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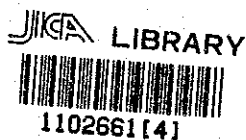
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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF PUBLIC WORKS
THE GOVERNMENT OF THE REPUBLIC OF INDONESIA

THE DEVELOPMENT STUDY
ON
WASTEWATER DISPOSAL FOR DENPASAR

EXECUTIVE SUMMARY



24605

JANUARY 1993

PACIFIC CONSULTANTS INTERNATIONAL

**THE DEVELOPMENT STUDY
ON
WASTEWATER DISPOSAL FOR DENPASAR**

Mr. Kensuke YANAGIYA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the final report entitled "THE DEVELOPMENT STUDY ON WASTEWATER DISPOSAL FOR DENPASAR". This report has been prepared by the Study Team in accordance with the contract signed on 27 September 1991 and 3 June 1992 between the Japan International Cooperation Agency and Pacific Consultants International.

The report examines the existing conditions of wastewater disposal in Denpasar, presents a master plan of sanitation and sewerage development and the results of a feasibility study on sewerage development for the priority areas selected by the master plan.

The report consists of the Executive Summary, Main Report, and Supporting Study Report. The Summary Summarizes the results of all studies. The Main Report contains background conditions, overall sanitation and sewerage development plan, urgent sewerage development project, conclusions and recommendations. The Supporting Study Report includes data and technical details. In addition, a Data Book has been prepared and is submitted herewith.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in Indonesia, and also to officials and individuals of the Government of Indonesia for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the socio-economic development and the improvement of health and hygiene in Denpasar.

Yours faithfully,



Naohito MURATA

Team Leader

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EXECUTIVE SUMMARY

1. Introduction

Denpasar and its vicinity, the political, economical and tourism centers of Bali, is undergoing rapid urban and tourism developments in recent years. The population has increased from 0.256 million in 1975 to 0.477 million in 1990, and is expected to grow further to 0.709 million in 2010. The number of tourists visiting there has doubled in the recent 10 years from 1.24 million in 1980 to 2.55 million in 1990.

However, the area virtually lacks an environmentally and sanitarly acceptable means of wastewater disposal in commensuration with its urbanization and tourism development.

Hence, the formulation of a comprehensive sewerage and sanitation development plan has become necessary to improve sanitary environments and to protect tourism resources of the area.

The objectives of the Study are as follows:

- Formulate a master plan of sewerage and sanitation development encompassing the whole Study Area for the target year of 2010.
- Conduct a feasibility study for sewerage development for the areas selected by the master plan.

The Study Area of the master plan, shown in Fig. 1, encompasses Denpasar and its vicinity with an area of 237 km².

Following the master plan study, the feasibility study was conducted for central Denpasar and Sanur districts with a total area of 3,423 ha shown in Fig. 1.

This wastewater disposal project was carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with the Directorate General of Human Settlements (Cipta Karya), Ministry of Public Works of the Government of Indonesia from October, 1991 to December, 1992.

The whole study, including the executive summary, consists of the following reports:

- (1) Executive Summary
- (2) Main Report
- (3) Supporting Report I (Master Plan Study)
- (4) Supporting Report II (Feasibility Study)
- (5) Data Book
- (6) Drawing

2. Wastewater Disposal Master Plan

2.1 Water Environments

The wastewater generation in the Study Area is expected to double in 2010 due to the rapid urbanization and tourism development. It will cause a serious deterioration in the water environments of the Study Area if no appropriate countermeasures are taken.

- (1) The average river water quality of central and southern Denpasar areas will worsen from 27.2 mg/l in 1990 to 55.0 mg/l in 2010 as stream BOD. In some areas, it is forecast to reach approximately 100 mg/l.
- (2) The existing sea water quality of Sanur, Kuta and Nusa Dua beaches is 5 mg/l in terms of COD_{Cr} on an average, however, it exceeds 8 mg/l in some areas. This water quality is considered to be in a critical level for swimming and other water recreations in comparison with international standards.

The future increase of wastewater generation in the Study Area will also have a severe effect on the sea water quality.

- (3) More than 90% of the toilet waste in the Study Area is disposed into underground by leaching system. However, a large portion of gray water are directly discharged to the road side drains or rivers/canals, resulting in creation of unsanitary environments in the communities. Such unsanitary environments concentrate in the densely populated areas.
- (4) Heavy groundwater contaminations are recognized in central and southern Denpasar areas due to the human waste disposals into

underground. It is critical even in the resort areas of Sanur, Kuta and Nusa Dua.

- (5) As the consequence, the Study Area is afflicted with waterborne diseases at a high contraction rate of 57.1 cases per 1,000 population per year.

2.2 Zoning of Wastewater Disposal

The conditions for the environmental and sanitary improvements of the Study Area are different by region. Hence, the most appropriate wastewater disposal system shall be planned by region.

Zoning of the wastewater disposal system was established based on the following policies.

- (1) The river water quality shall be maintained below 20 mg/l in stream BOD.
- (2) The sea water quality of the resort beaches shall be maintained below 5 mg/l in COD_{Cr} or at least, below the existing level.
- (3) Sanitary environments of the resort areas shall be maintained in a satisfactory level as international resort.
- (4) Wastewater disposal system with a high treatment level shall be applied for high population density areas, however, system with a moderate treatment level can be proposed for medium population density areas.
- (5) Wastewater disposal into underground shall carefully be managed to control groundwater contamination.

The proposed zoning of wastewater disposal system is as follows.

- (1) Conventional sewerage system capable of treating both toilet waste and gray water up to 20 mg/l in BOD is applied for central Denpasar, and Sanur, Kuta and Nusa Dua resort areas.
- (2) Septic tank with up-flow filter system is proposed for southern Denpasar area. This system will treat both toilet waste and gray water up to 60 mg/l in BOD.
- (3) Septic tank with leaching pit system is recommended for the other areas.

The service area and served population in 2010 by each system are summarized below.

	Service Area (ha)	Served Population in 2010
Conventional Sewerage	4,207 (18%)	335,020 (47%)
Septic Tank with Up-flow Filter	3,614 (15%)	107,700 (15%)
Septic Tank with Leaching Pit	15,832 (67%)	266,580 (38%)
Total	23,653 (100%)	709,300 (100%)

Location of each zone is shown in Fig. 2.

2.3 Sewerage Development Plan

Three (3) new sewage collection systems of conventional separate type are proposed for 2,683 ha of Denpasar area, 648 ha of Kuta area and 740 ha of Sanur area. Moreover, the existing sewage collection system of Bali Tourism Development Corporation (BTDC) of conventional separate type is developed to cover the whole Tanjung Bena area of 136 ha including Nusa Dua beach.

Wastewater of Denpasar, Kuta and Sanur areas are almost all treated by one (1) common treatment plant of aerated lagoon type proposed in the Suwung Swamp Area along Bena Bay. A portion of the wastewater of Kuta area is treated by the treatment plant of the on-going East Java and Bali Urban Infrastructure Development Project. However, wastewater of Tanjung Bena area is treated by remodelling the existing treatment plant of oxidation pond type to aerated lagoon type.

The main features of the proposed sewerage master plan are shown in Table 1. Location of the sewerage systems are shown in Fig. 2.

The total project cost of sewerage development is estimated at Rp.253.6 billion at 1992 price. The total operation and maintenance (O&M) cost of the sewerage system is estimated to be Rp.2,670 million per annum under the full operation in 2010 at 1992 price.

Break-down of the project cost and O&M cost of the proposed sewerage master plan are shown in Table 2.

2.4 Project Evaluation

(1) Water Pollution Abatement

The proposed wastewater disposal project will control the future river water quality of the Study Area below the target one of 20 mg/ℓ in BOD. The existing and future river water quality of central and southern Denpasar areas are compared below.

(Unit : BODs mg/ℓ)

	Range	Average
Existing (1990)	15.6 - 52.1	27.2
Future without Project (2010)	21.7 - 101.5	55.0
Future with Project (2010)	9.3 - 23.1	16.4

The proposed project will also reduce the pollution loads to the sea from the Study Area. The pollution loads under the existing, future without project and future with project conditions are shown below.

Pollution Load to Sea
(BODs, ton/day)

Existing (1990)	10.8
Future (2010) without Project	21.9
Future (2010) with Project	10.2

The proposed project will maintain the future sea water quality of the Study Area around the existing level. The existing and future polluted sea areas exceeding the target water quality of 5 mg/ℓ in COD_{Cr} are compared below.

Polluted Sea Area
(km²)

Existing (1990)	28.3
Future without Project (2010)	36.5
Future with Project (2010)	28.6

(2) Reduction of Water-borne Disease

Contraction of the water-borne diseases causes two (2) major economic costs: medical cost and opportunity cost of time spent by a hospitalized patient.

The total annual economic cost across the Study Area is calculated to be Rp.3,809 million under the existing conditions. A considerable portion of this economic cost will be reduced by the proposed project.

(3) Increase of Tourism Income

The tourism income of the Study Area is estimated to increase from Rp.183 billion in 1990 to Rp.717 billion in 2010 if wastewater disposal and the other all related infrastructures are well developed in future. However, it is expected that the future tourism income will much decrease from the above estimated one if the sea and river environments get worse in future than present.

The proposed project will much contribute to the increase of tourism income.

(4) Financial Aspects

The total amount of willingness to pay of the households and establishments in the proposed sewerage service area in 2010 is estimated to be Rp.4,460 million/year. It is more than the required O&M cost of Rp.2,670 million/year in 2010.

The development budget for infrastructures of the Study Area over the 17 years of the project implementation period from 1994 to 2010 is estimated at Rp.3,246 billion at 1992 price. This amount is adequate to carry out the proposed sewerage development project with the initial cost of Rp.254 billion at 1992 price.

3. Feasibility Study of Sewerage Development

The feasibility study area covers 2,683 ha in central Denpasar and 740 ha in Sanur, adding up 3,423 ha.

3.1 Sewerage Development Plan

(1) Sewer Network Plan

(i) Overall Plan

The detailed sewer network plans of Denpasar and Sanur areas, targeting the year of 2010 were prepared based on the policies and frames established by the master plan study.

The proposed overall plan of Denpasar covers the net sewerage service area of 2,663 ha with a total served population of 284,100 in 2010. The entire service area is covered by conventional separate sewer system.

The overall plan proposed for Sanur covers the net sewerage service area of 726 ha and serves the population of 27,800 in 2010. The entire service area is covered by conventional separate sewer system.

The collected wastewater of Denpasar and Sanur areas are transferred to the common treatment plant by a conveyance sewer of 4.4 km and a force main with booster pump of 5.2 km respectively.

The main features of the proposed overall sewerage plans for Denpasar and Sanur areas are shown in Table 3. The proposed overall main sewer networks for Denpasar and Sanur areas are shown in Fig. 3.

(ii) Urgent Plan

The urgent sewer networks of Denpasar and Sanur areas, targeting the year 2000 were selected from the respective overall sewer networks.

The urgent plan of Denpasar covers the most developed central area of Denpasar with a high population density where the highest cost-effectiveness of sewerage development is expected. The planned service area and served population in 2000 are 1,030.8 ha and 117,864 respectively. The proposed urgent plan, however, covers the service area combined with the conventional separate sewer system covering 714.6 ha and interceptor collection system covering 316.2 ha to minimize the project cost and to facilitate the project implementation.

The urgent plan of Sanur covers the Sanur beach area of 331.8 ha in view of the importance of ensuring its continued tourism potential. The planned served population is 11,513 in 2000. The entire urgent service area is covered by conventional separate sewer system.

The collected wastewater of the urgent plan are transferred to the treatment plant in the same way as the overall plan.

The main features of the proposed sewerage urgent plans for Denpasar and Sanur areas are shown in Table 3. The proposed urgent main sewer networks of Denpasar and Sanur areas are shown in Fig. 3.

(2) Treatment Plant

The proposed treatment plant of aerated lagoon system is located at Suwung Swamp Area along Bena Bay.

The treatment plant is planned to treat only the wastewater of Denpasar and Sanur areas until 2000, thereafter it is expected to treat the wastewater of Kuta area as well. Required capacity of the treatment plant in the year 2000 and 2010 are 44,000 m³/day and 117,000 m³/day respectively.

The urgent plan of the treatment plant targeting the year 2000 consists of inflow pump station of capacity of 70 m³/min., aerated lagoon with 450 kW of aerator, facultative aerated lagoon with 132 kW of aerator, polishing pond, sludge drying bed and other facilities. The required land space of the urgent plan is 9.2 ha.

(3) Estimated Cost and Implementation Programme

Project cost of the urgent sewerage development is estimated to be Rp.82,400 million at 1992 price. Annual O&M cost of the urgent project is estimated at Rp.1,194 million/year at 1992 price. Break-down of the project cost and O&M cost of the proposed sewerage urgent plan are shown in Table 4.

3.2 Economic Social and Environmental Evaluation

(1) Water Pollution Abatement

The proposed urgent project will control the future river water pollution of the most developed central and southern Denpasar areas to a large extent. The control effects are shown below.

(Unit : BOD₅ mg/l)

	Range	Average
Existing (1990)	22.9 - 51.8	32.2
Future without Project (2000)	35.1 - 80.3	52.7
Future with Project (2000)	15.3 - 30.8	23.0

The urgent project will reduce the pollution load to the sea from the Study Area under the existing, future without project in 2000 and future with urgent project are shown below.

	Pollution Load (BOD ₅ , ton/day)
Existing (1990)	10.8
Future (2000) without Project	17.2
Future (2000) with Urgent Project	11.6

As the consequence, the sea water quality of the Project Area in 2000 will be maintained around the existing level. The existing and future polluted areas exceeding 5 mg/l in COD_{Cr} are compared as follows.

	Polluted Sea Area (km ²)
Existing (1990)	28.3
Future without Project (2000)	35.3
Future with Project (2000)	31.1

(2) Reduction of Water-borne Disease

The annual number of water-borne disease contraction and the related economic costs in the urgent project area are estimated to be 7,387 cases and Rp.1,032 million respectively in 2000.

The urgent project will greatly contribute to the reduction of these water-borne diseases and related economic costs.

(3) Increase of Tourism Income

The tourism income of the sewerage development areas of Denpasar and Sanur is expected to increase from Rp.40,388 million in 1990 to Rp.94,986 million in 2000 and Rp.161,250 million in 2010 if wastewater disposal and the other all related infrastructures are well developed in future.

However, it is forecast that the future tourism incomes will much decrease from the above estimated ones, if the sea and river environments get worse in future than present.

Tourism benefits to be produced by the sewerage development project of Denpasar and Sanur areas are estimated to be Rp.10,788 million in 2000 and Rp.36,628 million in 2010.

(4) Economic Evaluation

Economic efficiency of the sewerage development project of Denpasar and Sanur areas is evaluated as follows.

Net Present Value (NPV)	:	Rp.42,321 million
Benefit Cost Ratio (B/C)	:	1.40
Economic Internal Rate of Return (EIRR)	:	14.1%

(5) Environmental Assessment

The anticipated environmental impacts due to the project activities are mostly beneficial as the Project in itself is an environmental improvement project. No significant long term adverse environmental effects by the Project are identified since the treatment plant is located far from residential areas and expected to be surrounded by mangrove forestation in future.

3.3 Financial and Institutional Aspects

(1) People's Willingness to Pay

The total amount of annual willingness to pay in the urgent sewerage service area is estimated to be Rp.1,314 million in 2000 at 1992 price. In 2010, the sewerage services are expected to cover the entire sewerage development area of Denpasar and Sanur. As a result, the total annual willingness to pay will reach Rp.3,582 million in 2010.

These annual willingness to pay are more than the required annual O&M costs of Rp.1,194 million in 2000 and Rp.2,670 million in 2010 respectively.

(2) Affordability and Contribution of Tourism Industry

The Project is primarily economically motivated, although it has an important social role by improving public health. Therefore, the major part of project costs will be borne by beneficiaries themselves. And the balance will be borne by the government.

Hotels are the prime beneficiary of the clean, clear and beautiful sea which will be kept that way by the Project. Accordingly, hotels in the sewerage service area will bear the initial investment cost that are to be duly expected of them. The construction costs of household package treatment plant are considered as the upper limit that hotels can bear.

The sewerage development project in Denpasar and Sanur areas will have beneficial effects on tourism industry more or less over the entire master plan study area. Therefore, a substantial part of the

remaining initial investment costs will be borne by the tourism industry there, represented by hotels and restaurants.

(3) Proposed Sewerage Charge

(i) Sewerage Service Charge

Sewerage service charge is levied on all the beneficiaries having direct connection to the sewers. The proposed monthly charge is summarized below.

Households	:	Rp.22/m ²
Hotels	:	Rp.125/m ² for classified hotels Rp.50/m ² for other hotels
Restaurants	:	Rp.50/m ²
Shops	:	Rp.70/m ² for large shops Rp.30/m ² for other shops
Offices	:	Rp.30/m ² - Rp.50/m ²

A household will pay 0.935% of average monthly income.

The present value of the cumulative sewerage service charge accounts for 140.5% of that of the cumulative O&M costs.

(ii) Capital Works Charge

Capital works charge will be applied to all the existing and future hotels located within the sewerage service areas. The proposed capital works charge is Rp.1.97 million/room for classified hotels and Rp.1.41 million/room for non-classified hotels/other accommodations.

The contribution of the capital works charge to the initial investment costs of the Project is estimated at 5.8%.

(iii) Tourism Tax

Hotels and restaurants in the master plan study area are subjected to the tourism tax of 2% at present. Out of 2%, 0.7% will be appropriated for the recovery of the initial investment costs of

the sewerage development project along with the above capital works charge.

This tourism tax will be collected by the government and later will be transferred to the sewerage organization as subsidy.

The contribution of the tourism tax to the initial investment costs of the Project is estimated to be 55.4%.

(4) Financial Analysis

It is proposed that :

- (i) The central/local governments will grant 35% of the initial investment costs and further the central government will extend a loan for the remaining 65% of the initial investment costs.
- (ii) The entire replacement cost will be self-financed by the sewerage organization.
- (iii) The entire O&M cost will be recovered by sewerage service charge.
- (iv) The initial investment costs borrowed from the central government will be recovered by capital works charge and tourism tax.

For the above financial conditions, the financial internal rate of return (FIRR) of the Project is estimated at 5.5% which is considered as sufficient and reasonable.

(5) Sewerage Organization

It is recommended to set up a new department for wastewater management in the existing PDAM rather than establishing an independent organization.

3.4 Recommendations

- (1) An immediate implementation of the Project is necessary for both development of the tourism industry and improvement of the overall sanitary environments of the Project Area.

Hence, it is recommended to commence the necessary financial procurement at the earliest.

- (2) Monitoring system of the water quality of rivers, coastal sea and groundwater shall be developed for better environmental management of the Project Area.

For this purpose, a laboratory with sufficient experimental equipment shall be immediately established.

Table 1 Main Features of Sewerage Master Plan

Item	Denpasar	Kuta	Sanur	Tanjung Benoa	Total
Service Area (ha)	2,683	648	740	136	4,207
Served Population in 2010	284,100	21,580	27,800	1,540	335,020
Wastewater Generation (m ³ /day)	75,300	18,400	16,800	4,220	114,720
Secondary & Tertiary (km)	418.4	65.7	97.2	3.1	584.4
Main (km)	50.9	12.5	10.9	3.4	77.7
Conveyance Sewer (km)	4.4	1.2	-	-	5.6
Force Main (km)	-	5.2	5.2	-	10.4
Sub-total	473.7	84.6	113.3	6.5	678.1
Lift/Booster Pump (place)	2	4	4	1	11
Treatment Plant		1		1	2

Table 2 Project Cost and O&M Cost of Sewerage Master Plan

	Denpasar	Kuta	Sanur	Tanjung Benoa	Total
Project Cost (million Rp.)					
Direct Const. Cost	129,335	41,640	33,199	7,135	211,309
Collection Sewer	113,794	33,673	23,078	3,957	174,502
Force Main	-	4,965	6,644	-	11,609
Treatment Plant	15,541	3,002	3,477	3,178	25,198
Administration Cost	2,869	554	642	161	4,226
Engineering Cost	11,477	2,218	2,567	643	16,905
Physical Contingency	14,366	2,776	3,214	804	21,160
Total	158,047	47,188	39,622	8,743	253,600
O&M Cost (million Rp./yr.)	1,581	424	537	128	2,670

Note: The construction cost and O&M cost of the integrated treatment plant are allocated for Denpasar, Kuta and Sanur in proportion to the wastewater generation of each area.

Table 3 Main Features of Sewerage Overall and Urgent Plans

Item	Denpasar		Sanur		Total	
	Overall	Urgent	Overall	Urgent	Overall	Urgent
Service Area (ha)	2,663	1,030.8	726	331.8	3,389	1,362.6
Served Population	284,100	117,864	27,800	11,513	311,900	129,377
Secondary & Tertiary Sewer (km)	418.4	126.02	97.22	32.72	515.62	158.74
Main Sewer (km)	48.75	15.14	10.94	4.31	59.69	19.45
Conveyance Sewer (km)	4.39	4.39	-	-	4.39	4.39
Force Main (km)	1.07	-	5.16	5.16	6.23	5.16
Total (km)	472.61	145.55	113.32	42.19	585.93	187.74
Lift/Booster Pump (place)	2	-	4	3	6	3
(m ³ /min.)	54.0	-	43.28	23.17	97.28	23.17
Treatment Plant (m ³ /day)	-	-	-	-	117,000*	44,000

Note: * including wastewater of Kuta area

Table 4 Project Cost and O&M Cost of Sewerage Urgent Plan

	(1992 price)		
	Denpasar	Sanur	Total
Project Cost (million Rp.)			
Direct Const. Cost			66,000
Collection System	42,634	11,166	53,800
Secondary & Tertiary Sewer	16,933	3,657	20,590
Main Sewer	14,143	4,222	18,365
Conveyance Sewer	11,558	-	11,558
Force Main	-	1,992	1,992
Lift/Booster Pump	-	1,295	1,295
Treatment Plant			12,200
Land Acquisition			500
Administration Cost			1,320
Engineering Cost			7,920
Physical Contingency			6,660
Total			82,400
O&M Cost (million Rp./year)			
Collection System			160
Treatment Plant			849
Overhead			185
Total			1,194

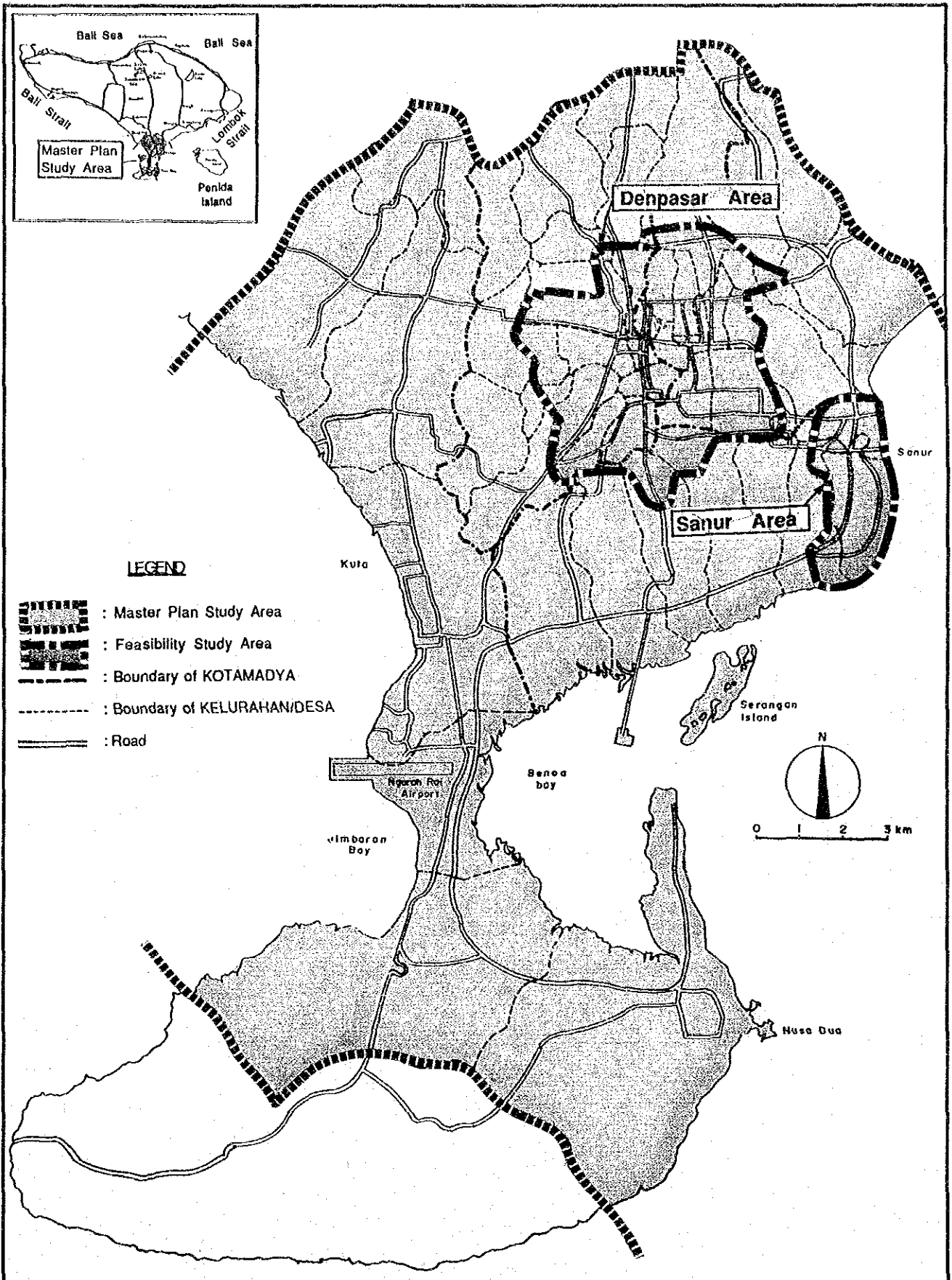


FIG. 1

MASTER PLAN AND FEASIBILITY STUDY AREAS

THE DEVELOPMENT STUDY ON WASTEWATER DISPOSAL FOR DENPASAR

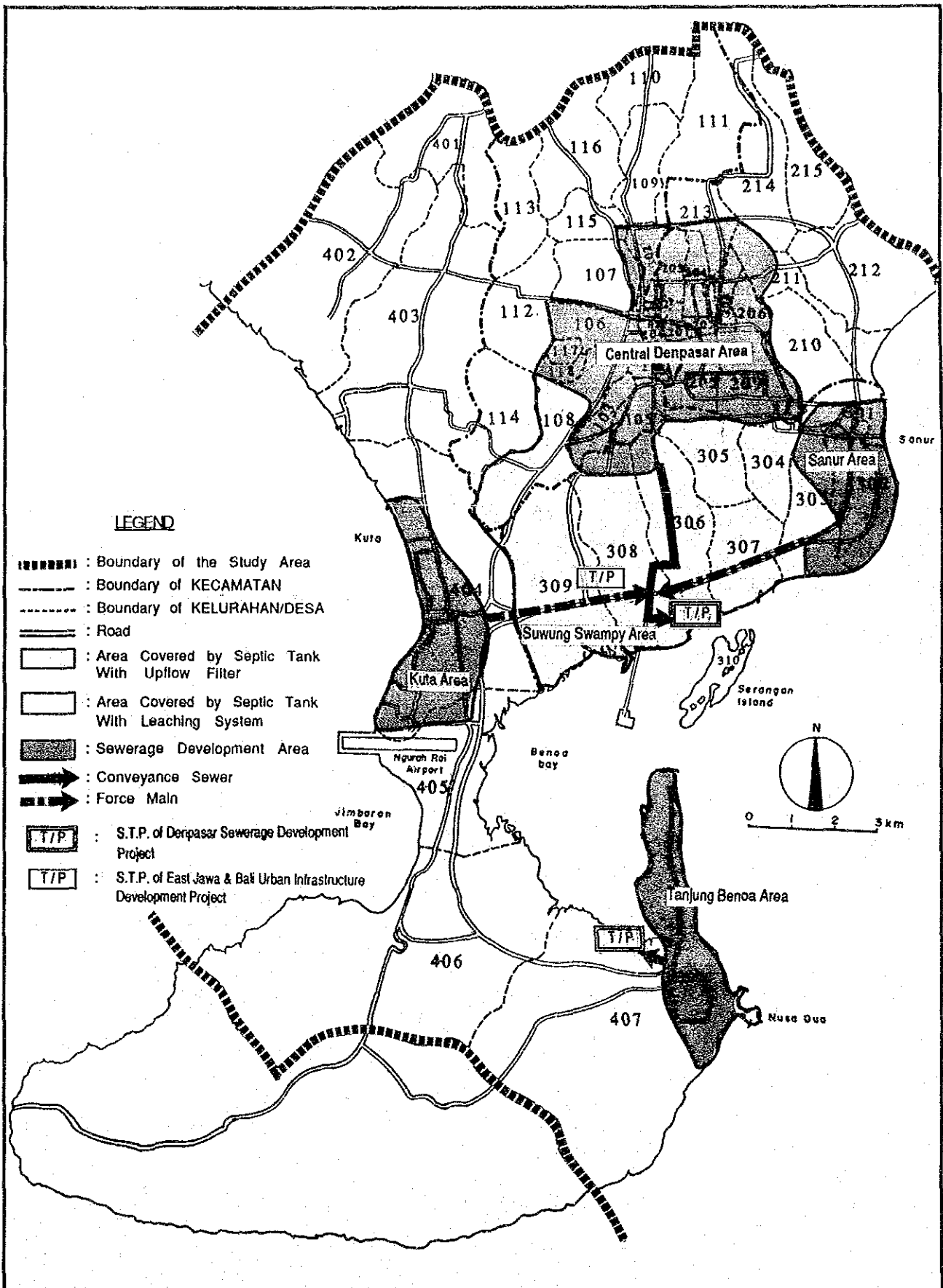


FIG. 2

WASTEWATER DISPOSAL ZONING
AND SEWERAGE DEVELOPMENT SYSTEM

THE DEVELOPMENT STUDY ON WASTEWATER DISPOSAL FOR DENPASAR

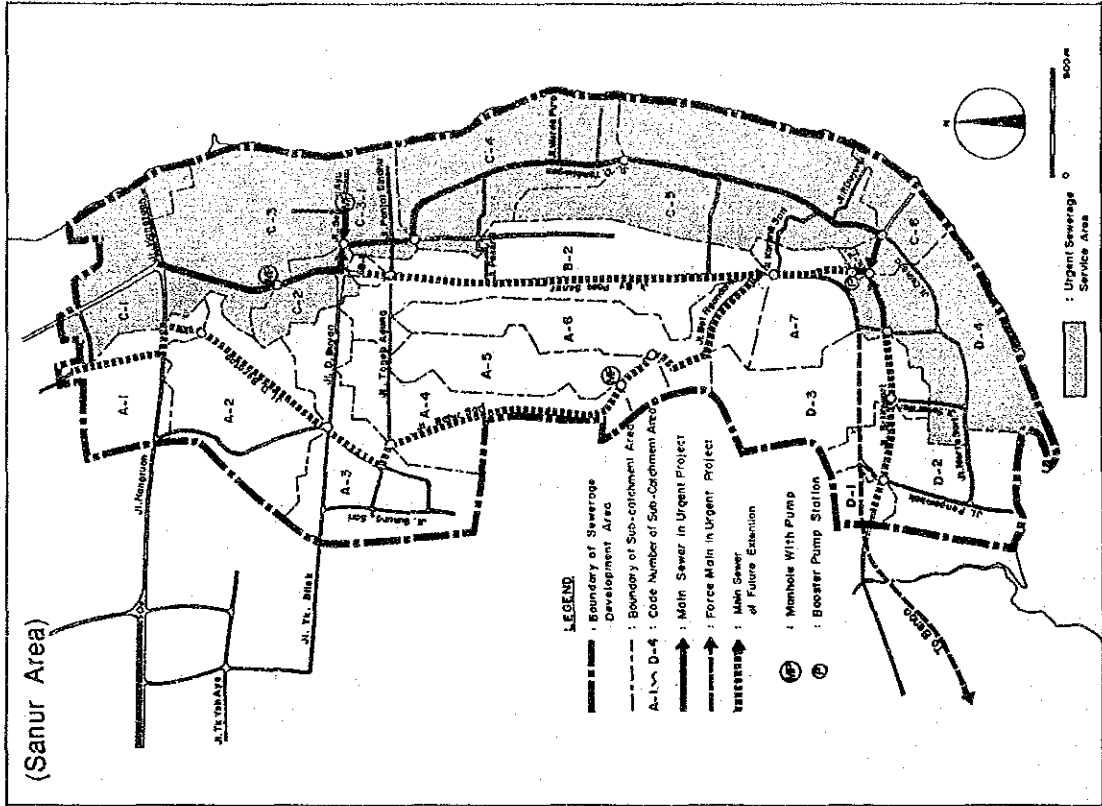
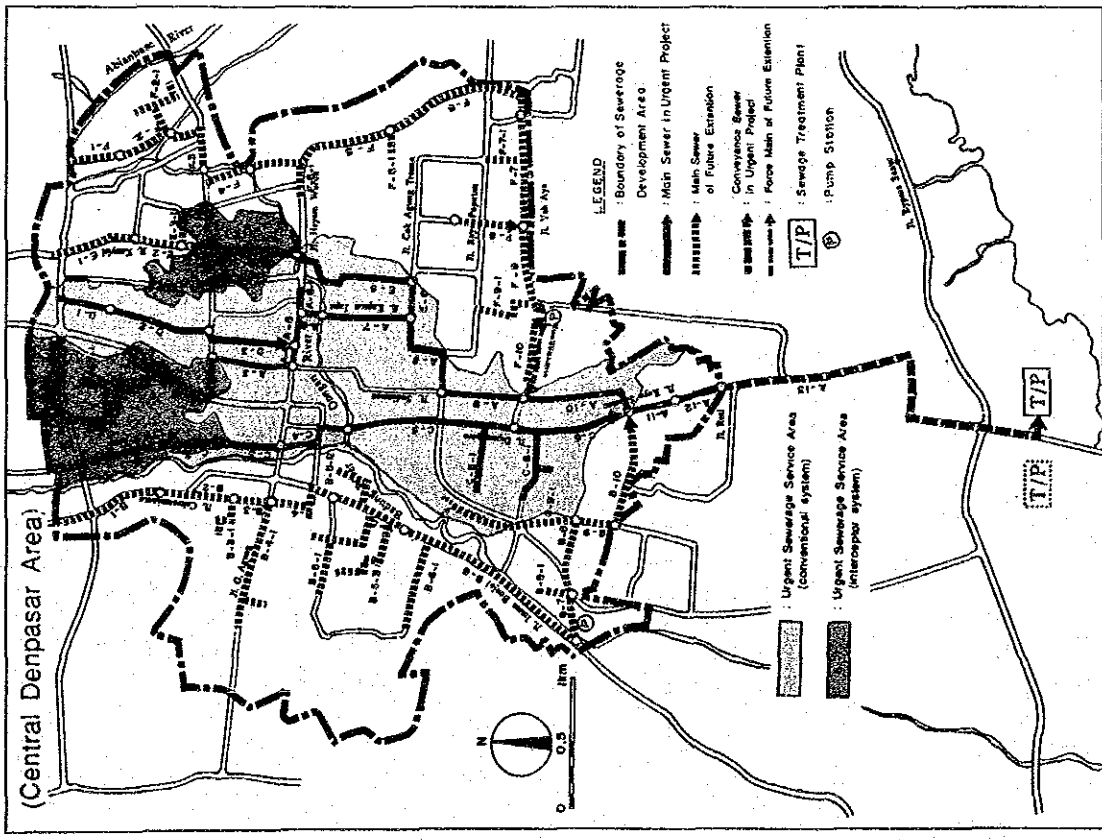


FIG. 3 OVERALL AND URGENT MAIN SEWER NETWORKS

THE DEVELOPMENT STUDY ON WASTEWATER DISPOSAL FOR DENPASAR

