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REPUBLIC OF INDONESIA
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DIRECTORATE GENERAL OF HOUSING BUILDING
PLANNING AND URBAN DEVELOPMENT (CIPTA KARYA)

MEDAN URBAN DEVELOPMENT, HOUSING,
WATER SUPPLY AND SANITATION PROJECT

VOLUME V

MASTER PLAN AND FIRST STAGE PROGRAM FOR WATER SUPPLY AND SANITATION

PART 2- MASTER PLAN AND FIRST STAGE PROGRAM FOR WASTEWATER

OCTOBER 1980

ENGINEERING-SCIENCE, INC.
SINOTECH ENGINEERING CONSULTANTS, INC.
A JOINT VENTURE
in association with
PADCO and P.T. DACREA

PREFACE

The feasibility reports emanating from the Medan Urban Development, Housing, Water Supply and Sanitation Project were submitted in draft form to the Government of Indonesia (GOI) in February 1980. These reports, together with the earlier master plan reports, were reviewed by GOI in July 1980 and discussed with the Consultant at a series of meetings at that time. The outcome of this review process was that certain changes in content and format were agreed. These changes have been incorporated into the final printed reports.

A result of adopting the new guidelines provided by GOI is that differences occur between the Repelita III investments proposed in the master plan studies and those contained in the first stage program recommendations. The latter incorporate the final adjustments and represent the recommended program for Repelita III.

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ORGANIZATION OF PROJECT REPORTS

The results of investigations carried out in connection with the Medan Urban Development, Housing, Water Supply and Sanitation Project are contained in the following series of reports:

Inception Report for Long Term Urban Development Plan and Feasibility Study on First Stage Housing Development Project

Volume I	Summary
Volume II	Interim Strategic Plan and Feasibility Study
Volume III	Long Range Urban Development Plan
Volume IV	Housing Development Program
	Part 1 - Housing Development Situation and Strategy
	Part 2 - Kampung Improvement Program
	Part 3 - Sites and Services / Low Cost Housing Program
Volume V	Master Plan and First Stage Program for Water Supply and Sanitation
	Part 1 - Master Plan and First Stage Program for Water Supply
	Part 2 - Master Plan and First Stage Program for Wastewater
	Part 3 - Master Plan and First Stage Program for Drainage
	Part 4 - Master Plan and First Stage Program for Solid Wastes

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Note: Parts 1-3 of Volume IV and Parts 1-4 of Volume V are bound as separate report volumes. Appendices to Part 1, Volume V are also bound separately.

LIST OF ABBREVIATIONS

ORGANIZATIONS

ADB	Asian Development Bank
DKKP	Medan Solid Waste Management Department
KIP	Kampung Improvement Program
LCH	Low Cost Housing
MUDS	Medan Urban Development Study
SSCH	Sites and Services and Core Housing
UNDP	United Nations Development Program
USAID	United States Agency for International Development

TECHNICAL

mm	millimetre
m	metre
km	kilometre
sq m	square metre
ha	hectare
sq km	square kilometre
l	litre
cu m	cubic metre
s	second
min	minute
d	day
y	year
m/s	metres per second
l/min	litres per minute
cu m/s	cubic metres per second
cu m/d	cubic metres per day
mg/l	milligrams per litre
l/c.d	litres per capita per day
mg	milligram
g	gram
kg	kilogram
t	tonne (metric)
BOD	5-day, biochemical oxygen demand
TDS	Total dissolved solids
ES	Electrical conductivity
TU	Turbidity units
DO	Dissolved oxygen
TDH	Total dynamic head
LS	Lump sum
ea	each
na	not available or not known
Rp	Indonesian Rupiah

SECTION 1

INTRODUCTION

1.1 AUTHORIZATION

On 12 October 1978, an agreement was signed by the Government of Indonesia, Ministry of Public Works, Directorate General of Housing Building and Planning, and Engineering Science, Inc., for consulting services in connection with the Medan Urban Development Housing, Water Supply, and Sanitation Project. The project was financed under the terms of a loan to the Government of Indonesia from the United States of America Agency for International Development (AID loan no.497-T-G40, dated 28 July 1976). Engineering Science, Inc. and Sinotech Consultants, Inc., a joint venture, carried out the work in association with Planning and Development Collaborative International and P.T. Dacrea. Additional architectural expertise was provided to the Project from P.T. Perencana Jaya through subcontractual arrangement with P.T. Dacrea.

1.2 OBJECTIVES OF THE PROJECT

The long range objective of the Project is to assist the Government of Indonesia in directing the long-term urban development of Medan, particularly with regard to: (1) the construction of new and improvement of existing urban settlements within the context of the governments kampung improvement (KIP), sites and services and core housing (SSCH), and Low Cost Housing (LCH) programs; and, (2), improvement and expansion of water supply, sewerage, drainage, and solid waste disposal systems.

The immediate objective of the Project is to assist the Government in the preparation of a Long-Term Urban Development Plan for Medan up to the year 2000 and to assist the government in preparing a Feasibility Study for a First Stage Housing Development Project which will permit appropriate investment decisions.

The housing development Feasibility Study is aimed at assisting the Government, as part of the Long-Term Urban Development Plan, to formulate a well defined first stage housing development project which will be ready for investment decisions. The first stage housing project will be designed to achieve an optimum balance between the City's short-term needs on the one hand, and resources, local capability and socio-economic aspects on the other, with due consideration of financial and

economic benefits.

Another major objective is to develop, as part of the overall urban improvement program for the City of Medan, long-range Master Plans through the year 2000 for water supply, wastewater, drainage and solid waste systems which will assist Government in the management, operation, and financing those systems.

Feasibility Studies for the first stage development of the Master Plan are to include economic and technical evaluations of projects suitable and complete enough in detail to enable a consultant to proceed directly into final design and thereby allow the Government to obtain construction financing from an international or bilateral lending agency such as the World Bank, the Asian Development Bank, or AID.

1.3 SCOPE OF WORK

The scope of work is divided into five major components as follows:

1. Preparation of a long term urban development plan.

2. Preparation of a feasibility study for housing development projects including a Kampung Improvement Program and a sites and Services and Low Cost Housing Scheme.

3. Develop long-range Master Plans for water supply, wastewater, drainage and solid wastes systems in the study area through the year 2000.

4. Prepare First Stage Feasibility Studies for water supply, wastewater, drainage and solid wastes systems to meet needs through the year 1990.

5. Carry out detailed engineering for the first stage Sites and Services Scheme and the Low Cost Housing Scheme.

In addition, In-Service Professional Training Programs shall be conducted.

1.4 THE STUDY AREA

1.4.1 Description

Medan is located on the coastal plain of North Sumatra between the Malacca Straits and a range of volcanic mountains which run roughly north-west to south-east throughtout the island of Sumatra. Geographic proximity to the major neighbouring cities such as Kuala Lumpur and Singapore gives the city an international character in terms of trading business (see Figure 1.1).

Medan and Belawan port are the hub for an entire region which extends beyond the provincial boundaries of North Sumatra to include Aceh, Riau and parts of West Sumatra (see Figure 1.2).

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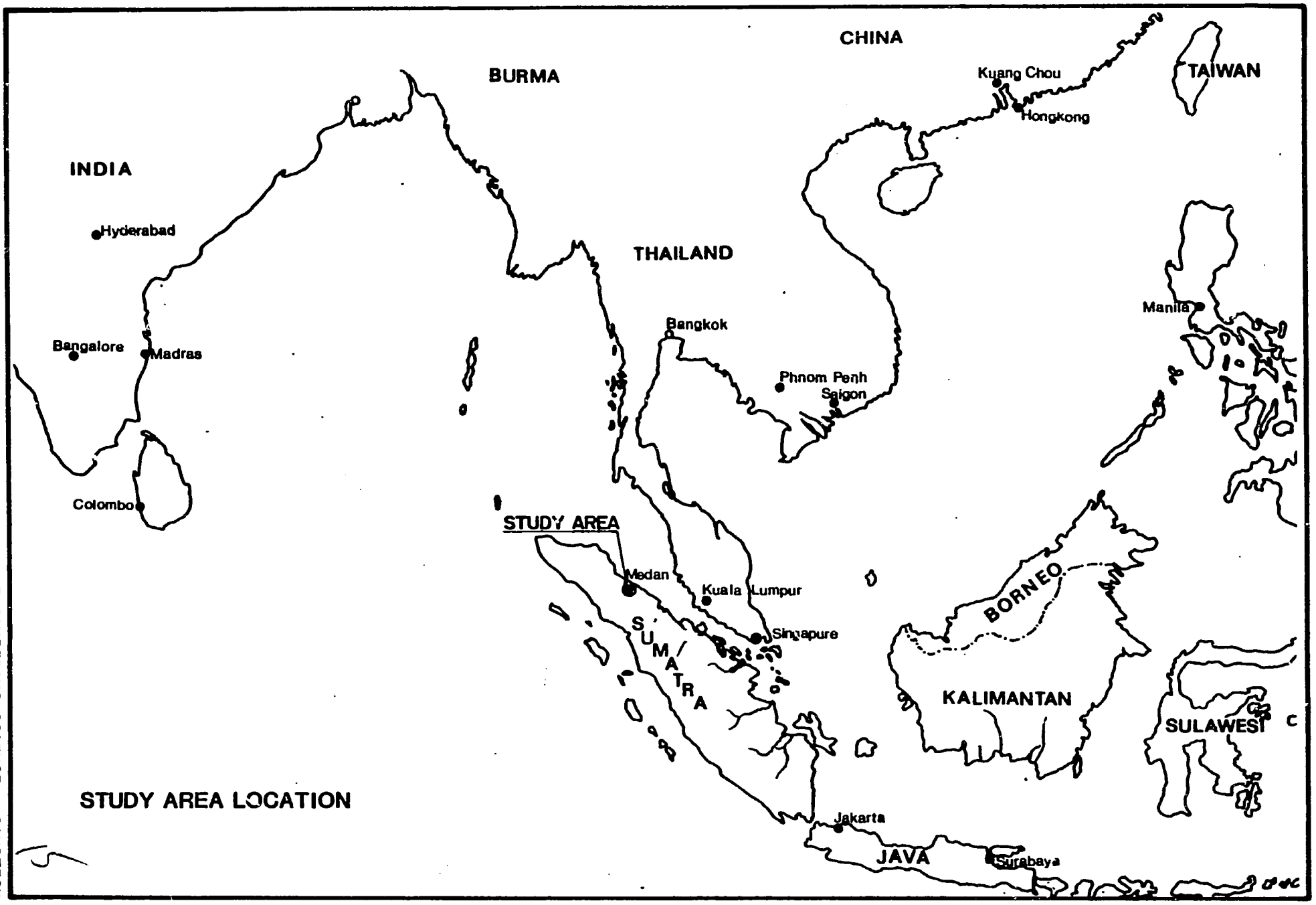


STUDY AREA LOCATION

FIGURE 1.1

A great portion of the influence over such a vast area is attributable to Belawan port, the third largest port of the country, and the presence of an international airport. Medan has grown to become the centre of the region in terms of international trading, finance, business, employment opportunity, higher education and industrial development, as well as being the processing and distribution centre for products of the surrounding agricultural areas.

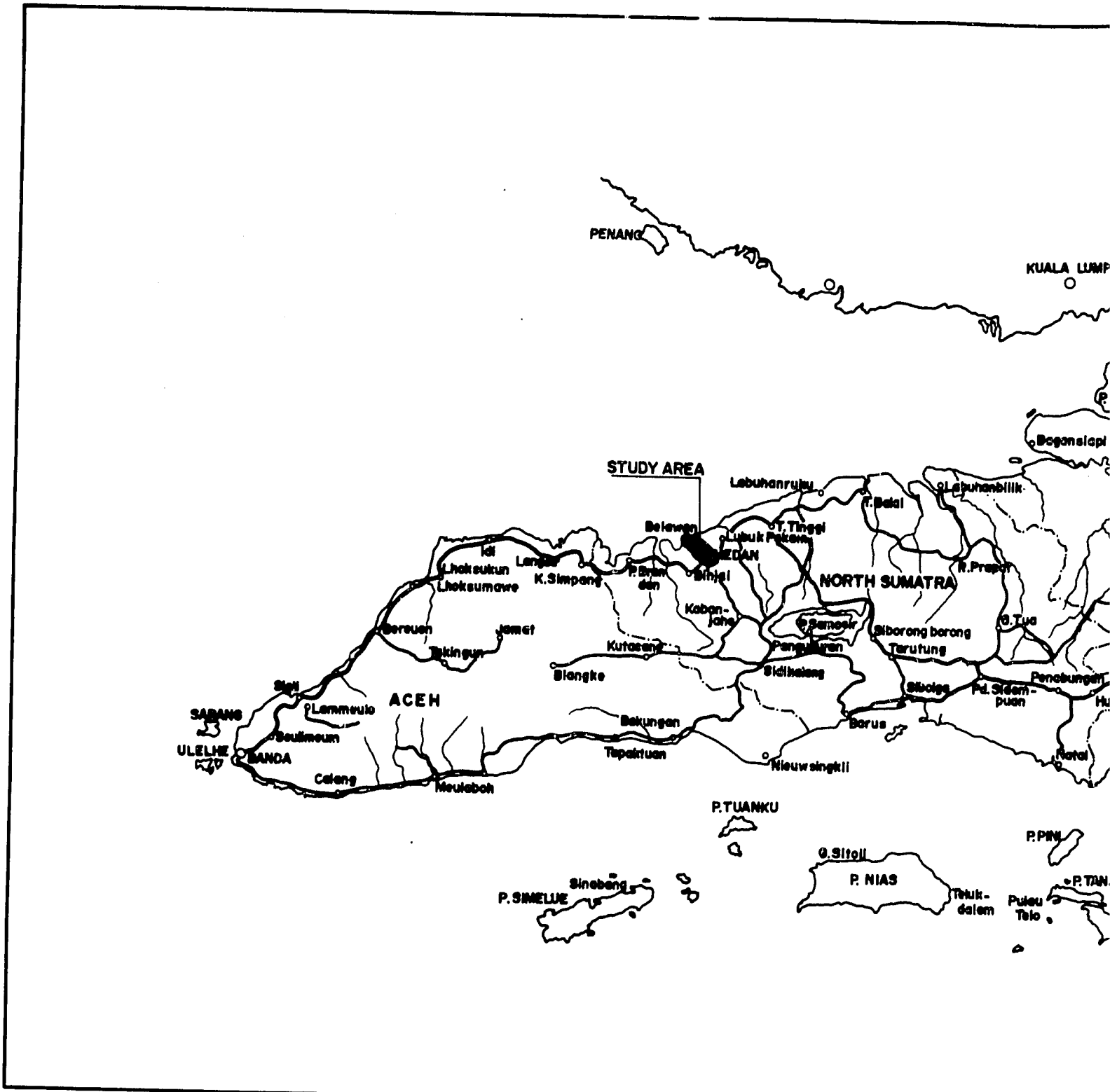
The city has a population of approximately 1.2 million people and is the fourth largest city in the country. The total land area of the city is 26,500 hectares, divided into eleven political districts called kecamatans. Geographically, the urban form of the city is rather irregular. Urban development has occurred mainly around the central area of Medan. Except in the oldest portions of the city, housing is primarily single storey and of relatively low density. In the oldest portion of the city, densities are much higher, consisting largely of three or four storey walk-up flats, with shops and businesses located on the ground floor. Growth trends are visible outside the city boundaries with village development parallelling the banks of rivers. Rivers and railroad alignments contain a small amount of high density informal housing for very low income groups. The rest of the city's area is made up of agricultural land, including tobacco and coconut plantations, rice paddie and swamp.

1.4.2 Topography

The study area lies between sea level and about 55 metres above sea level, on the northern end of regional basins which continue upward to the crest of the Barisan range (2000 metres in elevation) near Brastagi, 60 kilometres to the south. General contours for the study area are presented in Figure 1.3.

The northern end of the study area is in a coastal tidal zone which lies below 2.5 metres elevation. This zone is about seven kilometres wide in a north-south direction. The coastal plain lies above the zone of tidal influence and extends for about eight kilometres up to about 15 metres elevation. The plain is relatively low, poorly drained ground.

Above 15 metres elevation, the land is better drained and underlain by consolidated bedrock or more developed soils. This portion of the study area covers a zone about 12 kilometres wide (north-south) between 15 and 35 metres elevation. South of Medan, the land begins to rise as a series of low hills followed by broad ridges. From about 70 metres elevation, the hills and ridges gradually narrow and the flat valley floors shrink. At 300 metres elevation, the terrain consists of steep slopes between ridges and streams. This terrain has occasional broad ridges, particularly above 700 metres. The ridges and peaks of the Barisan Mountains separate the Belawan-Deli-Percut basin from the Brastagi basin.



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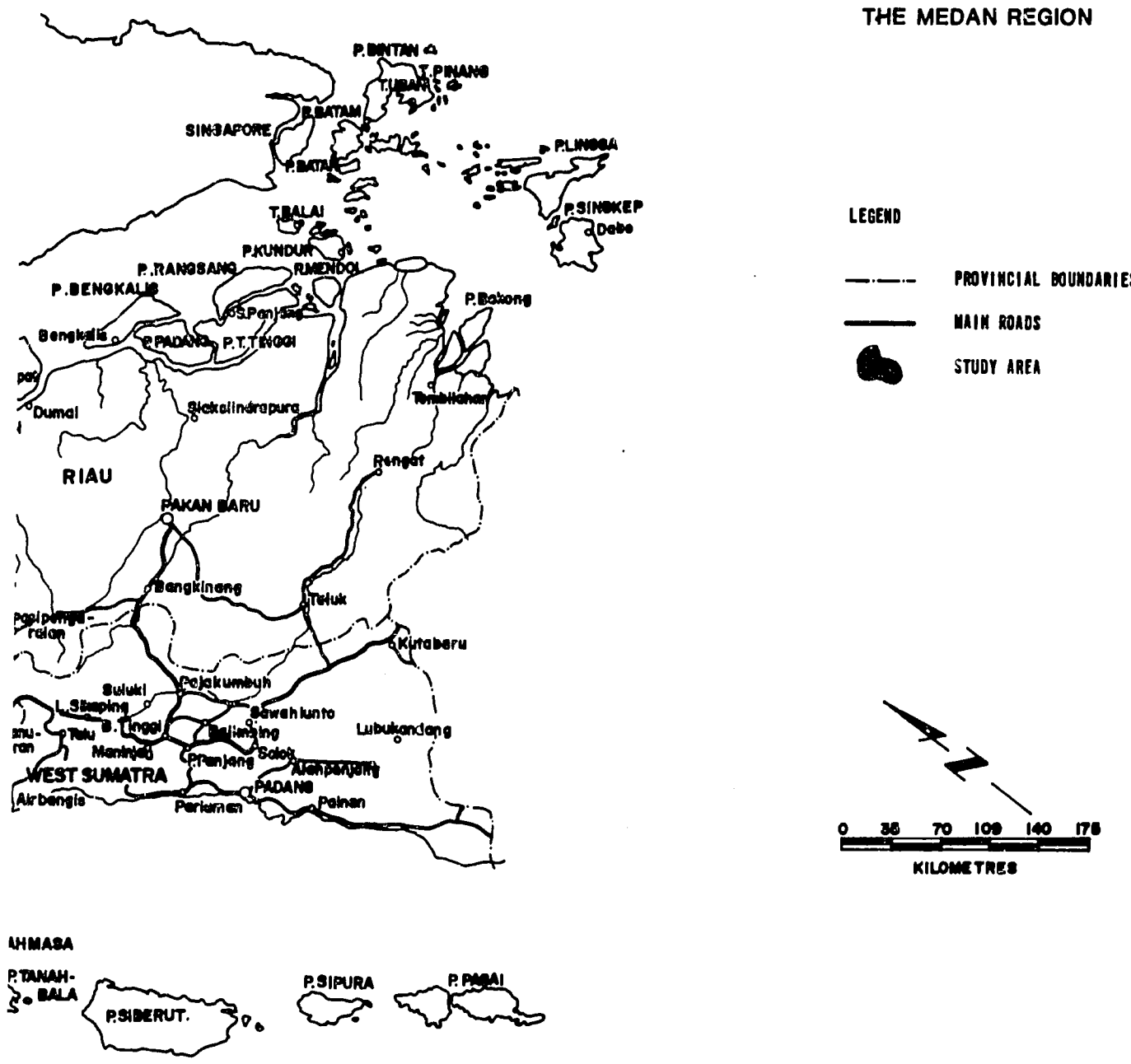

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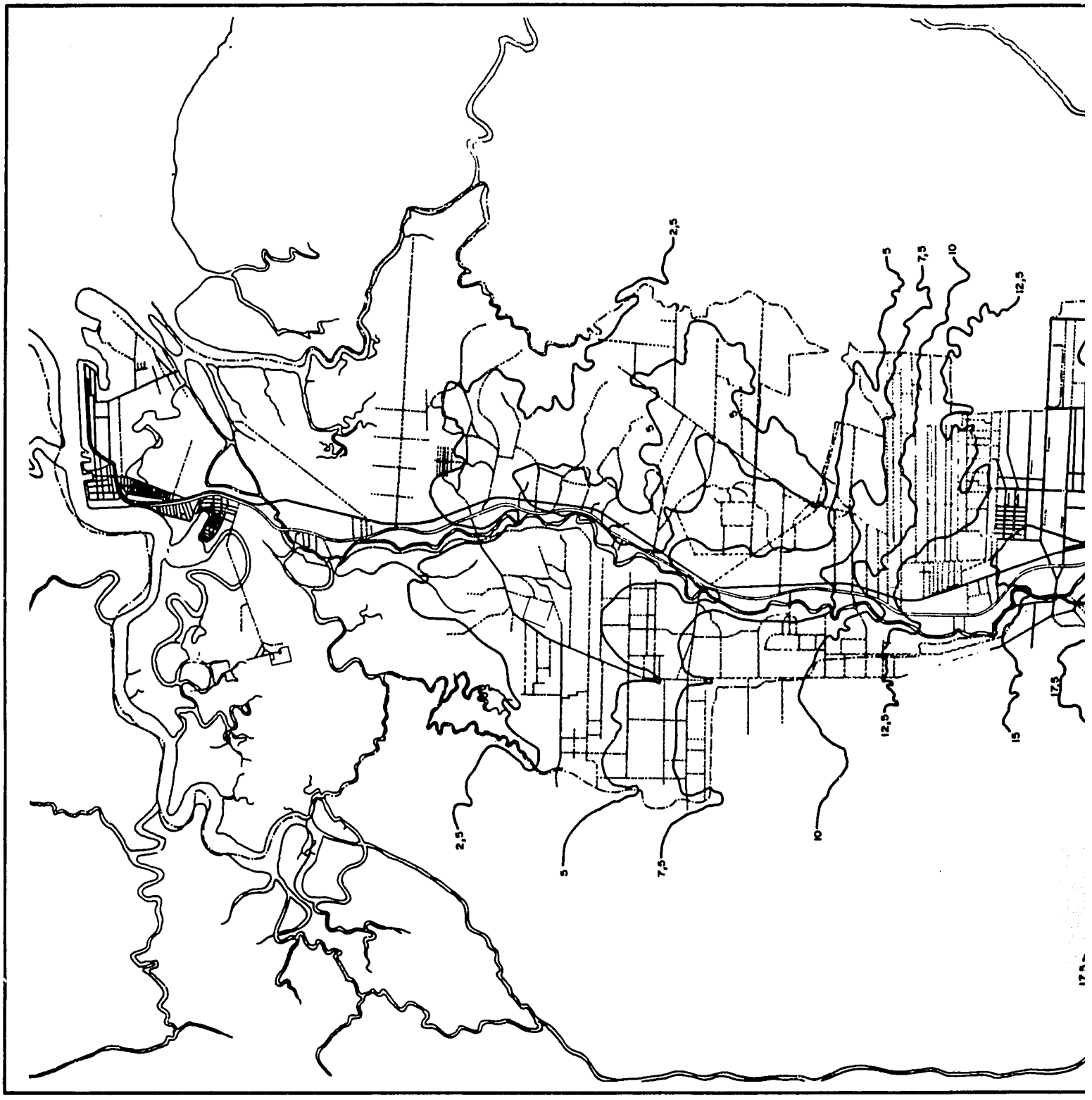

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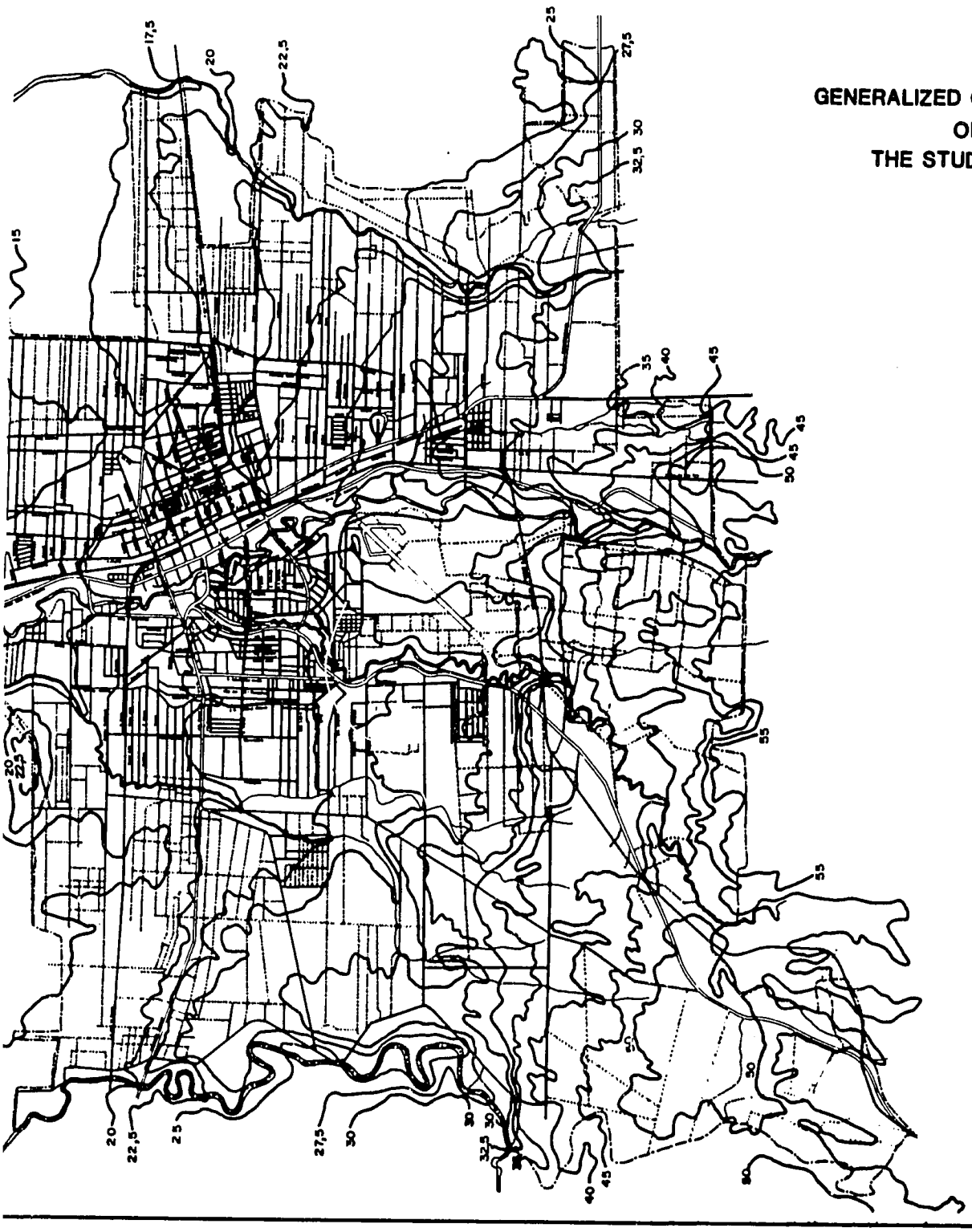
FIGURE 1.3



GENERALIZED CONTOUR MAP
OF
THE STUDY AREA

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Relief and gradients within the study area are generally small although some steep slopes of 5 to 10 percent may be found along rivers and low ridges on the southern margin of the study area. Most slopes and river gradients are less than 0.4 percent within heavily urbanized areas and 0.1 to 0.2 percent in the coastal plain and tidal zones. Interpretations of 2.5 metre contour maps indicate somewhat steeper slopes on the east side of the Deli between 5 and 12.5 metres elevation and between 15 and 25 metres elevation. Numerous benches (wide, relatively gentle terrain) are located in the southwestern and southeastern sectors of the study area above 25 metres while very small benches lie among the steep valley and ravines in the south central sector. Above 50 metres elevation, wide ridges or benches are separated from the lower benches but many of these join in the Belawan River valley in the southwestern sector.

1.4.3 Climate

The equatorial location and low elevation of Medan largely determines the tropical climate of the region. Although rainfall, temperatures and sunshine show some seasonal periods, these seasons are not as distinctly marked as in Java and many other areas of Asia. Two rainy periods occur during the fall and spring rather than during the more typical "monsoon" seasons which occur over much of Asia. These rainy periods closely resemble those in southern India, Sri Lanka, and Equatorial Africa. Medan rainfall has been recorded since 1879 at three stations. During the period of record annual rainfall has varied from 1,352 to 2,873 mm with 10 percent of the years having rainfall above 2,400 mm and 10 percent below 1,600 mm. About 80 percent of the annual rainfall ranged from 2,000 to 2,400 mm, and the average annual rainfall for 40 years was about 2,050 mm. Distribution of rainfall throughout the year shows two high rain months: October and May, although the longer "rainy season" extends from September to January. Eighty percent of the months have rainfall between 60 and 300 mm, while about sixty percent have rainfalls of 300 to 400 mm.

Long-term rainfall data for Medan indicated only three days with 250 to 290 mm of rain in 24 hours. Although these storms occured in December or January, they occurred at widely different years: 1907, 1937, and 1956, and these storms coincide with high monthly rainfalls but not with highest rainfall years. Such scattered temporal distribution indicates that the storms were of limited areal extent and period and that rainfall quickly decreased beyond the intense centre of rainfall.

Diurnal rainfall data shows a strong tendency towards afternoon and night rains and relatively dry morning periods. Records indicate that periods of 6 to 12 hours separate the rainy periods of each day and thereby allow runoff to occur before the next day's rains.

1.4.4 Soils

Soil type and relatively high groundwater levels have strongly influenced urban growth patterns and agricultural land uses in the

study area. The general distribution of soils and groundwater tables may be separated into three zones: (1) coastal tidal zone; (2) coastal plain; and, (3), piedmont. Within the coastal tidal zone, alluvial soils are generally rich in organic material and clay and the water table is at or close to the ground surface.

Along the major rivers, some alluvial sands and gravels may be found and the water table is usually at the same level as the river. On the coastal plain, soils have developed on older alluvial deposits which are higher and somewhat coarser than those in the coastal tidal zone. Better drainage allows the water table to drop to about 1.5 metres below ground surface, although localized water tables may be higher due to poor local drainage.

The highly organic and fine-grained sediments in the tidal zone requires substantial filling and extra foundation work in order to develop even the simplest structural uses. Some long-term subsidence or differential settlement could be expected even with special foundation preparations. Most organic and fine-grained sediments and high soil moisture content from corrosive acid conditions with a high sulphate content.

Within the study area and general vicinity, eight different soil types in five elevation zones have been identified. In the coastal tidal zone, two alluvial soils are recognized: (1) grey humur soil of clay and grey alluvium phases and; (2), grey hydromorph soils. The grey, brown and yellow-brown regosol and grey hydromorphic soils are most common on the coastal plains and lower hills. A brown andosol on pre-Toba and a brown podosal on Toba volcanics extends from the Percut River to the north and south. Above the study area, a brown podosol extends from about 150 metres up to 400 metres, where it is replaced by a brown andosol developed on the volcanics which form the source for the Sibolangit springs. High moisture content increases the acidity in the clay soils and sediment derived from acid-volcanic bedrock. All soils are acidic and many are high acidic; some have a high hydrogen sulfide content and are corrosive.

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SECTION 2

EXISTING WASTEWATER SYSTEM

2.1 INTRODUCTION

In the City of Medan, wastewater collection and disposal is provided almost entirely by a combination of surface drains and individual on-site disposal systems. Separation of wastewater flows into grey and black water components is typical throughout the city. Grey water (sink and basin drainage) is discharged to the surface drainage system which is comprised almost entirely of open roadside ditches. Black water (toilet wastes) are discharged to septic tanks or soak-away pit latrines. The restrictive soil conditions found in the city limit the success of these disposal systems, and a considerable quantity of septic tank effluent is entering the surface drains either directly or indirectly.

A social and economic survey carried out in Medan in 1978 and 1979 jointly by Bappeda S.U. and the provincial census and statistics office provided the following information on methods of sanitary waste disposal:

Households with toilet		84.3%
Households without toilet using:		
Streams	5.8%	
Joint use	2.8%	
Yard	1.3%	
Public toilet	1.1%	
Fish pond on rice paddy	0.2%	
Other	4.5%	15.7%

A survey of waste disposal practices in nine kampungs carried out as part of this project generally confirmed these findings and provided additional data on areas where there are virtually no household toilets and the use of streams, yards and "other" methods for waste disposal is predominant.

The pollution of streams and drainage ditches that enter the Deli river, which is extensively used for bathing and individual water supply, constitutes both a nuisance and a serious health hazard to the residents of Medan.

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2.2 THE MUNICIPAL SEWERAGE SYSTEM

A small area of the city, which is shown on Figure 2.1, may be said to be served by a combined sewerage system. In this area, the connection of raw sewage discharges to underground drainage conduits was common prior to 1969. In many of the more densely populated areas of the city, the connection of septic tanks to underground conduits is presently allowed by special permit.

With these two exceptions, the city of Medan has no municipal sewerage system.

2.3 OTHER SEWERAGE SYSTEMS

2.3.1 Belawan Port Authority

The Belawan Port Authority area discharges wastes to nearby rivers and the ocean through combined drainage channels. A major expansion of port facilities is currently underway, and a site for future sewage treatment facilities has been set aside as part of the expansion plan (see Figure 2.2).

2.3.2 Public Facilities

The results of the kampung survey indicated that public toilets and latrines are used by very few residents of Medan. This survey confirms the findings of the 1978-79 joint study conducted by Bappeda S.U. and the provincial census and statistics office which found that only 1.1 percent of the population used this type of facility. Moreover, the kampung survey indicated that the demand for public facilities was very low and their use was limited to areas where no other means of disposal were available, such as very high density areas not adjacent to a stream or river.

2.3.3 Commercial and Industrial

A survey of commercial and industrial establishments was conducted in order to determine what practices are currently employed for the collection and disposal of wastewater from these areas. The Medan Jaya Building, a seven story structure which can accommodate up to 600 occupants, is representative of this type of establishment.

This building has a dual drainage system, as do most homes in the city. Grey water flows directly to surface drains. Black water flows to a septic tank disposal system which combines the functions of a septic tank and a cesspool. The system is comprised of two concrete tanks, each with a volume of 90 cubic metres, the bottoms of which are filled with layers of rock and fiber from palm trees. These materials act as a filter and liquid percolates into the soil. Maintenance of this system involves pumping each tank once every three years when the building is fully occupied, and less frequently when it is not.

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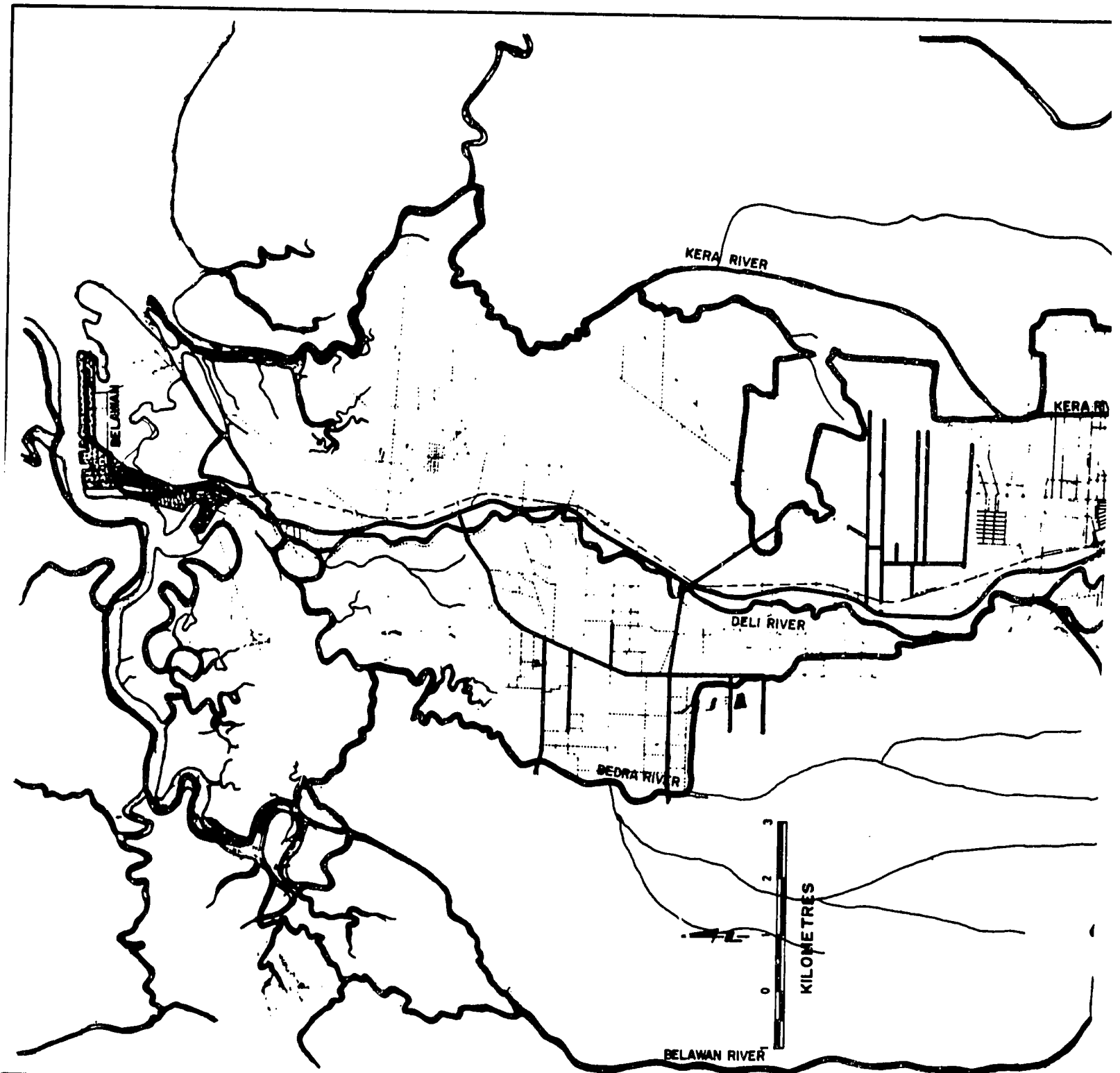

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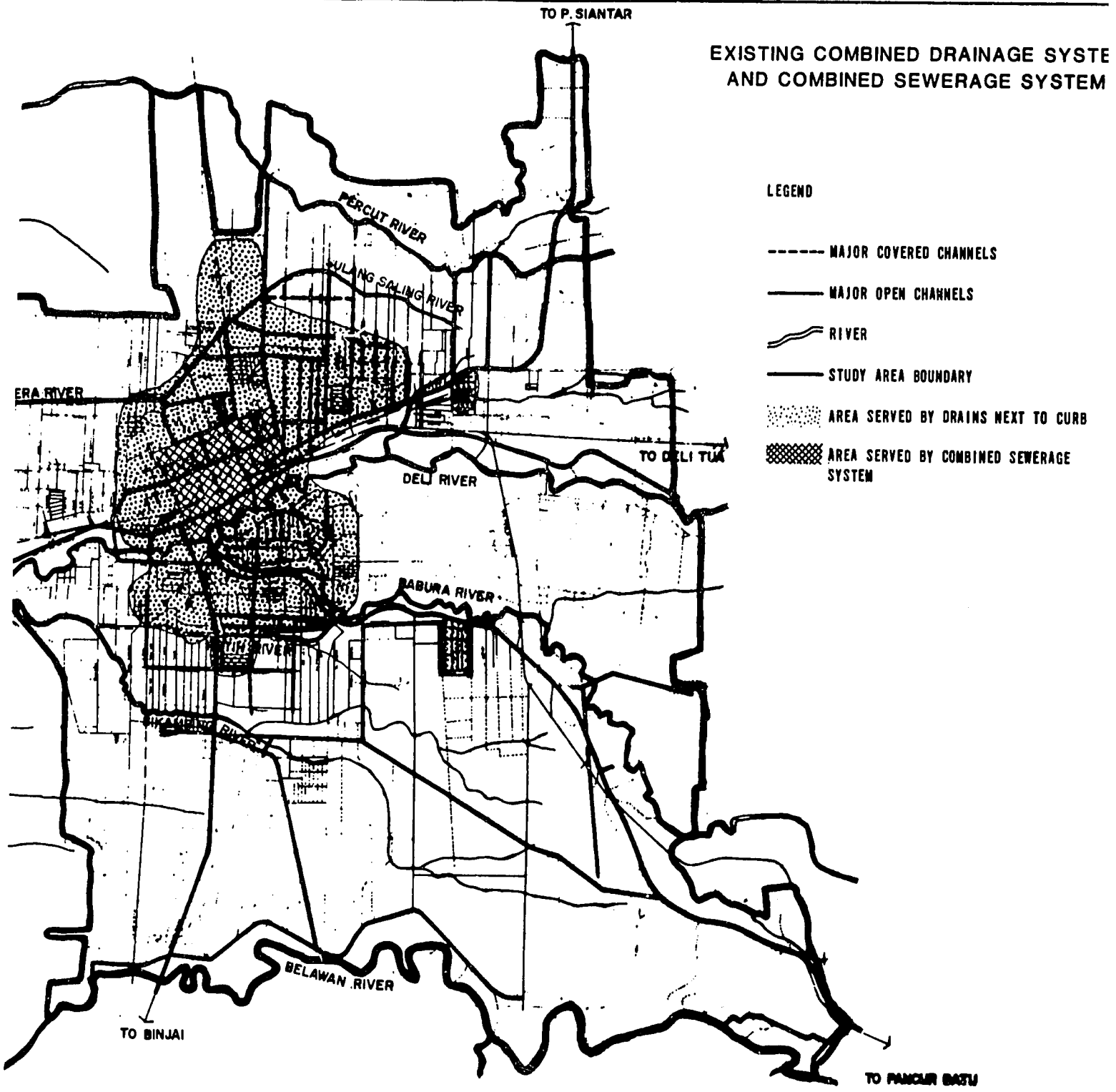

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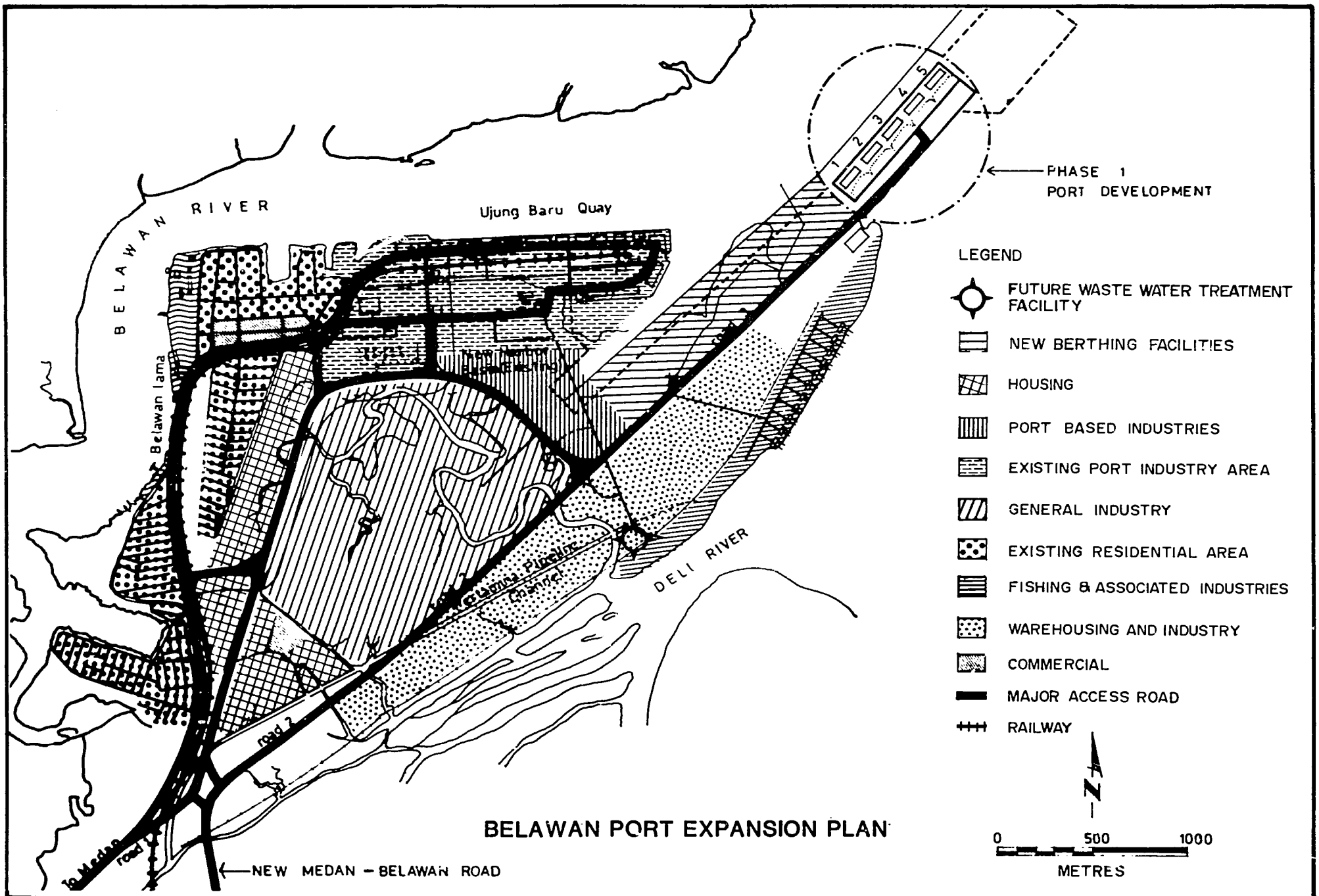


BELAWAN PORT EXPANSION PLAN

FIGURE 2.2

2.3.4 Individual Domestic

The results of the kampung survey and several other studies provide a great deal of information about individual domestic waste disposal practices in the city of Medan. From this information, it was found that the study area could be divided into three general categories with regard to these practices. These three categories are:

1. Semi-rural areas representing the northern and southern parts of Medan

2. Developed areas with a mixture of good and poor disposal facilities.

3. Developed areas with poor disposal facilities.

In semi-rural areas, such as Kampung Baru Ladang Bambu in the Tuntungan area and Kampung Terjun in Labuhan, the overall quality of housing and sanitation is largely determined by the effectiveness of the kampung leadership and by the efforts of the people in the community. In these areas, nearly 100 percent of the households have individual outside latrines and problems related to waste disposal area, on the average, less common than in more densely developed urban areas. Many households have water-seal latrines provided by the Health Department or have constructed similar latrines themselves.

Kampung Harjo Sari, Kampung Sukaramai I and Kampung Bantan are representative of developed urban areas with a mixture of good and poor conditions. In Kampung Harjo Sari, for example, approximately 25 percent of the houses have indoor toilets with septic tanks and the remainder have private latrines, yet the schools have inadequate toilet facilities. Kampung Sukaramai I has become so densely developed that although 25 percent of the houses do not have private toilets or latrines, there is not enough room available to build more. Some latrines are used in common and some households use other disposal methods such as plastic bags. Roughly half the residents of Kampung Bantan have indoor toilets or private latrines. There are no public latrines. The problems resulting from the lack of toilets for possibly 10,000 residents are indicated by excreta on the ground and the leader of the kampung is concerned about diseases.

A few developed areas of Medan were surveyed which have poor or nonexistent domestic waste disposal facilities. Kampung Lorong Aur and Kampung Desa Durian are representative of these areas. Less than 10 percent of the estimated 2000 residents of Kampung Lorong Aur have any type of toilet and nearly all the residents dispose of their wastes in the Deli river. Almost none of the 293 living units in Kampung Desa Durian have private toilet facilities. There are several public latrines which the people pay to have maintained. Nevertheless, many of these are either out of service or are too far away from the houses for convenient use, and residents often seek other disposal methods such as burial or plastic bags. Excreta is also evident on the ground.

2.3.5 Government Latrine Program

The Government of Indonesia has instituted a program to provide improved waste disposal system for families which are not presently, and will not be in the near future, served by a sewerage systems. The immediate goal of this program, which is administered by the District Health Centre of the Public Health Department, is to provide 1000 water seal latrines per year to Medan residents whose needs are most urgent. About 4300 of these latrines have been provided since 1975.

The principal unit provided is a concrete slab in which a squatting type step plate is arranged above a water-sealed opening. The slab is usually placed directly over a pit or vault which is constructed by the people, as are the curbs and shelters surrounding the latrine. These slabs may also be installed indoors with a discharge pipe leading to an outdoor pit or vault.

Public acceptance of and demand for these water seal latrines is high. Many people who were unable to obtain a slab from the Health Department have constructed their own latrines of this type from available materials. A survey of areas where several of these latrines had been installed found them to be generally free from odors and in good condition. The lack of excreta on the ground indicated that their availability and use had resulted in significantly improved conditions.

SECTION 3

PROJECTED WASTEWATER QUANTITIES

3.1 POPULATION AND LAND USE PROJECTIONS

General estimates of projected population in the study area were developed by kecamatan in Section 2 of the Long-Term Development Report, which was prepared as part of these investigations. To determine water demand and waste generation patterns, however, it was necessary to assess population distribution on the basis of smaller political units, kampungs, and further subdivide these into percentages of residential types according to income and population densities. Kecamatan and kampung boundaries within the study are shown in Figure 3.1.

The existing population distribution by kampung was obtained from registration records. The numbers and locations of the various residential categories of consumers are necessary to make realistic projections because water use and waste generation are functions of affluence level. The following residential classes were identified by density and income level within each kampung from 1972 aerial photographs.

High Income - Low density

High Income - Medium density

Medium Income - Low density

Medium Income - Medium density

Medium Income - High density

Low Income - Low density

Low Income - Medium density

Low Income - High density

Projections of the population in different income-density groups within the 1978 built-up areas were based on the existing income-density distribution. Details of the population distribution by income and density in the 75 kampungs in the 1978 built-up area are given in Table B.1 of Appendix B. Projections made in areas which are not presently built-up but will be by the year 2000 were based on the following assumed pattern:

Low Income - Low Density - 70 percent

High/Medium Income - Low Density - 30 Percent

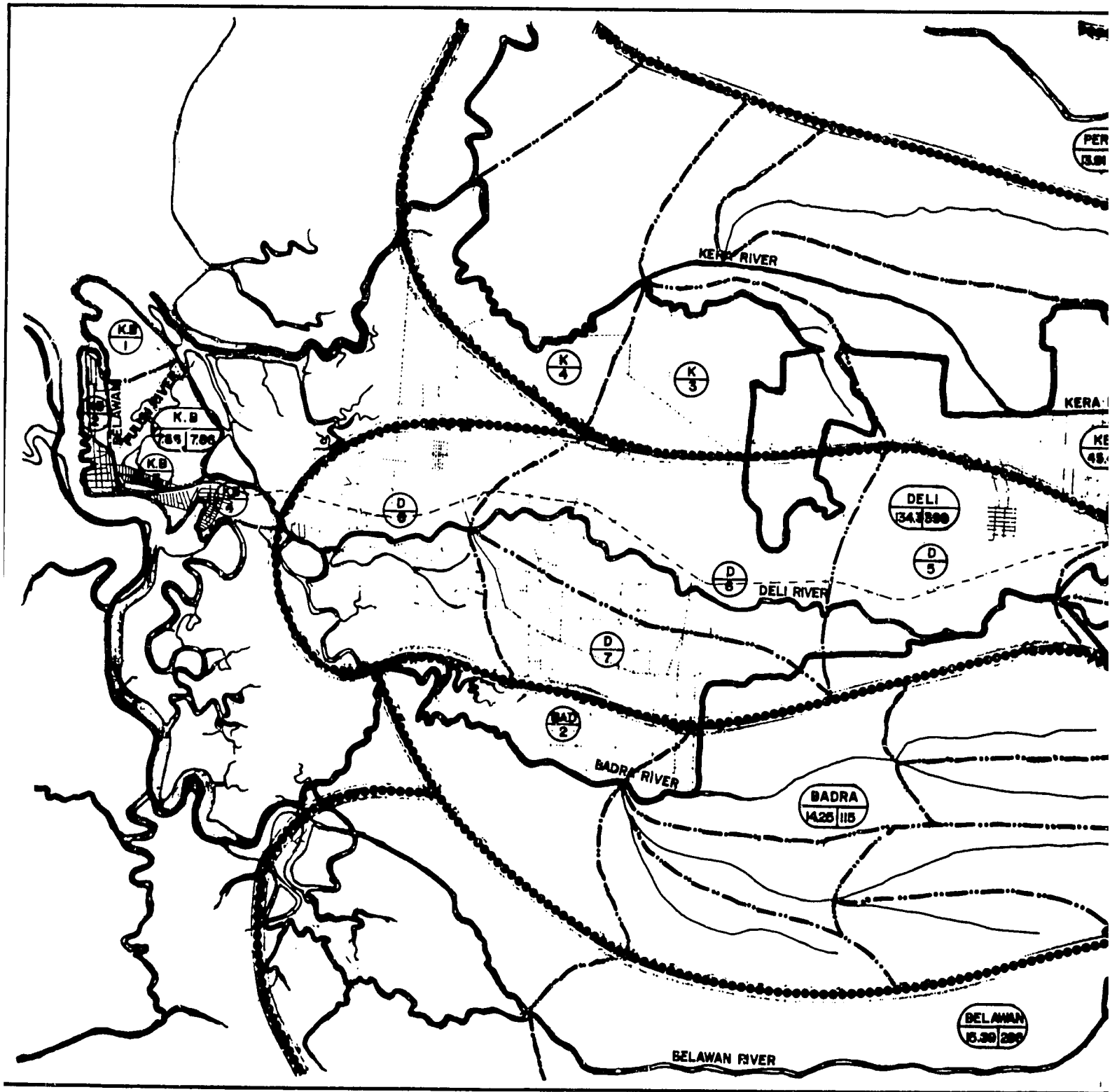
The population projections by kecamatan are presented in Table 3.1.

TABLE 3.1

POPULATION DISTRIBUTION BY KECAMATAN

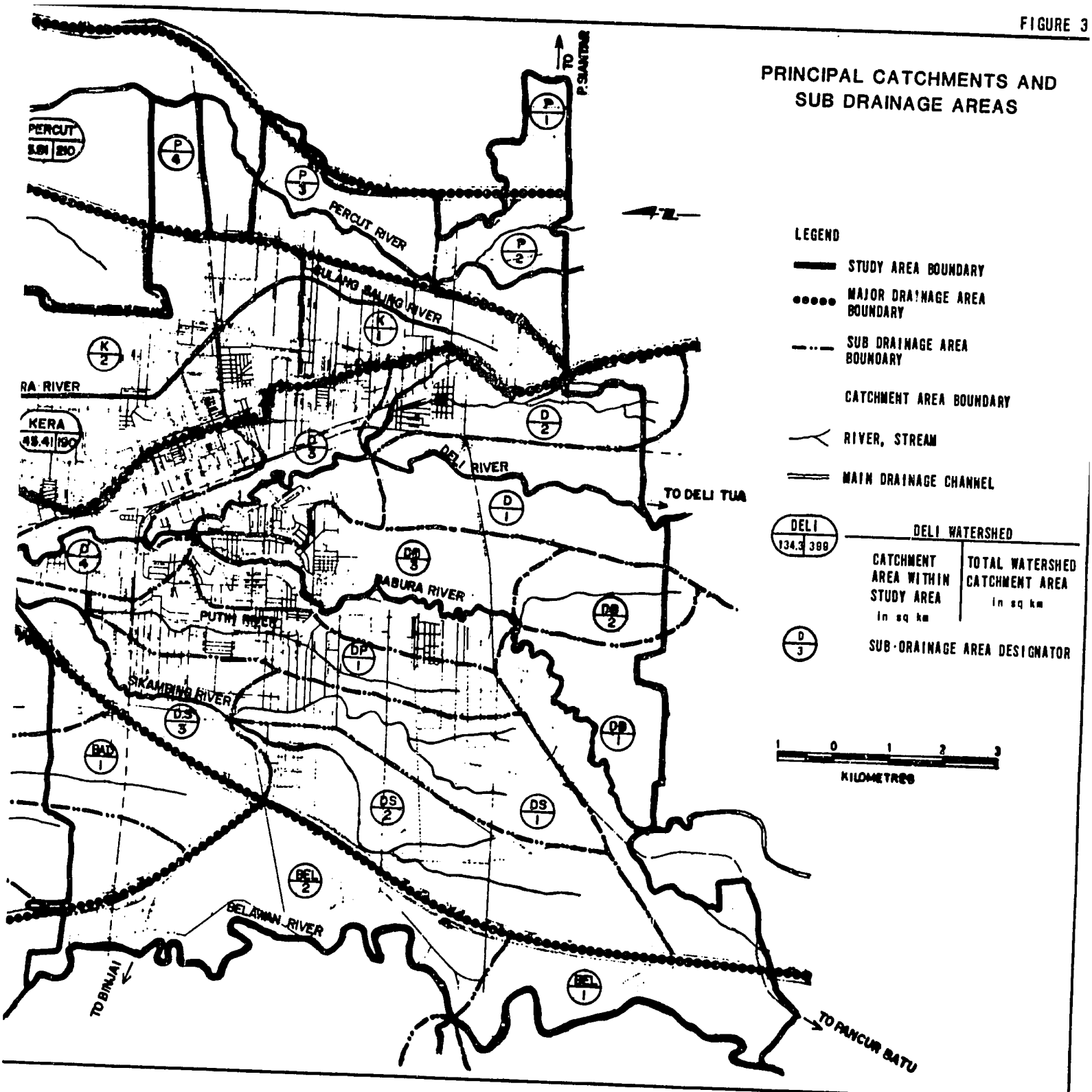
Kecamatan	1978	1980	1985	1990	1995	2000
Medan Kota	232,230	236,900	249,000	261,100	275,000	289,000
Timur	178,790	183,960	193,340	214,000	225,000	236,500
Baru	121,508	126,400	141,080	159,000	178,100	206,640
Barat	132,287	137,600	151,900	175,700	194,800	215,100
Denai	119,416	124,240	138,280	178,000	207,400	249,000
Labuhan	54,031	57,320	63,300	69,900	78,800	87,000
Johor	54,660	56,870	62,800	79,300	95,300	120,200
Tuntungan	17,475	18,180	56,070	66,900	83,860	107,590
Sunggal	94,383	99,200	109,500	143,900	179,600	211,100
Deli	51,456	56,200	62,050	68,500	76,000	86,200
Belawan	60,000	61,200	64,300	67,600	71,000	75,000
Medan II	-	46,800	51,670	57,100	63,000	69,600
Total	1,116,236	1,204,870	1,343,290	1,541,000	1,727,860	1,952,930

The existing and projected land use needs were based on 1972 aerial photographs and 1976 land use maps and are summarized as follows:


KERA RIVER
K 4
K 3
K.B 1
K.B
K.B
DELI
134.8 | 396
D 5
D 6
D 6
DELI RIVER
D 7
BAD 2
BADRA RIVER
BADRA
14.25 | 115
BELAWAN
BELAWAN RIVER

ADCO-DACREA

FIGURE 3



ENGINEERING-SCIENCE - SINOTECH

Estimated Land Use Needs (hectares)

Type	1980	1985	1990	1995	2000
Commercial	391	479	654	656	761
Industrial	358	399	440	480	516
Institutional	323	378	437	502	576
Total	1,072	1,256	1,431	1,638	1,853

The detailed demographic and land use projections from which Table 3.1 and the above land use summary were prepared are presented in Table B.1 of Appendix B for each of the 75 kampungs.

3.2 METHODOLOGY AND ASSUMPTION

It was assumed that the projected water use rates would provide the most reliable basis for estimating wastewater quantities since a substantial data base was available for those projections. It was further assumed that the average wastewater flow rates from domestic, commercial, industrial and institutional sources would be best represented as a fixed percentage of the average water use rates for all these categories. It was assumed that the average wastewater flows from domestic sources would be 70 percent of the projected water use and that flows from commercial, industrial and institutional sources would be 80 percent of the projected water use. These are referred to as wastewater return factors.

Water other than wastewater invariably enters sewerage systems in amounts great enough to require consideration from a design standpoint. Water which enters the system through leaky joints, cracked pipes and faulty service connections is referred to as infiltration and water which enters through illegal storm and house drain connections is referred to as inflow.

Two basis methods of estimating infiltration and inflow (I/I) are commonly used. One method is to estimate an I/I rate in terms of cubic metres per second per millimetre of pipe diameter per kilometre of pipe length. This method is most useful when the configuration of a proposed sewerage system is known in fairly great detail. The second method is more general and estimates I/I rates in terms of cubic metres per day per hectare of service area. For the purposes of this study it was considered more appropriate to use the second method and an assumed I/I rate of 10 cu m/d ha was used for the wastewater flow projections. This figure was selected as being typical of the conditions encountered elsewhere under high groundwater level similar conditions.

3.3 SEWERAGE SERVICE AREAS

The drainage areas of the six major rivers in the study area, the Percut, Kera, Deli, Babura, Badra and Belawan, were analysed to determine what sewerage service area boundaries could be established in order

to make the best use of gravity components in the collection system. This analysis indicated that the study area should be divided into thirty sewerage service areas which correspond to the natural drainage sub-basins shown in Figure 3.1. The topography of these areas is in general favourable for the design of gravity collection systems.

3.4 PROJECTED WASTEWATER FLOWS

The projected wastewater flows from each sewerage service area for the year 1985, 1990, and 2000 were determined by the following procedure:

First, that portion of each kampung that fell within the boundaries of each sewerage service area was identified. If a kampung was partially within a service area, the percentage of the area of the kampung inside the service area was determined.

Next, the projected wastewater flows from each kampung were determined for each design year. This was done by multiplying the projected kampung water use rates for domestic and non-domestic purposes by the appropriate wastewater return factor. The projected average wastewater flows for each sewerage service area were then computed by adding the flows produced by each kampung or portion of kampung in each sewerage service area. The contribution of wastewater from kampungs lying partially within a given sewerage service area was considered to be proportional to the area.

Finally, the volume of flow contributed by infiltration and inflow was computed and added to the average flows to produce the projected service area wastewater flows which will serve as the basis for long range planning and for evaluation of alternative wastewater management systems.

A summary of the projected total wastewater quantities the study area is presented in Table 3.2. Infiltration and in-flow add approximately 30 percent to the quantities indicated in this table.

TABLE 3.2

SUMMARY OF PROJECTED TOTAL WASTEWATER FLOWS

	Estimated Quantity, in cu m/d			
Category	1980	1985	1990	2000
Domestic	95,560	118,600	14,993	222,510
Commercial, Industrial and Institutional	43,750	50,110	56,540	68,360
Total	139,310	168,710	206,470	290,870

SECTION 4

PUBLIC HEALTH

4.1 PRESENT CONDITIONS AND PROBLEMS

4.1.1 Health Statistics

In any area, the incidence of enteric diseases is a measure of the general level of sanitation. The available health statistics in Medan confirm the problems that are evident even from a cursory examination of the water supply and sanitation systems.

Table 4.1 presents health data for 1978 obtained from the Medan Health Department, the Provincial Health Department, hospitals and other sources. At best, these statistics are incomplete because there is not comprehensive, uniform system in the city for reporting diseases incidence statistics. Many disease cases are unreported or are not treated in established health care facilities. As a consequence, the figures shown in Table 4.1 err on the low side.

Comparisons between kecamatan should be made only very cautiously. For example, Kec.Johor reported no cases of diarrhoeal diseases from the Health Centers in 1978. It is highly improbable that there were no cases; it is more likely that cases of diarrhoeal disease that did occur were not reported for one reason or another.

The data shown in Table 4.1, incomplete as they are, strongly support the fact that many people in Medan are using water from unsafe sources. In 1972-73, there was a major outbreak of cholera in North Sumatra where 22,745 cases were reported. This was an increase of about 50 times the rates reported over the previous three years in the Province. Diarrhoeal diseases (for which Health Centers above reported treating four percent of the population in 1978) are a major contributor to the extremely high Medan infant mortality rate of about 110 per 1000 population.

Typhoid fever is also common in Medan, but it is usually treated in the hospitals and reported only irregularly.

Partial statistics from the Medan Health Centers are available for some other diseases that are related to poor sanitation. These are summarized below:

TABLE 4.1

INCIDENCE OF REPORTED ENTERIC DISEASES IN 1978

Kecamatan	1978 Population	Hepatitis		Cholera		Bacillary Dysentery		Diarrhoeal Diseases	
		Cases	No./1000	Cases	No./1000	Cases	No./1000	Cases	No./1000
Kota	232,230	884	3.8	296	1.3	4,364	18.8	15,118	65.1
Baru	121,508	307	2.5	55	0.5	948	7.8	4.168	34.3
Barat	132,287	271	2.0	139	1.1	1,249	9.4	13,466	101.8
Timur	178,790	300	1.7	113	0.6	841	4.7	4,216	23.6
Sunggal	94,383	63	0.7	84	0.9	497	5.3	1,427	15.1
Tuntungan	17,475	74	4.2	3	0.2	74	4.2	832	47.6
Johor	54,660	-	-	2	-	-	-	-	-
Denai	119,416	37	0.3	97	0.8	213	1.8	350	2.9
Deli	51,456	94	1.8	3	0.1	51	1.0	677	13.2
Labuhan	54,031	-	-	192	3.6	1,952	36.1	84	1.6
Belawan	60,000	-	-	189	3.2	307	5.1	1,930	32.2
TOTAL	1,116,236	2,030	1.9*	1,173	1.1	10,496	9.9*	42,268	39.8

* Excluding Kec. Johor

Disease	Reported Incidence (cases per 100 pop.)
Ascaris	6.0
Hookworm	0.5
Scabies	8.1

These incidence rates are extremely misleading, because only the most severely afflicted cases are seen at the Health Centers. Studies reported by the Child Health Department of the Medan General Hospital (RSUPP) indicated that nearly 100 percent of the children in Medan had round worms at some time of the year. One study showed that 87 percent of the children examined had Ascaris (round worm) and 16 percent had hookworms. A special study in Kec.Tuntungan in 1976-77 showed 80 percent of the population were infected with Ascaris and 22 percent were infected with hookworm. A study in Kec. Deli Tua showed that 90 percent of the children had hookworms. Another study showed that 14 percent of the children were infected with Gardia lamblia.

In 1978 the Medan Health Department reported a total of 2083 cases of malaria from eight of the eleven kecamatans. Two-thirds of the cases were from Kota, Labuhan, and Belawan. Dengue (transmitted by the Aedes aegyptes mosquito which also transmits yellow fever) also occurs in Medan.

4.1.2 Wastewater Disposal

Given the absence of any formal, piped sewerage system in Medan, the separation of toilet waste (black water) from washing and other wastewaters (grey water) is the only feasible way to handle the sewage problem at the present. However, it is not a satisfactory long-term solution.

The relatively low permeability of the soils and the high groundwater table do not provide good conditions for septic tank or seepage systems for sewage disposal. In the high density areas of the city there is insufficient area available for even rudimentary leach fields for septic tanks. As a consequence, many septic tanks in the central city are connected directly to closed drains which carry the wastes to the rivers. Even in the less dense areas, septic tank and latrine wastes find their way into the open drainage ditches.

The present sewage disposal system represents a serious threat to health for a number of reasons:

- Untreated and partially treated wastes are discharged to the rivers which are used for washing, bathing and swimming.

- Septic tanks and latrines are located too close to many deep and shallow wells which results in contamination of the groundwater.

- Excrement left on the ground contributes to the high incidence of hookworm and round worm, and can contaminate wells during periodic flooding.

It is imperative that the present waste disposal practices be improved. Various alternatives for immediate implementation will probably bring some improvement, but ultimately only systems which can collect waste-water and remove it from the developed areas will provide acceptable protection of the health of the public health.

4.2 CURRENT REGULATIONS

There are certain National and local regulations which are intended to ensure that adequate safeguards of the public health are maintained. These regulations pertain to both water supply and waste-water disposal.

The surveillance of a city water supply system is properly the shared responsibility of the Water and Health Departments. The surveillance should be carried out under authority of National, Provincial and Municipal governments. The National or Provincial health authorities should have the responsibility to see that local authorities carry out their surveillance responsibilities and that applicable laws and regulations are enforced and complied with.

The Indonesian laws include:

1. Act on Public Hygiene, Nr.11, 1962 Gazette Nr. 48, 1962

2. Act on Basic Public Health Nr.9, 1960, Gazette Nr.131, 1960.

To assure that the public water supply meets requirements necessary to protect public health, a surveillance program should be planned, executed and continuously carried out to meet the requirements of the Act on Public Hygiene which is intended to assure "Protecting/maintaining/increasing public health which include prevention of diseases which endanger the public". It is common for countries to use the World Health Organization's "International Standards for Drinking Water (1971)" as the basis for their standards, making such modifications as are necessary and acceptable. These standards indicate that microbiological tests should be conducted regularly in a water supply system such as Medan's. The Medan Public Health Department, until 1978-79, did a limited amount of sampling for measuring chlorine concentrations and for testing according to WHO microbiological standards but are not presently taking and analysing such samples. The Water Department makes chemical and physical analyses but does no microbiological testing of the supply.

The fact that neither the Water Department nor the Health Department has any authority to regulate private water systems which are connected to the public system — and can cause widespread contamination — indicates that one of these departments should begin a program of microbiological sampling immediately to ensure that the objectives of the Act on Public Hygiene are met.

The Building Department of Medan has regulations concerning the requirements for wastewater systems in new buildings. These regulations are based on two primary land classifications for the urban areas of Medan. Open areas are those that require an open lot area at least 6 metres wide on each side of the building and that the building not occupy more than 60% of the total lot. Closed areas are those where the buildings may extend to the front properly line or side-walk and there need not be space between the buildings. There must be a strip of land at least 1.5 m wide, at the back, for the septic tank system.

In both open and closed areas, the grey water must be in a piping system separate from toilet wastes so it can be disposed of separately. All buildings for housing must have toilet facilities. However, this rule does not apply to houses for the poor in open areas, for whom there are no such requirements. The Health Department tries to educate them toward providing a latrine. For dense closed areas all are required to have toilets but the rules are not enforced regarding housing for the poor.

Since 1969 amendments to the regulations require that all toilet wastes be discharged to an acceptable septic tank. While no written specifications are available, it was stated by the Director of the Building Department that septic tanks for single family dwellings must be at least 2.5 m long, 1.25 m wide and 2 m deep. Using inside dimensions, allowing for wall thickness, and 0.2 m for "free-board", the capacity would be about 3.15 cu m.

It is the policy of the Building Department to try to dispose of all septic tank effluent in special sub-surface seepage systems. These are usually made of 3 alternate layers of gravel and palm fibre. They may have as many as 3 parallel, perforated pipes which are 2 metres apart, laid in the disposal bed, to distribute the liquid. There is no special investigation of the soil permeablility or of the groundwater level required before installation of the septic tank or seepage system.

For new buildings in closed areas, where there is not enough room for seepage systems, or where such systems would not handle the volume of liquid, permission may be granted to discharge septic tank effluent to closed drains which discharge to the Deli River. Where existing seepage systems fail, permission may be granted to bypass the seepage system and discharge the septic tank directly to an open or closed drain.

4.3 CURRENT PROGRAMS

The Government of Indonesia, as is common in much of the world, adopt five year development plans for which there are budgetary appropriations. One element of the plans is to provide improved water supply and excreta disposal for families which are not presently, and will not in the next several years, be provided with public water supplies and sewerage systems. The five year plans are called "Repelita I", "Repelita II", "Repelita III", etc. When the first water and sanitation plan was adopted it was estimated that only five percent of the families in areas to be served by the program had latrines, and one percent had access to an approved water supply.

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The goal of Repelita II, which was completed in 1979, was to have 15 percent of the families served by sanitary latrines and 10 percent of the families to have access to a safe water supply. Repelita III will aim to have sanitary latrines for 24 percent of the families.

The basic latrine program is to help people provide a sanitary latrine for every family. The principal type of unit has a "water-sealed" opening under a squatting type step plate as described in Section 2.3.5.

The program is administered by a unit of the Public Health Department's District Health Center Program. Funding is provided through the Hygiene and Sanitation Division of the Provincial Health Department (North Sumatra Province). The Medan Public Health Department works through the administrative headquarters of the villages and the person in charge of the program. A model unit may be built so the people may examine and use it, and become familiar with the program. Public meetings are held to explain how the units may be obtained. People sign-up, and agree to help install the slabs and build the shelters.

National project funding provides payment for selected village persons who help supervise the people who pour, deliver and install the slabs.

The Provincial Chief of Hygiene and Sanitation favors building the slabs at the sites where they will be installed. In most kampungs, the city Public Health Department has poured the slabs at central locations and the people have moved them to their home sites. In one or more kampungs the materials to make the slabs were provided to the people, and they poured the slabs at the site of installation. This avoids the problem of moving heavy slabs without having trucks and hoists. Four to six men can move and install a slab.

The cost for materials, local labor and related expenses for the Public Health Department is approximately Rp. 4,100 per slab according to Medan figures and Rp. 6,000 according to Provincial estimates. As indicated previously, public acceptance of these water-seal latrines has been good, and the program has been generally successful.

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SECTION 5

DESIGN CRITERIA AND BASIS FOR COST ESTIMATES

5.1 INTRODUCTION

The purpose of this section is to delineate design and cost estimating criteria for the physical facilities required for the wastewater system. The design criteria presented herein represent a combination of accepted international and locally developed design concepts. Within the constraints of acceptable levels of performance and good engineering practise, full consideration was given to the need to minimize costs in the capital-short environment in which the system must operate.

The cost data presented in this section are based upon the best currently available information obtainable from suppliers and contractors and the records of local agencies. Where appropriate, these data have been modified to reflect the estimated impact of changes in design concepts or construction methods as envisioned for the proposed facilities. All cost figures reflect prices applicable for mid-1979 unless noted otherwise.

Where the alternative evaluation process involved costing of a large number of the same type of facility of varying capacities, cost curves were prepared. If the facilities to be compared were few in number, general unit rates for materials and labor were developed for use in estimate preparation. Where appropriate, preliminary screening of alternatives was carried out on the basis of a comparison of average annual costs.

5.2 DESIGN CRITERIA

5.2.1 General Criteria

Elevations used to determine the slope of various wastewater collectors were estimated from 1:50,000 scale topographic maps. The elevations are therefore approximate and more detailed level surveys will have to be made before final design.

5.2.2 Sewers

Local Collectors: It was assumed that all local collection pipes 200 mm or less in diameter would be made of PVC and all collectors greater than 200 mm in diameter would be asbestos cement pipe with a corrosion resistant lining. Concrete, cast iron and unlined asbestos cement pipe

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were also evaluated but were not considered suitable for use in this project. Unlined asbestos cement pipe does not have adequate corrosion resistance for long term use. Concrete pipe requires greater slopes and more maintenance than PVC or cast iron to avoid corrosion problems, which increases the pumping requirements and the overall cost. The use of cast iron pipe cannot be recommended because of its present high cost and its marginal advantages over lined asbestos cement pipe. Vitrified clay pipe (VCP) would be the preferred type of pipe material for local collector sewers, but it is not currently manufactured in Indonesia and the cost of importing it would make it non-competitive with the local PVC or corrosion resistant AC pipe. The manufacture of VCP is labor intensive and does not require large capital investment or complex technology. Encouragement of local manufacture of this type of pipe could both significantly reduce sewerage system costs and provide employment.

Interceptors: The high temperatures and high projected BOD concentrations of the wastewater indicate that by the time wastewater reaches large interceptors it may be septic and the generation of hydrogen sulfide will have begun. This produces a very corrosive environment and materials must be carefully selected to provide adequate corrosion resistance. Concrete pipe would not be suitable under these conditions and large diameter lined asbestos cement pipe would be very expensive. Brick channels with either brick arch or precast concrete slab covers made with acid resistant cement were therefore considered to be the best choice for large sewers. Even though the use of acid resistant cement increases the cost somewhat, the advantages of the materials and the labor intensive construction techniques required make this the most suitable alternative.

Manholes may be made of either concrete or brick. Manholes should be placed about 100 metres apart on sewers less than 400 mm in diameter, and 150 metres apart on larger sewers.

Pipe sizes and slopes should be selected to prevent surcharging, maintain a minimum flow velocity of at least 0.6 metres per second, and avoid peak flow velocities in excess of 3.0 metres per second.

5.2.3 Pump Stations

All pump stations, except booster stations, were assumed to be equipped with bar screens and manual grit removal equipment.

Centrifugal pumps, either of a horizontal or long shaft vertical pattern, with open or semi-open impellers, were chosen for all conceptual lift station designs. The centrifugal pump sets were assumed to have average pump and electric motor efficiencies of 70 and 85 percent respectively.

The normal peaking factor at pump stations in areas similar to Medan has been reported to range between 1.3 to 1.8 times average daily flow with the larger peaks occurring only as a result of rainfall. Estimates of power consumption were based on the hypothetical response of a pump station having three equally sized pump sets to a diurnal flow variation pattern with dry weather peak and minimum flow rates of 1.7 and 0.3 times the average daily flow respectively.

5.2.4 Forcemains

Class 10 (10 kg/sq m) cast iron or PVC pipe should be used for all forcemains. Hydraulic calculations for forcemains were made using a Hazen-Williams friction factor of 120.

5.2.5 Wastewater Treatment

Multi-stage oxidation ponds consisting of two or more basins of 1.8 metres depth were adopted as the preferred method of treating wastewater in Medan. An oxidation pond surface area requirement of 1.3 hectares per million litres per day average flow was formulated from results obtained in areas similar to Medan. Bar screens and manually cleaned grit channels were included in the conceptual design. It was assumed that the basins would be constructed with 2 : 1 side slopes at a depth sufficient to allow a ten percent of excavation. The cost of rip-rap side slopes protection was also included.

5.3 BASES FOR COST ESTIMATION

5.3.1 General Bases for Pricing

Current prices of local materials and labor in Medan are summarized in Table 5.1. The unit prices of earthwork and masonry include the costs of labor, materials, equipment, a ten percent contractors overhead and a ten percent allowance for contractors profit. No provision is included for supervision and taxes.

5.3.1.1 Price Contingencies

No allowance has been made in this study for price escalation arising from inflationary causes. The prices used are current market prices prevalent around mid-1979.

5.3.1.2 Land Acquisition

Most of the wastewater collection mains will be laid on the public roads, and the cost of land acquisition for these items consequently will be very small. Additional land will be needed, however, for the treatment plant and pumping stations. Provision has been made for these requirements taking into account the locality where the parcels of land are required and the prevalent land prices in such areas.

5.3.1.3 Engineering Services

The cost of engineering services during the design and construction phase is estimated at ten percent of the construction cost of the facilities and has been accordingly included in the estimates.

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TABLE 5.1

GENERAL MATERIALS AND LABOR COSTS

Description	Unit	Unit Cost (Rp.)
Labor		
Unskilled labor	day	700
Skilled labor		
Mason	day	1,200
Carpenter	day	1,400
Assistant to skilled labor	day	800
Foreman	day	1,250
Material (delivered to site)		
Sand for filling	cu m	1,400
Sand for mortar	cu m	1,700
Sand for concrete	cu m	2,000
Gravel for concrete	cu m	2,900
Broken stone	cu m	3,400
Sirtu (sandy stone)	cu m	2,400
Crushed stone	cu m	3,900
Brick	100 pcs	1,850
Portland cement (Cibinong)	40 kg	2,100
Lime	100 kg	3,500
Asphalt	100 kg	9,000
Reinforcement steel	kg	300
Earthworks		
Escavation by hand		
0-1 metre	cu m	500
0-2 metres	cu m	600
Soil transport by pikulan over maximum distance of 50-100 m	cu m	200
Back filling	cu m	250
Sand filling	cu m	1,500
Loading and unloading of truck using man-power	cu m	250
Trench excavation up to depth of 1.5 m	cu m	550
Filling including compaction (each layer 20 cm)	cu m	1,250
Masonry		
Stone masonry	cu m	19,500
Plastering	sq m	750
Concrete mixed in place 1:3:5	cu m	18,000
Concrete mixed in place 1:2:3	cu m	23,000
Reinf. steel including binding and placing	100 kg	45,000
Timber formwork for concrete	cu m	57,000

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TABLE 5.1 Continued

Description	Unit	Unit Cost (Rp.)
Housing material		
Paint		
Wall paint	3.5 litres	6,900
Wood paint	1 litres	2,750
Roof		
Cement roof tile	pcs	100
Corrugated asbestos cement 14 x 4 mm x 5 feet	sheet	2,200
Asbestos cement roof 4 mm x 1 m x 2 m	sheet	2,360
Floor		
P. C. Tile 20 x 20	pcs	45
P. C. Tile 30 x 30	pcs	160
Glas (transparant)		
t = 3 mm	sq m	3,500
t = 5 mm	sq m	5,750
Wood - depending on quality	ton	40,000 to 115,000

5.3.1.4 Physical Contingencies

A physical contingency allowance of 15 percent has been added to the estimated costs of all facilities to provide for any unexpected items of work that may be found necessary during construction and also to provide for any inadvertant omissions or other inaccuracies in the cost estimates.

5.3.2 Wastewater System

5.3.2.1 Collection

Estimated costs for various types and sizes of sewerage pipe are shown in Figure 5.1. It may be seen from this figure that for pipes 200 mm in diameter or less, PVC is the least expensive of the acceptable materials. For pipes over 200 mm in diameter, asbestos cement pipe with a corrosion resistant lining is the least costly acceptable alternative.

The cost of the wastewater collection system could be substantially reduced if vitrified clay pipe (VC) were utilized for the smaller sewers (up to 600 mm), but unfortunately this type of pipe is not currently manufactured in Indonesia. It is estimated that substitution of VC pipe for PVC and corrosion resistant asbestos cement pipe would reduce sewer construction costs by about 20 percent.

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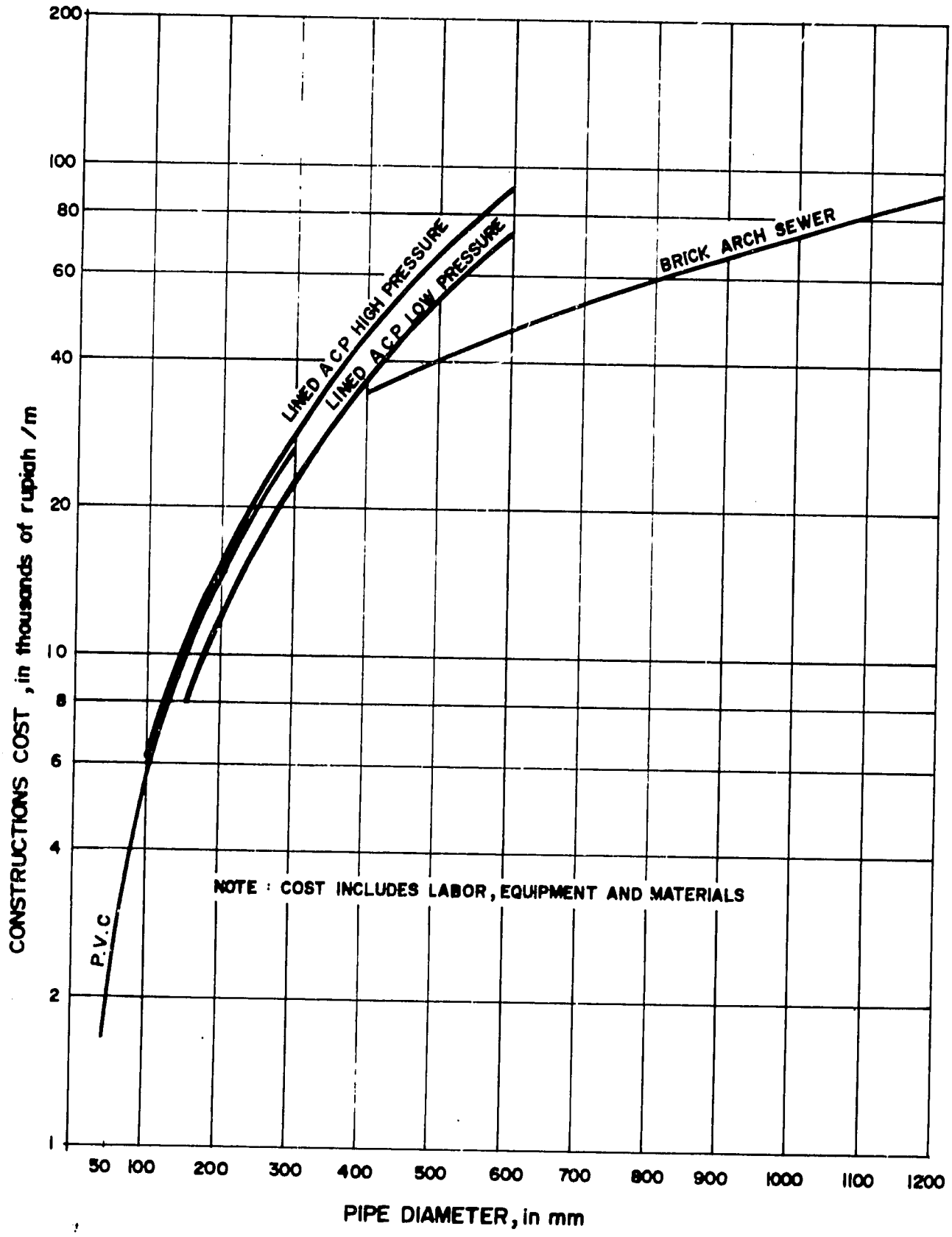
FIGURE 5.1



COST OF ALTERNATIVE SEWER
PIPE MATERIALS

The cost of brick interceptors in very large sizes was computed from the materials and labor costs obtained for bricks and skilled bricklayers. The cost of sewers of this type are shown in Figure 5.1 in equivalent pipe sizes.

5.3.2.2 Pumping

The estimated cost of the large pump station which will pump wastewater from the Kera basin into the Deli basin for treatment was based on a comparison with the cost of other pump stations which have been constructed recently in areas similar to Medan. The information from which this cost estimate was made is shown in Figure 5.2. The estimated costs of the small lift stations which will be included in the collection system were also based on this information.

5.3.2.3 Treatment

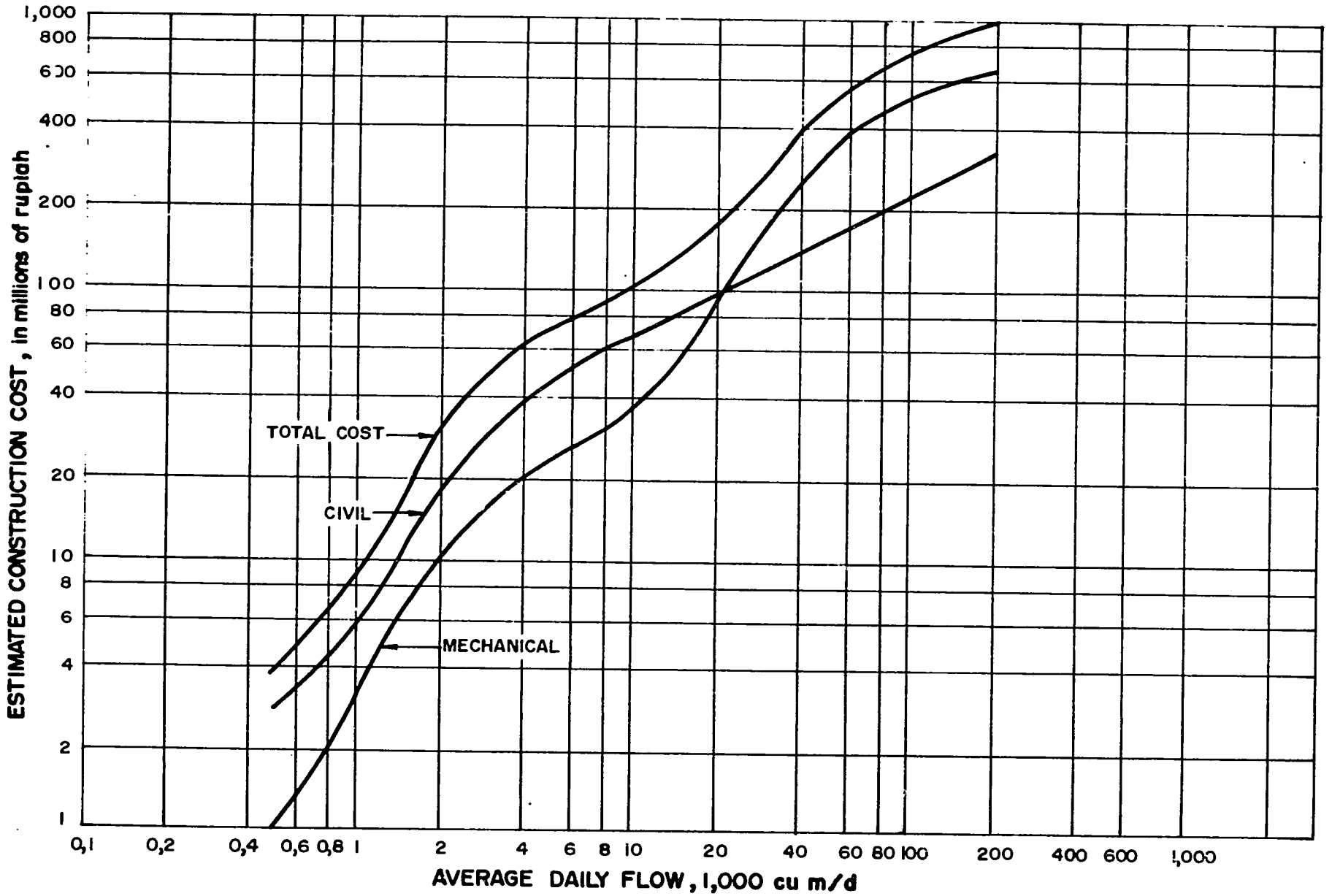
When the wastewater oxidation ponds are constructed, the major costs involved will be purchasing the necessary amount of land and providing labor and equipment for the required excavation and embankment. Costs for the construction of the lagoon and for embankment protection were determined from the curves shown in Figures 5.3 and 5.4, respectively. In later years, mechanical aerators will be added to maintain an acceptable level of treatment. The cost of these aerators was determined from information provided by local equipment supplies.

5.3.2.4 Operation and Maintenance

The annual operation and maintenance cost for each component of the wastewater collection and treatment system was assumed to be a fixed percentage of the total capital cost of that component. The percentages used are listed below:

Facility	O & M Cost as a percentage of Capital Cost
Pump stations	2
Interceptor sewers	1
Major collector sewers	1
Minor collector sewers	1
Service connections	1
Treatment facilities	2

ESTIMATED CONSTRUCTION COST OF SEWAGE PUMP STATION



WASTEWATER OXIDATION PONDS (NON-AERATED)

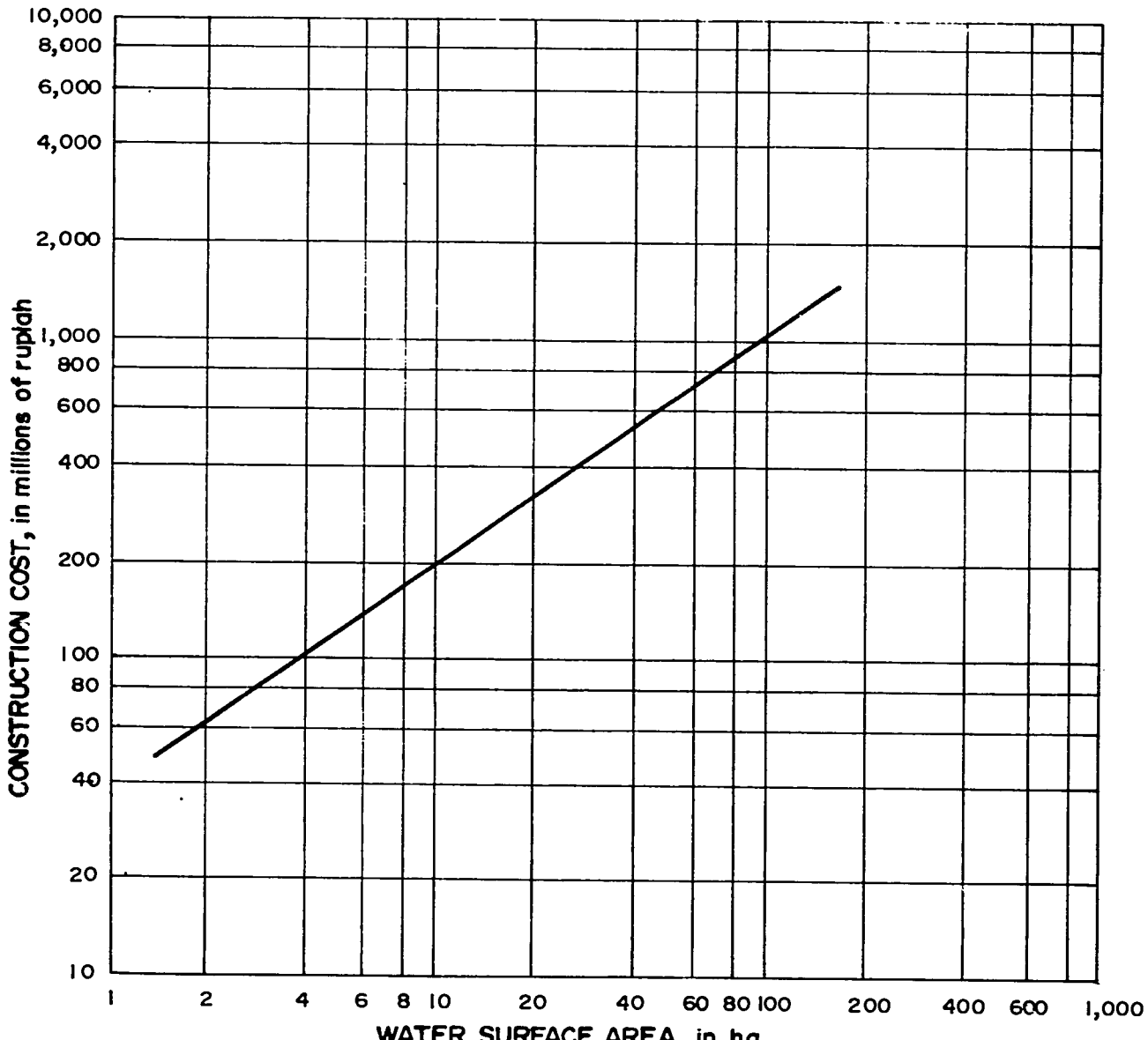
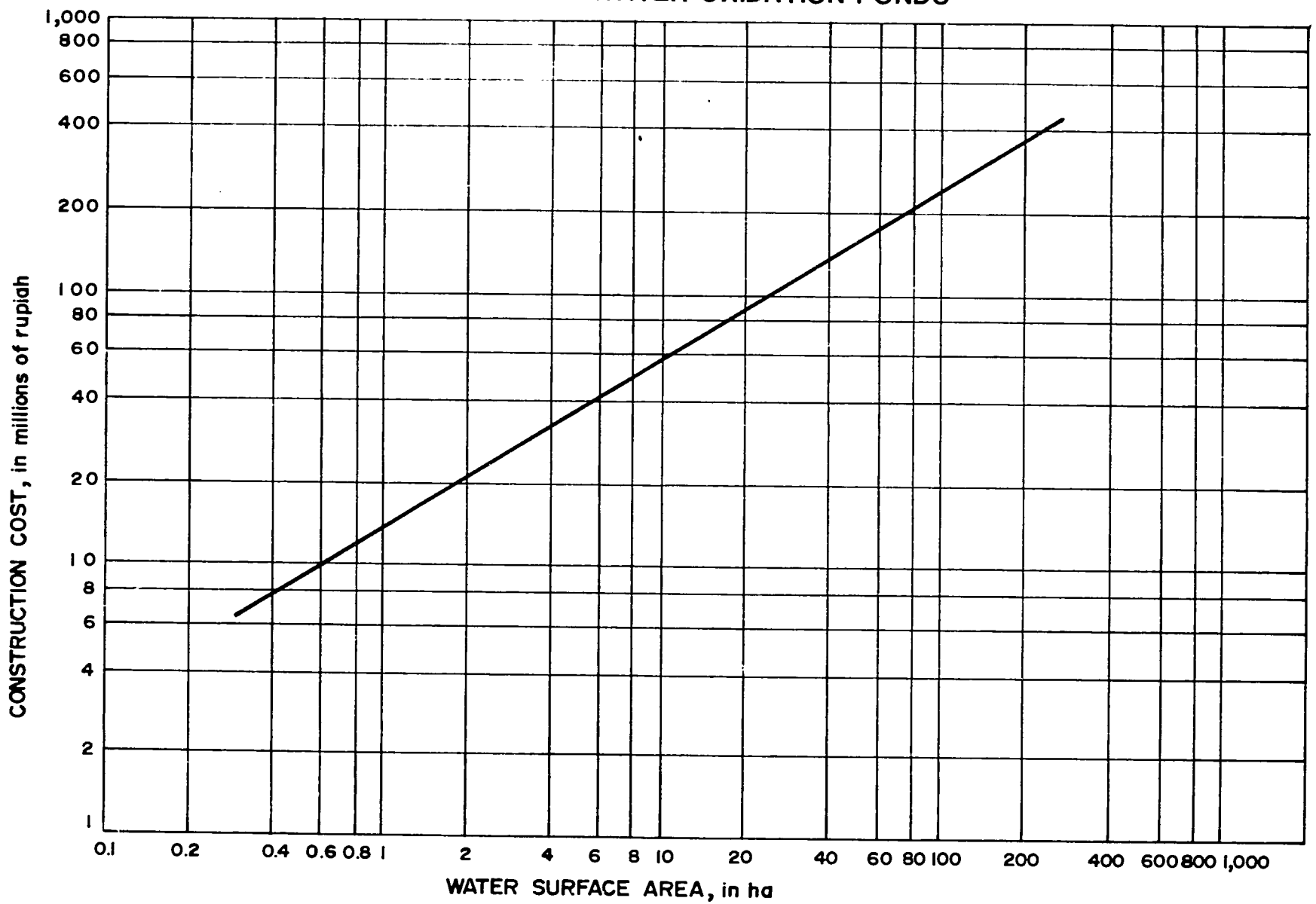


FIGURE 5.3

FIGURE 5.4

CONCRETE SLAB EBANKMENT PROTECTION COST
FOR WASTEWATER OXIDATION PONDS



SECTION 6

ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS

6.1 INTRODUCTION

Major public health problems in Medan result from inadeqaucies in the current methods of disposing of human waste. A discussion of these problems and of existing management programs to alleviate them has been presented in Section 4. This section will consider alternative management systems that combine these programs and additional programs involving traditional practices with various levels of sewerage service in areas where these programs cannot be expected to achieve satisfactory results. Section 7 will discuss the recommended wastewater management system in detail.

6.2 ALTERNATIVE SERVICE LEVELS

Four alternative levels of service will be evaluated. These range from continued reliance on existing programs and practices throughout the city of Medan to complete elimination of these practices within the limits of urban development by the year 2000.

6.2.1 Alternative 1 - Maintain Existing Service Service Levels

The simplest alternative is to continue using present methods for waste disposal and to provide whatever improvements are possible through phased programs such as the water seal latrine program. Additional programs would have to be implemented to provide public facilities for people living in areas where there is not enough land available to construct individual latrines or other on-site systems.

6.2.2 Alternative 2 - Provide Limited Sewer Service

In this alternative, most areas of the city would continue to be served the present systems, and limited areas of the city where wastewater generation rates are highest would be provided with a separate sewerage system. The sewerage system would serve areas which are very densely developed, have population densities greater than 400 people per hectare, or have very high property values. Phased improvement programs for on-site systems would also be necessary under this alternative, although on a smaller scale than Alternative 1 would require.

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6.2.3 Alternative 3 - Provide Expanded Sewer Service

This alternative would provide sewer service to the areas indicated in Alternative 2 and would extend this service to medium density areas where the population exceeds 200 people per hectare. As in Alternative 2, people in areas not served by the system would continue to rely on on-site systems, and improvement programs would be required, although on a more limited scale.

6.2.4 Alternative 4 - Provide Complete Sewer Service

The fourth possible alternative involves the construction of a separate sewer system which would serve all the residents of Medan. All on-site systems such as latrines and pit privies would be abandoned by the year 2000.

6.3 EVALUATION OF COMBINED AND SEPARATE SEWERS

Both combined and separate sewer system were considered for use in Medan. Combined sewers are designed to carry both sewage and storm water runoff. In dry weather, the sewers carry very little runoff and therefore function essentially as a sanitary sewerage system. During rainy periods, however, combined sewers also function as elements of the drainage system and raw sewage becomes mixed with the stormwater.

An analysis of stormwater runoff quantities which can be expected to occur at various frequencies and the costs of providing drainage system elements to accommodate these runoff quantities indicated that within existing financial constraints, it is extremely difficult to provide a drainage system which will not overflow periodically (see Volume V, Part 3). In a combined sewer system, this results in raw sewage leaving the system. If these overflows can be discharged directly to a river or stream, this problem is minimized and in certain situations is acceptable. However, the relatively flat terrain in Medan introduces constraints on the drainage system which make direct discharge of overflows impossible, and a certain amount of flooding in residential and business districts is inevitable. The potential for raw sewage overflows in residential and business districts on a regular basis significantly lowers the overall quality of urban life in Medan and would be totally unacceptable from a public health standpoint.

For these reasons, separate sanitary sewers are recommended for use in selected areas in Medan. These sewers are not designed to transport storm water, and therefore the possibility of storm related overflows is eliminated. The evaluation of alternative service levels and the cost estimates included in this evaluation were based on the use of separate sewers.

6.4 EVALUATION OF ALTERNATIVE SERVICE LEVELS

Four criteria have been selected to evaluate the alternative service levels which could be provided in Medan. These criteria are the population served, the public health aspects, the environmental aspects, and

cost. The cost and number of people who will be served are criteria which affect specific portions of the population, are easily quantified and can be compared directly. The public health and environmental aspects are less easily quantified and have a broader impact which affects the entire population of Medan directly or indirectly. Comparison of these aspects is therefore done on a relative rather than an absolute basis. Various statistics and figures are presented in the discussion of each alternative.

6.4.1 Alternative 1 - Maintain Existing Service Levels

6.4.1.1 Population Served

If this alternative were implemented, none of the residents of Medan would be provided with sewer service.

6.4.1.2 Public Health Aspects

The high incidence of water-borne disease in Medan is a very serious problem that results directly from the inadequacy of the present methods of wastewater disposal in the developed urban area. Adequate separation between man's waste and his environment must be maintained if this problem is to be remedied. The peoples reliance on latrine and pit privies has failed to maintain this separation, and the situation will undoubtedly become more critical as development continues. This problem is aggravated by the shortage of safe water for drinking and bathing which forces many people to rely on rivers and shallow wells for their supplies. It may be many years before this shortage can be eliminated.

For these reasons, this alternative would have an increasingly detrimental effect on public health.

6.4.1.3 Environmental Aspects

Short term environmental impacts of this alternative would be minimal since the only construction involved would be digging new latrines, septic tanks and drain fields.

Long term impacts would be significant. Soak-away pit latrines would continue to contaminate the surface aquifer and the rate and extent of this contamination would increase as development increased. Septic tank effluent would undoubtedly continue to enter surface drains as is happening presently. Both of these sources would continue to degrade the quality of surface waters in the urban area, particularly the Deli River.

6.4.1.4 Cost

The only direct cost involved in this alternative would be that of maintaining the existing private and public latrine programs throughout the design period. The total cost of these programs cannot be estimated accurately, and comparisons based on such estimates are apt to be misleading. For this reason, the cost of maintaining these programs was not

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included in this evaluation. The social costs, although difficult to quantify, would be very high. From the standpoint of health alone, the costs of illness, lost working time, and the long-term, indirect costs related to the high infant mortality rate represent a real burden, not only in money, but also in suffering.

6.4.2 Alternative 2 - Limited Sewer Service

6.4.2.1 Population Served

Alternative 2 would provide sewer service in a limited portion of the city which is comprised primarily of densely developed and densely populated areas, but which also contains a significant amount of high income, low density and commercial property. This area is shown in Figure 6.1.

The projected populations of this area for the years 1985, 1990 and 2000 are presented below.

Year	1985	1990	2000
Population	265,000	360,000	461,000

A survey of population density and income levels in all of the residential kampungs in Medan conducted in 1972 and updated in 1978 indicated that the population to be served by Alternative 2 could be characteristized by the following figures.

Income Level	Population Density Low	Medium	High	Total
Low	0.3 %	36.5 %	27.3 %	64.1 %
Medium	2.0	17.0	11.1	30.1
High	5.1	0.6	0.1	5.8

6.4.2.2 Public Health Aspects

The degree of improvement in public health that will result from an improvement in public services is difficult to quantify accurately. This problem is further complicated by the fact that sufficient data were not available to establish a kampung-by-kampung ranking system based on the severity of existing public health problems.

It was, however, possible to establish a ranking system to identify the potential for public health problems based on the presence of certain conditions which have historically been detrimental to the health of the public. It is logical to assume that any improvement in these conditions in an area with a high potential for health problems will benefit the people more than would the same change in an area where this potential was lower. This type of ranking system was used to evaluate the alternative service areas and to determine the relative benefit which would be achieved in each by the construction of a sewer system.

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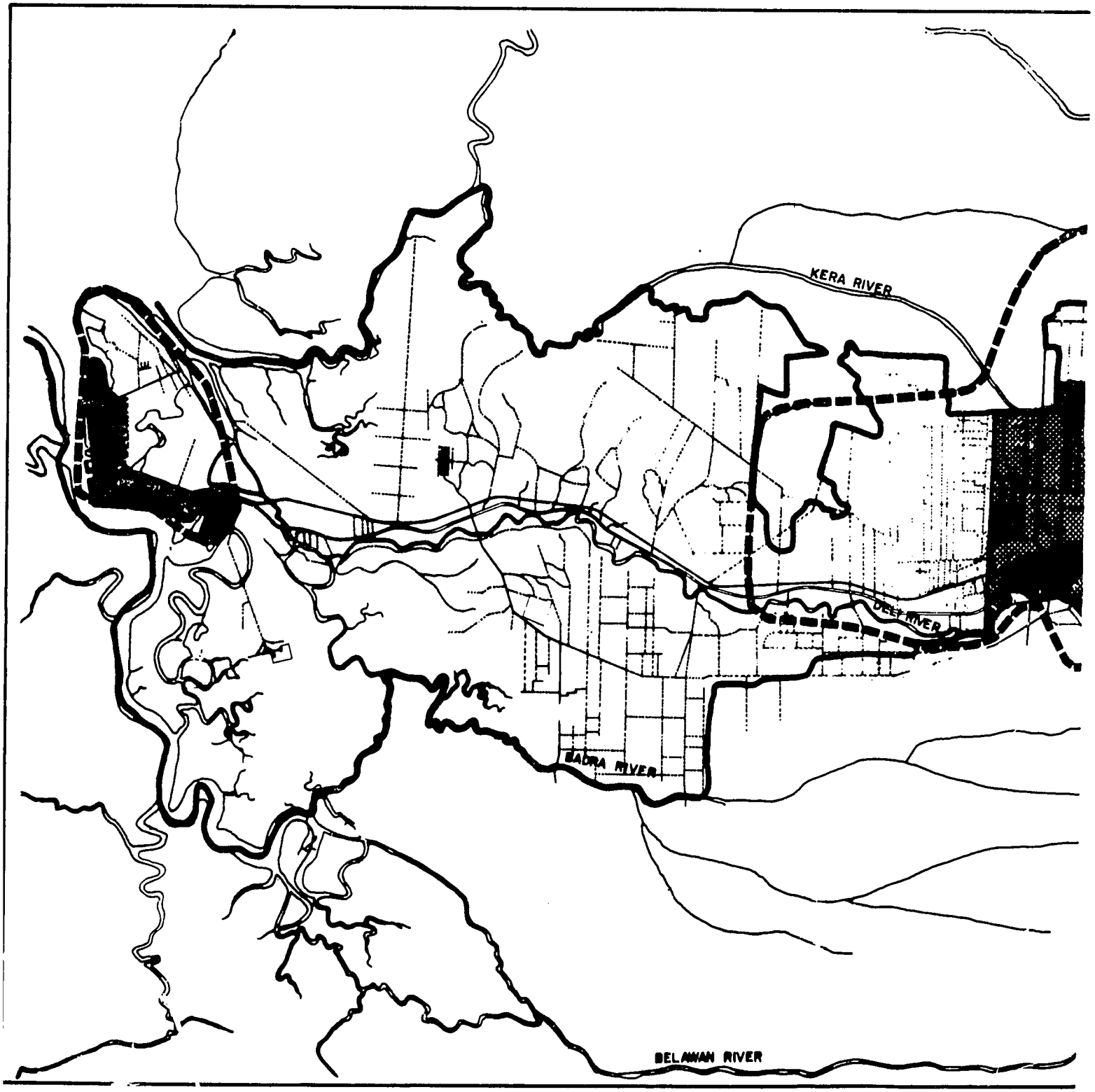

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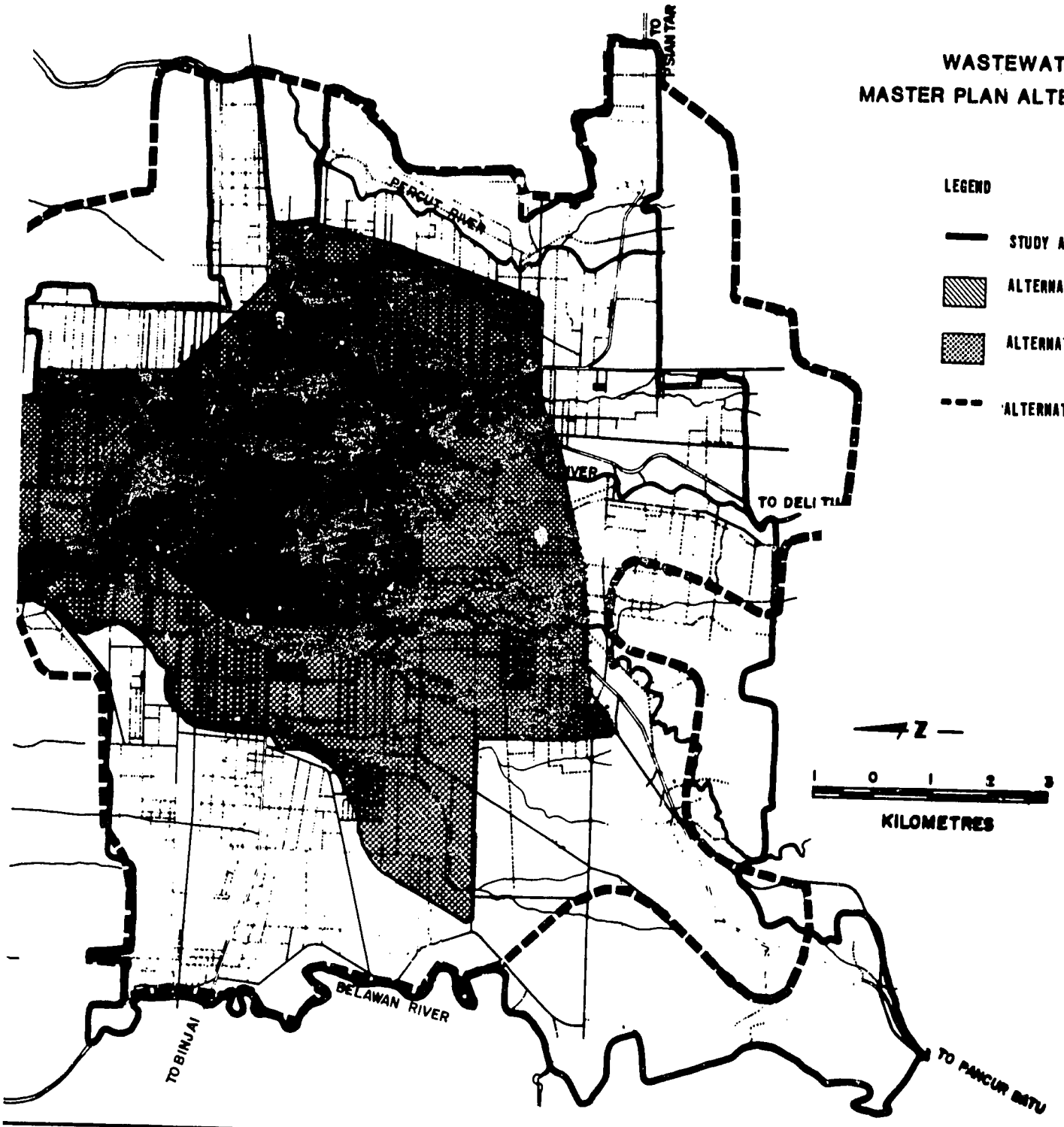

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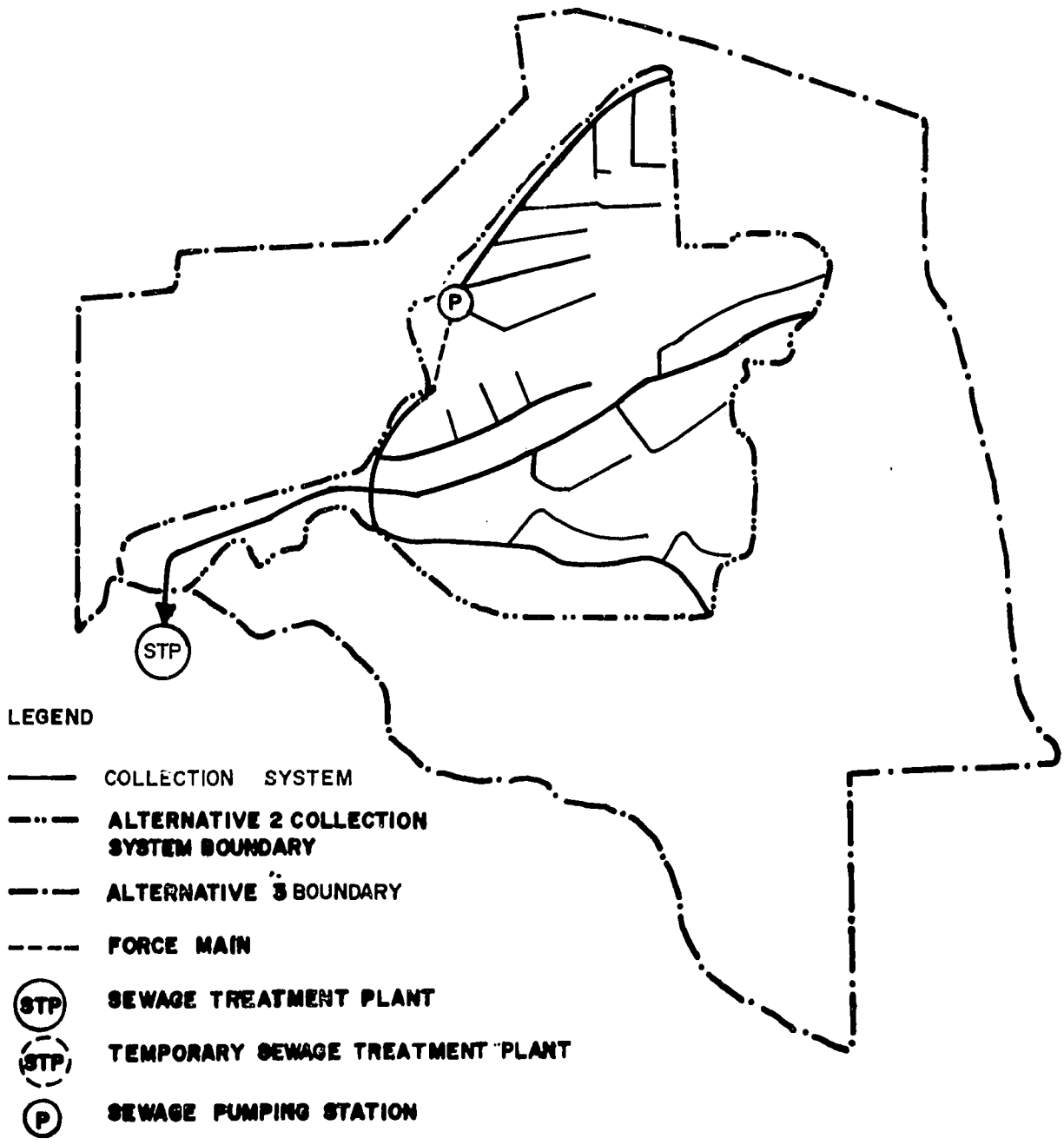
ALTERNATIVE INTERCEPTOR ALIGNMENT NO.1 FOR ALTERNATIVE 2 WASTEWATER COLLECTION SYSTEM



The criteria selected for ranking the kampungs in each service area were population density and public service coverage. High population density and low service coverage tend to increase the potential for problems. The ranking system was established as follows:

Service Coverage	High Density	Low Density
Poor	High benefit potential Rank = 1	Moderate benefit potential Rank = 2
Good	Low benefit potential Rank = 3	Very low benefit potential Rank = 4

The population weighted average of all the rankings for the kampungs included in the service area of Alternative 2 is 2 : 1. This number serves as a useful index for comparing the potential public health benefits which could be realized by providing sewer service in this area with the benefits which could be realized in the additional areas included in Alternatives 3 and 4. The analysis also indicates that the potential for health problems in the Alternative 2 service area is great enough that the construction of a sewer system would probably provide a significant improvement in the living conditions of the people.

6.4.2.3 Environmental Aspects

Short term environmental impacts resulting from the construction of sewers in urban areas of Medan will be significant. Dirt, dust and noise would be generated by the digging of trenches, which would be a nuisance to residents living in the construction area. Trenching would also result in temporary disruption of established traffic patterns, areas of localized congestion, reduced availability of parking spaces, and adverse aesthetic effects on the urban environment. These results would have an impact on all residents of Medan who work in, live in, or commute through the service area while construction is in progress.

Although the short term effects of providing a sewer system are detrimental to the environment, the long term effects would benefit not only the immediate service area, but other areas as well. The sewer system would eliminate sources of pollution which are presently contaminating the area's groundwater, which will probably be needed as a source of water supply for many residents for years to come. These sources also contribute to the pollution of surface waters which degrades environmental quality not only in the service area, but in downstream areas as well.

In an area that is as densely developed as the service area of Alternative 2, and that is expected to become even more densely developed in the future, it is imperative that proper measures be taken to provide adequate long term environmental protection. As development increases, problems caused by failure to provide these measures will become more acute. At the same time, the short term environmental cost of providing them will increase. Therefore, the long term benefits which will be realized by providing a sewerage system in the Alternative 2 service area outweigh the short term costs and will result in an overall improvement in environmental quality.

6.4.2.4 Cost

The estimated capital cost of the Alternative 2 wastewater collection system is Rp. 5,564 million. The amortized capital cost per person served by this system for the year 1985, 1990, and 2000 populations are shown below.

Year	Per Capita Amortized Cost* (Rp/y)
1985	2130
1990	1570
2000	1220

* Amortized at 10% over 50 years.

6.4.3 Alternative 3 - Expanded Sewer Service

6.4.3.1 Population Served

Alternative 3 would provide sewer service in an area which is comprised of the Alternative 2 service area and surrounding medium density areas where wastewater generation rates are higher than average, although generally not as great as in the higher density areas. This service area is shown in Figure 6.1.

The projected future population of the additional area which would be served by the Alternative 3 sewerage system, and the total population served, are presented below:

Year	Additional Population Served	Total Population Served
1985	412,000	677,000
1990	560,000	920,000
2000	716,000	1,177,000

The results of the 1972/1978 kampung surveys of population density and income levels indicated that the additional area which would be served by the Alternative 3 sewerage system could be characterized by the following figures.

Income Level	Population Density Low	Medium	High	Total
Low	10.1 %	0.1 %	1.2 %	11.4 %
Medium	71.5 %	4.5 %	0.1 %	76.1
High	11.5 %	0.9	0.1	12.5

6.4.3.2 Public Health Aspects

The same kampung ranking system described in Section 6.4.2.2 was used to evaluate the overall potential for public health problems in the additional area which would be served by the Alternative 3 sewerage system.

The population weighted average of rankings for all the kampungs included in this additional area is 1.8, which indicates that the potential for public health problems is slightly greater in these primarily medium density areas than in the higher density areas served by the Alternative 2 system. The potential benefit which would result from providing a sewer system in these medium density areas would therefore be somewhat greater than in the higher density areas. For this reason, Alternative 3 would provide a greater potential improvement in public health conditions than would Alternative 1 or 2.

6.4.3.3 Environmental Aspects

Short term environmental impacts which would result from construction of the Alternative 3 sewerage system would be similar in nature to those which construction of the Alternative 2 system would produce, but would be more severe due to the greater extent of the construction area. The dirt, dust and noise problems caused by trenching would affect more residents of the city, as would the unavoidable traffic, parking and aesthetic disturbances, although the generally lower level of development in the additional area would tend to decrease the local intensity of these problems slightly.

The long term effects of providing the expanded sewerage system will be beneficial to the environment, and the benefit will be greater than that which would result from providing the smaller Alternative 2 system. This benefit would again be derived from the elimination of latrines, pit privies and ineffective septic tank and drain field systems which are presently polluting ground and surface waters, and would extend beyond the boundaries of the service area. Finally, since the service area of Alternative 3 is greater than Alternative 2, both the short and long term harm to the environment that would result from delaying the construction of this sewerage system would be correspondingly greater.

For these reasons, the construction of the Alternative 3 sewerage system would provide an overall improvement in environmental quality in Medan, and this improvement would be somewhat greater than that which Alternative 2 would provide.

6.4.3.4 Cost

The estimated cost of Alternative 3 wastewater collection system is Rp. 21,350 million. The per capita amortized capital cost of this system, and the per capita cost for the additional population served (over Alternative 2), are shown below for the year 1985, 1990 and 2000 populations.

Year	Total Per Capita Amortized Cost (Rp/y)	Per Capita Amortized Cost for the Additional Population Served (Rp/y)
1985	3200	3,890
1990	2350	2,860
2000	1840	2,240

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6.4.4 Alternative 4 - Complete Sewer Service

6.4.4.1 Population Served

Alternative 4 would provide sewer service for all the residents of the city of Medan living in areas which will become urbanized by the year 2000, as shown in Figure 6.1. The present and projected future population of the additional area which would be served by the Alternative 4 system, and the total population which would be served, are presented below:

Year	Additional Population Served	Total Population Served
1985	303,000	980,000
1990	400,000	1,320,000
2000	513,000	1,650,000

The result of the 1972/1978 kampung surveys of population density and income levels indicated that the additional area which would be served by the Alternative 4 sewerage system could be characterized by the following figures:

Income Level	Population Density			
	Low	Medium	High	Total
Low	13.1 %	73.1 %	4.6 %	90.8 %
Medium	0.1 %	0.1 %	0.1 %	0.3
High	8.7 %	0.1	0.1	8.9

6.4.4.2 Public Health Aspects

The kampung rank system described in Section 6.3.2.2 was again used to evaluate the overall potential for public health problems in the additional areas which would be served by the Alternative 4 sewerage system. The population weighted average of the rankings all the kampungs include in this additional area is 2.0, which indicates that the potential for public health problems is essentially the same in this area as in the more densely developed areas which would be served by the Alternative 2 system and only slightly less than that in the primarily medium density areas which would be included in Alternative 3. This intermediate ranking implies that the potential benefit which a sewer system in this area would provide is significant and would fall somewhere in between the degree of improvement that could be achieved in those other areas.

Since the Alternative 4 service areas is the largest, and since a sewerage system could significantly reduce the potential for public health problems throughout this service area, this alternative would provide the greatest public health benefit of the four.

6.4.4.3 Environmental Aspects

The extension of the Alternative 4 sewerage system beyond the moderately-to-heavily developed and populated areas of the city prodeces a fundamental change in the relative trade-offs between long and short term

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environmental consequences. Extension of the sewerage system into widely scattered low and medium density residential areas would require extensive construction both in relatively unpopulated areas and along frequently traveled roads. The same short term problems that would result from construction in urban areas will also result in these more rural areas, and although the local severity of these problems will probably be less, their areal extent and the number of people affected will be greater. Furthermore, prompt and effective restoration of the rural environment will be required to ensure that the aesthetic quality of these areas is maintained.

As with Alternatives 2 and 3, the construction of the Alternative 4 sewerage system would eliminate sources of polution which are now contaminating ground and surface waters in the study area, and would, therefore, have a beneficial long term effect on the environment. However, since the average population density of the additional area served by Alternative 4 is relatively low, the benefits that will be realized by the residents of these areas are somewhat less than for residents of higher density areas. This is primarily due to the fact that in low density areas where land is abundant, latrines and pit privies are more often located and maintained so as to prevent pollution than in high density areas where there is frequently no choice in location or room for replacement.

Nevertheless, the long term benefits that Alternative 4 would provide outweigh the increase in short term environmental disturbance, and these benefits would be extended to more people than would those of Alternatives 2 or 3. This Alternative is therefore the most beneficial of the four in terms of protecting environmental quality.

6.4.4.4 Cost

The estimated cost of Alternative 4 wastewater collection system is Rp. 40,000 million. The per capita cost of this system, and the per capita cost for the additional population served, are shown below for the year 1985, 1990 and 2000 populations.

Year	Total per Capita Amortized Cost (Rp/y)	Per Capita Amortized Cost for the Additional Population Served (Rp/y)
1985	4140	6240
1990	3070	4730
2000	2400	3690

The cost of this collection system is much higher than the cost of the Alternatives 2 and 3 systems, as indicated by the cost summary below:

Alternative	Total per Capita Amortized Cost (Rp/y)	Per Capita Amortized Cost for the Additional Population Served (Rp/y)
1	0	0
2	2130	2130
3	3200	3890
4	4140	6240

This summary indicates that the incrementel cost for the additional population served by Alternative 4 is greater than the incremental cost of Alternatives 2 or 3. Existing problems related to waste disposal are in general least severe in the area which Alternative 4 would add to the sewerage system, and therefore the benefits to the additional people served would not be as great as the benefits that would result in the more densely developed urban areas served by Alternatives 2 and 3. Thus, Alternative 4 has both a higher cost and a lower benefit to cost ratio than the others. For this reason, and because of the limited financial resources available, Alternative 4 cannot be considered as a feasible option for implementation during the study period and is therefore given no further consideration in this analysis.

Although it is not currently feasible to provide sewer service throughout the urban development area, the improvements in public health and environmental quality that could be achieved by providing this level of service are nevertheless great. This need should be addressed as the economic growth of Medan continues and additional financial resources become available.

6.5. ALTERNATIVE TREATMENT SITES AND INTERCEPTOR ALIGNMENTS

The wastewater collected by the Alternatives 2 and 3 systems can be treated and discharged at several alternative locations within the study area. Different interceptor alignments are required to carry the flows to each of these alternative sites. The alternative interceptor alignments and treatment sites which were considered for the Alternatives 2 and 3 collection systems are shown in Figure 6.2 through 6.4 and 6.5 through 6.7, respectively. The service area boundaries shown on these Figures correspond to those shown in Figure 6.1.

Factors which were reviewed in the evaluation of these alternatives were the suitability of the land at each treatment site, the size and length of gravity interceptors and force mains required, and the advantages and disadvantages of including pump stations of various capacities in each system.

The recommended treatment sites and interceptor alignments are those which provided the best overall combination of cost, reliability and ease of maintenance within the constraint that all necessary engineering requirements be met.

Three treatment alternatives (Figure 6.2-6.4) were evaluated for the Alternative 2 collection system. The recommended alternative involves the construction of a single treatment facility in the Deli river

ALTERNATIVE INTERCEPTOR ALIGNMENT NO.2 FOR
ALTERNATIVE 2 WASTEWATER COLLECTION SYSTEM

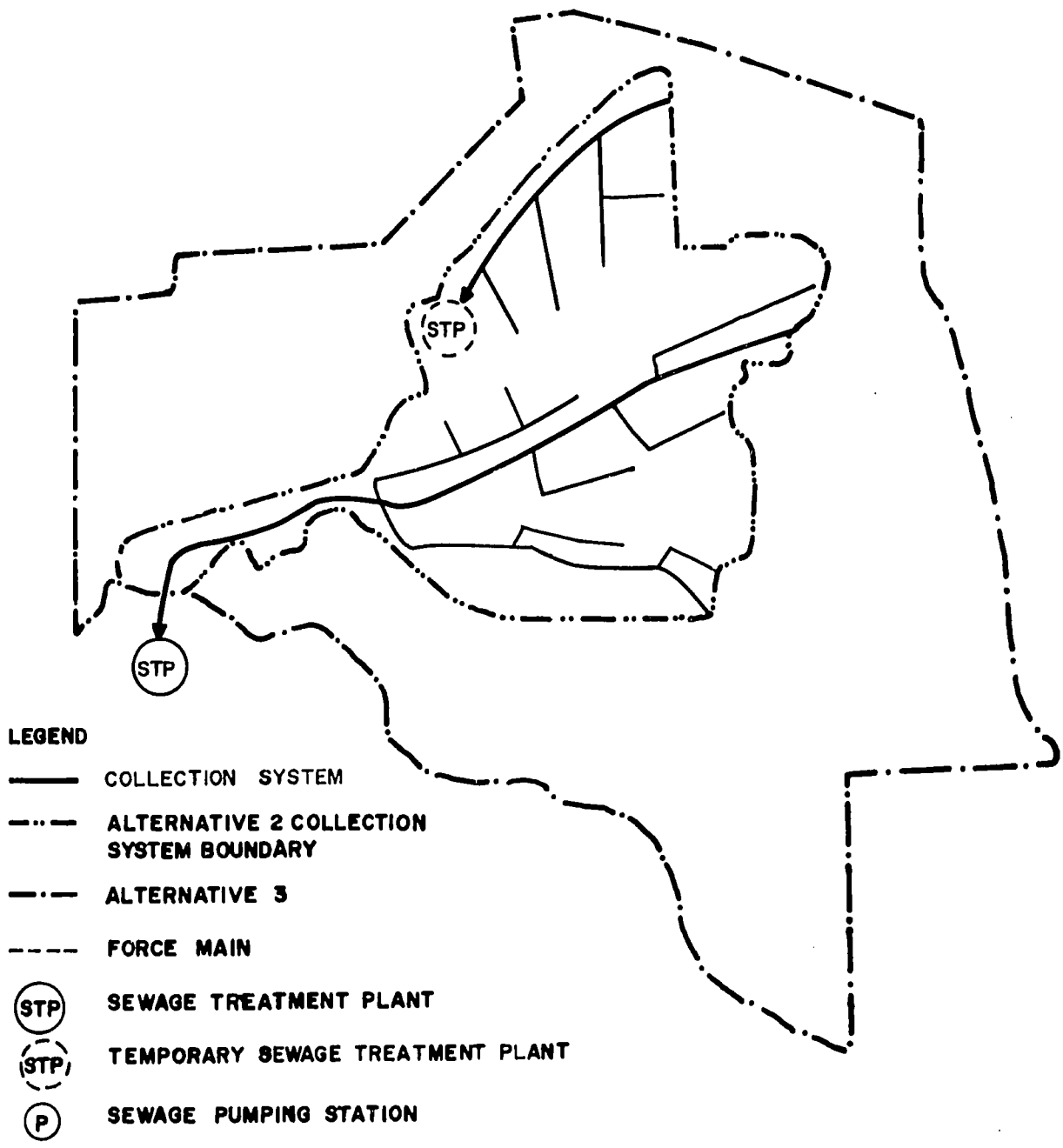

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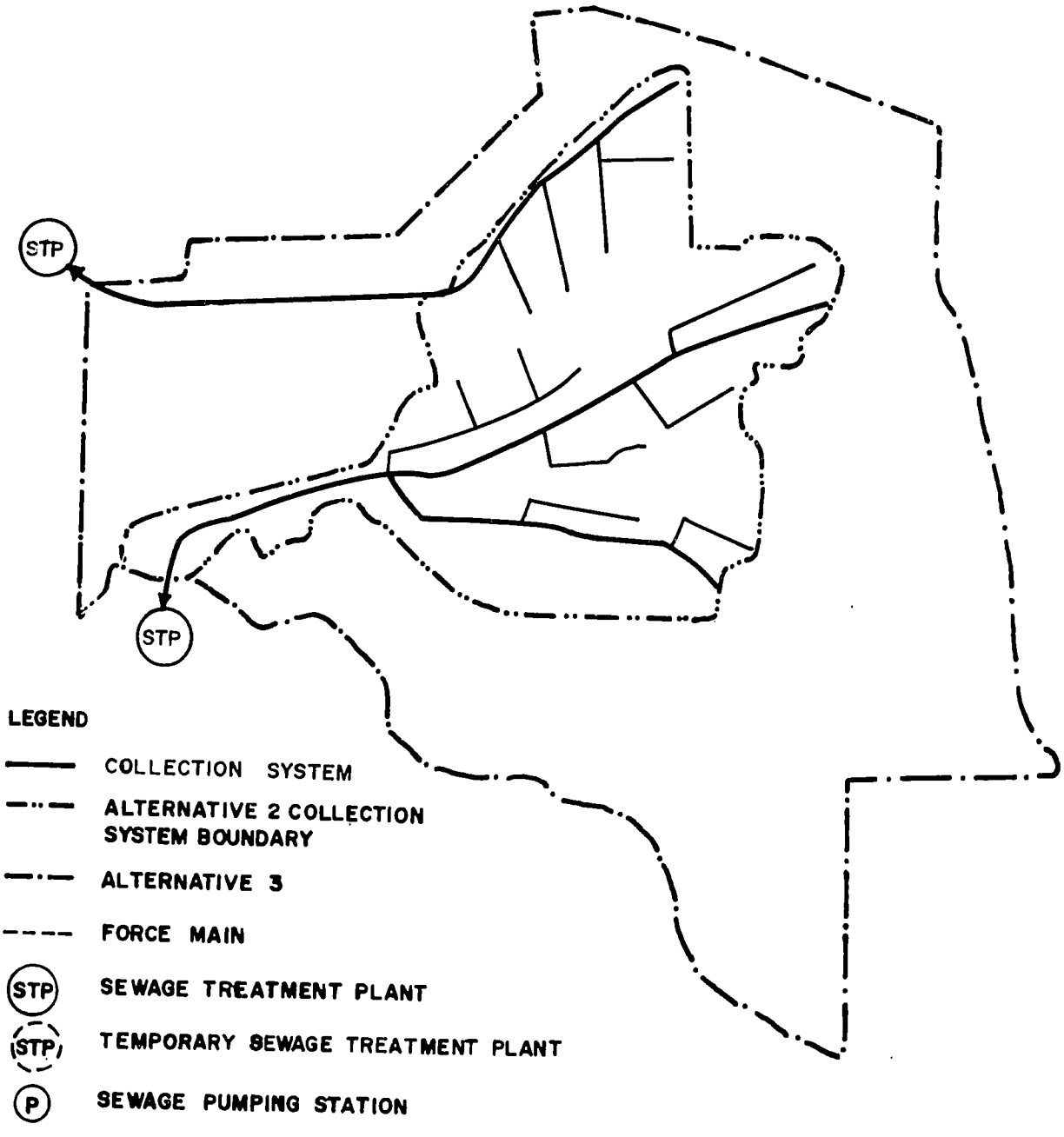
FIGURE 6.4

ALTERNATIVE INTERCEPTOR ALIGNMENT NO.3 FOR ALTERNATIVE 2 WASTEWATER COLLECTION SYSTEM



ALTERNATIVE INTERCEPTOR ALIGNMENT NO.1 FOR ALTERNATIVE 3 WASTEWATER COLLECTION SYSTEM

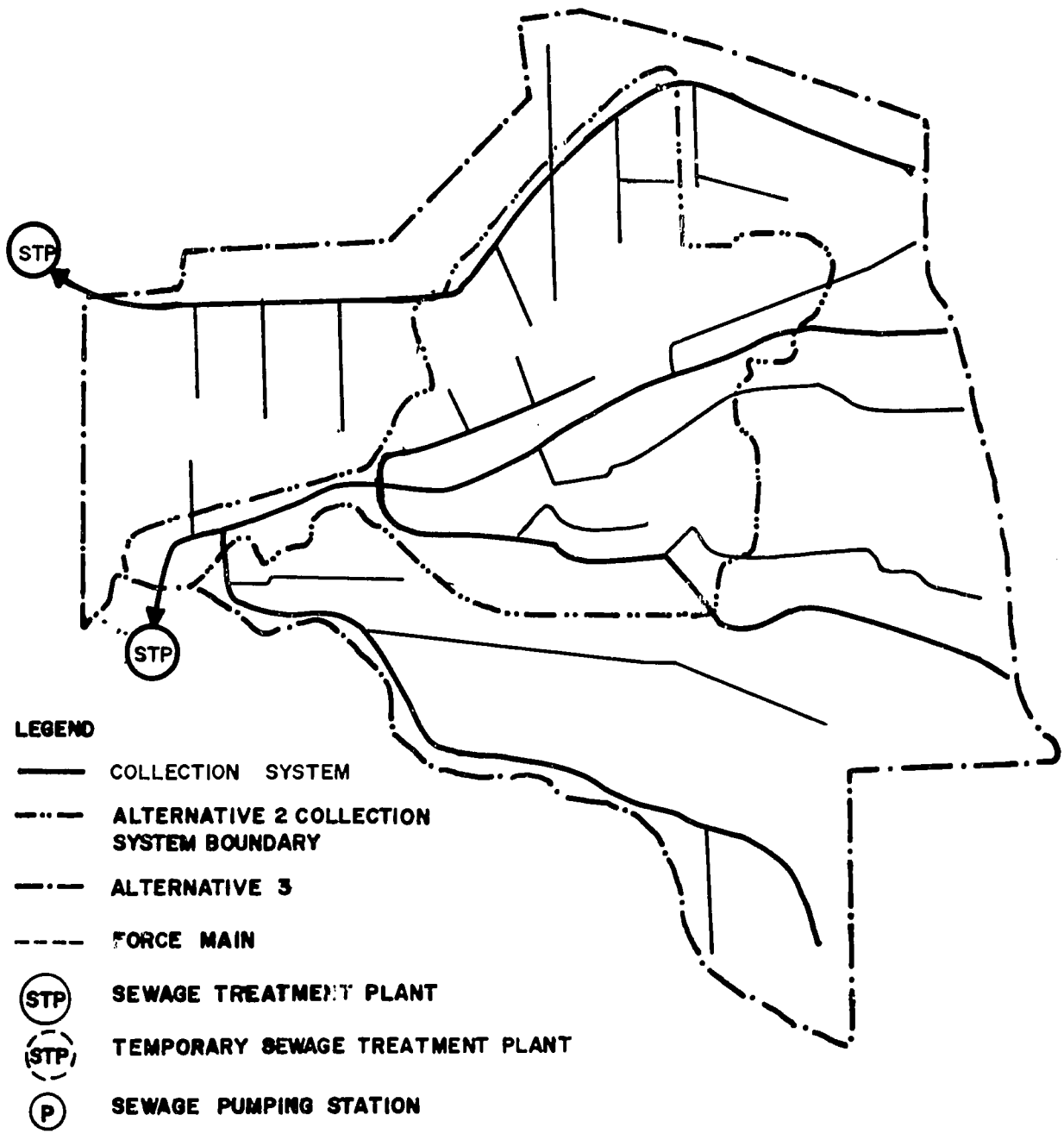
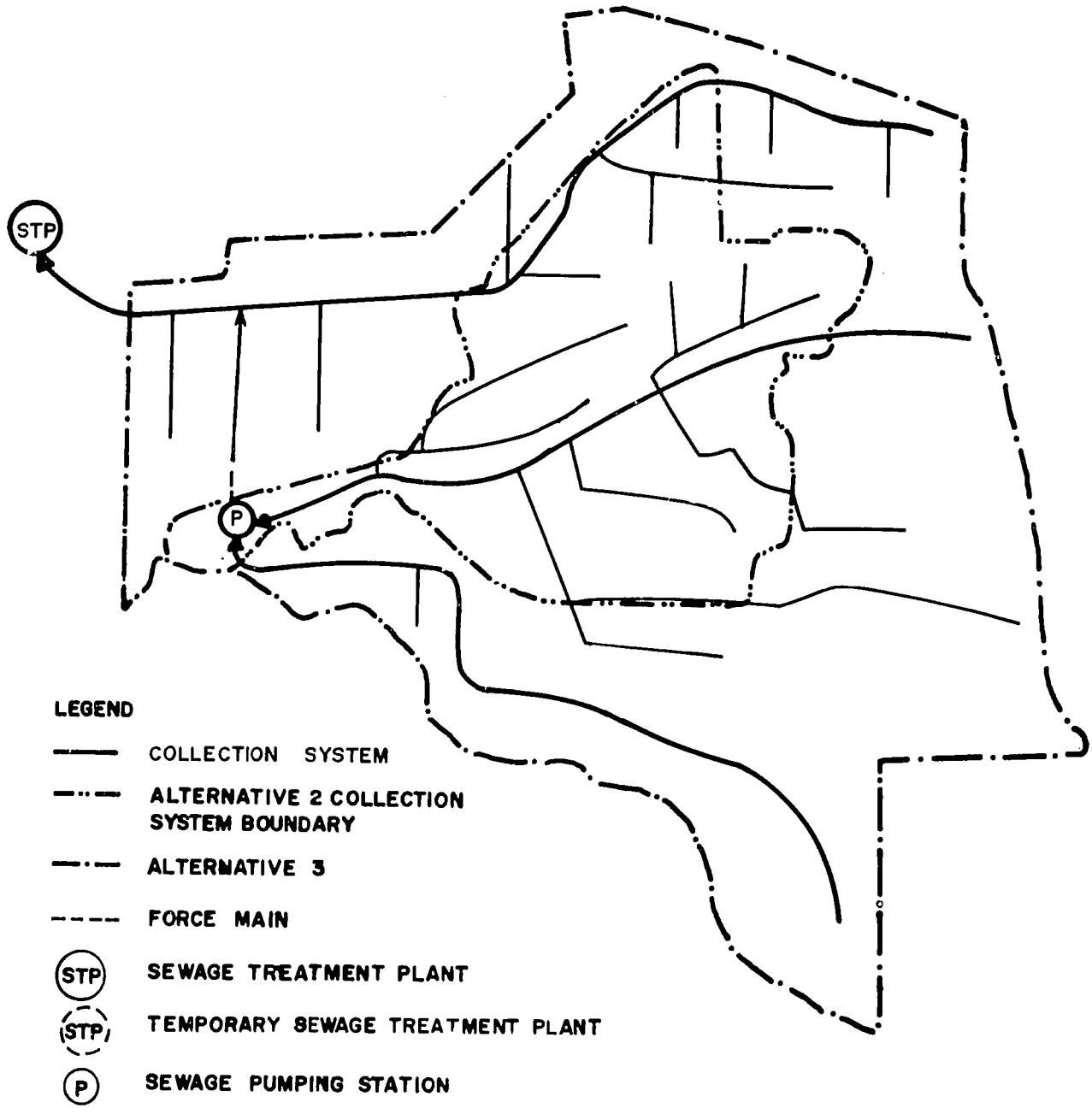
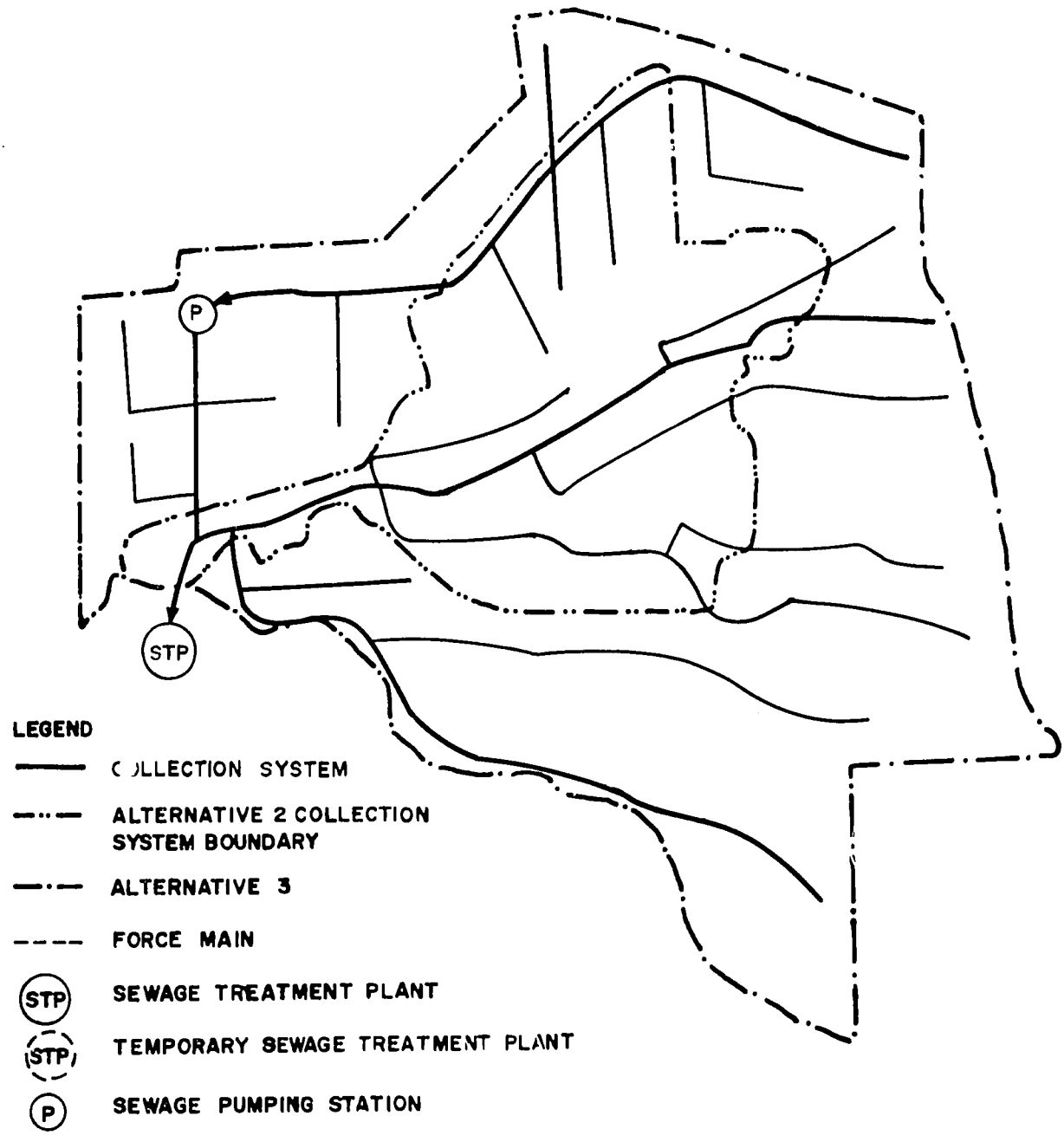


FIGURE 6.6

ALTERNATIVE INTERCEPTOR ALIGNMENT NO.2 FOR
ALTERNATIVE 3 WASTEWATER COLLECTION SYSTEM



ALTERNATIVE INTERCEPTOR ALIGNMENT NO.3 FOR ALTERNATIVE 3 WASTEWATER COLLECTION SYSTEM



basin. Wastewater from the Deli basin will flow to the treatment site by gravity. Flows from the Kera basin will be pumped to the boundary of the Deli basin and will flow from there to the treatment site by gravity. Alternatives which were rejected involved the construction of separate permanent treatment facilities for the Deli and Kera river basins which would be fed by gravity, and the construction of a temporary gravity fed treatment facility for the Kera flows which would be abandoned in the year 1990 and replaced with a pump station to transport the flows to the treatment facility in the Deli basin, which would then be enlarged.

The estimated cost of the recommended interceptors and the Kera pump station for the Alternative 2 collection system is Rp. 1,506 million.

Three alternatives (Figures 6.5-6.7) were also evaluated for the Alternative 3 collection system. The recommended alternative involves the construction of separate gravity fed treatment facilities to serve the Deli and Kera basins. Alternatives which involved pumping the Kera flows into the Deli basin or the Deli flows into the Kera basin were considered, but were rejected because of the very high power costs that would result from these large stations. These alternatives also include a separate gravity intercepter for the Belawan collection system.

The estimated cost of the recommended interceptors for the Alternative 3 collection system is Rp. 3,452 million.

The amortized costs of the interceptors for the Alternative 2 and 3 collection systems are presented below:

Alternative	Total per Capita Amortized Cost (Rp/y)	Per Capita Amortized Cost for the Additional Population Served (Rp/y)
2	580	580
3	520	480

6.6 ALTERNATIVE TREATMENT LEVELS

Wastewater must be treated in some way before it can be discharged to avoid creating public health hazards and nuisance conditions. The primary objectives of the treatment process are to reduce the concentrations of pathogenic organisms and to reduce the BOD and suspended solids content of the wastewater so that the receiving waters are not degraded excessively. A number of treatment processes can be used to achieve these ends, and the choice of which should be used in a particular situation depends on the amount of money available, the level of treatment required, and the level of technology which can be reasonbly implemented.

Treatment processes which could be used in Medan include primary clarification, activitated sludge, trickling filters and oxidation ponds. Methods of treatment which can produce a very high quality effluent, such as activitated sludge and trckling filters, are very expensive and require

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sophisticated equipment which must be carefully maintained. The high cost and the level of maintenance required for these processes makes them inappropriate for the Medan wastewater system.

Primary clarification can provide a substantial reduction in BOD and suspended solids and the cost is much lower than for activitated sludge or trickling filters. Chlorination or some other type of disinfection is required if adequate bacterial reduction is to be achieved. Both the clarifiers and the disinfection system require a significant amount of maintenance.

Oxidation ponds, of which there are several types, can provide greater BOD and suspended solids removal than primary clarifications, and can also reduce bacterial concentrations without chemical disinfection. Little maintenance is required, and that which is required does not involve sophisticated technology. Oxidation ponds are flexible with regard to phased improvement and the initial cost is low.

A preliminary analysis of alternative types of oxidation ponds indicated that aerated lagoons and non-aerated facultative ponds were most suitable for treating Medan's wastewater and that the capital costs of these two alternatives was very nearly equal. A detailed cost estimate was therefore prepared for each type of treatment facility for the Alternatives 2 and 3 collection system. The results of this detailed estimate are shown in Table 6.1.

Even though the capital cost of the aerated lagoons is slightly lower than that of the non-aerated lagoons, the cost of the electric power required makes the overall cost of aerated lagoons higher, and this alternative is therefore not recommended.

Non-aerated lagoons are not only less expensive overall than aerated lagoons, but also have the advantage that they can be significantly upgraded by adding aerators if the cost of land increases to the point where this becomes the cost effective alternative for providing increased treatment capacity. Aerated lagoons can only be upgraded by increasing the area of the lagoon or by constructing secondary or tertiary polishing ponds which are expensive and require additional land. Unaerated, multistage facultive lagoons are therefore the recommended method of treatment for both the Alternatives 2 and 3 wastewater systems.

The amortized costs of the recommended treatment facilities are presented below.

Alternative	Total per Capita Amortized Cost (Rp/y)	Per Capita Amortized Cost for the Additional Population Served (Rp/y)
2	1380	1380
3	1460	1510

TABLE 6.1

ESTIMATED COST OF AERATED AND NON-AERATED LAGOONS FOR ALTERNATIVES 2 AND 3 WASTEWATER COLLECTIONS SYSTEMS (MILLIONS OF RUPIAH)

Description	Deli System	Kera System	Belawan System	Total
1. Alternative 2				
Non Aerated Lagoon				
Lagoons	2,334	-	-	
Embankment Protection	652	-	-	
Land	625	-	-	
Sub-Total	3,611	-	-	3,611
2. Alternative 2				
Aerated Lagoon				
Lagoons	1,052	-	-	
Embankment Protection	318	-	-	
Land	225	-	-	
Aerators	1,630	-	-	
Electricity*	2,562	-	-	
Sub-Total	5,787	-	-	5,787
3. Alternative 3				
Non Aerated Lagoon				
Lagoons	3,556	2,445	408	
Embankment Protection	911	645	148	
Land	1,000	580	50	
Sub-Total	5,467	3,670	606	9,743
4. Alternative 3				
Aerated Lagoon				
Lagoons	1,652	1,890	167	
Embankment Protection	437	311	53	
Land	350	185	25	
Aerators	2,964	1,777	202	
Electricity*	4,423	3,416	304	
Sub Total	9,826	7,579	751	18,156

* Present worth.

6.7 SUMMARY

Selection of the recommended alternative will be based on an evaluation of the relative benefits that each would provide, and the financial and social costs that each would incur to the people of Medan.

The financial cost of Alternative 1, as mentioned previously, is considered to be zero in this evaluation. However, in view of the severe public health and environmental problems that Medan currently experiences, the social cost of this alternative is very high and will become higher as growth and development increases. Alternative 1 is therefore unacceptable and cannot be recommended.

For a number of environmental and public health reasons, it is desirable to provide a sewage collection and treatment system which will serve as many of the residents of Medan as possible. As the number of residents served increases, so does the cost of the system. As the population density of the area served decreases, the per capita cost increases as well. Selection of the recommended service level thus becomes a question of determining when the benefit derived by committing additional financial resources to the wastewater system becomes less than the benefit that would result from committing those resources to other recommended programs.

Of the two remaining alternatives, Alternative 3 serves a greater population and therefore has a greater overall benefit than Alternative 2. The cost of Alternative 3 is also greater than the cost of Alternative 2 as shown below in Table 6.2.

The total capital and annual ammortized costs of the Alternative 3 system are 224 and 43 percent higher than those of the Alternative 2 system, respectively.

Although Alternative 3 would provide a greater overall benefit than Alternative 2 because of the larger population served, the per capita benefit that each wastewater system would provide to the residents served is essentially equal. Since Alternative 2 provides this benefit at a lower per capita cost, this alternative has a higher overall benefit to cost ratio than Alternative 3. This, of course, does not mean that the benefit/cost ratio of Alternative 3 is not also positive but given that:

1. Medan's financial resources are limited (this is discussed in Section 21 of Volume III) and

2. GOI's stated preference for an initial demonstration project

Alternative 2 is recommended as the initial wastewater management system. The fact that this level of service will still leave many undesirable environmental and public health conditions uncorrected means that additional programs will have to be undertaken to remedy problems beyond the boundaries of the service area. A description of these additional programs and complete details of the recommended wastewater management system are presented in Section 7 of this report.

TABLE 6.2

TOTAL COST OF THE ALTERNATIVES 2 AND 3 WASTEWATER COLLECTION AND TREATMENT SYSTEMS

System Component	Alternative 2		Alternative 3	
	Total Capital Cost (Millions of Rupiah)	Per Capita Ammortized Cost (Rupiah/year)	Total Capital Cost (Millions of Rupiah)	Per Capita Ammortized Cost (Rupiah/year)
Collection System	5,564	2,130	21,350	3,890
Interceptors	1,506	580	3,452	480
Treatment	2,986	1,140	8,113	1,220
Sub-Total	10,056	3,850	32,915	5,590
Engineering Fees	1,006	390	3,292	560
Land	625	240	1,630	240
Contingencies	1,753	670	5,676	960
TOTAL	13,440	5,150	43,513	7,350

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SECTION 7

RECOMMENDED WASTEWATER MANAGEMENT SYSTEM

The recommended wastewater management system for the city of Medan combines programs to improve private and public disposal facilities with the construction of a sewer system in urban areas where latrines and septic tank systems cannot provide acceptable service.

7.1 DESCRIPTION OF THE RECOMMENDED SYSTEM

7.1.1 Collection System

The configuration of the major collectors of the wastewater system and the recommended staging of their construction are shown in Figure 7.1.

The area to be served by the wastewater collection system is partly within the Deli River basin and partly in the Kera basin. The natural topography of the area therefore requires that hydraulically independent sub-systems be provided to collect the flows from each drainage basin. The Deli system is the larger of the two and collects approximately two-thirds of the total wastewater flow.

Wastewater from the Deli basin will flow to the treatment site by gravity. Wastewater from the Kera basin will flow to a pump station which will pump the flow to the boundary of the Deli basin. From that point, the wastewater will flow to the treatment site by gravity. This pump station will be designed for an average flow of 39,300 cu m/d and a peak flow of 60,000 cu m/d by the year 2000. The station will have a separate wetwell and pump room. Automatic level controls and stand-by diesel generators will also be provided.

The relatively flat terrain of Medan indicates that several small lift stations will be required in the collection system to avoid excessively deep excavation. The level of detail of the available topographic maps was not, however, sufficient to determine the exact number and location of the lift stations which will be required. A rough estimate of the cost of these lift stations was made on the basis of the limited information available and was included in the cost of the minor collector sewers.

7.1.2 Treatment

Treatment of the wastewater will be provided by several two stage lagoons operating in parallel. The first stage will consist of an anaerobic lagoon with a detention time of approximately five days. The second stage will consist of a facultative lagoon with a detention time of approximately 23 days. This two stage treatment process will provide 80 to 95 percent BOD removal and over 99 percent bacterial reduction without chemical disinfection. Effluent will be discharged to the Deli River via an open channel.

The ponds will be preceeded by bar screens and manually cleaned grit removal channels to prevent large objects and heavy inorganic solids from entering the ponds.

The configuration of these lagoons, as sized for the 1990 and year 2000 wastewater flows, is shown in Figure 7.2.

7.1.3 Interim and Long Term Latrine Programs

An interim latrine improvement program will be needed in the portion of the city where the sewer system will be constructed to relieve existing problems before the system becomes fully operational. Of particular concern are several low income, high density urban areas where there are presently few if any toilet facilities of any kind.

The interim improvement program should concentrate on providing water seal latrines in areas where the need is greatest. Water seal units are much more desirable than open pit latrines from a public health standpoint, are relatively inexpensive, and their public acceptance is very high. The emphasis of the interim improvement program should be on providing individual family latrines wherever possible. Where this is not possible, efforts should be made to provide latrines that are shared by no more than three families, and preferably three related families.

The long term latrine program will serve to improve waste disposal facilities in medium and low density areas of Medan where it is not economically feasible to install sewers and may not be for many years to come. The goal of this program should be to provide every resident of Medan who lives outside the sewered area of the city with access to a properly constructed individual family latrine, preferably a water sealed unit. In a few scattered locations, shortages of land may make this infeasible. In these places, shared latrines might be acceptable provided that they are shared by no more than three families.

7.1.4 Septic Tank Pumpage

It is recommended that the current practice of discharging septic tank pumpage directly to the Deli river be discontinued as soon as possible. When the wastewater oxidation ponds have been completed and put in operation, septage should be discharged to the headworks of the ponds.

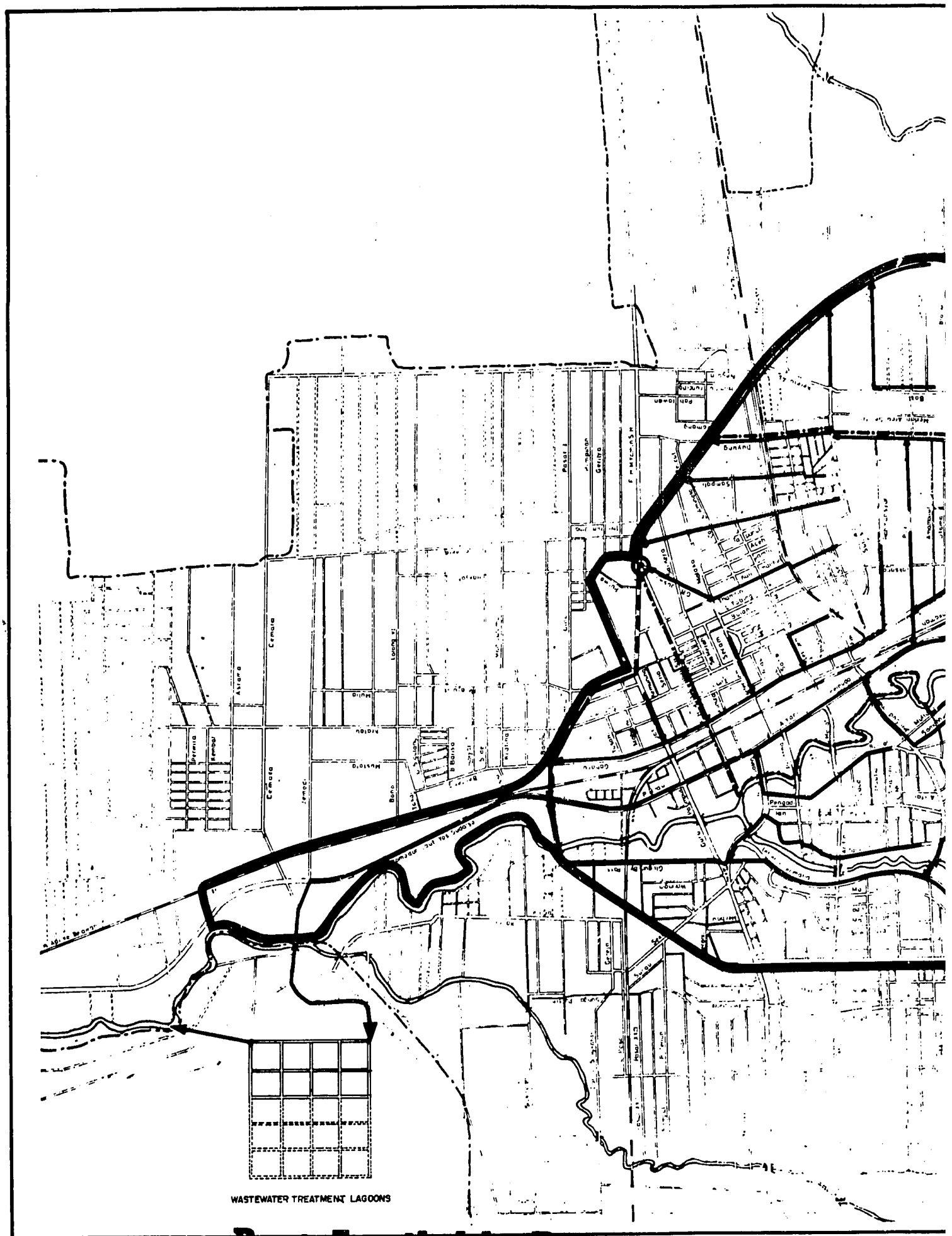

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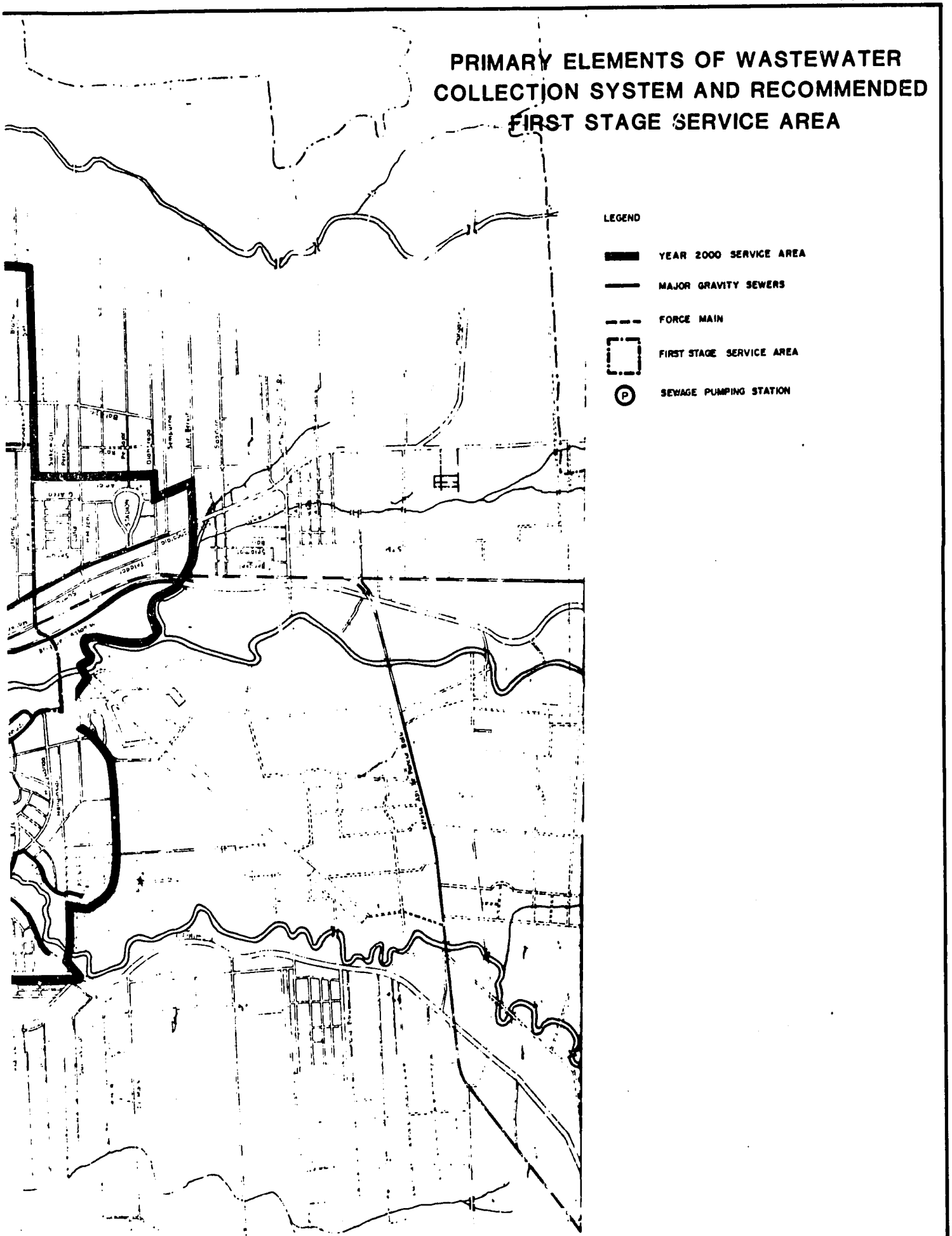
FIGURE 7.1



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7.2 OPERATION AND MAINTENANCE

7.2.1 System Operation

Although the wastewater collection and treatment systems will require a significant amount of maintenance to ensure reliable performance, the operational requirements are rather modest. The large wastewater pumping station in the Kera basin will be provided with automatic controls. However, one operator will be required in the station at all times to ensure that all equipment functions properly and to activate stand-by equipment in the event of any mechanical failure. The small lift stations incorporated into the collection system and the collection system itself will require regular inspection. The treatment lagoons will require a significant amount of maintenance. The treatment process itself does not require extensive operational control.

7.2.2 System Monitoring

It is essential to the efficient operation of the wastewater system that an accurate, thorough and continuous monitoring program be implemented. Data accumulated by this program will not only provide a measure of system efficiency, but will also identify developing problems and allow management to take corrective action in the early stages.

7.2.2.1 Collection System Performance

The overall performance of the wastewater collection system must be regularly checked to determine where repair, replacement or expansion is needed. Accurate flow measurements are the most valuable tool for making these determinations. Measurements should be made at the junction of all local collectors with trunk sewers at least once each year by installing temporary V-notch weirs in the junction manholes. Flow should be measured and recorded on an hourly basis for one full day each time. Measurements made very early in the morning are useful for assessing the amount of infiltration entering the system through leaky joints or cracked pipes. Excessive amounts of infiltration can severely reduce the effective capacity of the system and can, in extreme cases, result in surcharging and overflows. Measurements taken during periods when the daily flows are highest can indicate the necessary capacity of various components of the system. Peak flows recorded during periods of heavy rainfall show how much inflow is entering the system through manholes, storm drain connections and other sources which should be eliminated wherever possible.

Long term records of this type are extremely valuable indicators of changes in flow, inflow and infiltration and can be used to pinpoint problems, determine what measures are most desirable for correcting them and to project what future capacity will be required in the system.

7.2.2.2 Treatment Process Control

The primary objectives of the treatment process are to provide sufficient removal of bacteria and organic matter that the discharge

does not cause excessive physical and chemical degradation of the Deli river and does not create a public health hazard.

Treatment facilities will initially be sized to provide adequate treatment for only a small portion of the ultimate flows. As the collection system is gradually extended, flows will increase and additional lagoons will have to be constructed to maintain the recommended level of treatment. Also, the gradual accumulation of sludge in the lagoons will effectively reduce their volume thus reducing the detention time of the wastewater and efficiency of the treatment process. Regular monitoring of the BOD, suspended solids and bacterial content of the effluent will be required to verify that adequate treatment is being provided and to determine when expansion of the lagoons is necessary. Monitoring of the influent BOD and suspended solids content should also be done to determine the efficiency of the treatment process so that future expansions of the lagoons will be properly sized. The thickness of the sludge layer in the lagoons should also be monitored to determine when the lagoons need to be cleaned.

7.2.2.3 Receiving Water Quality

In order to verify directly that the discharge of treated wastewater does not degrade the physical, chemical or bacteriological quality of the Deli river excessively, a sampling program should be established to monitor the quality of the Deli river above and below the point of discharge from the oxidation ponds. BOD, suspended and dissolved solids, dissolved oxygen and coliform bacteria connectration should be sampled at a minimum of two locations downstream of the discharge point, and at one location immediately upstream of the discharge.

In addition to documenting the effects of existing discharges, these samples will help determine whether or not higher levels of treatment will be required in the future as the wastewater flows increase.

Additional upstream and downstream sampling would provide valuable data on the extent of pollution entering the river from other sources, particularly from the urban areas of Medan. An expanded sampling program to include these areas should be established if sufficient financial resources are available. The ultimate goal of this program should be to establish numerical water quality standards for important water quality parameters, such as dissolved oxygen, pH and fecal coliform levels. These standards should be set at levels which will ensure that the existing uses of surface waters can be continued, and efforts should be made to improve these standards in all surface waters as development continues.

7.2.3 Repairs and Maintenance

The condition of the sewer system should be continuously monitored to determine the need for cleaning and to locate any areas that need additional attention. A special sewer inspection team should be organized to make systematic inspection at regular intervals. Manholes should be opened and the depth of sediment and flow recorded. The condition of the sewers and manholes themselves should also be noted. The timing of the inspections should be varied so that each inspection point is examined

very early in the morning and in the middle of the day on alternate inspections to obtain estimates of maximum daily flows and the rate of infiltration.

Upon discovery of any unsatisfactory conditions, cleaning or repair should begin as soon as possible to prevent further deterioration and possible failure of the system. Records of cleaning and repairs should be kept to pinpoint chronic problem areas and help determine possible long term solutions.

The pump stations should also be regularly inspected and any developing problems should be corrected at the earliest possible opportunity. It is particularly important that the flow and pressure at the discharge of the pumps in large pump stations be carefully monitored and recorded. This will provide an accurate measure of pump wear, changes in the condition of the force mains and, to some extent, the condition of the upstream collection system. To facilitate this monitoring, the Kera pump station will be equipped with a flow meter and totalizer and individual pump discharge pressure gages. Operators should keep a weekly record of the discharge pressure of each pump. Accurate records should also be kept of weekly power requirements, and each motor should be equipped with a running time meter.

The small lift stations will be provided with discharge pressure gages only, and pressure measurements should be taken and recorded weekly. These records will indicate when pumps should be taken out of service for repair or replacement.

Maintenance of the oxidation ponds will primarily involve removal of aquatic vegetation growing near the edge of the ponds to eliminate conditions favorable for insect breeding. The banks themselves will also require repair occasionally. Sludge will have to be removed from the lagoons when it begins to significantly reduce their volume, but this is normally done only one in several years. Grit removal and cleaning of the bar racks will be required daily.

7.3 PHASED IMPLEMENTATION PLAN

The implementation schedule of each component of the recommended wastewater management system is shown graphically in Figure 7.3.

The implementation of the recommended wastewater collection and treatment systems and the interim and long term latrine improvement programs will be phased over the entire 20 year planning period. Various portions of the collection system, such as the major interceptors, will be completed in the early stages of the project and will be put in service as soon as possible. Other portions of the system, such as the local collectors and service connections will be constructed at a uniform rate through the year 2000.

WASTEWATER TREATMENT LOGOONS SIZED FOR FIRST STAGE AND YEAR 2000

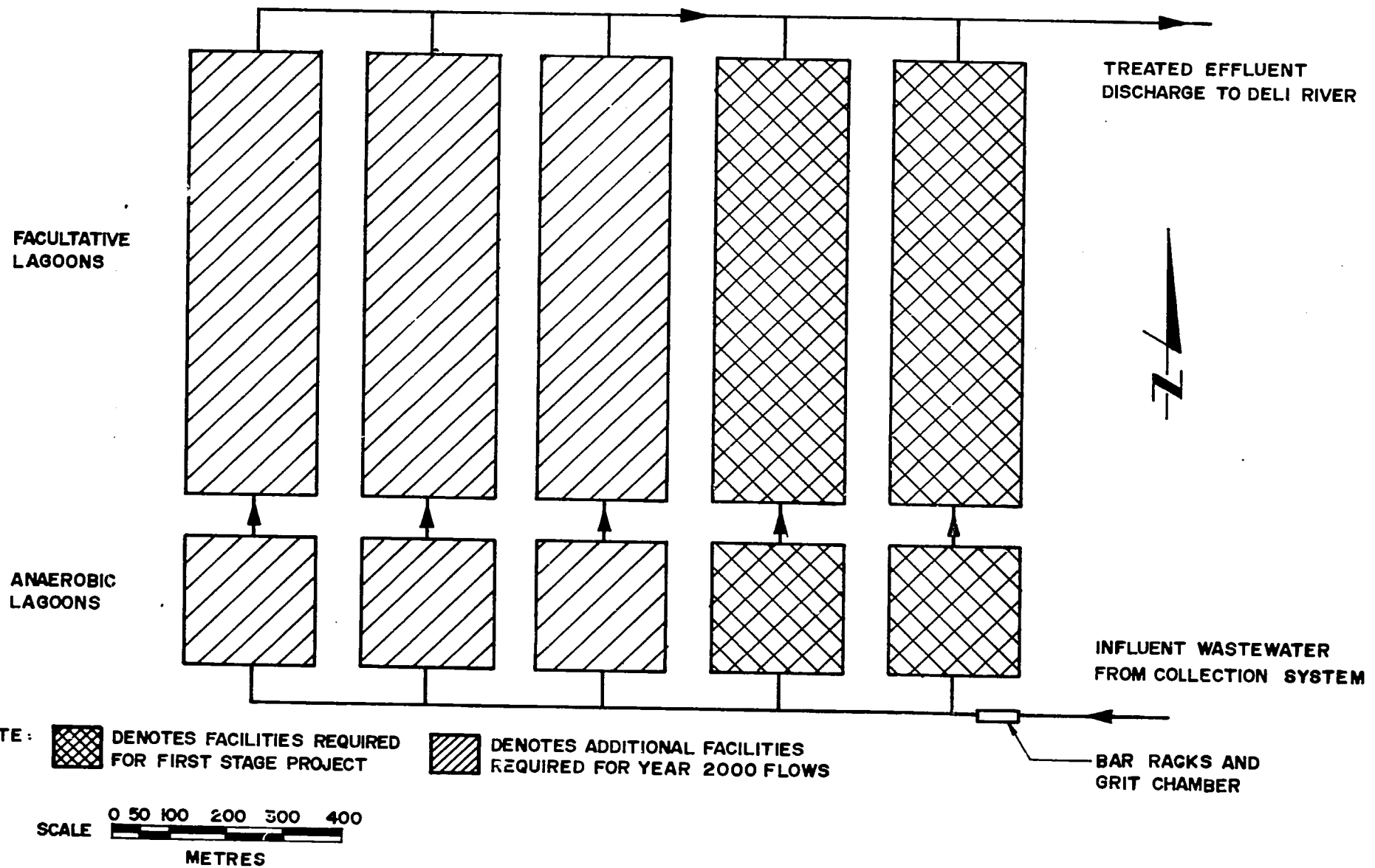

FIGURE 7.2

WASTEWATER SYSTEM IMPLEMENTION SCHEDULE

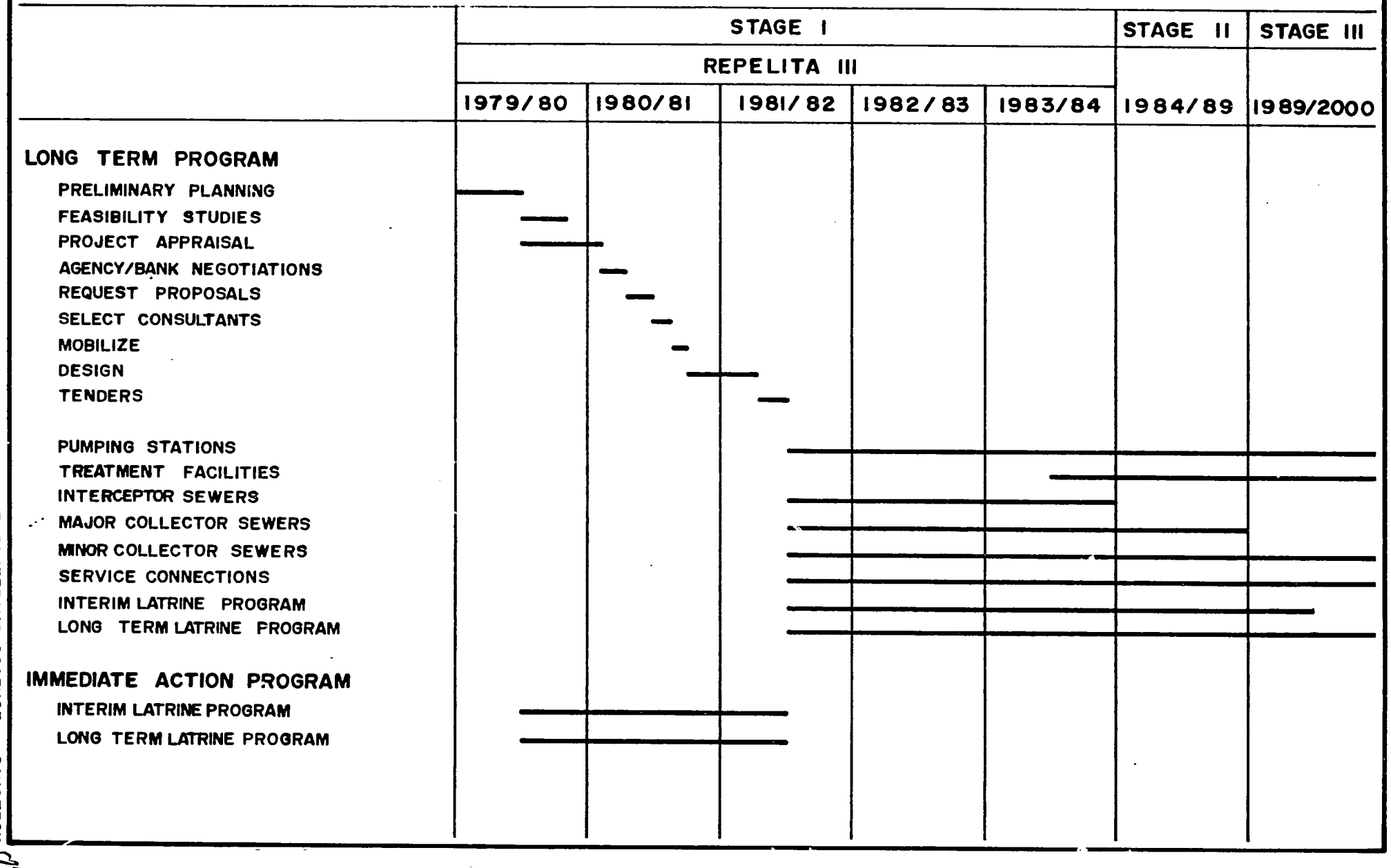

FIGURE 7.3

PADCO-DACREA

ENGINEERING-SCIENCE - SINOTECH

7.4 COSTS

The major unit components of the wastewater collection system are shown in Figures 7.1 and 7.2. The total estimated capital cost of each major phase of the program, including construction of collection and treatment facilities and the latrine improvement programs, is presented in Table 7.1. The estimated operation and maintenance costs for each component of the recommended system are presented in Table 7.2.

TABLE 7.1

ESTIMATED CAPITAL COSTS -
WASTEWATER MANAGEMENT SYSTEM Rp. (millions) CONSTANT 1979 PRICES

Item	Repelita III							Total
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000	1979/2000
Pumping Stations	-	-	8	16	16	8	8	56
Treatment Facilities	-	-	-	-	597	597	1,791	2,985
Interceptor Sewers	-	-	195	390	390	-	-	975
Major collectors sewers	-	-	35	71	71	354	-	531
Minor collector sewers	-	-	150	301	301	1,503	3,309	5,564
Service connections	-	-	58	116	116	581	1,279	2,150
Interim latrine program	-	-	8	17	17	83	83	208
	(8)	(17)	(8)	-	-	-	-	(33)
Long term latrine program			15	31	31	154	336	567
	(15)	(31)	(15)	-	-	-	-	(61)
Base Totals	-	-	469	942	1,539	3,280	6,806	13,036
	(23)	(48)	(23)	-	-	-	-	(94)
Engineering	-	-	45	89	149	304	639	1.226

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TABLE 7.1 --Continued

Item	Repelita III							Total
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000	1979/2000
Land	-	-	-	-	125	125	375	625
Contingencies	- (3)	- (7)	77 (3)	155 -	272 -	556 -	1,173 -	2,233 (13)
Totals	- (26)	- (55)	591 (26)	1,186 -	2,085 -	4,265 -	8,993 -	17,120 (107)

Note: ( ) indicates immediate action program expenditures

TABLE 7.2

ESTIMATED O & M COSTS - WASTEWATER MANAGEMENT SYSTEM Rp.(millions)
CONSTANT 1979 PRICES

Item	REPELITA III							Total
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000	1979/2000
Pumping Stations	-	-	0.2	0.5	0.8	4.5	10.5	16.5
Treatment facilities	-	-	-	-	11.9	89.6	489.5	591.0
Interceptor sewers	-	-	2.0	5.9	9.8	48.8	97.5	164.0
Major collector sewers	-	-	0.4	1.1	1.3	19.5	53.1	75.9
Minor collector sewers	-	-	1.5	4.5	7.5	82.7	407.5	503.7
Service connections	-	-	0.6	1.7	2.9	31.9	157.5	194.6
Totals	-	-	4.7	13.7	34.7	277.0	1,215.6	1,545.7

SECTION 8

ORGANIZATION AND FINANCE

8.1 EXISTING ORGANIZATION

At present there is no agency in Medan with responsibility for wastewater collection treatment and disposal. Related functions such as the septic tank clean-out service, the cleaning of drains which carry some sanitary sewage and most of the greywater, the installation of improved latrine facilities and the regulation of sanitation practices in housing and in commercial and public building construction are delegated to various agencies.

The absence of a program for wastewater management in Medan has resulted in many existing problems. The correction of these problems in addition to providing for the additional sanitation needs of a growing metropolitan region present a challenge which will require the efforts of an exceptionally strong organization of the required rate of progress is to be made.

8.2 RECOMMENDED ORGANIZATION

Several alternatives have been considered for the organization which will administer the wastewater program, as discussed below.

8.2.1 Local Enterprice

This alternative envisages the formation of a regional sewerage company similar to PAM Tirtanadi. A regional company could adopt management practices used in the private sector to attract and motivate qualified and able personnel and to help it operate on a self supporting basis.

Although the local enterprise would come under the control of regional government little difficulty is anticipated in assuring public support for the organization which would be readily identifiable by the public as a local organization serving only the needs of Medan.

8.2.2 Department of City Government

Under this alternative a separate sewerage department of the city administration would be established.

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The main advantage of integration within an existing organization is the possibility of utilizing existing organizational capacities for the new service. However, many of the required organizational characteristics are not available at the city level.

The ability to raise money to implement the program is of first importance. The city is dependant upon provincial and central government funding for much of its program of works. The general scarcity of funds results in budgeting shortfalls in most aspects of city administration. Existing municipal revenue collection practices are at present totally inadequate for the needs of a commercially oriented utility.

Municipal level public service employment conditions such as salaries, fringe benefits, scope of advancement and promotional practices based primarily on seniority are all factors which would make it difficult to attract personnel who could meet the requirements of the new organization.

8.2.3 Integration With Water Supply

The integrated operation of water supply and wastewater management systems is widely practiced. Together these systems provide for the management of water from source through treatment, delivery, use, collection treatment and return to natural waters.

The simultaneous development of both services is essential to avoid sanitation problems in urban areas where water use is high and, as in Medan and most other urban centers, where conventional private wastewater treatment disposal facilities can be applied with limited success.

Both systems have common management, planning, design, construction and operational elements which make it practical to integrate finance and administration activities, billing and collection, design and construction, and some operations and maintenance functions, as well as laboratory facilities.

Problems, however, may be encountered when integrating a new function into an existing organization such as providing additional office accommodation, disturbances to existing operations while staff members are being trained, and balancing new workloads and responsibilities. These problems are likely to be aggraveted when the water utility itself is adopting itself to the much larger scale of operations proposed during Repelita III.

8.2.4 Integration of Wastewater and Drainage

The integration of wastewater and drainage management systems are sometimes considered because of their many common technical elements and the use of combined sewerage systems in some urban areas. However, drainage management systems are not amenable to development as self supporting utilities with a rate structure and for this critical reason joint management with drainage is not recommended for Medan.

8.2.5 Summary

In view of the limited nature of the wastewater system proposed it is recommended that the city government undertake responsibility for its implementation initially. It is essential, however, that the short comings mentioned in 8.2.2 are overcome. A satisfactory method of charging must be introduced (see 8.3) and suitably qualitified personnel made available or recruited. The preferred organizational arrangement in the longer term, as the wastewater program expands and PAM Tirtanadi digests its own increased rate of development, is for intergration of the wastewater operations.

8.3 METHODS OF CHARGING

At present there is virtually no piped sewerage system provided in the city and no established method for paying for such a service. Under the wastewater management proposals, piped sewerage connections would commence in 1982 and charges would need to be introduced at the latest by that time.

There are several types of charges which are often used, either separately or in combination, for the provision of sewerage services, namely, taxes, flat rate fees, and surcharge on water bills.

8.3.1 Taxes

These can take many different forms. Where the metering of water supply is not in force, a tax based on property value is common. This form of charging has the disadvantage of not relating the amount paid to system usage; many properties with high rates of taxation would be responsible for only small amounts of wastewater. It can, however, be a useful method of collection from people who are not connected to the sewerage system but who benefit from the general environmental and sanitary improvements resulting from it.

Another form of tax is benefit tax. This recovers part, or all, of the cost of new investments from those properties which benefit directly from the new service and is usually based on property front footage. Often this will take the form of a special assessment against the properties adjacent to lateral sewers rather than a tax as such. The property owner thus pays directly for having a sewer in the street, to which he can connect his property if he so desires. The ability to connect is a convenience to the owner and is likely to add substantially to the value of his property. Also, assessments based on frontage probably reflect not only the actual cost of the sewer installed, but the owner's ability to pay. Recurrent costs are then recovered through a monthly charge based on water consumption.

8.3.2 Flat rate fees

This is often used in combination with a tax based on property value. The tax can be collected from all properties, whether sewered or not. An additional charge is then made on connected properties in

respect of the additional direct benefits which they receive. The charge may be varied in accordance with the number of water closets, sinks, bathrooms or a combination of such fixtures.

8.3.3 Surcharge on water bill

A surcharge on the water bill is probably the most equitable charging method when metering is used. A periodic payment is determined by metered water consumption, which may vary with usage blocks, sewage strength, property value or some other consumer related characteristic. This method of charging is based on recognition of the interdependence of water use and sewerage needs and has the advantage of apportioning costs according to demands placed upon the system, at least as long as the relationship between water use and sewage flows is constant across consumers.

8.3.4 Summary

A surcharge on the water bill is the preferred method of charging and should certainly be introduced when the water and wastewater operations are brought together in one organisation. As initially wastewater operations will remain under Medan municipality an alternative method of charging will be required at first. Although it would be feasible for PAM Tirtanadi to collect a wastewater surcharge and pass this on to the municipality on payment of a collection fee, this is likely to be unacceptable to Tirtanadi at the outset. The water authority is in the process of implementing a substantial tariff increase and will not want to aggravate possible collection difficulties by adding a wastewater surcharge. Later, when the new water rates are firmly established, this concern will diminish, but meanwhile an alternative charging method will be required.

It is recommended that the charging methods in 8.3.1 and 8.3.2 be adopted as an interim measure. In view of the limited number of connections during Repelita III and the high capital costs it will be necessary to maximise the tax element of the charge and minimise the direct charge on connected properties. This is discussed further in 10.4.

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SECTION 9

RECOMMENDED FIRST STAGE WASTEWATER PROJECT

9.1 GENERAL

At the present time Medan's wastewater management facilities consist of storm sewers serving a small part of the commercial area which receive sanitary wastes from some of the premises within their tributary area. In most other areas sanitary wastes are disposed of to septic tank systems or latrines. Separation of wastewater flows into grey water (sullage) and black water (toilet wastes) components is typical throughout areas served by septic tanks. Grey waters are discharged directly to existing stormwater drains.

Septic tank effluent is sometimes allowed to be discharged to stormwater drains by special permit but it is generally discharged to subsurface soil absorption systems. Soil conditions throughout the study area are generally unsuited for successful operation of subsurface disposal systems and septic tank effluent often finds its way either directly or indirectly to surface drains. A septic tank clean-out service is provided by the solid wastes management system but the collected septage is discharged directly to the Deli River at a point within the developed part of the city.

A significant proportion of the total population (about 12 percent) has access to neither household toilets, nor public latrines and has no option but to use streams, yards or other unsatisfactory methods for sanitary waste disposal. The resulting pollution in close proximity to living areas and of streams and ditches that enter the rivers of the study area constitutes both a nuisance and a serious health hazard to the residents of Medan.

Government policy for environmental sanitation is focused on areas which need urgent improvement including:

- areas inhabited by the lower income groups
- critical lands
- areas in which communicable diseases are prevalent
- kampung improvement programs and village housing improvement programs

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The implementation of environmental sanitation schemes is to be in balance with water supply schemes. Supporting requirements have been identified by Government to include:

- additional skilled personnel
- research on environmental technology
- environmental control, including the discharge of industrial of wastes
- the protection of water supplies and other water bodies
- regulations covering the construction of sewerage works and for economy of water use.

The Master Plan Studies have identified an optimum long term program for the improvement of wastewater management which was selected to meet sanitation objectives on the basis of public health benefits, program costs and financial constraints.

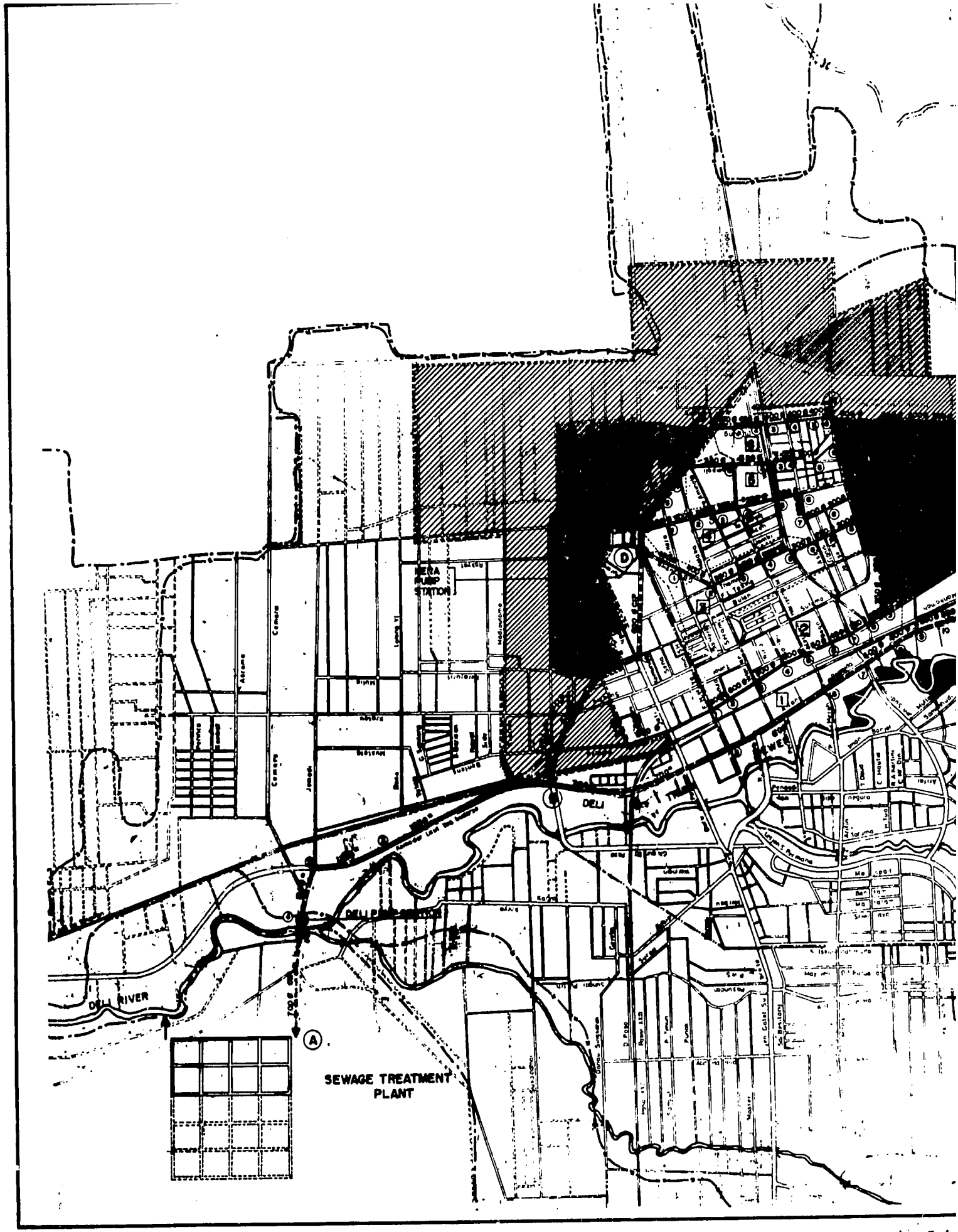
The strategy for improving wastewater management in Medan involves the implementation of a time phased program which envisages the improvement of present methods of disposal, rather than their immediate abandonment, in addition to the immediate implementation of the nucleus of a separate sanitary sewerage system to serve areas inhabited by low income groups and critical lands including high density central commercial areas.

The selected Master Plan program has the following elements:

1. A separate system of sanitary sewers and treatment facilities providing complete service to the area shown in Figure 9.1 by year 2000.
2. An interim latrine improvement program in the area where the sewerage system will be constructed, to relieve existing problems before the sewerage system becomes operational.
3. A long term latrine program to improve waste disposal facilities in medium and low density areas where it is not economically feasible to install sanitary sewers.
4. An MCK (a public sanitation unit incorporating clothes washing, bathing and toilet facilities) program for very high density areas where individual or family latrines are not practical because of space limitation.
5. A septic tank clean-out service.

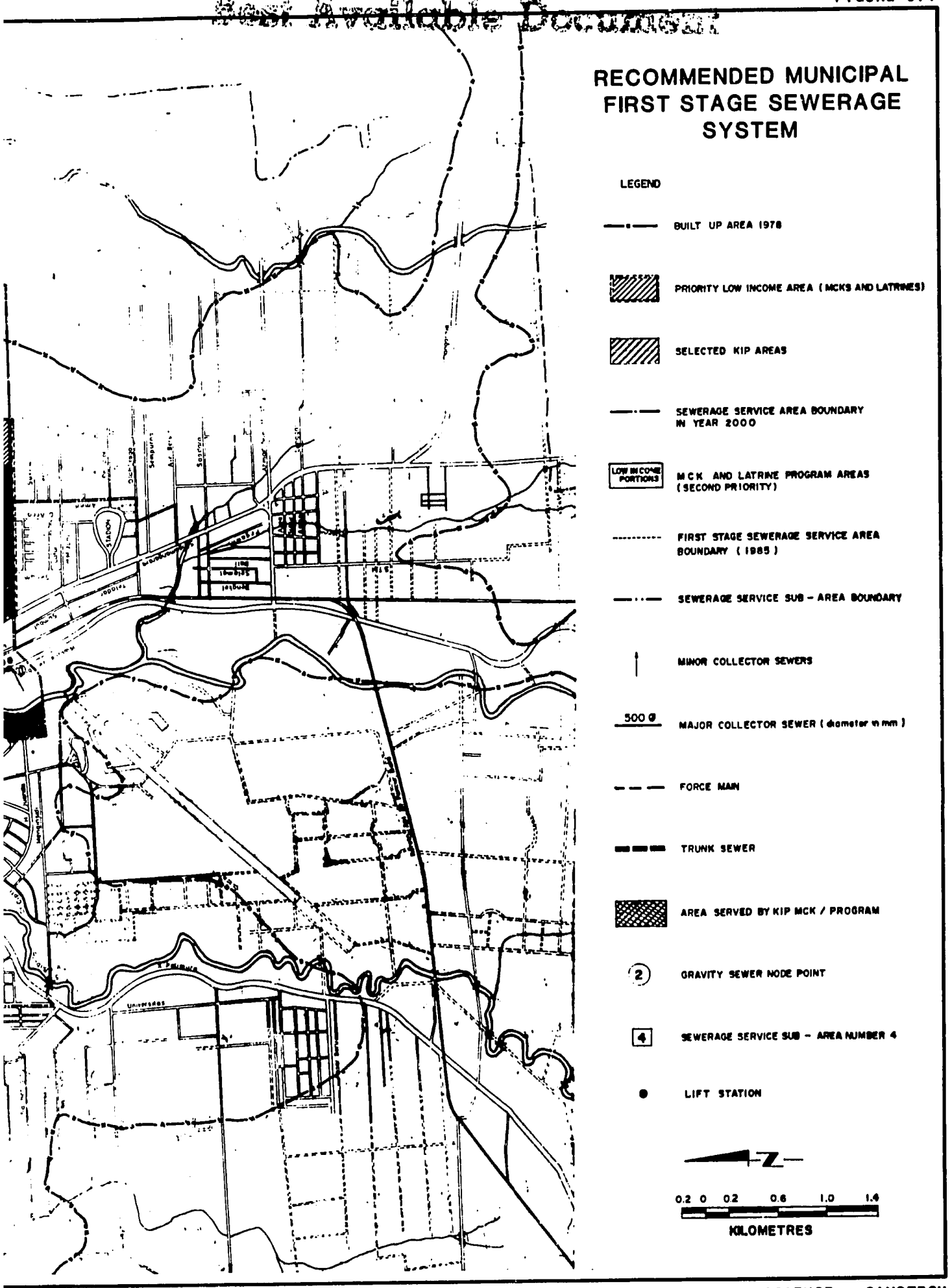
The major items of the recommended first stage sewerage improvement program are as follows:

1. Construct 36.85 km of collector sewers to serve 705 hectares of the central urban core area including high density low income areas.


DELI RIVER
SEWAGE TREATMENT PLANT
DELI
A
D

Best Available Document

FIGURE 9.1



ENGINEERING-SCIENCE - SINOTECH

2. Construct 9.85 km of trunk sewers, two sewage pump stations, and 2.05 km of force main to deliver wastewater to a waste stabilization ponds having a total surface area of about 50 hectares.

3. Provide 100 MCK's to serve high density, low income population in the study area.

4. Accelerate the existing private latrine improvement program from the present 1,000 water-seal latrine slabs per year to 5,000 per year.

5. Provide technical assistance for the development of local capabilities in the manufacture of vitrified clay sewer pipe, prestressed concrete pipe, and other precast concrete products required for construction of sewerage systems.

6. Provide technical assistance to develop appropriate organizational structure, standards, regulations, and staff capabilities to construct, operate, and maintain a municipal sewerage system.

Below further details of the first stage improvement project's elements noted above are presented and the financial feasibility of the first stage program is evaluated.

9.2 DESCRIPTION OF THE RECOMMENDED FIRST STAGE PROGRAM

9.2.1 Municipal Sewerage System

9.2.1.1 Collector Sewers

The general layout of the first stage sewage collection system is shown in Figure 9.1.

Wastewater collection systems must be designed to meet standards which will ensure that conditions which may shorten the service life or increase maintenance requirements of system components do not develop. Two of the most frequently encountered problems are pipeline corrosion caused by the generation of hydrogen sulfide, and the deposition of silt in pipelines and manholes.

The generation of hydrogen sulfide occurs when wastewater becomes anaerobic and sulfur compounds in sewage are transformed to sulfides by bacteria. Hydrogen sulfide gas is released from wastewater and is converted by bacteria to sulfuric acid on conduit surfaces in the air space above the wastewater surface. This can produce very rapid corrosion of concrete materials of manholes, at the pipe crown and other exposed surfaces. The offensive odor of hydrogen sulfide can create nuisance conditions near manholes and lift stations. Hydrogen sulfide is toxic even in relatively low concentrations, and can create extremely hazardous conditions for maintenance personnel who must enter manholes for inspection and repairs.

Sulfide generation is determined by wastewater composition and temperature, and by flow conditions. Sulfur compounds present in sewage originate in the water supply (mainly sulphates), and in domestic and industrial sources. Surcharging, low flow velocities, and long detention time in the sewers increase the probability that anarerobic conditions will develop.

The deposition of grit in pipelines and manholes may result if wastewater flow velocities are too low to keep heavy solids moving. Once grit has settled, much higher velocities are required to flush the lines than are required to prevent settling. If flow velocities are very low, organic solids may also settle out of the flow and form deposits. This is an extremely undesirable situation, as it generally causes rapid oxygen depletion in the wastewater and accelerates the rate of sulfide generation.

In order to eliminate conditions which many result in high sulfide levels or silt deposits, all local collectors and trunk mains were sized to carry their peak design flow without surcharging, and were designed with slopes not less than the minimum required to maintain a velocity of 0.6 m/s when the pipelines are flowing full. The minimum slopes for certain pipe sizes, based on an assumed Mannings "n" value of 0.015, are shown below. Pipeline alignments were chosen which would permit greater slopes whenever possible to provide higher flow velocities, and in some cases, permit the use of smaller conduits.

• Pipe size mm	150	200	250	300	400	600
• Slope m/m	0.0066	0.0045	0.0033	0.0026	0.0018	0.0010

The possibility of staging trunk sewers to minimize initial capital costs was reviewed with the conclusion that since the sewer sizes to meet year 2000 conditions are relatively small, significant savings would not result. Further, since the routes of major mains are generally along heavily travelled roads the major inconvenience of second period of construction should be avoided. Accordingly, trunk sewers have been sized to meet year 2000 system requirements.

The estimated wastewater quantities used in sizing the first stage pumping stations and treatment plant are summarized in Table 9.1. The total length of pipe of each size which will be installed in the first stage collection system, excluding service connections is indicated below:

Pipe Size	Length, mm	Material
150	15,800	PVC
200	9,440	lined ACP or VCP
250	1,330	"
300	1,370	"
350	1,780	"
400	1,590	"
450	1,070	"
500	520	"
600	1,400	"
600 force main	900	ACP
700 force main	1,150	CIP
Total Length	26,910	

TABLE 9.1

ESTIMATED WASTEWATER QUANTITIES
YEAR 1990

Item	Node	Tributary Area, ha	Average Flow cu m/d *
Deli Trunk Sewer	A	705	28,600
Kera Trunk Sewer	B	525	21,300
Major Collectors:			
1	B	180	7,300
2	C	173	7,000
3	D	81	3,300
4	E	71	2,900
5	F	54	2,200
6	G	60	2,400
7	H	86	3,500

* Including infiltration/inflow allowance.

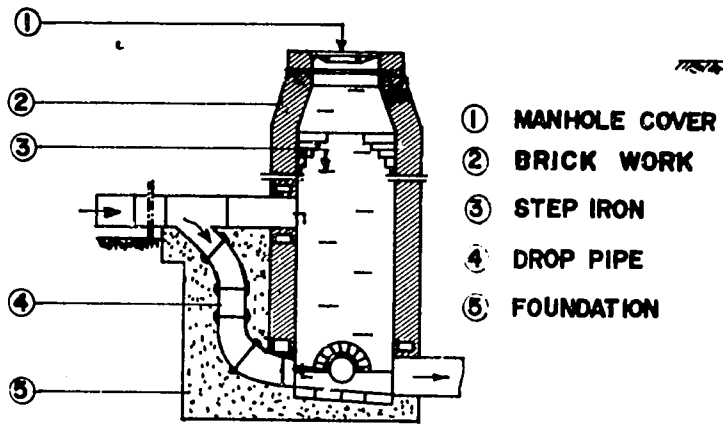
Manholes will be provided at regular intervals to permit inspection and cleaning of the wastewater collection system, and to allow periodic flow measurements to be made. The maximum spacing of manholes in sewer lines less than 1,200 mm in diameter should not exceed approximately 105 m.

Manholes should be provided at each bend, change in slope, and at junctions in the system. Manholes may be made of brick or concrete, depending upon the results of contract tendering. Brick and concrete manhole configurations on which cost estimates have been based for various conditions and pipe size, are illustrated in Figures 9.2 and 9.3 respectively. Estimated construction costs for brick and concrete manholes for the recommended major collector and trunk sewers are presented in Table 9.2. Subsequent capital cost summaries assume the use of brick manholes.

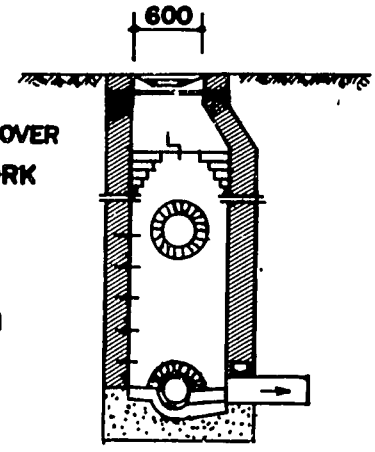
Five alternative pipe materials were considered for the Medan sewerage system: (1) concrete, (2) cast iron, (3) lined asbestos cement (AC), (4) polyvinyl chloride (PVC) and (5) vitrified clay (VC). Concrete, unlined AC, and PVC pipe are manufactured in the Jakarta area, but cast iron pipe is not made in Indonesia and VC pipe is not manufactured in the required sizes. Imported cast iron or VC pipe is prohibitively expensive, costing 2 to 3 times as much as locally made pipe.

FIGURE 9.2

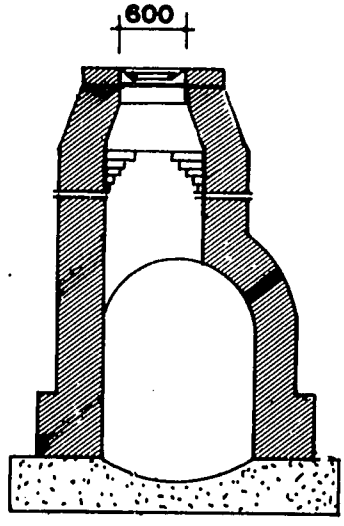
BRICK MANHOLES



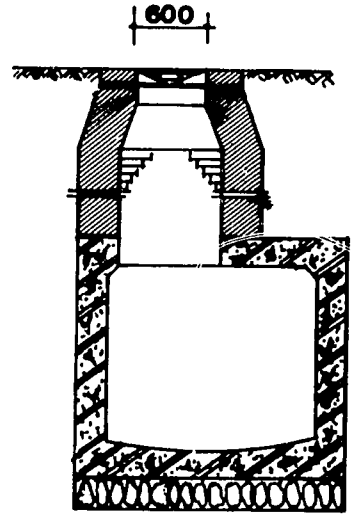
DROP MANHOLE



MANHOLE FOR PIPE

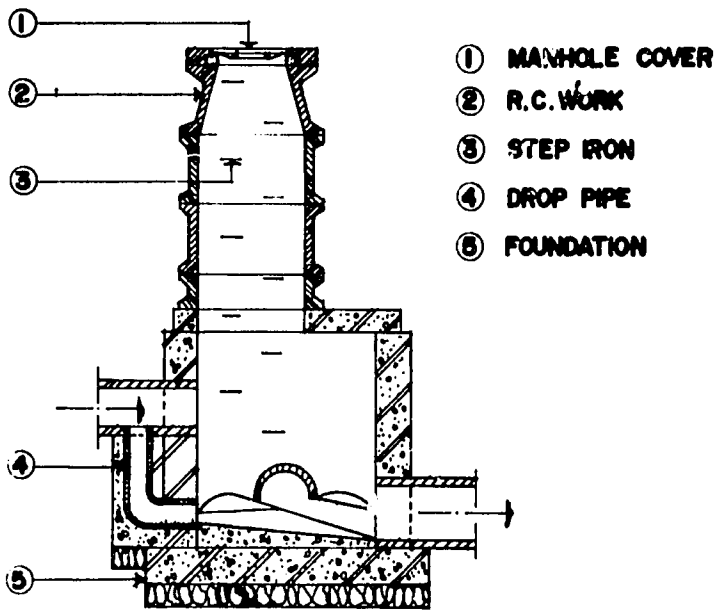


MANHOLE FOR BRICK ARCH SEWER

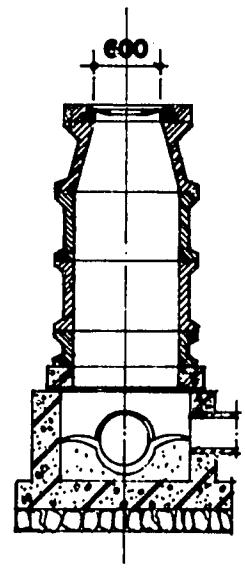


MANHOLE FOR CULVERT

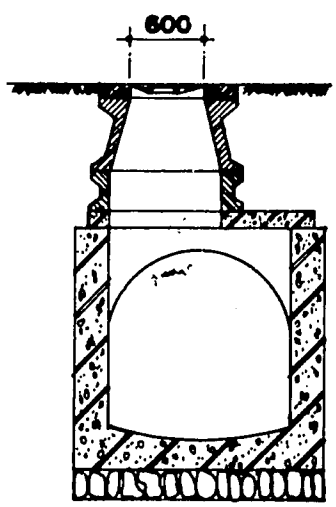
CONCRETE MANHOLES



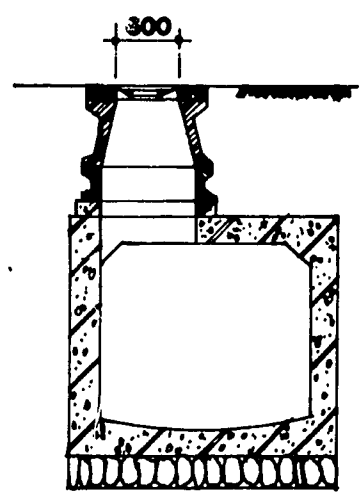
DROP MANHOLE



MANHOLE FOR PIPE



MANHOLE FOR BRICK ARCH SEWER



MANHOLE FOR CULVERT

TABLE 9.2

ESTIMATED MANHOLE CONSTRUCTION COSTS FOR TRUNK AND MAJOR COLLECTOR SEWERS

Item	Sewer Size, mm	Average Manhole Depth, m	Number of Manholes	Unit Manhole Cost, in 1000's of Rp		Estimated Cost, in 1000's of Rp	
				Brick	Concrete	Brick	Concrete
Deli Trunk Sewer	350 Ø	2.0	5	89.1	131.4	445.5	657.0
	400 Ø	1.0	5	60.2	90.8	301.0	454.0
	600 □	2.0	17	91.5	135.6	1,555.5	2,305.2
	700 □	2.6	5	106.7	162.2	533.5	811.0
	1200 □	1.9	9	52.4	245.9	471.6	2,213.1
	1200 □	1.5	3	48.3	226.6	144.9	679.8
Subtotal			44			3,452.0	7,120.1
Kera Trunk Sewer	600 Ø	1.0	3	62.0	95.0	186.0	285.0
	700 □	1.1	1	64.9	101.9	64.9	101.9
	700 □	1.5	3	93.3	125.9	279.9	377.7
	800 □	2.1	1	56.3	158.5	56.3	158.5
	900 □	1.1	2	43.9	115.9	87.8	231.8
	1000 □	1.9	1	52.4	182.9	52.4	182.9
Subtotal			11			727.3	1,337.8

TABLE 9.2 — Continued

Item	Sewer Size, mm	Average Manhole Depth, m	Number of Manholes	Unit Manhole Cost, in 1000's of Rp		Estimated Cost, in 1000's of Rp	
				Brick	Concrete	Brick	Concrete
Major Collector Sewer 2	200 Ø	1.6	4	75.1	100.5	300.4	402.0
	250 Ø	2.7	4	88.9	130.9	355.6	523.6
	350 Ø	1.8	8	79.0	106.1	632.0	848.8
	400 Ø	2.3	2	88.4	130.1	176.8	260.2
	450 Ø	1.6	2	81.1	109.3	162.2	218.6
	500 Ø	1.2	4	59.3	88.3	237.2	253.2
	600 Ø	1.0	10	60.2	79.6	602.0	796.0
Subtotal			34			2,466.2	3,402.4
Major Collector Sewer 3	200 Ø	1.2	3	55.7	79.9	167.1	239.7
	250 Ø	1.5	3	72.5	95.5	217.5	286.5
	300 Ø	1.4	5	61.0	89.8	305.0	449.0
	350 Ø	1.3	5	61.2	90.8	306.0	454.0
	400 Ø	1.1	3	57.8	85.2	173.4	255.6
	450 Ø	1.0	3	58.4	86.6	175.2	259.8
Subtotal			22			1,344.2	1,944.6

TABLE 9.2 — Continued

Item	Sewer Size, mm	Average Manhole Depth, m	Number of Manholes	Unit Manhole Cost, in 1000's of Rp		Estimated Cost, in 1000's of Rp	
				Brick	Concrete	Brick	Concrete
Major Collector Sewer 4	200 Ø	1.8	9	75.4	100.8	678.6	907.2
	250 Ø	2.2	6	84.5	123.5	507.0	741.0
	300 Ø	1.1	2	56.6	82.4	113.2	164.8
	350 Ø	1.0	2	57.2	83.8	114.4	167.6
	400 Ø	1.0	4	57.8	85.2	231.2	340.8
Subtotal			23			1,644.4	2,321.4
Major Collector Sewer 5	200 Ø	1.3	7	59.4	86.6	415.8	606.2
	250 Ø	1.3	1	60.0	88.0	60.0	88.0
	300 Ø	1.3	3	60.6	89.4	181.8	268.2
	350 Ø	1.1	5	57.2	83.8	286.0	419.0
Subtotal			16			943.6	1,381.4
Major Collector Sewer 6	750 □	1.0	3	62.0	95.0	186.0	285.0
	800 □	1.1	1	64.9	101.9	64.9	101.9
	850 □	1.5	3	93.3	125.9	279.9	377.7
	900 □	2.1	1	56.5	158.5	56.5	158.5
Subtotal			8			587.3	923.1

TABLE 9.2 — Continued

Item	Sewer Size, mm	Average Manhole Depth, m	Number of Manholes	Unit Manhole Cost, in 1000's of Rp		Estimated Cost, in 1000's of Rp	
				Brick	Concrete	Brick	Concrete
Major Collector Sewer 7	200 Ø	2.2	8	83.3	121.4	666.4	971.2
	200 Ø	1.2	3	55.7	79.9	167.1	239.7
	250 Ø	1.4	3	60.4	88.4	181.2	265.2
	300 Ø	1.2	4	56.9	82.7	227.6	330.8
Subtotal			18			1,242.3	1,806.9
Total			167			12,407.3	20,237.7

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High shipping costs for concrete pipe effectively remove this type of pipe from consideration until such time as a concrete pipe manufacturing capability has been developed near Medan. The potential for such a facility is discussed in Section 3.4. Concrete and AC pipe used in Medan will require a protective coating to control corrosion. The selection and application of coating materials will require detailed evaluation in the design stage.

Given the existing pipe manufacturing capability in Indonesia, the high cost of imported sewer pipes, and shipping costs from Jakarta to Medan, feasible options for sewer pipe reduce to the following:

1. PVC pipe (for under 200 mm diameter sewers) shipped from Jakarta.

2. Asbestos Cement pipe shipped from Jakarta and lined with protective coating on-site. Technical assistance to the contractor to obtain appropriate equipment and employ proper techniques in pipe coating procedures may be required for this option.

3. Develop a local capability to manufacture vitrified clay pipe. Technical assistance in obtaining equipment and training of staff would be required.

For the purposes of this investigation, sewerage system costs have been developed on the assumption that a combination of options 1 and 2 would be utilized. The costs presented herein for major collector sewers could be reduced somewhat if the option of developing local vitrified clay pipe manufacturing capabilities were to be pursued.

A summary of the estimated construction costs for major collector sewers is presented in Table 9.3.

An average of 32 metres of minor collector sewers per hectare of service area will be required. The minimum size of lateral sewers is 150 mm and the estimated cost of providing lateral sewers and lift stations is as follows:

Total service area size	705 ha
Total sewers	22,600 m
150 mm dia	15,800 m
200 mm dia	6,800 m
Cost	
150 mm @ Rp.8,000/m =	Rp. 126 million
200 mm @ Rp.11,000/m =	74
Manholes 215 @ Rp.91,500 =	20
Lift stations 2 @ Rp.30 million =	60
Total costs minor Collector system	Rp. 280 million

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TABLE 9.3

ESTIMATED CONSTRUCTION COSTS FOR MAJOR COLLECTOR SEWERS

Major Collector Sewer No.	Length, in m								Estimated Cost, in 100's of Rp.
	200 mm	250 mm	300 mm	350 mm	400 mm	450 mm	500 mm	600 mm	
2	300	300		650	180	240	520	1,900	193,000
3	200	190	470	450	350	350			53,000
4	650	530	220	200	430				39,000
5	570	60	300	480					26,000
6					630	480			40,000
7	950	250	380						22,000
Totals	2,670	1,330	1,370	1,780	1,590	1,070	520	1,900	373,000

9.2.1.2 Trunk Sewers

The location of Deli and Kera Trunk sewers A and B which carry wastewater to the treatment lagoons is shown in Figure 9.1. Details of the alignment, profile and size of these sewers are shown in Figures 9.4 and 9.5 respectively.

A summary of the gravity trunk sewer sizes and lengths to be constructed under the Stage I program is presented below:

Interceptor Size, in mm	Length, in m
350	550
400	520
600	2,760
700	1,370
800	200
900	1,150
1,000	300
1,200	3,000
Total Length	9,850

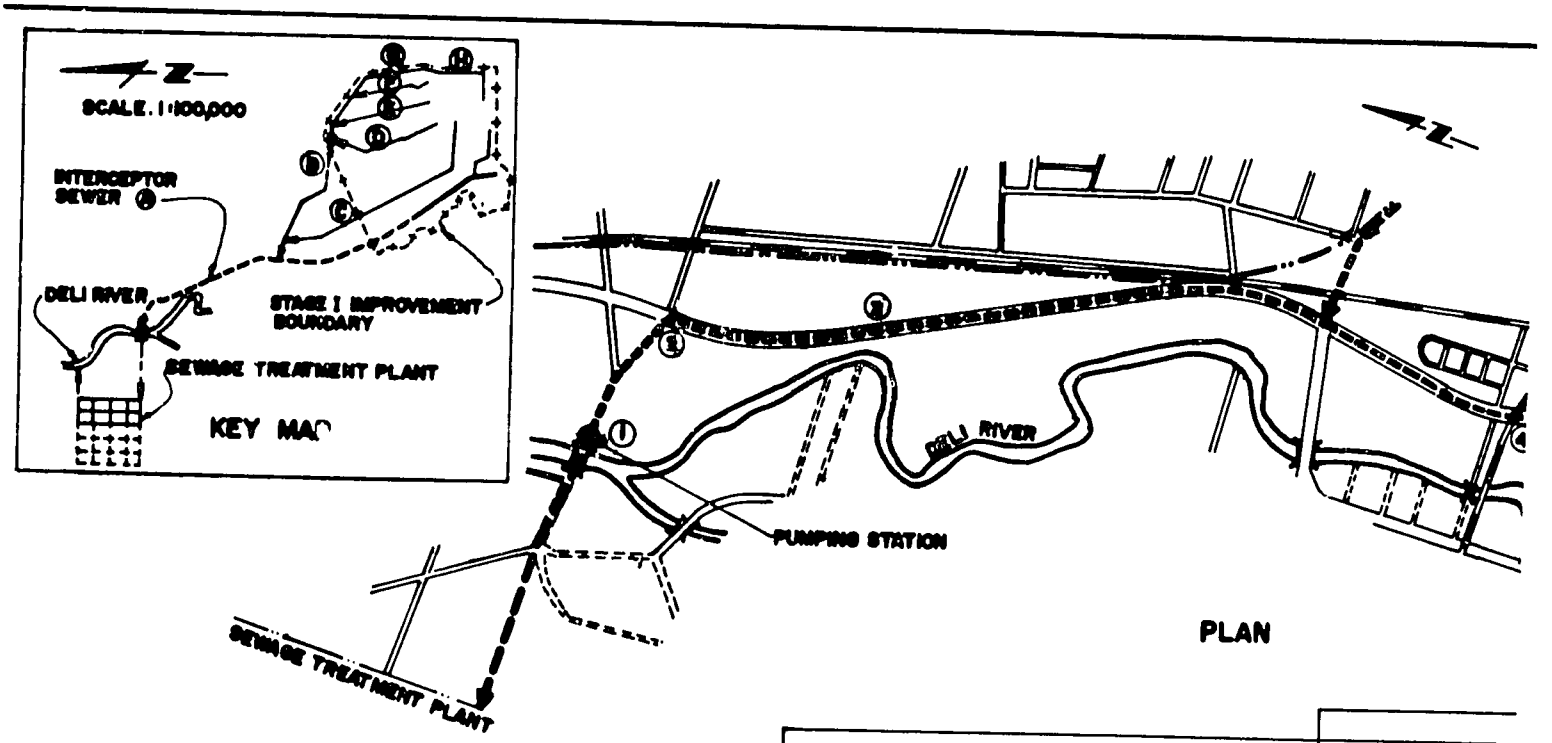
With the exception of a short length of pipe in the Deli trunk sewer, all gravity trunk sewers will be made of brick. Details of these brick arch sewers are presented in Figure 9.6 and Table 9.4. Acid resistant cement will be used to minimize the potential for corrosion problems. The trunk sewers were designed according to the same hydraulic criteria that were used to size collector sewers as described in Section 9.2.1.1. The estimated trunk sewer construction costs are presented in Table 9.5.

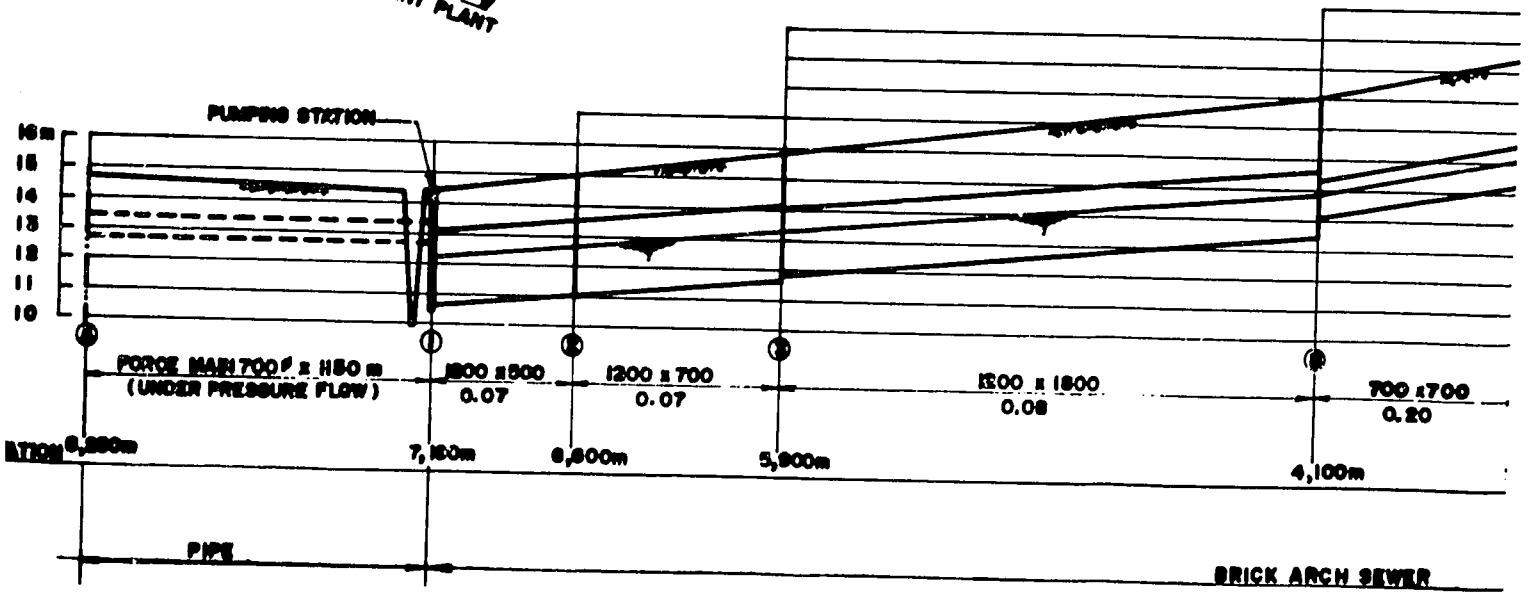
9.2.1.3 Pump Stations and Force Mains

Two large pump stations will be required to transport wastewater to the treatment site. One will pump the flows collected in the Kera basin into the Deli Basin and the other will pump the total wastewater flow from the east side of the Deli River to the treatment lagoons on the west side of the river. The locations of these stations are shown in Figure 9.1.

The Kera pump station was designed for an average flow of 21,300 cu m/d at 8.5 m TDH and a peak flow of 27,200 cu m/d at 10.5 m TDH in the year 1990. The station will be equipped with three 300 mm (discharge diameter) pumps, one of which will serve as a stand-by. Space will be provided for one additional 300 mm pump which will be required before the year 2000.

The Deli pump station was designed for an average flow of 28,600 cu m/d at 10.5 m TDH and a peak flow of 52,400 cu m/d at 13.0 m TDH by the year 1990. The station will be equipped with two 300 mm pumps and





Best Available Document

PROFILE

VERTICAL SCALE. 1:200

HORIZONTAL SCALE. 1:20,000

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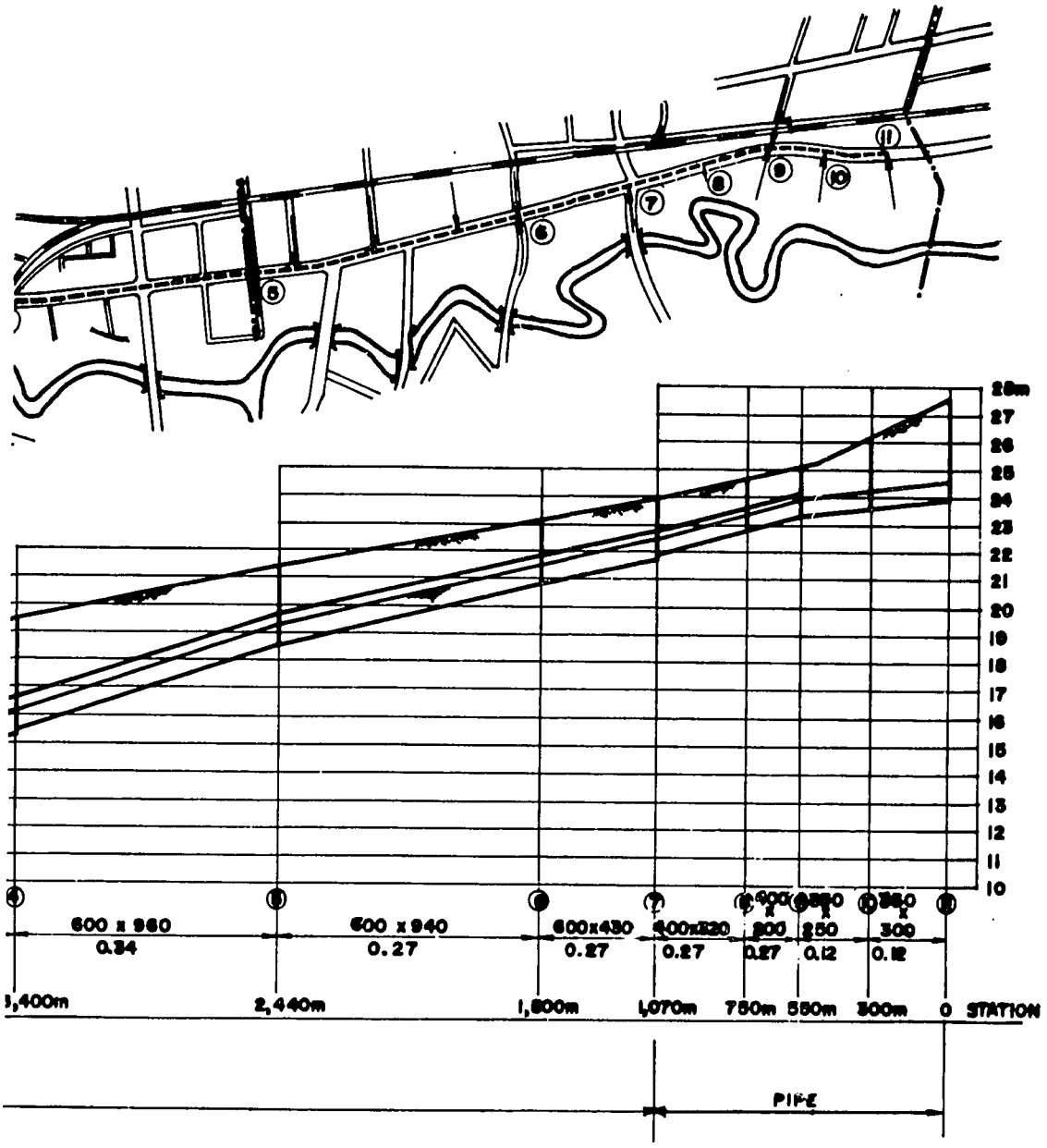
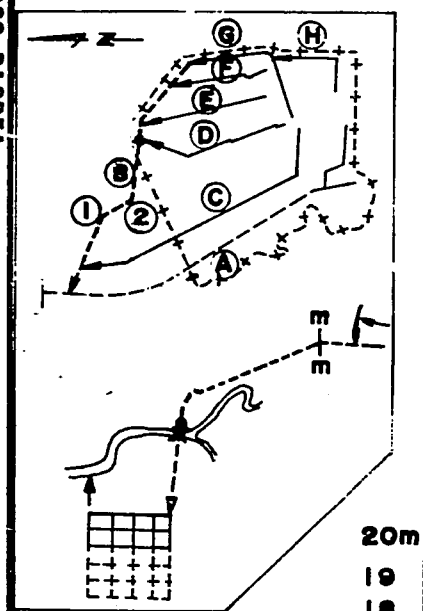
DELI TRUNK SEWER



LEGEND.

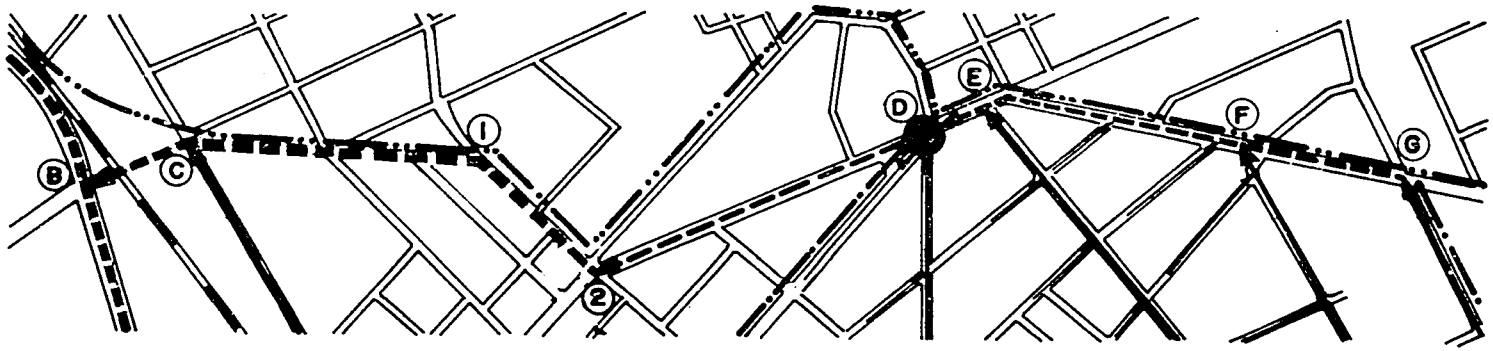
- : GROUND SURFACE
- 600ø : 600mm DIA PIPE
- 600▭ : 600mm x 600mm BRICK ARCH SEWER
- 0.27 : SEWER INVERT SLOPE IN PERCENT
- : SEWER
- : FORCE MAIN
- : PUMPING STATION
- (10) : SEWER NODE NUMBER, KEYED TO TABLE 3-1

Best Available Document

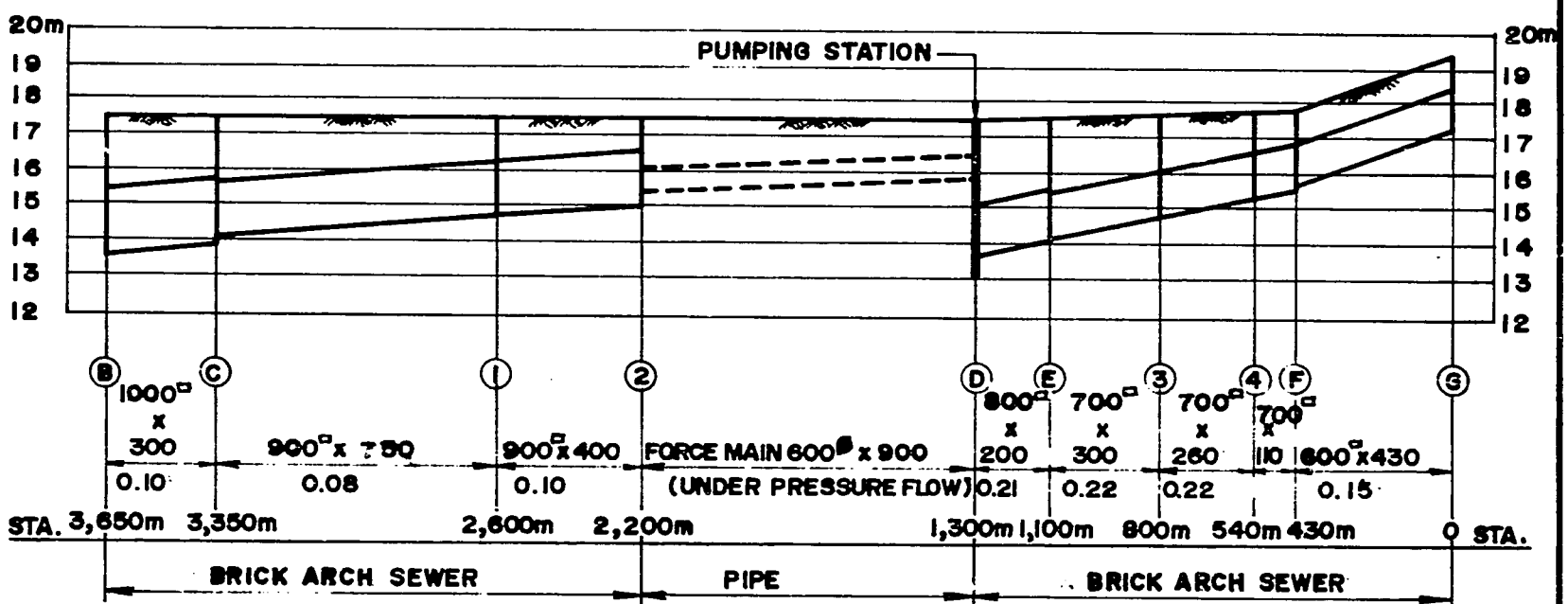


KEY MAP

SCALE. 1:100,000



PLAN



PROFILE

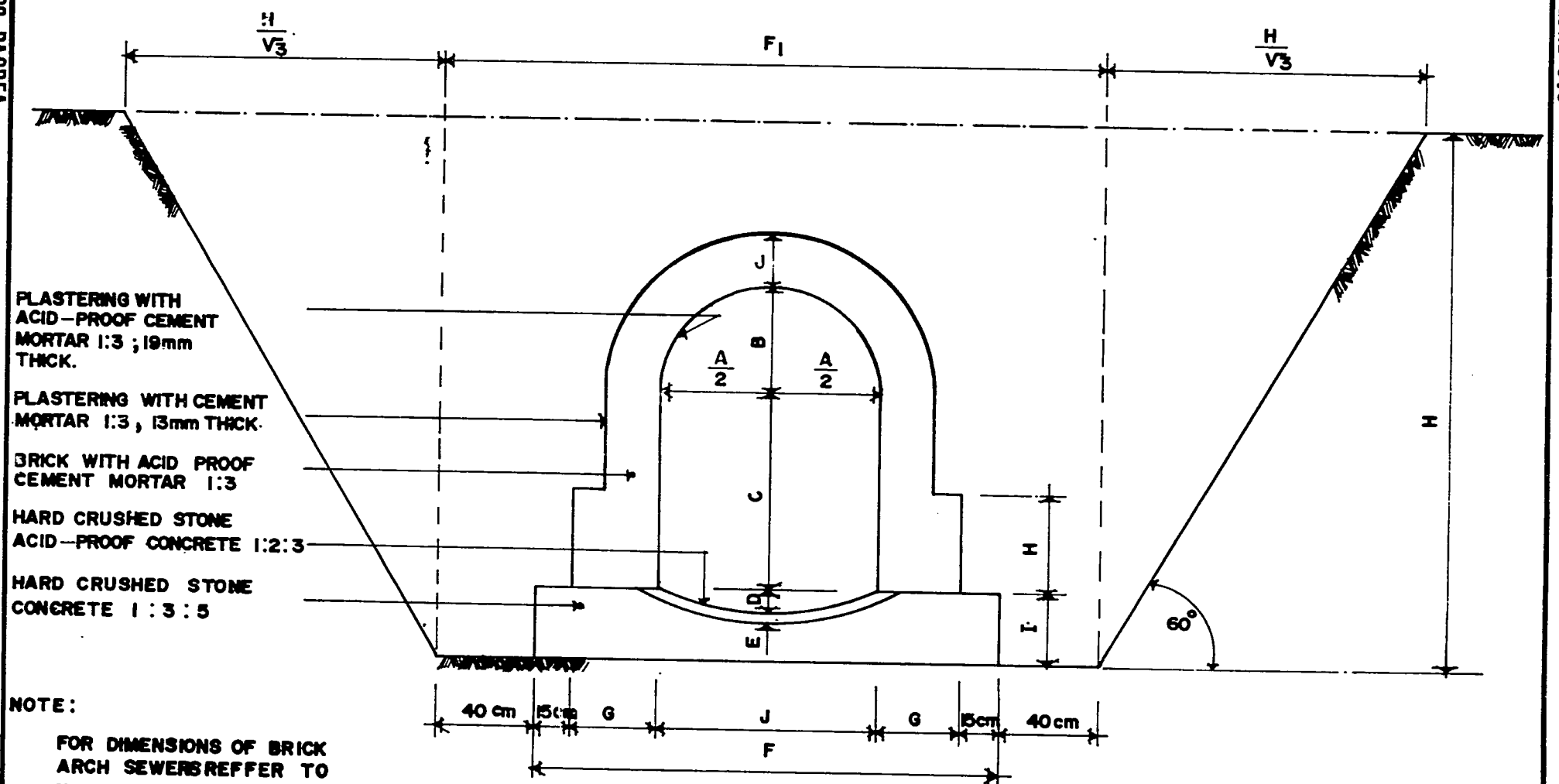
VERTICAL SCALE. 1:200

HORIZONTAL SCALE. 1:20,000

KERA TRUNK SEWER

(LEGEND SEE FIG. 3-4)

FIGURE 9.5



NOTE:

FOR DIMENSIONS OF BRICK ARCH SEWERS REFFER TO TABLE 3.4

TYPICAL CROSS SECTION - BRICK ARCH SEWERS

TABLE 9.4

DIMENSIONS OF BRICK ARCH SEWERS

Sewer Size, mm	Dimension, mm (keyed to Figure 3.6)									
	A	B	C	D	E	F	G	H	I	J
600 x 600	600	300	540	60	100	1,700	400	300	300	280
650 x 650	650	325	590	60	100	1,750	400	300	300	280
700 x 700	700	350	630	70	100	1,800	400	300	300	280
750 x 750	750	375	680	70	100	1,850	400	350	300	280
800 x 800	800	400	720	80	100	1,900	400	350	300	280
850 x 850	850	425	770	80	100	1,950	400	350	300	280
900 x 900	900	450	810	90	100	2,120	460	400	350	340
950 x 950	950	475	860	90	100	2,170	460	400	350	340
1,000 x 1,000	1,000	500	900	100	100	2,220	460	450	350	340
1,100 x 1,100	1,100	550	990	110	100	2,320	460	450	350	340
1,200 x 1,200	1,200	600	1,080	120	100	2,420	460	500	350	340
1,300 x 1,300	1,300	650	1,170	130	100	2,520	460	500	350	340
1,400 x 1,400	1,400	700	1,260	140	100	2,620	460	600	350	340
1,500 x 1,500	1,500	750	1,350	150	100	2,720	460	600	350	340
1,600 x 1,600	1,600	800	1,440	160	100	2,940	520	750	400	400
1,700 x 1,700	1,700	850	1,530	170	100	3,040	520	750	400	400
1,800 x 1,800	1,800	900	1,620	180	100	3,140	520	750	400	400
1,900 x 1,900	1,900	950	1,710	190	100	3,240	520	800	400	400
2,000 x 2,000	2,000	1,000	1,800	200	100	3,340	520	800	400	400

TABLE 9.5

ESTIMATED CONSTRUCTION COST OF TRUNK SEWERS

Item	Sewer Size mm	Length m	Unit Cost 1000's of Rp/m	Total Cost 1000's of Rp/m
Deli Trunk Sewer	350 Ø	550	31.2	17,160
	400 Ø	520	38.5	20,020
	600 □	2,330	48.9	113,937
	700 □	700	55.1	38,570
	1,200 □	3,000	93.6	280,800
	700 Ø (CIP)	1,150	208.0	239,200
Sub Total		8,250		709,687
Kera Trunk Sewer	600 Ø	430	48.9	21,027
	700 □	670	55.1	36,917
	800 □	200	62.0	12,400
	600 Ø (ACP)	900	93.6	84,240
	900 □	1,150	68.6	78,890
	1,000 □	300	76.9	23,070
Sub Total		3,650		256,544
Total		11,900		966,231

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one 500 mm pump. The 500 mm pump will serve as a stand-by. Space will be provided for one additional 500 mm pump which will be required before the year 2000. The two smaller pumps will also be replaced with 500 mm discharge pumps after 1990 to accommodate the expected increases in flow, and for this reason all suction and discharge piping will be initially sized for the large pumps. This will eliminate the need for replacement of expensive valves and fittings and will considerably shorten "down time" when the station is enlarged.

Both constant speed and variable speed pump control systems were evaluated for use in the Kera and Deli pump stations. Constant speed motors are less expensive and require less sophisticated controls than do variable speed drive systems. If constant speed motors are used, sufficient volume must be provided in the wet well to prevent rapid cycling of the pumps, which can damage the motors and controls. A maximum cycling time of 20 minutes between starts was established as a criteria for preliminary design.

Variable speed drive systems have in recent years become available at relatively low prices, and at the same time, the complexity of the controls has been reduced and their reliability improved. The use of variable speed drive systems greatly reduces the frequencies of pump cycling and therefore reduces the required wet well volume considerably.

A comparison of preliminary designs for each alternative indicated that the use of variable speed drives would reduce the required wet well volume by approximately 50 percent at both pumps stations. This would reduce the required excavation by approximately 20 percent and the amount of concrete by about 10 percent. Based on preliminary estimates, the construction cost savings would be greater than the additional cost of variable speed drive system. Smaller wet wells are also desirable from an operational standpoint in that the wastewater detention time is reduced, thus minimizing the possibility that the wastewater will become septic in the wet well and create odor problems. For these reasons, the use of variable speed pump control is recommended for both the Deli and Kera pump stations.

Preliminary drawings of the recommended design for the Deli and Kera pump stations are shown in Figures 9.7 and 9.8.

Force mains leaving the Deli and Kera pump stations were sized to provide a velocity of one metre per second at average daily flow in the year 1990. Peak flow velocities will be approximately two metres per second. Higher velocities can be achieved for short periods of time to flush the lines by operating all pumps manually including the stand-by unit. The force main leaving the Deli pump station will be 700 mm diameter, 1150 metres in length.

The Kera force main will be 600 mm diameter 900 metres in length. Both pump stations will require the construction of parallel force mains to accommodate increased flows after the year 1990.

Two small lift stations (average 2,600 cu m/d) will be required as indicated in Figure 9.1. A schematic design of a typical sewage lift station is shown in Figure 9.9.

The estimated cost of the two major sewage pumping stations is presented in Table 9.6.

TABLE 9.6

ESTIMATED CONSTRUCTION COSTS WASTEWATER PUMP STATIONS

Description	Cost of Deli Pump Station in 1,000's Rp	Cost of Kera Pump Station in 1,000's Rp
1. Civil Works	112,000	56,000
2. Pumps and Motors	112,000	53,000
3. Electrical & Controls	14,000	7,000
4. Pipes and Fittings	24,000	12,000
5. Gates and Bar Screens	2,000	2,000
Total	264,000	130,000

9.2.1.4 Treatment Lagoons

Wastewater treatment will be provided by a series of anaerobic and facultative lagoons which will be constructed in stages to accommodate increasing flows during the first stage project. Plan and elevation views of these lagoons as sized for the year 1990 flows are shown in Figure 9.10. Sizing lagoons is discussed in Appendix A.

Wastewater arriving at the treatment site will first flow through bar screens and grit removal channels to prevent coarse debris and heavy solids from entering the lagoons. Bar screens at the treatment plant will have narrower spacing between bars than those at the pump stations to provide more effective removal of rags and other non-degradable material.

Flow will then enter an anaerobic lagoon with approximately five days detention period. Wastewater will then pass through a series of three facultative lagoons, each with approximately six days detention time, before being discharged. This treatment process will provide 80 to 95 percent removal of BOD, 50 to 60 percent removal of suspended solids and a reduction in bacterial concentrations of over 99 percent. One series of lagoons will be constructed to treat wastewater flows up to the year 1987. At that time, a second series of lagoons will be constructed. These two sets of lagoons will operate in parallel, and will be adequate until the year 1990. Before the year 2000, three additional sets of lagoons will be required. Treated wastewater will be discharged

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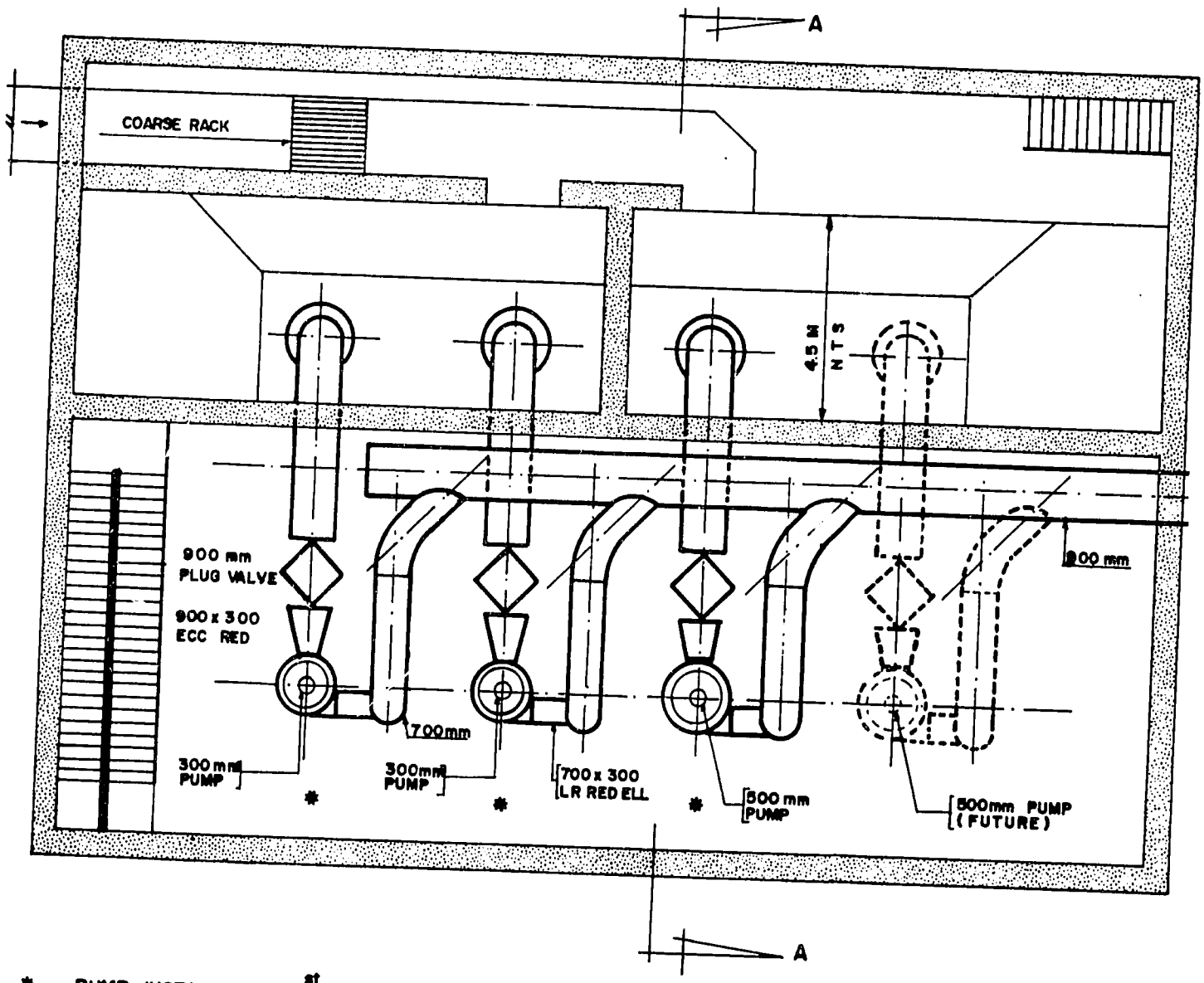
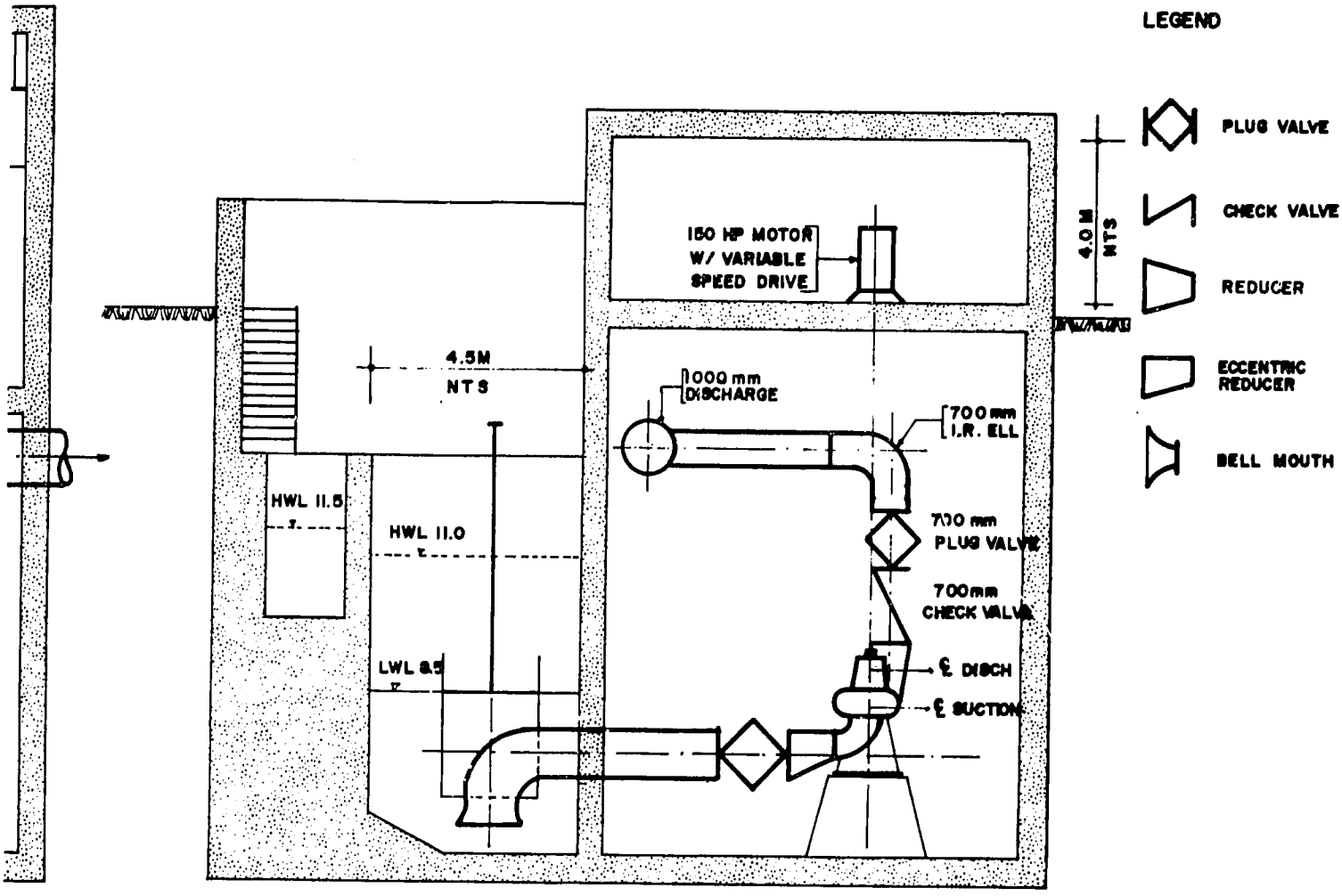


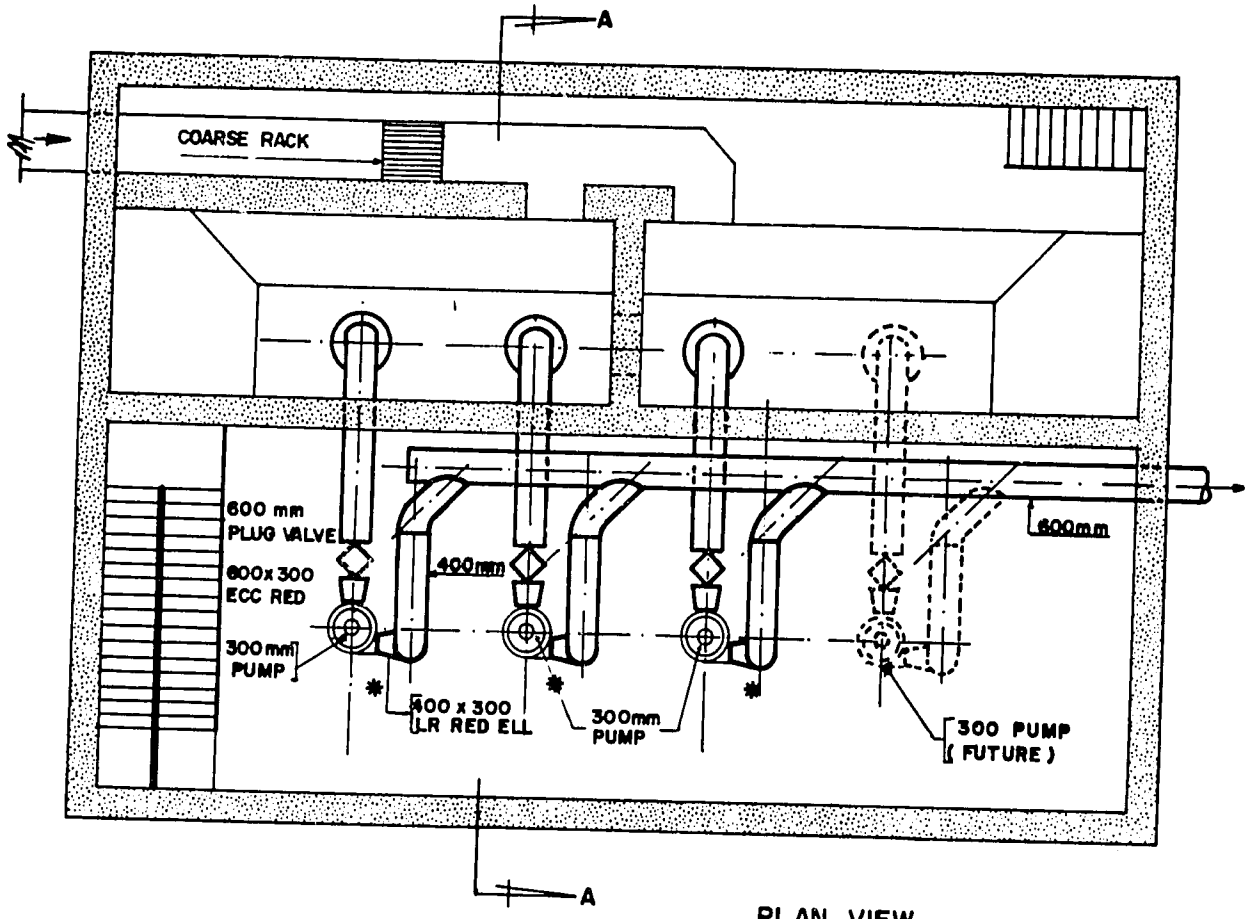
* PUMP INSTALLED IN 1st STAGE PROJECT

PLAN VIEW

DELI PUMP STATION



SECTION A - A

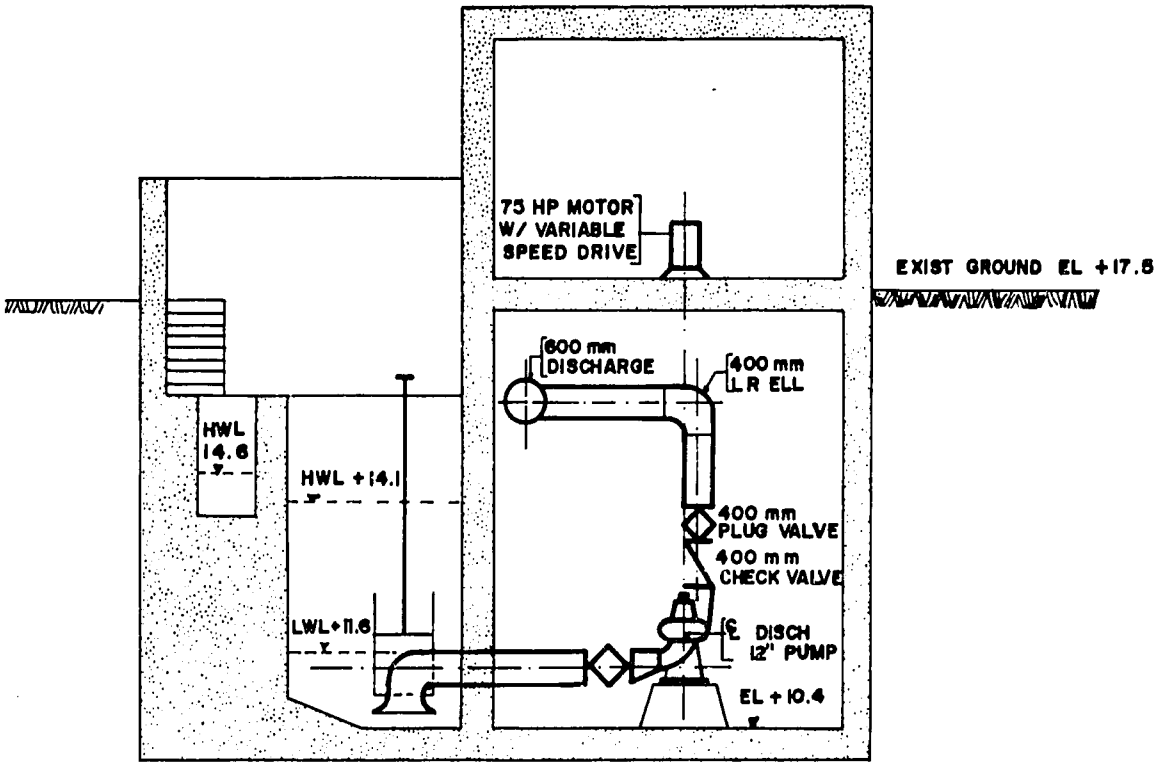


PLAN VIEW

* PUMPS INSTALLED IN 1st STAGE PROJECT

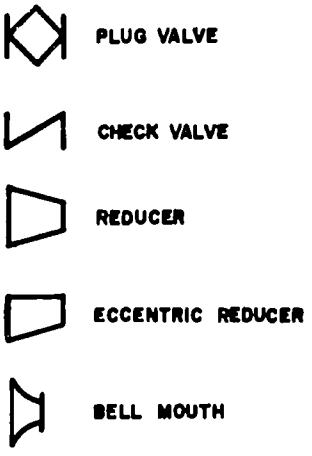
PADCO–DACREA

KERA PUMP STATION



SECTION A - A

LEGEND



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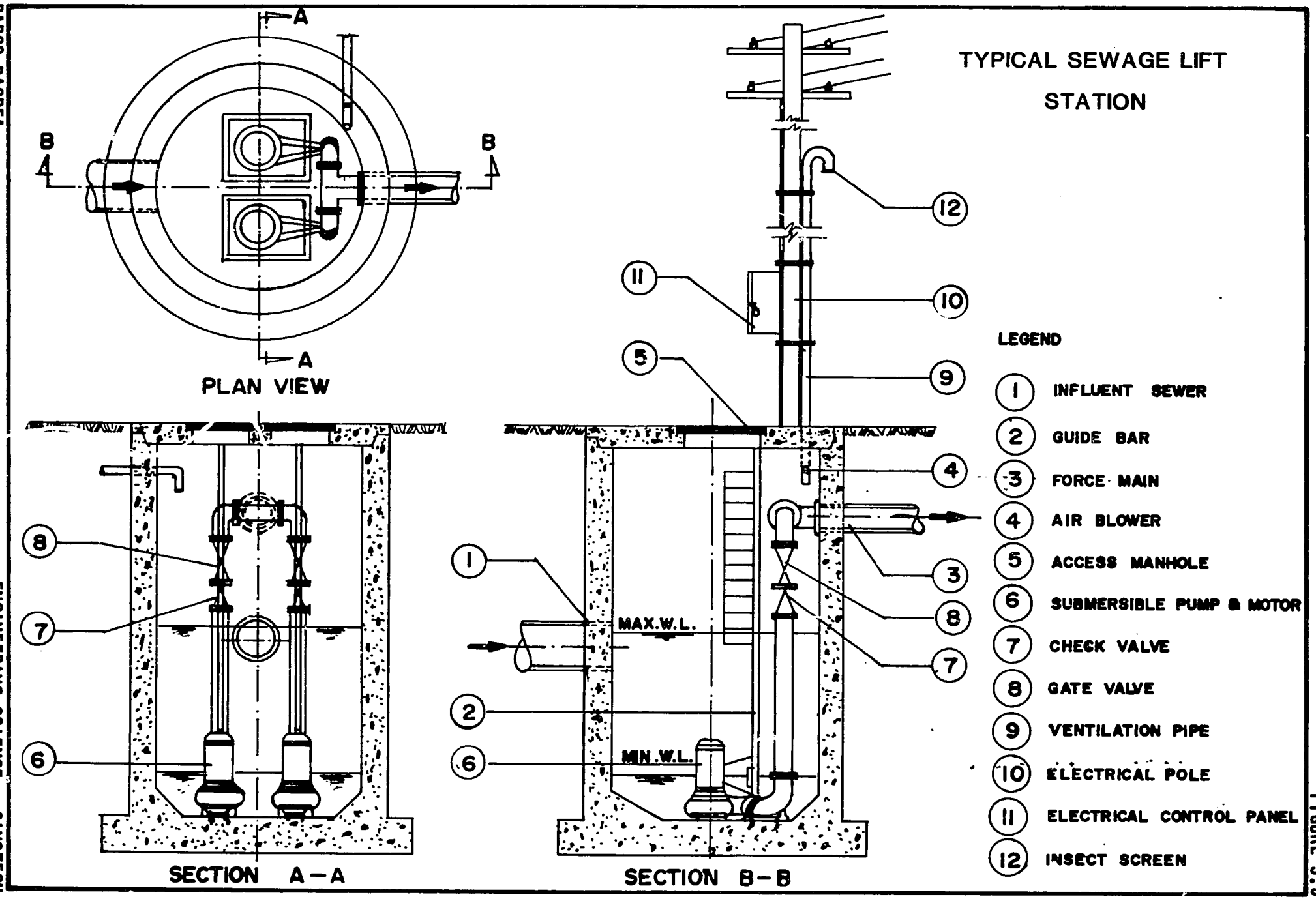

TYPICAL SEWAGE LIFT STATION
PLAN VIEW
A
B
SECTION A-A
SECTION B-B
MAX.W.L.
MIN.W.L.
LEGEND
1 INFLUENT SEWER
2 GUIDE BAR
3 FORCE MAIN
4 AIR BLOWER
5 ACCESS MANHOLE
6 SUBMERSIBLE PUMP & MOTOR
7 CHECK VALVE
8 GATE VALVE
9 VENTILATION PIPE
10 ELECTRICAL POLE
11 ELECTRICAL CONTROL PANEL
12 INSECT SCREEN

FIGURE 9.9

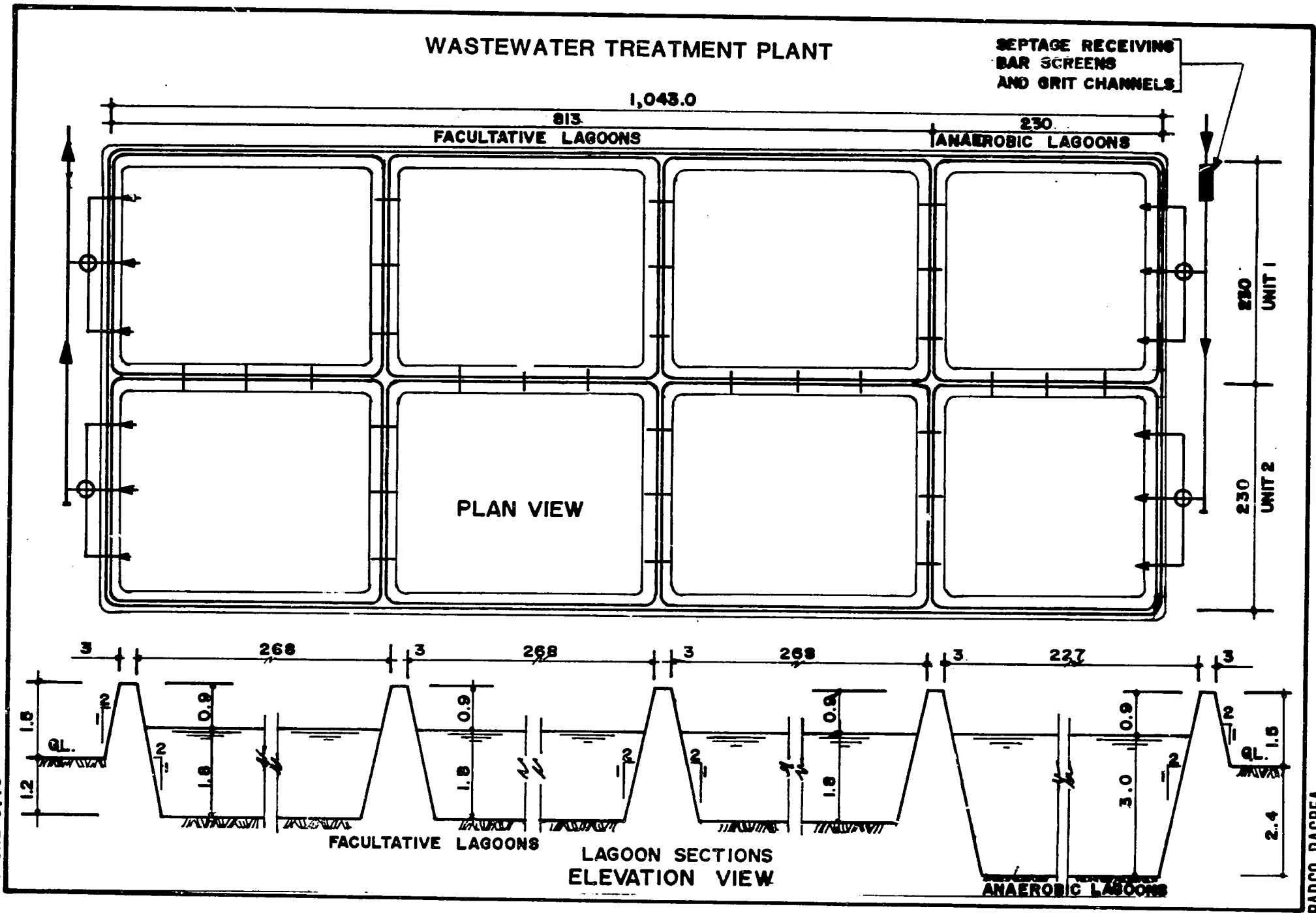


FIGURE 9.10

ENGINEERING-SCIENCE - SINOTECH

PADCO-DACREA

to the Deli River by a single gravity outfall. The estimated cost of the first stage wastewater treatment facilities is presented in Table 9.7.

TABLE 9.7

ESTIMATED CONSTRUCTION COST OF SEWAGE TREATMENT PLANT

Item	Estimated Cost, in millions of Rp
1. Pond Construction	187
2. Embankment Protection	26
3. Bar Screen, Grit Chamber	20
4. Inlet and Outlet Chambers	1
5. Plant Yard Piping	33
6. Effluent Channel and Outlet Structure	7
7. Operators' Shelter	17
Total	291

9.2.1.5 Service Connections

Details of a typical household service connection are showed in Figure 9.11. All service connections will be made of PVC or VC pipe, and each residence will have an individual connection to the collection system. The estimated cost of a typical household sewer service connection is given in Table 9.8. A total of 9,700 service connections are proposed for the Repelita III period to 1983/84.

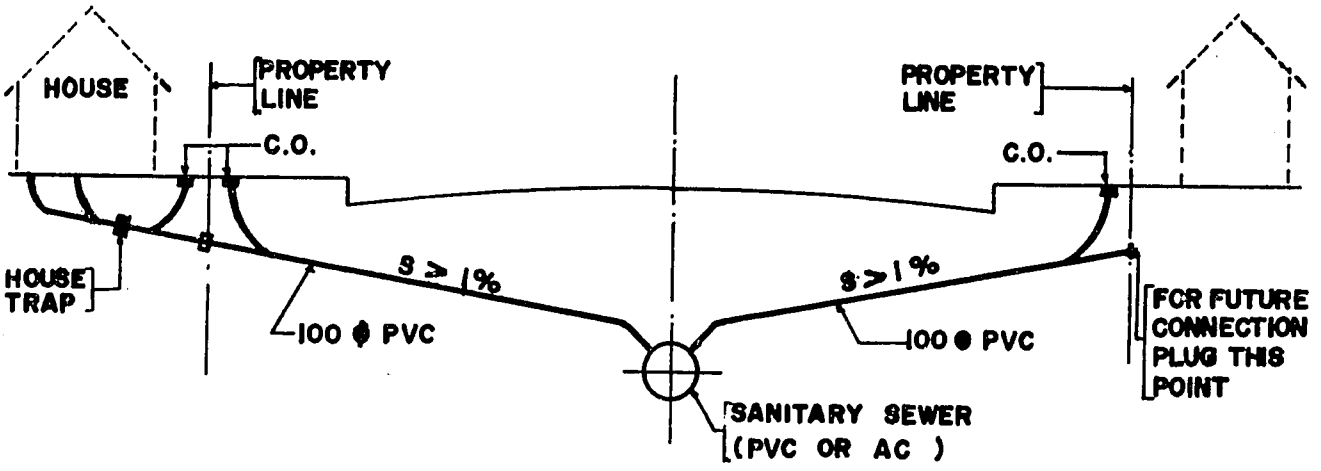
TABLE 9.8

ESTIMATED UNIT COST OF SERVICE CONNECTION

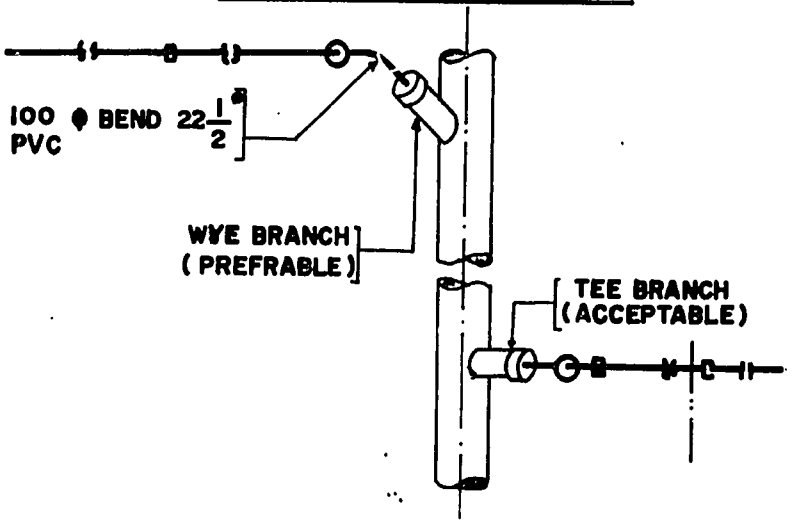
Item	Estimated Cost, in Rp
1. Clean Out	3,000
2. 4" Connection Pipe (PVC or VC) x 8 m	36,000
3. T or Y Branches	12,000
4. Miscellaneous	14,000
Total	65,000

FIGURE 9.11

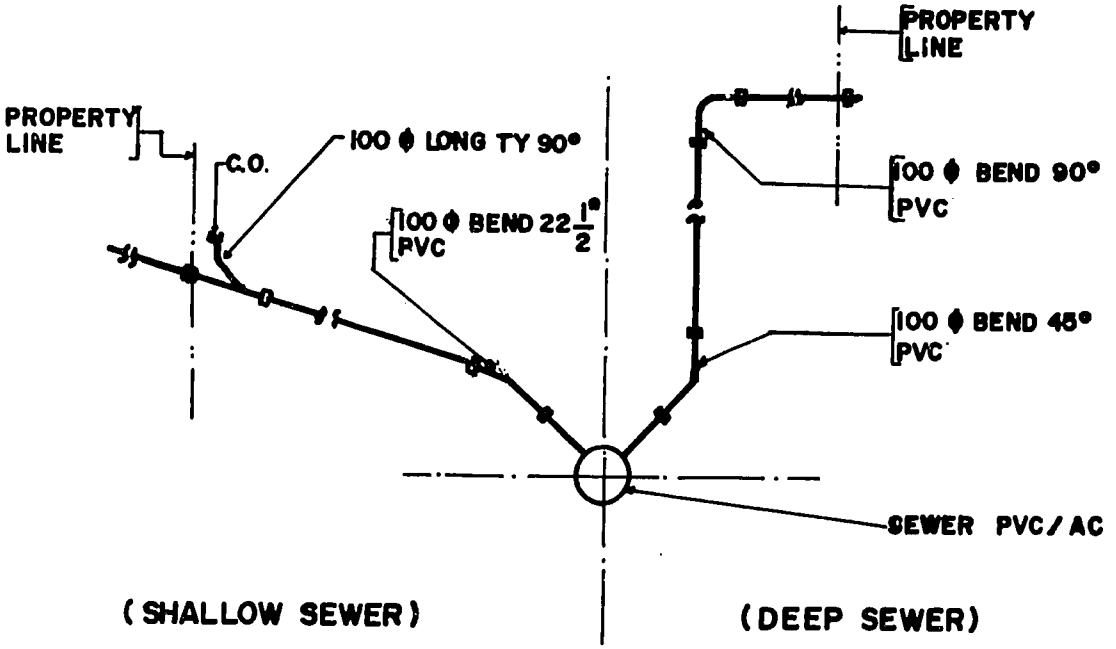
TYPICAL SERVICE CONNECTION



TYPICAL CROSS - SECTION



PLAN



ELEVATION

9.2.2 MCK and Private Latrine Program

A major goal of this first stage project will be to provide service in low income high population density areas where the need for improved sanitary facilities is greatest. In some of these areas, however, it will not be possible to provide individual household connections during the first stage project. In addition, the first stage project is intended to provide service to only a small percentage of the residents of Medan.

Additional programs are needed to improve sanitary facilities for people who live outside the boundaries of the first stage wastewater collection system or who live within the service area but cannot be provided with individual connections.

It is recommended that programs to improve private latrine and to provide MCK's where private latrines cannot be provided be implemented as part of this first stage project. These recommended programs are described below.

9.2.2.1 MCK Program

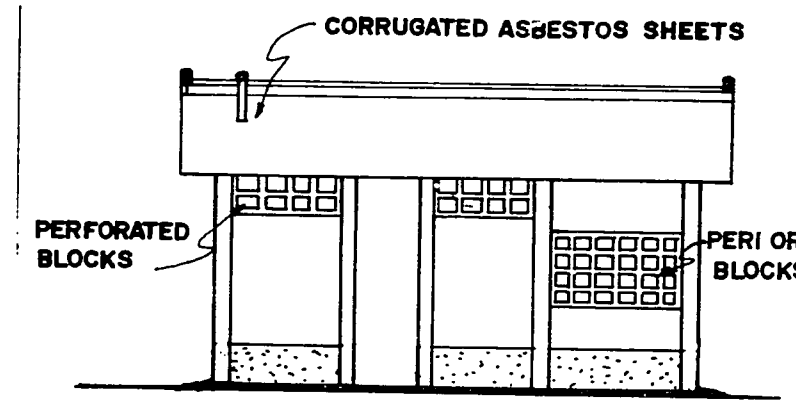
There are certain areas of Medan where very high population density has dictated that almost all of the available land be used for housing. In many of these areas there is simply not enough land to permit each family to have an individual pit latrine. In some cases public latrines have been provided, but the success of public latrines has been mixed, primarily due to problems involved with maintenance and replacement.

It is recommended that a program be established to provide MCK's in these high density areas where it is not feasible to provide individual family latrines. Areas which should be served by the MCK program are shown in Figure 9.1. Based on planning surveys and experience with previous MCK programs, it was determined that the goal of the Medan program should be to provide two four-unit MCK's per hectare. At a population density of 475 persons per hectare in the MCK service area each MCK will serve 240 persons within a 25-30 metre walking distance. Based on these criteria, it was estimated that 29 MCK's should be provided during the first stage KIP project and a further 71, totalling 100,in other high priority areas.

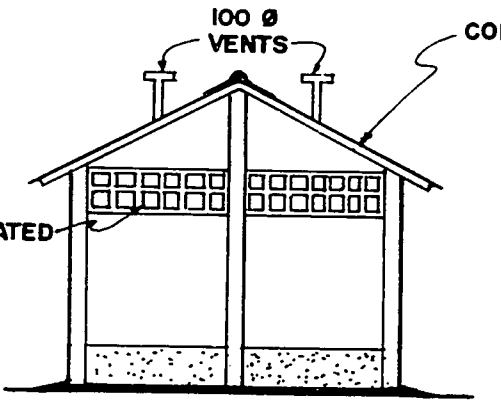
The recommended MCK design is shown in Figure 9.12. Wastewater from the MCK's will be disposed of in one of three ways.

1. If the MCK is within the wastewater collection system, a direct gravity connection to the system should be made.

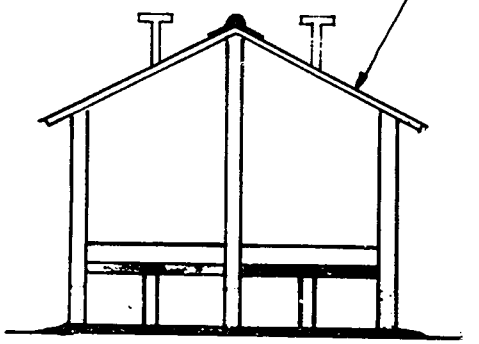
2. If the MCK is within or near the collection system but in a location which does not permit a gravity connection, black water will be held in a concrete sump and pumped to the nearest collector sewer. These pumps will be operated manually, and stand-by units provided.



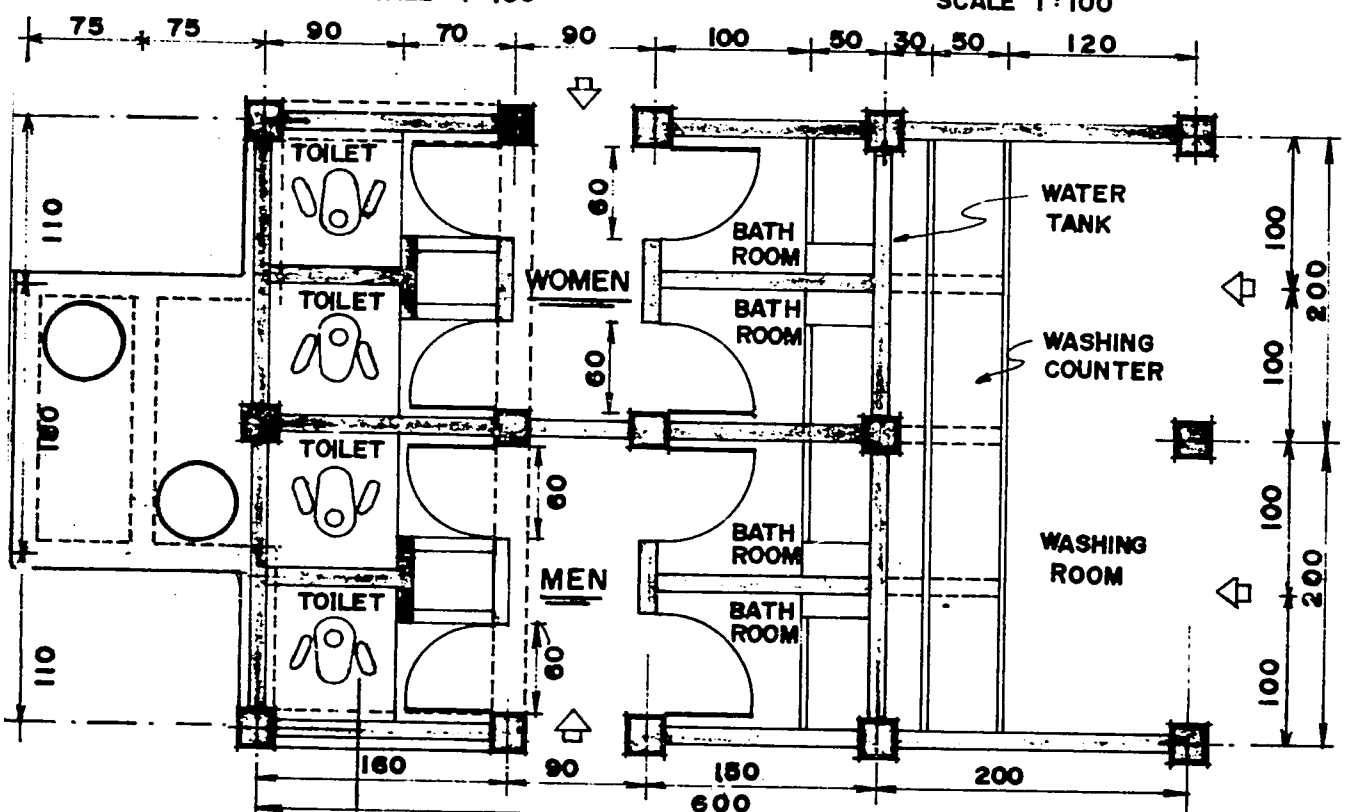
FRONT ELEVATION
SCALE 1 : 100



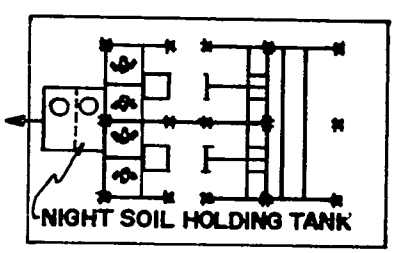
LEFT ELEVATION
SCALE 1 : 100



RIGHT ELEVATION
SCALE 1 : 100



PLAN SCALE 1 : 50



KEY PLAN

TYPICAL 4 - UNIT MCK

NOTE
- ALL DIMENSIONS SHOWN ARE IN CENTIMETRES UNLESS OTHERWISE INDICATED

FIGURE 9.12

3. In locations where it is not possible to connect directly to the wastewater collection system or to pump directly to it MCK's will be provided with a concrete sump to collect and hold black water until it can be removed by a tank trunk. These trucks will discharge the waste to the sewage treatment plant.

4. In areas where none of the foregoing disposal options are available,MCK's of the aqua privy type, with partially treated effluent dischargedto a drain or river, can be considered.

The estimated unit cost for a typical MCK is presented in Table 9.9.

TABLE 9.9

ESTIMATED UNIT COST OF MCK

Item	Cost, in 1000's of Rupiah
1. Preparatory works	15
2. Site work including foundation	175
3. Masonry (brick and concrete with or without reinforcing)	386
4. Carpentry	140
5. Roofing	124
6. Finishing	250
7. Sanitation	160
Total	1,250

9.2.2.2 Private Latrines

The Government of Indonesia has implemented a program to provide water sealed latrine slabs to improve sanitation in areas where open pit latrines are widely used. During Repelita II approximately 1,000 water sealed slabs were provided per year in Medan. Many of these slabs were installed in rural and semi-rural areas.

This latrine improvement program should be continued during Repelita III and IV with two significant changes. First, the number of slabs produced per year should be increased from 1,000 to 5,000, second, emphasis should be placed on providing the slabs to residents of urbanized

areas of Medan rather than more rural areas where sanitation problems are generally less severe. The design of a typical private latrine facility is shown in Figure 9.13.

Based on existing levels of sanitary service, the recommended implementation schedule of the wastewater collection system, and the projected population of the study area, it is estimated that 780,000 people will require private latrine improvement by the year 2000. Assuming on average household consists of 8 persons, approximately 98,000 additional water seal slabs will be required by the year 2000 to achieve satisfactory coverage. Low income areas of Medan should be given the highest priority for the delivery of slabs throughout the first stage project.

The design of the water seal latrine slabs themselves is quite simple and they can be constructed without highly specialized equipment. Slabs are normally cast as a single unit, which weighs in excess of 50 kg. This makes handling the slabs rather difficult. It is therefore suggested that slabs be cast in three pieces, as shown in Figure 9.14. These sections can be transported more easily than a one piece slab and can be grouted together to form a single unit when installed. It is also recommended that the practice of using bamboo to reinforce the slabs, which has been reported occasionally,be discontinued. Only steel reinforcing should be used as shown in Figure 9.15.

The estimated unit cost of a private latrine facility is presented in Table 9.10.

TABLE 9.10

ESTIMATED COST OF WATER SEALED LATRINE

Item	Estimated Cost, in Rp
Bamboo Matting Pit (80 cm Ø x 300 cm)	2,500
*R. C. Floor (1.1 m x 1.1 m x 0.06 m) = 0.07	3,500
Brick Works 1 (1.4 m x 1.4 m) - (0.8^2 x 0.785) x 0.35 = 0.51^3	9,200
*Water Sealed Toilet Bowl	2,500
Vent Pipe (PVC) and Fitting	5,000
Sand fill	800
Miscellaneous	5,600
Total	29,100

* Included in wastewater program.

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TYPICAL PRIVATE LATRINE

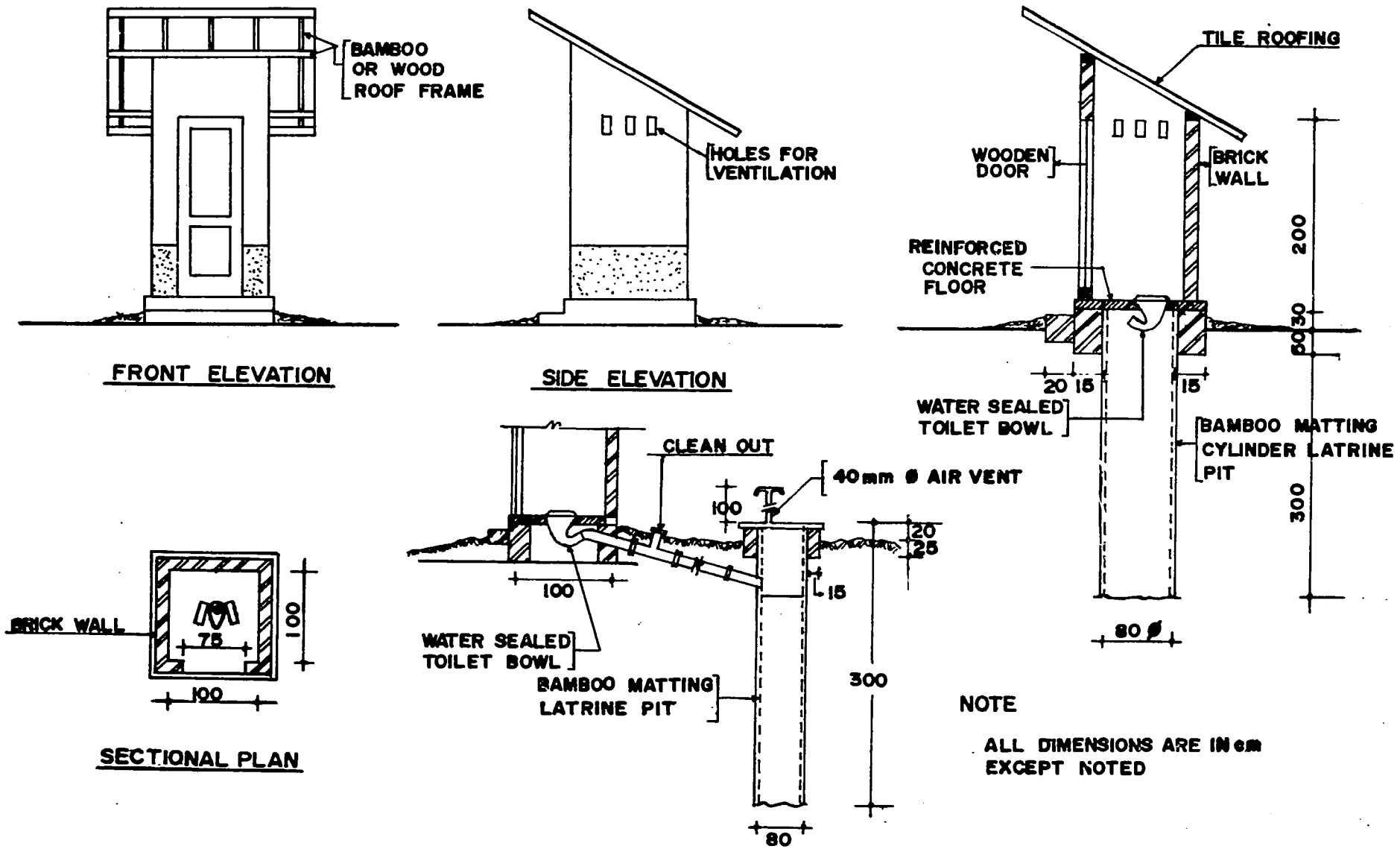
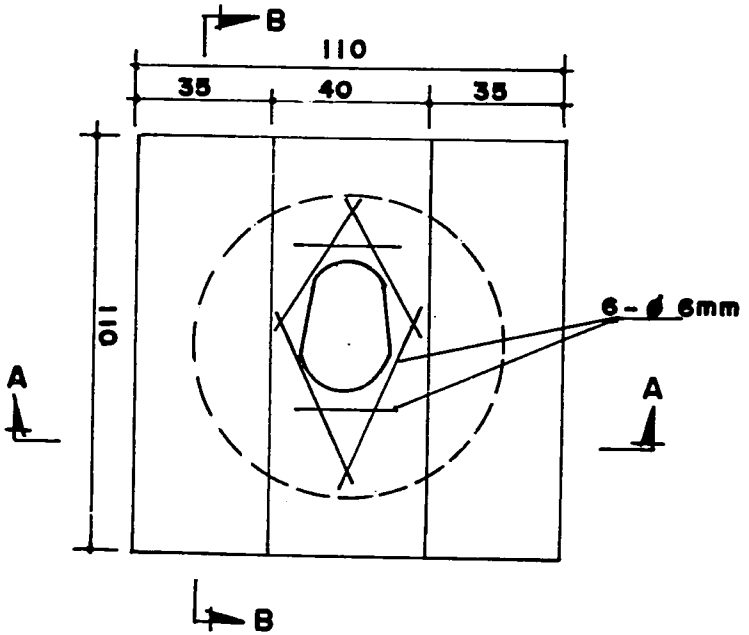
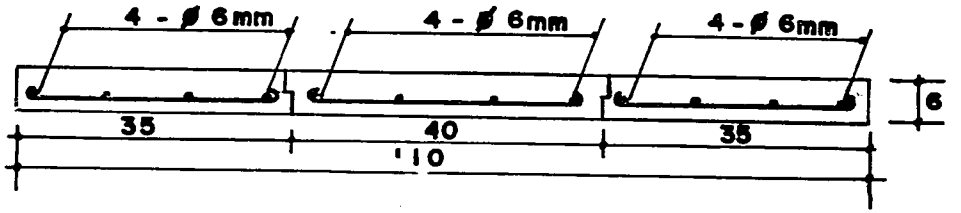


FIGURE 9.13

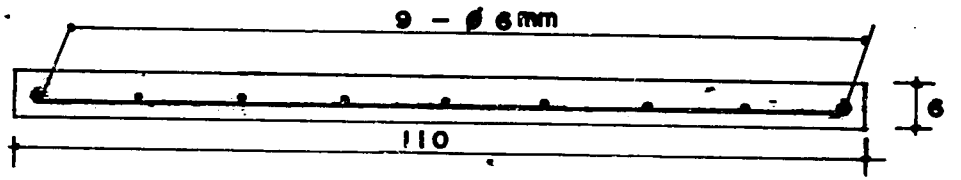
WATER - SEALED LATRINE SLAB



RINFORCED CONCRETE FLOOR
SCALE = 1 : 20



SECTION A – A
SCALE = 1 : 10



SECTION B – B
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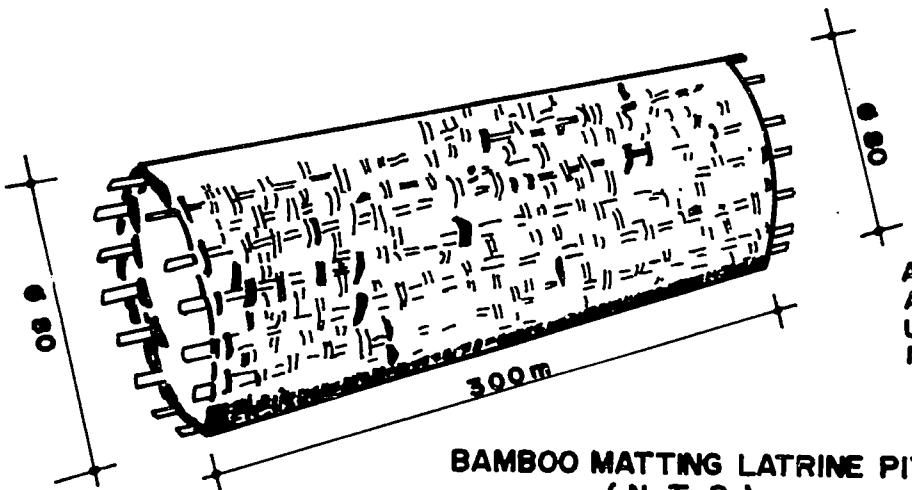
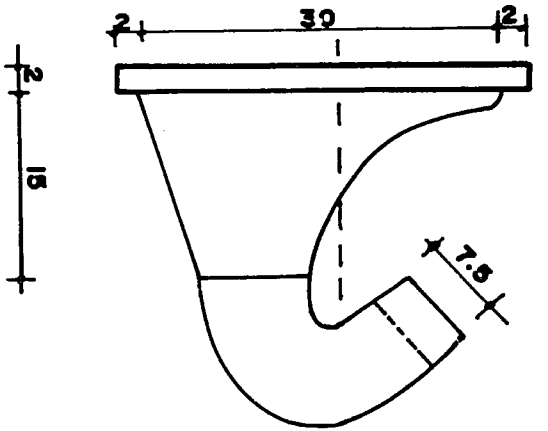


BAMBOO MATTING LATRINE PIT
(N.T.S.)

NOTE

ALL DIMENSIONS SHOWN ARE IN CENTIMETRES UNLESS OTHERWISE INDICATED



WATER - SEAL TOILET BOWL
(N.T.S.)

9.2.3 Standards and Regulations

Regulations and standards will have to be adopted to ensure that maximum benefit is derived from the expenditures made to improve sanitation in Medan, and that waste disposal practise adopted in the future are adequate to prevent the kinds of sanitation problems that Medan now experiences. Three primary areas which must be addressed are the wastewater collection and treatment systems, individual waste disposal systems, and surface water quality.

Regulations will be defined to control the discharge of any substance to the municipal collection system which would damage the pipelines or pump stations or reduce the efficiency of the treatment process. Materials such as industrial wastes, acids and other corrosive chemicals can greatly reduce the service life of system components and increase maintenance requirements. The discharge of toxic wastes cannot only pollute surface water directly, but can also lead to increased organic pollution be reducing the level of treatment provided. Standards must be prepared which clearly establish the concentration and amount of potentially harmful chemicals which may be allowed to enter the system. Fines should be imposed on any dischargers who violate these standards. In some cases it may be possible to provide partial treatment of potentially harmful wastes before discharge to the collection system. Where this is possible, pre-treatment standards should be established on a case-by-case basis.

Regulations should also be established which will make connection to the municipal wastewater system mandatory for residents who live within the service-area. Any new buildings constructed in the service area should be required to make a connection to the collection system during construction.

There are currently no regulations governing the design and construction of septic tank and drain field systems in Medan. Because of this, many such systems are inadequate and are currently contributing to the pollution of surface waters. Standards should be established to govern the design of septic tanks for all new construction in areas not served by the collection system. More importantly, soil permeability tests should be required before construction is begun to determine if the soils at the proposed location are suitable for septic tank use and how large a drain field will be required for proper disposal of the septic tank effluent.

One of the primary objectives of the recommended wastewater management system is to improve the quality of surface waters in Medan to the extent that they not longer constitute a public health hazard. Beyond this objective the existing sources of pollution create nuisance conditions which detract from overall aesthetics. Regulations for the control of the quality of water taken from water bodies for uses which are connected with public health were enacted by the Ministry of Health in 1977 and monitoring procedures have been established.

Sources of pollution which cause water quality standards to be violated should be identified, and action should be taken to eliminate all such discharges, in a manner consistent with the time phased implementation of the wastewater management system.

9.3 SOCIAL CONSIDERATIONS

The population of Medan which will benefit directly from the implementation of the wastewater management program is summarized in Table 9.11 illustrating that the low income priority areas will be the primary beneficiaries of the total wastewater management system.

TABLE 9.11

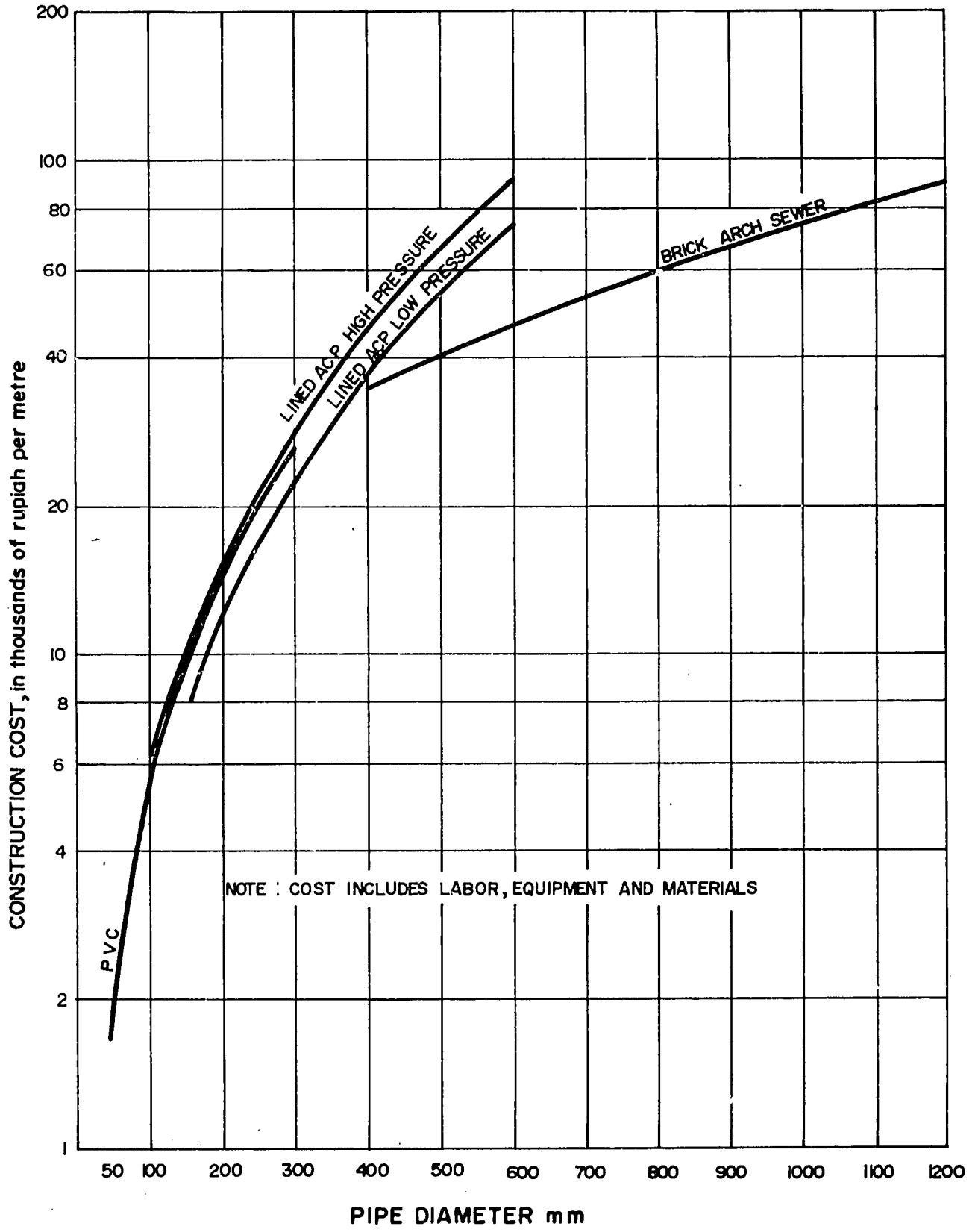
POPULATION SERVED
1983/84

Item	No.	Population Served				
		Total		Low Income	Medium Income	High Income
		No.	Percent			
Municipal Sewerage System Connections	9,700	77,600	5.9	3.0	2.0	0.9
MCK's	100	24,000	1.7	1.7	-	-
Private Latrines	15,000	120,000	9.2	9.2	-	-
Total		221,600	16.8	13.9	2.0	0.9

9.4 ECONOMIC CONSIDERATIONS

9.4.1 Importation of Engineering Materials

The availability of various types of pipe materials suitable for use in the municipal sewerage system has been discussed in Section 9.2.1.1. In general suitable materials are available in Indonesia for asbestos cement pipes up to 600 mm diameter. A coating is required to protect the interior of the pipe from corrosion damage and suitable procedures for ensuring effective application will have to be developed in the detailed design stage. This will be an important factor in the ultimate selection of pipe material. Conduits 600 mm and larger can be provided at least cost by brick arch sewers constructed in place using locally available materials. The cost comparison is illustrated by Figure 9.15.



COMPARATIVE COSTS
SANITARY SEWERS

9.4.2 Labor Intensive Methods

A discussion of labor intensive methods for underground conduit construction is presented in Vol.V, Part 3. The use of hand excavation and backfilling methods was found to provide greater economic benefits than the use of heavy excavating equipment and should be considered as an alternative at the time of tendering. The use of brick arch sewers is inherently highly labor intensive.

9.5 OPERATIONS AND MAINTENANCE

9.5.1 Organization

It is recommended that the organization for the wastewater management system be retained within the municipality initially but should eventually be incorporated with PAM Tirtanadi.

9.5.2 Staffing

The projected staff requirements for the operation and maintenance of the wastewater collection and treatment system were based on estimates of the necessary manpower and of the productivity of workers within the framework of current Indonesian labor practices.

Table 9.12 shows the projected manpower requirements and a breakdown of these requirements by speciality.

TABLE 9.12

PROJECTED STAFF REQUIREMENTS
WASTEWATER ORGANIZATION
1985 CONDITIONS

Item	Staff Required
Manager Wastewater Operation and Maintenance	1
Clerical	2
Collection System	
Superintendent	1
Clerical	2
Septic Tank Clean-out Service	
Foreman	1
Drivers	5
Laborers	20

TABLE 9.12--Continued

Item	Staff Required
Building Connections	
Foremen	2
Skilled Labor	4
Unskilled Labor	8
Cleaning and Repairs	
Foreman	1
Skilled Labor	2
Unskilled Labor	4
Treatment Plants and Pumping Stations	
Superintendent	1
Clerical	1
Oxidation Ponds	
Operator	1
Skilled Labor	5
Unskilled Labor	15
Pumping Stations	
Operator	1
Skilled Labor	3
Unskilled Labor	2
Supplementary Staff to other PAM Tirtanadi Sections	
Administration and Finance	
Book-keeper	1
Accounting Clerks	2
Clerical	2
Stores Clerks	2
Engineering Design & Construction	
Design Engineer	1
Draftsmen	2
Surveyor	1
Survey Assistants	2
Project Manager	1
Laboratory	
Analysts	2
Lab Assistants	4
Clerical	1
Total Wastewater Operations and Maintenance	105

9.5.3 Training

The provision of an effective wastewater management system in Medan will require personnel with experience which is as yet virtually unobtainable in Indonesia. For this reason an extensive training program will be required for staff at all levels. Experienced instructors will also be difficult to recruit locally. The lack of trained personnel to operate sewage pumping stations is of most critical concern. Steps should be taken early in the planning stage to recruit and train key operating personnel. Although the operation and maintanance of the municipal sewerage system is otherwise relatively simple many of the tasks are somewhat unpleasant and unattractive to many people, sometimes making the recruitment of suitable staff difficult. An important part of the training program will be to develop an understanding among the staff of the importance of the wastewater management system to the well being of the community. The development of skills and procedures which will permit even the most unpleasant tasks to be undertaken conveniently and safely will help to instill the positive attitudes among the staff that are necessary for the successful operation of a wastewater management system.

Initially there will be a requirement for qualified and experienced expatriate instructors for on the job training in existing systems elsewhere. The training of national personnel in this way will create the nucleus of a training group who with specialist advisors can provide on the job training to new recruits in Medan when the system becomes operational.

Subject material should include:

1. Fundamentals of Planning Municipal Wastewater System:
   - Alternatives and their evaluation - cost effectiveness analysis
   - Master Planning - updating requirements and procedures

2. Sanitary Sewer Design:
   - sewage quantity estimates
   - hydraulics of sewers including the control of sulfide generation and self-cleaning properties
   - calculation of loads on underground conduits
   - strength design of underground conduits

3. The Design and Operation of Sewage Pumping Stations and Appurtenances:
   - including the evaluation of pump and drive systems
   - control systems
   - station appurtenances

4. Wastewater Treatment Fundamentals and Waste Stabilization Ponds

5. Sewerage System Appurtenances:
   - manholes
   - building connections
   - building sewers, vents, traps, cleanouts
   - cross connections

6. Materials selection and corrosion control in wastewater systems

7. Maintenance Equipment

8. Occupational Safety

9.6 ESTIMATED COST AND IMPLEMENTATION SCHEDULE

It should be noted that the first stage program now recommended differs to that proposed as part of the master plan projections (Table 7.1). This reflects changes resulting from master plan review meetings held with GOI and design modifications. In particular, additional pumping facilities were found to be necessary.

9.6.1 Capital Costs

The estimated construction cost of the recommended first stage wastewater management system is summarized in Table 9.13. This is shown in mid-1979 and January, 1980 prices. Expenditure by year during Repelita III is given in Table 9.14.

TABLE 9.13

ESTIMATED CONSTRUCTION COSTS - STAGE I
(Millions of Rupiah)

Item	Description	Quantity	Unit	Unit Price (Mid.'79)	Total	Cost Mid.'79	Cost Jan.'80
Sewage Treatment Plant	Two stage anaerobic facultative waste stabilization pond system	1	ea	L.S.	291	291	338
Sewage Pump Stations	Deli P.S.	1	ea	L.S.	264		
	Kera P.S.	1	ea	L.S.	130		
	Sub Total Pond System					394	457
Trunk Sewers	A - Deli Basin	8,250	m	L.S.	710		
	B - Kera Basin		m	L.S.	256		
	Manholes				4		
	Sub Total Trunk Sewers					970	1,140
Major Collectors	2		m	L.S.	193		
	3		m	L.S.	53		
	4		m	L.S.	39		
	5		m	L.S.	26		
	6		m	L.S.	40		
	9		m	L.S.	22		
	Manholes				9		
	Sub Total Major Collectors					382	444
Minor Collectors	150 Ø 200 mm diameter	23,000	m	L.S.	220		
	Sewage Lift Station	2	ea	30	60		
	Sub Total Minor Collectors					280	327
Service Connections		9,700	ea	0.65	630	630	734
MCK's*		71	ea	1,240	89	89	105
Latrine Program	Water seal slabs	10,000	ea	.000006	60	60	70
	Total					3,096	3,615

* Excluding KIP program components.

TABLE 9.14

SCHEDULE OF CAPITAL EXPENDITURES - WASTEWATER
Millions of Rupiah - 1st. Jan 1980 prices

Item	81/82			82/83			83/84			Total		
	C 1)	S 2)	T 2)	C	S	T	C	S	T	C	S	T
Pumping Stations	-	-	-	-	-	-	195	262	457	195	262	457
Treatment Plant	-	-	-	-	-	-	330	8	338	330	8	338
Trunk Sewers	158	68	226	330	141	471	311	132	443	799	341	1140
Major Collectors	44	44	88	92	92	184	86	86	172	222	222	444
Minor Collectors	26	39	65	54	81	135	51	76	127	131	196	327
Service Connections	73	73	146	152	151	303	143	142	285	368	366	734
Latrine Program 3)	23	-	23	24	-	24	23	-	23	70	-	70
MCK Program 3)	35	-	35	36	-	36	34	-	34	105	-	105
TOTAL	359	224	583	688	465	1153	1173	706	1879	2220	1395	3615

1) Excludes Land Contingencies and Engineering
2) C = Civil Works, S - Equipment & Materials, T = Total
3) Excludes KIP program components.

9.6.2 Annual Operating and Maintenance Costs

The estimated annual additional operating and maintenance costs attributable to the wastewater management system in 1985 are summarized in Table 9.15 in 1980 prices.

TABLE 9.15

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS IN 1985
Millions of Rupiah - 1980 prices

Item	Total Cost
A. Direct Cost	
Materials	
Power	38
Other materials & equipment	83
Employee Costs	
Wages and fringe benefits	127
Other	19
B. Indirect Costs	
Administration	
Wages and fringe benefits	28
Insurance	2
Other	24
	321
Less Existing Septic Tank Service	11
Net Incremental O & M Cost	310

9.6.3 Implementation Schedule

The implementation schedule for the proposed wastewater supply program is illustrated in Figure 9.16

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WASTEWATER IMPLEMENTATION SCHEDULE

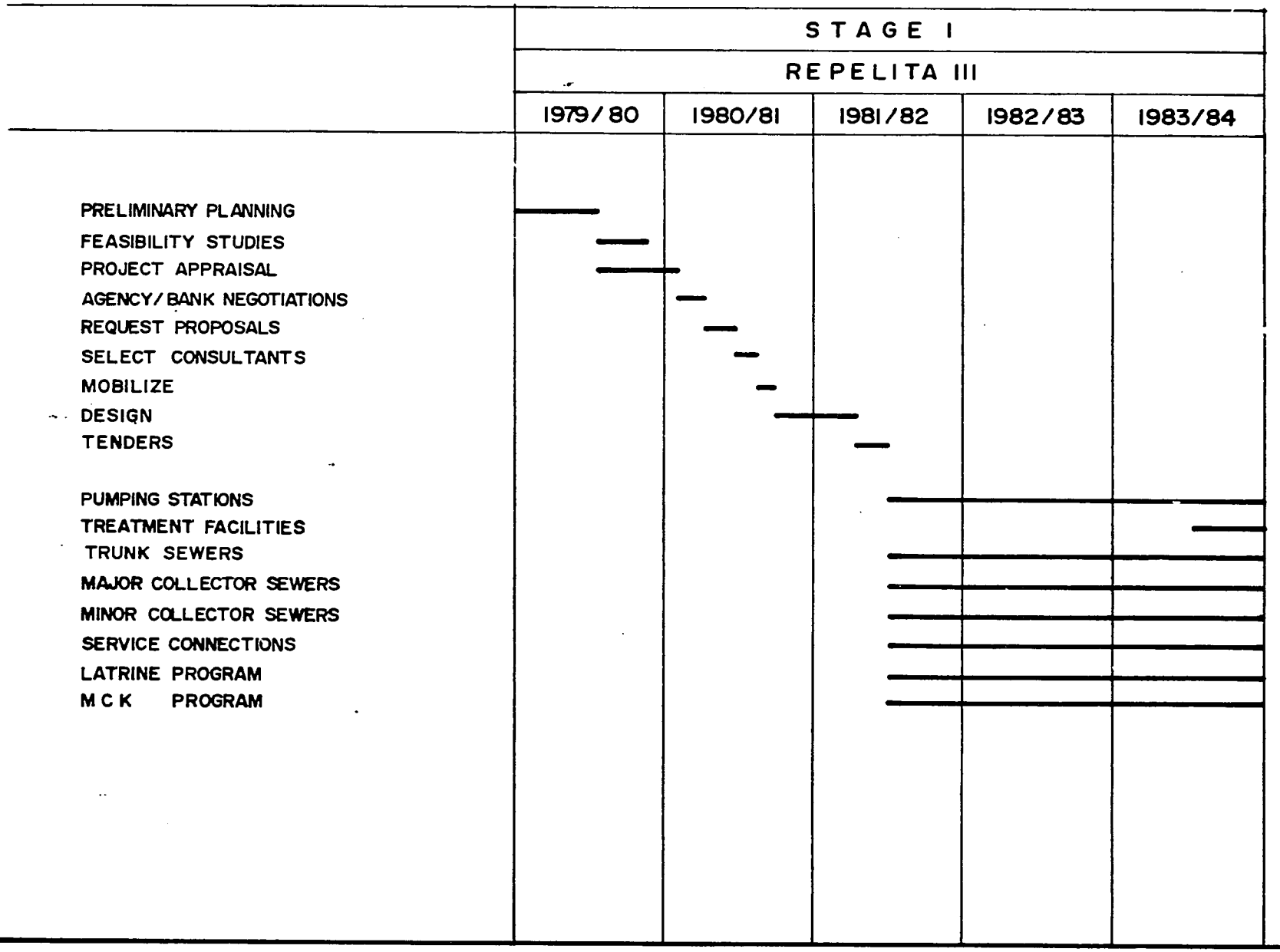

FIGURE 9.16

PADCO-DACREA

ENGINEERING-SCIENCE - SINOTECH

SECTION 10

ECONOMIC AND FINANCIAL ANALYSIS OF FIRST STAGE PROGRAM

10.1 INTRODUCTION

In this section, financial and economic appraisal is undertaken of the investments proposed during 1980/81-1983/84. The financial projections cover the period 1980/81 through 1989/90 but do not allow for possible investments in Repelita IV. It is to be hoped that the nucleus of the system which will be established during Repelita III will be significantly developed in the years following (as anticipated in the master plan). As the timing of additional works and the basis of their funding are so uncertain at present no attempt has been made to anticipate these in the projections.

As there is no satisfactory method for valuing the benefits associated with the project investments, the economic rate of return has not been calculated. Rather, the value which would have to be placed on the investment program at selected discount rates has been calculated and assessed.

10.2 PROJECT COSTS

10.2.1 Capital Costs

The recommended wastewater investment costs are summarized in Table 10.1. A breakdown of these by year is given in Appendix B.

These costs are based on the engineering estimates contained in Section 9.6 and adjusted as follows:

- Physical contingencies at 15 percent of total capital costs and engineering supervision at 10 percent of costs (excluding land)have been incorporated into the estimates

- Price contingencies (inflation allowances) have been added, based on estimates provided by the Asian Development Bank. The rates are:

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	1980	1981	1982	1983	1984
Local Currency	15 %	15 %	10 %	10 %	8 %
Foreign Exchange	8 %	8 %	7 %	6 %	6 %

TABLE 10.1

WASTEWATER CAPITAL COSTS - FIRST STAGE PROGRAM
Millions of Rupiah

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land	-	-	-	142	142
Civil Works	500	474	974	1246	2220
Equipment & Materials	822	109	931	464	1395
Engineering & Construction Supervision	180	-	180	181	361
Sub-Total	1502	583	2085	2033	4118
Physical Contingencies	224	88	312	305	617
Sub-Total	1726	671	2397	2338	4735
Price Contingencies	358	154	512	876	1388
Total	2084	825	2909	3214	6123

10.2.2 Foreign Exchange Costs

Out of the total cost of Rp. 6,123 million just under half (47.5%) is in foreign exchange. This is considered a maximum estimate. There is always a considerable degree of uncertainty when estimating foreign exchange quirements as the allocation of supply and civil contracts between foreign and local companies cannot be predicted with certainty. The foreign exchange estimates here assume that when construction and supply contracts are considered likely to attract international bids, the latter would be successful. Other assumptions used in estimating foreign exchange costs are as follows:

- The classification of a foreign exchange cost as either direct or indirect has been made on the basis of whether payment is made in local or foreign currency by the project. For instance,

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Indonesia is a net importer of cement and is likely to remain so during the project construction period. Cement is therefore considered a foreign exchange cost but as it will be purchased by the project in rupiah it is classified as indirect.

- In cases when materials and equipment are imported direct to the project, c.i.f. prices have been taken as the foreign exchange component. Customs duties, taxes and subsequent handling and transportation charges are local costs.

- Foreign contractors profits and overheads have been taken as 20 percent, with 5 percent allowance for depreciation on imported plant. These are treated as direct foreign exchange costs.

10.2.3 Operation and Maintenance Costs

Operation and maintenance costs as discussed in 9.6.2 have been incorporated into the analyses.

10.3 PROJECT FUNDING

10.3.1 General approach to funding MUDS programs

In discussions with GOI officials it was emphasized that priority should be given to obtaining funds from local governments for investment in the sanitation programs proposed as part of the MUDS investments. To determine the ability of Kotamadya Medan to contribute to the program a detailed analysis was undertaken of the municipality's financial resources, existing and potential. Full details of this analysis are contained in Section 21 of the Long Term Urban Development Plan report (Vol.III). The conclusion reached was that while considerable potential exists for improving municipal receipts this requires a major change in financial practices and controls, particularly in respect of tax assessments, collections and budgetary procedures. Technical assistance has been recommended to assist the municipality in effecting these changes but full benefits will only materialise over a period of years. Until these improvements in fiscal and accounting practices are achieved, the municipality's financial position will remain, as at present, extremely constrained.

Even on the assumption that tax receipts can be improved during Repelita III, only a very limited contribution from the Kotamadya's own resources will be available for investment in the MUDS programs. This reflects both the size of the investments required and the demand for increased funds to renovate and maintain existing urban facilities which have been seriously neglected in recent years.

In Table 10.2, the Kotamadya's own financial resources available for development expenditure are shown. The assumptions used in making this projection are given in detail in Section 21 of Volume III. Table 10.2 also shows how these resources have been allocated to the MUD's sectoral programs.

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TABLE 10.2

PROJECTION OF KOTAMADYA MEDANS CONTRIBUTION TO MUDS PROGRAMS
Rp. in Millions

	1981/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Current Account Surplus								
Constant 1978 prices[a]	762	651	512	754	944	1284	1563	1882
Current Prices[b]	1189	1107	957	1538	2067	3005	3923	5044
Allocation to MUDS Programs								
1. Wastewater								
Cash Operating Costs	-	56	121	533	573	615	657	704
Debt Service	-	-	-	-	-	282	282	282
2. Drainage								
Cash Operating Costs	85	160	191	225	260	277	297	318
Debt Service	-	-	-	-	-	585	585	585
3. Solid Wastes								
Own Capital Investment	300	300	200	-	-	-	-	-
Working Capital	350	150	-	-	-	-	-	-
Debt Service[c]	-	-	-	-	-	-	-	-
4. KIP[d]								
"Own" Capital Investment	200	350	300	-	-	-	-	-
Total Allocated	935	1016	812	758	833	1759	1821	1889

Notes:
- a Source: Table 21.9, Section 21, Volume III.
- b Converted to current prices using local inflation factors provided by ADB (see 10.2.1).
- c Solid wastes debt service and operating costs will be paid from solid waste revenue generation. The cash surplus resulting from solid waste operations has not been added back into the resources available for investment as this will be required for vehicle replacement and expansion of solid wastes service coverage.
- d Some operating costs will be necessary for KIP but these will come substantially from sectoral programs.

The trend of the surplus in constant prices during Repelita III declines despite the assumption that revenues will start to increase during this period as a result of improved revenue and budgetary procedures. This is because of the need to give priority to improving the level of maintenance on existing facilities. Approximately 85 percent of the surplus available in the Repelita III period is allocated to the MUDS programs; this means that very few local funds will be available for non-MUDS expenditures. In the circumstances this is acceptable as the MUDS program covers the priority sectors. It should also be noted that in 1978/79 external funds accounted for just under 40 percent of development investment in Medan and can be expected to be available in future for other developments in Medan.

Only in the case of the KIP and solid wastes programs has part of the surplus been allocated to front-end capital investment in Repelita III. In the other sectors the surplus has been allocated to "cash" operating and working capital requirements as necessary. It would be possible, of course, to reduce the "own" capital investment in KIP and solid wastes and spread it evenly among the other sectors. This, however, would simply mean that the KIP and solid waste loan/grant requirements would increase by a corresponding amount. Giving priority to KIP and solid wastes for municipal investment contribution reflects current GOI requirements.

Because of the limited "own" funds available from the Kotamadya during Repelita III, the municipality will be required to obtain loan and grant finance from GOI for the balance of the funds. It is possible that such finance would be channeled through the provincial government but it is unlikely that the provincial government would be in position to provide these funds from its own resources. The mix of loan/grant finance has been based on discussions with GOI officials and the ability of the Kotamadya to handle future debt service payments. As can be seen from Table 10.2 the latter does not present a problem under the loan terms assumed (these are discussed separately under the financial assumptions in each of the appropriate sanitation reports).

A further consideration in respect of debt service is the GOI guideline that this should not exceed 20 percent of development expenditures. If the latter is assumed to be the total of own (municipal) and external development expenditure, the maximum which MUDS debt service represents of this is 18 percent in 1986/87. In making this calculation, debt service for solid wastes has been excluded as both operating costs and debt service payments for this service will be met directly from operating revenues (user charges). If the solid wastes debt service is included, total debt service increases by almost 50 percent and the percentage of debt service to development expenditure becomes 27 percent in 1986/87. However, this reduces to 22 percent in 1987/88 and 18 percent in 1988/89. So even on this "maximum" debt service assumption, only for two years is the guideline exceeded.

	1986/87	1987/88	1988/89
Development Expenditure (Rp.m) 1)			
Own	2113	2969	4022
External	2595	2784	2972
Total	4708	5753	6994
Debt Service (Rp.m) 2)	867	867	867
Debt Service %	18	15	12

Notes:

1) Own development expenditure has been determined by deducting the cash operating costs for the MUDS sanitation and KIP programs (excluding solid wastes) from the current price surplus (see Table 10.2). External development expenditure has been calculated by assuming that the 1978/79 level will remain constant throughout. This has been converted to current prices using the ADB local inflation factors.
2) Debt service excludes that for solid wastes.

It should be emphasized again that the ability of the Kotamadya to meet even the limited investment contribution, operating cost and debt service charges proposed is dependent upon the progressive adoption of improved revenue and taxation practices and general financial housekeeping. The immediate implementation of a program such as that recommended in Section 21 and Appendix A of Volume 3 is an essential requirement if the Kotamadya is to meet the financial commitments proposed.

10.3.2 Wastewater funding

As just discussed, only in the case of the KIP and solid wastes programs has investment from the municipality's own funds been included. Wastewater has assumed to be financed by a combination of loan and grant finance. In line with guidelines received from GOI, it has been assumed that grant finance would be made available to fund basic system expenditures. It has been assumed that trunk sewers, pumping stations and the treatment plant constitute the core of the system. Collection networks would be progressively added to this core and would be financed by loan. The core works in Repelita III represent just over 50 percent of the costs, with the collection sewers and service connections representing the balance. For funding purposes a 50/50 grant/loan split has therefore been assumed.

10.4 TARIFF REQUIREMENTS

10.4.1 Revenue objectives

The tariff requirements for wastewater will be determined by the financial performance criteria which are set. These are likely to be in terms of a

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target rate of return on net assets (or capital employed) or in terms of covering specific categories of costs. The latter approach has been followed here. As it is intended that ADB will assist in the funding of the wastewater investments, the conditions that the Bank are likely to impose have been adopted, namely, that sufficient revenue should be generated to cover operating expenses plus depreciation or debt service, whichever is the greater.

10.4.2 Tariff structure

Different approaches to charging for the provision of wastewater services have been discussed in sub-section 8.3. A surcharge on the water-bill is considered the most equitable basis for charging but it is unlikely that such a system would be introduced prior to the integration of water supply and wastewater into one organisation. Meanwhile it has been recommended that tax and, in due course, a flat rate charge be used for revenue generation.

In practice, the municipality will almost certainly have to rely initially on allocations from the pool of general taxes. The scope for imposing user-specific charges is limited. By the end of Repelita III there would still be less than 10,000 system connections; the charge per connection in 1984/85 if the revenue requirement were to be met exclusively through connections would be Rp. 4,740 per month. At the median income level this would represent just under 10 percent of income, a totally unacceptable level.

An alternative approach would be to charge direct users just for cash operating costs only on the basis that such costs result specifically from system usage. This would reduce the charge to Rp. 3,269 per month, or approximately 6.5 percent of income. This is still a very substantial charge, even before including connection costs, which would add a further Rp. 1,000. Given this, and the undoubted collection difficulties which would result from the imposition of a new fee at a time when water charges are being increased, (along with municipal taxes and charges generally), a specific sewerage charge on users is not recommended during the initial years of development.

An additional reason for utilising general tax revenues rather than user-specific charges in the initial years is that a piped sewerage system is virtually new to Medan. Every effort should be made to encourage connection to the system so that its benefits can be perceived. A further justification is that the community as a whole enjoys the environmental and public health benefits resulting from the introduction of a sanitary sewerage system.

10.5 FINANCIAL EVALUATION

10.5.1 Introduction

Financial projections for the period 1980/81-89/90 have been prepared. These are based on the capital expenditure and operating and

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maintenance costs associated with the first stage program; possible investments in Repelita IV have not been included owing to the uncertain nature of these and the basis on which they might be funded.

The financial statements - income statement, flow of funds statement and balance sheet - are shown in Tables 10.3 through 10.5. All financial calculations are in current prices, based upon the inflation assumptions for local and foreign costs provided by the Asian Development Bank (1980 to 1984 - see 10.2.1) and a composite rate of 7 percent from 1985 onwards.

10.5.2 Financial Assumption

10.5.2.1 Income Statement

As discussed in 10.4.1, revenue has been fixed at the level necessary to cover operating expenses plus depreciation or debt service, whichever is the greater.

Depreciation has been calculated on annually revalued fixed assets on a straight line basis. The following depreciation rates have been adopted:

Type of Asset	Annual Rate %
Treatment Plant	2.5
Pumping Stations	6.5
Sewers	2.5
Service Connections	2.5
Latrines	5.0
MCKs	5.0

10.5.2.2 Balance Sheet and Flow of Funds

Fixed Assets. Fixed assets have been revalued annually in line with the inflation assumptions discussed above. Existing assets are insignificant and have been ignored.

Depreciation includes an allowance for backlog depreciation; an equivalent amount has been added to the revaluation surplus.

Capital expenditure is shown as work in progress in the year of asset acquisition and transferred to fixed assets in the following year, from which time depreciation commences. This assumes that use will be made of the sewers prior to the construction of the treatment works in 1983/84.

Working Capital. Inventories are estimated at 10 percent of current year capital expenditure plus 25 percent of annual expenditures on materials.

Accounts payable are estimated at 10 percent of current year capital expenditure and one month's cash operating expenses. Cash is calculated as a residual figure on the sources and application of funds

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TABLE 10.3

WASTEWATER - PROJECTED INCOME STATEMENT
Rp. Million in Current Prices

	1981/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Revenue	22	82	202	773	830	897	951	1018	1090
Operating Expenses									
Direct Costs	18	42	91	444	477	511	547	586	627
Indirect Costs	4	14	30	89	96	104	110	118	127
Total Costs	22	56	121	533	573	615	657	704	754
Income before depreciation	-	26	81	240	257	282	294	314	336
Depreciation	-	26	81	240	257	275	294	314	336
Income before interest	-	-	-	-	-	7	-	21	-
Interest	-	-	-	-	-	231	227	222	216
Net surplus (deficit)	-	-	-	-	-	(224)	(227)	(222)	(216)
Operating ratio	-	68.29	59.90	68.95	69.04	68.56	69.09	69.16	69.17

TABLE 10.4

WASTEWATER - PROJECTED FLOW OF FUNDS STATEMENT
Rp. Million in Current Prices

	1981/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Source of Funds									
Income before depreciation	-	26	81	240	257	282	294	314	336
Consumer Contributions	43	129	213	192	191	190	156	81	-
GOI Loan	389	769	1413	-	-	-	-	-	-
GOI Grant	429	920	1713	-	-	-	-	-	-
Total Sources	861	1844	3420	432	448	472	450	395	336
Application of Funds									
Project Investment	858	1839	3426	-	-	-	-	-	-
Increase/Decrease in working Capital*	-	-	-6	+20	+1	+1	+1	+1	+1
Loan Interest	-	-	-	-	-	231	227	222	216
Loan Amortisation	-	-	-	-	-	51	55	60	66
Total Applications	858	1839	3420	20	1	283	283	283	283
Net Cash Generated	3	5	-	412	447	189	167	112	53
Opening Cash Balance	-	3	8	8	420	867	1056	1 223	1335
Closing Cash Balance	3	8	8	420	867	1056	1223	1335	1388

* Excluding cash.

TABLE 10.5

WASTEWATER - PROJECTED BALANCE SHEET
Rp. Million in Current Prices

	1981/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Assets									
Fixed Assets	-	945	3272	6940	7430	7951	8501	9095	9734
Less Depreciation	-	26	109	357	639	959	1320	1726	2183
Net Fixed Assets	-	919	3163	6583	6791	6992	7181	7369	7551
Work in progress	858	1839	3171	-	-	-	-	-	-
Inventories	88	188	347	58	63	67	72	77	82
Cash	3	8	8	420	867	1056	1223	1335	1388
Total Current Assets	91	196	355	478	930	1123	1295	1412	1470
Total Assets	949	2954	6689	7061	7721	8115	8476	8781	9021
Equity and Liabilities									
Revaluation Surplus		87	318	807	1272	1748	2231	2733	3251
GOI Grant	429	1349	3062	3062	3062	3062	3062	3062	3062
Operational Surplus	-	-	-	-	-	(224)	(451)	(673)	(889)
Total Equity	429	1436	3380	3869	4334	4586	4842	5122	5424
Long Term Debt (Net)	389	1158	2571	2521	2520	2465	2405	2339	2268
Accounts Payable	88	188	353	44	48	51	55	59	63
Current Maturities	-	-	-	-	51	55	60	66	71
Total Current Liabilities	88	188	353	44	99	106	115	125	134
Consumer Contribution	43	172	385	577	768	958	1114	1195	1195
Total Equity/Liabilities	949	2954	6689	7061	7721	8115	8476	8781	9021
Current Ratio	1.03	1.04	1.01	10.86					
% Debt/(Debt+Equity)	47.56	44.64	43.20	39.92					
Working Capital	3	8	2	434					

statement. The cash surplus shown during Repelita IV would not materialize. The surplus results from depreciation provisions and consumer contributions (to service connections) at a time when no allowance has been made for continuing capital expenditure. It would, in practice, be used for second stage investments. No interest income has been provided for on what is, in effect, a nominal cash surplus.

Service Connections. In order to encourage connections to the new system it is recommended that term payments are introduced. As with new water connections, it is suggested that a down payment of one-fifth is made and the balance repaid over five years in equal monthly installments. No interest charge has been included.

Loan Terms. The funding mix has been discussed in 10.3.2. The terms on which the 50 percent loan finance would be provided have been given by GOI officials as:

- Loan repayment over 25 years, including a 5 year grace period.
- Interest rate 9 percent p.a. - waived during construction
- Repayment by way of a flat rate annuity of Rp. 282 million, commencing 1986/87.

Financing Plan. The financing plan for 1981/82-83/84 which derives from the source and application of funds statement is shown below:

Summary of Financing Plan 1981/82-83/84

	Rp. Million	US$ Million	%
Application of Funds			
Project Cost	6,123	9.8	99.9
Working Capital	2	*	0.1
Total	6,125	9.8	100.0
Source of Funds			
GOI Loan *	2,571	4.1	41.8
GOI Grant	3,062	4.9	50.0
Internal Cash Generation	107	0.2	2.1
Consumer Contribution	385	0.6	6.1
Total	6,125	9.8	100.0

* It is anticipated that, at minimum, the foreign exchange element of the project costs would be lent to GOI by ADB. This represents Rp. 2.9 million of investment costs and would on-lent by GOI to the project as part of its grant/loan funding.

10.5.3 Financial Evaluation

The critical considerations in reviewing the projected financial performance of wastewater operations are:

1) Whether the required revenue will be available from the municipality's resources and

2) Whether the assumed funding conditions are realistic.

The revenue requirement has already been discussed (10.4) and would seem attainable. The funding basis has likewise been determined after discussions with GOI officials. The postulated funding mix of 50 percent grant and 50 percent loan on "soft" terms is a critical factor in achieving the satisfactory operating performance shown in the projections. If the grant proportion were substantially reduced or the loan terms hardened this could adversely effect the main financial performance criterion adopted, namely, sufficient revenue (income) to cover operating expenses plus depreciation or debt service, under the existing assumptions, this performance is achievable.

10.6 ECONOMIC EVALUATION

10.6.1 Introduction

The very limited extent of Medan's wastewater facilities has been described in Section 2 of this report. The first stage investment program would:

- Provide piped sewage collection, transmission and treatment to 705 hectares of the central urban core area, including high density low income kampungs.

- Accelerate the existing private latrine improvement program from the present 1,000 water seal latrine slabs per year to 5,000 per year.

- Provide 100 MCKs in high density low income areas of the city.

The benefits and cost of the proposed investments are evaluated below.

10.6.2 Benefits of Proposed Investments

10.6.2.1 Health Benefits

Any improvement in the city's sanitary conditions resulting from the more efficient collection and disposal of human wastes will almost certainly improve health. Health benefits have already been discussed in considering water supply benefits (Vol.V, Part 1). These included the private benefit of reduced personal suffering, the possible reduction or reallocation of medical costs and greater productivity and output resulting from a reduction in the hours of work lost through sickness. Health benefits constitute one of the major justifications of the proposed sewerage investments.

10.6.2.2 Environmental Benefits

A major benefit of the proposed scheme would be the improvement in the quality of the environment; with the installation of sewers foul smells would be reduced and the attractiveness of the environment enchanced.

Reference has already been made to the highly polluted condition of the waterways running through Medan. Besides being malodorous, they are used for swimming, washing, and as a drinking water source by some inhabitants. Any reduction in their pollution level is obviously highly desirable as it would lower the health risks and provide a general environmental improvement.

10.6.2.3 Cost Savings

The costs of installation, operation and maintenance of individual disposal systems (septic tanks and cesspits) which would be saved by introducing a piped sewerage system represent a tangible cost saving. Not only would the current costs of emptying and maintaining these existing alternative facilities be saved, but also the future capital costs which would be incurred in the absence of the project. The sum of these savings is important when one considers the length of life of a sewerage network.

10.6.2.4 Limitation of benefits

It has to be recognized that the first stage sewerage investments are limited in scope and represent just the first step in developing a reliable and efficient sanitary system in a major Indonesian city. The initial program is estimated to serve directly around 6 percent of the population, although many more people will enjoy improved health and environmental conditions in the down-town area.

10.6.2.5 Valuation of benefits

The difficulties of benefit valuation of sewerage are even more problematical than for water schemes. This is particularly the case in Medan where virtually no sewerage system exists and where there is thus no historical indication of what consumers might be willing to pay for such a service. Similarly there is no evidence of the effect on property values of such investments. This can sometimes be a guide to the value placed on the provision of piped sewerage, although the problem often arises of isolating the effect of the specific wastewater investment from the multitude of other possible causes of property value increases.

Information was sought from other cities in Indonesia on willingness to pay for sewerage services and potential property value increases but lack of such facilities elsewhere meant no comparative data was available. As no satisfactory direct valuation method is available the approach followed has been to assess the value which would have to be placed on the investment program at selected discount rates. A subjective assessment is then necessary as to which of these rates, if any, produces a value which seems reasonable, and whether such a rate represents a satisfactory rate of return.

10.6.3 Economic Costs

The project costs are summarized in Table 10.1 and Appendix B. Certain of these costs have been adjusted to reflect economic resource costs ; taxes and duties have been excluded and unskilled labour priced at its opportunity cost. The latter has been taken as 0.5 of the market wage (see Volume V, Part 1, Section 10).

10.6.4 Economic and Financial Internal Rates of Return

Economic Rate of Return: The unit prices required to give different rates of return have been calculated at different discount rates. The project life is taken as 50 years, with all costs and benefits being discounted to 1980. The non-discounted costs and water flows were given in Table 10.6.

TABLE 10.6

WASTEWATER COSTS AND METERED FLOWS

Year No	Year	Wasteflows cu m/d	Costs* Rp M		
			Capital	O&M	Total
1	1981/82	-	625	8	633
2	82/83	-	1188	29	1217
3	83/84	-	2092	79	2171
4-50		6856**	-	310	310

* Excludes MCKs and Latrines
** Excludes infiltration and inflow

The unit rates (Rp per cu m) at which the service would need to be valued to give rates of return of 12 percent, 5 percent, and 1 percent are:

12% ERR: Rp. 372 per cu m
5% ERR: Rp. 228 per cu m
1% ERR: Rp. 172 per cu m

Strictly, the rate of return required should relate to the opportunity cost of capital in Indonesia. This is unlikely to be less than 12 percent. At the 12 percent rate a value of Rp. 372 per cu m of metered wasteflow would be required; to achieve just a positive return (1 percent) the value reduces to Rp. 172 per cu m. These are high unit values and compare, for instance, with the average unit water rate proposed for 1984/85 of Rp. 106 per cu m. As the initial sewerage investment will be in the central commercial area, a fairer comparison is probably with the average commercial rate in that period which is Rp. 348 per cu m.

Comparison with water rates is only indicative. The external, non personal benefits are normally much more significant with sewerage system investments and there is not necessarily a relationship between the private valuation of water and the community valuation of sewerage services. It is very unlikely that the private valuation of such services would be sufficient to even produce a positive rate of return. But when the general social and environmental benefits are taken into account, this becomes more probable. Many more people than those living in the directly serviced downtown area will enjoy the resultant environmental and health benefits when they visit the town center.

In terms of the capital expenditure per head, the proposed program in Repelita III represents Rp. 36,165 (US $ 58) per head of population living in the service area. Not all of these people (170,000) will be connected to the system by the end of 1983/84 but all will be living in a cleaner and healthier environment. It should also be remembered that the system has been designed to meet wasteflows projected for the year 2000. Thus the unit rate and investment per head calculations are overstated to the extent that more people and greater wasteflows will be covered by the initial investment.

In the end, the wasteflow investments should be viewed in the context of the overall MUDS program which has the objective of upgrading and improving the low level of urban amenities in Medan with its population of over 1 million. The introduction of a sewerage system is a logical and essential component of such a program and while it is not possible to calculate a definitive economic rate of return, the indicators are that this is positive.

As there is no distinct and identifiable revenue stream resulting from the sewerage program, it is not possible to calculate the financial internal rate of return.

APPENDIX A

DESIGN OF WASTEWATER TREATMENT FACILITIES

A.1 OBJECTIVES

The major objective of any wastewater treatment involves the removal of harmful materials within the sewage which may endanger public health or limit reuse of the water. In many countries, receiving water or discharge requirements have been established by national and state agencies and must be met by wastewater treatment facilities. In Medan and throughout Indonesia, raw sewage and effluent from septic tanks is allowed to enter the waterways, therefore the first level of treatment should reduce the pollutants of raw sewage to a level similar to that of septic tank effluent. A second level of treatment would reduce pollutants to those levels found in receiving waters. The receiving waters of the rivers in Medan contained:

BOD	3-17 mg/l
Dissolved Oxygen	4.9-6.8 mg/l
Total Coliform	23,000-1,100,000 MPN/100 ml
Fecal Coliform	4,000-93,000 MPN/100 ml

The general water quality limits should be less than the levels of pollutants reported in the local rivers of Medan. In order to improve the receiving water quality, criteria for treatment outflow were set at less than 20 mg/l of BOD and 40 MPN/100 ml.

A.2 DESIGN CRITERIA

The non-aerated waste stabilization lagoon system was selected for its simplicity, ease of operation, and high degree of treatment (see Section 6, Volume V, Part 2). The system uses a series of three types of ponds: anaerobic, facultative, and maturation. In the anaerobic pond, anaerobic decomposition occurs within the raw sewage flowing from the sewer collection system. In the facultative pond, a combination of aerobic decomposition by algae and anaerobic decomposition by bacteria occurs, while in the maturation ponds, aerobic decomposition dominates and substantially reduces the bacterial content of the pond and the outflow coming from the pond. Therefore, the actual division of facultative and maturation processes may vary, and the term facultative ponds has been used for description of all non-anaerobic ponds.

In the design of the initial series of ponds, two series of four ponds will be required to meet needs in 1990, and the construction of the first series will begin at the end of the First Stage Implementation period, 1983/84.

The sewage characteristics and volumes have been estimated for 1990 at BOD (5 day) loading of 400 g/cu m, a coliform content of 10^8 MPN per 100 ml (10^{12} MPN/cu m), and more than 28,600 cu m/d (average dry weather flow). An estimated flow of 400 cu m was assumed for discharge of septic tank waste disposal at the headworks of the treatment facility. This waste was assumed to have a concentrated BOD_5 of about 2000 g/cu m. Air, sewage, and ground temperatures are assumed to be 25°C or higher.

The physical design features of the sewage treatment works have been discussed in Sections 5, 6, and 7 of Volume V, Part 2 and illustrated in Figures 7.2, 9.1, and 9.10. In order to provide adequate operations through 1990, two series of four ponds would be constructed before 1990. Based upon the above assumptions and following calculations the two series would provide adequate or better treatment for sewage flows up to or beyond 1990. Provisions were made so that the anaerobic pond (first pond of each series) would operate either as a completely anaerobic system or as a mixed anaerobic-aerobic system (facultative) which would reduce odors and so that solids would settle into the deeper first pond. It is assumed that up to one meter (1.0 m) of the anaerobic ponds would eventually become dead storage and that the sludge would be cleared after five to ten years.

A.3 CALCULATIONS

A.3.1 Anaerobic Ponds

For fully anaerobic decomposition, BOD_5 reduction and retention generally followed a trend of:

1 day	:	50 percent reduction
2.5 days	:	60 percent reduction
5.0 days	:	70 percent reduction and
10.0 days	:	80 percent reduction (estimated).

Based upon Figure 9.10 (p. 9-30; Vol. V, Part 2), the first set of ponds would have a retention time of 10 d initially which would then decline to 6.5 d as the dead solid storage was filled.

$(217.4\ m)^2$ x 3 m depth x 2 ponds divided by 29,000 cu m/d;

$(219.4\ m)^2$ x 2 m depth x 2 ponds divided by 29,000 cu m/d

With these retention times, the volumetric loading of BOD_5 would be less than 100 g/cu m.d. At such loadings, the first set of ponds would be a mixed anaerobic-aerobic system. The aerobic sector would largely dominate the upper layer of the ponds (in direct sunlight during the day) and would reduce escape of odors.

Using the standard aerobic equation of

$$\text{Outflow BOD} = \frac{\text{Inflow BOD}}{(1 + k \times t)} = \frac{450}{(1 + 0.38 \times 6.4\ d)} = 185\ \text{mg/l}$$

the outflow strength would be reduced by more than 60 percent compared to the BOD load entering the ponds. If the longer initial retention time of 9.5 days is substituted, the reduction is almost 80 percent. These estimates are slightly less than those expected for fully anaerobic ponds, although the reduction should approach the higher values (lower BOD leaving the ponds) as the loading increases and the ponds become dominated by anaerobic decomposition.

The BOD reduction is assumed to be about 75 percent (a loss of 330 g/cu m) and the resulting outflow from the first ponds would have a range of 100 to 150 mg/l of BOD_5 which would enter the facultative ponds.

A.3.2 Facultative Ponds and BOD Reduction

Anaerobic decomposition reduces the BOD load of the sewage by 65 to 75 percent, while subsequent decomposition by anaerobic and aerobic processes follow a formula which has a somewhat smaller decomposition rate, indicated in the following formula:

$$\text{BOD Load Outflow} = \frac{\text{BOD Load Inflow}}{[1 + k \times t\ (\text{days})]^{p\ (\text{number of ponds})}}$$

$$k\ (\text{decomposition factor}) = 0.38 \text{ at } 25°C;\ k = 0.30 \times (1.05)^{25-20}$$

Two series of three facultative/maturation ponds were sized in order to reduce BOD load to less than 5 mg/l with some provision for solids storage. Two series of three sets of ponds, each of 261 m x 261 m x 1.8 m (1.5 m effective depth), will provide 7.2 to 8.6 days of retention (assumed 8 for calculations for each set). With the retention time of 8 days and the inflow BOD load of 100 to 150 mg/l, the outflow load can be calculated as follows:

$$BOD_{LO} = \frac{100\text{-}150\ \text{mg/l}}{(1 + 0.38 \times 8)^3}$$

$$= \frac{100\text{-}150}{65.9}$$

$$= 1.5 \text{ to } 2.3\ \text{mg/l}$$

Therefore, the recommended series of one anaerobic pond and three facultative/maturation ponds would reduce BOD load by about 99.8 percent of the raw sewage load and equal to about one-half of the reported load in the receiving waters of the Deli River.

A.3.3 Facultative Ponds and Bacterial Removal

The above sizing of the treatment ponds for BOD reduction has

established the limits in which the bacterial removal was considered. Calculation of bacterial removal follows a formula similar to that used in BOD reduction and is as follows:

$$\text{Fecal Coliform Concentration at Outflow (MPN per 100 ml)} = \frac{\text{Inflow Concentration (MPN per ml)}}{(1 + k_{fc}t_a)\ (1 + k_{fc}t_f)^p}$$

For planning purposes, the inflow fecal coliform concentration is assumed to equal 10^8 MPN per 100 ml. Where $k_{fc} = 2.6 \times (1.19)^{25-20}$, t_a = 10 to 6.5 days, and t_f = 8 days each for three ponds (= p). Substitution of the above factors in the formula results in the following calculation:

$$FC_{out} = \frac{10^8 \text{ MPN/100 ml}}{(1 + 6.2 \times 10 \text{ to } 6.5)\ (1 + 6.2 \times 8)^3}$$

$$= 12 \text{ to } 18 \text{ MPN per 100 ml}$$

Therefore, the combined bacterial removal from both the anaerobic and facultative ponds sized for BOD reduction would yield an outflow with about 10^{-6} of the fecal coliform content as the raw sewage and with about 0.01-0.0001 of that reported in the Deli River in 1979.

A.3.4 General Operations

As indicated above, the recommended treatment facilities should produce effluents which meet the pollutant guidelines of 30 mg/l of BOD_5 and 40 MPN per 100 ml or which have a lower pollutant concentration. Actual operations, retention times, and effluent loads will be determined after the start up of the first series of ponds in 1983/84. Two series of ponds will be required in order to allow settled solids removal from the first pond series at about 1990. Flow and loads would also exceed the probable capacity of the first series of ponds by or before 1990, although the second series will allow BOD and coliform limits to be met well beyond 1990. Without more precise sewage characteristics and quantities, the recommended design for sewage treatment facilities will be adequate for 1990 flows and will allow cleaning and considerable contingency during start-up and training operations.

A.4 RECEIVING WATERS AND WATER QUALITY IMPROVEMENTS

As indicated in the report (Volume V, Part 2, Section 7), the treated wastewater outflow from the treatment ponds would be discharged to the Deli River at the northern, downstream stream perimeter of the urbanized area of Medan. Although the discharge of treated wastewater can sometimes produce adverse effects upon receiving waters, water quality of the Deli River should improve with the implementation of the wastewater treatment facilities in three ways.

The sewer collection area of the recommended and First Stage plans includes most areas in which residences and offices discharge raw sewage to the existing drains. Such discharges will be collected and raw sewage will no longer go directly into the Deli River from the sewered areas. Therefore, some improvement or reduction in BOD and fecal coliform content should occur at the point of treated wastewater outflow.

The city of Medan collects septic tank sludge from throughout the city in areas not to be served by the recommended sewerage system. This sludge is disposed of by dumping into the Deli River and contributes to the degraded water quality of the river. The recommended wastewater treatment ponds will be adequate to treat both the raw sewage from the collection system and the septic tank sludge from the city. Elimination of sludge discharge to the Deli River will further improve the water quality of the Deli River.

Because of the improvement of the water quality in the Deli River from reduction or elimination of the discharges of sewage and sludge to the river, the outflow of treated wastewater from the treatment ponds will enter receiving waters which will be somewhat improved over existing levels of pollutants. As indicated above the treated wastewater outflow will be of better water quality than the reported 1979 quality and should contain the same or somewhat lower levels of BOD and fecal coliform than the future water quality of the Deli River. Unfortunately, the river will continue to receive some raw sewage, percolation and discharges from septic tanks, and general urban runoff, and these will maintain some degraded water quality within the Deli River.

APPENDIX B

WASTEWATER CAPITAL COSTS : 1981/82 - 1983/84

WASTEWATER CAPITAL COSTS: 1981/82 -1983/84
Millions of Rupiah

1981/82

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	-	-
Civil Works	75	80	155	204	359
Equipment & Materials	152	-	152	72	224
Engineering & Construction Supervision	29	-	29	29	58
Sub Total	256	80	336	305	641
Physical Contingencies	38	12	50	46	96
Sub Total	294	92	386	351	737
Price Contingencies	39	12	514	70	121
Total	333	104	437	421	858

1982/1983

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	-	-
Civil Works	157	151	308	380	688
Equipment & Materials	316	-	316	149	465
Engineering & Construction Supervision	57	-	57	58	115
Sub Total	530	151	681	587	1268
Physical Contingencies	79	23	102	88	190
Sub Total	609	174	783	675	1458
Price Contingencies	109	36	145	236	381
Total	718	210	928	911	1839

WASTEWATER CAPITAL COSTS: 1981 - 1983/84 — Continued

1983/84

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	142	142
Civil Works	268	243	511	662	1173
Equipment & Materials	354	109	463	243	706
Engineering & Construction Supervision	94	-	94	94	188
Sub Total	716	352	1068	1141	2209
Physical Contingencies	107	53	160	171	331
Sub Total	823	405	1228	1312	2540
Price Contingencies	210	106	316	570	886
Total	1033	511	1544	1882	3426