JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL OF HUMAN SETTLEMENTS (CIPTA KARYA)
MINISTRY OF PUBLIC WORKS (PU)
GOVERNMENT OF INDONESIA

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

FINAL REPORT

EXECUTIVE SUMMARY

MARCH 1996

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
YACHIYO ENGINEERING CO., LTD., TOKYO

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In this report project cost is estimated at June 1995 price and at an exchange rate of 1 US$ = Rp. 2,250 (= ¥100)

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a master plan and feasibility study on wastewater and solid waste management for the city of Ujung Pandang and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Ryuji Yanai of Pacific Consultants International (PCI) five times between June 1994 and February 1996.

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

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

March 1996

藤田公郎

Kimio Fujita
President
Japan International Cooperation Agency

MASTER PLAN AND FEASIBILITY STUDY
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WASTEWATER AND SOLID WASTE MANAGEMENT
FOR
THE CITY OF UJUNG PANDANG

March 1996

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

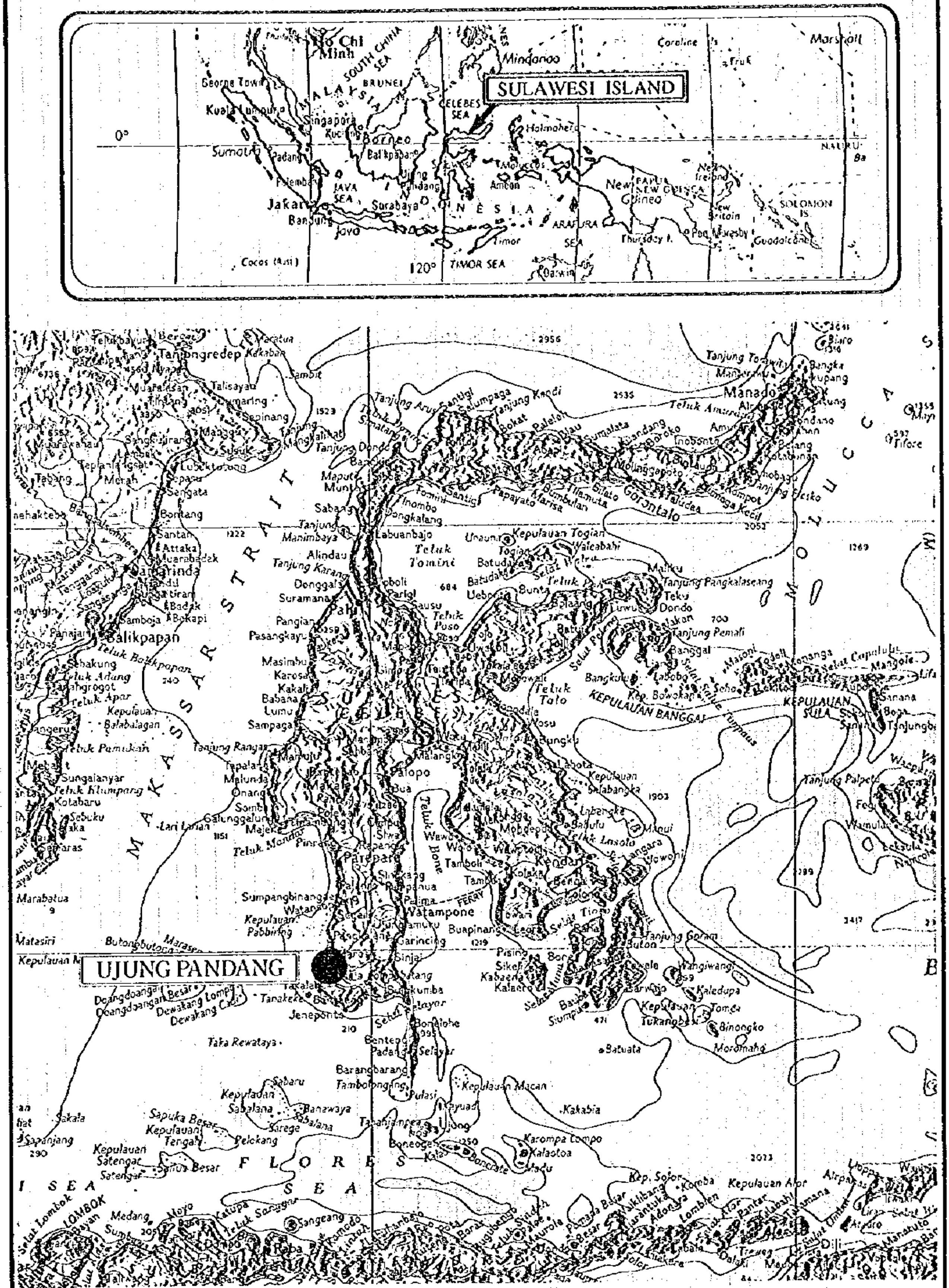
We are pleased to submit herewith the final report entitled "MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG". This report has been prepared by the Study Team in accordance with the contract signed on 14 June 1994, 24 April 1995 and 1 November 1995 between the Japan International Cooperation Agency and Pacific Consultants International in association with Yachiyo Engineering Co., Ltd.

The report, based on the results of analysis of existing condition of wastewater and solid waste management in Ujung Pandang, presents a master plan and feasibility study of wastewater and solid waste management, and an alternative study for wastewater management. The report consists of Executive Summary, Main Report and Supporting Report. The Executive Summary briefly illustrates the findings of the entire Study. The Main Report, in three (3) parts, presents the master plan (Part I), feasibility study (Part II) and alternative study (Part III). The Supporting Report describes in details the technical aspects of the master plan and feasibility study. Moreover, the relevant data and drawings are compiled as the Data Book & Drawing.

All members of the Study Team wish to express grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, Ministry of Health and Welfare 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 this study will contribute to the socio-economic development and environmental sanitation improvement in Ujung Pandang, the gateway to East Indonesia.

Yours faithfully,

Ryuji Yanai
Team Leader



LOCATION MAP

DEFINITION OF TECHNICAL TERMS

A. Wastewater Management

1. On-site System	:	The system treating wastewater within each building lot.
2. Off-site System	:	The system collecting and treating wastewater from multiple number of building lots.
3. Package Wastewater Treatment Plant (PWTP)	:	The compact blackwater and graywater treatment system which can obtain high BOD removal efficiency. The popular treatment processes of this system are an anaerobic filter-contact aeration process and separate contact aeration process.
4. Small Modular System (B)	:	The system consisting of collection system, septic tank and leaching bed to collect and treat black water from about 20 households.
5. Small Modular System (B/G)	:	The off-site system that serves about 1 RT (250 people) with collection and treatment system for both blackwater and graywater. The treatment system will be abandoned after integration into conventional sewerage system.
6. Large Modular System	:	The off-site system that serves about 10,000 ~ 50,000 people with collection and treatment system for both blackwater and graywater. The treatment system will be abandoned after integration into conventional sewerage system.

7. Developer Modular System : The off-site system with collection and treatment system for both blackwater and graywater covering a housing complex constructed by developer.

8. Small Scale Sewer : The separate collection system from each household to main sewer constructed under foot path or housing lot at a shallow depth less than 1.0 m.

9. Interceptor Sewer : The collection system that receives gray water from road side ditch during dry weather.

B. Solid Waste Management

1. Primary Collection : Solid waste collection from houses and transport to communal stations or TPS using hand cart or small satellite vehicle.

2. Secondary Collection : Solid waste collection from communal stations and generator premises and transport to final disposal site or intermediate treatment facilities.

3. Semi-sanitary Landfill : The solid waste disposal system which requires leachate collection, re-circulation and pre-treatment (aeration) facility and gas removal facility in addition to the necessary facilities of control landfill.

CONTENTS OF EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. Introduction

The Municipality of Ujung Pandang (KMUP), the provincial capital of South Sulawesi, is the largest city in Eastern Indonesia and would continue to take a leading role in the development of Eastern Indonesia. The population of KMUP has rapidly increased from 0.75 million in 1985 to 1.00 million in 1992, and is estimated to grow further to 1.52 million in 2005 and 2.20 million in 2015. The urban area has considerably expanded with an annual increasing ratio of over 10% since 1979.

Environmental sanitation service of KMUP is under the jurisdiction of Dinas Kebersihan (Cleansing Department), however the service level is far from satisfactory. The existing service level of solid waste collection is estimated to be 57% of total solid waste generation, and still worse in the field of wastewater management as there is no service except for quite insufficient septage collection. Consequently the highly urbanized central part of the city encounters severe environmental sanitation problems, which have been spread to the whole city with the recent rapid urbanization of the suburban area.

Hence, the formulation of a comprehensive wastewater and solid waste management plan has become necessary to improve environmental sanitation of the area.

Under these circumstances, the Government of Indonesia requested the Government of Japan in 1993 to conduct a full-scale study for the improvement of environmental sanitation (wastewater and solid waste management) of KMUP. Responding to the request, this Study 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 and KMUP from June 1994 to February 1996.

The objectives of the entire Study are as follows :

- To formulate a master plan aiming at the year 2015 for improvement of wastewater and solid waste management in KMUP.
- To conduct a feasibility study aiming at the year 2005 on the high priority projects selected from the master plan.
- To conduct an alternative study for wastewater management.

The Study Area, shown in *Fig 1*, is the Municipality (city) of Ujung Pandang (KMUP) with an area of about 176 km^2. Nevertheless, if a facility planned in the Study is located beyond the administrative boundary of KMUP, such an area would also be incorporated in the Study Area.

The Master Plan aims to secure health requirement and cleanliness of living conditions following the achievement of satisfying the minimum health requirement, with following basic policies.

a. Stepwise approach
   Not only "should be image" but also "on-the-way image" has been considered. "On-the-way image" is delineated as Short Term Plan up to 2005, which is formulated to be in conformity with the "should be image" of the Master Plan up to 2015.
b. Financial sustainability
   The project will be limited within the affordability of the governments and users.
c. Community participation
   The public education of environment promoted by the government shall be stressed to guide them how to work together for environmental sanitation improvement.
d. Private sector participation
   Incentives and enforcement to stimulate private sector participation is considered.

Wastewater included in the Study is domestic wastewater from households and offices, commercial and industrial wastewater which is not hazardous. But the Study does not include disposal and management of stormwater. Solid wastes included in the Study are those from households, offices, factories, hospitals, etc. and from roads and drains. But the Study does not include hazardous industrial wastes requiring special treatment and disposal.

The master plan and feasibility study for wastewater and solid waste management was conducted during June 1994 and September 1995, followed with the alternative study for wastewater management during October 1995 and February 1996.

The reports of the entire Study are as follows:

i) Main Report : English version (in three(3) parts of Part I, Part II, and Part III)
ii) Summary Report : English version (This Report) and Indonesian version
iii) Supporting Report : English version
iv) Data Book & Drawing : English version

2. Master Plan for Wastewater Management

2.1 Existing Conditions

In the Study Area many households have on-site facilities like septic tanks and leaching pits to treat blackwater, but almost all of the facilities are estimated to be unsatisfactory to mitigate groundwater from contamination. In addition to this, there are people who lack any sanitation facilities. Concerning graywater there are no treatment facilities. The existing public service of wastewater management is only insufficient septage collection service by Dinas Kebersihan.

The present environmental conditions of water bodies are as follows:

(1) Surface water

The BOD level in most of Panampu-Jongaya canal, the largest water body in the urban area of KMUP, is measured to be in the range of 120 ~ 180 mg/ℓ, and this figure is far above the least permissible standard limitation of 30mg/ℓ as BOD. Moreover bacterial pollution, measured as total coliform, exceeds 10^3 No./100mℓ, with a maximum of about 10^6 No./100mℓ.

(2) Groundwater

Bacterial pollution of groundwater in the entire Study Area is rather widespread, therefore it is not suited for direct potable use with no treatment, since they do not meet the required bacteriological quality for such direct potable use as per Classification-A of the usage based national water quality standards of the Ministry of Environment.

(3) Sea water

The coast line along the city center is somewhat polluted visibly. Pollution due to floating solid wastes also noted in these coastal sea waters. Bacterial pollution of coastal waters was found to be significant. High Total Coliform levels exceeding 10^3 No./100 mℓ are noted in the river mouth areas and the near coastal sea waters.

2.2 Planning Conditions

Wastewater generation in the Study Area is estimated to increase from 78,000 m^3 in the year 1992 to 237,000 m^3 in 2005 and 362,000 m^3 in 2015. This rapid increase reflects, in addition to population increase, the extension of water supply service. Accordingly pollution load generation in terms of BOD in the Study Area is estimated to increase from 24,000 kg/day in the year 1992 to 56,000 kg/day in 2005 and 79,000 kg/day in 2015.

2.3 Proposed Short Term Plan up to the year 2005

Basic strategy for formulating short term wastewater management plan consists of following five (5) steps.

i) To identify the no-toilet areas and find out appropriate schemes for providing basic toilet facilities for such areas.
ii) To demarcate the most recommendable technical options according to the characteristics of each area.
iii) To find out schemes for each area to be served by the most recommendable technical option.
iv) To optimize public sector project schemes so as to maximize private sector participation.
v) To determine the priority projects which will be completed until the year 2005 as public sector project schemes.

For no-toilet areas located in slum areas, Small Modular System (B) (hereafter called as SMS(B))/public toilet is most recommendable. If the physical condition is suitable for installing house connection sewer, SMS(B) could be recommendable on the condition that user could provide ones own water closet, otherwise public toilet shall be provided.

Except for no-toilet areas, demarcation of the most recommendable technical options consists of following two (2) steps.

i) To separate out the areas where leaching pit can be applied.
ii) To separate out the areas where septic tank with leaching field can be applied.

The criteria for leaching pit are that population density is less than 100 persons/ha and critical groundwater table level is deeper than 4 m from ground level.

The criteria for septic tank with leaching field is the specific pollution load generation from all sources other than blackwater be less than 2.7 kgBOD/day/ha. In this area, water quality level of 60 mgBOD/ℓ can be obtained with only blackwater treatment by septic tank with leaching field.

Following table shows schemes of recommendable technical options for each area.

Characteristics of Area				Schemes of Wastewater Management	
Specific Type	Ground water	Population Density	Specific BOD	Private Sector	Public Sector
Slum Area				No schemes	Provision of **SMS(B)/Public Toilet**
Non Slum Area and Non Housing Complex	Deeper than 4 m	Less than 100 persons/ha	Less than 2.7 kg/d/ha	Residents should provide **Leaching Pit** when they construct or renew their housing.	Establishment of **Guidelines** and **Regulations. Monitoring.**
	Shallower than 4 m	Less than 100 persons/ha	Less than 2.7 kg/d/ha	Residents should provide **Septic Tank with Leaching Field** satisfying standard when they construct or renew their housing.	Establishment of **Guidelines** and **Regulations. Monitoring.**
		More than 100 persons/ha	More than 2.7 kg/d/ha	No schemes	**Off-site system with secondary treatment** shall be installed so far as conditions permit.
Housing Complex				Housing Developer should provide **Developer Modular System** satisfying standard in their own housing estates.	Establishment of **Guidelines** and **Regulations. Monitoring.**

The area located beyond housing estates and needs to be covered by off-site systems is the most difficult area to be improved. Moreover, it is obvious that pollution load generation in such an area causes severe water quality deterioration. Accordingly, this area is need to be studied in more detail as the Priority Area.

Following (3) systems are selected as technical options for the Priority Area.

a. Small Modular System (B/G) using Package Wastewater Treatment Plant (hereinafter called as SMS (B/G) using PWTP)
b. Large Modular System (hereinafter called as LMS)
c. Conventional Sewerage System (hereinafter called as CSS)

Among these three (3) systems, both LMS and SMS (B/G) using PWTP have not been demonstrated in Indonesia. In case of LMS, there are no significant distinction from CSS. But SMS (B/G) using PWTP is a very unique system and hence pilot scale demonstration prior to full scale introduction is strongly recommended. Considering this point, the strategies for the Priority Area are as follows.

i) To determine the optimum LMS/CSS development plan based on the result of prioritizing and consideration of topographic condition and cross-subsidy
ii) To introduce SMS (B/G) using PWTP in pilot scale as an effort to investigate its practicability, especially with respect to O&M requirement

iii) To improve O&M of existing sanitation facilities for the non-served area of off-site system

Determination of LMS/CSS development area has been based on population density, public land use ratio, average income level and distance from potential site of treatment facility.

Zoning of proposed Short Term Plan up to the year 2005 is shown in *Fig. 2.*

2.4 Proposed Master Plan up to the year 2015

The criteria for demarcation of short term plan can still be applied to formulate Master Plan with the inclusion of additional criterion that the specific pollution load discharge shall be less than 1.8 kg BOD/day/ha, in order to achieve required water quality standard of 30 mg/ℓ in terms of BOD.

Basically the schemes of master plan are continuous development of the short term plan. The entirely new scheme is the integration of modular system into conventional sewerage system. This integration will be necessary for all modular systems located within the conventional sewerage system development area.

Schemes of Master Plan after completion of Short Term plan is shown below.

Characteristics of Area			Schemes of Wastewater Management	
Specific Type	Groundwater	Specific BOD	Private Sector	Public Sector
Non Housing Complex	Deeper than 4 m	Specific BOD load except for blackwater is less than 1.8 kg BOD/d/ha	Residents should provide **Leaching Pit** when they construct or renew their housing.	**Monitoring.**
	Shallower than 4 m		Residents should provide **Septic Tank with Leaching Field** satisfying standard when they construct or renew their housing.	**Monitoring.**
		Specific BOD load except for blackwater is more than 1.8 kg BOD/d/ha	No schemes	**Off-site system with secondary treatment** shall be installed.
Housing Complex			Housing Developer should provide **Developer Modular System** satisfying standard in their own housing estates.	**Monitoring.** For the area enclosed in sewerage system, **Integration into Conventional Sewerage System** shall be done.

Zoning of the proposed Master Plan (2015) is shown in *Fig. 3.*

For an off-site system with secondary treatment, CSS is selected as optimum system considering its cost efficiency and practicability. The optimum development plan of CSS has been determined based on the alternative study. For alternative study, CSS development area is divided into five (5) zones as follows.

Sewerage Zone	Design Wastewater Discharge
Northern zone	53,600 m^3/day
Central zone	63,400 m^3/day
North-eastern zone	26,300 m^3/day
Southern zone	41,000 m^3/day
South-eastern zone	77,700 m^3/day
Total	262,000 m^3/day

Among the various combinations of above divided zones, the plan comprising of three sewerage zones shown in *Fig. 4* has been selected as the optimum development plan.

As the treatment system, aerated lagoon is recommended due to its simplicity and operational flexibility. Moreover, the stabilization pond system recommended in the Short Term Plan can be easily upgraded to aerated lagoon with installation of aerators.

The total investment cost of the proposed Master Plan for wastewater management is estimated to be Rp.551.3 billion including the cost of house connection and the annual O&M cost is estimated to be Rp. 9.8 billion, both at 1995 price. The cost breakdown is shown in *Table 1*. These costs do not include price and physical contingencies.

2.5 Priority Projects for Feasibility Study

Among all schemes of the short term plan, following components requires direct investment by public sector.

a. Provision of SMS (B) / public toilet
b. Procurement of vacuum trucks
c. Rehabilitation of access road to Antang septage treatment plant
d. Construction of CSS
e. Pilot project for SMS (B/G)

These components are selected as priority projects for Feasibility Study.

3. Master Plan for Solid Waste Management

3.1 Existing Conditions

Dinas Kebersihan (DK) is responsible for solid waste management in KMUP, with the exception of industrial waste. DK is also in charge of street sweeping, ditch cleansing and desludging. The waste is collected and transported to the final disposal site at Tamangapa and amounts to 270 ton/day on average. As the solid waste generated is estimated at about 471 ton/day, excluding industrial waste, the disposed amount is only 57% of the total generated waste bearing in mind that KMUP operates only one (1) disposal site.

3.2 Solid Waste Amount and Composition

Based on the results of surveys and observation of the waste amounts entering Tamangapa disposal site by type, the waste amount is estimated to be 471 ton/day, excluding industrial waste, and this figure is estimated to increase to 861 ton/day in the year 2005 and 1,438 ton/day in 2015, due to the growth of socio-economic framework and increase of unit generation rate.

Characteristics of solid waste composition in KMUP are summarized as follows.

a. High content of putrescible matter (67% by wet base)
b. Low non-combustible content such as metal and glass (5%)
c. High moisture content (58% in dry season, 68% in wet season)
d. Low calorific value (920 Kcal/kg in dry season, 590 Kcal/kg in wet season)

Solid waste characteristics are sensitive to changes in life style, and experience in other countries shows the following tendencies in future.

a. Paper, plastic and metal will increase
b. Putrescible content, cinder, stone will decrease
c. Moisture content will decrease and organic content will increase
d. Lower calorific value will increase
e. Bulk density will decrease

In line with these tendencies, the future composition of domestic waste is estimated. The result shows that lower calorific value will exceed 1,200 kcal/kg after the year 2005, and also in future moisture content will be high and lower calorific value will be low during wet season.

3.3 Target of Master Plan

The targets of solid waste management (SWM) are to provide speedy, efficient and economical service to collect solid waste from areas where it is generated and dispose of it in a sanitary manner, in order to provide the citizens with a sound sanitary environment. The targets may be broken down into short and long terms as follows.

- Short term targets
  a. Expand collection service to 90% by the year 2005 using an efficient collection system
  b. Implement semi-sanitary followed with sanitary landfill disposal system
  c. Provide a SWM financial base based on new fee collection system
  d. Strengthening of institutional set-up
  e. Strengthen public sanitary education and citizens participation
  f. Introduction of private sector participation

- Long term targets
  a. Expand collection service to 95% by the year 2015 using an efficient collection system
  b. Implement sanitary landfill disposal system
  c. Promotion of waste volume reduction
  d. Provide a SWM financial base
  e. Strengthen public sanitary education and citizens participation
  f. Expansion of private sector participation

3.4 Proposed Short Term Plan up to the year 2005

The most important issue is to upgrade the collection service ratio to 90% by the year 2005. Also for the near future, the only possible location for the final disposal of solid waste is the present Tamangapa site. The new disposal site, Samata, shall start operation in 2002.

Proposed Short Term Plan is described below.

(1) Collection and Haulage

Four types of discharge and collection systems shall be applied; door - to - door, open station, Jali - Jali, and communal container. Dump truck and armroll truck shall be mainly used and primary collection will be provided only where vehicle accessibility is very low and at places where pick-up points are located too far from dischargers. All waste discharged to open

stations or door - to - door shall be packed. Collection frequently shall be at least 3 days in a week.

(2) Final disposal site

As a final disposal site, Tamangapa disposal site shall be utilized with extension. Semi-sanitary land fill method will be applied. There is no need to introduce a transfer station and direct hauling shall be employed.

(3) Street sweeping and ditch cleansing

Daily sweeping of class I and class II streets and every other day sweeping of class III streets are proposed. Mechanical sweepers will be used to sweep class I streets only. Concerning the ditch cleansing, in addition to continue the present work method backhoe operation will be introduced to improve working conditions and efficiency. An accurate inventory of ditch network is recommended to be undertaken.

(4) Other Activities

SWM institution shall be improved through upgrading of Dinas Kebersihan (DK) to PD Kebersihan and introduction of contracting - out to the private sector. In addition a new branch office will be set up at Panakkukang to cope with the rapid housing development in the suburban areas.

The new fee system introduced in 1994 will be continued, and the tariff level shall be adjusted to fairly distribute the burden and strengthen the SWM financial base.

3.5 Proposed Master Plan up to the year 2015

As the potential site for final disposal sites which can be utilized until the year 2015, following three (3) sites have been selected.

a. Samata (Gowa)
b. Maros
c. Bulurokeng (KMUP)

Based on these three (3) potential sites, following alternatives were formulated.

Alt-1. All collected waste of KMUP shall be disposed of in Gowa
Alt-2. All collected waste of KMUP shall be disposed of in Maros
Alt-3. All collected waste of KMUP shall be disposed of in Gowa and Maros

Alt-4. Transfer Station shall be constructed and all collected waste of KMUP shall be disposed of in Maros

Alt-5. The waste collected from the central area of KMUP shall be incinerated and ash and other waste shall be disposed of in Gowa and Maros

Alt-6. All collected waste of KMUP shall be disposed within KMUP

Flows of collected waste amount under each alternative are shown in *Fig. 5.*

Based on technical and financial evaluation, Alternative 1 was selected as the optimum one. Proposed Master Plan is described below.

(1) Collection and transport

Collection service ratio will continue to be upgraded to 95% of the total population of KMUP. The compactor vehicle (10 m^3) is recommended since it is more cost efficient than tipper and armroll considering the distance of more than 15 km between Samata disposal site and central city.

(2) Final Disposal site

Expansion of the Samata disposal site will be implemented, and Zone 2 will start operation in 2012.

(3) Street sweeping and ditch cleansing

To avoid increasing the number of manual sweepers, in addition to Class I streets a part of the Class II streets will also be mechanically swept. The short term plan for ditch cleaning shall be continued.

(4) Other Activities

The second branch office, Biringkanaya will be constructed, as soon as possible because of the rapid development of the residential area.

The tariff level shall be continued to be adjusted with the target of cost recovery realization.

The future solid waste flow along with Master Plan is shown in *Fig. 6.* The location of the final disposal sites and branch offices is shown in *Fig. 7.*

The total investment cost of the proposed Master Plan for solid waste management is estimated to be Rp. 126.4 billion and the annual O&M cost is estimated to be Rp. 14.2 billion, both at 1995 price. The cost breakdown is shown in *Table 2.* These costs do not include price and physical contingencies.

3.6 Priority Projects for Feasibility Study

Up to the year 2005, important projects concerning solid waste management according to the implementation schedule are as follows.

a. Further expansion of collection service through procurement and renewal of collection equipment and introduction of more efficient collection system
b. Construction of Samata landfill site in Zone I
c. Construction of branch office
d. Institutional reorganization to PD Kebersihan
e. Proper tariff system
f. Introduction of contracting - out in the old Kecamatan

The above six (6) projects are selected as the project components of the Feasibility Study based on this Master Plan of solid waste management.

4. Evaluation of Master Plan

4.1 Environmental Evaluation

(1) Mitigation of water pollution

The pollution load discharge under the conditions of both "with" and "without" the proposed Master Plan, in the year 2015, is compared as shown below.

Area	Pollution Load Discharge (kgBOD/day)	
	WITH Master Plan	**WITHOUT** Master Plan
On-site System Area	18,500	18,500
Off-site System Area	3,700	37,400
Total	22,200	55,900

Under "with Master Plan" condition, specific pollution load discharge will remain less than 1.8 kgBOD/day/ha based on the Kelurahan-wide data.

As a result, the proposed Master Plan for wastewater management up to the year 2015 will ensure the water quality of surface water bodies in the whole Study Area to be less than 30 mg BOD/ℓ .

Besides, the proposed Master Plan for wastewater management is expected to contribute to the mitigation of groundwater pollution presently caused by inadequate treatment of blackwater, not only in the off-site area but also in the on-site area.

(2) Improvement of living environment

Present total generation of solid waste in KMUP is 471 ton/day except industrial waste, and the amount of uncollected waste by Dinas Kebersihan reaches 200 ton/day except industrial waste, resulting in a collection ratio of about 57%.

Future total generation of solid waste of the whole Study Area in the year 2015 is estimated at 1,438 ton/day, except industry waste, which is more than 3.1 times the present one. It is obvious that existing capacity of solid waste collection service would be extremely inadequate and consequently illegal dump sites would proliferate further resulting in severe deterioration of living environment, if no countermeasure is undertaken.

With the completion of the proposed Master Plan for solid waste management, the whole Study Area except for those area with low population density less than 50 persons/ha will be covered by regular solid waste collection service. Consequently illegal dump sites will disappear in the whole Study Area.

In conclusion, the proposed Master Plan for solid waste management will contribute to improvement of living environment of the Study Area to a great extent.

4.2 Institutional Evaluation

(1) Wastewater management institution

The type of the institution is one of the directorates in the organization structure of PDAM. Revision of Perda No. 6/1974 and of mayor decree No. 21./P/II/1976 makes it legally possible to set up the type of the institution. The total number of personnel of PDAM in 2015 is figured out to be 1,910 persons, of which 250 persons are proposed for the wastewater directorate to achieve 100% of wastewater collection service ratio in the year 2015. The organization chart is shown in *Fig. 8.*

(2) Solid waste management institution

The type of the institution is PD based upon the issuance, promulgation and legislation of anew Perda, since it was drafted by the municipality. Solid waste collection in old Kecamatan and new housing areas shall be contracted out up to 50% of collection. The total number of personnel of PD Kebersihan in the year 2015 is figured out to be 975 persons as the maximal number to accomplish 95% of waste collection service ratio considering contracting out of collection service. The organization chart is shown in *Fig. 9.*

4.3 Financial and Economic Evaluation

With the prospective project beneficiaries pertaining to the present and future industrial, commercial and residential consumers in sight, the project comprising the two components of wastewater and solid waste is in line with the strategy adopted by the government to achieve important social and economic policy goals in the eastern region of the country.

Available fund projection for the project period shows that the total funds available for the sanitation subsectors in KMUP, within the time-slice of 20 years, will be Rp.237.6 billion as per 1995 price up to the year 2005, of which about 65 percent of funds emanates from the public sector. In addition, Rp.490.9 billion from the year 2006 up to the year 2015 would arise from both of the public and the private sectors, combining to a total of Rp.728.5 billion at maximum.

With this and an estimated annuity of Rp.13.5 billion to Rp.15.8 billion, thus making it possible for the project to be formulated, on SLA (Subsidiary Loan Agreement) re-lending terms and conditions, at maximum Rp.180.0 billion in association with grant from the central government and fiscal transfer from the provincial government and/or equity participation standing at Rp.67.5 billion and Rp.11.3 billion, respectively.

5. Feasibility Study of Wastewater Management

5.1 Sanitation Improvement Project

Sanitation improvement project consists of two (2) project components, namely, provision of accessible basic sanitation facilities in slum areas and improvement of septage management. These projects are slated for urgent implementation until the year 2000.

(1) Sanitation improvement for slum area

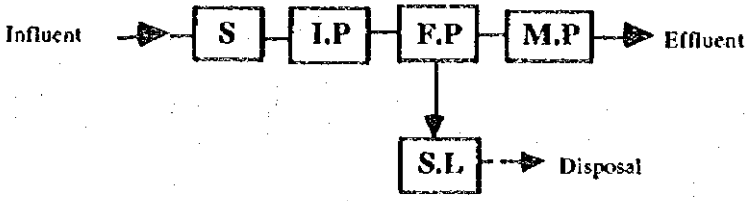
Project work includes rehabilitation of 59 malfunctioned public toilets and construction of 66 SMS (B)/public toilets, basically to be accomplished until the year 1998.

(2) Improvement of septage management

Project work includes procurement of vacuum trucks on regular basis in conformity with the quantity of generated septage until the year 2015 and improvement of the access road to the existing Antang septage treatment plant to be accomplished until the year 1998.

5.2 Sewerage Development Project

Sewerage Development Project is comprised of three (3) sewerage projects shown in *Fig. 10.* Stabilization pond is applied as the treatment system for all the proposed sewerage systems. The flow diagram of the stabilization pond treatment process adopted is shown below.



S	:	Screen
I.P	:	Inflow Pump
F.P	:	Facultative Pond
M.P	:	Maturation Pond (minimum of two ponds in series)
S.L	:	Sludge Lagoon (minimum of two cells)

The collection system is comprised of a combination small scale sewers, ordinary sewers and interceptor sewers. Small scale sewer is applied as the tertiary sewer prior to house connection sewer when the width between the front of houses and

road is at least 3m, or the road has pedestrian walkway of at least 1m width. Interceptor sewers with no direct house connection is used in areas of poor accessibility and congested areas.

Project work of each sewerage system is described below.

(1) Northern sewerage system

Northern sewerage system will cover the northern part of the Priority Area with its treatment facility located at Lembo. The capacity of Lembo wastewater treatment plant (WTP) is very limited and consequently this plant will be abandoned with the expansion of service area according to the Master Plan.

The significant features are as follows.

Service area	:	73 ha
Design population	:	22,900 persons in the year 2005
Design inflow to WTP	:	5,500 m^3/day

(2) Central sewerage system

Central sewerage system will cover the central part of the Priority Area with its treatment facility located at Pampang.

The significant features are as follows.

Service area	:	435 ha
Design population	:	130,600 persons in the year 2005
Design inflow to WTP	:	28,600 m^3/day

(3) Southern sewerage system

Southern sewerage system will cover the southern part of the Priority Area with its treatment facility located at Maccini Sombala.

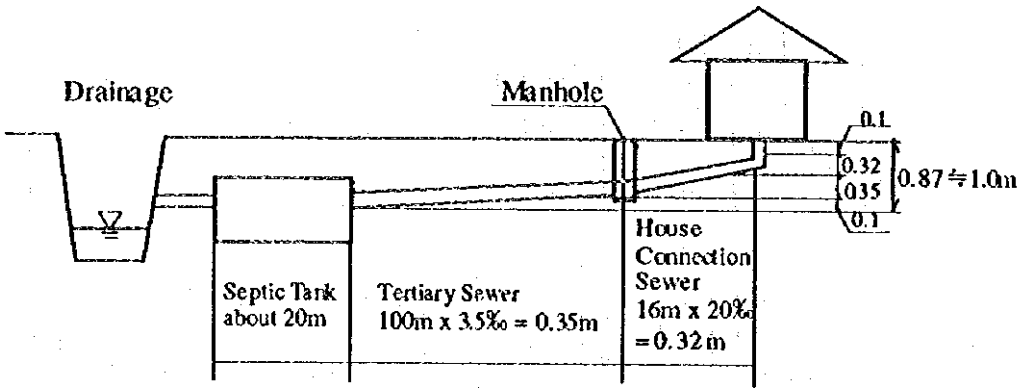
The significant features are as follows.

Service area	:	162 ha
Design population	:	70,800 persons in the year 2005
Design inflow to WTP	:	11,000 m^3/day

5.3 Pilot Project

Pilot project, which aims to demonstrate SMS (B/G), is planned at six (6) potential sites shown in *Fig. 10.* Among six (6) potential sites, Losari site is planned with package wastewater treatment plant (PWTP) and remaining sites with septic tank.

Typical profile of SMS (B/G) is shown below.



The above typical profile assumes a service area of about 1 ~ 2 ha.

5.4 Project Cost

The total investment cost of the entire Feasibility Study projects of wastewater management is estimated to be Rp. 76.35 billion. The relevant annual O/M cost in the year 2005 is estimated to be Rp. 2.45 billion/year. The cost breakdown is shown below (price and physical contingencies are not included).

Project Item	Project component	Served population (persons)	Investment cost (Rp.billion)	Annual O/M cost (Rp.billion)
Sanitary Improvement Project	Rehabilitation of malfunctioning public toilet	15,950	0.03	0.41
	Provision of SMS(B)/public toilet	7,260	0.33	0.13
	Procurement of vacuum trucks	1,363,000	1.54	0.77
	Improvement of Antang access road		0.54	
Sewerage Development Project	Provision of LMS (north)	22,900	6.91	0.14
	Provision of CSS (central)	130,600	40.31	0.81
	Provision of CSS (south)	70,800	8.46	0.17
Pilot Project	Provision of SMS (B/G) using septic tank	2,068	1.53	0.01
	Provision of SMS (B/G) using PWTP	935	0.74	0.01
Sub total			60.39	2.45
Land Acquisition			8.16	
Administration			1.11	
Engineering service			6.68	
Total			**76.35**	**2.45**

6. Feasibility Study of Solid Waste Management

6.1 Improvement of Collection and Transport

Improvement of collection and transport is comprised of procurement plan of required equipment and operation plan.

(1) Procurement plan

Procurement plan has been prepared considering the normal conditions applied in obtaining foreign loan.

Procurement schedule is determined as follows.

Equipment	1998	2000	2001	Total Procurement
1. Armroll	32	8	25	65
2. Tipper large (6 m^3)	14	35	21	70
3. Tipper small (3 m^3)	6	2	0	8
4. Container	311	83	127	521
5. Hand cart	429	429	0	858

(2) Operation plan

Primary collection using hand carts will be limited to areas where such service is absolutely necessary. About 420 hand carts with their workers have been included in the project for this purpose. In line with the present KMUP policy, the haul container system will be gradually expanded to cover 60% of the collected waste by the year 2005 (at present about 30%).

6.2 Improvement of Street Sweeping and Ditch Cleansing

Introduction of mechanical sweeper is proposed for street sweeping to improve work efficiency. In total three (3) mechanical sweepers shall be introduced, starting in 1998.

For improving ditch cleansing and working conditions two (2) backhoes and dump trucks will be introduced.

6.3 Expansion of Tamangapa Disposal Site

According to the Master Plan, Tamangapa disposal site will be used until the year 2001 and expanded up to 32 hectare as a semi-sanitary landfill site. Necessary facilities for upgrading to semi-sanitary landfill are as follows.

- Leachate collection pipe
- Leachate circulation system
- Leachate discharge facility
- Gas removal facility

Design conditions for the expansion of Tamangapa disposal site are given below.

a.	Landfill area	:	32 hectares
b.	Landfill height	:	15 m (include covering soil)
c.	Landfill capacity	:	1,520,000 ton
d.	Period of usage	:	until the year 2001 (six years)
e.	Landfill method	:	Semi-sanitary landfill
f.	Service area	:	whole area of KMUP
g.	Waste amount to be collected	:	571 ton/day in the year 2000

6.4 Construction of Samata Disposal Site Phase I

According to the Master Plan, Samata disposal site will be constructed as an inter-municipal disposal site, for the waste generated from KMUP and Kabupaten Gowa in consideration of the MINASAMAUPA concept. For Samata final disposal site sanitary landfill, which would require complete leachate treatment facility, is proposed.

Design conditions for the construction of Samata disposal site are given below.

a.	Landfill area	:	65 hectares
b.	Landfill height	:	15 m (include covering soil)
c.	Landfill capacity	:	3,540,000 ton
d.	Period of usage (Phase I)	:	2002 ~ 2012 (10 years)
e.	Landfill method	:	Sanitary landfill
f.	Service area	:	whole area of KMUP and Sungguminasa area of Kabupaten Gowa
g.	Waste amount to be collected	:	774 ton/day in the year 2005

6.5 Other Activities

For the purpose to expand the collection service in suburban area, Panakkukang branch office shall be constructed and the operation of this branch office shall be started in the year 2000. Two (2) hectare of land shall be kept for the necessary facilities of this branch office, such as office building, parking lot etc., and in consideration of future development of solid waste management facilities such as incineration plant, recycling facilities, and so on, additional two (2) hectare of land shall be secured at the same time.

The Panakkukang branch office would function mainly as the depot of the collection vehicles and administrative base for the waste collection service.

To improve the institution frame of SWM, PD Kebersihan shall be established with a staff of 859 persons. Contract - out of waste collection and transport in the six(6) old Kecawetan shall be introduced. Tariff levels shall be continuously reviewed to maintain a strong financial base for the SWM activity.

6.6 Project Cost

The total investment cost of the entire Feasibility Study projects of solid waste management is estimated to be Rp. 50.38 billion. The relevant annual O/M cost in the year 2005 is estimated to be Rp. 7.66 billion/year. The cost breakdown is shown below (price and physical contingencies are not included).

Project component	Investment cost (Rp.billion)	O&M cost (Rp.billion)
Collection	11.03	5.17
Street sweeping	0.89	0.46
Ditch cleansing	0.34	0.12
Final Disposal Site	23.36	1.91
Office	1.98	0
Sub total	37.59	7.66
Land acquisition	7.29	
Administration	0.78	
Engineering service	4.71	
Total	**50.38**	**7.66**

7. Project Evaluation

7.1 Institutional Evaluation

7.1.1 Wastewater Management

For the responsible organization of wastewater management sector, amalgamation with PDAM is proposed. The organization structure of PDAM is accepted as it is and the amalgamation of a wastewater management institution will be accomplished.

The minimal number of personnel and scale of the organization are studied in detail enough to institutionally be implementable for providing 90% of the population with the service of on-site sanitation and 15% with that of off-site sewerage system. That is, 5% of the population will be furnished with the dual services of on and off-site systems for a certain period (interceptor service population).

The Study on PDAM with a wastewater management institution of KMUP in 2005 is evaluated as institutionally feasible. The organization chart is shown in *Fig. 11.*

7.1.2 Solid Waste Management

PD Kebersihan of KMUP in 2005 (with 1,508 personnel) can be evaluated as follows.

a. Good, compared to the Dinas Kebersihan KMUP in 1994. The present Dinas Kebersihan of KMUP will require 1,911 persons in 2005, should it operates as it does at present.

b. Not always good, compared to Bandung PD Kebersihan in 1994. Compared as 1,508 persons against 1,424 persons, 84 persons in excess.

c. Not good, compared to the contents of the M/P. The number of 134 persons exceeds the level of the M/P.

As a conclusion, proposed organization of solid waste management is acceptable because of the reason as evaluated above in (a.). The organization chart is shown in *Fig. 12.*

7.2 Pricing and Tariff Structure

Provided that the maximum amount payable for the tariffs accrued to the sanitation services concerned are generally accepted at 1 percent, 0.75 percent and 2 percent of disposable income which accounts for 90 percent of the total income for sewerage, septage management, and solid waste management, respectively, willingness to pay are summarized as follows.

Willingness to Pay (Rp./month)

	Low income residents	Middle income residents	High income residents	Business and public entities
Sewerage	1,440	3,040	6,400	1,186,000
Septage Management	1,080	2,280	4,800	890,000
Solid Waste	2,880	6,080	12,800	2,373,000

Considering affordability of the beneficiaries associated with the project scope, the tariff structure in compliance with the policy of full cost recovery for the whole project components will be infeasible with the highly excessive pricing level in terms of people's affordability, or willingness to pay.

The proposed tariff structure that covers the total operation and maintenance (O/M) cost and the construction cost of house connection for the sewerage sub-component will be addressed in tandem with those tariff to meet the total cost recovery accuruable to the septage management and solid waste management services. The proposed tariff structure is as follows.

Proposed Monthly Tariff

	Low income (Rp./HH)	Middle income (Rp./HH)	High income (Rp./HH)	Small comm. (Rp./m^2)	Large comm. (Rp./m^2)	Public Inst. (Rp./m^2)
Sewerage (Rp.)	1,115.3	3,345.8	8,364.6	95.1	608.9	149.5
Septage (Rp.)	119.0	357.0	892.4	503	375.4	92.1
Solid Waste(Rp.)	872.5	1,963.2	4,417.2	401.6	1,715.0	526.2

All the tariff indicated above rest below or near the neighborhood of willingness to pay for households. Hence, it would be acceptable to assess the project scope to be affordable. As for business entities, the monthly weighted average tariff of Rp.172.1/m^2 would be feasible considering the average willingness to pay for sewerage services provided be about Rp.100,000 per month and the average floor area of business entities in the city is most likely be less than 580 m^2.

7.3 Financial Analysis

Financial viability of the Project has been established by estimating a financial internal rate of return (FIRR).

The benefits comprise tariff revenues as borne out by the provision of sewerage, desludging and solid waste management services attributable to the investments during the fiscal years from 1997 to 2000 for the sewerage and desludging component, and up to the year 2001 for the solid waste component. In addition, capital works charge which leads to the city revenue at Rp.10,000 /m^2 up to the year 2005 and Rp.20,000 /m^2 onwards is taken into account.

The FIRR of the investment plan with all costs and benefits expressed as per 1995 price level, is estimated at 10.5% and 12.7% for the wastewater and the solid waste sub-sectors, respectively. With the current opportunity cost of capital standing at around 8 to 10%, the FIRRs for the projects are to exceed the real cost of project capital, thereby making it possible to evaluate the projects as financially viable.

7.4 Economic Analysis

Economic analysis of the projects under the study has been quantitatively carried out wherever possible while taking into account a number of economic, social and environmental benefits accrued. The economic internal rates of return (EIRR) has been expeditiously estimated with the marginal cost-based tariff and the shadow priced project costs.

EIRR on the Project as a whole works out to 11.7%, with 10.8% and 12.9% for the wastewater and solid waste sub-components, respectively. Thus, the Project with those sub-projects altogether is substantially viable and acceptable, while the currently estimated opportunity cost of capital which stands at around 10% is taken into account.

8. Recommendation

(1) Immediate Implementation of Master Plan

The result of the Study indicates that without effective measures to restore environmental sanitation it would be impossible to avoid further aggravation of the environmental condition. In order to mitigate the progressing deterioration of environmental sanitation in the Study Area, an immediate implementation of the proposed Master Plan is required.

Accordingly, it is recommended to commence adequate financial procurement to initiate the master plan as soon as possible.

(2) Enhancement of Environmental Awareness

The result of the Study shows that people's awareness on deterioration of environmental sanitation is still quite low. A very significant attribution of this lack of environmental awareness is the illegal dumping of solid waste in ditches and drains and discharge of toilet waste to public water bodies.

Hence, enhancement of environmental awareness including public health education is strongly recommended as the key of environmental sanitation improvement.

(3) Development of Surface Water Quality Monitoring System

At present there are no monitoring stations of surface water quality in KMUP. For understanding the trend in time series and to expedite the necessary environmental improvement measures, establishment of permanent monitoring stations and measurement of water quality at regular time interval is very necessary. Hence, it is recommended to develop monitoring system of surface water quality. This program shall include the training of monitoring staff.

(4) Improvement of Industrial Waste Management

The characteristics of industrial waste vary widely and are recognized as one of the major source of pollution associated with rapid industrial development. From this view point, industrial waste especially hazardous waste shall be treated adequately. Hence it is recommended that regulations to enforce installation of adequate treatment facilities by industries be implemented by the concerned governmental institution.

9. Alternative Study for Wastewater Management

9.1 Objective of the Alternative Study

The objective area of the alternative study for wastewater management is the Priority Area shown in *Fig. 13* as identified in the Master Plan (ref. Section 2).

This alternative study was intended at identifying and evaluating essentially simple alternative wastewater management strategies as a stop-gap measure, principally targeting graywater management, in the event the implementation of the proposed sewerage development projects as per the Feasibility Study delineated in Section 5 is delayed due to financial constraints or any other unforeseen circumstances.

Moreover, in order to optimize public sector investment, a social aspect study was conducted to investigate potential active community participation for realizing the simple options of graywater management.

9.2 Options of Wastewater Management

Wastewater management aspects of this alternative study principally targeted that of graywater management, since the necessary improvement measures for blackwater management have been incorporated as the urgent project component of the Feasibility Study (ref. Section 5).

Options of graywater management could be selected to target either living environment improvement or water environment improvement, though in general an applied option would result in some form of water environment improvement.

An option principally targeting improvements near residents is for living environment improvement, while an option targeting improvement of a water body is for water environment improvement.

A total of ten (10) strategic options were conceived for wastewater management in the objective area, as follows :

(1) Cleansing of ditches and drains

(2) Provision or improvement of ditches and drains

(3) Installation of screens in ditches and drains

(4) Provision of household based infiltration trench

(5) Graywater collection and infiltration using ditches and drains

(6) Graywater collection and treatment using ditches and drains

(7) Provision of treatment system within canal

(8) Introduction of flushing or dilution water from Jeneberang river

(9) Graywater conveyance and treatment system using canal

(10a) Interceptor for coastal water protection

(10b) Interceptor sewerage system for living environment improvement

The first five (5) options target living environment improvement. They are simple and hence easily amenable for active community participation. While the remaining ones are rather complex and target, other than the last option No. 10b, water environment improvement. Accordingly, these remaining options are not amenable for active community participation. Active community participation implies involvement of community from the initial planning stage to the final operation and maintenance stage of a facility.

The first three (3) options are very simple, where the strategy is essentially the basic maintenance of a drainage ditch. Still they are very important to mitigate the accumulation of graywater in a ditch or drain.

The options No.4 and No.5 target infiltration of graywater into natural soil, respectively, within a household yard (household system) and nearby a road side ditch or drain (communal system). These systems, though simple, are relatively more complex compared to the above three (3) options.

The option No.6 is aimed at the treatment of graywater, using anaerobic filter system, near the outlet of a secondary drain prior to discharge into the primary drainage canal system, the Panampu ~ Jongaya canal.

The options from No.7 to No.9 are aimed at the water quality improvement of Panampu - Jongaya canal. In case of option No.7 installation of aerators in the canal is considered. The option No. 8 envisages introduction of flushing or dilution water into Jongaya canal from the long storage of Jeneberang river. The long storage is provided basically for the potable water supply development by PDAM. The option No.9 is aimed at the conversion of Panampu ~ Jongaya canal into double section, with the inner section conveying the graywater in dry season. The conveyed wastewater will be treated in two (2) separate treatment plants (stabilization pond systems) located at Lembo (to the north) and Maccini Sombala

(to the south). These treatment plants would conform to that proposed in the Feasibility Study (ref. Section 5 and *Fig. 10*).

All the above three (3) options assume the provision of three (3) gates, one each at Jongaya, Sinrijala and Panampu canal. The gates while facilitating the separation of wastewater from sea water, would also contribute to mitigation of salinity intrusion.

The option No.10a is aimed at protecting the water quality of Losari beach area, by intercepting the outflows and treating the collected graywater with anaerobic filter system.

The option No.10b envisages the development of interceptor sewer system as the initial step of conventional sewerage development in the central area of the objective area, with the service area being in conformity with the Feasibility Study (ref. *Fig. 10*).

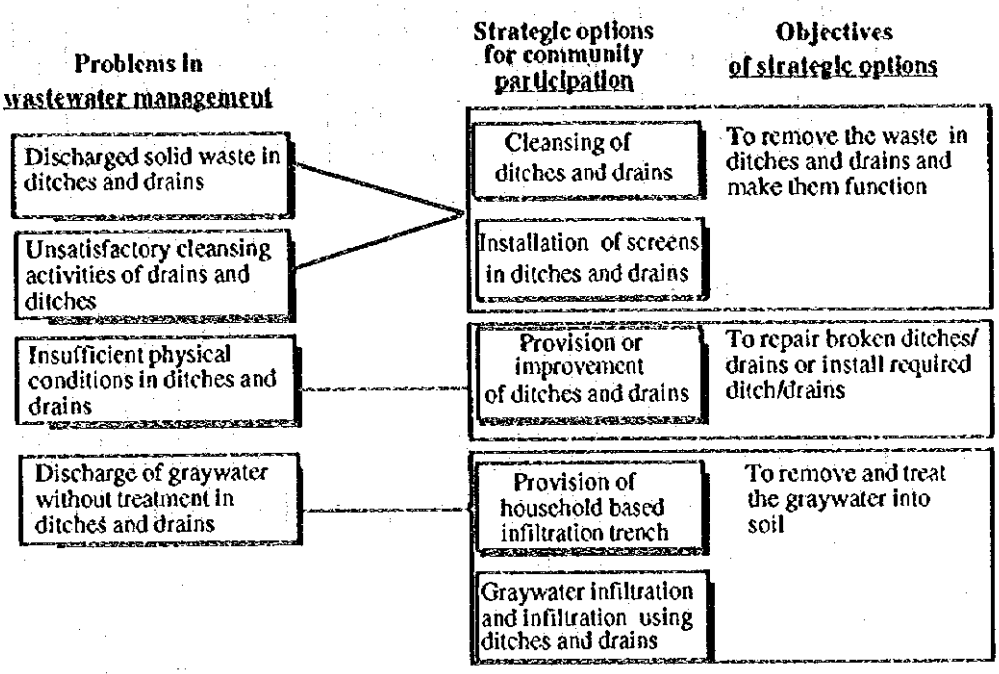
9.3 Social Study for Wastewater Management

The goal of the community participation is to improve the living environment at community level by enhancing people's awareness of the need for wastewater management and hence engaging communities and individuals in the planning, implementation and operation and maintenance of facilities. Utilization of local resources to the maximum extent possible will be promoted.

The social survey has been conducted in order to confirm the commitment of community participation for implementing the simple community oriented strategic options (option No.1 to No.5) in the selected model areas, which represent residential categories in Ujung Pandang as follows:

- Kelurahan Losari, Kecamatan Ujung Pandang: High income residential area
- Kelurahan Parang, Kecamatan Mamajang: Middle income residential area
- Kelurahan Pattunuang, Kecamatan Wajo: High income commercial area
- Kelurahan Maradekaya Selatan and Kelurahan Bara-baraya Selatan, Kecamatan Makassar: Middle and low income residential area

The following figure clarifies the major causes of problems in wasterwater management indicated by the community in the social survey and the objectives of options oriented to the community participation.



9.4 Evaluation of Alternative Strategies

9.4.1 Social Aspects

Throughout the social survey, the community's agreements on the improvement for the wastewater management and their willingness to participate in the program have been confirmed. The community participation will be in the form of retribution, manpower as well as mutual help and/or material input depending on their capabilities. Regarding the specified simple strategic options (option No. 1 to No. 5), the respondents in each model area indicated their preferences as shown below:

Model Area / Strategic Options No.	Losari		Parang		Pattunuang		Maradekaya Selatan / Bara-baraya Selatan	
	Household survey	Key information interview	Household survey	Key information interview	Household survey	Key information interview	Household survey	Key information interview
(1) Cleansing of ditches/drains	50%	80%	34%	40%	50%	100%	57%	58%
(2) Improvement of ditches/drains	20%	0%	22%	20%	10%	0%	25%	33%
(3) Installation of screens	2%	10%	6%	10%	3%	0%	0%	8%
(4) Infiltration trench (household)	16%	0%	0%	0%	3%	0%	12%	0%
(5) Infiltration trench (communal)	2%	10%	38%	0%	25%	0%	7%	0%
Others	10%	0%	0%	30%	10%	0%	0%	0%

Even though technically these five (5) options could be easily implemented by the community with a minimum technical guidance from the local government and the utilization of local resources, still as an incentive to encourage community participation, it would be preferable that the local government provides the sophisticated materials to those communities willing to install the systems. Moreover, public campaign and continuous technical guidance of the local government is essential.

9.4.2 Technical Aspects

Comparative evaluations of complex strategic options, those from No.7 to No.10, that are essentially projects requiring significant investment, were conducted to identify the possible optimum projects and the relevant constraints, if any.

Based on the results of comparative evaluation, as the canal water improvement program, among the relevant strategic options (Option No.7 to No.9), dilution water introduction from the long storage (option No.8) is identified as the most economical one. Though this could be implemented very quickly, there would be no water available for dilution once the ongoing water supply project is completed.

Between the other two (2) options, double canal section with the required influent pump facilities and treatment plants, one each at Lembo and Maccini Sombala (option No.9), is more economical than the other one (option No.7). Moreover, the option No.9 is more preferred from all other physical, environmental and functional aspects of the canal, as this option does not interfere with the canal.

Box type (covered channel) interceptor system, where the collection system of graywater is combined with that of treatment, insitu anaerobic filter system, is determined as the most economical means of Losari beach protection (option No.10a). However, with the necessary structural modifications this interceptor system could be constructed along the coast line of Losari beach to serve a multipurpose use of coastal beach erosion mitigation cum promenade.

The optimum interceptor sewerage system for the central area (option No.10b) is determined as the one that would limit the maximum length of exposure of graywater in a ditch or drain, prior to interception into the collection sewer network, to 600m. The project cost of this interceptor system would be about 37% of the corresponding cost of conventional sewerage system as per the Feasibility Study (ref. Section 5).

The direct construction cost of the these options requiring significant investment (option No.7 to No.10b) are given below.

Unit : Rp. million

Option No.	Description of option	Direct construction cost
7 *	Aerators within the canal	5,046
8 *	Dilution water introduction	515
9 *	Canal water conveyance and treatment	4,335
10a-1	Losari beach interceptor (single purpose)	1,700
10a-2	Losari beach interceptor (multipurpose)	7,365
10b	Interceptor sewerage system	13,270

Note : * All these options assume the provision of three (3) gates, one each at Jongaya, Sinrijala and Panampu canals

9.5 Findings of Alternative Study

(1) Community participation (involvement) for realizing the simple means of graywater management shall be promoted under the initiative of the Municipality of Ujung Pandang (KMUP) and those options should be implemented in step by step, starting from the five Kelurahans where the social survey has been carried out.

(2) When the overall environmental improvement of the objective area is targeted on a short term basis, the three (3) project components of option No.8, No.10a-1 and No.10b of above are recommendable as the cost effective (least cost) project package. These projects would contribute to both the improvement of living environment and water environment of the objective area. The total direct construction cost is about 15.5 billion Rp.

The project components delineated above are illustrated in *Fig. 14.*

However, if the multipurpose interceptor system for overall protection of Losari beach, including that of coastal erosion mitigation, is used instead of the single purpose system (option No.10a-1 is replaced with option No.10a-2) then the total direct construction cost becomes 21.150 billion Rp., an increase of 5.665 billion Rp.

Moreover, in the medium term if the graywater conveyance and treatment system is to replace the dilution water introduction (due to the unavailability of water from Jeneberang river), as the canal water improvement program, then the required additional investment as the direct construction cost would be 3.905 billion Rp.

It is noted that the investment for interceptor sewerage system for the central area is of long term, since the project is also the initial stage of conventional sewerage system development as per the Feasibility Study (ref. *Fig.10* and *Fig. 14*).

Moreover, this interceptor system is financially viable (cost recovery is possible), with a tariff system set within the affordability of beneficiaries, when the wastewater management service is comprised of both interceptor sewerage (graywater management) and desludging of septage (septage/blackwater management).

Table 1 Total Cost of Proposed Master Plan for Wastewater Management

1. Investment Cost Unit : Billion Rupiah

Project Component	1996~2005	2006~2015	Total
Sanitary Improvement	2.44	4.77	7.21
SMS (B/G)	2.27	0	2.27
Sewerage System	55.68	405.29	460.97
Sub-total	60.39	410.06	470.45
Land Acquisition	8.16	8.14	16.30
Administration	1.11	8.11	9.22
Engineering Service	6.68	48.63	55.32
Total	**76.35**	**474.94**	**551.29**

2. Annual O&M Cost Unit : Billion Rupiah / year

Project Component	2005	after 2015
Sanitary Improvement	1.31	0.53
SMS (B/G)	0.03	0
Sewerage System	1.11	9.22
Total	**2.45**	**9.75**

Table 2 Total Cost of Proposed Master Plan for Solid Waste Management

1. Investment Cost Unit : Billion Rupiah

Component	1996~2005	2006~2015	Total
Collection	15.62	27.97	43.58
Street Sweeping	1.25	1.71	2.96
Ditch Cleansing	0.34	0.11	0.46
Disposal	26.40	27.59	53.99
Office	1.58	0	1.58
Sub-total	45.20	57.38	102.57
Land Acquisition	6.66	2.80	9.46
Administration	0.90	1.15	2.05
Engineering Service	5.42	6.89	12.31
Total	**58.19**	**68.21**	**126.40**

2. Annual O&M Cost Unit : Billion Rupiah / year

Component	2005	2015
Personnel	1.72	2.17
Fuel	1.85	2.71
Maintenance	0.55	1.16
Depreciation	3.32	7.52
Others	0.41	0.62
Total	**7.85**	**14.17**

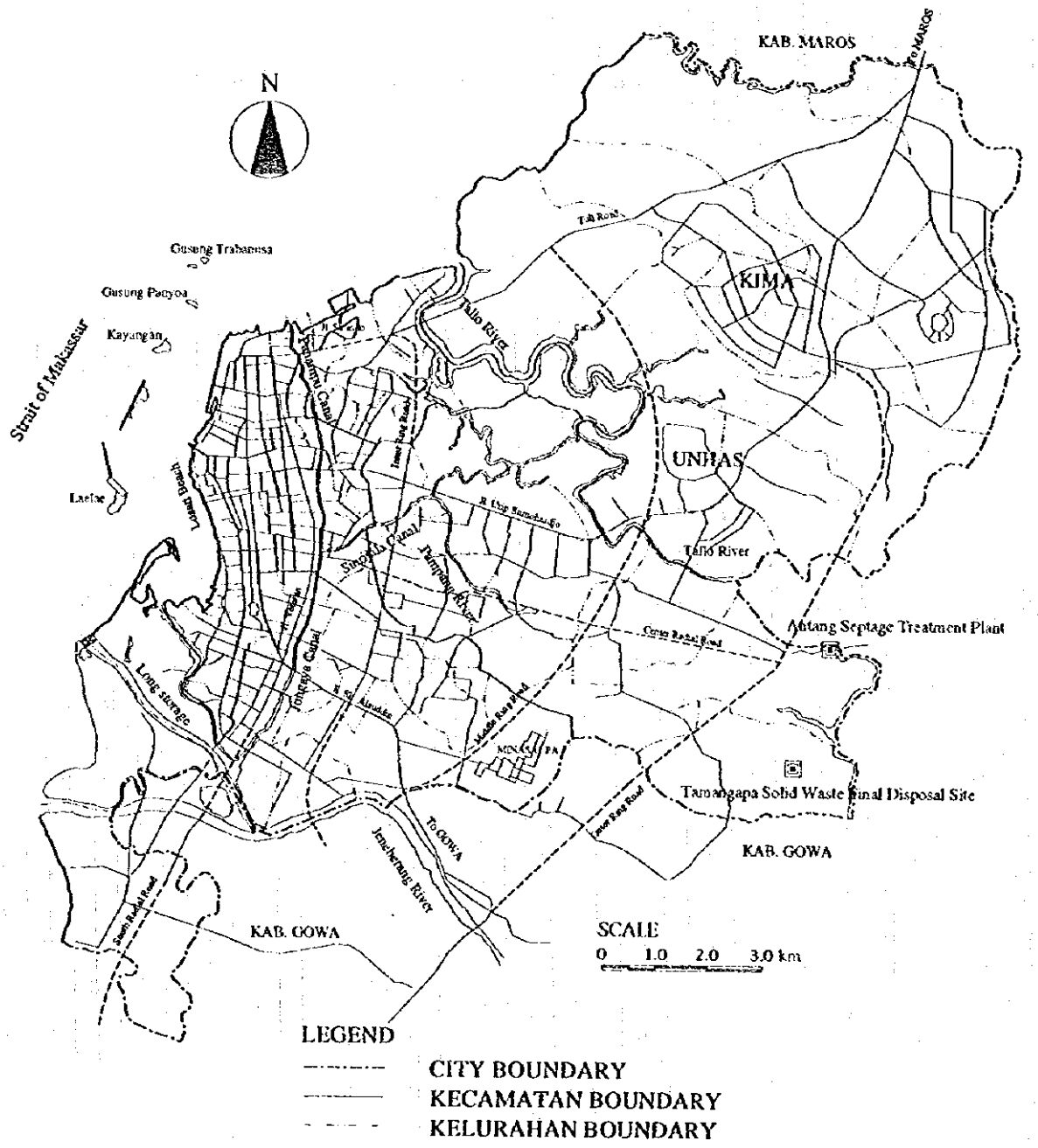


FIG. 1 Study Area

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

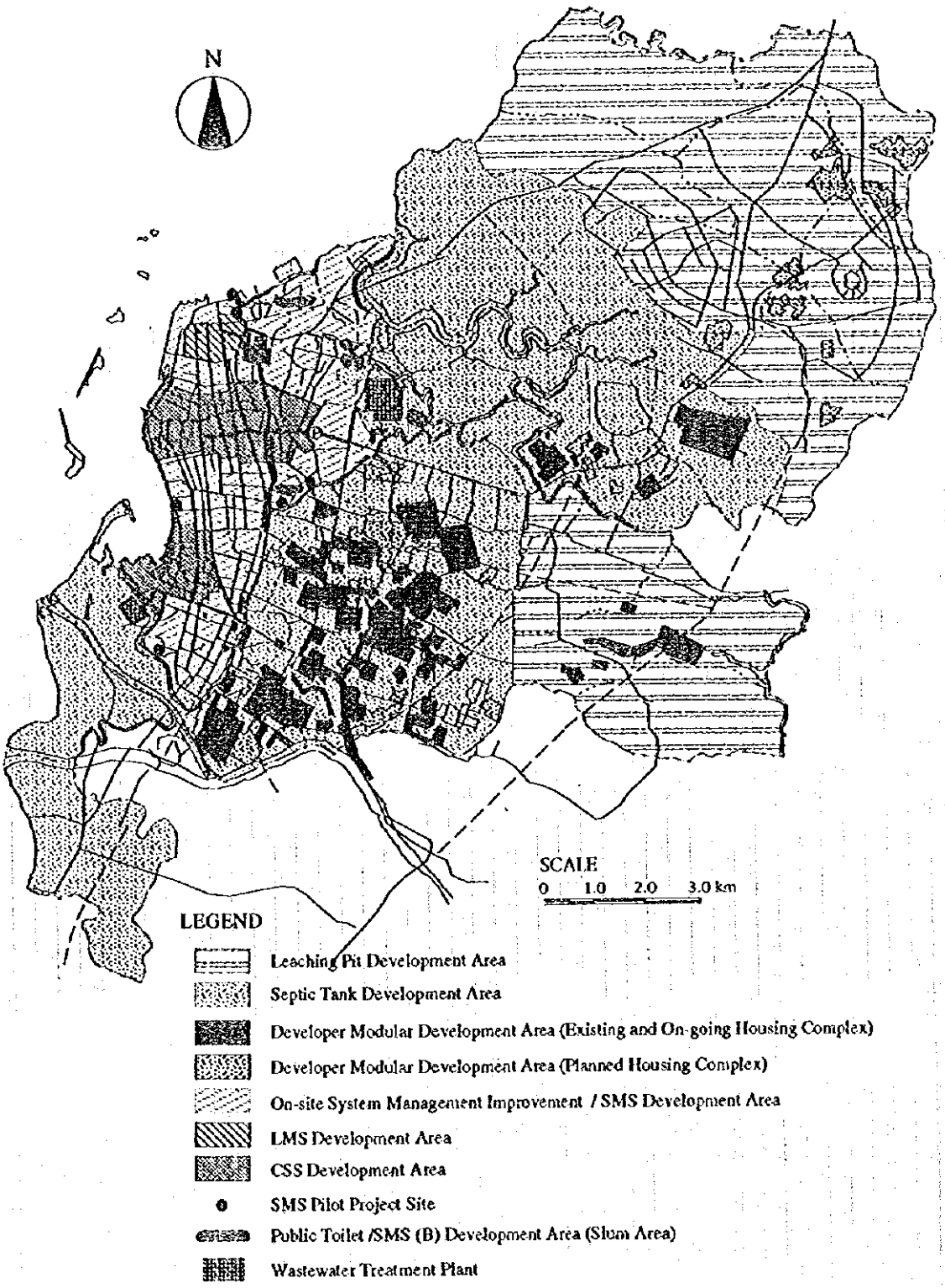


FIG. 2 Short Term Wastewater Management Plan in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

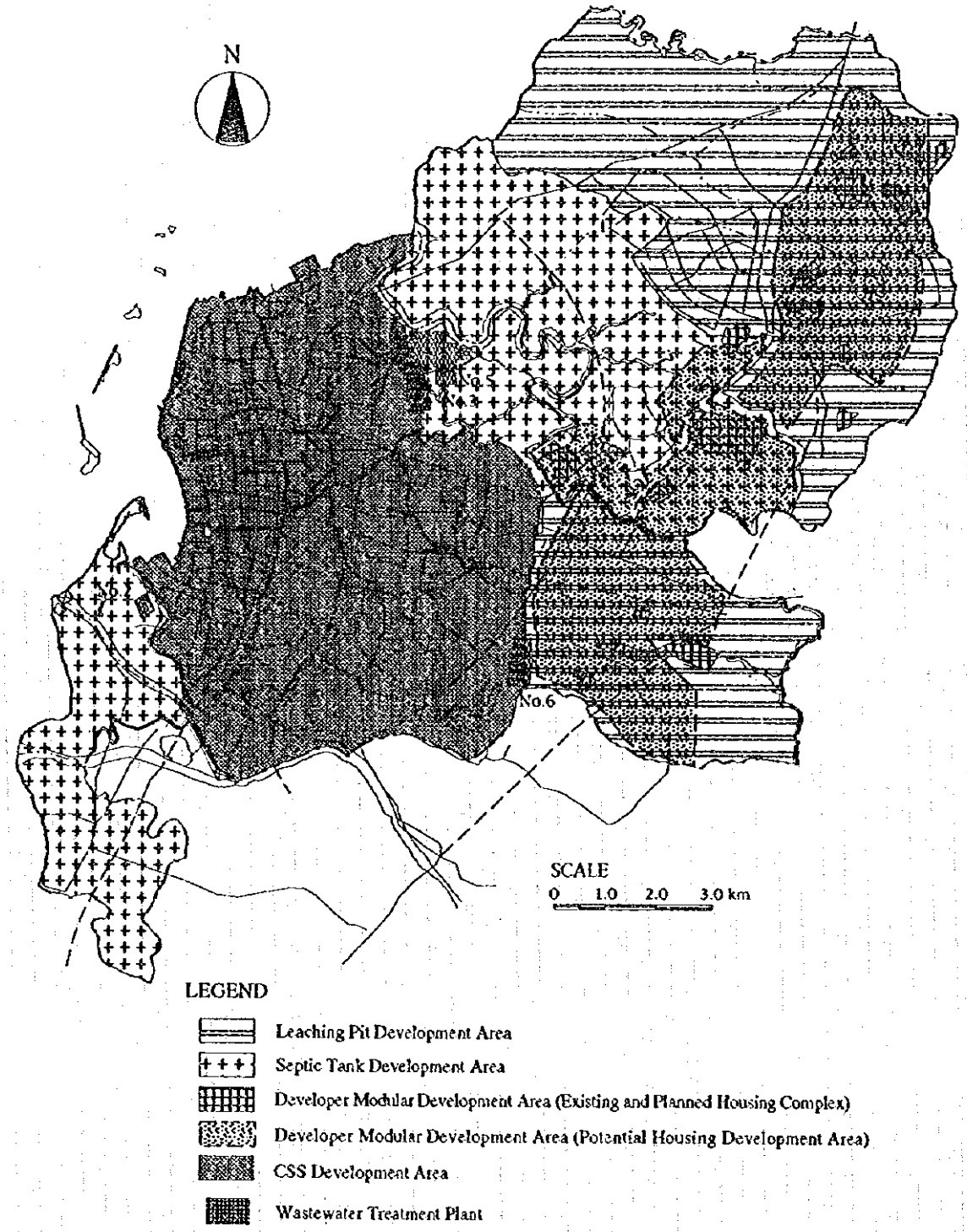


FIG. 3 Master Plan of Wastewater Management in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

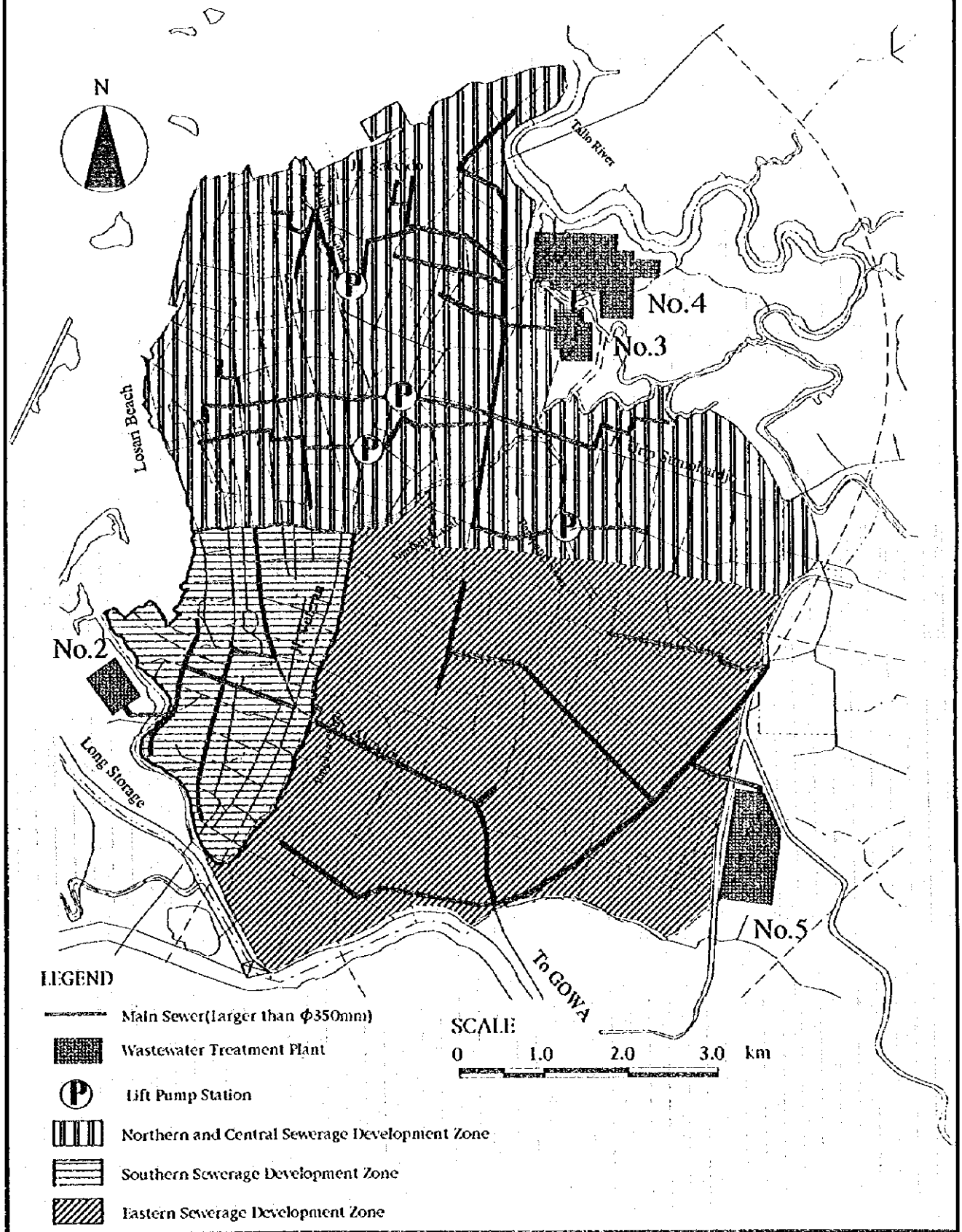
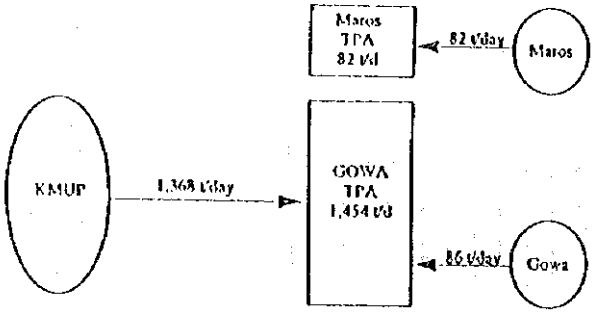


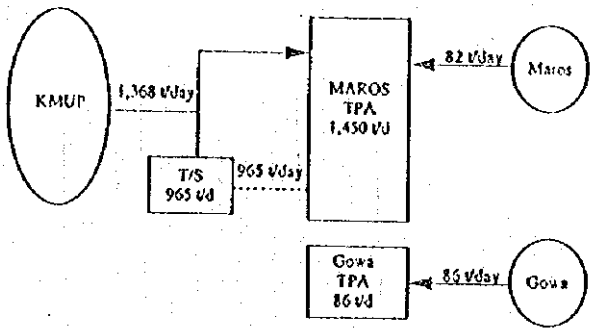
FIG. 4 Optimum Sewerage Development Plan

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

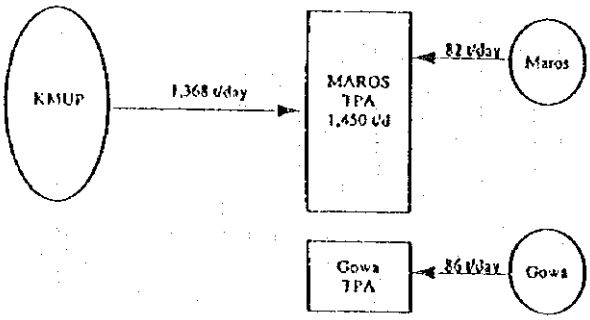
JICA A.D.1995



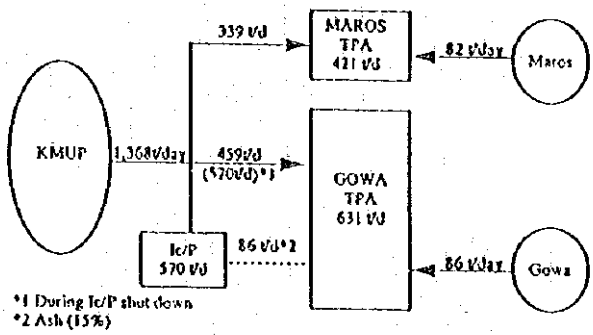
Alternative 1 - GOWA Disposal Site



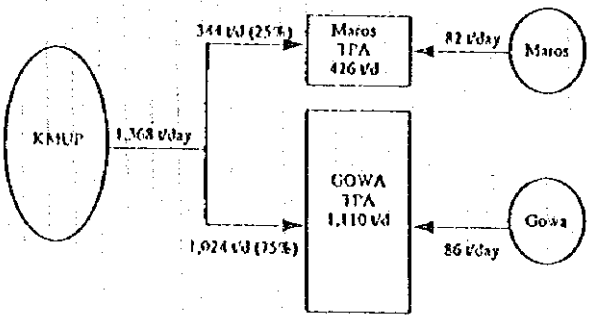
Alternative 4 - T/S and MAROS Disposal Site



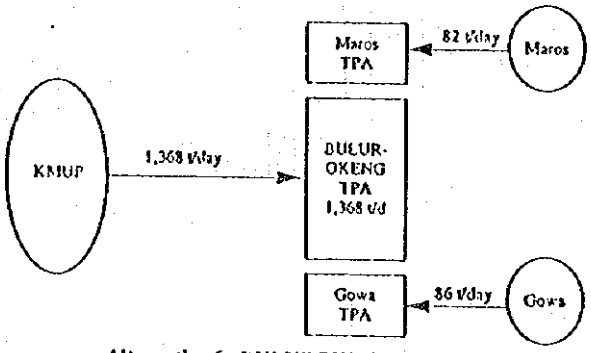
Alternative 2 - MAROS Disposal Site



Alternative 5 - I/P and GOWA & MAROS Disposal Sites



Alternative 3 - GOWA and MAROS Disposal Site



Alternative 6 - BULUROKENG Disposal Site

FIG. 5 Solid Waste Management Alternatives in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

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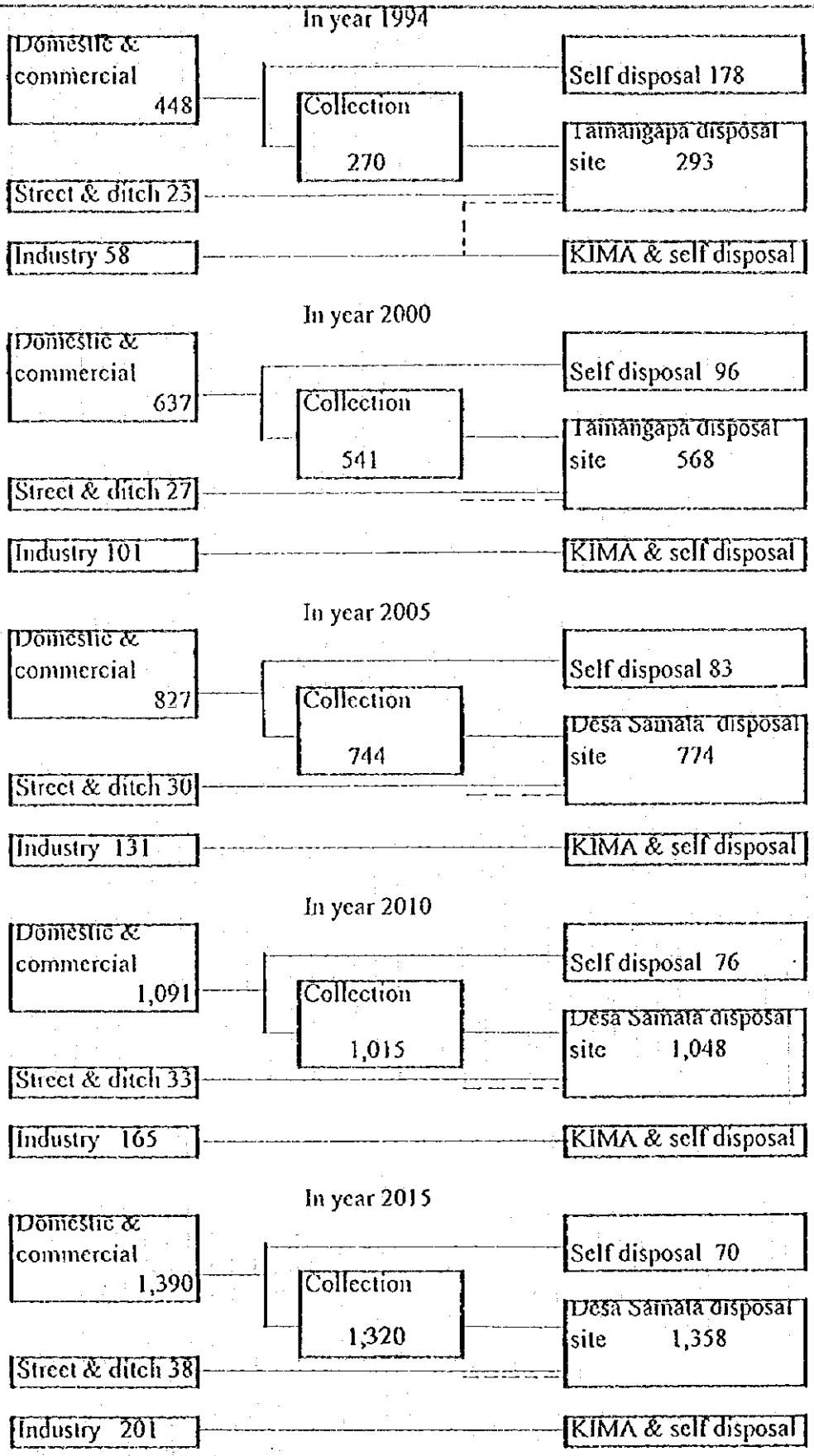
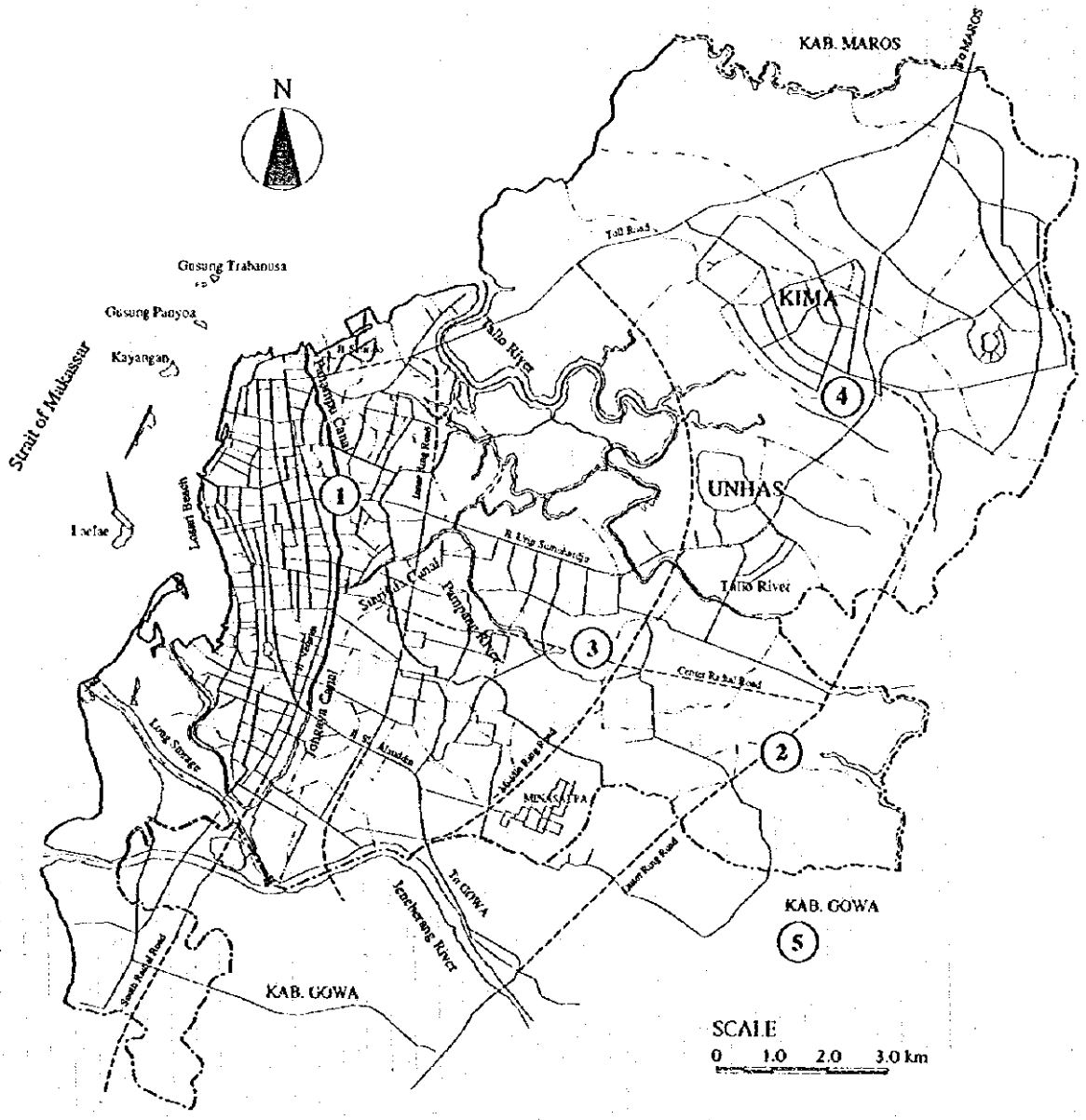


FIG. 6 Solid Waste Flow

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995



LEGEND

(1) Headquarters and Branch Office

(2) Tamangapa Disposal Site Workshop and Depot

(3) Branch Office, Depot and Intermediate Treatment Facility Site (panakkukang Branch Office)

(4) Branch Office (Biringkanaya Branch Office)

(5) Samata Disposal Site

FIG. 7 Location of Final Disposal Sites and Branch Offices

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

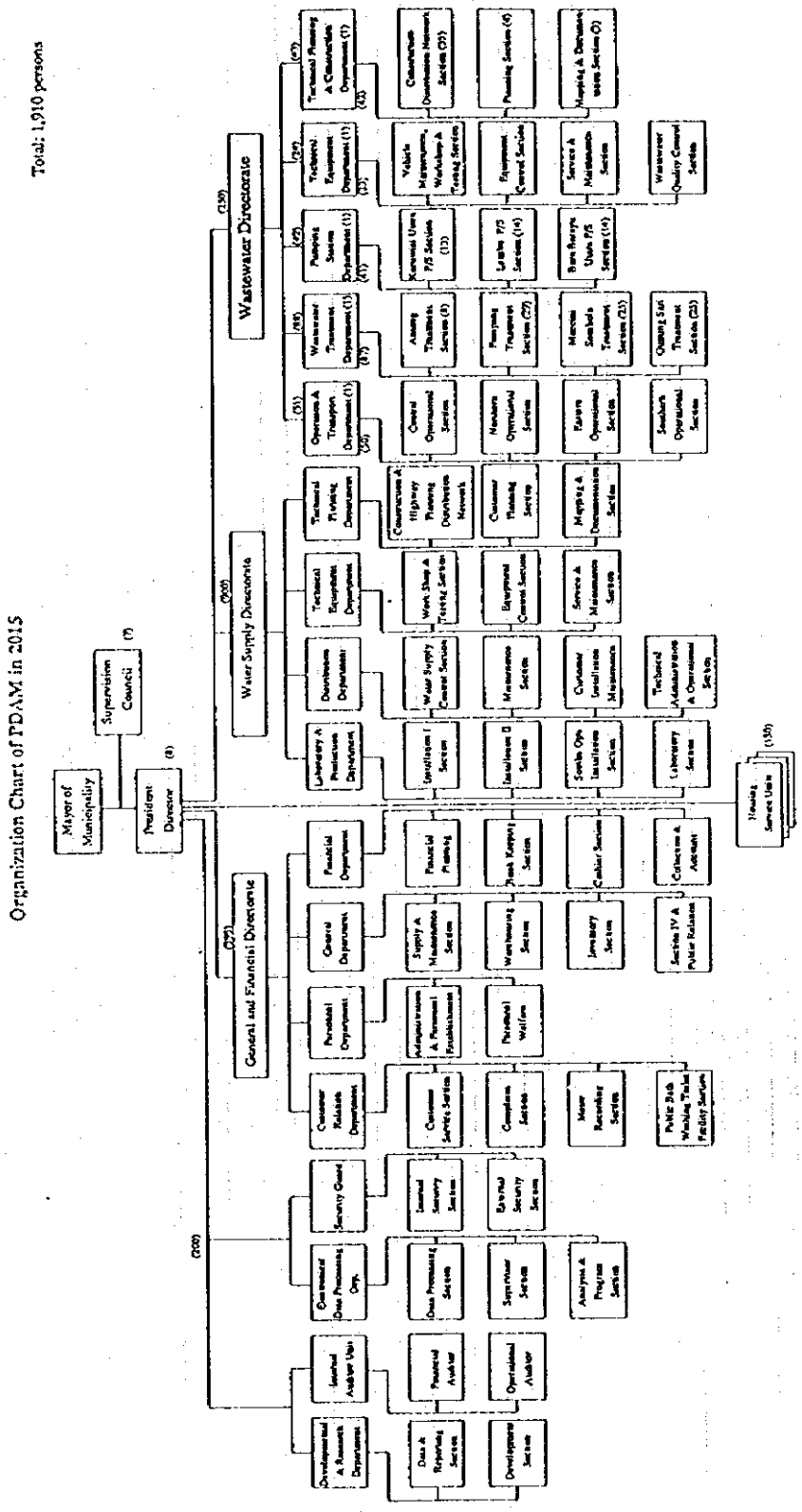


FIG. 8 | Organization Chart of PDAM in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

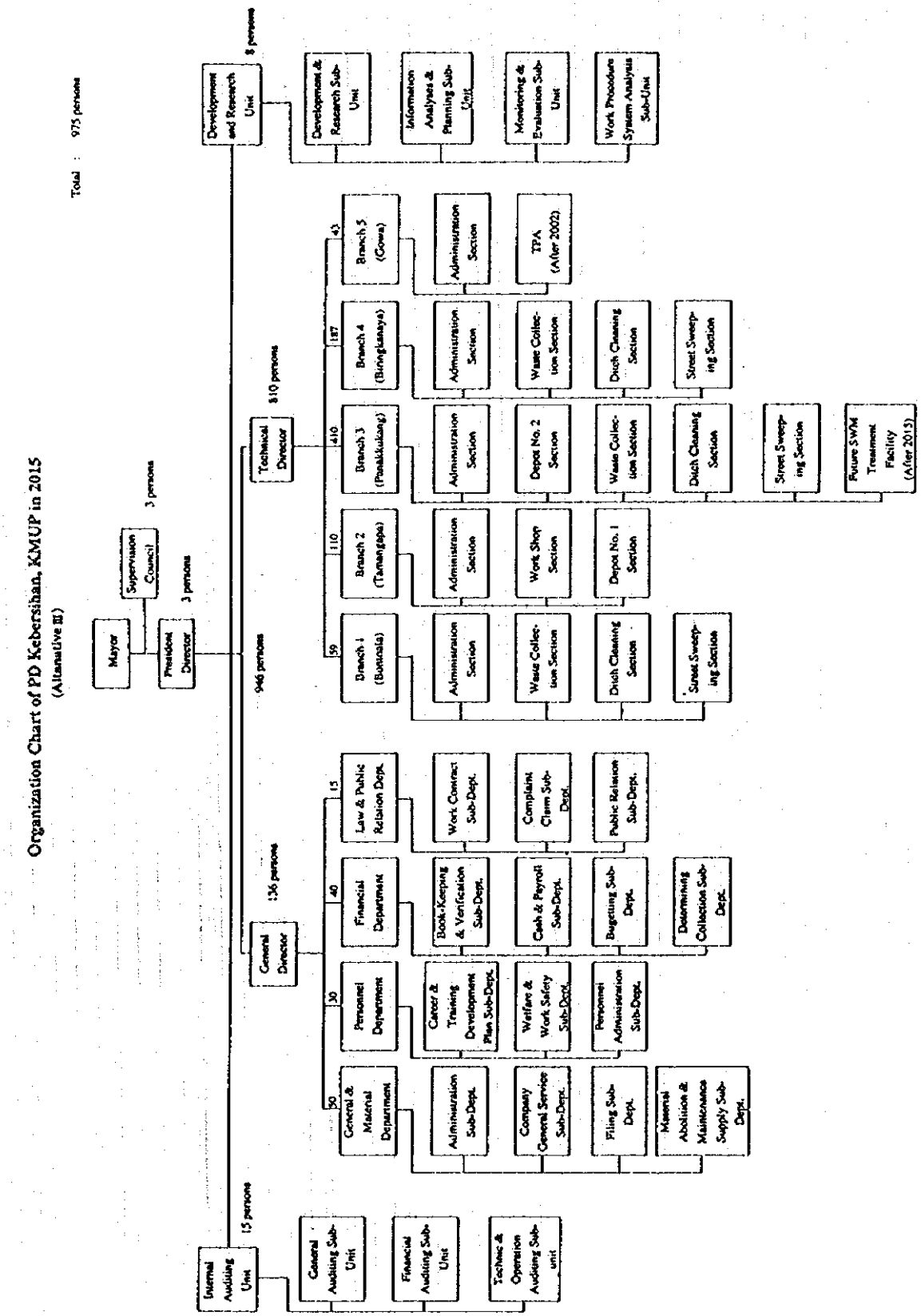


FIG. 9 Organization Chart of PD Kebersihan,KMUP in 2015

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

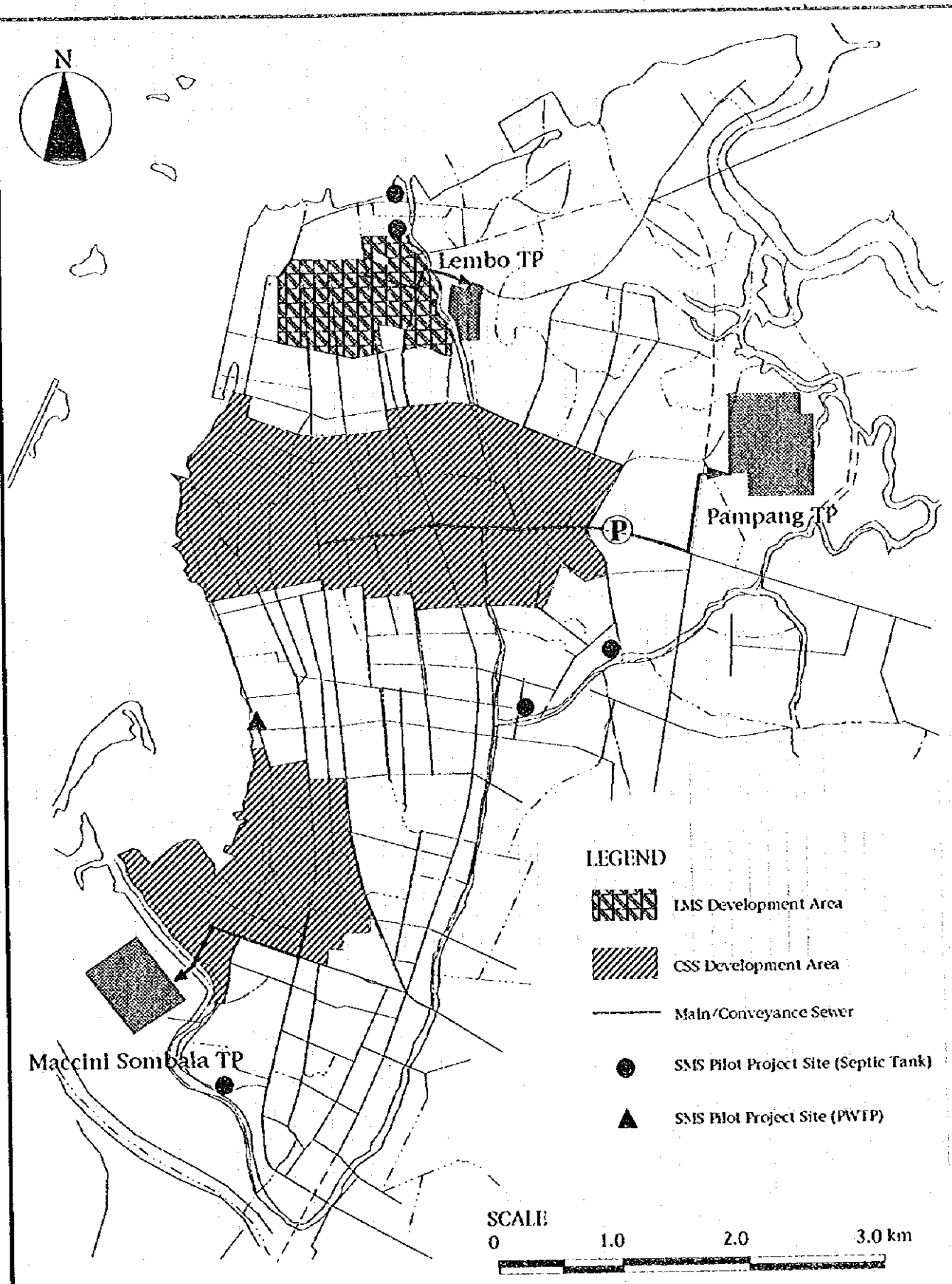


FIG. 10 LMS/CSS Development Plan until 2005 and SMS Pilot Project Sites

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

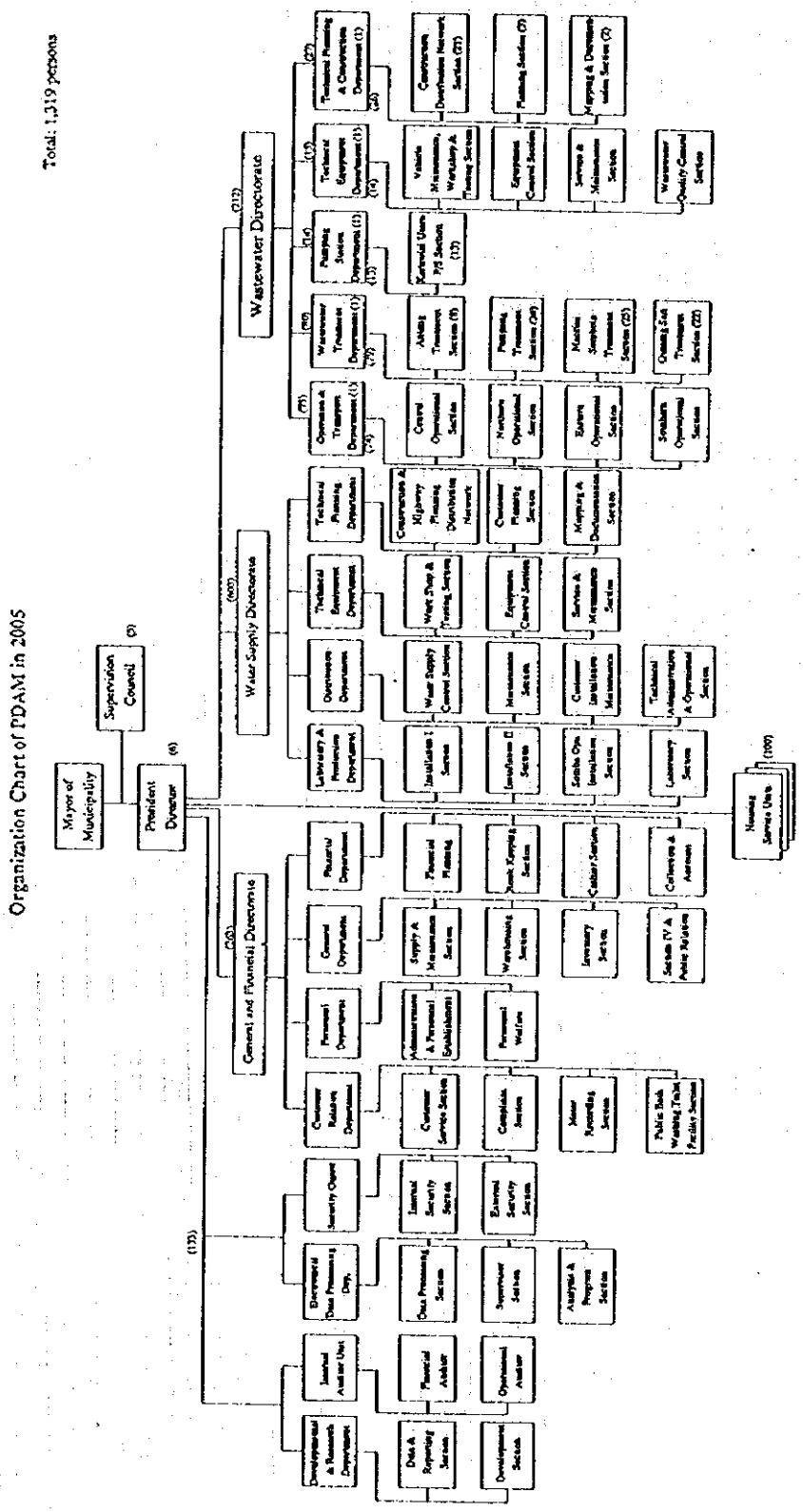


FIG. 11 Organization Chart of PDAM in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

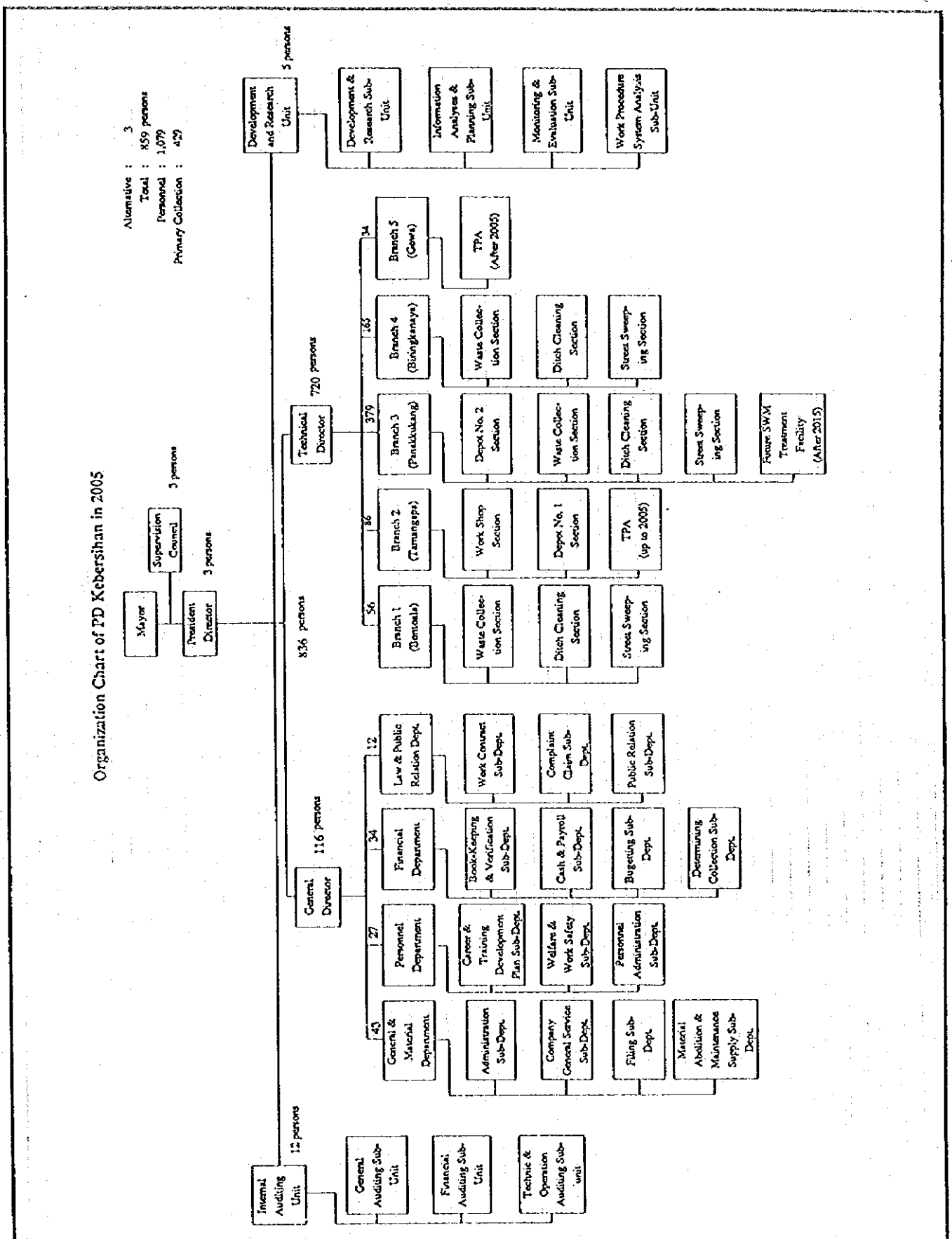


FIG. 12 Organization Chart of PD Kebersihan in 2005

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

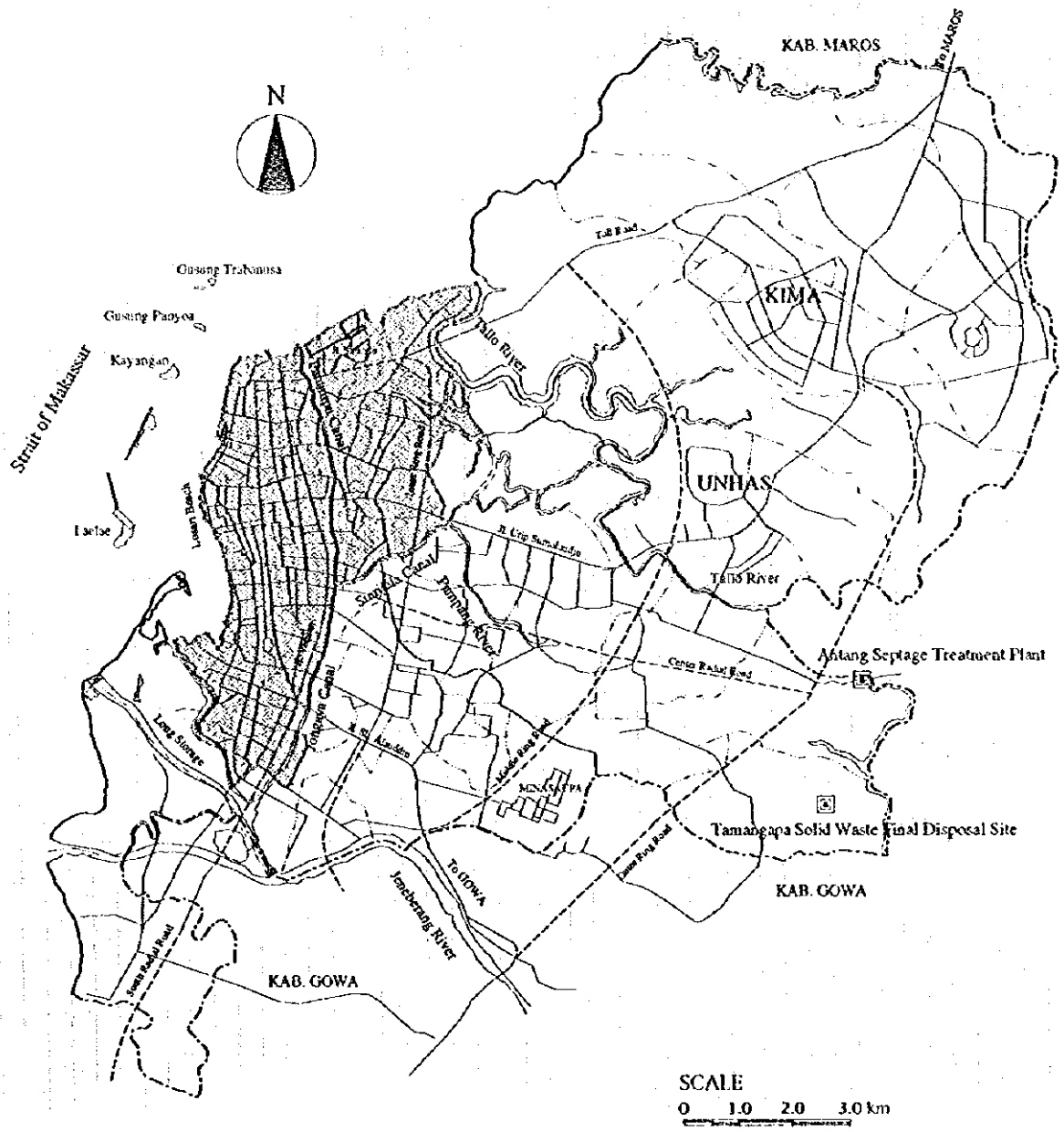


FIG. 13 Objective Area for Alternative Study

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995

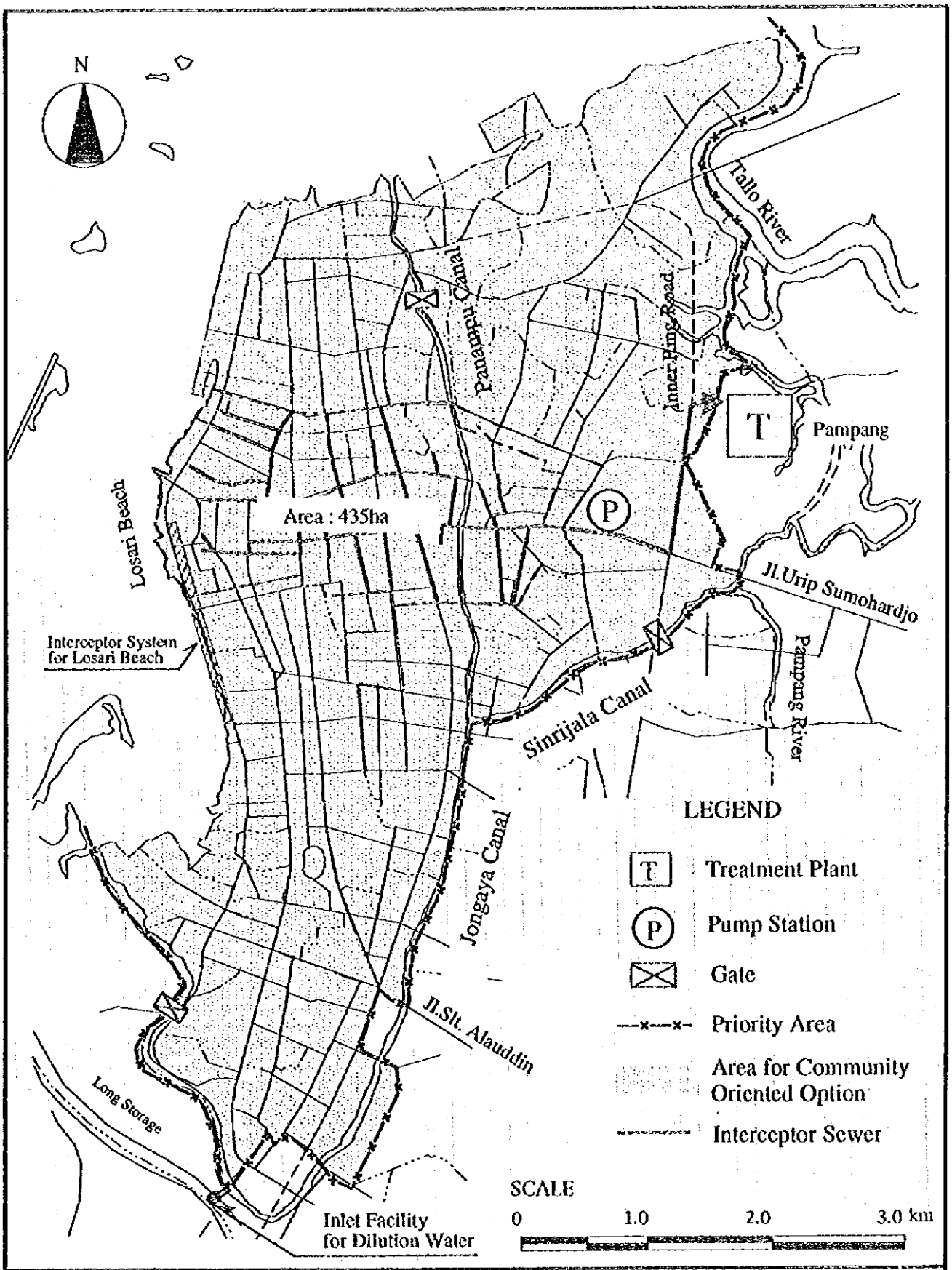


FIG. 14 Recommended Project Components of Alternative Study

MASTER PLAN AND FEASIBILITY STUDY ON WASTEWATER AND SOLID WASTE MANAGEMENT FOR THE CITY OF UJUNG PANDANG IN THE REPUBLIC OF INDONESIA

JICA A.D.1995