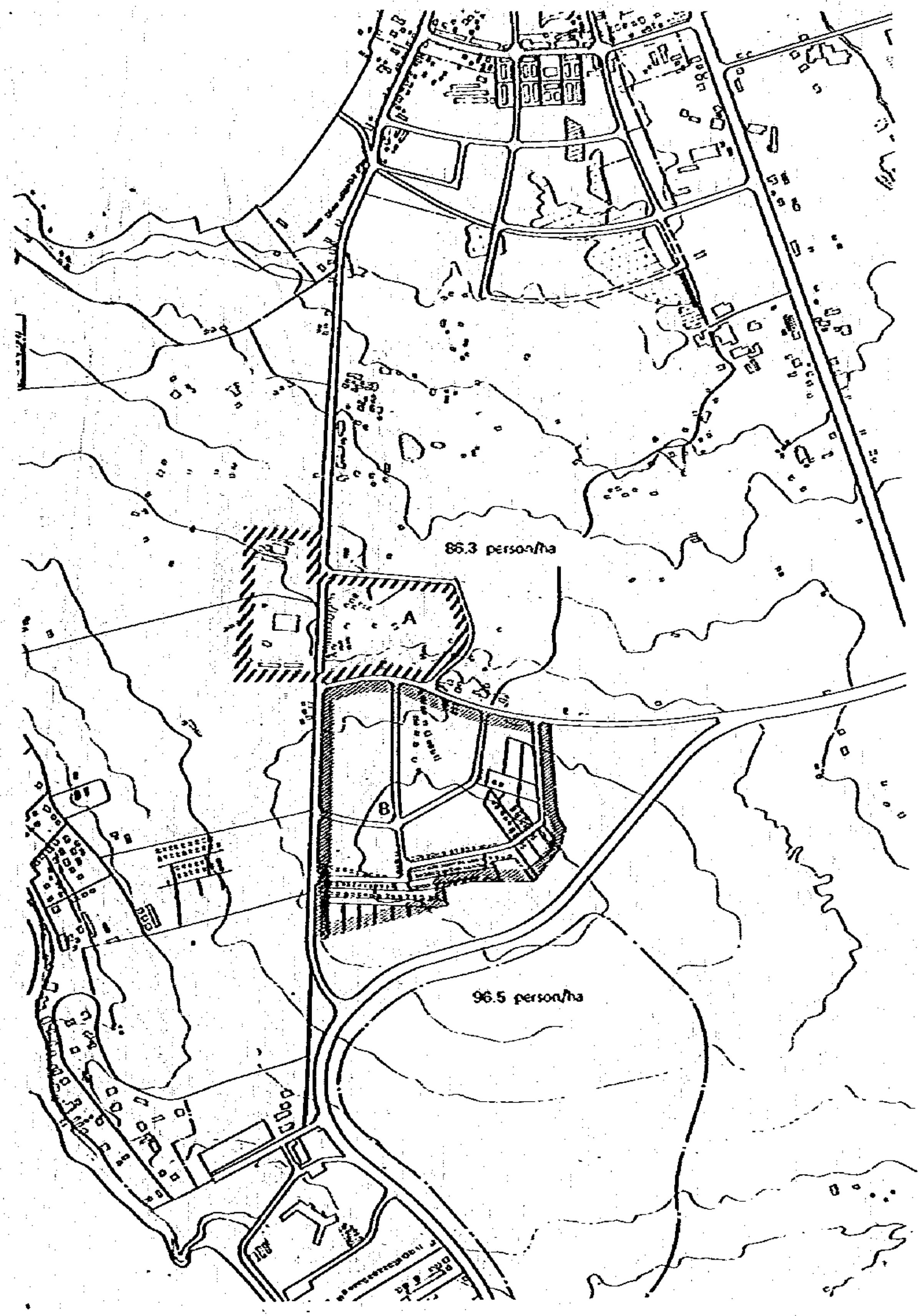


Fig. 3.6.7 Population Density in Each Area of Northern New Town

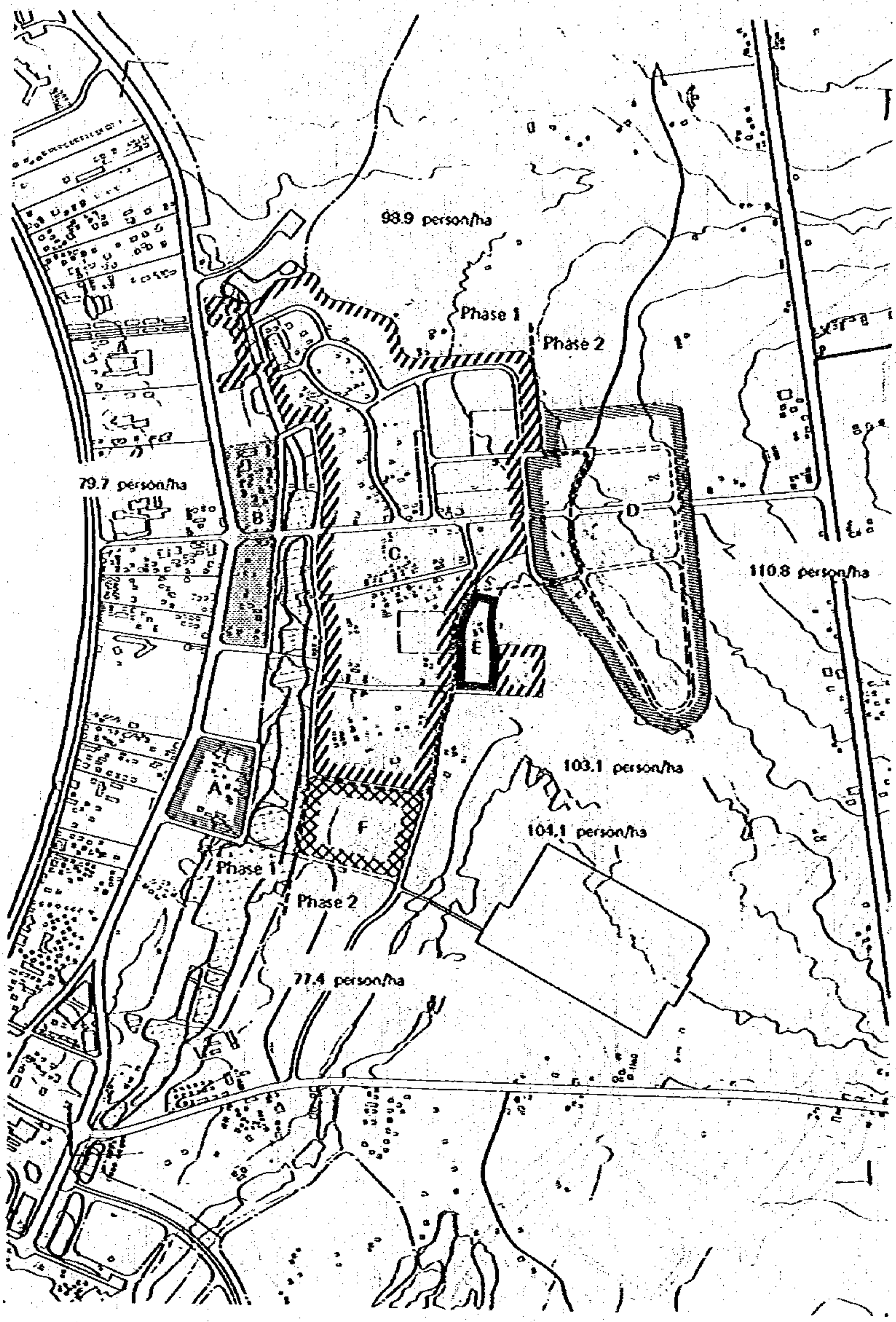
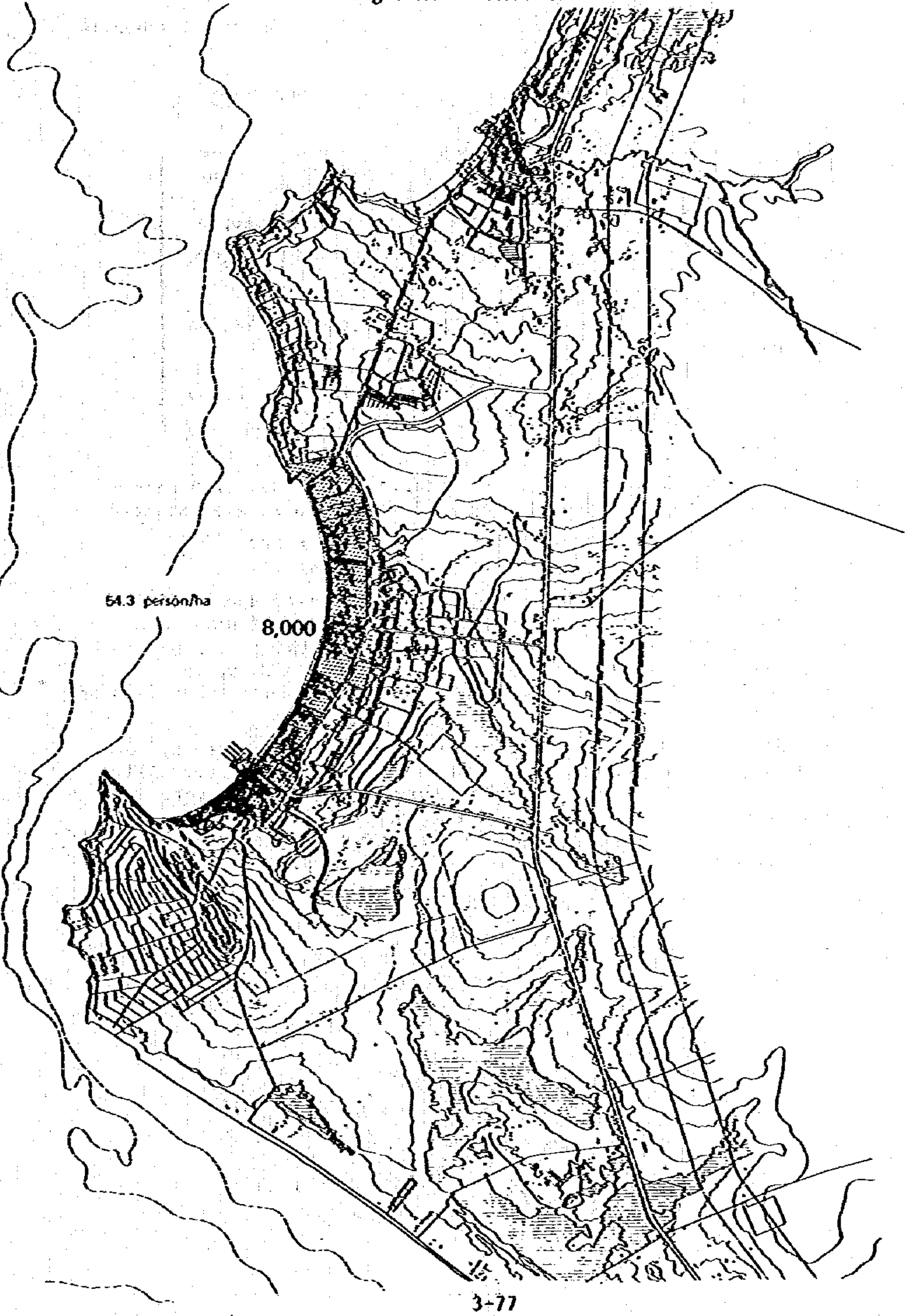


Fig. 3.6.8 Hotel Area



(c) Day Trippers

The number of day trippers is anticipated to follow the trend shown in Table 3.6.16 according to the master plan of JICA.

Table 3.6.16 Anticipated Trend in Number of Day Trippers

Year		1981	1986	1996
Number of trippers	Annual	people 458,000	people 625,000	people 960,000
	Daily Maximum	5,500	7,500	12,000
	Daily Average	1,300	1,700	2,600

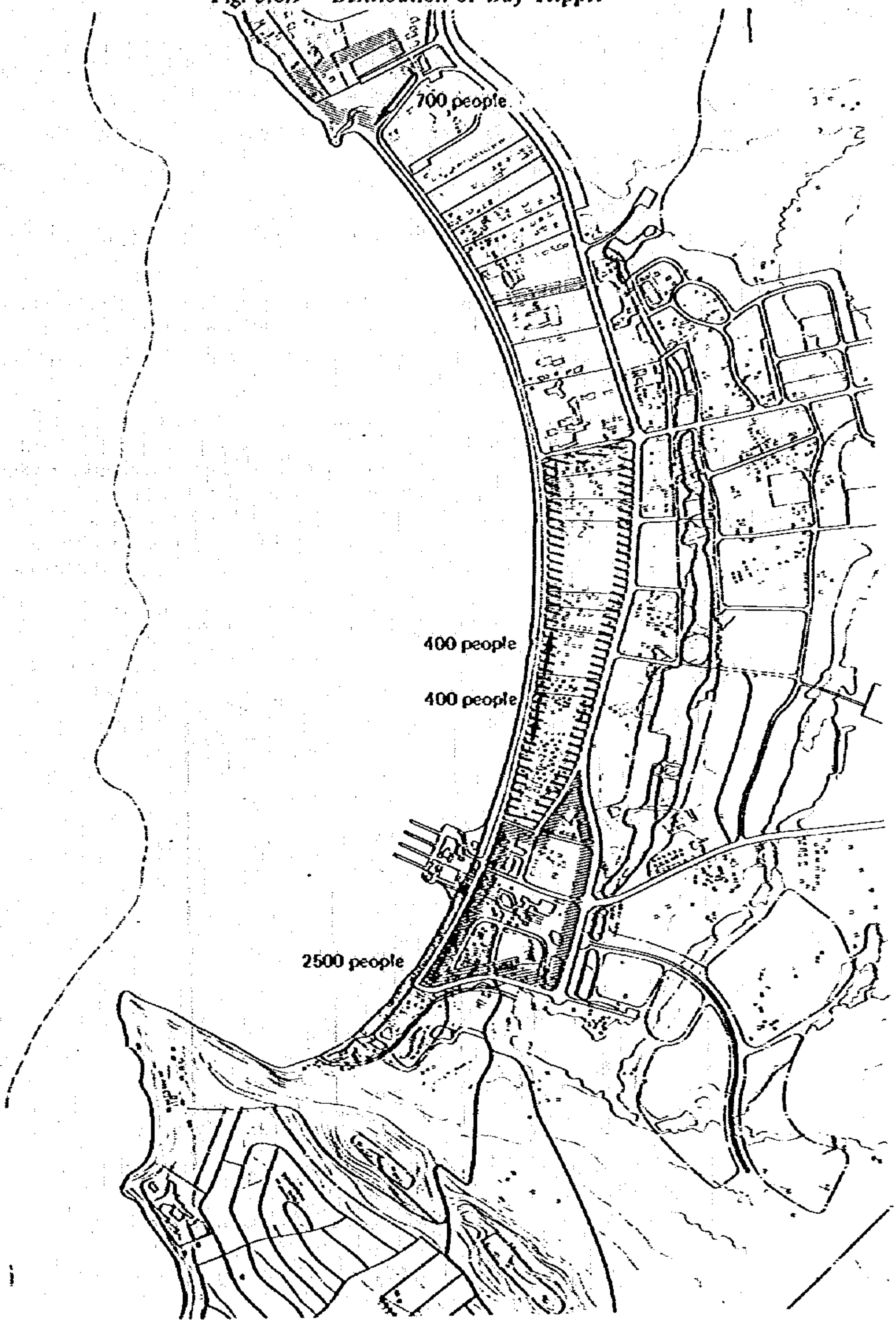
In Phase I, 7,500 day trippers are expected to visit the north site of Pattaya Hill, and in Phase II, the following numbers are expected:

North Site of Pattaya Hill: 4,000 persons
South Site of Pattaya Hill: 8,000 persons

The north site of Pattaya Hill should be planned based upon 7,500 people of Phase I. However, since the nit discharge of day trippers is relatively small, the diameter of the pipings can be designed based upon 4,000 people of Phase II (1996). Thus, in the present plan the piping diameters are determined based upon data of Phase II.

Since the day trippers are assumed to concentrate in the amenity core and on the beach, the present plan assumes that the wastewater will go into the upstream point of the pipeline serving the amenity core and the beach. The day trippers at the north site of Pattaya Hill are assumed to concentrate in the hotel area, with the distribution shown in Fig. 3.6.9. A sewerage system prevalence rate of 100% is assumed.

Fig. 3.6.9 Distribution of Day Tripper



(d) Restaurants

Like the day trippers, the restaurants will be distributed along the amenity core and the Pattaya downtown area. The distribution of restaurant users will be similar to the distribution of day trippers.

According to the master plan, 50% of the day trippers and 90% of the hotel guests will use the restaurants.

(e) Industrial Wastewater

° The quantity of industrial wastewater expected for 1996 is 5,000 m^3/day (daily maximum).

° The amount of wastewater in the various factories is calculated based upon the Data of Tapioca Factories in Bang Lamung.

° The factories existing in Phase II area of Na Klua Town A are not eliminated, because they already exist in Phase I.

° Since the future situation of the factories which are not presently in operation is not clearly known, they are not assumed to be eliminated either. However, since the quantity of wastewater from Factory No. 20 is not clearly known even in the data mentioned above, it is taken here to be zero. Assuming a total quantity of 5,000 m^3/day, wastewater from various factories will have the following distribution:

Table 3.6.17 Amount of Wastewater from Various Factories

Number*	Q'ty of wastewater	Number*	Q'ty of wastewater
	m^3/D		m^3/D
1	180	13	120
2	180	14	120
3	180	15	120
4	120	16	270
5	120	17	40
6	120	18	120
7	100	19	20
8	120	20	-
9	100	21	90
10	180	22	180
11	2,400	Total	5,000
12	120		

* No. is shown in Fig. 3.6.1.

Factory No.11 is First Grade, and is provided with its own wastewater treatment facility, being therefore excluded from the present plan. The planned volume of wastewater in respective years, which were calculated based upon the conditions mentioned above, are presented in Table 3.6.18 and Table 3.6.19.

Since the sewage pipings are planned to be constructed together with the roads, the actual quantity of wastewater discharged into the sewer pipe will be smaller than the planned quantity for 1981.

In 1986 the construction of the pipings of Phase I will be finished, and as a consequence, the quantity of influent wastewater will coincide with the planned quantity. Figure 3.6.10 and Figure 3.6.11 show the construction works to be executed in respective years.
Tables 3.6.20 and 3.6.21 show the quantity of influent wastewater in respective years in the plan.

(f) Groundwater

In the case of separate sewerage system besides wastewater, groundwater flows into the pipes from jointed points of the pipings.

Thus, when planning the collection pipe and the wastewater treatment facilities, the quantity of groundwater should also be taken into consideration.

In the present plan, the quantity of influent groundwater is assumed to be 20% of the daily maximum of wastewater by 1996.

The following shows the volume of groundwater in the Na Klua area and in the Pattaya area.

Na Klua Area	13,630 m^3/d x 20% = 2,730 m^3/d
(Excluding the wastewater of First Grade tapioca factories and bungalows)	11,080 m^3/d x 20% = 2,220 m^3/d
Pattaya Area	11,900 m^3/d x 20% = 2,380 m^3/d
(Excluding the wastewater of bungalows)	11,570 m^3/d x 20% = 2,320 m^3/d

Table 3.6.18 Expected Volumes of Wastewater (Daily Average)

A Area (Na Klua)

Note: Figures in parenthesis include bungalows and tapioca factories of 2,400m3

Year	Resident					One Day Tripper			Hotel						Restaurant			Industry	Sewage Quantity		
	Population	Unit Demand	% of Service	Sewage Quantity		Population	Unit Demand	Sewage Quantity	No. of Room			% of Use	Unit Demand	Sewage Quantity	Population	Unit Demand	Sewage Quantity		Sub Total	Ground Water 20%	Total
	head	l/h.d		m^3/d	Total m^3/d	head	l/h.d	m^3/d	Existing	Newly	Total		$m^3/r.d$	m^3/d	head	l/h.d	m^3/d	m^3/d	m^3/d	m^3/d	
1981	*1 12,800 *2 8,400	137 137	100 100	1,760 1,150	2,910	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	5,510 (7,990)	1,420 (1,930)	6,930 (9,920)
1986	*1 18,300 *2 8,400	144 144	100 100	2,640 1,210	3,850	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	6,450 (8,930)	1,700 (2,210)	8,150 (11,140)
1991	*1 21,950 *2 9,700	150 150	100 100	3,300 1,460	4,760	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	7,360 (9,840)	1,980 (2,490)	9,340 (12,330)
1996	*1 25,600 *2 9,700	157 157	100 100	4,020 1,530	5,550	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	8,150 (10,630)	2,220 (2,730)	10,370 (13,360)

*1 : Population of Town or Hotel Area

*2 : Population along the Main Street

B Area (Pattaya)

Year	Resident					One Day Tripper			Hotel						Restaurant			Industry	Sewage Quantity		
	Population	Unit Demand	% of Service	Sewage Quantity		Population	Unit Demand	Sewage Quantity	No. of Room			% of Use	Unit Demand	Sewage Quantity	Population	Unit Demand	Sewage Quantity		Sub Total	Ground Water 20%	Total
	head	l/h.d		m^3/d	Total m^3/d	head	l/h.d	m^3/d	Existing	Newly	Total		$m^3/r.d$	m^3/d	head	l/h.d	m^3/d	m^3/d	m^3/d	m^3/d	
1981	*1 11,600 *2 10,100	137 137	100 100	1,590 1,390	2,980	1,900	30	60	2,050 (2,260)	-	2,050 (2,260)	95	0.85	1,660 (1,830)	4,170	20	90	-	4,790 (4,960)	1,660 (1,730)	6,450 (6,690)
1986	*1 15,400 *2 10,100	144 144	100 100	2,220 1,460	3,680	2,500	30	80	2,050 (2,260)	430	2,480 (2,690)	95	0.85	2,010 (2,180)	5,060	20	100	-	5,870 (6,040)	2,040 (2,110)	7,910 (8,150)
1991	*1 17,700 *2 10,100	150 150	100 100	2,660 1,520	4,180	2,500	30	80	2,050 (2,260)	430	2,480 (2,690)	95	0.85	2,010 (2,180)	5,060	20	100	-	6,370 (6,540)	2,200 (2,260)	8,570 (8,800)
1996	*1 20,000 *2 10,100	157 157	100 100	3,140 1,590	4,730	1,400	30	50	2,050 (2,260)	430	2,480 (2,690)	95	0.85	2,010 (2,180)	4,510	20	90	-	6,880 (7,050)	2,320 (2,380)	9,200 (9,430)

Table 3.6.19 Expected Volumes of Wastewater (Daily Maximum)

A Area (Na Klua)

Note: Figures in parenthesis include bungalows and tapioca factories of 2,400m³.

Year	Resident: Population head	Resident: Unit Demand l/h.d	Resident: % of Service	Resident: Sewage Quantity m³/d	Resident: Sewage Quantity Total m³/d	One Day Tripper: Population head	One Day Tripper: Unit Demand l/h.d	One Day Tripper: Sewage Quantity m³/d	Hotel: No. of Room Existing	Hotel: No. of Room Newly	Hotel: No. of Room Total	Hotel: % of Use	Hotel: Unit Demand m³/r.d	Hotel: Sewage Quantity m³/d	Restaurant: Population head	Restaurant: Unit Demand l/h.d	Restaurant: Sewage Quantity m³/d	Industry m³/d	Sewage Quantity: Sub Total m³/d	Sewage Quantity: Ground Water 20% m³/d	Sewage Quantity: Total
1981	*1 12,800	210	100	2,690	4,460	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	7,060 (9,610)	1,420 (1,930)	8,480 (11,540)
	*2 8,400	210	100	1,770																	
1986	*1 18,300	220	100	4,030	5,880	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	8,480 (11,030)	1,700 (2,210)	10,180 (13,240)
	*2 8,400	220	100	1,850																	
1991	*1 21,950	230	100	5,050	7,290	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	9,890 (12,440)	1,980 (2,490)	11,870 (14,930)
	*2 9,700	230	100	2,240																	
1996	*1 25,600	240	100	6,150	8,480	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	11,080 (13,630)	2,220 (2,730)	13,300 (16,360)
	*2 9,700	240	100	2,330																	

*1 : Population of Town or Hotel Area

*2 : Population along the Main Street

B Area (Pattaya)

Year	Resident: Population head	Resident: Unit Demand l/h.d	Resident: % of Service	Resident: Sewage Quantity m³/d	Resident: Sewage Quantity Total m³/d	One Day Tripper: Population head	One Day Tripper: Unit Demand l/h.d	One Day Tripper: Sewage Quantity m³/d	Hotel: No. of Room Existing	Hotel: No. of Room Newly	Hotel: No. of Room Total	Hotel: % of Use	Hotel: Unit Demand m³/r.d	Hotel: Sewage Quantity m³/d	Restaurant: Population head	Restaurant: Unit Demand l/h.d	Restaurant: Sewage Quantity m³/d	Industry m³/d	Sewage Quantity: Sub Total m³/d	Sewage Quantity: Ground Water 20% m³/d	Sewage Quantity: Total
1981	*1 11,600	210	100	2,440	4,570	5,500	45	250	2,050 (2,260)	-	2,050 (2,260)	100	1.59	3,260 (3,600)	6,980	30	210	-	8,290 (8,630)	1,660 (1,730)	9,950 (10,360)
	*2 10,100	210	100	2,130																	
1986	*1 15,400	220	100	3,390	5,620	7,500	45	340	2,050 (2,260)	430	2,480 (2,690)	100	1.59	3,930 (4,280)	8,760	30	270	-	10,180 (10,510)	2,040 (2,110)	12,220 (12,620)
	*2 10,100	220	100	2,230																	
1991	*1 17,700	230	100	4,080	6,410	7,500	45	340	2,050 (2,260)	430	2,480 (2,690)	100	1.59	3,930 (4,280)	8,760	30	270	-	10,970 (11,300)	2,200 (2,260)	13,170 (13,560)
	*2 10,100	230	100	2,330																	
1996	*1 20,000	240	100	4,800	7,230	4,000	45	180	2,050 (2,260)	430	2,480 (2,690)	100	1.59	3,930 (4,280)	7,000	30	210	-	11,570 (11,900)	2,320 (2,380)	13,890 (14,280)
	*2 10,100	240	100	2,430																	

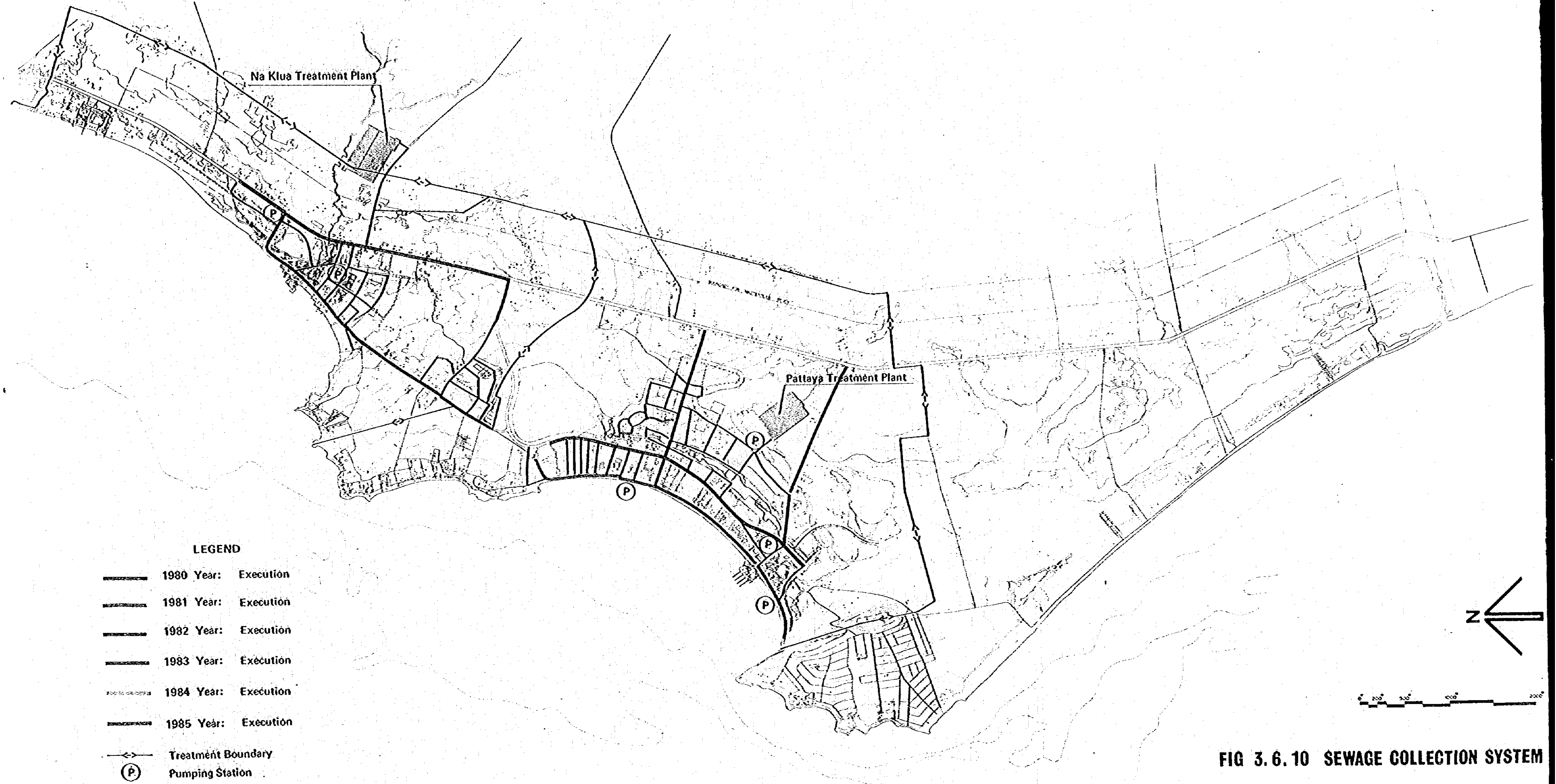


FIG 3.6.10 SEWAGE COLLECTION SYSTEM

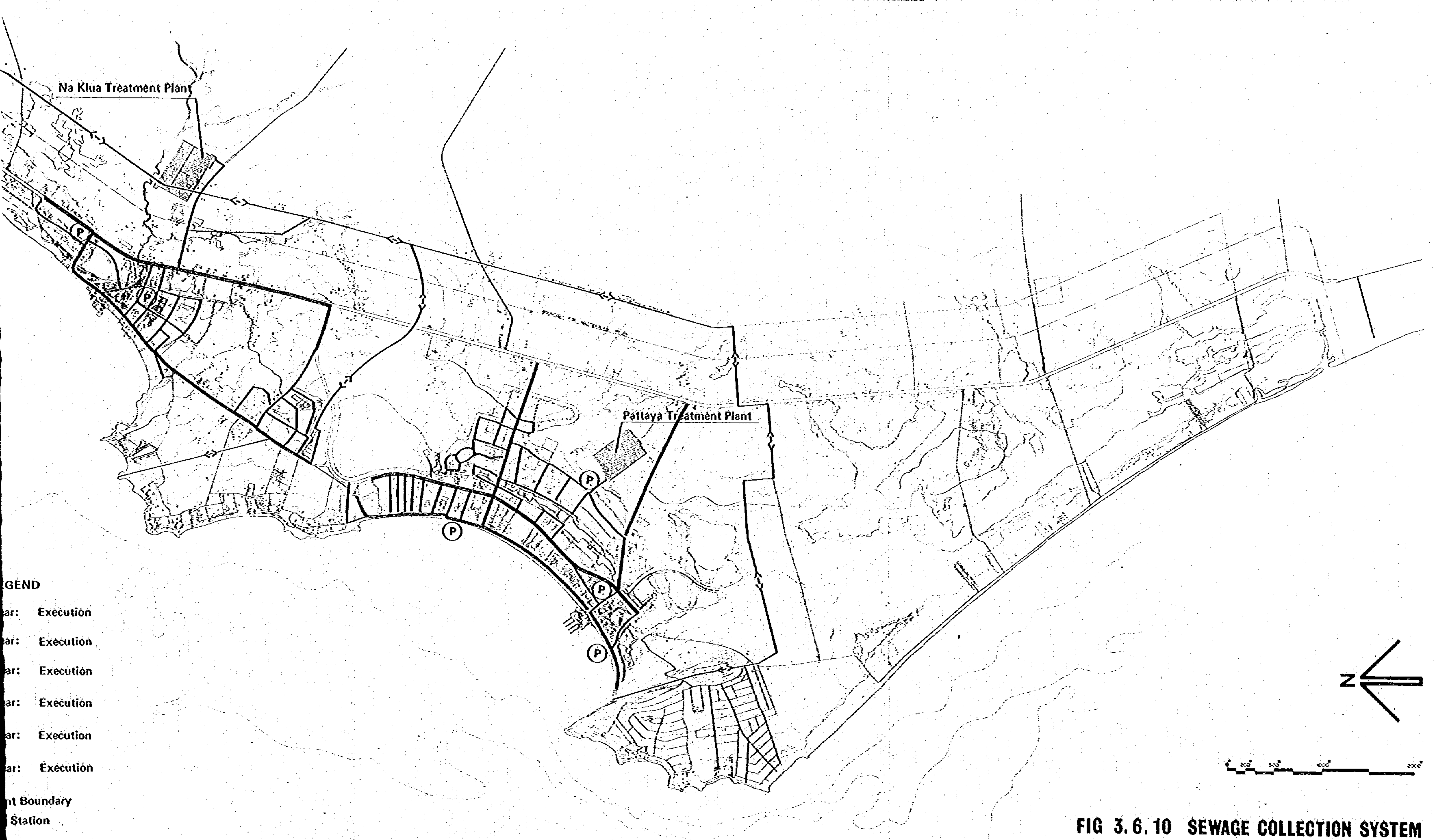


FIG 3.6.10 SEWAGE COLLECTION SYSTEM

Fig. 3.6.11 Development Plan in Na Klua Town 'A'

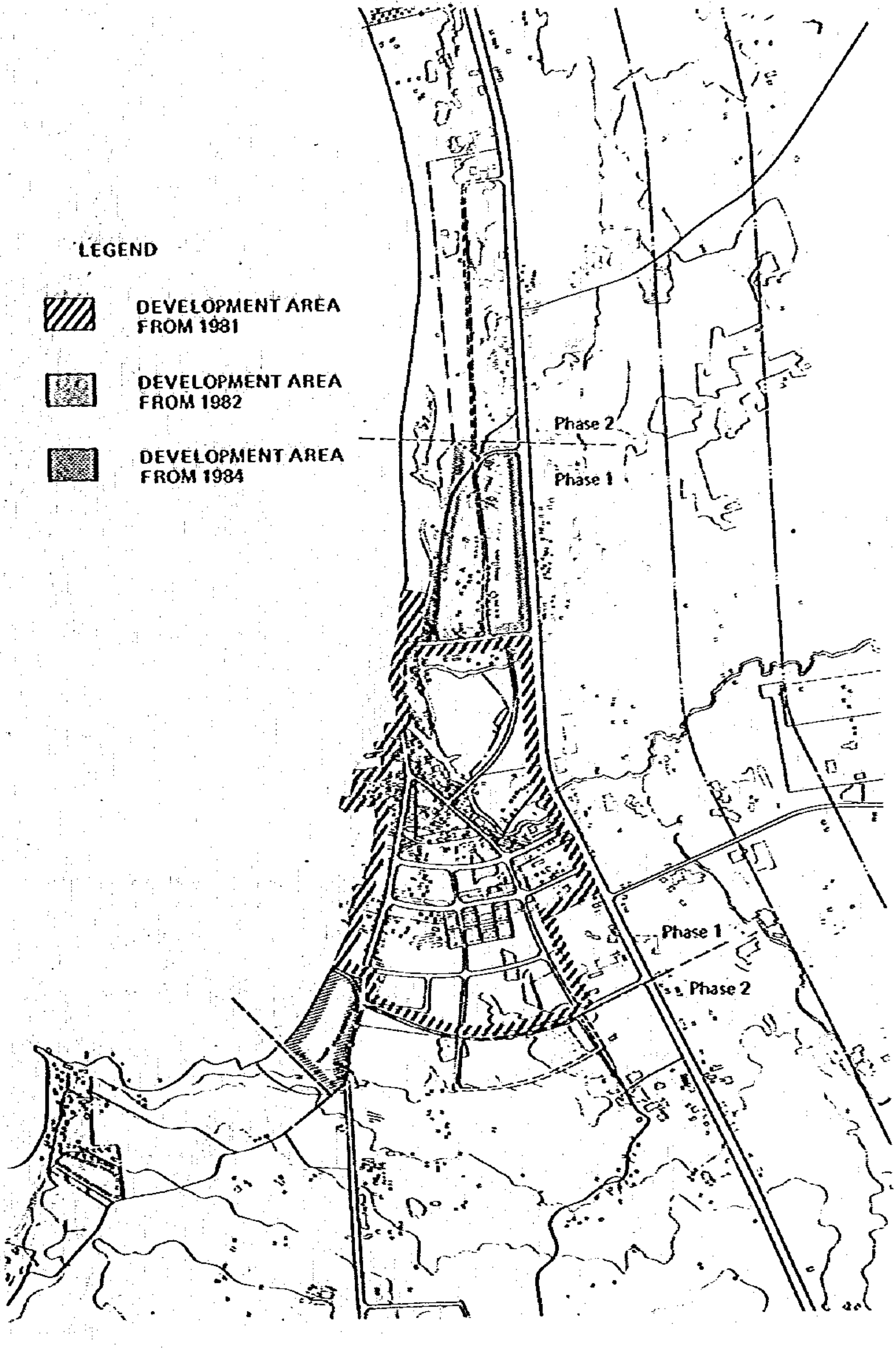


Fig. 3.6.12 Development Plan in Na Klua Town 'B'

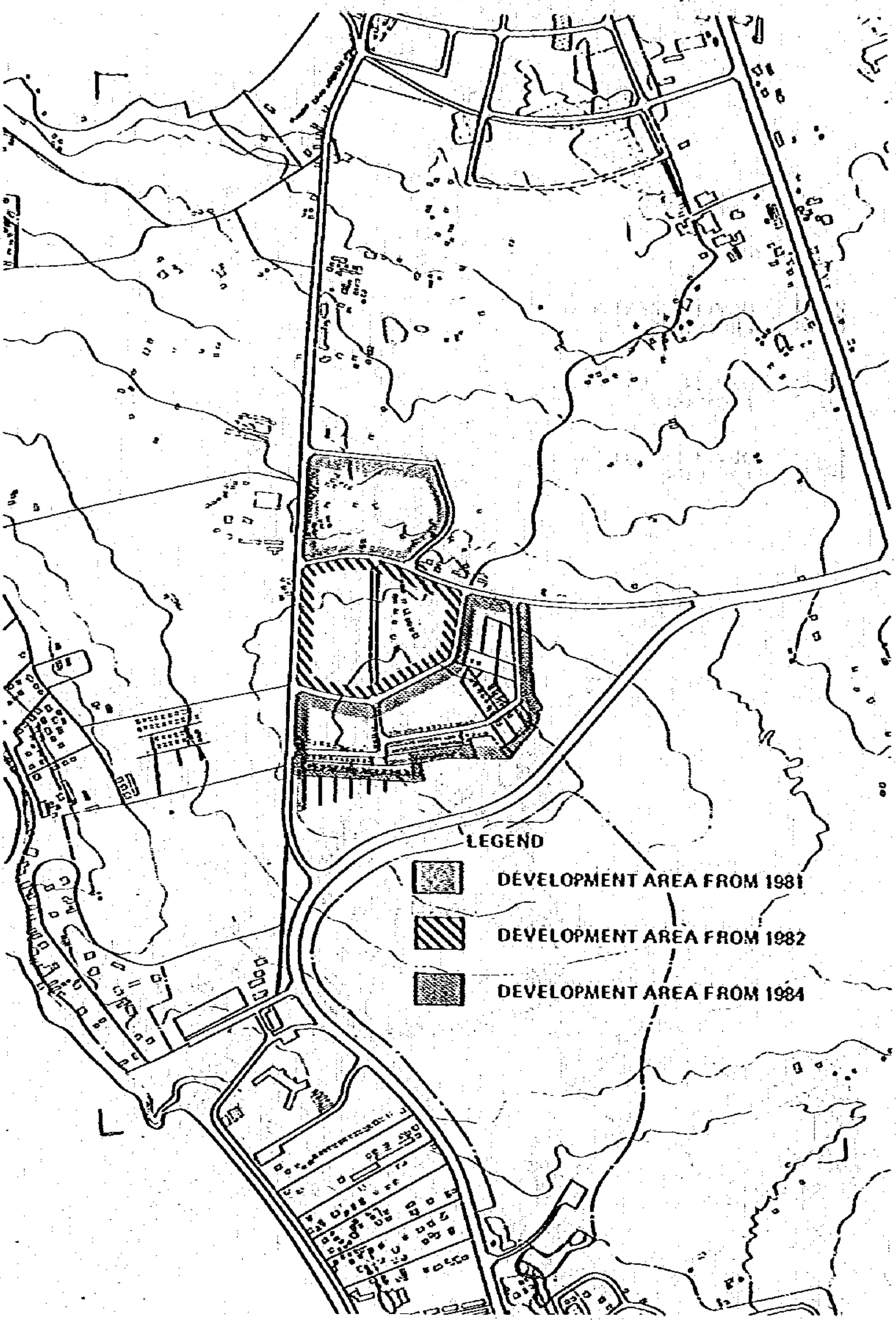


Fig. 3.6.13 Development Plan in Northern New Town

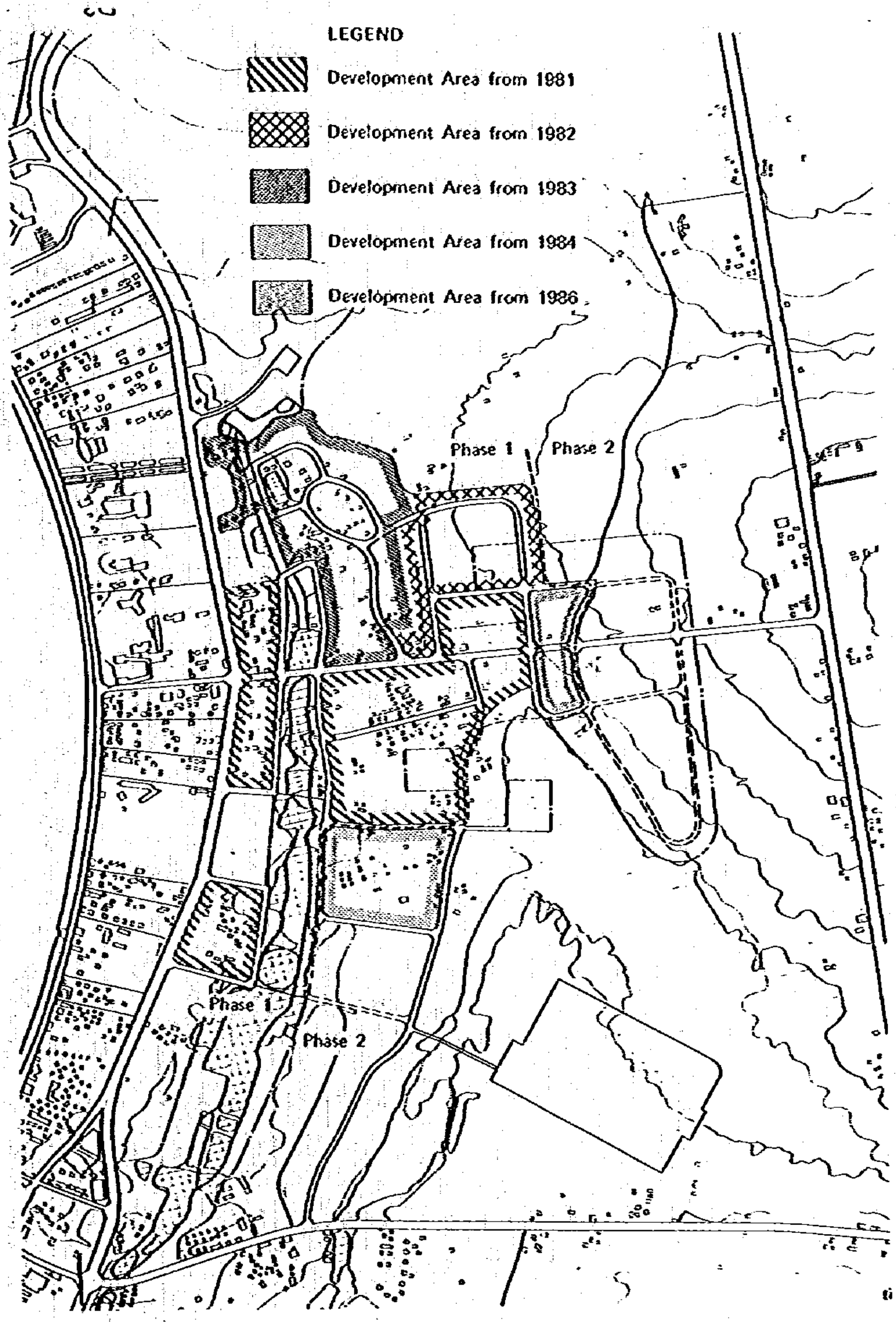


Table 3.6.20 Expected Volumes of Wastewater, in the Na Klua Area, in the Light of Planned Future Construction (Daily Average & Daily Maximum)

Na Klua

Note: Figures in parenthesis include bungalows and tapioca factories of 2,400m³.

	Year	Resident					One Day Tripper			Hotel						Restaurant			Industry	Sewage Quantity		
		Population head	Unit Demand l/h.d	% of Service	Sewage Quantity m³/d	Sewage Quantity Total m³/d	Population head	Unit Demand l/h.d	Sewage Quantity m³/d	No. of Room Existing	No. of Room Newly	No. of Room Total	% of Use	Unit Demand m³/r.d	Sewage Quantity m³/d	Population head	Unit Demand l/h.d	Sewage Quantity m³/d	m³/d	Sub Total m³/d	Ground Water 20% m³/d	Total
Daily Average	1981	12,800	137	100	1,760	2,090	-		-	-		-			-	-		-	2,600 (5,000)	4,690 (7,090)	1,160 (1,420)	5,850 (8,510)
		2,400	137	100	330																	
	1982	14,460	139	100	2,010	2,620	-		-	-		-			-	-		-	2,600 (5,000)	5,220 (7,620)	1,320 (1,520)	6,540 (9,140)
		4,400	139	100	610																	
	1983	16,080	141	100	2,270	3,170	-		-	-		-			-	-		-	2,600 (5,000)	5,770 (8,170)	1,480 (1,630)	7,250 (9,800)
		6,400	141	100	900																	
	1984	16,900	142	100	2,400	3,590	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	6,190 (8,690)	1,610 (1,740)	7,800 (10,430)
		8,400	142	100	1,190																	
	1985	17,600	143	100	2,520	3,720	-		-	- (90)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	6,320 (8,810)	1,650 (1,760)	7,970 (10,570)
		8,400	143	100	1,200																	
	1986	18,300	144	100	2,640	3,850	-		-	- (99)	-	- (90)	95	0.85	- (80)	-		-	2,600 (5,000)	6,450 (8,930)	1,700 (1,790)	8,150 (10,720)
		8,400	144	100	1,210																	
Daily Maximum	1981	12,800	210	100	2,690	3,190	-		-	-		-			-	-		-	2,600 (5,000)	5,790 (8,190)	1,166 (1,640)	6,950 (9,830)
		2,400	210	100	500																	
	1982	14,460	212	100	3,070	4,000	-		-	-		-			-	-		-	2,600 (5,000)	6,600 (9,000)	1,320 (1,800)	7,924 (10,800)
		4,400	212	100	930																	
	1983	16,080	214	100	3,440	4,810	-		-	-		-			-	-		-	2,600 (5,000)	7,410 (9,810)	1,480 (1,970)	8,890 (11,780)
		6,400	214	100	1,370																	
	1984	16,900	216	100	3,650	5,460	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	8,060 (10,610)	1,610 (2,130)	9,670 (12,740)
		8,400	216	100	1,810																	
	1985	17,600	218	100	3,840	5,670	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	8,270 (10,820)	1,650 (2,170)	9,920 (12,990)
		8,400	218	100	1,830																	
	1986	18,300	220	100	4,030	5,880	-		-	- (90)	-	- (90)	100	1.59	- (150)	-		-	2,600 (5,000)	8,480 (11,030)	1,700 (2,210)	10,180 (13,240)
		8,400	220	100	1,850																	

Table 3.6.21 Expected Volumes of Wastewater in Pattaya Area, in the Light of Planned Future Construction (Daily Average)

Pattaya

Note: Figures in parenthesis include bungalows

Year	Resident					One Day Tripper			Hotel						Restaurant			Industry	Sewage Quantity		
	Population head	Unit Demand l/h.d	% of Service	Sewage Quantity m³/d	Sewage Quantity Total m³/d	Population head	Unit Demand l/h.d	Sewage Quantity m³/d	No. of Room Existing	No. of Room Newly	No. of Room Total	% of Use	Unit Demand m³/r.d	Sewage Quantity m³/d	Population head	Unit Demand l/h.d	Sewage Quantity m³/d	m³/d	Sub Total m³/d	Ground Water 20% m³/d	Total
1981	T. 3,610	137	100	490	920	1,190	30	40	280	-	280	95	0.85	230	2,090	20	40	-	1,230	430	1,660
	K. 1,420	137	100	190																	
	H. 1,780	137	100	240																	
1982	T. 4,210	139	100	590	1,310	2,020	30	60	1,780	-	1,780	95	0.85	1,440	2,180	20	40	-	3,050	1,100	4,150
	K. 2,840	139	100	390																	
	H. 3,780	139	100	530																	
1983	T. 6,210	141	100	880	2,400	2,140	30	60	1,950	-	1,950	95	0.85	1,570	4,530	20	90	-	4,220	1,450	5,570
	K. 4,260	141	100	600																	
	H. 6,510	141	100	920																	
1984	T. 7,210	142	100	1,020	2,960	2,260	30	70	2,050	-	2,050	95	0.85	1,660	4,710	20	90	-	4,780	1,670	6,450
	K. 5,680	142	100	810																	
	H. 7,950	142	100	1,130																	
1985	T. 7,210	143	100	1,030	3,260	2,380	30	70	2,050 (2,260)	-	2,050 (2,260)	95	0.85	1,660 (1,820)	4,890	20	100	-	5,090 (5,250)	1,760 (1,830)	6,850 (7,080)
	K. 7,100	143	100	1,020																	
	H. 8,450	143	100	1,210																	
1986	T. 7,450	144	100	1,080	3,670	2,500	30	80	2,050 (2,260)	430	2,480 (2,690)	95	0.85	2,010 (2,180)	5,060	20	100	-	5,870 (6,040)	2,040 (2,110)	7,910 (8,150)
	K. 9,600	144	100	1,380																	
	H. 8,450	144	100	1,220																	

(Daily Maximum)

Pattaya

Note: Figures in parenthesis include bungalows

Year	Resident: Population head	Resident: Unit Demand l/h.d	Resident: Service	Resident: Sewage Quantity m³/d	Resident: Sewage Quantity Total m³/d	One Day Tripper: Population head	One Day Tripper: Unit Demand l/h.d	One Day Tripper: Sewage Quantity m³/d	Hotel: No. of Room Existing	Hotel: No. of Room Newly	Hotel: No. of Room Total	Hotel: % of Use	Hotel: Unit Demand m³/r.d	Hotel: Sewage Quantity m³/d	Restaurant: Population head	Restaurant: Unit Demand l/h.d	Restaurant: Sewage Quantity m³/d	Industry m³/d	Sewage Quantity: Sub Total m³/d	Sewage Quantity: Ground Water 20% m³/d	Sewage Quantity: Total
1981	T. 3,610	210	100	760	1,430	3,440	45	150	280	-	280	100	1.59	450	3,500	30	110	-	2,140	430	2,570
	R. 1,420	210	100	300																	
	H. 1,780	210	100	370																	
1982	T. 4,220	212	100	890	2,290	6,060	45	270	1,780	-	1,780	100	1.59	2,830	3,770	30	120	-	5,510	1,100	6,610
	R. 2,840	212	100	600																	
	H. 3,780	212	100	800																	
1983	T. 6,210	214	100	1,320	3,620	6,420	45	290	1,950	-	1,950	100	1.59	3,100	7,840	30	240	-	7,250	1,450	8,700
	R. 4,260	214	100	910																	
	H. 6,510	214	100	1,390																	
1984	T. 7,210	216	100	1,360	4,310	6,780	45	310	2,050	-	2,050	100	1.59	3,260	8,150	30	250	-	8,330	1,670	10,000
	R. 5,680	216	100	1,230																	
	H. 7,950	216	100	1,720																	
1985	T. 7,210	218	100	1,370	4,960	7,140	45	320	2,050 (2,260)	-	2,050 (2,260)	100	1.59	3,260 (3,600)	8,470	30	260	-	8,800 (9,140)	1,760 (1,830)	10,560 (10,970)
	R. 7,100	218	100	1,550																	
	H. 8,450	218	100	2,840																	
1986	T. 7,450	220	100		3,620	7,500	45	340	2,050 (2,260)	430	2,480 (2,690)	100	1.59	3,950 (4,280)	8,760	30	270	-	10,180 (10,510)	2,040 (2,110)	12,220 (12,620)
	R. 9,600	220	100																		
	H. 8,450	220	100																		

3.7 Sewage Treatment Plan

3.7.1 Study of treatment system

(a) Concentrated Treatment and Individual Treatment

A sewerage system plays a big role in the establishment of pleasant and hygienic living modes. Flush toilets must be connected to the public sewer system or to purifying tanks for individual treatment. However, small purifying tanks tend to perform lower quality treatment and to be poorly maintained. Filthy drainage will flow out, and periodical cleaning is necessary. The best system is for flush toilets to be connected to a public sewer system. As clarified by the present investigation, the existing sewage treatment facilities in some hotels are not well operated. It is because of the unfavorable maintenance. It is preferable, however, that even those hotels with currently well-operating facilities be connected to the central treatment system.

(b) Drainage Systems (Separate System and Combined System)

There are 2 systems for collecting the sewage. The separate system is to drain sewage and storm water by different pipes, and the combined system means the draining of sewage and storm water by the same pipe. Features of both systems are as follows.

1) Separate system

Separate systems may be sub-divided into the complete separate system, in which both pipes for sewage and storm water are laid. This sewage-separating system is operated by laying the sewage pipes, only while draining the storm water by the conventional channels. In this project, the sewage-separating system is planned. Storm water will be drained by the repair or remodelling of conventional waterways. Also, ditches along the sides of roads will be completed for use in draining storm water. Thus, pipes will be used only for sewage, and their sectional diameters can be smaller than would otherwise be the case. The sewer pipes located in the upper positions may become deposited with sediment, while middle and lower positions show less sediment because of the constant and smooth flow.

In a separate system, even after rains, all sewage is transfered to the treatment plant through the sewage pipes, but deposits on the road or in separate water drainage pipes will be discharged directly into the rivers by the flow of storm water. Sewage pipes can be of small diameter, but their slope must be great enough to obtain the necessary flow-speed. Thus, sewage pipes in a separate system should be buried deeper and lift stations will be more numerous in comparing with the combined system. Because the pipes for sewage alone will be smaller in diameter, construction costs will be less, the working period for construction will be shorter, and the construction efficiency will be higher.

2) Combined system

In this system, pipes will be planned by calculating the flow of the combined volume of sewage and storm water. In general, however, storm water is up to 50-100 times more than the volume of sewage; and pipe diameters must be decided in compliance with storm water volume.

Therefore, sewage takes up less than 10% of the pipe on a fine day, while on rainy days, the pipe is nearly filled with sewage and storm water. Because the water level in the pipe fluctuates so much, filthy matter may become deposited on the pipe walls. On fine days, the water level in the pipe is lower and the flow-speed is low because filthy matter is liable to be deposited and putrefied. Objectionable odors may spread widely from openings of storm water. On rainy days, the pipes in a combined system will discharge untreated sewage into the rivers mixed with storm water.

Especially in the initial stage of a rainfall, the flow of the rivers is still relatively low, and thus negative influence on water quality will be grave.

However, in this system, the pipe is larger in diameter, maintenance is more convenient, and because the pipe is favorably ventilated, there is less stagnation of gas.

In this system, determination of pipe diameter is very difficult since the flow condition is completely different on fine and rainy days, and there is no ideal decision which satisfies both cases.

3) Decision on type of drainage system

In view of the above characteristics of both systems, in the present project, the separate system was adopted from the following reasons:

(1) The project area is a resort area, and there is thus a high necessity to prevent water pollution. Establishment of a sewerage system is quite urgent.

(2) Conventional drainage channels can be rather easily remodelled, and there is no necessity to lay pipes for storm water.

(3) Construction cost is less.

(c) Treatment Systems

A comparative study is made about the following 4 alternatives of the "Concentrating Method of Treatment".

Treatment System No.1:

1) Sewage discharged into the seawater after primary treatment.
In this system, the raw sewage, after passing through sedimentation ponds, is sterilized with chlorine, and is carried off-shore by means of discharging pipe installed on the sea bed.
Thus, discharge will be made in the sea water and sewage will be treated by natural purification and diffusion as well as by dilution. In the west coast of the USA, especially in California, this method has been widely adopted.
Recently, this system of discharging water after primary treatment has been reviewed by E.P.A. (The US Environmental Protection Agency), and it was decided that after 1982, all sewage should be given secondary treatment before it is discharged. If this method is applied to the Pattaya area, the sedimentation pond must be constructed in an inland area. There is no possible construction site along the coast down to the

Pattaya Hill in the south. Pattaya faces an enclosed bay, and the purification efficiency will be inferior compared to the open coasts like California. The bay has many possibilities for future development of its coasts. Thus the pollution load should be kept as small as possible, and the protection of marine resources is essential also. In this project, the alternative of discharging the primary treatment water was rejected.
For reference, calculation was made on the environmental effect when primary treatment water is discharged to the sea by the way of submerged pipe on the Pattaya sea-bed, as follows:

(1) Study on sea-bed discharge pipe

1. Topography of sea-bed

The slope of the sea-bed around a discharge pipe in the area would be about 1/150 - 1/400. The sea-bed is mainly composed of sand mixed with fine clay and colloid matter.

2. Flow

The flow in this area arises from tidal current, showing regular flow. There is a northern flow at flow tide and southern flow at ebb tide, with average current-speed at mean high water of about 0.4m/sec. Fig. 3.7.2 & 3.7.3 show the flow at mean high water.

3. Water temperature

According to the survey data by JICA in 1977, the water temperature is always reflecting the high atmospheric temperatures in the day time. At the time of the survey in 1977, the water temperature was more than 29°C, and there was no large variation vertically.

4. Water quality

The water quality of this sea area does not show particular contamination as a whole. There are several points with respect to water quality as a beach resort which deserve attention. Especially, the pollution problems of Na Klua River and the sea in front of Pattaya Beach need caution. The pollution of Pattaya Beach and frontal sea area is produced mainly due to house sewage discharged directly into the beach area. Water Quality Survey, 1977, JICA.

5. Study on discharge system

A certain degree of water depth is necessary for the discharging system into water. Water discharged by jet system is mixed and diluted with seawater, before discharged water reaches to the surface of the sea. The discharged water does not affect the shore when the location of the outfall is set far away from the shore and also when dispersion on the surface part is in small range.

6. Selection of location of the discharging point

In considering the discharge to the ocean, better effect for dilution can be obtained by deeper discharging, and less pollution affect seashore when the outfall is installed far away from seashore and the dispersion is into small area. However, a far offshore outfall requires high construction cost. In deciding the location of the discharge point, it is necessary to pay attention not only to economic aspects, but also to the influence on the beach as a result of dispersion.

Fig. 3.7.1 Contour Map of Pattaya Bay

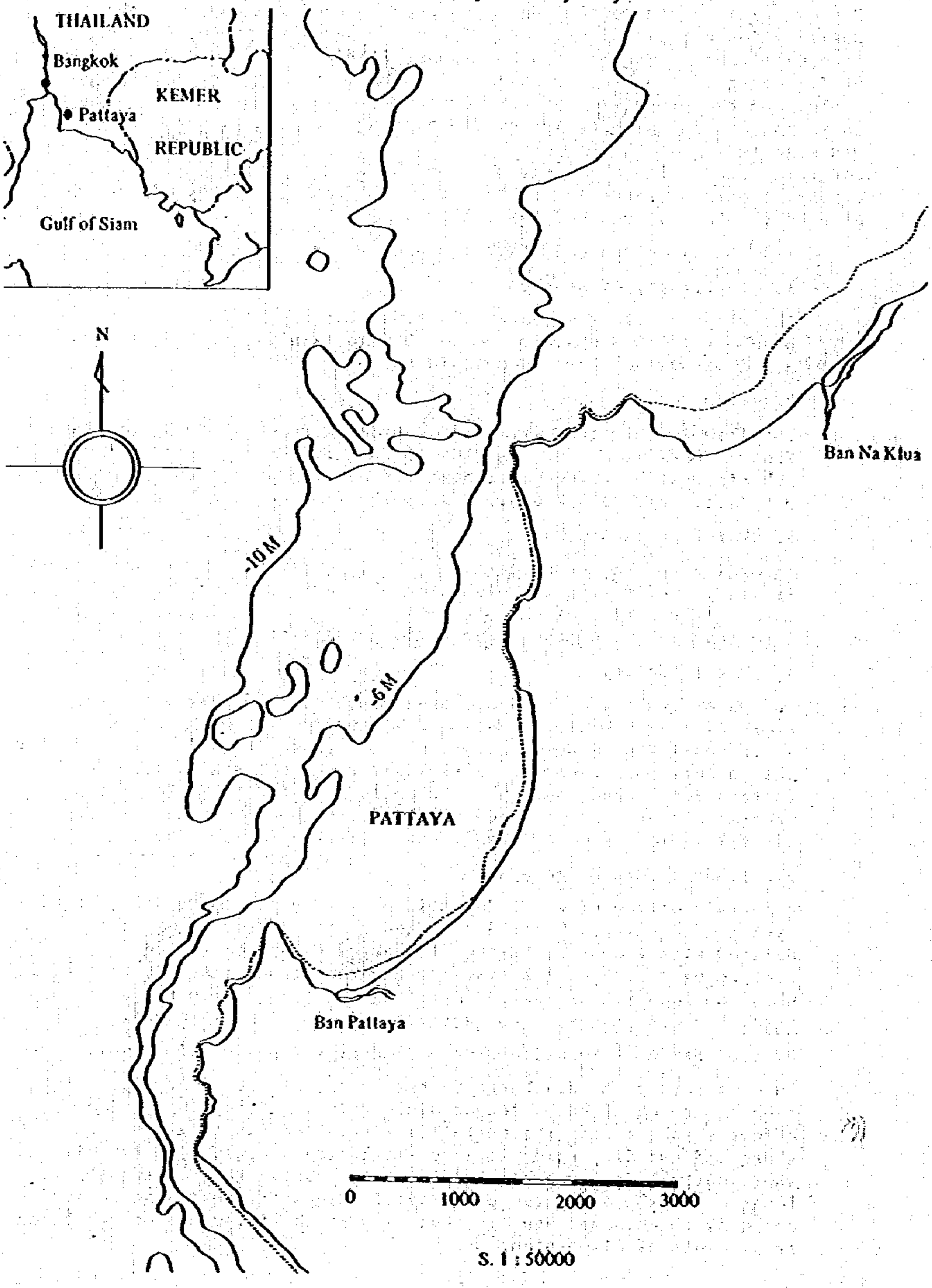


Fig. 3.7.2 Flood Current at Mean Spring Tide

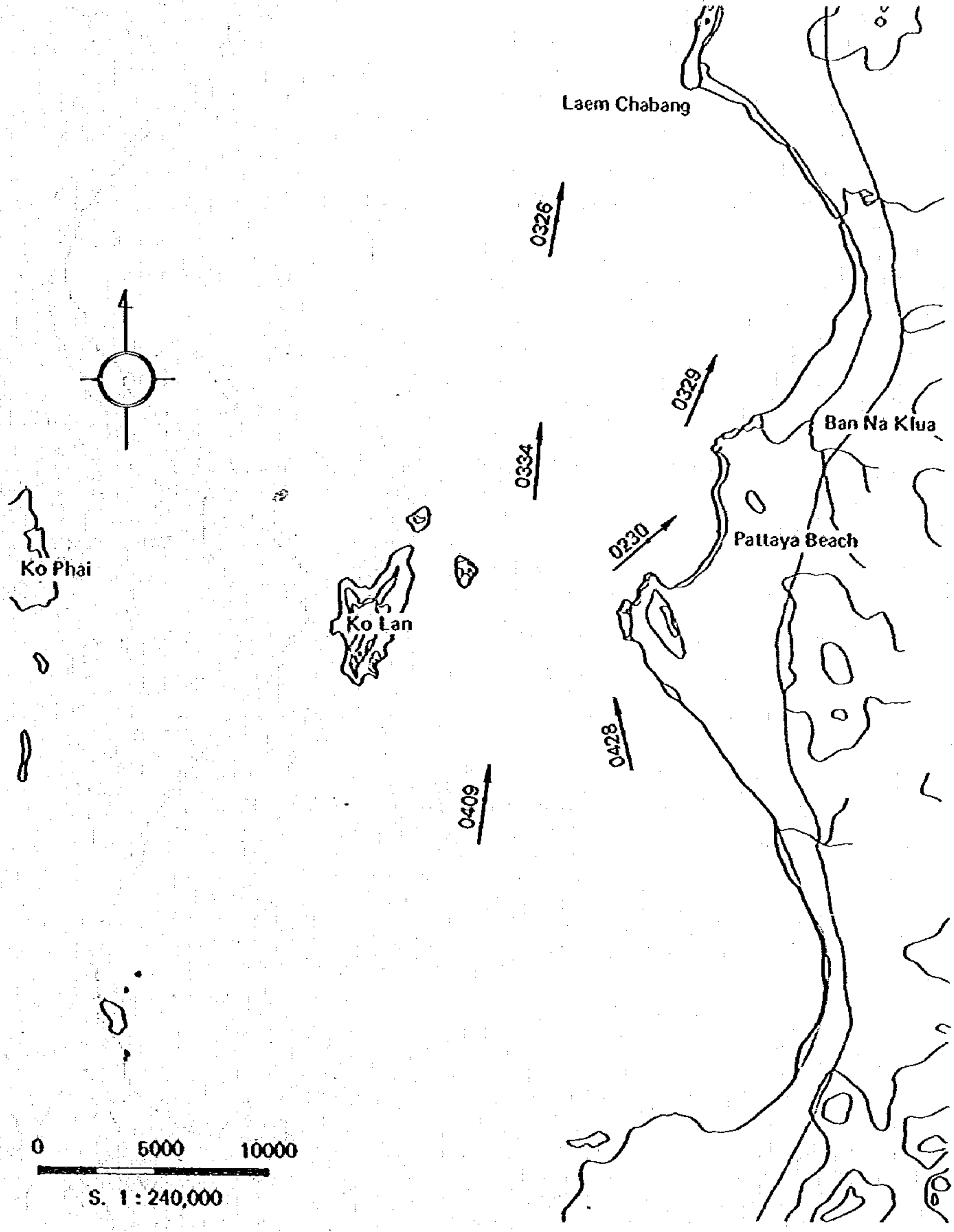
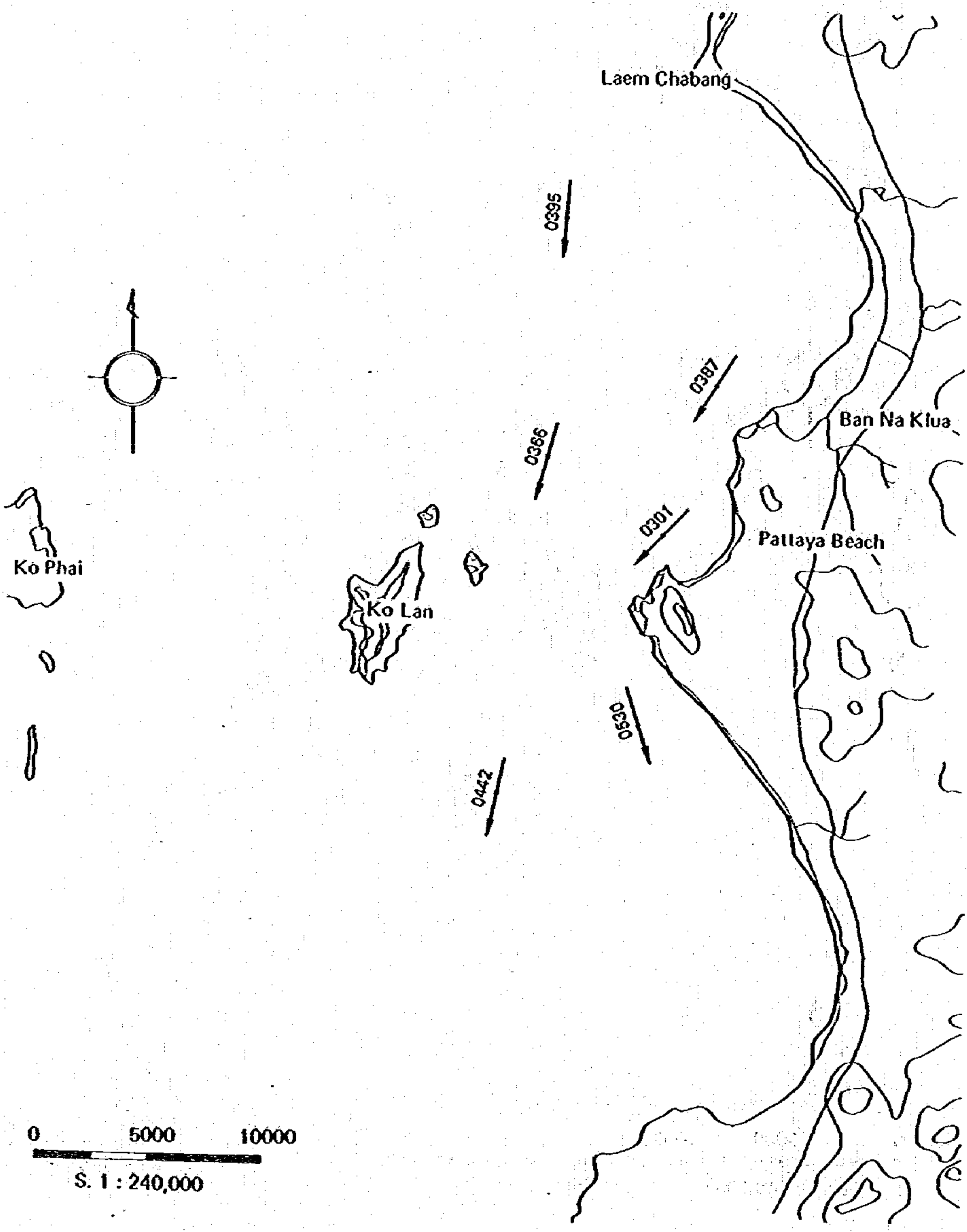


Fig. 3.7.3 Ebb Current at Mean Spring Tide



7. Study on dispersion

Simple method to estimate dispersion is obtained from the technical report by Japan Electric Central Research Laboratory and by Joseph and Sendoner's formula.

a. Data on sea-bed discharge system in the study area.

	Pattaya Area	Na Klua Area
Discharging quantity	14,280 m^3/day	16,360 m^3/day
Relative density	0.025	0.025
Discharging system	Horizontal under-water-discharging system	Horizontal under-water-discharging system
Number of discharging nozzle	8	8
Diameter of discharging nozzle	100 mm	125 mm
Flow rate (quantity) per nozzle	0.0207 m^3/s	0.0237 m^3/s
Flow speed at discharging nozzle	2.62 m^3/s	1.93 m^3/s
Depth of water of position of discharging nozzle	9.0 m	7.0 m
Surrounding waterdepth	over 10.0 m	over 8.0 m

b. Result of study

Fig. 3.7.4 shows the result of prospect on the diffusion area with the dilution ratio S=1:500.

Pattaya Area:

Diffusion area in the quiet condition of current has a radius of about 290m (A=260,000m^2). In case current is flouring, the area of dispersion is generally considered smaller than the dispersion area in quiet condition. The dispersion area is considered to lie primarily in the direction of the flow when there is a flow. Fig. 3.7.4 indicates this fact. The position of a discharge point in the Pattaya Area would be 1,500m offshore at a water depth of -10m or deeper.

Na Klua Area:

The dispersion area in quiet condition of current has a radius 560m (A = 1 million m^2). There is almost no influence on the seaside in Pattaya Area. Therefore, the position of an outfall in Na Klua Area would be 1,400m offshore at a water depth of -8.0m or deeper.

Fig. 3.7.5 and 3.7.6 show the vertical dispersion rates calculated by computers when the outfall pipe is installed on sea-bed for Pattaya Area and Na Klua Area. The dilution ratio on reaching the sea surface is 112.4 times in Pattaya Area and 61.9 times in Na Klua Area. This difference is caused by the variety in water depths.

Fig. 3.7.4 Expectation of Diffusion Area

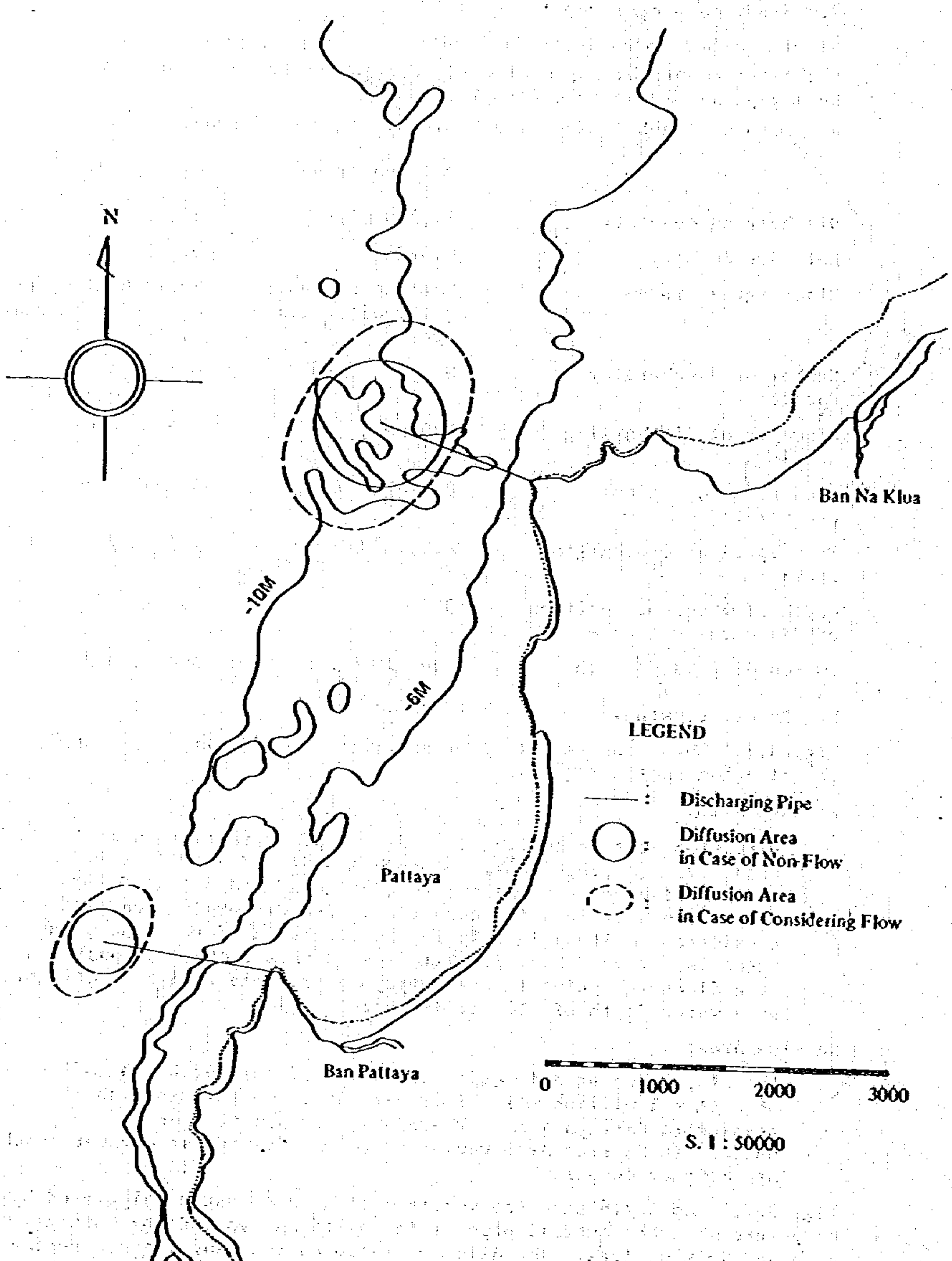


Fig. 3.7.5 Diffusion Rate in Pattaya

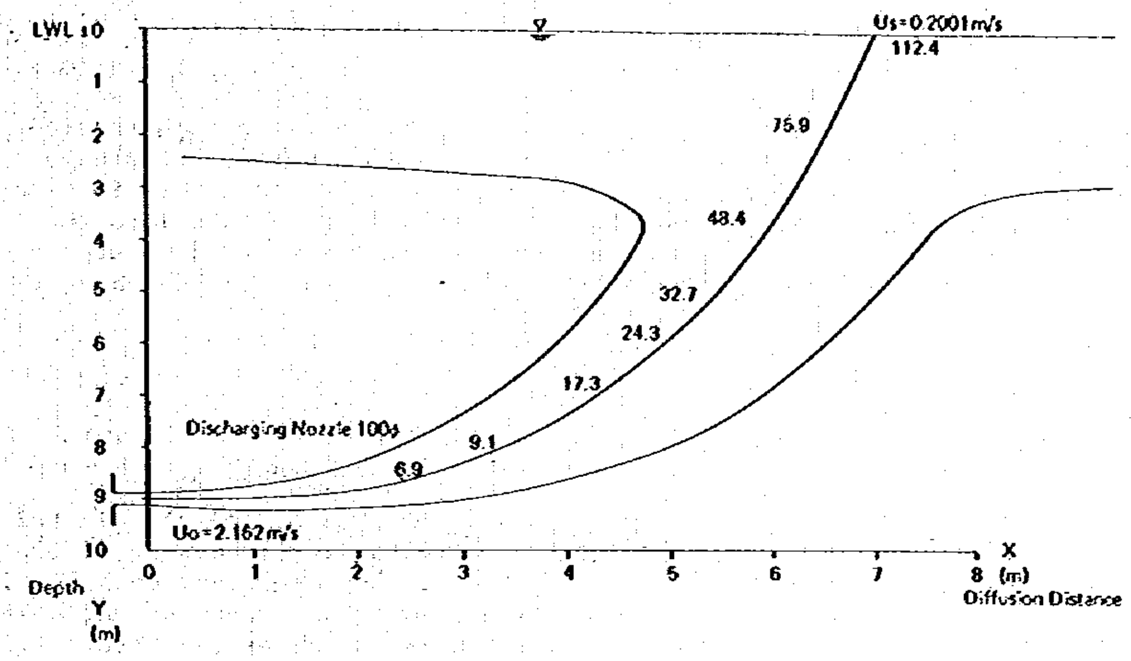
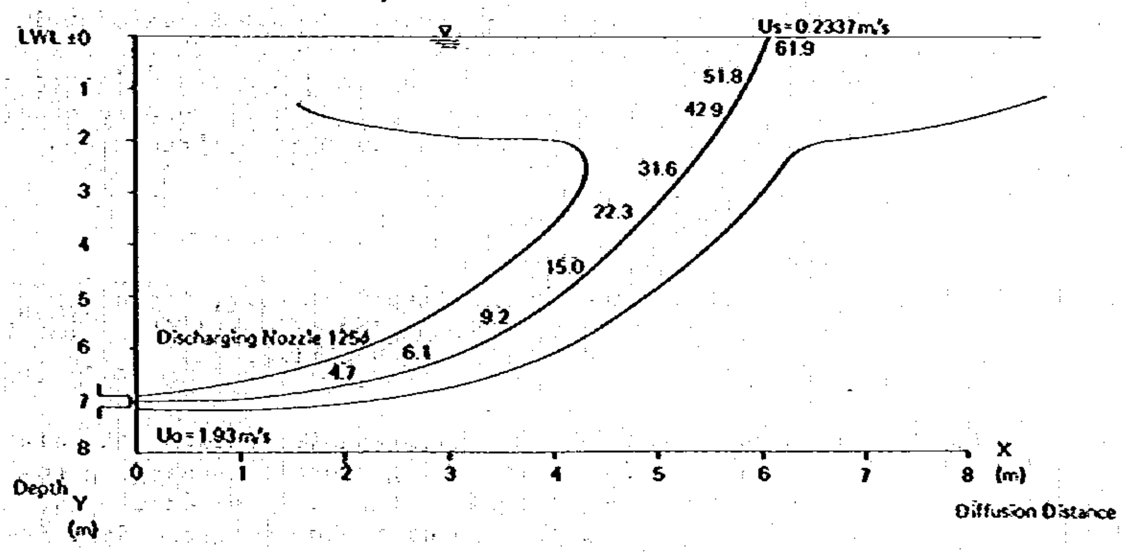


Fig. 3.7.6 Diffusion Rate in Na Klua



Treatment System No.2:

2) Sewage after secondary treatment is discharged into water channel

In this system, the sewage after secondary treatment is discharged into the water channel. 70-90% of BOD_5 will be removed at the treatment stations, BOD_5 after treatment will become 20-60 mg/lit. as compared to raw sewage BOD_5 of 200 mg/lit. There may be no problem in discharging such treated water in rainy season, because of dilution with storm water, but sludge may be deposited in the dry season. Since the whole project area is made up of sandy ground, however, most treated water will penetrate into the ground, and the discharge into the sea will be greatly reduced. This is the most economical discharging method. This system was considered as the first alternative in this project.

Treatment System No.3:

3) Discharge into sea water is done after secondary treatment

This system is a combination of the above alternatives 1) and 2). In this system, pollution load is less than that of alternative 1) because of the discharge of secondary treated water into the sea-bed; however, construction cost will be high because of the necessity of secondary treatment and sea-bed facilities. Therefore, it is considered only as one of the alternatives.

Treatment System No.4:

4) Secondary treated sewage effluent is scattered into fields and/or mountains

In the case of using the effluent for irrigation purposes, as in the case of penetration into the ground without any other economic purpose, purification is carried out by a combination of physical, chemical and biological processes. Physical effects are filtration, absorption and ventilation, while chemical effects include oxidation and ion-exchange. Generally speaking, the earth irrigation method expects the decomposition of pollutants by aerobic microorganisms in the soil. However, with respect to the present plan, decomposition by aerobic organisms is not a major factor since the effluent to be scattered would have already undergone secondary treatment. This method may be roughly subclassified into three types as follows.

1. Irrigation method
2. Surface flow method
3. Penetration-filtration method

The irrigation method can be adopted to most types of soil, including sand and clay, but is most applicable to soils with good permeability. The flow rate (cm/week) is, however, low. The method is excellent for the irrigation of crops.

The surface flow method can either utilize existing irrigation channels making the wastewater flow down along declinning slope (discharging the effluent to the natural streams) or sprinkling the effluent on slopes, collecting it in drainage ditches at the end of fields for secondary irrigation. By this method, the effluent which penetrate into the soil is limited to the area near the surface and the amount is small. It is suited to soils with low permeability like clay or loam rich with clay. The slopes need the gradient from 2% to 6% so that the effluents flow down over all the surface of the earth smoothly. A part of the purification process can be accomplished by planting grass along the slope for breeding bacteria. One may consider that the surface flow method has almost no influence on ground water, and thus the problem of protecting the purity of ground water is not importantly affected by site selection.

By the penetration filtration method, effluent is kept temporarily standing on the ground surface with a depth of 0.3-0.6 meters. Sand, gravel, loam rich in sand, and sand rich in loam are suited to this method. The method cannot be used, however, for the cultivation of crops. The necessary site is going to be located for discharge treatment of Na Klua and Pattaya in penetration filtration method, the most efficient among the three types discussed above. In the calculations below, a low flow load rate was used because of releasing effluent water into the soil. However, in a plan like the present one in which secondary treatment is conducted before irrigation, it would seem possible to make use of a higher flow load rate.

5) Study on land penetration of treated water

The following values with respect to the penetration filter method are reported in "Alternative Waster Management Techniques for Best Practicable Waste Treatment, EPA".

Flow load rate:	0.3 - 1.0 ft/week (9-30 cm/week)
Yearly applicable volume:	18 - 500 ft/year (5.4 - 150 m/year)
Necessary depth to surface of ground water:	about 15ft (about 4.5 m)

In this project area, the depth to the surface of ground water in the rainy season is G.L.-1.5m. It is considered to be somewhat lowered in the dry season, but it still is only about 1/3 of the necessary depth of -4.5m given above.

As for the soil conditions, the upper part is composed of sand, and its coefficient of permeability is 10^{-3} cm/sec (0.864m/day). Regarding the flow-load rate, the above values seems to be too great considering the necessary depth to the surface of ground water. Thus, the following value was taken as a mean value between upper and lower limits.

Flow load rate: 0.65 ft/week (0.20 m/week)

Concerning the yearly applicable volume, water filling should be made intermittently in order to maintain the permeating speed. Thus, the following value was adopted, with the drying period of 2 weeks and water filling for 3 weeks, in reference to the example of Flushing Meadows in Arizona.

Yearly applicable volume:

$$0.65 \text{ ft/week} \times 52 \text{ week/year} \times \frac{3}{5} = 20.3 \text{ ft/year (6.1 m/year)}$$

6) Necessary treatment area

(1) Na Klua Area

Yearly maximum sewage:

$16,360\ m^3/day \times 365\ days \times \frac{1}{1.5} = 3,980,933\ m^3/year$

$A = 3,980,933 \div 6.1\ m/year = 652,612 = 65.3\ ha$

Thus, the necessary area is 65.3 ha.

(2) Pattaya Area

Yearly maximum sewage:

$14,280\ m^3/day \times 365\ days \times \frac{1}{1.5} = 3,474,800\ m^3/year$

$A = 3,474,800 \div 6.1\ m/year = 569,639 = 57.0\ ha$

Thus, the necessary area is 57.0 ha.

In view of the above results, for this project, the method of discharging the secondary treated water into the river was adopted as the first alternative. In the future, however, it is desirable to carry out a detailed survey, irrigation of the mountain area, with a view to preventing a worsending of water quality cooperating with other facilities.

3.7.2 Plan of Sewage Collection System

The piping plan was made in compliance with the following rules.

1. The natural gravity flow system shall be employed as much as possible, and the installation of pump shall be avoided as much as possible.
2. Even if it is necessary to install pumps, the number of pumping stations and the head of pumps shall be as low as possible.

In the project area, there are numerous hotels and restaurants along the seaside. There is scarcely the space for building treatment stations, and it is thus impossible to locate the sewage treatment station at the center of the resort, it was inevitable to plan its location on the mountain side. Therefore, it was difficult to have piping systems using natural topographic slopes and we were obliged to construct pumping stations. Fig. 3.7.7 shows the piping plan.
As for the position of the pipe along Sukhumvit Road, it shall be buried under the side slope.

Since T-1 Road is as wide as 31m, the main pipe is buried at the center and a service pipe is buried at the edge of the road. Pipes are, as a rule, planned to be laid on the north or east sides of roads for the purpose of coordinating them with other infra-structures (waterworks, electricity, telephones, etc.) and in the road with pedestrian road, the sewers are to be installed under it.

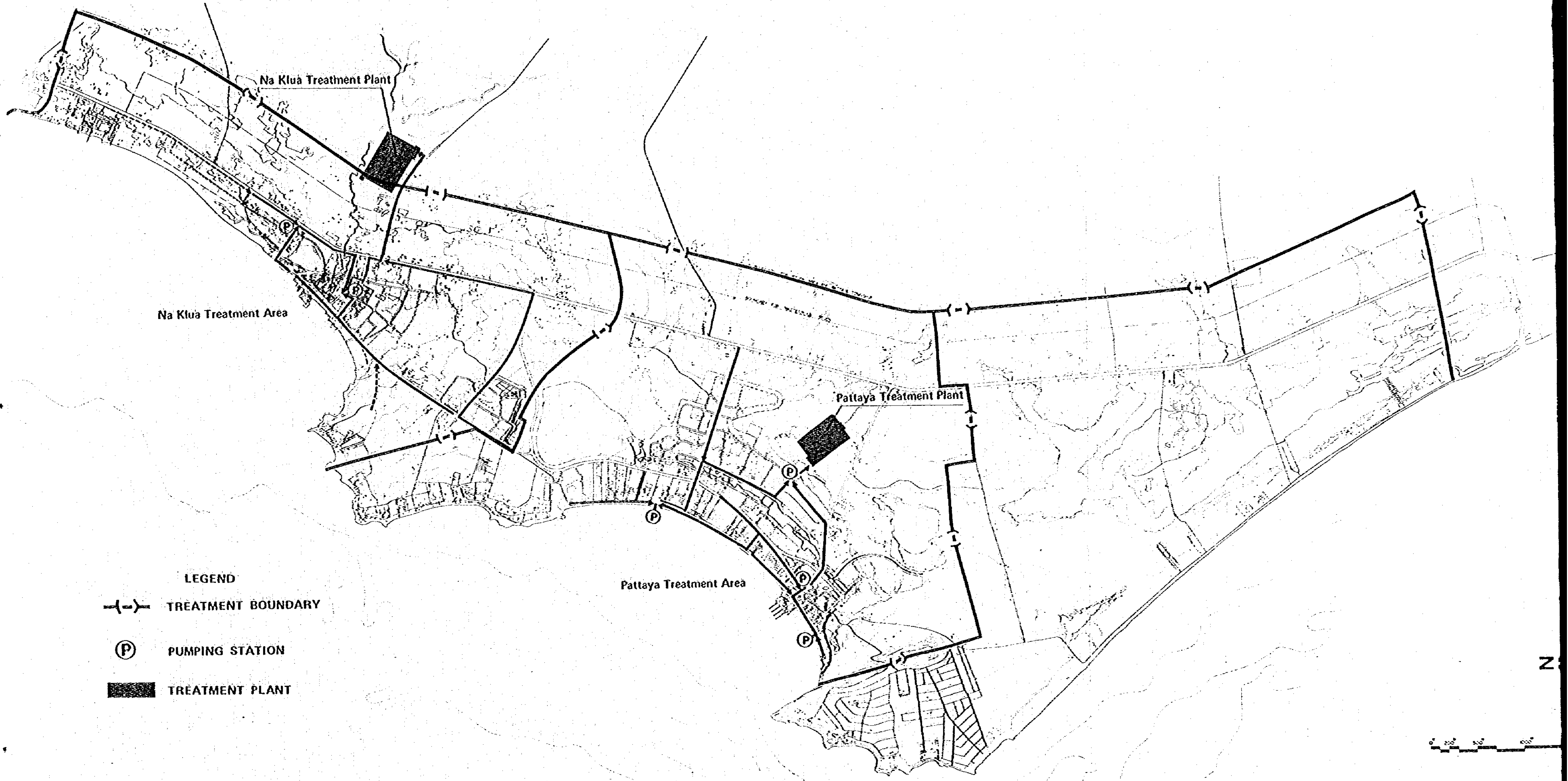


FIG 3.7.7 SEWERAGE S

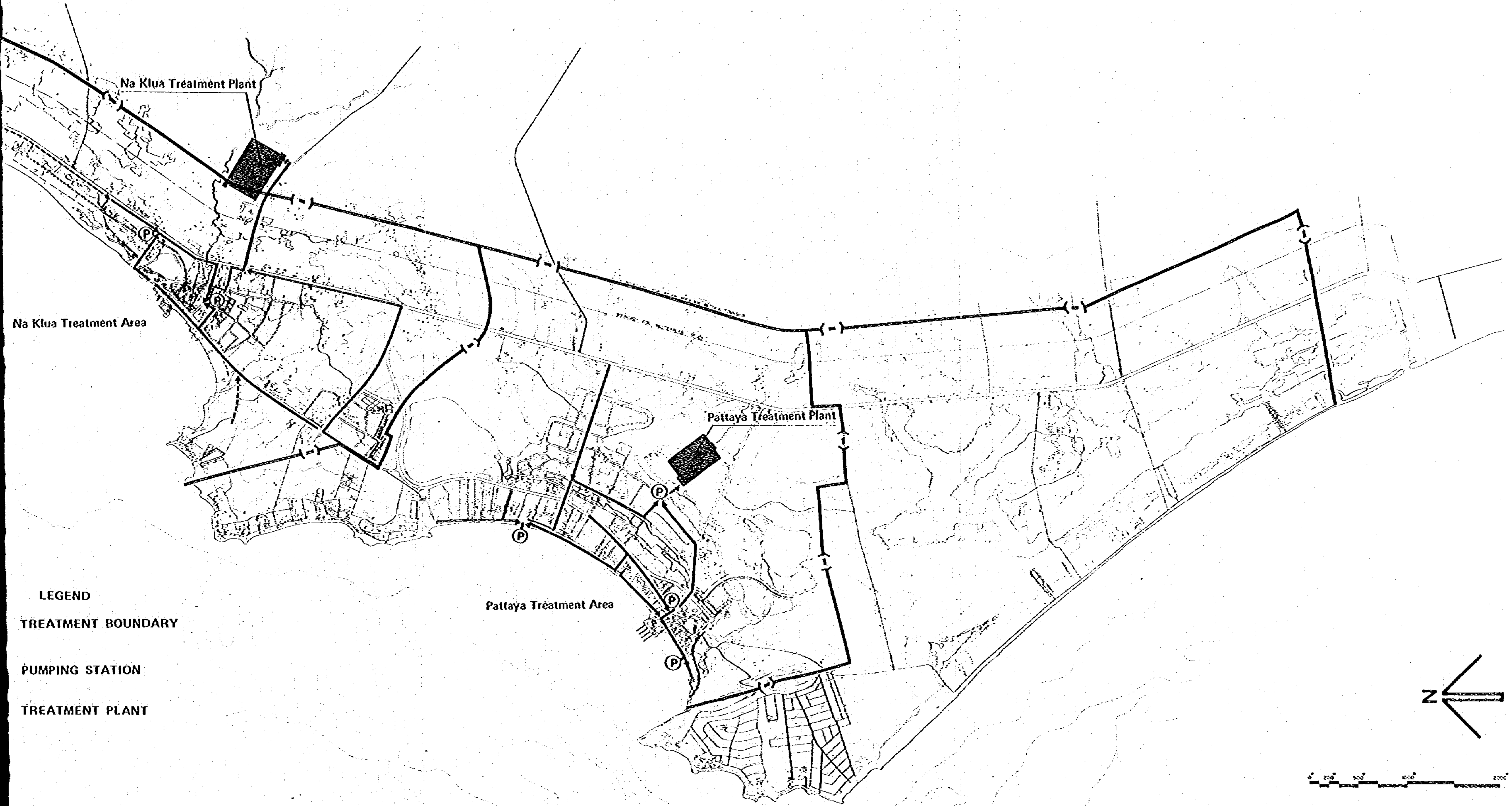


FIG 3.7.7 SEWERAGE SYSTEM

Materials for pipes (culverts) are of concrete, asbestos cement, and reinforced prestressed concrete. However, the pipe around the pumping stations shall be ductile cast iron pipe.
The cost is the highest in the case of reinforced prestressed concrete pipe, followed by asbestos cement pipe and concrete pipe. Therefore, concrete pipe will be employed as much as possible, while pressed transporting part will be of asbestos cement and reinforced prestressed concrete.

Types of pipes used are listed by pipe-diameters in Table 3.7.1.

Table 3.7.1 Types of Pipes Used

Concrete pipe	Asbestos cement pipe	Reinforced prestressed concrete pipe
-	*ϕ200	-
-	*ϕ250	-
-	*ϕ300	-
*ϕ400	ϕ400	ϕ400
*ϕ500	ϕ500	ϕ500
*ϕ600	ϕ600	ϕ600
-	-	*ϕ700
*ϕ800	-	ϕ800

* Using pipe type.

At points where piping crosses rivers or storm water drainage channels, it is planned to construct pipe beam bridge and inverted siphon culverts. A difference from the master plan is that Na Klua Town B is included into a Na Klua Treatment Area. In the master plan, Na Klua Town B was divided into 2 areas according to topography, but as Na Klua Town B is one developing area, it is unified into the Na Klua Treatment Area. Also, the pumping stations along Pattaya beach were reduced.

3.7.3 Plan for Pumping Stations

(a) Pumping Stations

A total of 6 pumping stations were planned, 2 in Na Klua Treatment Area, and 4 in Pattaya Treatment Area. In the present project area, a rather flat topography is observed on the sea side to the west of Sukhumvit Road. According to geological surveys, it is generally situated on hard subsoil with N-values reaching over 50 at depths of -4 to -5m from the ground surface. The groundwater level is about -2m below the present ground surface even in the dry season at the shallow point. In such circumstances if the excavation is deep, it is apparently disadvantageous technically and economically.

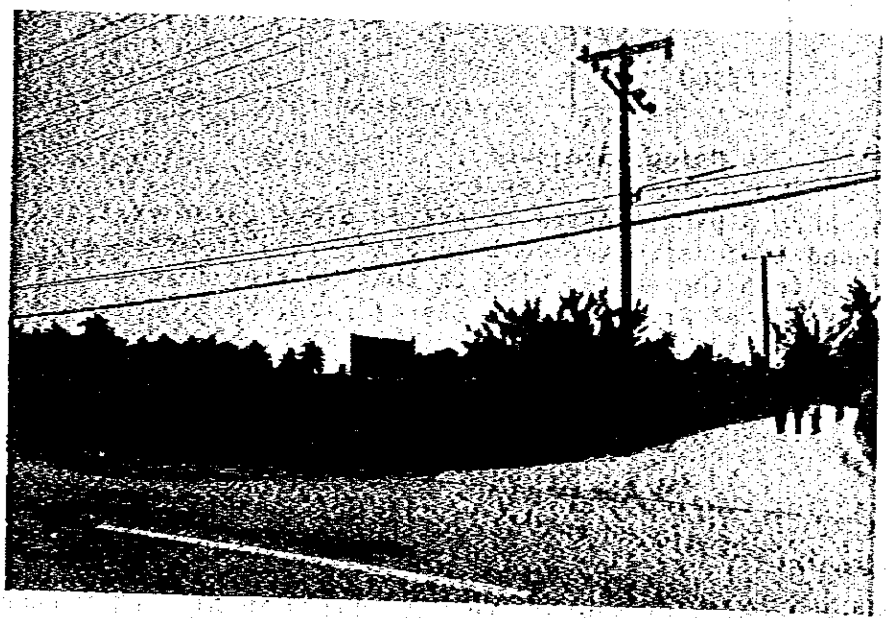
It should be remarked that average tidal level is +1.0m along the sea-shore; thus deeper excavation seems to be very difficult, and should be avoided. Therefore, along the seaside road, pipes should not be laid so deeply. As regards pumping equipment, submarged pump is adopted. The sewage flows into the pumping stations to be pulverized by a comminutor and flows down into the pump pit. A spare pump is to be installed. Pumping stations shall be constructed in concrete buildings, and pile seems unnecessary taking hard soil condition into considerations.

(b) Pumping Stations in the Treatment Plants

Na Klua Treatment Plant will install one pumping station. There will be no pumping station in Pattaya Treatment Plant, No. 2 pumping station substituting for the pumping station in the treatment plant.

Regarding the specifications of the pumping station in Na Klua Treatment Plant, there will be installed 3 units of submerged pumps with diameter ϕ300mm and 15m in head.

Pump installation plan in respective lift pump stations is shown in the following tables.



One of the Proposed Pumping Station Site in Central Pattaya.

1) Plan of lift pump stations

(1) Na Klua Area

Table 3.7.2 Necessary Number of Pumps (period 1981 through 1986)

(Submerged sewage pump)

Lift Station No.	Specifications of pump	1981	1982	1983	1984	1985	1986	Final (1996)
No.1	∅150x2.1m³/min x 11m x 11 kw	2	2	2	2	2	2	3
No.2	∅200x5.8m³/min x 12m x 22 kw	2	2	2	3	3	3	3
No.3	∅100x0.3m³/min x 25m x 7.5 kw	-	-	-	-	-	-	2

(One pump will be spare.)

(2) Pattaya Area

Table 3.7.3 Necessary Number of Pumps (period 1981 through 1986)

(Submerged sewage pump)

Lift Station No.	Specifications of pump	1981	1982	1983	1984	1985	1986	Final (1996)
No.1	∅200x3.4m³/min x 17m x 22 kw	2	3	3	3	3	3	3
No.2	∅250x6.1m³/min x 15.5m x 37 kw	2	3	4	4	4	4	4
No.3	∅100x1.1m³/min x 4m x 3.7 kw	2	2	2	2	2	2	2
No.4	∅150x3.1m³/min x 6m x 11 kw	2	2	2	2	2	2	2
No.5	∅100x0.72m³/min x 19m x 7.5 kw	-	-	-	-	-	-	2

(One pump will be spare.)