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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 4- MASTER PLAN AND FIRST STAGE PROGRAM FOR SOLID WASTES

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 Feasbility 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	Mudan Urban Development Study
SSCH	Sites and Services and Core Housing
UNDP	United States 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 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.

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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 Programme 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 throughout 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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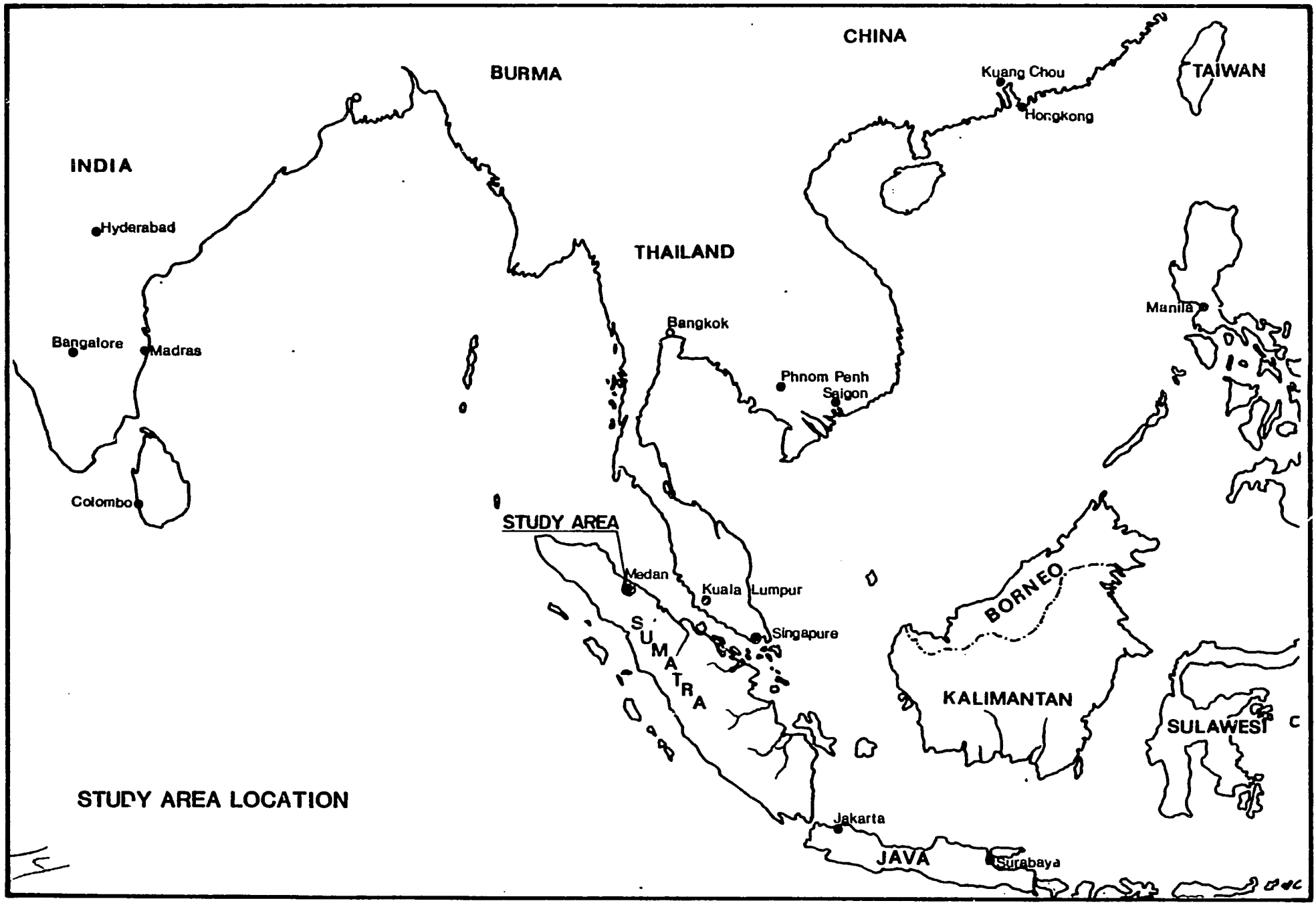

STUDY AREA LOCATION

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.

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

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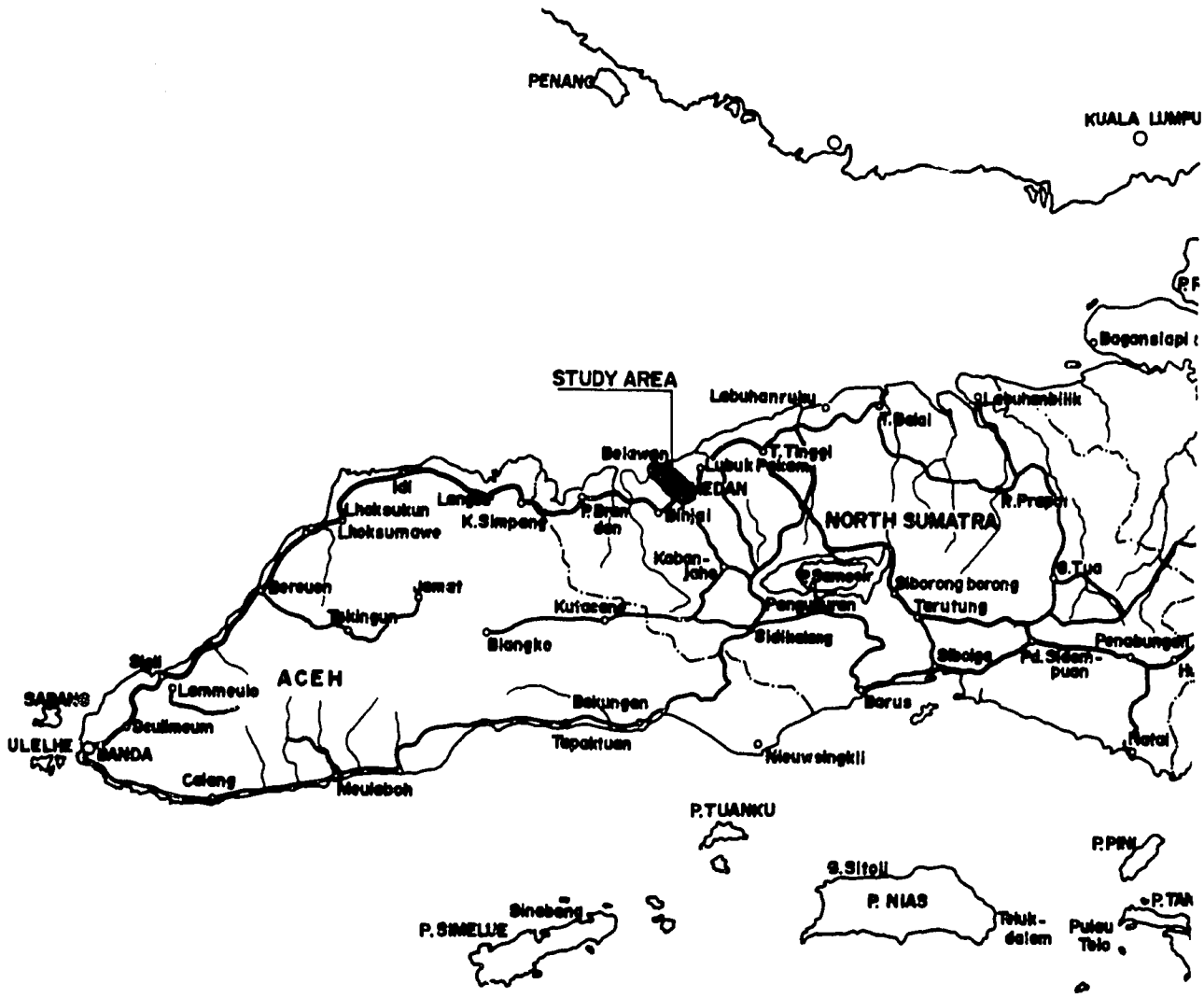

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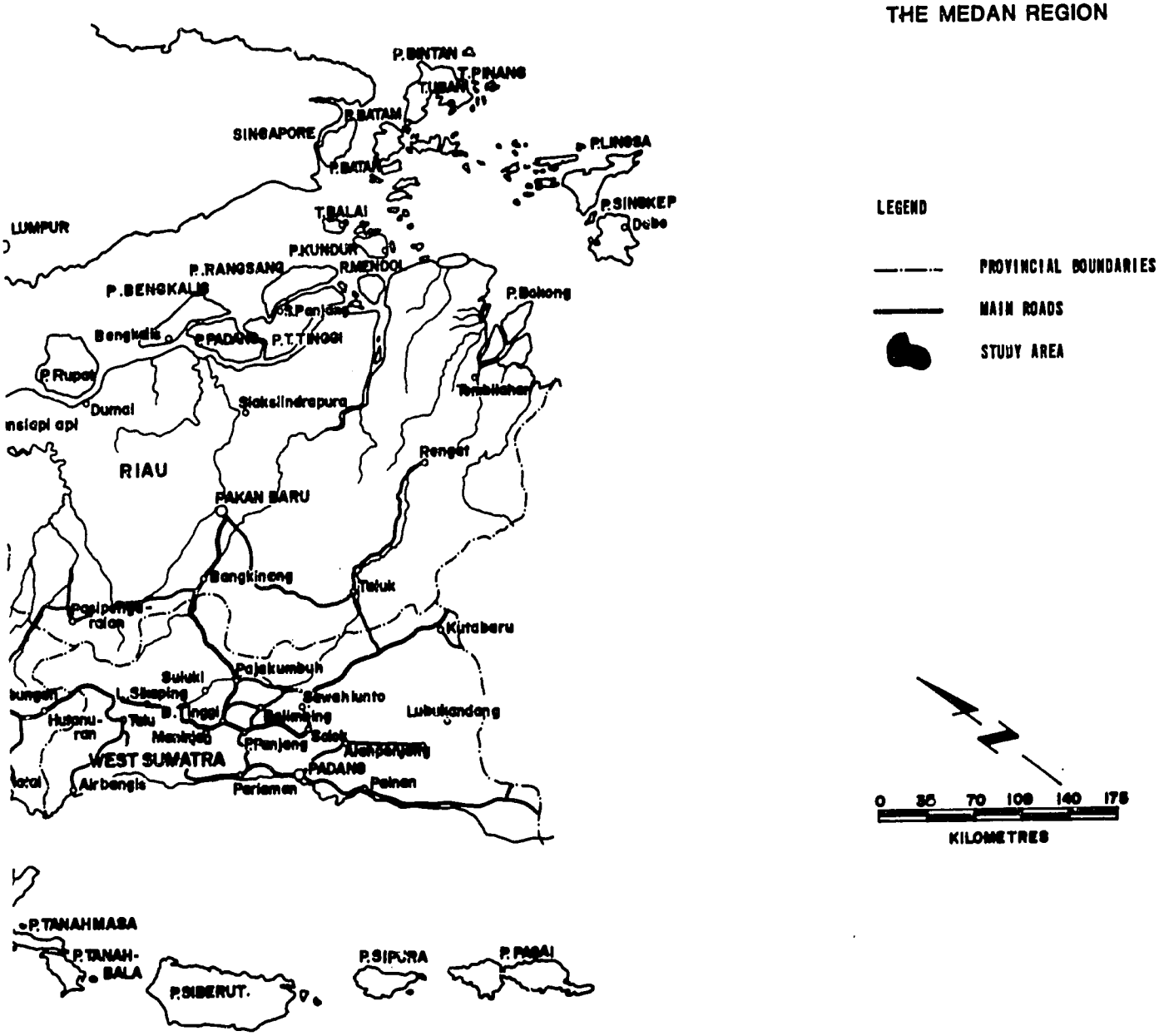
FIGURE 1.

THE MEDAN REGION



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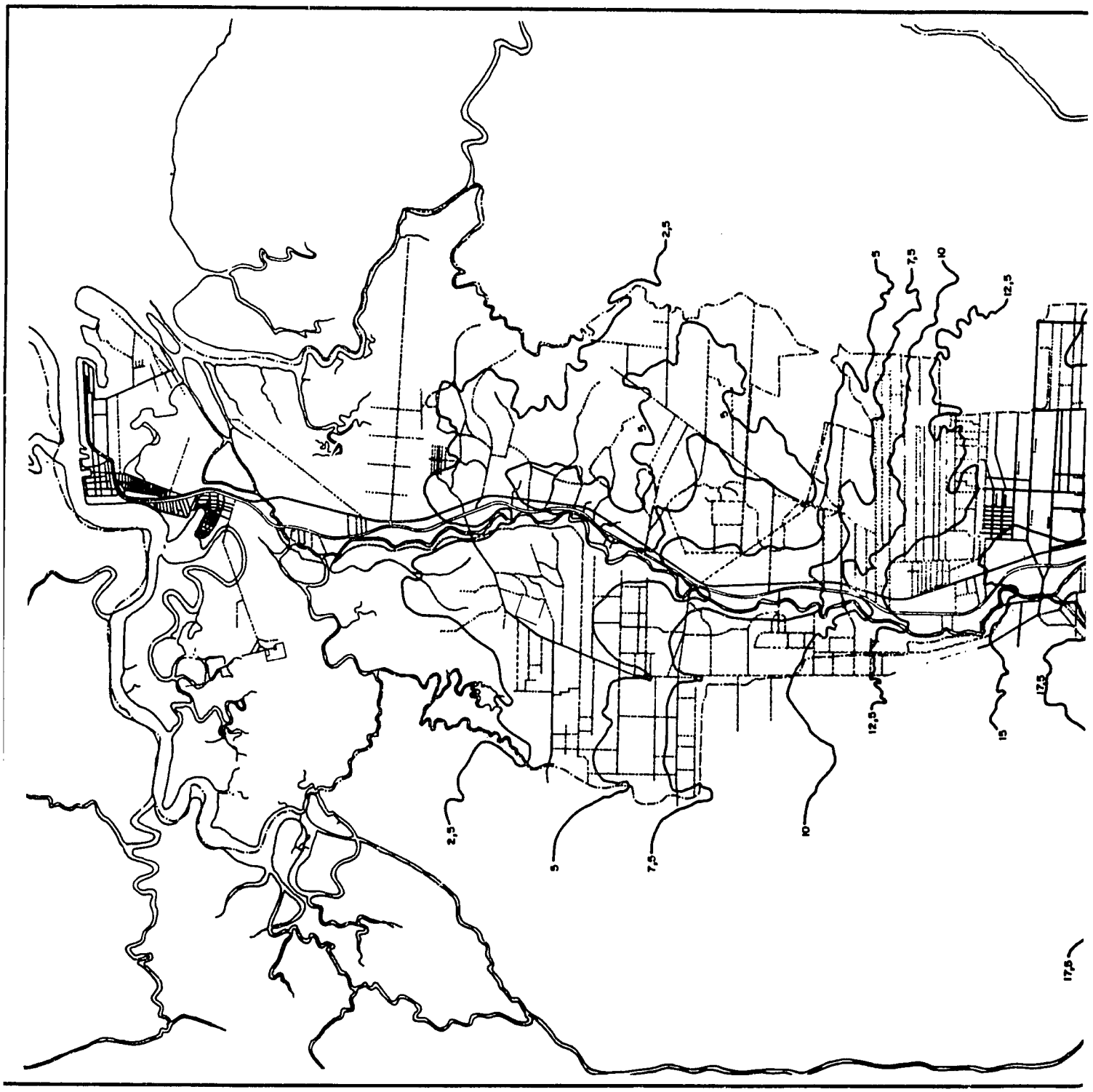

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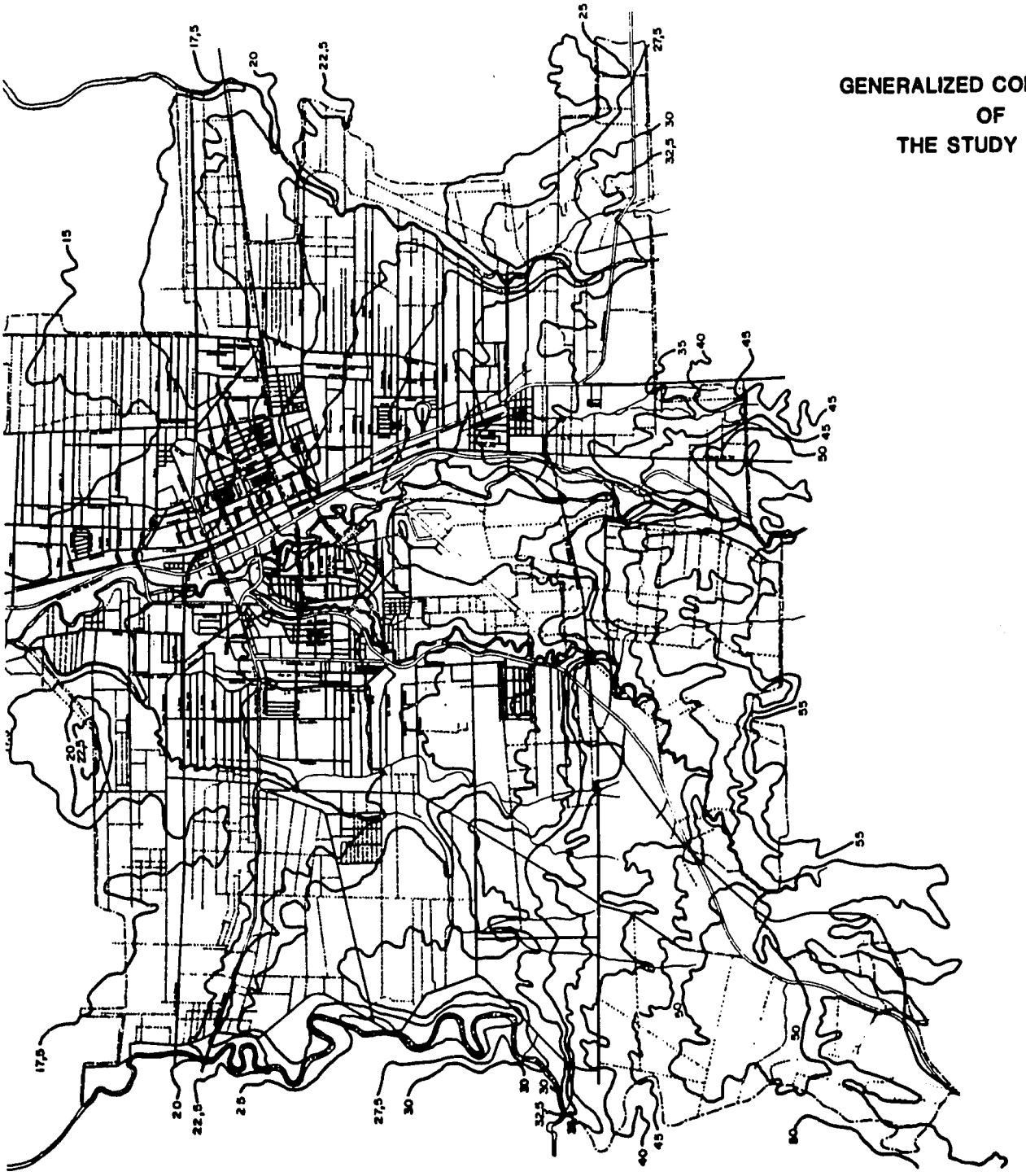
FIGURE 1



GENERALIZED CONTOUR MAP
OF
THE STUDY AREA

ENGINEERING-SCIENCE - SINOT

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 "mansoon" 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 occurred 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 form corrosive acid conditions with a high sulphate content.

Within the study area and general vicinity, eitht different soil types in five elevation zones have been identified. In the coastal tidal zone, two alluvial soils are recognized: (1) grey humus 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 podosol 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 highly acidic; some have a high hydrogen sulfide content and are corrosive.

SECTION 2

EXISTING SOLID WASTE SYSTEM

2.1 INTRODUCTION

In 1979 the results of a 1978 household economic survey became available which provided information on current household solid waste disposal practices and illustrated the continuing need for expanded solid waste management services. Also in 1979, a report of a joint solid waste study being carried out in Medan and three other cities by the Government of Indonesia and the Netherlands Government was issued.

The information from these investigations and reports defines the current solid waste management problem in Medan.

1. About 25 percent of the solid waste generated in the high density urban area is collected by the municipal system.

2. In the study area 84 percent of households dispose of solid waste by burning, disposal to streams, or burial.

3. The threat to public health, property damage due to flooding, and the general nuisance created by accumulation of solid waste are recognized by public officials as factors detracting from the quality of life in Medan.

2.2 THE MUNICIPAL SOLID WASTE SYSTEM

2.2.1 General Description

DKKP provides a solid waste management service within the area shown in Figure 2.1. The service includes:

1. Collection (jointly with the Kampung administration), transportation, and disposal of solid waste from residential, commercial, industrial and institutional areas.

2. Cleaning of roads, parks, and open drains.

3. Collection and disposal of septic tank pumpage.

4. Maintenance of green areas and cemeteries (green areas include playing fields, open spaces, road berms, traffic islands, and boulevards).

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Kotamadya Medan area is divided into a primary area, a secondary area, and a tertiary area as shown in Figure 2.1.

In the primary area DKKP provides all men and equipment used in the collection service. Collection operations are controlled jointly with the Kampung administration.

In the secondary area residents arrange to have their solid wastes taken to a pool site, and DKKP transports the solid wastes from there to the disposal sites. The primary and secondary areas constitute the current DKKP service area. DKKP provides assistance from time to time to the Kecamatan administrations in the tertiary area when emergency conditions exist. At the present time service is severely curtailed in the primary and secondary areas because of a shortage of collection vehicles, and DKKP is able to collect only about 150 tons of solid waste per day.

Solid wastes from Perumnas I (Helvetia) housing site (in the tertiary area) are collected and transported to the city disposal site by Perumnas.

The collection of solid wastes from the markets is carried out by the Dinas Pasar (Markets Department of the city administration) in cooperation with DKKP. A commercial composting operation (Dano Process) processes 100 tons per day of market wastes originating in Medan and Binjei.

In 1979 Bappenas and Kantor Sensus dan Statistik of North Sumatra carried out a survey in Medan in which 1,150 household were randomly selected and methods of solid waste disposal were determined. The results of the survey are as follows:

Household Disposal Method	Percentage of Households	
Service by DKKP (wholly or partially):		
Carried to a solid wastes pool	16.3	
Container removed at a scheduled time	6.7	23.0
Other:		
Burning	56.0	
Burial	7.8	
Disposal to ditch or stream	12.4	
Other	0.8	77.0
		100.0

These data illustrate the relatively minor impact of the municipal solid wastes management system on the collection and disposal of solid wastes in the study area.

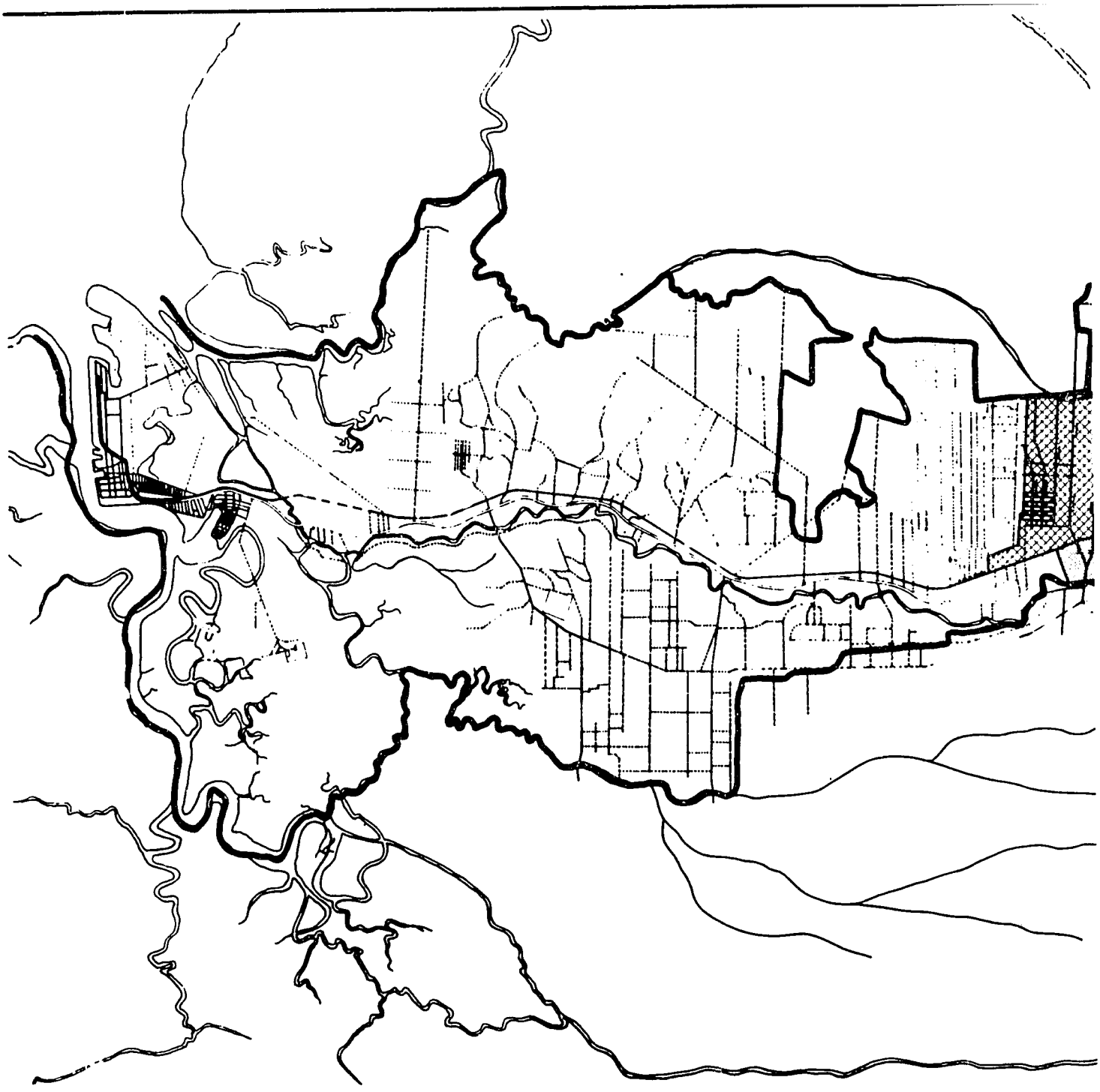

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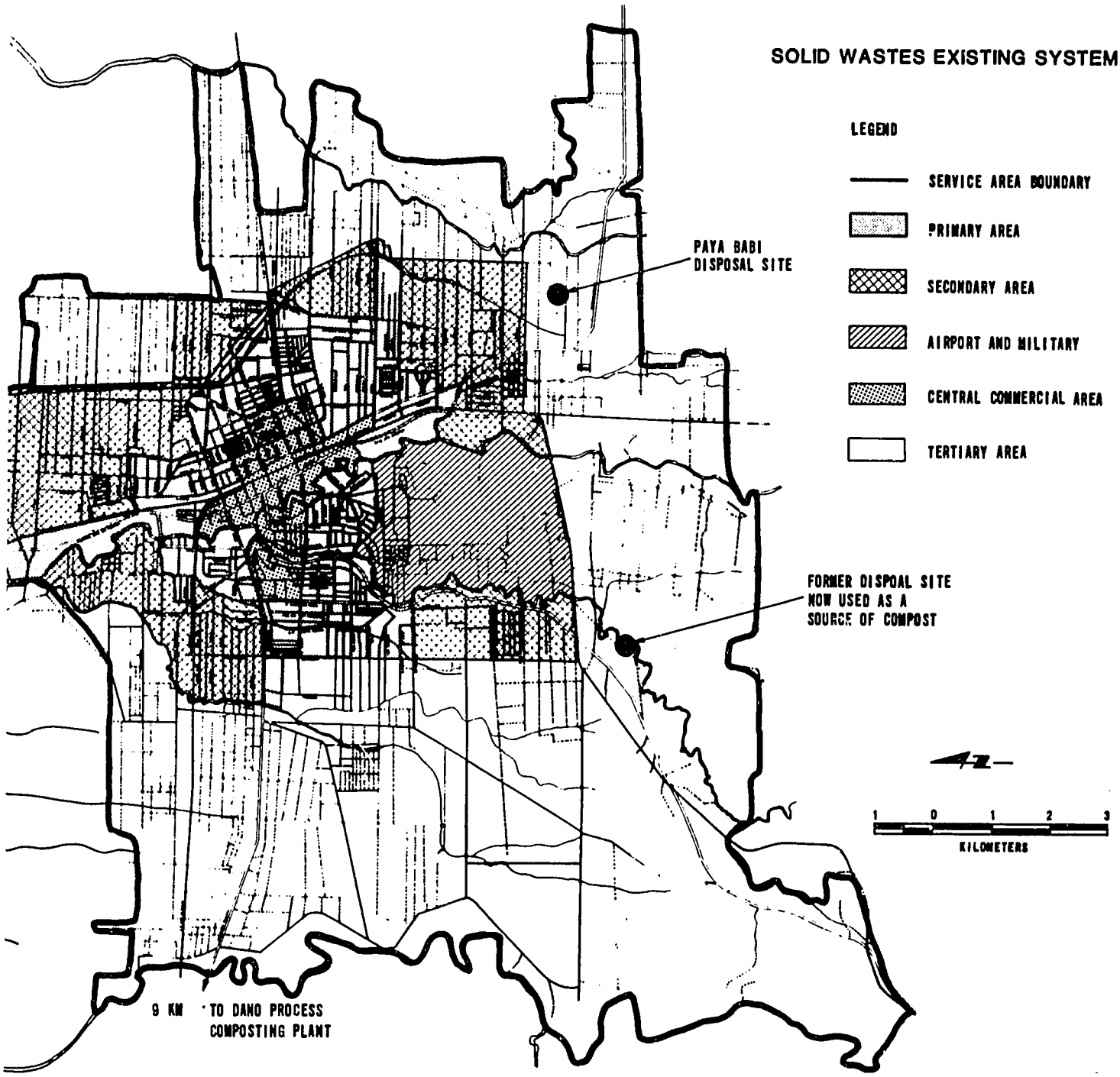
FIGURE



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2.2.2 Collection and Transfer Operations

Solid wastes are collected by DKKP with both trucks and gerobaks. Wastes collected by truck are hauled directly to the disposal site; those collected by gerobak are hauled to transfer areas where they are either held temporarily or transferred directly to a truck for haul to the disposal site.

Wastes are collected either from within the premises or from curbside. In the former case, collection workers enter the yard of the household or business, place the wastes in a collection basket, and carry the wastes to the truck or gerobak on the street. For curbside collection, the owner places the wastes in a container at the curb, and the collection workers transfer the wastes from this container to the vehicle.

Truck collection requires a crew of four, one driver, two carriers, and one man to assist in loading the truck. Collection by gerobak requires a crew of two. The standard work day is seven and one-half hours for truck crews, and six hours for gerobak crews.

Except for one street sweeper truck (with container), streets are swept by hand. Usually four to six sweepers per kilometre are assigned, who work a six-hour day. The streets that are swept are entirely in Kecamatans Medan Kota, Baru, Barat, Timur, and Belawan. A total of 224 km of streets are swept from once to four times per day as follows:

Sweeping Frequency (per day)	Length (km)
once	101
twice	104
three times	16
four times	3
	224

Wastes collected by gerobak are transported to transfer areas. The gerobaks are unloaded for storage at the transfer area or directly to a collection truck. The unloading and reloading operations are carried out manually. Many of the transfer areas are little more than an allocated space at the roadside with few facilities to contain stored refuse or to assist in the transfer of wastes to trucks. Frequently wastes remain in storage for a long period at time at the pool site creating both nuisance and potential threat to public health. Local residents consider the existing pool system extremely unsatisfactory, and this makes acquisition of new transfer sites difficult.

2.2.3 Disposal

The low wet area at Paya Babi used for the disposal of solid wastes by DKKP has a total area of 8.7 ha and has been estimated by DKKP to have sufficient capacity for five years disposal. The site has two natural watercourses through it, and water leaching through the wastes has polluted the water downstream which is used for livestock watering and rice irrigation. Because of complaints from local residents resulting from the many unsatisfactory features of the site, DKKP is looking for new disposal sites.

A large number of people salvage materials from the disposal site and from the various transfer areas (pool sites). Salvaged materials include metals, glass, plastics, and bones.

In addition to the commercial composting of market wastes mentioned before, a second commercial operation extracts about ten tonnes per day of compost from a former municipal disposal site.

2.2.4 DKKP Staff and Equipment

A total of 1464 persons are employed in the solid waste management system in Medan in the following classifications:

1.	Officials and technical/administration staff		154 persons
2.	Laborers - Full time		133
	- Part time		7
3.	Day laborers		
	Area workers	723	
	Parks and cemeteries	75	
	Special area	100	
	Workshop	20	
	Disposal	28	
	Demonstration project	5	
	Drivers	33	
	Assistant drivers	132	
	Foremen	54	1170
			1464 persons

DKKP has a total of 80 collection trucks. Five of these are five tonne trucks, the remainder are three tonne, only about 50 of these trucks are in service. The organization has about 25 other vehicles (street sweeper, tank trucks, pickup trucks, cars, etc.) of which about 20 are in service. About 80 of the total of 150 gerobaks are operational.

Motor vehicles are usually repaired in commercial shops. Plans are being considered for a centralized city vehicle repair facility.

2.3 OTHER SOLID WASTES DISPOSAL

More than seventy-five percent of the people in Medan are not served by the municipal solid waste collection system. About three-quarters of these people burn their wastes (except for some food wastes that are fed to pigs). The remainder of the wastes are either buried or dumped in ditches and streams.

SECTION 3

PROJECTED SOLID WASTES QUANTITIES

3.1 PRESENT UNIT GENERATION RATES

In 1976 a feasibility study of waste disposal in four cities in Indonesia was initiated jointly by the Government of Indonesia (Cipta Karya) and the Netherlands Government. The objective of the project was to obtain basic information with respect to:

1. Determining the quantity and composition of solid wastes in the four cities.

2. Identifying the most suitable equipment for collection and disposal of solid wastes in Indonesian circumstances.

The data resulting from the project were considered to be essential for the development of detailed Master Plans for each city.

The project consisted of replacing the existing solid waste collection systems in selected areas of Bandung, Medan, Pontianak, and Ujung Pandang with alternative collection systems which had proven successful in other areas.

In April of 1979, a separate study of solid wastes generated within the primary service area of Medan was undertaken by senior operating staff of DKKP. Estimates of solid waste quantities generated each day were prepared based on field observations. These estimates included wastes from domestic, commercial, industrial and institutional sources. The total quantities of solid waste generated in each major source area were found to be as follows:

Source	Quantity, in t/d
Kecamatan Medan Kota	103
Kecamatan Medan Timur	62
Kecamatan Medan Baru	95
Kecamatan Medan Barat	71
Kecamatan Kota Belawan	35
Parks	15
Markets	74
Total	455

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This information, together with the unit domestic solid waste generation data obtained by the GOI/Netherlands study and current land use data, was used to calculate a per hectare generation rate for commercial, institutional and industrial sources.

A summary of the relevant unit generation data available is presented in Table 3.1.

TABLE 3.1

SUMMARY OF UNIT SOLID WASTE GENERATION RATE DATA

		Unit Generation Rate		
Location	Description	Domestic kg/c.d	Commercial* (specified Kampungs) kg/c.d	Commercial** Institutional Industrial t/ha.d
Bandung	Measured	0.35		
	GOI/Netherlands	0.30	-	-
	Study	0.36		
Medan	Measured			
	GOI/Netherlands			
	Study			
	Desa Mesjid		0.828	
	Desa Pandau Hulu I	0.50		
Medan	DKKP Special			
	Study (adapted)			
	Kec. Medan Kota			0.16
	Kec. Medan Baru			0.22
	Kec. Medan Barat			0.15
	Kec. Medan Timur			0.24
	Kec. Medan Belawan			0.16

* Applies to 9 desas: Mesjid, Pasar Baru, Pusat Pasar, Sei Rengas I, Aur, Kesawan, Gang Buntu, Petisah Tengah, Belawan.

** The tabulated values were obtained by subtracting the domestic component from the DKKP estimates and dividing the difference by the total commercial, institutional and industrial land use in each kecamatan.

3.2 PROJECTED UNIT GENERATION RATES

Increases in per capita domestic waste generation rates of between one and three percent per year are being experienced throughout the world resulting from increased per capita consumption and from increased use of packaging materials. In Medan a transition towards the increased use of plastic film in place of banana leaves for food wrapping could tend to minimise this rate of increase. Future commercial, institutional, and industrial unit generation rates are not expected to increase significantly over the study period as wastes from these sources already reflect the effects of higher technology and a higher living standard on waste production. The projected unit solid wastes generation rates adopted for purposes of developing the Master Plan solid waste program are as follows:

Category	Unit	Unit Rate			
		Present	1985	1990	2000
Domestic	kg/c.d	0.50	0.56	0.62	0.75
		(Projected at a 2 percent increase per year)			
Commercial Institutional Industrial	t/ha.d	0.2	0.2	0.2	0.2
Markets and Parks		(Projected on the basis of total production in proportion to total domestic production).			

3.3 PROJECTED SOLID WASTE QUANTITIES

3.3.1 Present Total Generation

Based on the foregoing data, estimates of total solid waste production in the Study Area have been prepared and are presented in Table 3.2.

TABLE 3.2

SUMMARY OF PRESENT SOLID WASTE QUANTITIES

	Present Solid Waste Quantities, 1000's of t/d				
Service area	Domestic	Commercial (nine desas)	Other Commercial Industrial Institutional	Markets Parks	Total
Primary Area					
Medan Kota	77	10	16		
Medan Timur	27	3	32		
Medan Baru	48	4	43	91	
Medan Barat	36	8	27		
Kota Belawan	20	4	11		
Sub-Total	208	29	129	91	457
Secondary Area					
Medan Kota	39				
Medan Timur	63				
Medan Baru	12				
Medan Barat	30				
Kota Belawan	5				
Sub-Total	149				149
Tertiary Area					
Urban	138		47		
Rural	90				
Total	585	29	176	91	881

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3.3.2 Present Quantity of Solid Waste Collected

The following is a summary of the quantity of solid wastes collected in the Study Area during 1978 as estimated by the GOI/Netherlands Government Studies.

Month	Tonnes (thousands)	Tonnes per day (average)
January	5.1	165
February	3.7	132
March	4.0	129
April	3.5	117
May	4.6	148
June	4.4	147
July	4.7	152
August	5.2	167
September	4.4	147
October	4.9	158
November	4.9	163
December	5.3	171
Total/Annual Average	54.7	150

During April and May 1979 the DKKP disposal site at Paya Babi was inoperative and all solid wastes were disposed of at the Binjei Road composting plant where the truck sources were recorded and weights measured, thus providing an independent check of quantities. The results were as follows:

Truck Source	Average Quantity, in t/d
DKKP including parks	115
Markets	19
DAF container project	11
Perumas	3
Total	148

The quantity of solid wastes presently collected for disposal is about 25 percent of the total estimated solid waste generated in the primary and secondary service areas.

3.3.3 Projected Solid Waste Quantities

Projected quantities of solid wastes generated were estimated using the previously developed unit generation rates and projected future population and land use data.

The total quantities of solid wastes generated within the study area throughout the program period are summarized below and are shown graphically in Figure 3.1 and summarized in Table 3.3.

FIGURE 3.1

QUANTITY OF SOLID WASTES GENERATED

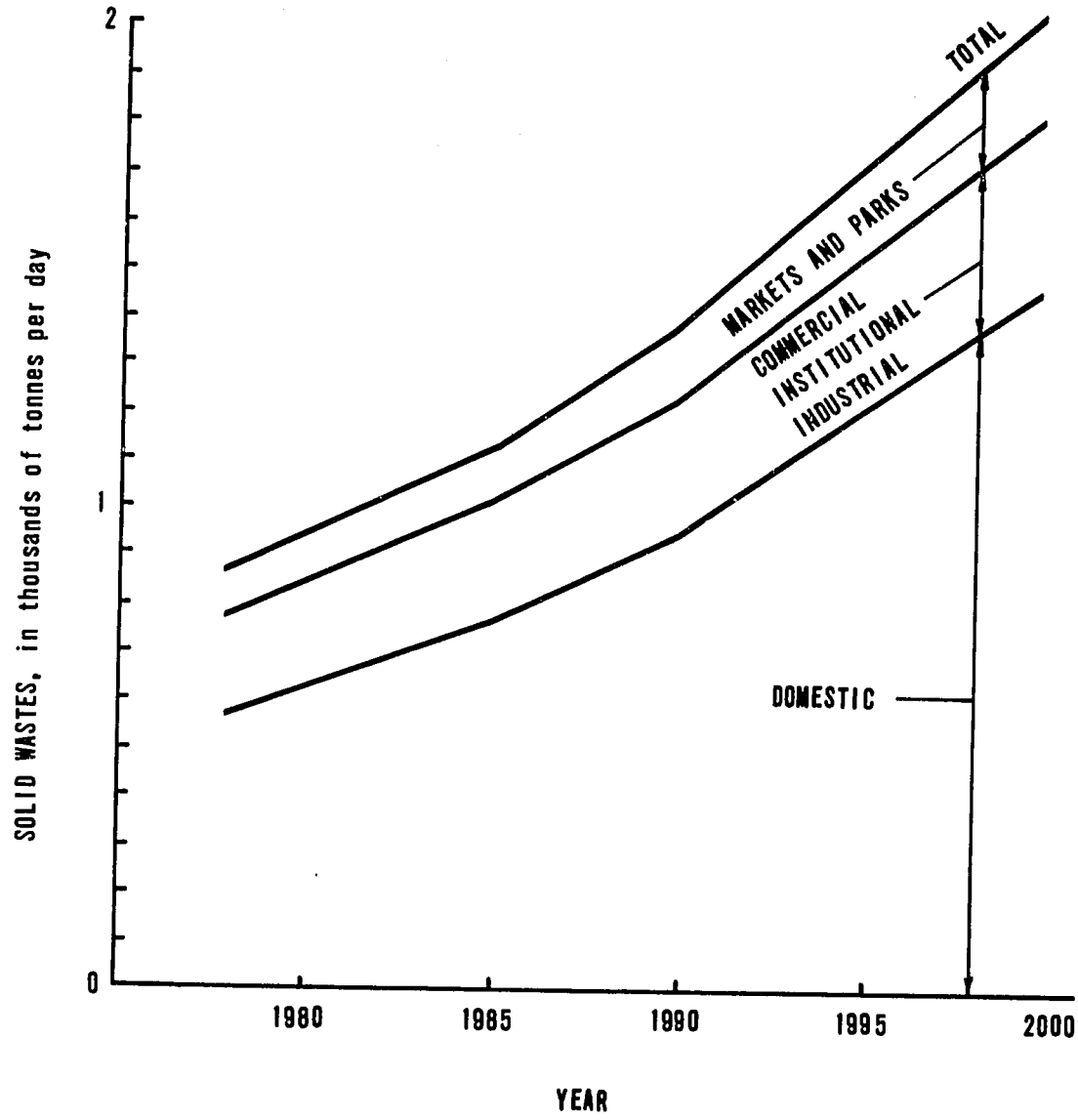

TABLE 3.3

SUMMARY OF PROJECTED SOLID WASTE QUANTITIES

Source	Estimates Solid Waste Quantities, 1000's of t/d			
	1980	1985	1990	2000
Domestic	585	751	941	1465
Commercial, Institutional, Industrial	205	242	274	354
Markets and Parks	91	103	131	196
Total	881	1096	1346	2015

Details of projected solid waste quantities by consumer category and kampung are given in Table A-1 of Appendix A.

3.4 SOLID WASTES COMPOSITION

3.4.1 Present Composition

There is little available information on the composition of solid wastes in Medan. In an effort to obtain an indication of the general character of the wastes, several pool sites and disposal facilities were visited and estimates were obtained of the composition of materials salvaged. The results are summarized in Table 3.4.

TABLE 3.4

ESTIMATED SOLID WASTE COMPOSITION

Component	Composition as a percentage of total weight (including moisture			
	Pool Medan Mentawai	Pool Medan Petisah	Medan Disposal Site	Medan Composting Plant
Paper	2.7	0.2	0.2	2.2
Plastic	0.5	1.2	4.0	12.3
Glass	0.2	0.1	2.5	4.2
Metal	0.2	0.5	2.5	8.8

TABLE 3.4 --CONTINUED

Component	Composition as a percentage of total weight (including moisture)			
	Pool Medan Mentawai	Pool Medan Petisah	Medan Disposal Site	Medan Composting Plant
Rubber	0	0	0.5	1.8
Leaves & food wastes	96.4	98.0	90.3	70.7

Moisture content was reported to vary from 65 to 90 percent at the composting plant.

The density of the solid wastes as collected has been measured by the GOI/Netherlands program with the result summarized in Table 3.5 .

TABLE 3.5

SUMMARY OF DATA ON SOLID WASTE DENSITY

Source	Type	Observed Density, kg/cu.m
Bandung	Domestic	210 240 (new system)
Medan	Domestic & market	277 257 (new system)
Pontianak		204 254 (new system)
Ujung Pandang		500 351 (Large container, new system)
Medan Desa Mesjid	Commercial	359
Medan Desa Pandau Hulu I	Domestic	306
Market DAF Truck		240
Medan Total (excluding DAF) 1978		280

The following values are considered to be representative of average densities for Medan's solid waste.

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Source	Density, kg/cu.m
Domestic	310
Commercial Area	360
Industrial	260
Markets & Parks	240
Weighted Average	280

3.4.2 Future Composition

Long term trends in solid waste composition are expected to result in a decrease in the percentage of leaves and an increase in the percentage of paper and plastics with an overall decrease in the food waste component.

SECTION 4

PUBLIC HEALTH

4.1 PRESENT CONDITIONS

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 no comprehensive, uniform system in the city for reporting disease 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 kecamatans 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	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 1000 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.

4.2 SOLID WASTES

Medan's solid waste management system is inadequate and has resulted in unsatisfactory environmental and health conditions. Two primary problems which can arise from solid waste disposal are large populations of flies and rats, which can transmit disease, and the contamination of surface and groundwaters. Both of these problems are presently encountered in the city.

The city dump, for example, is a several hectare site which is convenient to collection routes but is on land which is subject to periodic flooding. There are two natural water courses through the site. Downstream these are used to water animals and irrigate rice. The rain water which seeps through the rubbish and the flood water in which it is soaked absorbs organic material and becomes polluted. The pollution may seep into the soil to cause degradation of the shallow groundwater.

The present dump causes strong complaints because of heavy fly breeding and odors. Spraying is not effective — proper covering of most garbage and organic waste is necessary. The dump is unsightly and extends to within 100 m of residences.

Until recently, when a tractor was obtained to help compact, material was scattered at depths of about one metre over several hectares. The top material was primarily waste bamboo containers and other material which will decompose only very slowly. The result is land which will have little value unless extensive, expensive reclamation work is done in the future.

The extensive burning of solid wastes by householders has the advantage of reducing the fly and rat problem, but it does contribute to air pollution. However, until a more comprehensive program of solid wastes collection and disposal is implemented, burning is probably preferable to the widespread practise of dumping refuse in the drainage ditches and rivers.

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 solid wastes 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 alternative was carried out on the basis of a comparison of average annual costs.

5.2 DESIGN CRITERIA

5.2.1 Service Life

The following service lives were used for the conceptual design of alternative solid waste management systems developed in subsequent sections.

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Item	Service Life
Land	- permanent
Structure	- 50 years
Process equipment, vehicles and heavy machinery	- 5 years

5.2.2 Collection

The following design criteria were applied to the alternative collection systems which were evaluated under these investigations:

1.	Collection crew size - truck	- 4 persons (excluding driver and helper)
	- handcart	- 2 persons
2.	Household containers	- maximum size 40 litres
3.	Commercial containers	- maximum size 60 litres
4.	Loading facility storage (when provided)	- maximum capacity 15 cu m
5.	House to house collection rate	- truck 0.30 tonnes/h (4 collectors)
6.	House to house collection rate	- handcart 0.18 tonnes/h (2 collectors)
7.	Kerbside collection rate	- truck 0.42 tonnes/h (4 collectors)
8.	Kerbside collection rate	- handcart 0.27 tonnes/ha (2 collectors)
9.	Maximum spacing of communal containers	- 300 metres
10.	Maximum spacing of loading facilities	- 1 km

The solid waste load carrying capacity and average travel speed of various types of collection vehicles are summarized in Table 5.1.

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TABLE 5.1

COLLECTION VEHICLE CHARACTERISTICS

Vehicle	Capacity		Travel Speed (km/h)	Crew in addition to collectors	
	Volume (cu m)	Weight (tonnes)		Driver	Helper
Dump	7.1	2	35	1	1
	10.7	3	35	1	1
	21.4	6	35	1	1
Packer*	5	2.8	35	1	
	10	5.6	35	1	
	15	8.4	35	1	
Agricultural Tractor-Trailer	4	1.1	20	1	
	6	1.7	20	1	
Handcart	0.7	0.20	3		
Handcart containers	0.08	0.025			

* 2 to 1 compaction ratio assumed.

The following operational criteria apply to all solid waste system vehicles:

1. Loads should be covered during transport especially at vehicle speeds in excess of 30 km/h.

2. Loading height is critically important under local conditions. A typical design value is approximately 1.5 m. Experience has indicated that loading heights of about 1 m should be used.

3. Designs must take into account the method of transfer of wastes from small primary collection vehicles such as handcarts to secondary vehicles. Transfer should not involve dumping the load on the ground.

4. Hand operated vehicles should be designed to meet high mechanical standards.

5. A solid waste worker can manually load/unload approximately 4 cu m of solid wastes per hour.

5.2.3 Transfer

A detailed discussion of transfer requirements is contained in Section 6. Transfer stations are to be considered only for haul distances in excess of 10 km.

5.2.4 Disposal

Criteria for the conceptual design of sanitary landfill alternatives to the extent necessary to identify factors of primary importance for system planning are given below:

Design Criteria	Value
Depth of solid wastes layer	2 m
Cover material thickness	20 cm
Density of compacted solid wastes layer (long-term)	700 kg/cu m
Density of cover material	1800 kg/cu m
Total landfill density	920 kg/cu m
Cover material required per tonne of solid wastes	0.36 cu m/tonne
Single layer area requirement per tonne of solid wastes	1.8 sq m/tonne (one metre layer thickness)

The assumed characteristics of equipment used at the landfill site are summarized in Table 5.2.

TABLE 5.2

LANDFILL EQUIPMENT CHARACTERISTICS

Item	Function	Operation capacity, tonnes/d of Solid Wastes	Size
Bulldozer	Form solid wastes and spread cover material	200	80 HP
		400	180 HP
Fronted	Excavate and transport cover material, excavate and store topsoil	200	0.5 cu m bucket
		400	0.2 cu m bucket
Weigh scale	One required per landfill site with operation building including facilities for landfill operators		

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A sanitary landfill site crew should include the following:

- 2 heavy equipment operators
- 2 helpers
- 2 weighbridge operators
- 2 site laborers

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 5.3. The unit prices of earthwork and masonry include the costs of labor, materials, equipment, a ten percent contractors overhead and ten percent allowance for contractors profit. No provision is included for supervision and taxes.

TABLE 5.3

GENERAL MATERIALS AND LABOR COSTS

Description	Unit	Unit Cost (Rp)
Labor		
Unskilled labor	day	600
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

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TABLE 5.3--Continued

Description	Unit	Unit Cost (Rp)
Earthworks		
Excavation 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
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
Glass (transparent)		
t = 3 mm	sq m	3,500
t = 5 mm	sq m	5,750
Wood - depending on quality (1 ton - 1.35 cu m)	ton	40,000 to 115,000

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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

Land will be required for transfer stations, work yards and disposal sites. Land costs ranging from Rp. 200 sq m to Rp.15,000 sq m have been used, depending on location.

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.

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 Solid Waste System

5.3.2.1 Collection

The following is a summary of the costs of the major elements of the solid waste collection system:

Element	Cost, Rp. Capital	Cost, Rp. Annual O & M (excluding Crew Costs)
Collection vehicles		
Truck 2 tonne payload	7,200,000	2,000,000
Truck 3 tonne payload	10,000,000	2,500,000
Handcart 0.7 cu m capacity	85,000	8,500

5.3.2.2 Transfer

The estimated cost of equipment and facilities utilized to transfer solid wastes from collection vehicles to long-haul vehicles bound for disposal sites are summarized below:

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Element	Cost, Rp. Capital	Annual O & M (Excluding Crew Costs)
Transfer vehicles		
Truck 10 tonne	15,500,000	4,000,000
Truck/trailer 20 tonne	26,000,000	6,500,000
Transfer station	(range 650-1,250 Rp./tonne including amortized capital and O & M)	

5.3.2.3 Disposal

The following unit costs have been used in estimating the total cost of landfill operations assuming a 400-500 tonne per day site capacity:

- Land — 2,000,000-7,000,000 Rp./ha
- Weighbridge + building — 37,000,000 Rp. Lump Sum
- Bulldozer (200 HP) — Capital 82,000,000 Rp. each annual O & M 21,800,000 Rp. each (excluding crew)
- Front end loader 2 cu m bucket — Capital 52,000,000 Rp. each annual O & M 25,900,000 Rp. each (excluding crew)

5.3.2.4 Labor Costs

The following unit costs were utilized in estimating labor cost associated with solid waste system operations:

- Labor — 600 Rp./day
- Skilled Labor — 1,000 Rp./day
- Driver — 1,500 Rp./day
- Equipment Operator — 2,500 Rp./day

All of the above labor costs were multiplied by a factor of 1.6 to allow for payroll and administration overheads.

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SECTION 6

ALTERNATIVE SOLID WASTES MANAGEMENT SYSTEMS

6.1 INTRODUCTION

The development of a feasible solid wastes management program for Medan requires the consideration of a broad range of alternatives. Financial and administrative constraints must be considered in developing the scope of the program relating to both the selection of the service area boundary and the levels of service to be provided to various sectors of the community. A set of alternatives can be selected involving variations in quality in terms of householder effort applied to the collection and disposal process, frequency of service, the location and size of system storage elements, and costs.

The objective of the program is to provide an acceptable standard of service to as many people as possible at an overall cost which is within the community's ability to pay.

6.2. ALTERNATIVE SERVICE LEVELS

6.2.1 Service Areas

The magnitude of the task of increasing the current level of service to provide for the collection of all wastes generated within the study area necessitates that a staged approach be considered. The critical need for improved service also requires that immediate action be taken to improve conditions in priority areas. The following priorities and tentative staging have been adopted for developing the master plan program alternatives.

By 1980 Immediate Action

Upgrade service to provide for the collection of all wastes generated in the primary area.

By 1985 First Stage

Extend service to include all of the primary and secondary areas, the corridors of regional roads and selected satellite residential areas within the tertiary area.

By 1990 Second Stage

Extend service to include the entire area of Kotamadya Medan excepting isolated low density rural areas, which can continue to effectively employ household disposal methods.

By 2000 Third Stage

Expand service to keep pace with urban development.

Figure 6.1 shows the service areas of the city included within each of the foregoing stages. This staged program results in a partial collection of the total solid wastes generated. Table 6.1 gives a summary of the quantity of solid wastes which will require handling by DKKP under the foregoing program.

TABLE 6.1

PROJECTED SOLID WASTES COLLECTED

Source	Solid Wastes Collected, Tonnes per day			
	1980	1985	1990	2000
Domestic	234	468	795	1300
Commercial, Institutional and Industrial	161	242	274	354
Markets and Parks	91	103	131	196
Total	486	813	1200	1850

These estimates are summarized graphically in Figure 6.2.

6.2.2 Frequency of Collection

The frequency of collection is determined by two major factors:

1. Flies, which can make use of vegetable putrescible matter as a breeding medium, require about one week for a complete cycle from egg laying to emergence of the adult fly.

2. Decomposition of the putrescible component becomes apparent during the first two days.

When communal containers are used there is little control over the age of the wastes placed in the container which may be already infested with fly larvae. The larger quantities of wastes which are stored at communal sites have a greater potential to become a nuisance to nearby residents. It is preferable therefore to collect wastes from community pools daily. The collection frequency should not be less than three times weekly.

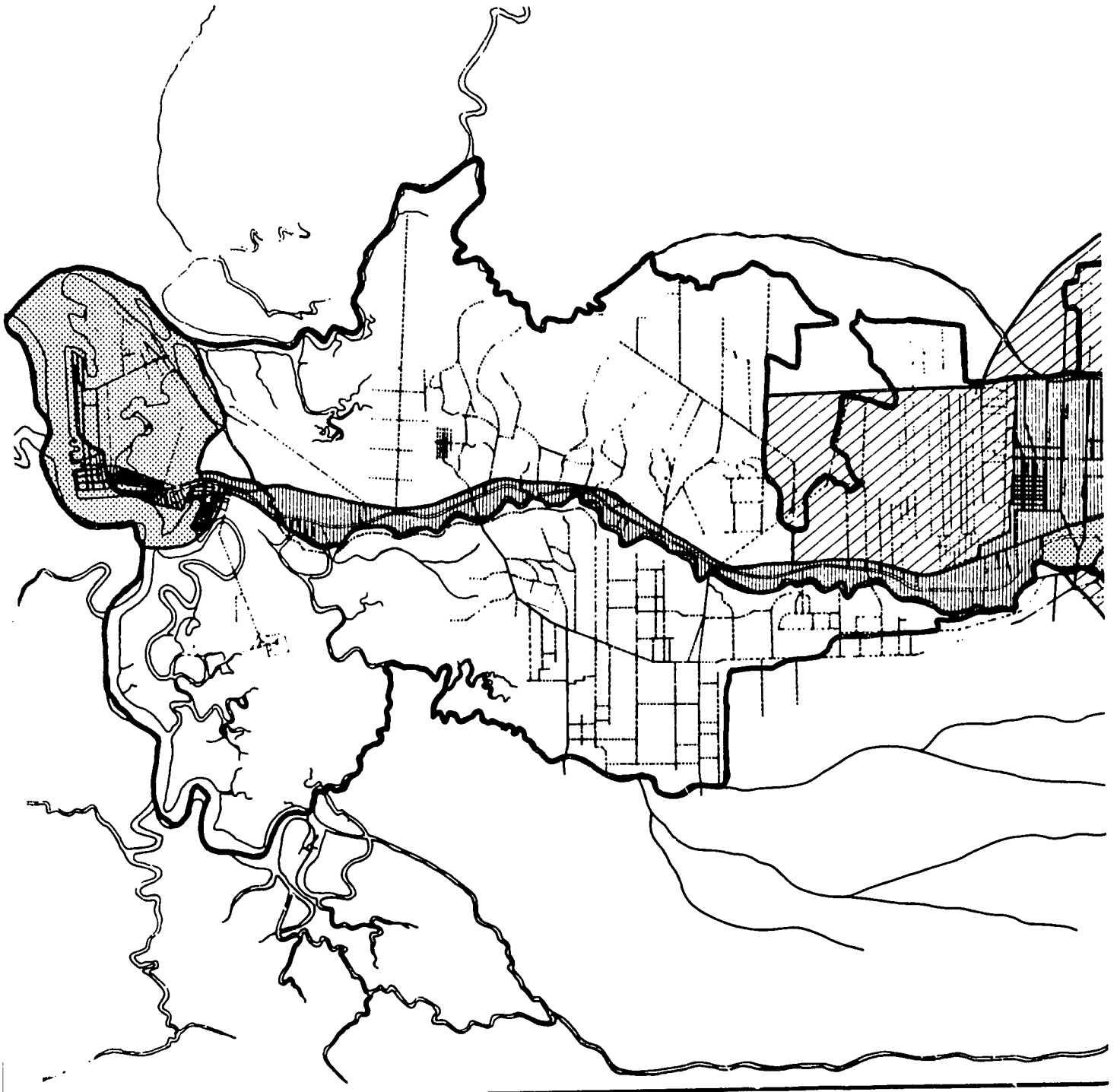

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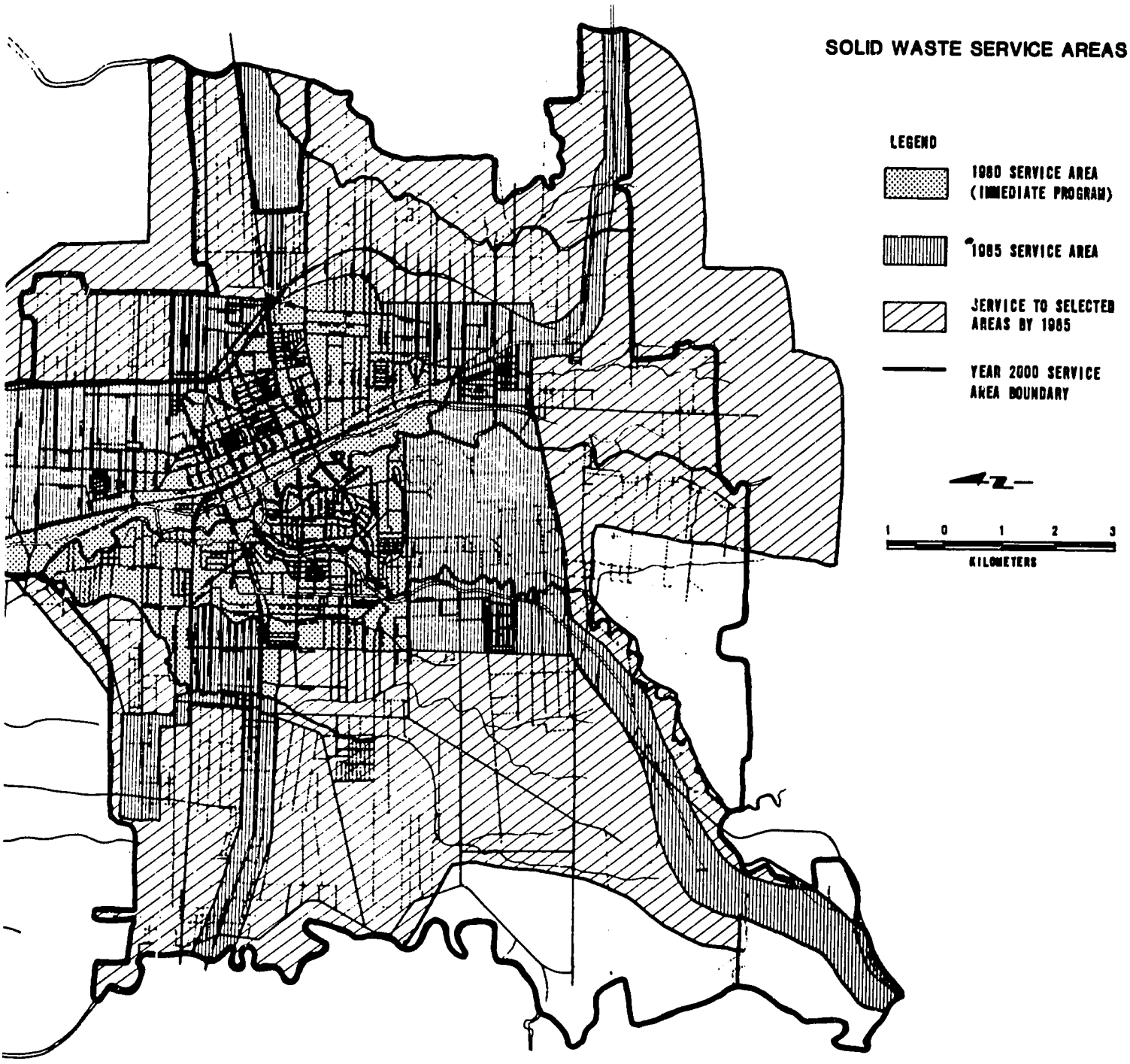
FIGURE



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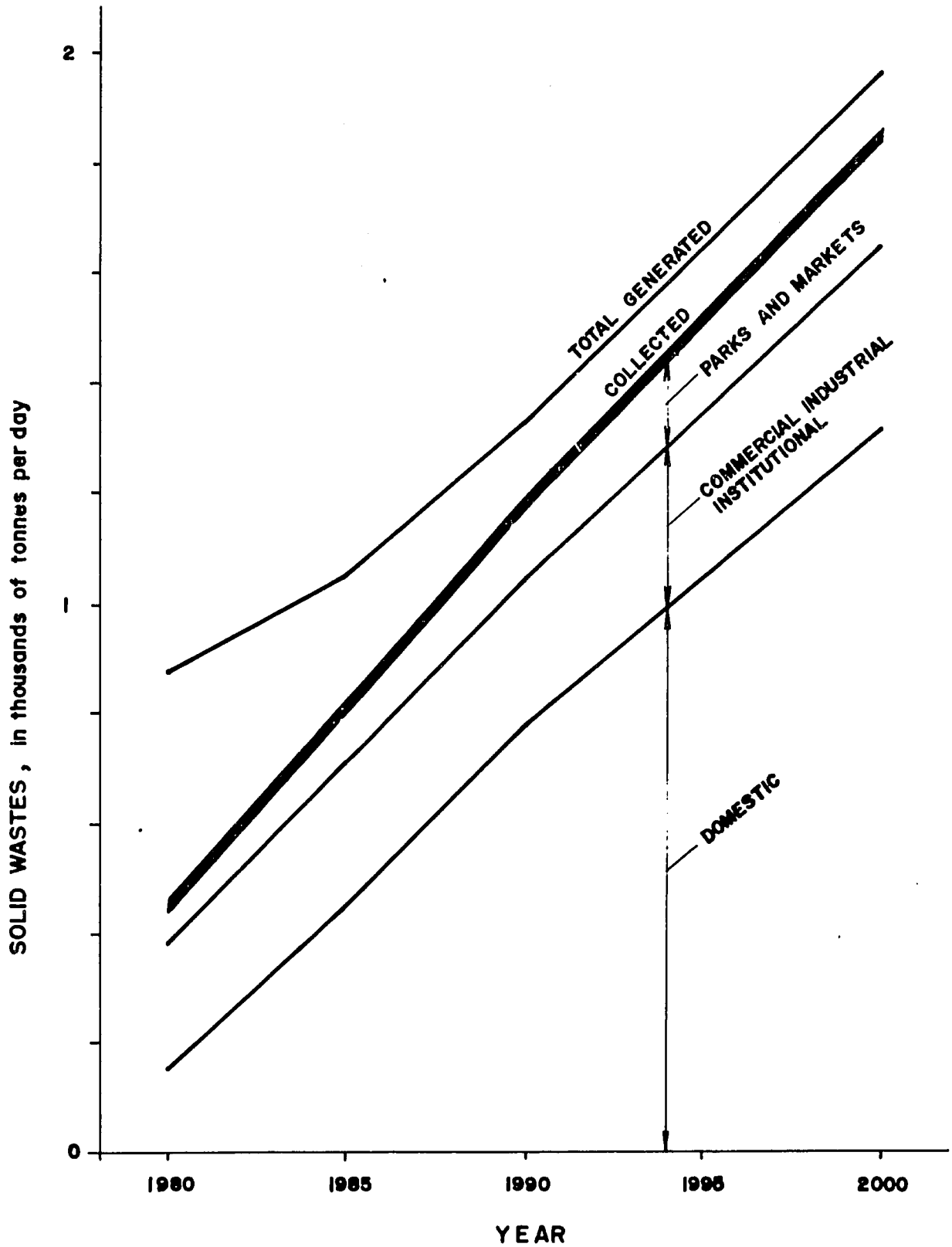
PROJECTED SOLID WASTES QUANTITIES COLLECTED



At individual households where there is space for outdoor storage of wastes in containers with well fitting lids, collection frequencies of once or twice weekly can be considered.

In commercial and industrial areas the quantities of wastes produced, the limited space for storage, the need to maintain higher aesthetic standards, and the quality of the wastes, all contribute to a general requirement for frequent collection service. In some parts of the central commercial area of the city, service is provided 24 hours per day. Daily service should be considered as standard for the commercial, institutional and industrial sectors with modified service available by special arrangement.

6.2.3 Collection Service Types

6.2.3.1 General

In addition to collection frequency the location and size of the storage and transport elements of the system are also major service level variables. Given the kinds of storage and transport methods available locally, the following alternative collection service types were identified for evaluation:

House to house-truck

The solid wastes worker enters the householder's compound to collect the wastes from a household container and carries the wastes to a truck.

House to house-handcart

As above but wastes are carried to a handcart which is taken to a site where the wastes are loaded into a truck or container.

Curbside-truck or handcart

Householder carries solid wastes to the side of the road in a household container in which the wastes are either retained or deposited in a roadside container and are left for subsequent collection by truck or handcart.

Block Collection

Householder delivers the wastes to a collection vehicle at the time of collection.

Communal Collection

Householder delivers the wastes to a community storage facility from which the wastes are regularly collected.

A large number of options are available for specific components of each of the foregoing collection service types. In the design of alternative collection systems, a number of important criteria which have be-

come evident as a result of experience gained under the GOI/Netherlands program must be taken into consideration. These factors are listed below:

- Road conditions limit access to large vehicles in many areas and preclude all 4-wheeled vehicle access in many densely populated areas.
- Delays in collecting containers result in overfilling and spillage creating additional environmental sanitation problems.
- Container size selection in relation to access in various types of areas (in Bandung small household containers were found impractical in kampung areas - large containers were found to be more practical).
- Container durability and the availability of replacement units and parts.
- Maintenance of vehicles and availability of spare parts.
- Vehicle operation at the disposal site.
- Ease of container loading.
- Availability of sites to locate large containers.
- Public participation and education.

Size in relation to accessibility is the single most important factor affecting collection vehicle selection. Current experience in Medan has resulted in maximum truck sizes of 2 tonne payload capacity for general collection service and 3 tonne payload capacity under special circumstances. The 14 cu.m containers used under the GOI/Netherlands program can be used on large major throughfares only.

6.2.3.2 House to House Collection by Truck

The estimated number of households served per collection worker varies primarily with crew size. The more members in a crew the more houses a worker must pass to get to his next pickup. The following estimates have been confirmed to apply to Medan and assume that dwellings are located on individual plots with side yards and are set back from the street allowance. Both sides of the street are assumed to be collected simultaneously.

Crew size (collectors only)	Households per hour per crew	Households per hour per collection worker
2	60	30
4	100	25
6	132	22
8	152	19

Containers used at households will generally not have to be larger than 40 litres to provide for a family of 6 at a maximum collection interval of 4 days. Containers of 50 to 60 litre capacity can be used at shops and market stalls, multiple dwelling units, schools, hotels, and offices.

Comparative unit collection costs were estimated assuming trucks and crews of various sizes with the results show in Figure 6.3. The estimates indicate that:

1. Costs are relatively constant in relation to the size of the collection vehicles.

2. A crew consisting of 4 to 6 collection worker is optimum.

Figure 6.4 shows the relationship between cost and frequency of collection. Although a once weekly collection service is the least costly the increase in cost is particularly significant when collection is more frequent than twice weekly.

6.2.3.3 House to House Collection by Handcart

From the householder's standpoint, the quality of service differs from house-to-house truck service only by the presence of loading stations where the contents of handcarts are transfered to a truck. These stations would be located at intervals of approximately 1 km. Various designs can be considered for the loading stations which will be discussed in later sections.

Comparative costs for this collection alternative are illustrated in Figure 6.4 which shows that handcart collection costs are relatively insensitive to the frequency of collection and are considerably lower than truck collection costs at collection frequencies of 1 and 2 days.

6.2.3.4 Curbside Collection

Curbside collection results in more wastes being collected per hour per crew member because of the shorter distances the wastes must be carried to the collection vehicle. The disadvantage of this type of service is the unsightly presence of either fixed or portable containers at the edge of the road. Production rates are estimated to be as follows:

Crew size (Collection workers only)	Households per hour per crew	Households per hour per collection worker
2	90	45
4	140	35
6	170	28

Comparative unit costs for curbside truck and handcart service have also been shown in Figure 6.4 illustrating that curbside collection service is about 70 percent of the cost of house to house collection service.

CREW SIZE VERSUS COLLECTION COSTS

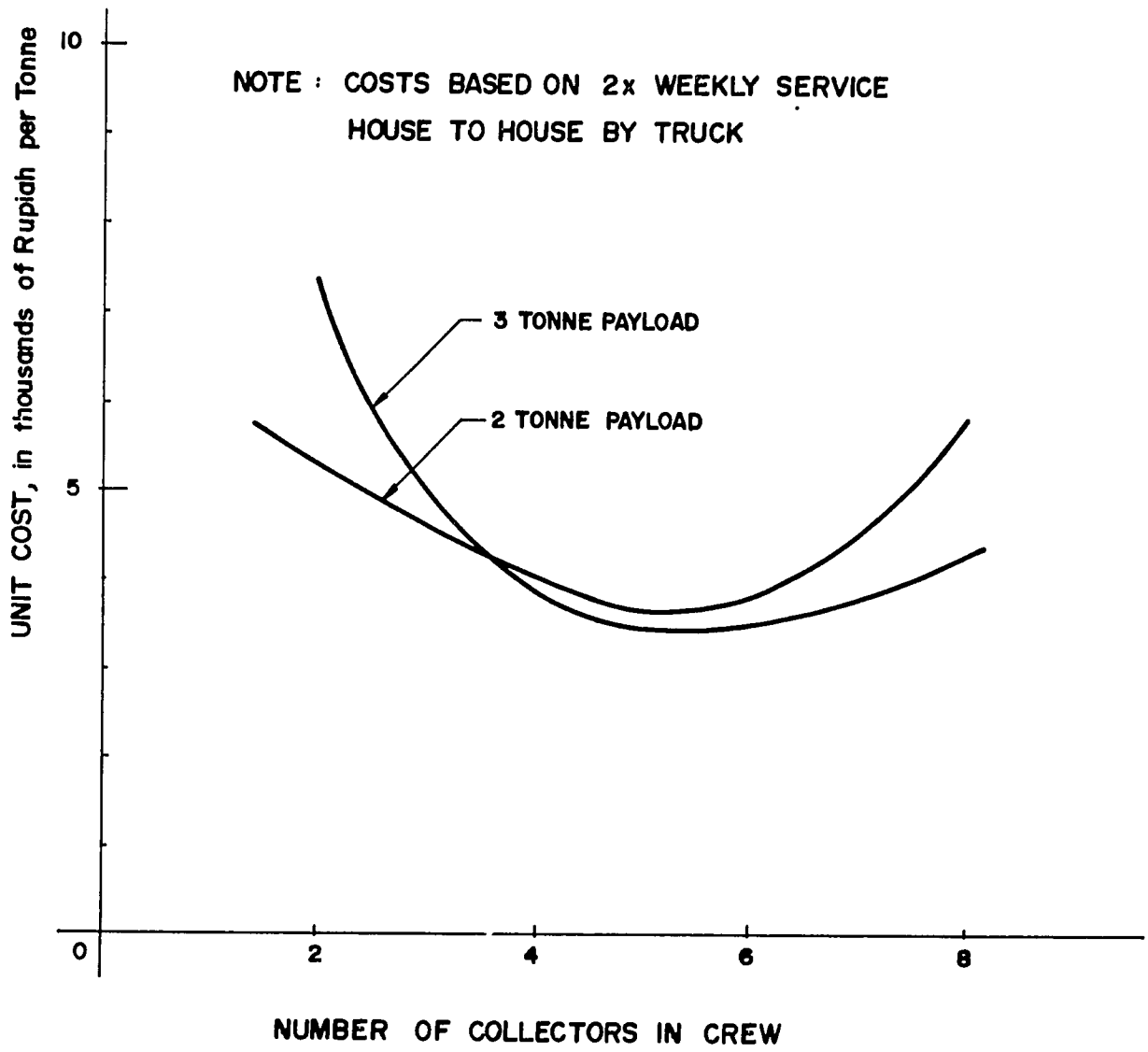
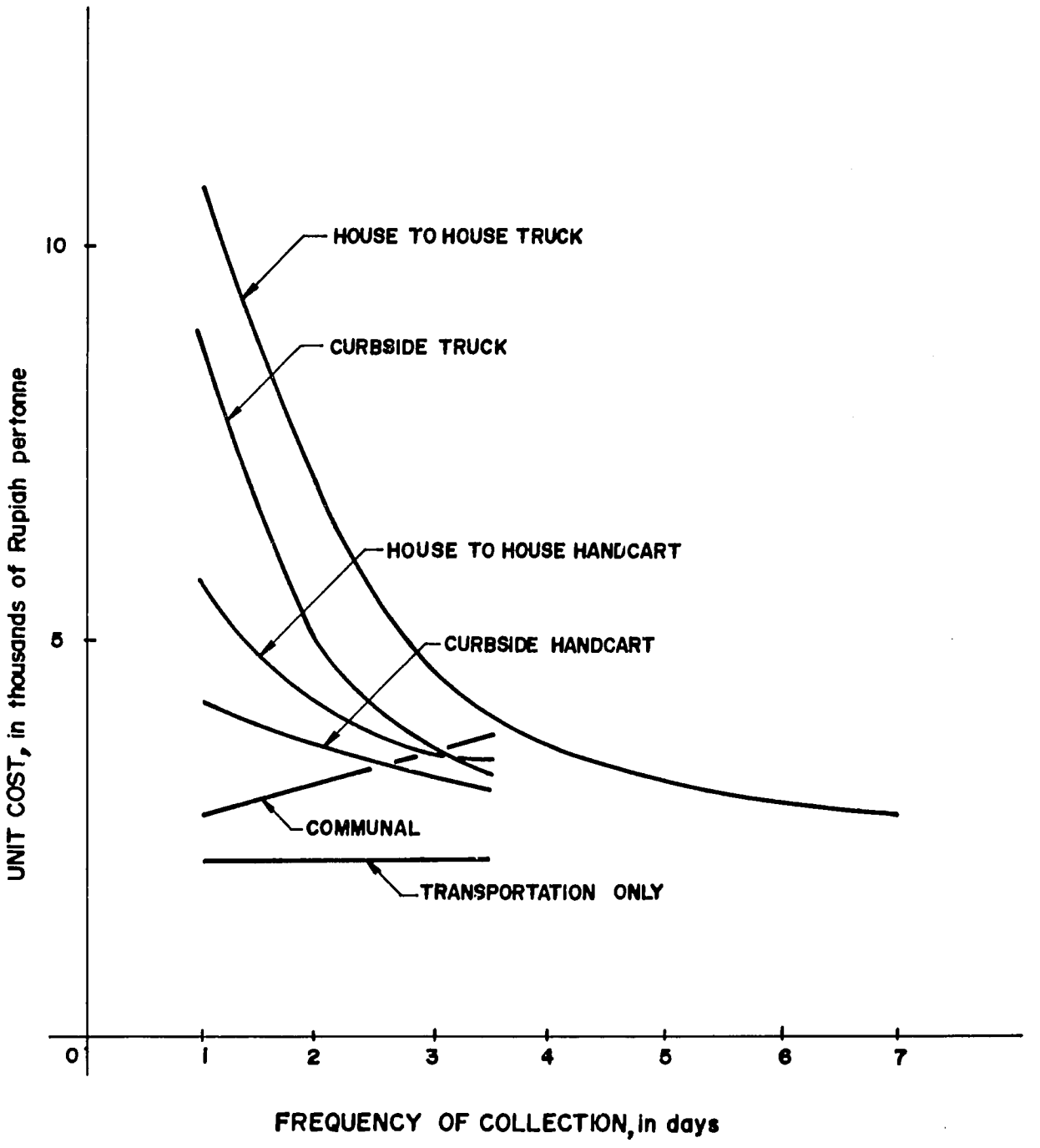


FIGURE 6.4

COMPARATIVE COSTS OF COLLECTION ALTERNATIVES



6.2.3.5 Block Collection

Discussion with local solid wastes management personnel indicate that with this type of service, it would be very difficult to synchronize truck location and householders' daily activities to ensure effective service. This difficulty is a common problem with this type of service, and for this reason this alternative was not given further consideration.

6.2.3.6 Communal Collection

The size and spacing of loading sites used in connection with handcart of similar collection systems and communal facilities is a function of vehicle or container size, contributing population density and optimum travel distance. Distances over which individuals may be required to carry wastes to a communal facility should not exceed 100 to 150 metres.

Determination of the optimum spacing for loading sites requires more detailed analysis; however, it is likely that maximum size of the loading facility is the critical factor. Suitable loading sites must be found where potential nuisances to nearby residents can be minimized. Sites with a storage capacity greater than 15 cu m (4.2 tonnes approx.) should not be considered except under special circumstances. Figure 6.5 shows the maximum spacing for community storage and loading facilities in residential areas for various population densities. From this Figure it can be seen that the optimal range in size of community storage facilities, spaced with a maximum carrying distance of 125 metres, is from 0.5 to 2.0 cu m in residential areas.

In residential areas where collection is by handcart and maximum storage capacity at a loading site is limited to 15 cu m, the spacing ranges from about 0.7 to 1.2 km for population densities ranging from 500 to 200 per ha.

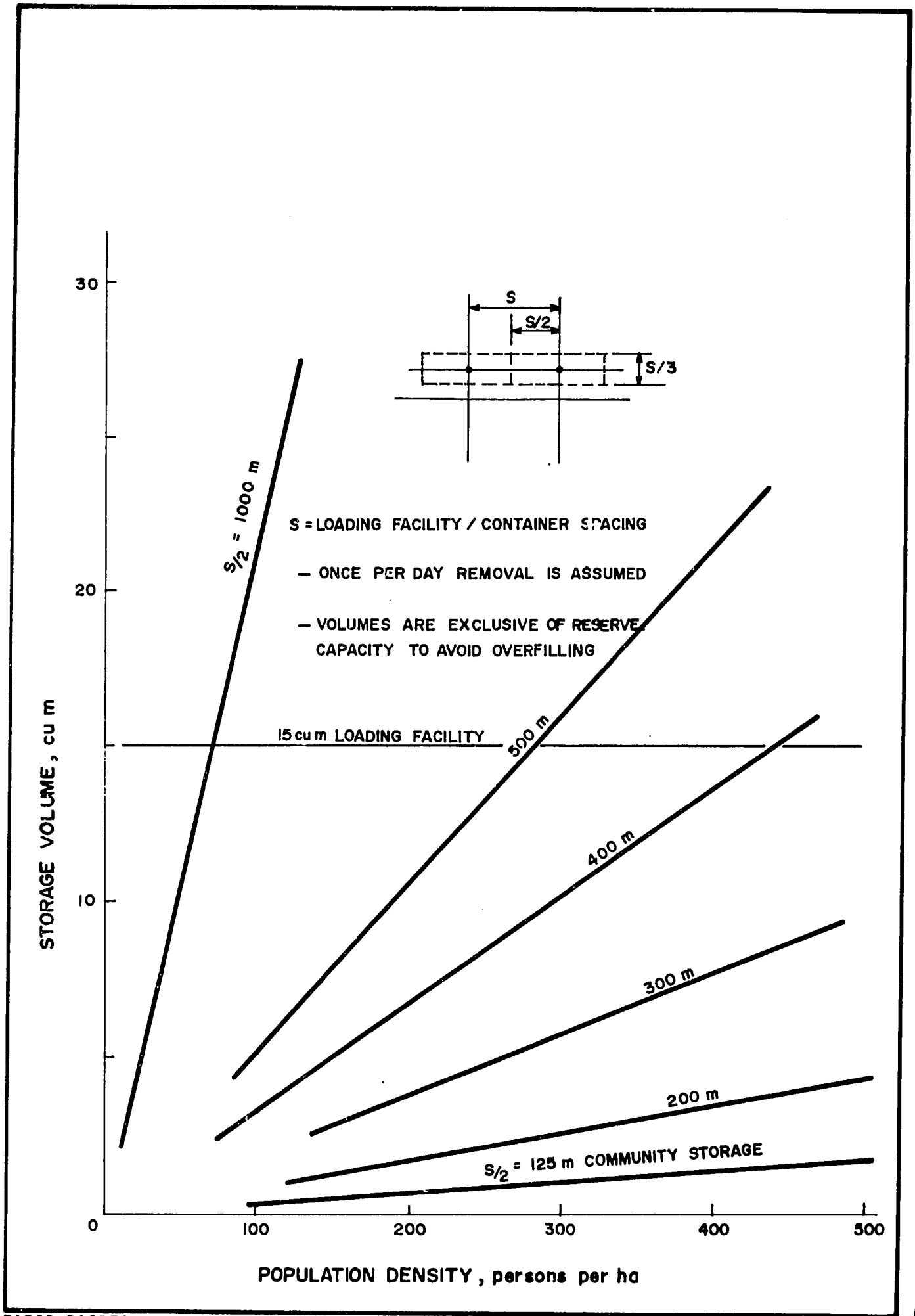
To minimize container overflow it is recommended that additional storage of from 50 to 100 percent be provided at community storage and loading facilities to allow for short-term variations in generation rates and some irregularity of collection service.

The relatively small size of communal storage facilities derived above suggests that a mobile container such as a gerobak or some alternative handcart design would be ideally suited for this application.

The collection task carried out by each worker would consist of pulling the handcart to a loading station site, transfering the contents to a truck, and then taking the emptied handcart to the next pickup location, leaving it there and taking the full handcart to the loading station site.

Experience in Medan has shown that about a 0.7 cu m handcart can be conveniently handled by a 2-man crew. Handcarts would be positioned at suitable locations in the service community and spaced so that the container is filled to capacity during the time between collections. The maximum spacing would be about 150 metres.

FIGURE 6.5


S
S/2
S/3
S = LOADING FACILITY / CONTAINER SPACING
— ONCE PER DAY REMOVAL IS ASSUMED
— VOLUMES ARE EXCLUSIVE OF RESERVE CAPACITY TO AVOID OVERFILLING
S/2 = 1000 m
500 m
400 m
300 m
200 m
S/2 = 125 m COMMUNITY STORAGE
15 cu m LOADING FACILITY
STORAGE VOLUME, cu m
0
10
20
30
100
200
300
400
500
POPULATION DENSITY, persons per ha

With the above collection model the effect of providing less frequent service is to increase the required storage capacity in the system and to increase costs.

Figure 6.4 also shows the comparative cost of this type collection service which at collection intervals of one or two days offers significant reductions in cost.

If the householder were to assume the task of carrying wastes to the loading facilities, a maximum distance of 0.5 km, costs could be further reduced as indicated in Figure 6.4. However, experience in other developing countries has shown that the effectiveness of this form of communal service is limited and will undoubtedly result in refuse being disposed of at more convenient locations such as drains or open areas.

It is also of interest to note that the longer the interval between collections, the less significant the cost difference among alternatives becomes.

6.2.3.7 Summary of Collection Service Types

The comparative costs of the various collection alternatives are summarized in Table 6.2.

TABLE 6.2

SUMMARY OF UNIT COSTS FOR
ALTERNATIVE SOLID WASTE SERVICE LEVELS

	Thousands of rupiah per tonne Frequency of collection		
Service Classification	1 day	2 day	2 x weekly
House to House truck	10.7	7.0	4.0
Curbside truck	8.7	5.0	3.3
House to House handcart	5.7	4.2	3.5
Curbside handcart	4.2	3.7	3.1
Communal	2.8	-	-
Transportation	2.3	-	-

In order to select appropriate systems for application in Medan it is necessary to rank the various service types according to local preferences. A ranking system is presented in Table 6.3.

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TABLE 6.3

RANKING SYSTEM FOR ALTERNATIVE SOLID WASTE SERVICE LEVELS

Preference Ranking	System		Comparative Unit Cost, thousand Rp. per tonne
1	Daily - house to house	- truck	10.7
2	Daily - house to house	- handcart	5.7
3	Daily - curbside	- truck	8.7*
4	Daily - curbside	- handcart	4.2
5	2 day - curbside	- truck	5.0
6	2 day - curbside	- handcart	3.7
7	2 day - house to house	- truck	7.0*
8	2 day - house to house	- handcart	4.2*
9	2 x week - curbside	- truck	3.3
10	2 x week - curbside	- handcart	3.1
11	2 x week - house to house	- truck	4.0*
12	2 x week - house to house	- handcart	3.8*
13	Communal		2.8
14	Transportation only		2.3

* Denotes cost higher than a prefered alternative.

A strong local preference is evident for daily collection of any type rather than less frequent collection. For collection intervals exceeding 1 day, curbside pickup is prefered over house to house service as householders seem to prefer not to store wastes on their premises even for periods of 2 days. However, experience has indicated that with proper household containers and where adequate exterior household storage space exists, 2 days service can be acceptable.

Little preference was indicated between truck and gerobak service, possibly indicating that the householders primary concern is within the immediate environment of the home. However, current experience in Medan indicates that the acquisition of sites at which handcart loads can be transfered to transportation vehicles will be difficult to obtain because of fears that they will create a nuisance to nearby residents.

Based on the foregoing considerations, the alternative systems shown in Table 6.4 have been identified as being suitable for application to the various categories of solid waste generato s in Medan.

TABLE 6.4

APPROPRIATE SOLID WASTE SERVICE LEVELS FOR MEDAN

Service Level	Description			Unit Cost Thousands of Rp/tonne
Domestic				
1	Daily	- House to house	- truck	10.7
2	2 Day	- House to house	- truck	7.0
3	Daily	- House to house	- handcart	5.7
4	2 Day	- House to house	- handcart	4.2
5	2 Day	- Curbside	- handcart	3.7
6	2 x weekly	- Curbside	-	3.3*
7	Communal			2.8
Commercial, Industrial, Institutional				
1	Daily	- House to house	- truck	10.7
2	Daily	- Curbside	- truck	8.7
3	Daily	- Curbside	- handcart	4.2
Markets and Parks				
	Transportation only			2.3

* The difference in cost between the use of truck and handcart collection vehicles in this service level is insignificant.

6.2.4 Street Sweeping

Street wastes fall into the following categories:

Natural wastes - dust blown from unpaved areas

- decaying vegetation such as leaves, blossoms and seeds.

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Traffic wastes - oil, rubber and mud from motor vehicles

- animal excrement

- mud and debris from construction sites

- load spillage

Human generated- litter

- disposal of household and commercial solid wastes in the street

- human spittle and the excrement of household pets

Other - ditch dredgings, grass and shrubbery clippings.

Human generated wastes constitute the greatest proportion of the street wastes in most areas of the city.

Three types of surface are found in most of the street rights-of-way which are cleaned by the street sweepers:

- paved road surface, consisting of the roadway crown and edges. The road edges may be provided with a curb and gutter with drainage outlets to allow street drainage to enter the roadside ditches or underground drainage conduits.

- walkways

- grassed areas with plantings.

The control of street wastes can be affected by the following methods in addition to the provision of an effective street cleaning operation.

Natural wastes - careful selection of the type of trees planted in the city.

Traffic wastes - regulatory control, especially with regard to load spillage and wastes from construction sites.

Human generated- effective municipal refuse collection

- provision of litter bins

- public education

- regulation.

In Medan the low cost of labour and its flexibility is the major factor affecting the choice of cost effective methods for street cleaning. The operation of mechanized street sweepers would be confined to paved

surfaces leaving walkways and grassed areas to be swept by hand. Congested streets also restrict the movement of street sweeping machines.

Projected future street sweeping requirements in the city are presented in Table 6.5.

TABLE 6.5

PROJECTED STREET SWEEPING REQUIREMENTS

Frequency of sweeping	Length of street surface to be swept/km			
	Present	1985	1990	2000
1 x daily	101	118	135	168
2 x daily	104	121	139	173
3 x daily	16	19	21	27
4 x daily	3	3.5	4	5
Total	224	261.5	299	373

6.3 TRANSFER AND DISPOSAL ALTERNATIVES

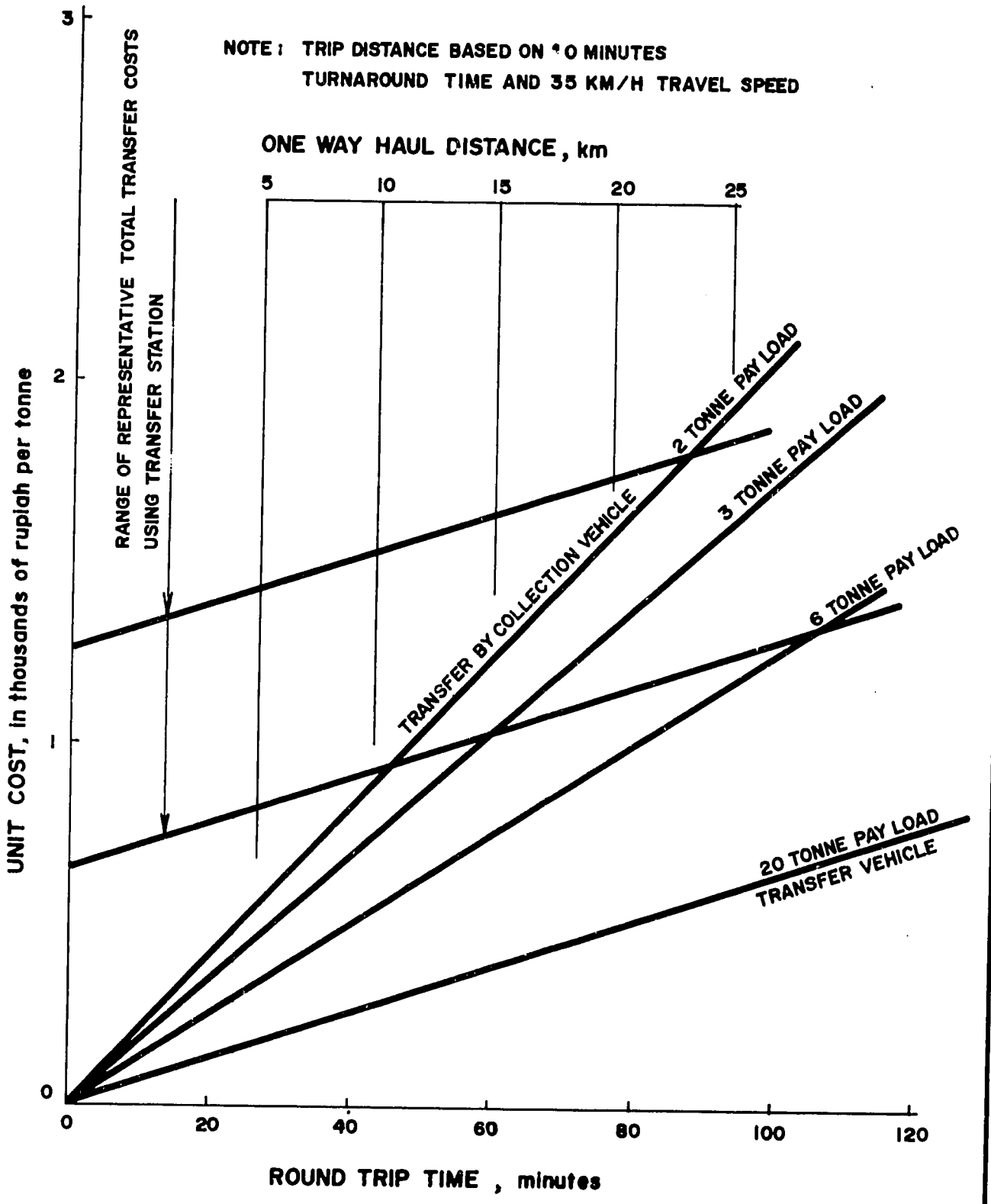
6.3.1 Transfer

Conventional solid wastes transfer facilities are employed at central locations in or near the service area to transfer solid wastes from collection vehicles to larger truck/trailer combinations for transportation to distant disposal sites. Typically such facilities may be more cost effective than direct haul in the collection vehicles when one way haul distances exceed approximately 10 km. Typical relationships are shown in Figure 6.6.

In Medan the maximum probable mean one way haul distance (to a potential disposal site near Belawan) is approximately 20 km. A number of other potential disposal sites are located within 10 km.

On the basis of the foregoing it is apparent that transfer facilities should only be considered for mean haul distances in excess of 10 - 20 km, and then only after making a careful analysis and evaluation of costs and operational factors for any specific site. It is unlikely that transfer stations will prove to be a cost effective element of the solid waste management system in Medan.

FIGURE 6.6


NOTE: TRIP DISTANCE BASED ON 40 MINUTES TURNAROUND TIME AND 35 KM/H TRAVEL SPEED
ONE WAY HAUL DISTANCE, km
5
10
15
20
25
RANGE OF REPRESENTATIVE TOTAL TRANSFER COSTS USING TRANSFER STATION
UNIT COST, in thousands of rupiah per tonne
3
2
1
0
2 TONNE PAY LOAD
3 TONNE PAY LOAD
TRANSFER BY COLLECTION VEHICLE
6 TONNE PAY LOAD
20 TONNE PAY LOAD TRANSFER VEHICLE
0
20
40
60
80
100
120
ROUND TRIP TIME, minutes

6.3.2. Disposal

6.3.2.1 General Considerations

Sanitary landfill, composting and incineration are commonly considered for application for the disposal of solid wastes. Representative comparative costs for these systems are as follows:

Alternative			Unit Cost Rp/Tonne
Sanitary landfill			2,000
Composting	: Windrow system		
	Cost per tonne compost	7,500 Rp.	3,750
	Revenue per tonne compost	4,500 Rp.	
	Net cost per tonne compost	3,000 Rp.	1,500
Incineration	: No heat recovery and no special emission controls		7,000

Composting also has two interesting variants which are currently applied in Medan:

1. Compost derived from old landfill sites, and

2. The use of old landfill sites for agricultral purposes such as banana cultivation.

Both of these options represent future benefits derivable from proposed landfill operations.

Experience with composting operations elsewhere in the world has clearly indicated that composting as a commercial venture should be approached cautiously and should be undertaken only when markets and prices can be assured by contract, as is the case with the existing composting operation in Medan.

The expanded application of composting on a larger scale than at present as part of the master plan solid wastes disposal program should be a subject of ongoing investigation based in part upon experience gained by the existing commercial operations. Should it be determined that increased production of compost is commercially viable the payment of a disposal fee to the composting operation could reasonably be considered.

In the meantime, it is recommended that future system planning be based upon the use of sanitary landfills for solid waste disposal.

Alternative sanitary landfill systems which can be considered are discussed in the following section.

6.3.3 Sanitary Landfill Alternatives

The topography of the study area provides three general types of sites that are available for landfill operations.

Ravines

Erosion of the volcanic soils has created many ravine or gully type configurations. The adjacent topography associated with some of these, as related to drainage through the ravine, make some ravines suitable for consideration as potential landfill sites using ravine fill methods. These are located primarily to the south of Medan.

Plains

To the north, east and west of Medan there are tracts of flat land, most of which are currently under agricultural production, which are suitable for the development of landfill sites using an area fill type of operation.

Coastal lowlands

These areas are subject to frequent flooding. At other such locations in Indonesia, land reclamation using solid wastes as a fill material has been practised. Future uses of such fill areas must take into account potential problems associated with:

1. The escape of leachate from the fill to adjacent natural waters.

2. Long-term settlement of the solid wastes, making such sites unsuitable for the application of many building foundation systems.

3. Production of methane which can create hazardous conditions.

Areas of this type which can be considered are located in the vicinity of Belawan.

Typical sites which can be considered are shown in Figure 6.7. In view the relatively small capacity of collection transfer vehicles the simultaneous use of more than one landfill site must be considered in the interest of overall system economy and such disposal systems are evaluated in the following section. Total landfill volume requirements to year 2000 are shown in Figure 6.8.

6.3.4 Salvage and Recycling

At the present time materials recovery from domestic wastes is practiced in Medan by:

1. Householder recovery - bottles, rags, old clothing and paper.

2. Recovery at pool and disposal sites.

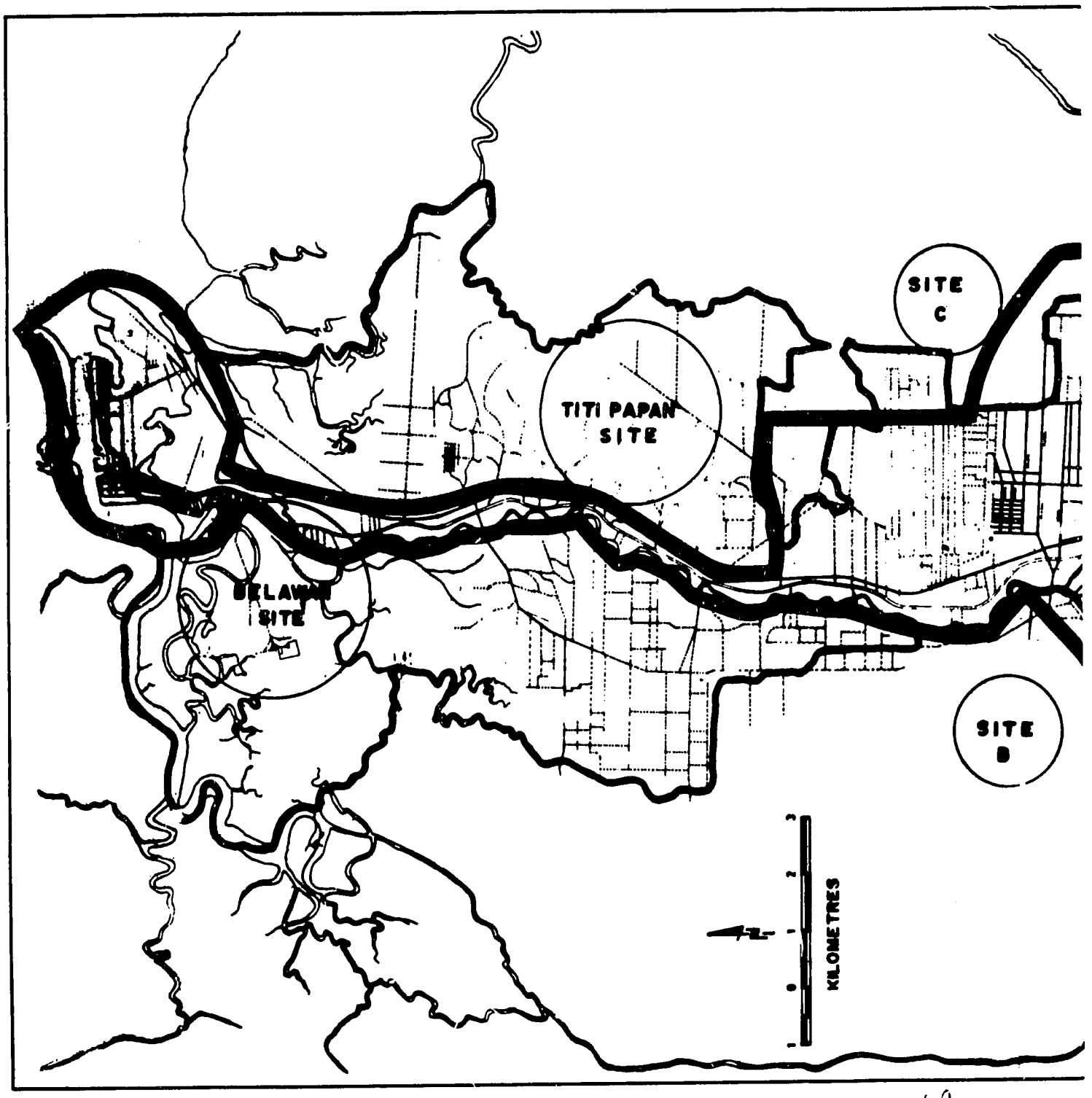


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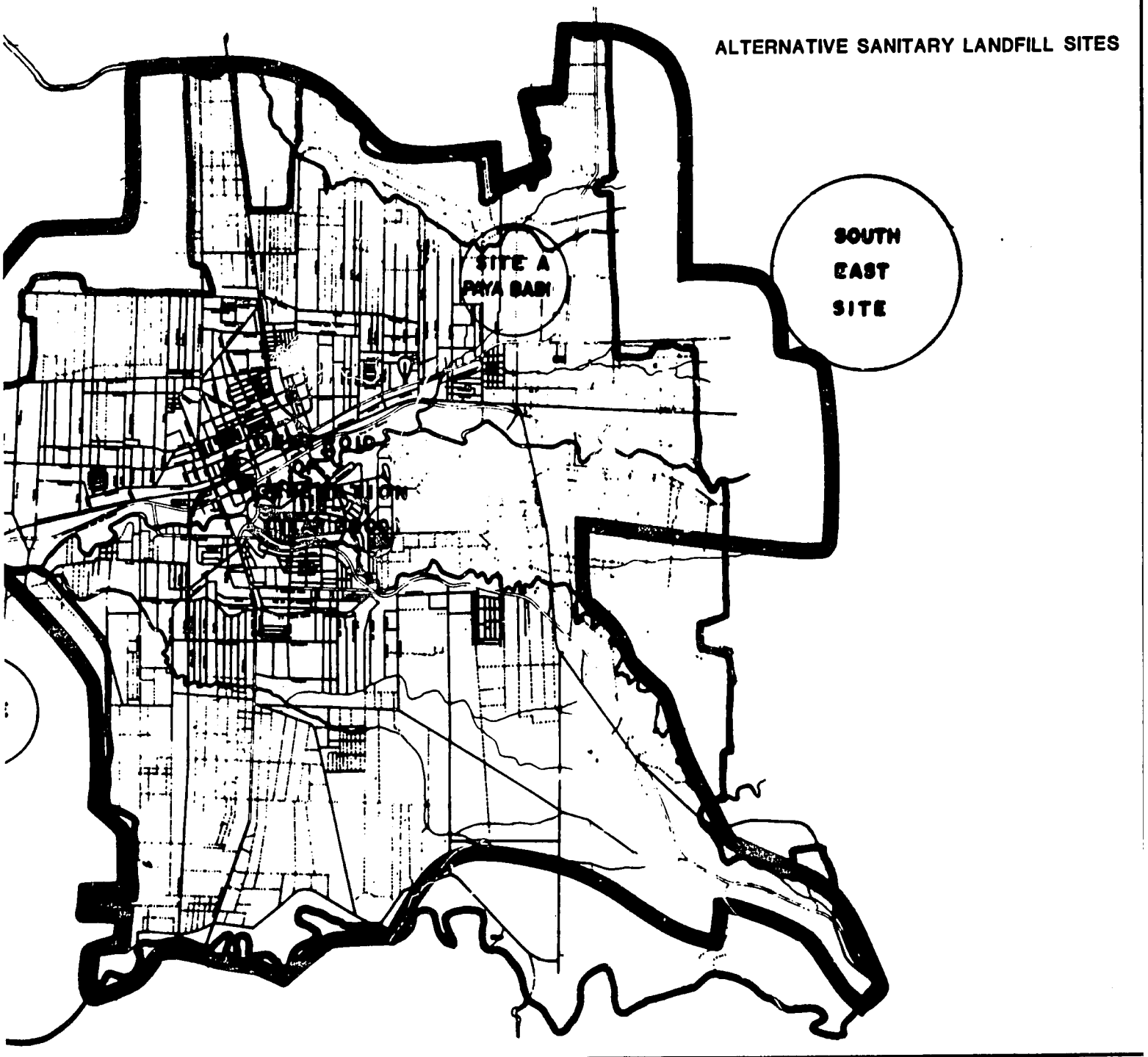
FIGURE 8.7



ENGINEERING-SCIENCE - SINOTECH

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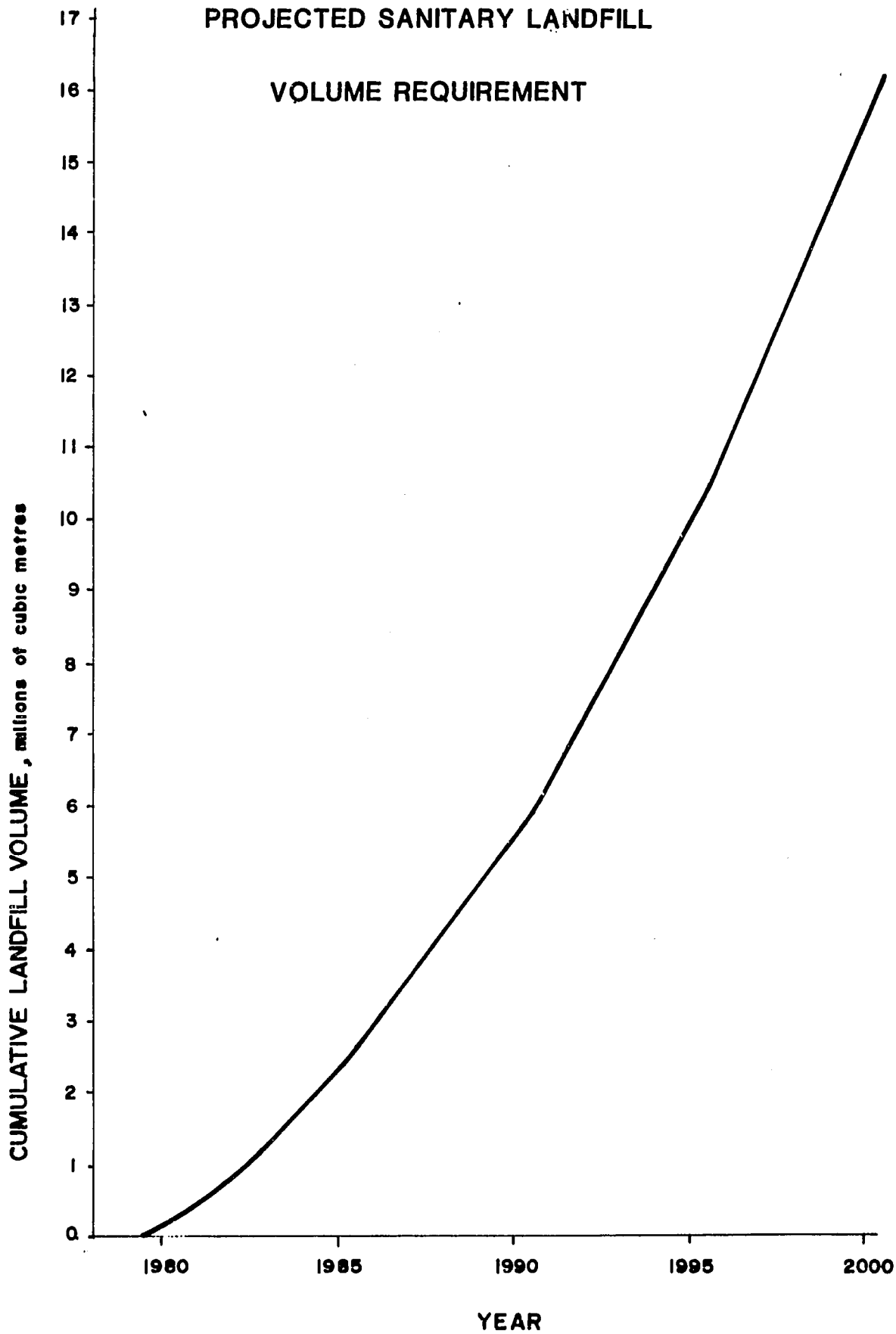
PROJECTED SANITARY LANDFILL
VOLUME REQUIREMENT
CUMULATIVE LANDFILL VOLUME, millions of cubic metres
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
1980
1985
1990
1995
2000
YEAR

In the future it is recommended that householder recovery be encouraged and that salvage operations at other points within the collection system be discouraged. It is recommended that such salvage activities be limited to the disposal area. Some control should be exercised to ensure minimum interference with disposal operations. Control could be accomplished by restricting access to the site and by issuing permits to salvage operators.

6.4 COLLECTION AND DISPOSAL OUTSIDE MUNICIPAL SERVICE AREAS

In many less densely populated areas existing household disposal practices such as burial or household composting can be continued with little difficulty. Under the staged program described in Section 9.2, many areas will continue to be without municipal solid wastes collection service provided by DKKP until 1990. It is proposed that in these areas DKKP offer an advisory service at the Kecamatan and Kampung levels to assist local officials with critical solid wastes management problems.

6.5 EVALUATION OF ALTERNATIVES

6.5.1 Service Area and Staging

The service area and staging alternatives previously described would result in the provision of solid wastes service to the various service groups as summarized in Table 6.6.

TABLE 6.6

ESTIMATED PERCENTAGE OF SOLID WASTES COLLECTED UNDER STAGED PROGRAM

Service Group	Percent of solid wastes collected 1980	1985	1990	2000
Domestic				
Low Income				
High Density	49	70	84	89
Medium Density	34	56	84	89
Low Density	15	72	84	89
Sub-Total	35	60	84	89
Medium Income	76	74	84	89
High Income	60	64	84	89
Total Domestic	40	62	84	89

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TABLE 6.6--Continued

Service Group	Percent of solid wastes collected 1980	1985	1990	2000
Commercial, Industrial Institutional	79	100	100	100
Markets & Parks	100	100	100	100
Total	57	74	89	92

Under the staged program, by the end of 1980, service would be provided to most of the commercial areas, markets and parks and also to about 35 percent of the low income group including 49 percent of the low income high density population.

The first stage program will then focus on the central city high density kampungs so that by 1985, 60 percent of the low income group including 70 percent of the high density low income population will be provided with service.

One of the distinct benefits of the staged program is that the proportion of wastes collected from the commercial, institutional and industrial sectors is large in relation to the domestic component including the income groups who must be provided with subsidized service. This enhances the overall financial feasibility of the program and the opportunity for cross subsidy in developing a rate structure for solid wastes service.

6.5.2 Alternative Collection Systems

The major factors in the evaluation and application of alternative types of collection service are cost and affordability. For the purposes of this evaluation it was assumed that the average household will be able to devote about one percent of its monthly household expenditures for solid wastes service. The cost per household for each alternative collection system was calculated as summarized in Table 6.7.

TABLE 6.7

ESTIMATED UNIT COSTS OF ALTERNATIVE SOLID WASTE SERVICE LEVELS

Alternative Collection Service Level		Cost, Rp/month/ household
Daily	- house to house, truck	760
2-Day	- house to house, truck	420

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TABLE 6.7--Continued

Alternative Collection Service Level		Cost, Rp/month/ household
Daily	- house to house, handcart	310
2-day	- house to house, handcart	170
2-day	- curbside handcart	130
2 x weekly	- curbside	90
Communal		50

Transportation and disposal costs were then added and the required household expenditure level was calculated.

The proportion of the population which can afford the various levels of service based on the foregoing criteria are shown in Figure 6.9.

This analysis indicates that only the high income group consisting of about 4 percent of Medan's household can afford the highest level of collection service, daily house to house collection by truck. For the middle income group, comprising 15 percent of households, intermediate levels of service can be provided. The recommended service types are therefore 2-day house to house truck and daily house to house handcart.

To the majority of households in the low income group, which make up about 82 percent of the population, not even the least costly form of collection service is affordable. Almost 60 percent of all households will require some level of subsidy if a minimum acceptable level of communal service is to be applied throughout the city.

For the remainder of the low income group (about 21 percent of all households a somewhat more prefered service can be considered including the 2-day house to house handcart, and 2-day or 2 x weekly curbside handcart service levels.

6.5.3 Costs

6.5.3.1 Transfer and Disposal Alternatives

The cost of alternative transfer/disposal systems is a critical factor affecting selection. A comparative cost analysis has been carried out considering transportation, site acquisition and operating costs with the results shown in Table 6.8.

AFFORDABILITY OF SOLID WASTE COLLECTION ALTERNATIVES

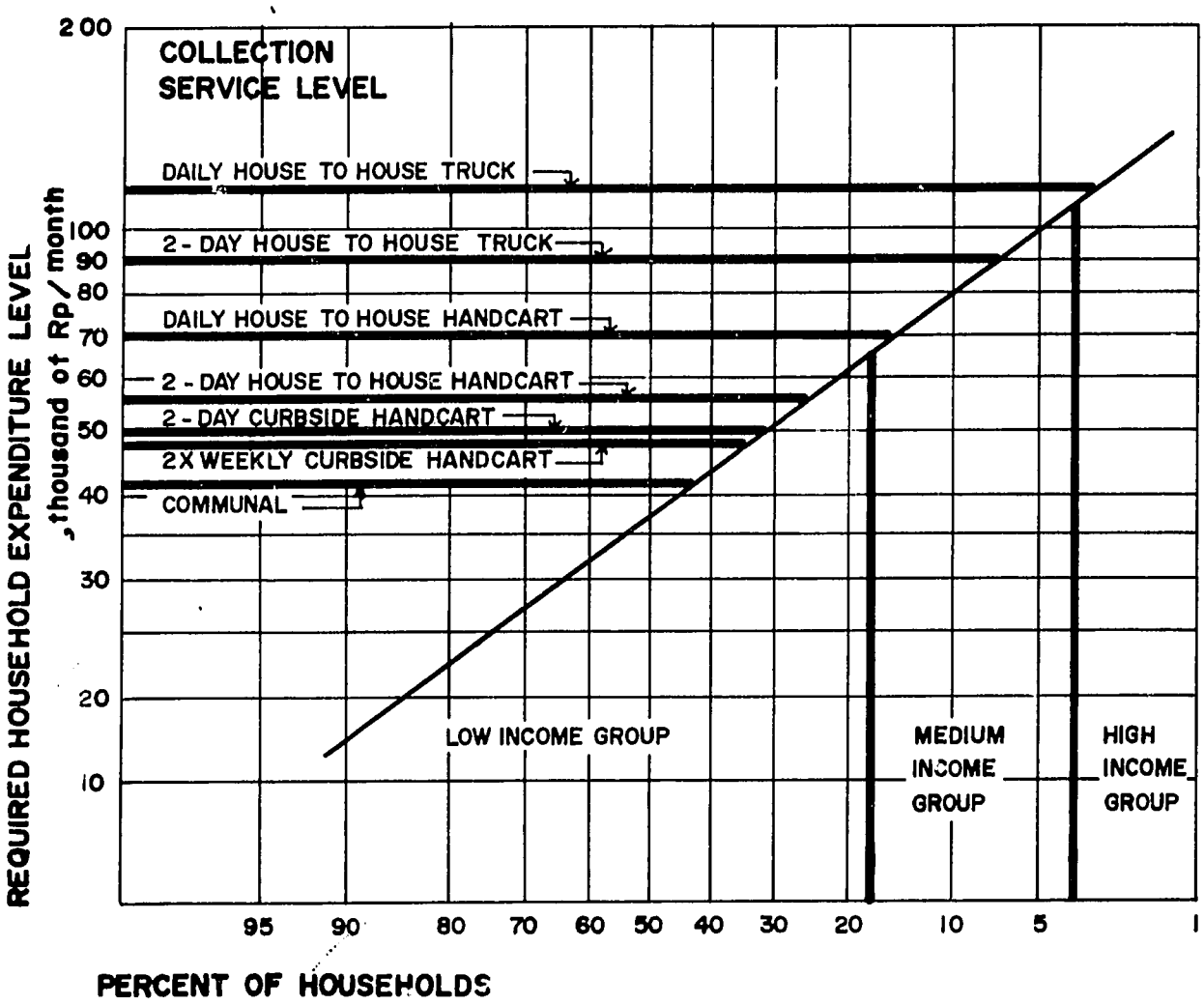

TABLE 6.8

SUMMARY OF ESTIMATED CAPITAL COSTS OF TRANSFER AND DISPOSAL ALTERNATIVES

Alternative Description	Unit Cost (4) Thousands of Rp/Tonne		
	Transfer	Disposal	Total
1. Single site Belawan (1)			
a. Direct	1,000	900	1,900
b. Transfer station	1500-2100	900	2400-3000
2. Single site - Titipapan (2)	800	1,600	2,400
- South East (2)			
3. Single site A Medan Barat(3)	400	2,000	2,400
B Paya Babi Area (3)			
4. Multiple sites (3)			
Medan: a. Site A & B	350	2,000	2,350
b. Sites A, B, & C	300	2,000	2,300

Notes: (1) Land costs based on 200 Rp/sq.m
(2) Land costs based on 500 Rp/sq.m
(3) Land costs based on 700 Rp/sq.m
(4) Land costs exclude compensation for improvements and crops. Disposal costs assume cover material is available on site and that sites are readily accessible.

From the foregoing it is evident that the cost differential is not large among the transfer/disposal alternatives. The use of multiple sites does not result in significant cost reductions within the range of alternatives examined. The greater haul distances associated with the Belawan, Titi Papan and South East sites are offset by lower land costs. The use of transfer stations for the Belawan site is significantly more costly.

The acquisition of landfill sites is at best a difficult process from the standpoint of public acceptance. Without significant benefits the selection of multiple sites is difficult to justify. Initially in Medan a single landfill site should be considered.

The selection of the optimum site will depend upon a number of factors including land cost, compensation for land improvements and

crop losses, accessibility, and site development costs including the availability of cover material, all of which are dependent upon site-specific investigations.

At this stage of the investigation, sites in Belawan, Titi Papan, and to the South East of the city are all promising. Site development costs and the availability of cover material and the short term congestion along the road Belawan tend to make the cost and convenience of a Belawan site somewhat uncertain. With construction of the proposed Toll Road this latter situation will be improved considerably. Other disadvantages must be weighed against the advantage of the isolation of the site from areas suitable for urban development. If similarly priced sites are available closer to Medan, they would result in significant reduction in overall haul and disposal costs. Accordingly, system requirements for the Master Plan investigation have been based upon the use of the Belawan site. If all of the solid wastes generated under the staged program to the year 2000 are disposed of at Belawan to a finished depth of 2 metres the site area requirements would be approximately 800 hectares. Landfill sites are frequently developed to elevations much higher than the surrounding terrain with corresponding reductions in the total site area required. Such practices can be considered in Medan, although it must be recognized that future potential beneficial uses of the completed site would be restricted.

SECTION 7

RECOMMENDED SOLID WASTES MANAGEMENT SYSTEM

In Section 6 alternatives for solid wastes collection and disposal were evaluated for application in Medan and optimum system components were identified. In this section the recommended-system is described and preliminary system cost estimates are presented.

7.1 DESCRIPTION OF THE RECOMMENDED SYSTEM

7.1.1 General

The existing solid wastes management system requires substantial expansion to:

- Increase the quantity of solid wastes collected
- Provide a higher standard of service, particularly in relation to the operation of the pool and disposal sites, and
- Provide for the adequate disposal of collected solid wastes.

The up-grading of collection service to include all of the solid wastes generated in the central area of the city will require about three times the level of effort now being applied to the solid wastes management system.

The type of collection service can be varied to suit the service requirements, physical contraints (such as access for vehicles), and financial capabilities of the various areas of the city. Solid wastes collection will continue to be a labour intensive operation utilizing handcarts and sweepers in most areas.

The major elements of the recommended solid wastes management system are as follows:

1. Priorities and Staging

   1980 - Immediate Action

   Upgrade service to provide for all wastes generated in the primary area.

y 1985 - First Stage

Extend service to include all of the primary and secondary areas, the corridors of regional roads and selected satellite residential developments within the tertiary area.

By 1990 - Second Stage

Extend service to the entire area of Kotamadya Medan except in low density rural areas which can continue to employ household disposal methods effectively.

By 2000 - Third Stage

Expand service to keep pace with urban development.

2. Collection Service

Apply collection systems throughout the service areas described above in accordance with the following schedule:

Service Group	Service Level	Description
Domestic		
High Income	1	Daily-house to house-truck
Medium Income	2	Every second day - house to house-truck
	3	Daily-house to house-handcart
Low Income	4	Every second day - house to house-handcart
	5	Every second day - curbside-handcart
	6	Twice weekly - curbside
	7	Daily-communal
Commercial, Industrial, Institutional		
	C1	Daily-house to house-truck
	C2	Daily-curbside-truck
	C3	Daily-curbside-handcart
Markets and parks		Transportation only

3. Transfer Stations

Major transfer facilities are not recommended as elements of the Medan solid wastes management system. When haul distances to disposal sites exceed 10 km, vehicles with a minimum payload of 3 tonnes should be used.

Smaller, secondary transfer facilities or "loading stations" are required within the collection system to facilitate the transfer of handcart loads to trucks. Many optional designs are available which can be evaluated in subsequent feasibility

studies. The maximum spacing of loading stations is one kilometre. Solid wastes removal from loading stations will be carried either continuously or at intervals not exceeding one day. Temporary storage at loading station sites, if required, will not exceed 15 cu m.

4. Disposal

It is assumed that the existing commercially operated composting plant will continue to act as an element of the solid wastes disposal system at least in the short-term.

Sanitary landfill is proposed for the disposal of the rest of the municipal solid wastes. Several potential sites have been identified, and although conceptual planning has been based upon a site at Belawan, final site selection will be made at a later stage of project development.

The relocation of existing materials recovery operations to the disposal site should be considered.

5. Collection and Disposal Outside the Municipal Service Area

In areas outside of the boundaries of the municipal service area household disposal practices will continue.

In rural areas with low population density solid wastes can be disposed of effectively by burial or by composting. Some types of wastes, such as paper and leaves, can also be burned without creating significant nuisance.

The following features are considered to be important elements of the solid waste management program to mitigate current problems in densely populated areas which will not receive municipal service in the early stages of the program.

- Technical assistance by DKKP to kecamatan and kampung personnel for the mitigation of local disposal problems and the development of self help schemes
- Logistic support by DKKP to help solve critical disposal problems
- Public Health Education
- Public Health Inspection and regulation.

7.1.2 Collection

Total vehicle and manpower requirements for the collection service are as follows:

Year	Collection Vehicles*	Handcarts	Collection Workers	Street Sweepers
1980	85	730	670	900
1985	155	1640	1225	1050
1990	215	2730	1730	1200
2000	325	4415	2600	1500

* Based on 3 tonne payload capacity.

The final selection of vehicle type, size and special features as well as operating procedures (including routing and vehicle replacement schedules) are matters requiring detailed study in later stages of project development.

7.1.3 Transfer

Secondary transfer facilities are required for all systems involving collection by handcart. Alternative designs for these facilities are investigated in Section 9. The number of such facilities required at each stage of the program are as follows:

Year	Number of Secondary Transfer Stations
1980	50
1985	110
1990	180
2000	290

7.1.4 Disposal

Cumulative sanitary landfill site area requirements to year 2000 are as follows:

	Landfill area requirements, Ha			
	1980	1985	1990	2000
Cumulative area requirements	15	115	290	810
Remaining at existing site (approx.)	5	5	5	5
Equivalent area of compost plant (Assuming continued operation to 1985 at 75 tonnes/d from Medan)	2	12	12	12
Cumulative area required	8	98	273	793
Acquisition schedule	98	175	520	

The foregoing are net site area requirements assuming an area fill type of operation in two layers to a total compacted depth of two metres.

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7.2 OPERATIONS

7.2.1 System Operation

The operation of the proposed solid wastes management system is highly labor intensive. The effectiveness of service will depend upon maintaining a satisfactory level of productivity. The control of productivity can best be accomplished by setting realistic work objectives and standards as well as by adequate remuneration and other incentives.

The operational program for the expanded system must also provide for a much higher level of supervision and inspection than is presently provided. To accomplish this an expanded organizational structure is recommended as described in Section 8.

Three operational centers are proposed each with specific geographical (central, eastern, and western) and functional responsibilities.

7.2.2 Monitoring and Planning

The collection of accurate information upon which to base analyses of system performance and project future requirements is an essential part of the operational program.

Vehicle logs are required which record the operational data of each vehicle, such as vehicle type, crew size, route, type of service, times collection or loading are initiated and completed, travel time to the disposal site, weight of load, turn around time, and return travel time.

The analysis of such data will yield important information on generation rates and crew productivity.

An operational log should also be kept at the disposal site including site equipment operating data and weight scale data.

Each year the surface of the disposal site should be surveyed and the volume in place calculated. This information, used with the weight records, will yield an accurate evaluation of disposal site capacity requirements.

Samples of solid wastes should also be taken and analysed regularly. Careful attention must be paid to the design for the sampling program to ensure that the samples collected are representative and that sample size and storage methods are consistent with the requirements of subsequent analyses.

At least once per year samples should be taken to determine the composition of the solid wastes generated in each of the source classifications. The sorting procedures used to describe composition should be carefully selected to be adequate for use in evaluating materials recovery potential and future potential processing and disposal systems. The sampling program should include parameters such as density, moisture content, calorific content, and chemical compostion of selected components.

Some samples should also be taken monthly so that seasonal variations in important parameters such as moisture content, density and overall composition can be evaluated.

The availability of a long term record of such data collected on a consistent basis will reveal the presence of long term trends in generation rates and composition. This knowledge is necessary for effective long term planning.

7.2.3 Repairs and Maintenance

All vehicle repair and maintenance work other than routine service are currently undertaken by outside commercial garages.

Its recommended that DKKP upgrade its present servicing program to a complete fleet preventive maintenance service which could be coordinated with the proposed municipal vehicle repair facility.

The existing workshop and vehicle parking area has insufficient capacity to house the future vehicle fleet. It is recommended that satellite facilities be required which could form the nucleus of district operations centers and at which routine vehicle service is provided such as fueling, oil replenishment, tire inflation and repair, road service, and vehicle washing. It is also recommended that a comprehensive fleet operating and maintenance manual be prepared and that a training program be implemented to upgrade the existing program. Additional staff with appropriate qualifications will also be required to keep pace with fleet growth.

7.3 PHASED IMPLEMENTATION PROGRAM

Figure 7.1 illustrates the proposed implementation program in relation to the government's planning program (Repelita III), initial activities such as negotiations with potential funding agencies, detailed project planning and immediate action which can be financed initially by government.

It will be noted that the earliest expected implementation date for work with conventional international funding is mid 1981.

An expanded immediate action program has been developed for fiscal years 1979/1980, 1980/1981 and early 1981/1982 which is described in Table 7.1 together with other items included in the Repelita III period.

7.4 COSTS

The cost of the foregoing program of works for the solid wastes management system is summarized in Table 7.2 and 7.3.

An analysis of the organizational and financial requirements for the implementation of the program is presented in Section 8.

SOLID WASTES IMPLEMENTATION SCHEDULE

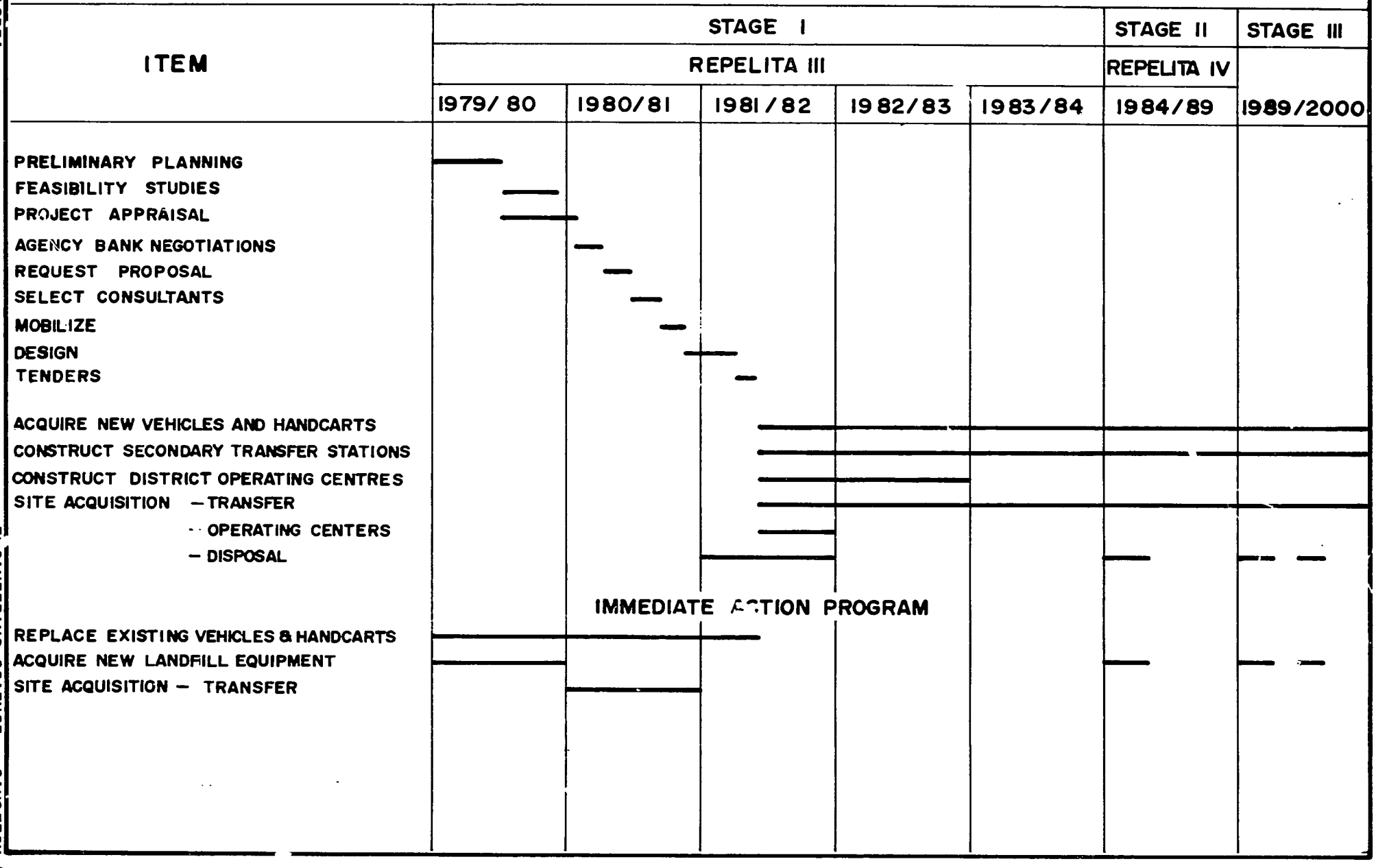


FIGURE 7.1

TABLE 7.1

IMPLEMENTATION PROGRAM FIRST STAGE
SOLID WASTES MANAGEMENT SYSTEM

	Fiscal Year				
	1979/80	1980/81	1981/82	1982/83	1983/84
New vehicles	37	36	30	18	18
New handcarts	150	520	230	250	250
Loading stations	-		65	15	15
Landfill Equipment					
Bulldozer	1				
Front end loader	1				
Loading station sites, ha			0.7	0.2	0.2
Sanitary landfill site, ha			110		
New district operations centers			2		

TABLE 7.2

ESTIMATED CAPITAL COSTS SOLID WASTES MANAGEMENT SYSTEM

	Estimated Capital Cost (1000's of Rupiah)						
	Repelita III						
Item	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000
1. Trucks	(370,000)	(360,000)	200,000 (100,000)	180,000	180,000	2,150,000	5,950,000
2. Handcarts	(13,000)	(44,000)	13,000 (7,000)	21,000	21,000	232,000	679,000
3. Loading Stations	-	-	195,000	45,000	45,000	210,000	330,000
4. Landfill Equipment							
a. Bulldozer	- (82,000)	-	-	-	-	164,000	656,000
b. Front-end Loader	- (52,000)	-	-	-	-	104,000	416,000
5. New District operating centers			120,000				
Totals	- (517,000)	- (404,000)	528,000 (107,000)	246,000	246,000	2,860,000	8,031,000
Technical Ass. Eng.'s Training	(52,000)	(40,000)	53,000 (11,000)	25,000	25,000	286,000	803,000

TABLE 7.2--Continued

	Estimated Capital Cost (1000's of Rupiah)						
	Repelita III						
	1979/80	1980/81	1981/82	1982/83	1933/84	1984/89	1989/2000
Land:							
1. Loading Stations Sites	-	-	87,000	25,000	25,000	87,000	137,000
2. Sanitary Landfill Sites		(50,000)	175,000	-	-	400,000	1,040,000
3. Op'g Centers			10,000				
Contingencies	- (85,000)	(74,000)	128,000 (18,000)	44,000	44,000	545,000	1,502,000
Total	(654,000)	(568,000)	981,000 (136,000)	340,000 -	340,000 -	4,178,000 -	11,513,000 -

Note: - All costs are in mid 1979 prices.
- ( ) indicates immediate action program expenditures.

TABLE 7 .3

ESTIMATED ANNUAL O&M COSTS SOLID WASTES MANAGEMENT SYSTEM

Item	Estimated Annual O&M Costs 1000's of Rupiah/Year *						
	Repelita III						
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000
1. Collection equipment							
a. Trucks	203,000	213,000	258,000	303,000	345,000	463,000	673,000
b. Handcarts	2,000	6,000	8,000	10,000	12,000	18,000	31,000
2. Loading Stations			4,000	3,000	3,000	4,000	6,000
3. Landfill Site Equipment	35,000	35,000	35,000	35,000	35,000	70,000	105,000
4. Labour - Direct & Indirect							
a. Collection - Drivers	71,000	75,000	90,000	106,000	121,000	160,000	237,000
- Labour	199,000	210,000	252,000	297,000	339,000	448,000	664,000
b. Disposal	5,000	5,000	5,000	5,000	5,000	10,000	15,000
5. Operations centers			6,000	6,000	6,000	6,000	6,000
6. Street Sweeping	149,000	162,000	168,000	174,000	180,000	216,000	243,000
Total	664,000	706,000	826,000	939,000	1,046,000	1,395,000	1,980,000

* Costs at 1979 prices including existing operating costs.

SECTION 8

ORGANIZATION AND FINANCE

8.1 EXISTING ORGANIZATION

The organization structure of the Cleansing Department of the city was officially changed in July 2, 1979 from that of Figure 8.1 to that shown in Figure 8.2.

The transfer of all functions other than cleansing to other city departments will enable greater direction of effort in the cleaning tasks. However, lack of direct control of even routine vehicle servicing and repairs may interfere unduly with collection operations. Further, the initiation of the new service levels will require special organizational features which can be defined in an organization chart.

Organization changes suggested for the proposed new solid wastes program are discussed below.

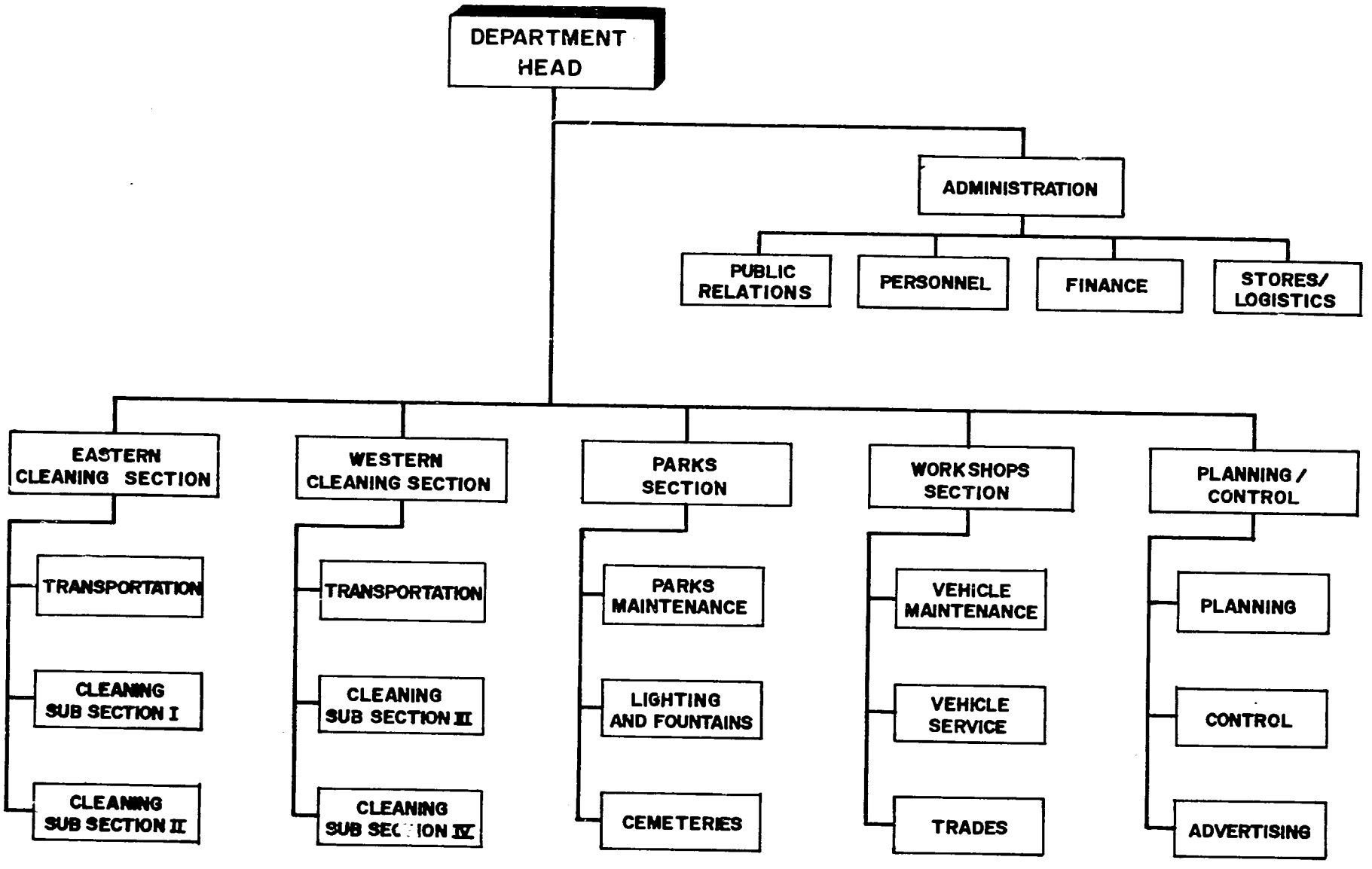
8.2 RECOMMENDED ORGANIZATION

The increase in size of the service area of DKKP and the large increase in the number of vehicles and staff requires that the organizational structure of DKKP be expanded to ensure that adequate levels of supervision and control are provided.

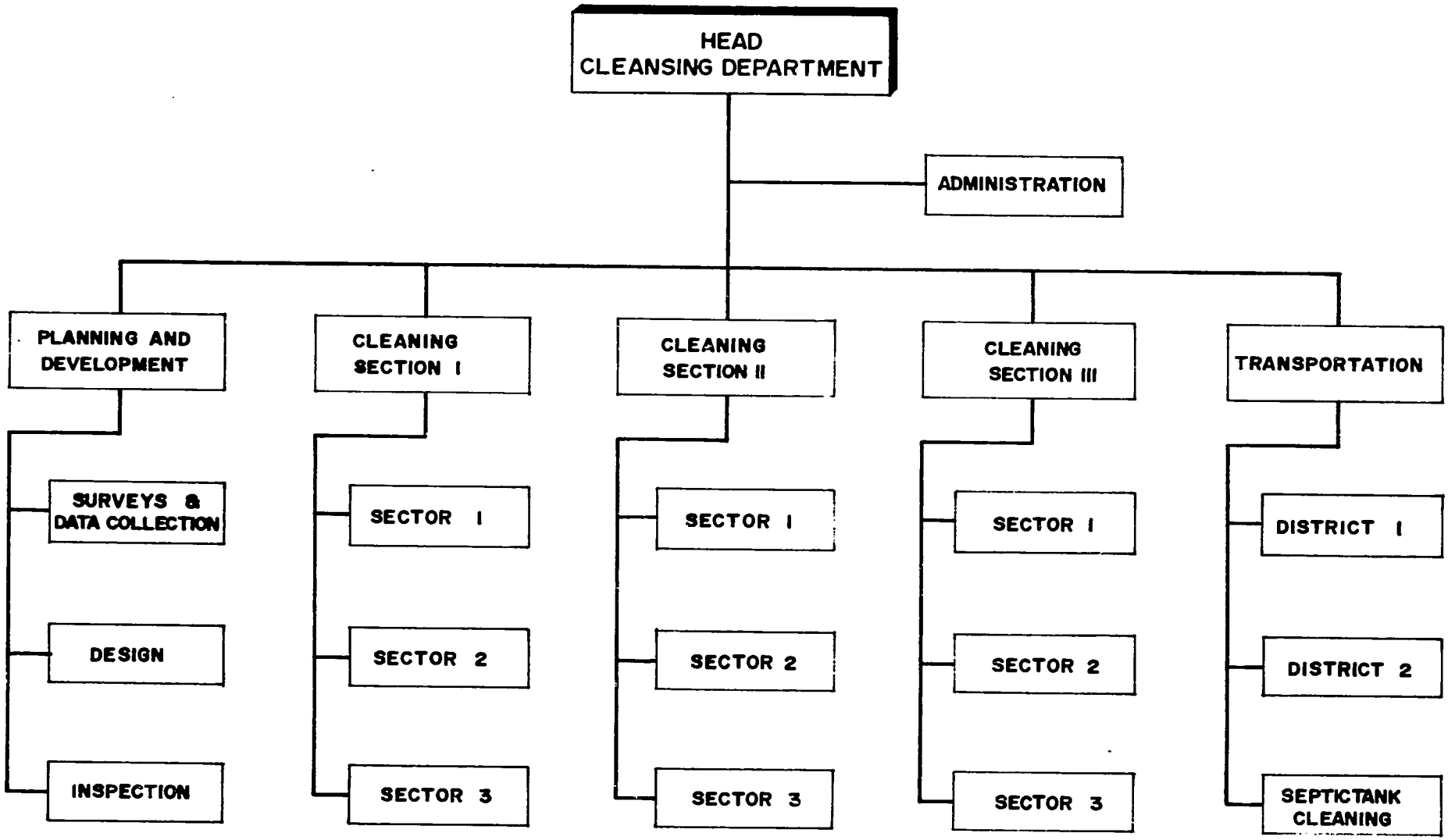
This can be accomplished by defining a greater number of operational units on the basis of service type and geographical area.

Because of the limited capacity of the existing DKKP works yard to accommodate additional staff and equipment and because of the greater operational efficiency that can result from decentralization, it is recommended that two additional operational centers be formed and that the organizational structure be strengthed as shown in Figure 8.3.

Consideration can be given to assigning certain of the organizational elements to other agencies. For example communal collection could be assigned to Kampung and Kecamatan administrations and other elements could be carried out by contract.

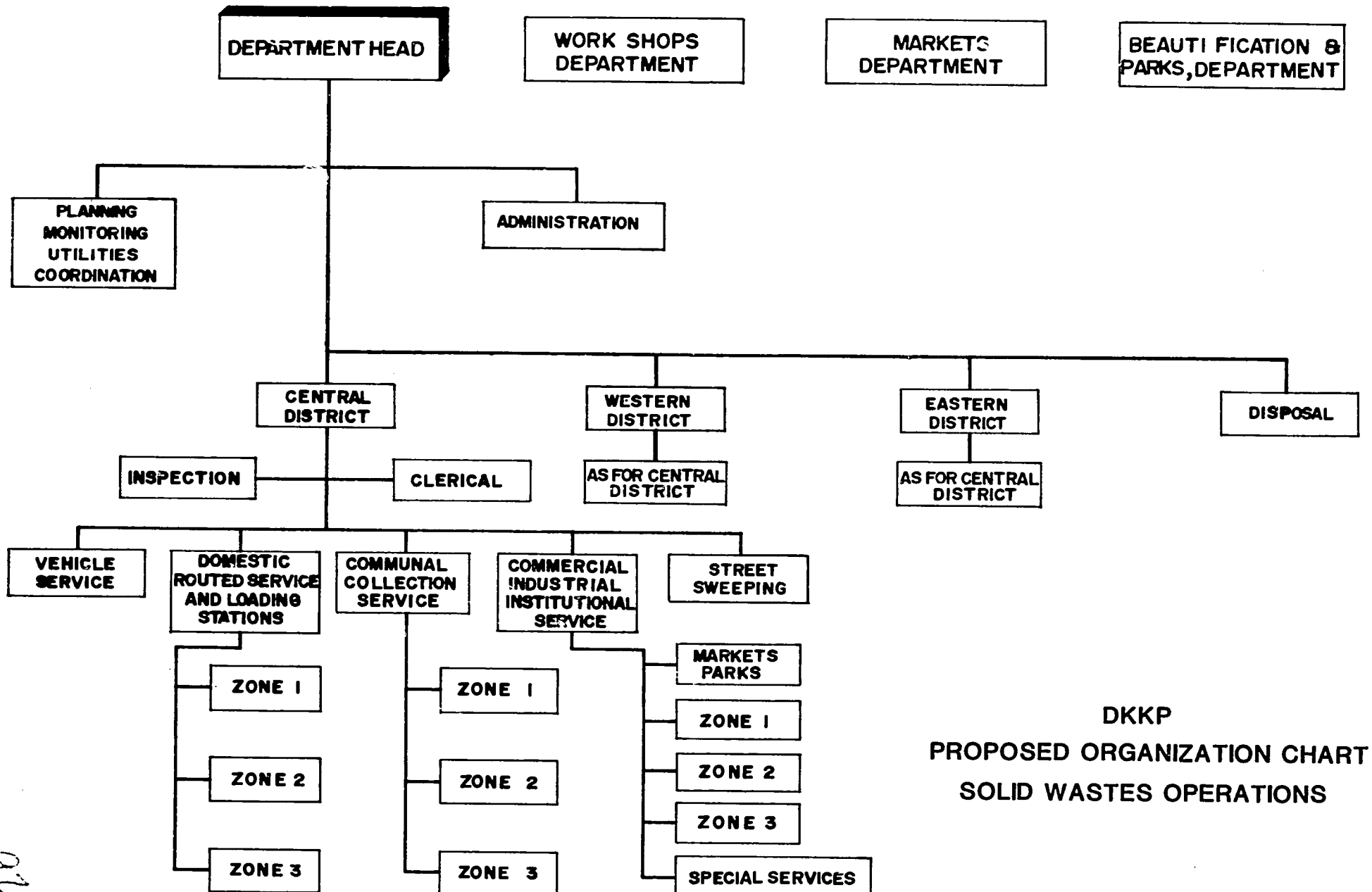


FORMER OGANIZATION CHART DKKP



EXISTING ORGANIZATION CHART
CLEANSING DEPARTMENT

FIGURE 8.2



DKKP
PROPOSED ORGANIZATION CHART
SOLID WASTES OPERATIONS

FIGURE 8.3

Operational planning, including such matters as vehicle and service schedules, should be under the direct control of the area superintendents. The area superintendents will also have an inspection staff who will observe the operation of the collection system and report variations from established operational programs so that corrective action can be taken.

8.3 REVENUE AND EXPENDITURE

Revenue and expenditure for solid waste collection in 1978/79 are shown in Table 8.1.

TABLE 8.1

SOLID WASTES - REVENUE AND EXPENDITURE, 1978/79
(RP MILLION)

Revenue	
Collection charges	14
Septic tank emptying	6
Taxes	386
Total	406
Expenditure	
Routine	299
Development	107
Total	406

Source: Dinas Pendapatan & DKKP

8.3.1 Current Charges

A range of charges is made, based on type of property, for solid waste collection:

Type of property	Monthly charge (Rp)
Large industrial	1,500
Small industrial	1,000
Large offices	750
Small offices	650
Permanent houses	550
Temporary houses	350

The actual collection of this money is the responsibility of the kampung chief who "sells" tickets to all properties in his area at the appropriate rate. He is then responsible for remitting receipts to the revenue department (Dinas Pendapatan).

The system falls down on a number of counts. The kampung chiefs have difficulty in collecting the fees as there is no guarantee that the waste collection will take place. As discussed earlier, the DKKP (solid wastes department) has only sufficient facilities to cover 25 percent of the wastes generated in the city. This inevitably results in an inadequate service and means that many properties use private collecting services to dispose of their garbage. Even when fees are collected for the official service, the revenue department does not know either what the potential take from a kampung should be or what proportion of the actual money collected is being remitted. Either way, the revenue department's receipts are extremely small and have actually declined slightly in recent years (from Rp. 14.1 million in 1976/77 to Rp. 13.6 million in 1978/79), despite the continued growth of the city. Thus the gap between specific charges and expenditure is very considerable and has to be bridged from the total municipal taxes pool.

8.3.2 Future Charges and Affordability

The proposed solid waste collection system is designed to provide different levels of service appropriate to different levels of household incomes.

By tailoring the services provided to what is affordable,there is, ipso facto, built-in customer ability to pay. However, this is subject to three caveats; firstly, is the criterion adopted for establishing what is affordable, reasonable; secondly, can the poor afford even the lower level of services which they would receive;and thirdly, although they could afford it, would the higher income groups be willing to pay for the high level of services proposed?

In respect of the overall criterion for determining affordability, one percent of household expenditure was adopted. This seems a reasonable yardstick, but, even so, on the basis of the analysis undertaken in Section 6, around 58 percent of the population would not be able to afford even the lowest level of services proposed. In fact, the percentage is probably somewhat lower than this as more recent income information for Medan has just become available to the project which shows incomes at higher levels than originally assumed. This does not alter the fact, however, that a significant segment of the population will be unable to contribute at the 1% level. This therefore means that either cross-subsidisation or some other form of subsidy will be necessary to provide a service to the poor people.

Clearly, cross-subsidisation will result in the higher income groups paying in excess of one percent of their incomes for services. How acceptable this would be depends, in part, on the amount of cross-subsidisation required. In the Repelita III period, 20 percent of total costs would be for the provision of services to people with poor ability to pay. If it is assumed that no contribution is forthcoming from these

people (the possibility and desirability of this will be examined as part of the financial studies) this would be the proportion of additional costs which have to be passed on to other users. In the case of industrial and commercial concerns this should be quite feasible but it may prove more difficult in the case of other domestic users.

The question also arises of whether they will be willing to pay for the high level of service proposed. At present the official charge for waste collection from permanent domestic properties is Rp.550 per month. Under the service levels proposed the monthly charge based on 1% of top monthly incomes would double this. Although this is a sharp increase there is every likelihood that it would be acceptable as rates similar to this (Rp.1000) are currently paid for private collection services.

It is also possible that part of the cross-subsidy element could be added to this rate in due course without seriously affecting willingness to pay but it is likely that most of the subsidy will have to be borne by industrial and commercial users.

SECTION 9

THE RECOMMENDED FIRST STAGE SOLID WASTES IMPROVEMENT PROGRAM

.1 GENERAL

Medan's present (1978) solid wastes management system provides only artial service to the most densely populated part of the study area. t present only about 150 tons per day are collected which is estimated o be about 25 percent of the total amount generated.

Solid wastes which are not collected by Medan's Cleansing Department re disposed of by burning, burial, or are deposited in ditches and streams here they contribute significantly to existing flooding and public health roblems and detract from the aesthetic quality of the city. The existing olid wastes management system is illustrated in Figure 9.1.

As discussed in earlier parts of the report, a strategy for improvng the existing solid wastes management system was developed providing or the staged expansion of the collection system. Initially service will e concentrated in the high density urban areas (primary and secondary reas) then by 1985 service will be extended to include the medium density rban areas as well as selected isolated satellite residential areas and long regional roads. At 1990 full service will be provided to the entire tudy area and through to year 2000 service will be expanded to keep pace ith the development of the city.

Existing commercial composting operations were considered to continue n operation utilizing a significant portion of the total solid wastes enerated. New sanitary landfill sites will be required for the disposal f the remaining solid wastes collected.

The existing solid wastes management system utilizes labor intensive ethods. Street sweeping is done almost entirely using hand brooms and erobaks are used in the collection of both street sweepings and solid astes. Loads from gerobaks are transfered using hand tools to convenional general duty trucks. Truck unloading is also done by means of and tools. Analyses carried out on the master plan investigation has ilustrated the cost effectiveness of labor intensive methods versus apital and equipment intensive methods for general collection service nd the cost effectiveness of sanitary landfill methods in comparison with ther disposal alternatives including composting and incineration.

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In this feasibility study further details of the alternative types of collection system are developed and areas in which various levels of service can be applied are reviewed. Further organizational and staffing requirements are developed, and the financial feasibility of the proposed program is studied.

9.2 DESCRIPTION OF FIRST STAGE SOLID WASTES SYSTEM IMPROVEMENT PROJECT

9.2.1 Collection

9.2.1.1 Types of Collection Service

The following alternative collection service types were identified for evaluation:

House to House - Truck: the solid wastes worker enters the householder's compound to collect the wastes from a household container and carries the wastes to a truck.

House to House - Handcart: as above but wastes are carried to a handcart which is taken to a site where the wastes are loaded into a truck or container.

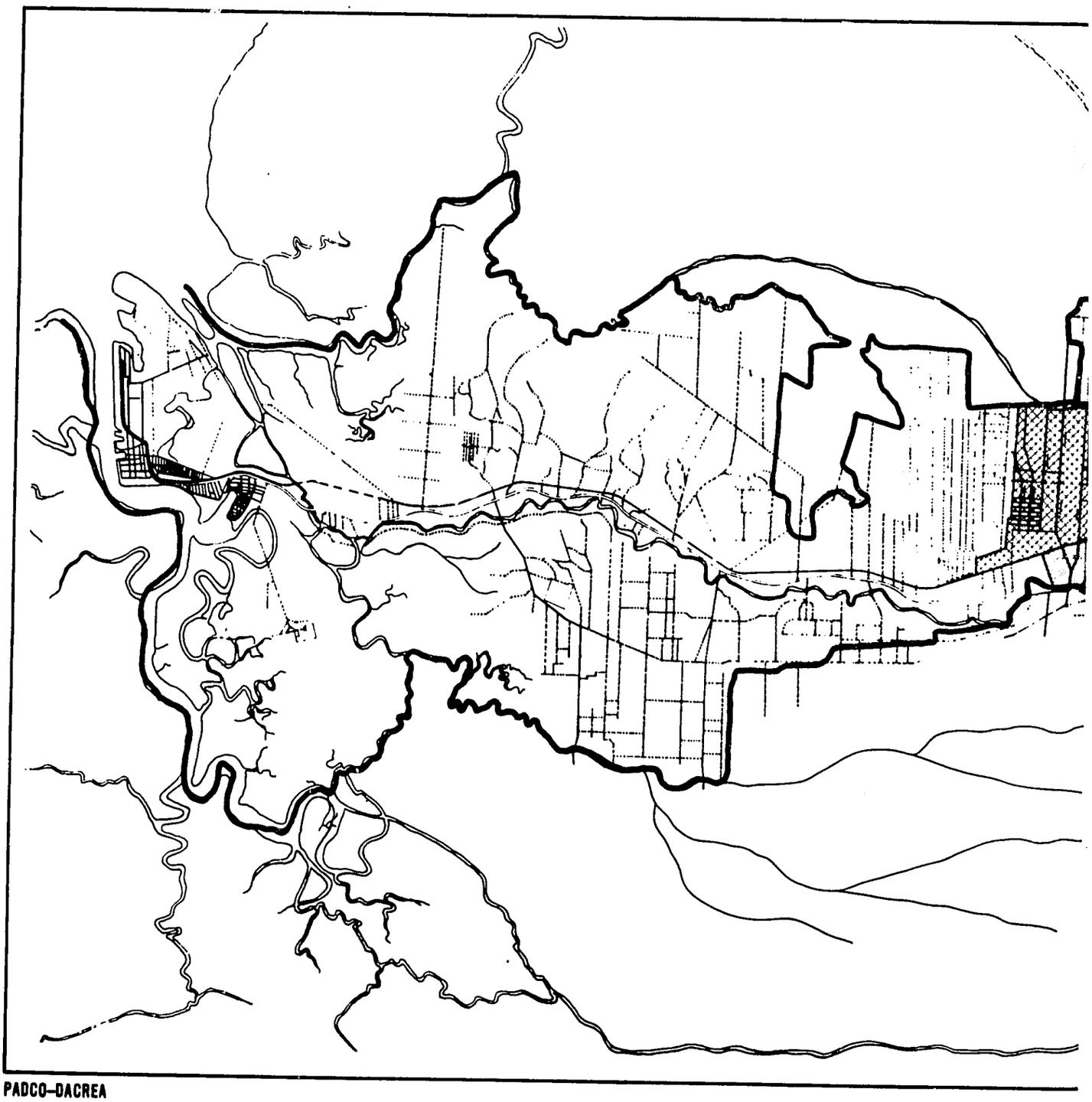
Curbside - Truck or Handcart: householder carries solid wastes to the side of the road in a household container in which the wastes are either retained or deposited in a roadside container and are left for subsequent collection by truck or handcart.

Block Collection: householder delivers the wastes to a collection vehicle at the time of collection.

Communal Collection: householder delivers the wastes to a community storage facility from which the wastes are regularly collected.

The Master Plan investigation evaluated these alternatives using various collection intervals and the following levels of solid wastes collection service were selected for consideration in Medan:

Service Group	Service Level	Description
Domestic		
High Income	1	Daily - house to house - truck
Medium Income	2	Every second day - house to house - truck
	3	Daily - house to house - handcart
Low Income	4	Every second day - house to house - handcart
	5	Every second day - curbside - handcart
	6	Twice weekly - curbside
	7	Daily - communal



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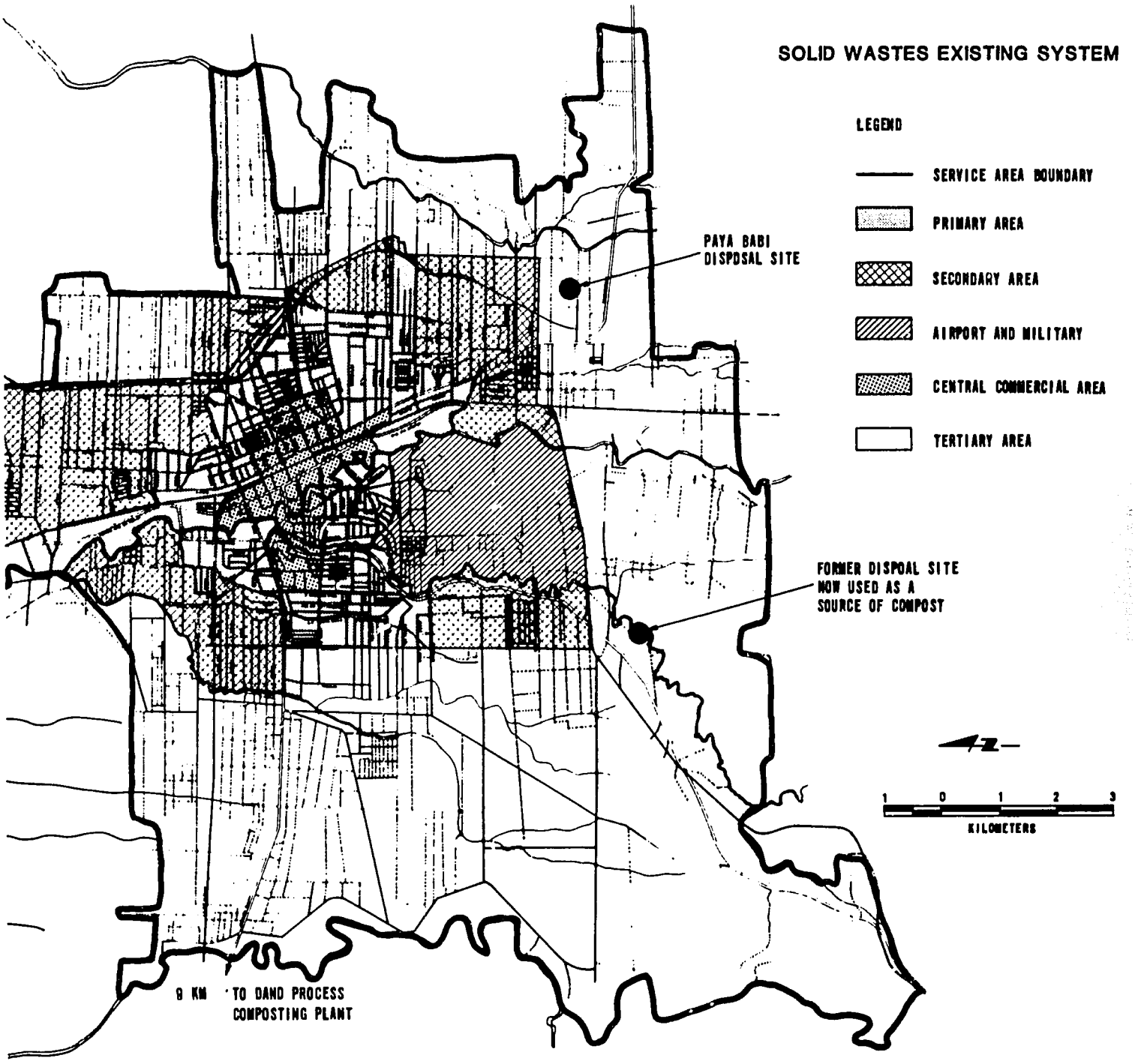
FIGUF



ENGINEERING-SCIENCE - SINC

TABLE 9.1

PROJECTED SOLID WASTE COLLECTIONS 1980/81-1985/86
Tonnes per day

Source	1981/82	1982/83	1983/84	1984/85	1985/86
Domestic	105	220	349	407	468
Commercial/Industrial	173	220	228	236	242
Markets	92	95	98	101	103
TOTAL	370	535	675	744	813

Service Group	Service Level	Description
Commercial, Industrial, Institutional		
	C1	Daily - house to house - truck
	C2	Daily - curbside - truck
	C3	Daily - curbside - handcart
Market and parks		Transportation only

The projected volumes of solid wastes to be collected during 1980/81-1985/86 are shown in Table 9.1.

9.2.1.2 System Components

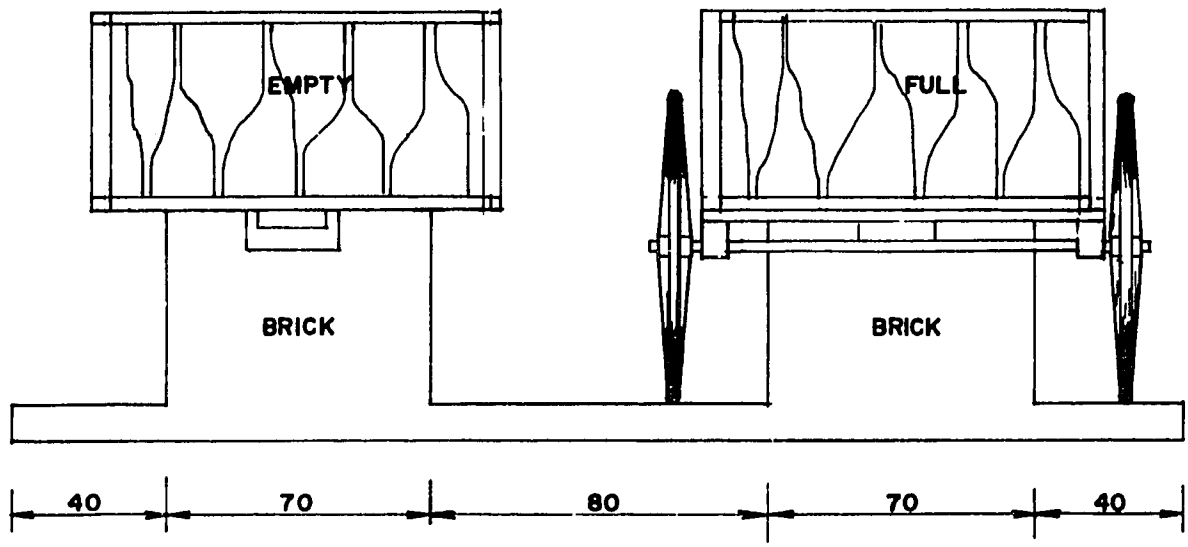
Household Containers: The adoption of house to house collection service in the commercial and upper income residential areas will require the use of household containers placed outside of buildings at locations convenient for collection.

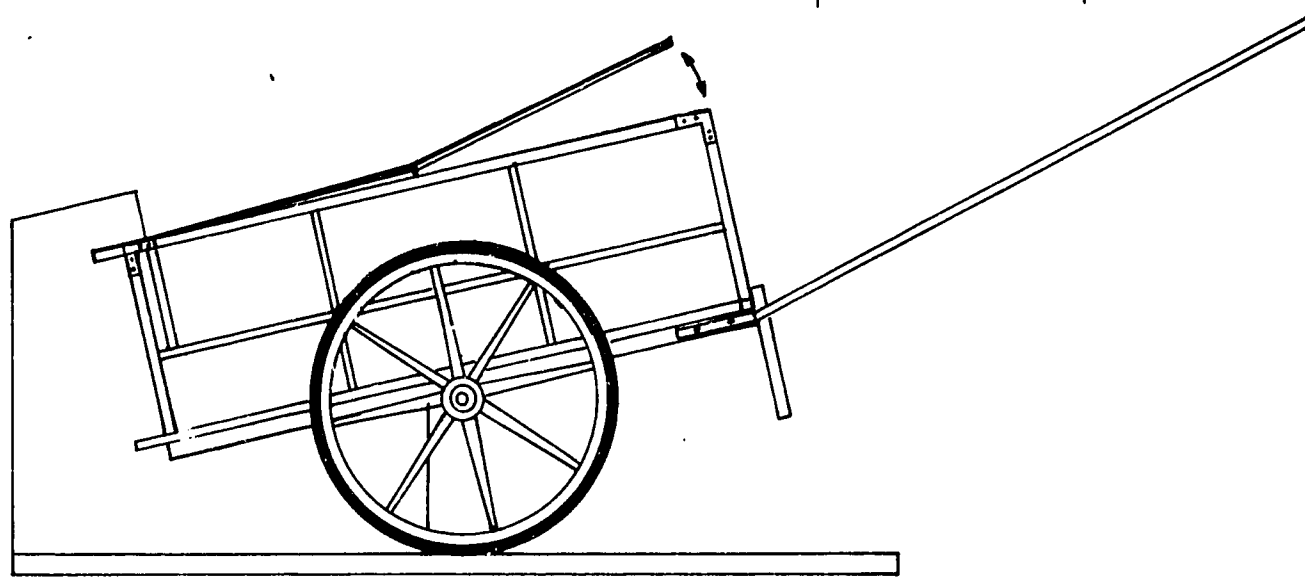
At the present time where house to house service is provided often the solid wastes worker must transfer wastes to a collection container (bamboo market basket) which is carried to the truck or gerobak. The use of containers which can be conveniently handled by one man is essential to the efficient execution of house to house service.

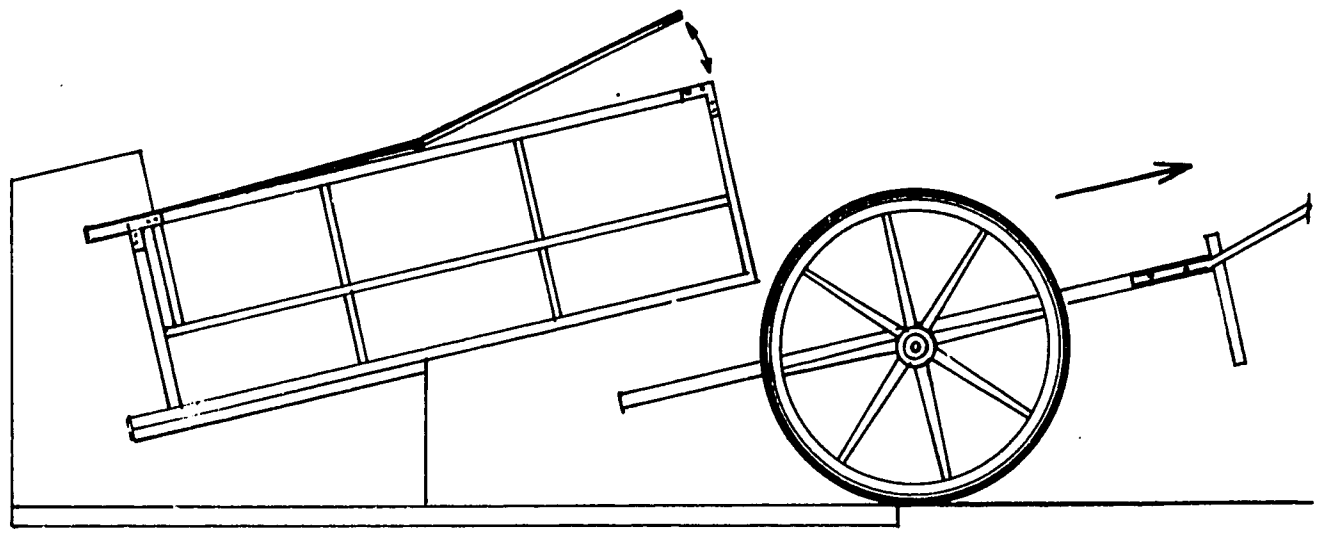
Galvanized iron and other metals, plastic and wood have been used in the past with either plastic pails or bags now being used generally in many major cities. It should be a condition of this type of service that the householder utilize containers which are strong enough for handling, are of a size and weight which can be easily handled by one man, and which can be easily emptied. The use of plastic bags to contain food wastes and most other household wastes would greatly facilitate collection service. However other types of containers may be more appropriate for some household wastes. Typical alternative household containers are shown in Figure 9.2.

Containers suitable for solid wastes service are not available commercially in Medan at the present time. However, facilities are available in Medan for the manufacture of plastic pails and bags from high density polyethylene. Retail prices have been estimated to be approximately Rp.1,500 and Rp.2,000 each for the 40 and 60 litre pails respectively and Rp.100 each for the plastic bags.

Curbside Containers: Many alternative types of curbside containers have been used in Medan and throughout Indonesia. Household containers could also be used for curbside service, household containers are placed at the curbside by the householder prior to a certain hour (8:00 a.m. for example) on the day of collection and must be removed by the householder after collection on the same day. The multiple use of fixed curbside containers by more than one household can also be considered.







COMMUNITY CONTAINERS
HAND CART CONTAINERIZED I

When collection is from fixed containers it is recommended that the solid wastes collection truck crews be equipped with containers to facilitate the transfer of wastes to the collection vehicle. Hand tools consisting of a dust pans and hand brooms are presently used for gerobak collection.

When fixed curbside containers are used it is recommended that they be of the alternative designs shown in Figure 9.3. It is recommended that curbside containers be provided by the householder and if of the fixed type they be constructed to standard specifications by the Municipality at the householder's expenses. Uniform standards should be adopted for certain areas of the city. Curbside containers are estimated to cost Rp.12,500 and Rp.14,500 each for the bucket and bin types respectively.

Communal Containers: Several alternative designs for communal containers have been considered including a conventional handcart (gerobak) as shown in Figure 9.4 and containerized handcart systems as shown in Figures 9.5 and 9.6. Fixed communal containers similar to curbside containers were also evaluated and a typical design is shown in Figure 9.7.

A comparative cost analysis of the communal container alternatives is included in Table 9.2 which illustrates that there is no significant difference in cost of the alternatives considered. It is recommended that each alternative be evaluated on a pilot basis to further assess operational characteristics and costs.

Trucks: At the present time specialized solid wastes collection vehicles are not manufactured or assembled in Indonesia. Conventional trucks with or without hydraulic dumping systems which are assembled in Indonesia are available through local suppliers. Special load boxes are manufactured in Medan.

Vehicle size, ease of loading and unloading, and load box size are critical factors affecting the selection of transportation vehicles for collection service in Medan.

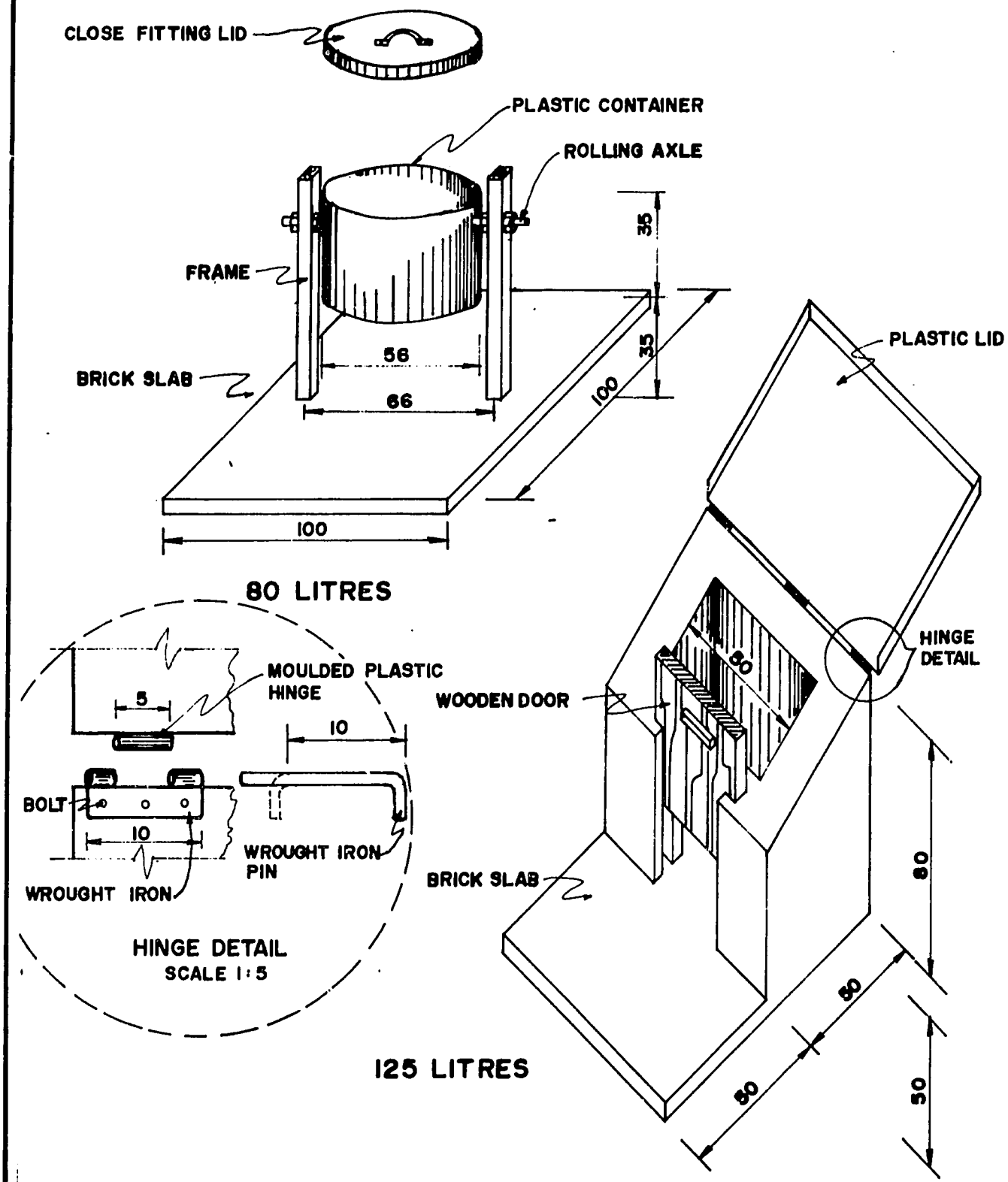
General road and traffic conditions practically limit the selection of vehicle size to 10 ton GVW. Loading and unloading conventional vehicles requires special truck load box designs and loading appurtenances. The density of solid wastes requires extra large load box size to fully utilize the load capacity of the truck.

Several alternative truck and loading station designs have been evaluated as shown in Figures 9.8, 9.9, 9.10, and 9.11.

Included is a containerized system using equipment evaluated in Medan under the GOI/Netherlands program as shown in Figure 9.12. The details of a comparative cost analysis of this system in comparison with the utilization of conventional trucks is summarized in subsection 9.2.1.5.

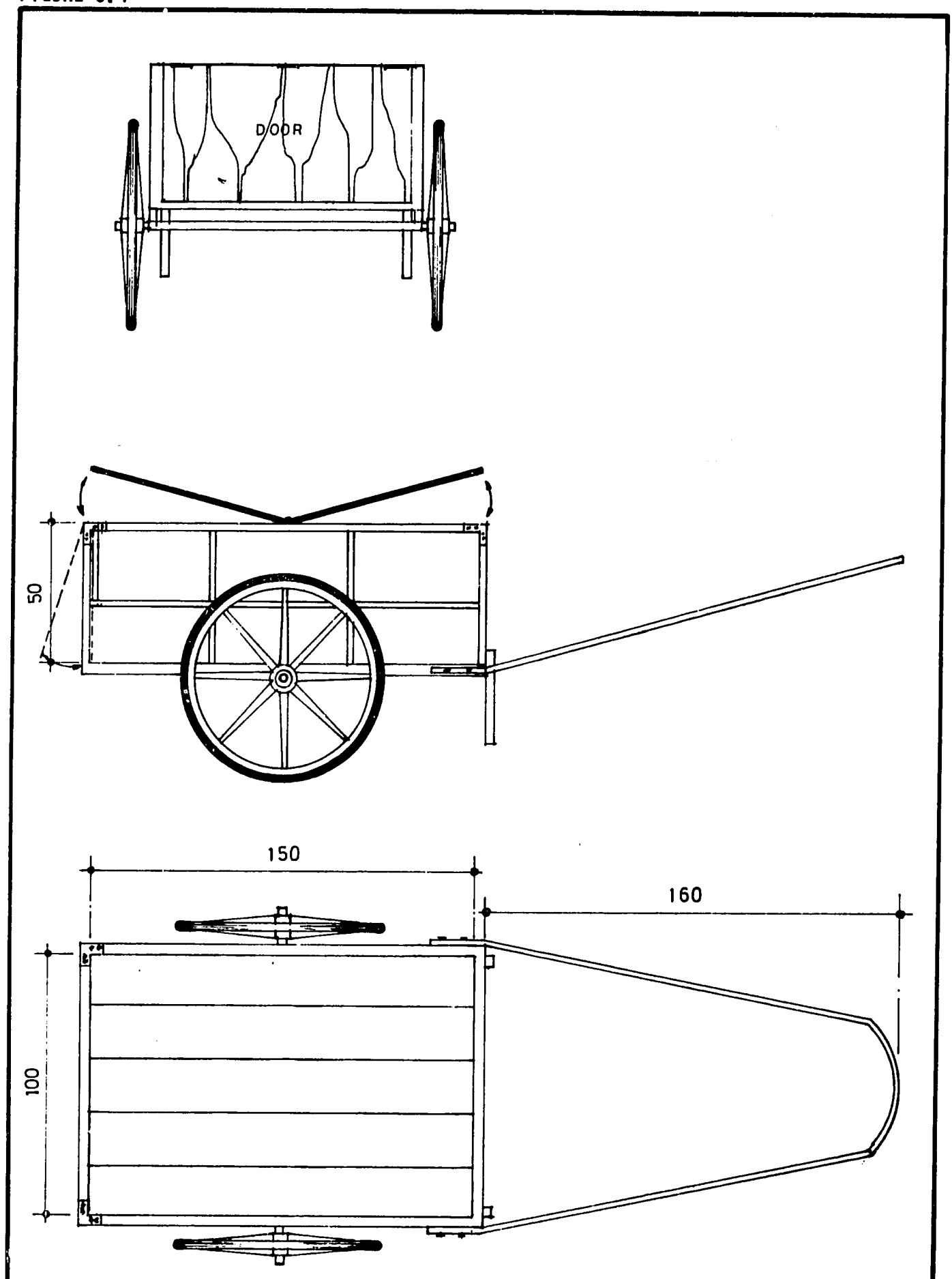
9.2.1.3 Residential Service

Service Level I - Daily house to house truck.

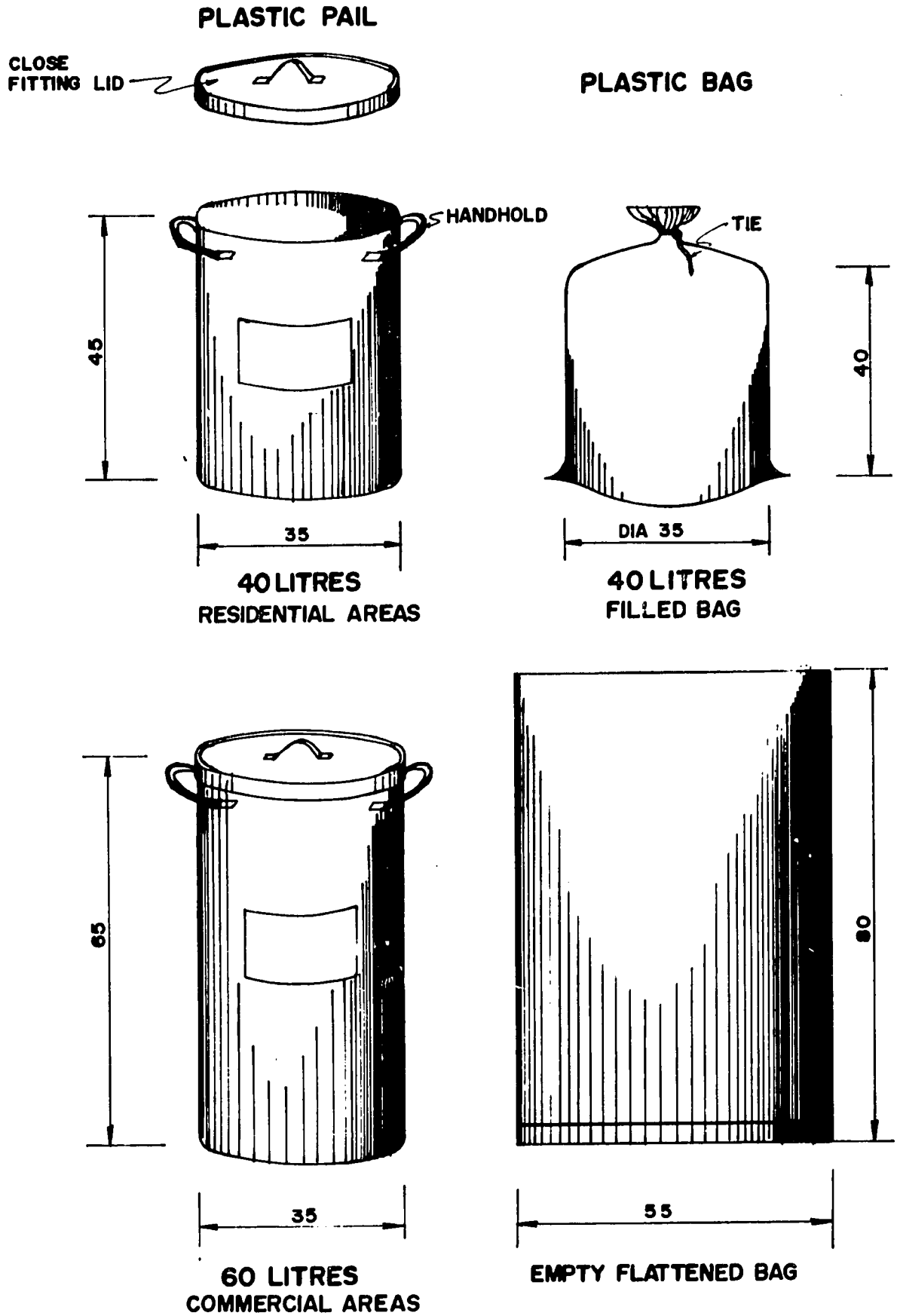


TYPICAL CURBSIDE CONTAINERS

FIGURE 9.4



COMMUNITY CONTAINERS HAND CART



TYPICAL HOUSEHOLD CONTAINERS

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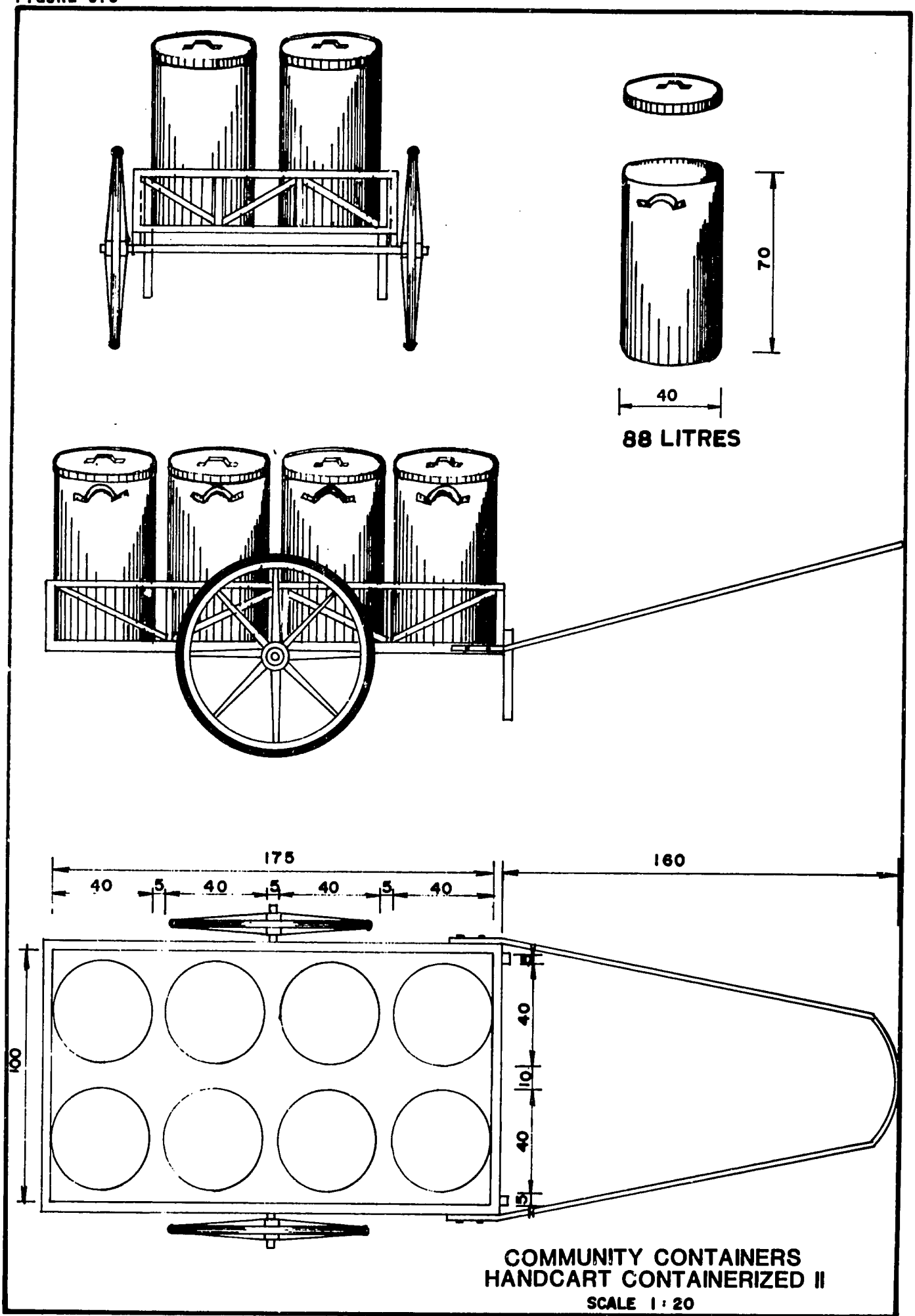
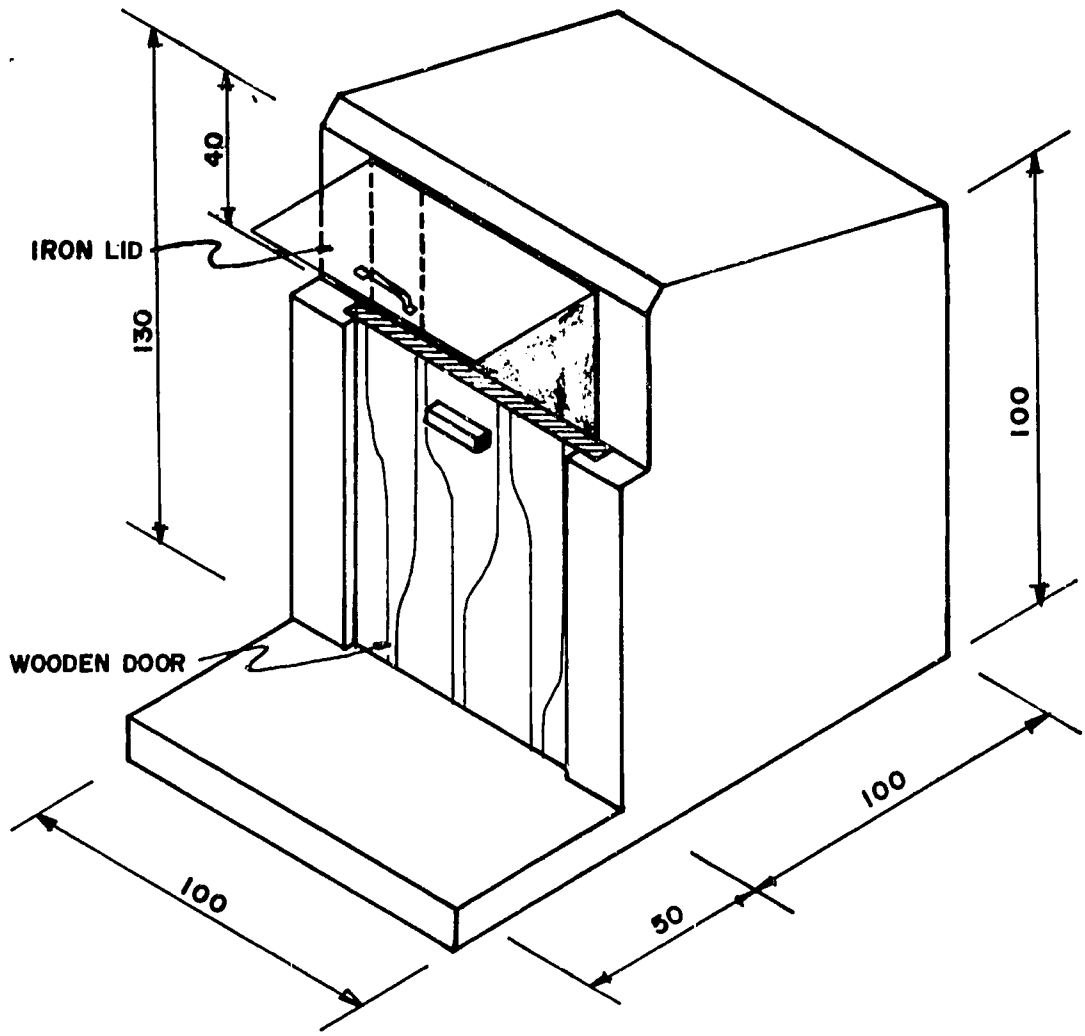
FIGURE 9.6


70
40
88 LITRES
175
160
40
5
40
5
40
5
40
100
40
10
40
5
COMMUNITY CONTAINERS
HANDCART CONTAINERIZED II
SCALE 1 : 20



COMMUNITY CONTAINER
FIXED TYPE

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TABLE 9.2

COMPARATIVE COST ANALYSIS - COMMUNITY CONTAINER SYSTEMS

Item	Conventional Handcart	Handcart Containerized I	Handcart Containerized II	Fixed Type
1. Quantity of wastes - tonnes per day	15	15	15	15
2. No of containers	0	75	0	54
3. No of handcarts	80	0	80	7
4. No of handcart's (wheels only)	0	5	0	0
5. Capacity of containers	0.2	0.2	0.2	0.28
6. Trips/day total	75	75	75	75
7. Trips/day/handcart crew	16	16	16	11
8. No of worker groups	5	5	5	5
9. No of workers per group	2	2	2	2
10. Overtime crew hours	0	0	0	0
11. Loading station type	Type 3	Type 3	None	Type 3
12. Working days/year	300	300	300	300
13. Capital cost (Rp. Millions)				
Handcarts	6.80	0	7.70	0.60
Handcarts(wheels only)	0	0.25	0	0
Sub total	6.80	0.25	7.70	0.60
Equivalent annual	1.80*	0.07*	2.03*	0.16*
Container cost	0	3.10	0	1.60
Equivalent annual	0	0.82*	0	0.19**
Structure if necessary	0	4.10	0	0
Equivalent annual cost	0	0.48**	0	0
Loading Station	1.60	1.60	0	1.60
Equivalent annual cost	0.19**	0.19**	0	0.19**
Total equivalent annual cost capital items Rp. millions	1.99	1.56	2.03	0.54

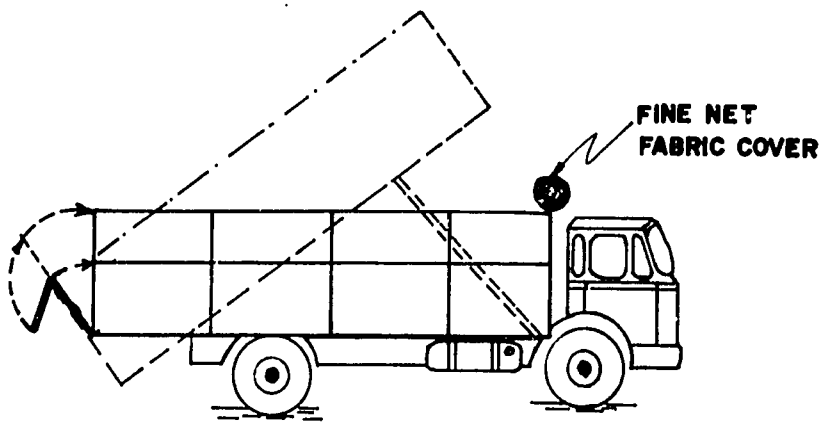
TABLE 9.2--Continued

Item	Conventional Handcart	Handcart Containerized I	Handcart Containerized II	Fixed Type
14. Crew cost/year	2.88	2.88	2.88	4.03
15. Repairs Rp. Millions/year	0.20	0.20	0.20	0.10
Total Comparative annual cost	5.07	4.64	5.11	4.67
16. Tonnes per year	4500	4500	4500	4500
17. Unit cost Rp./tonne	1130	1030	1140	1040

* 5 years @ 10 percent
** 20 years @ 10 percent

FIGURE 9.8

MANUAL REAR LOADING

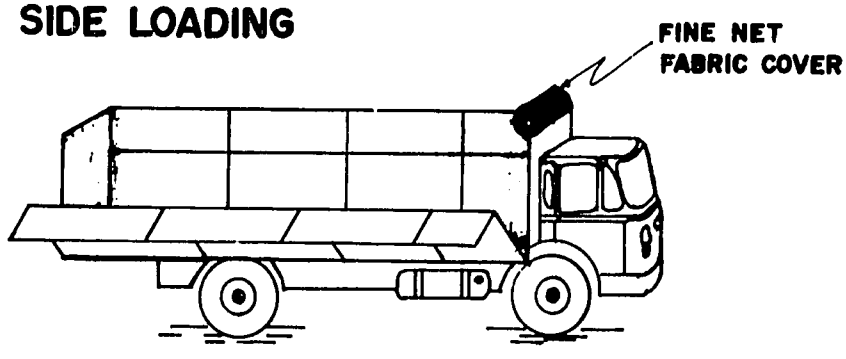


SPECIAL DESIGN OF TRUCK, USED AT THE TRANSFER STATION, LOADING METHOD FROM THE REAR OF TRUCK

BODY DIMENSIONS

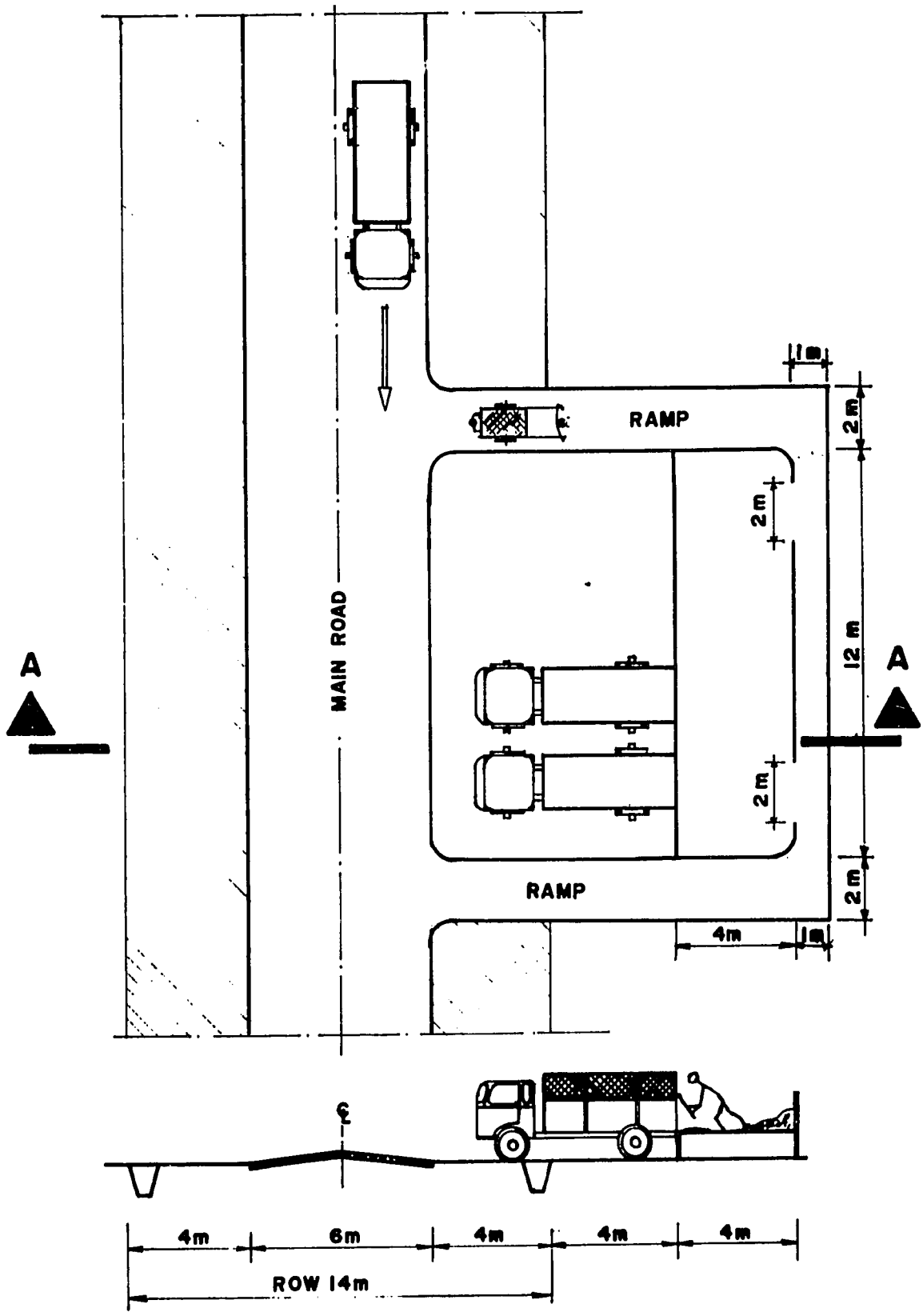
LENGTH : 4.3 m
WIDTH : 2.5 m
DEPTH : 1.3 m
VOLUME : 14 m^3
MAX PAYLOAD: 5 T (COMMERCIAL SOLID WASTES AT 360 Kg/m^3)

MANUAL SIDE LOADING



SPECIAL DESIGN OF TRUCK, USED AT THE TRANSFER STATION, LOADING METHOD FROM THE SIDE OF TRUCK AND FOR MANUAL SIDE OFF LOADING
(HYDRAULIC DUMP SYSTEM OPTIONAL FOR OFF LOADING)

COLLECTION TRUCK

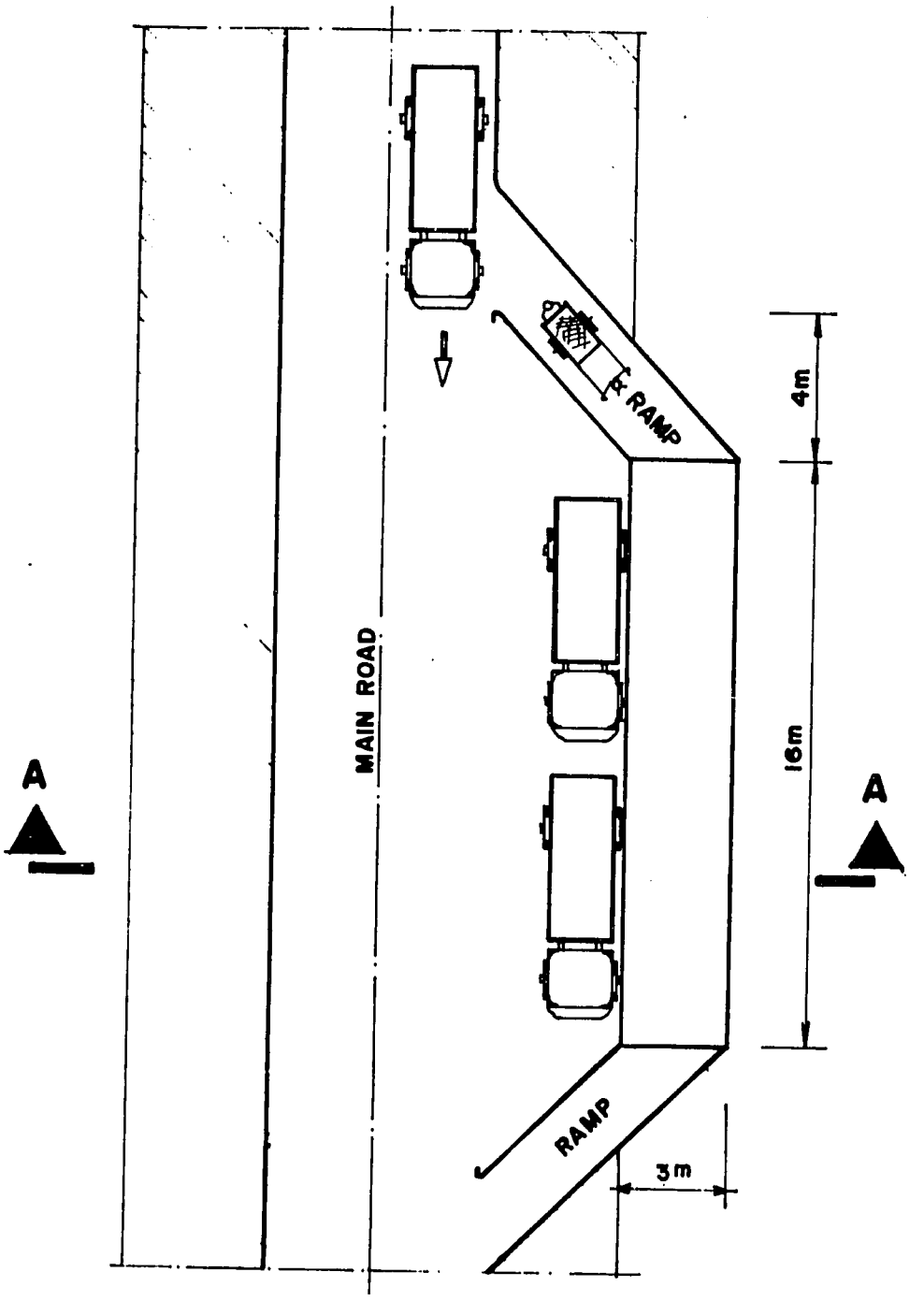


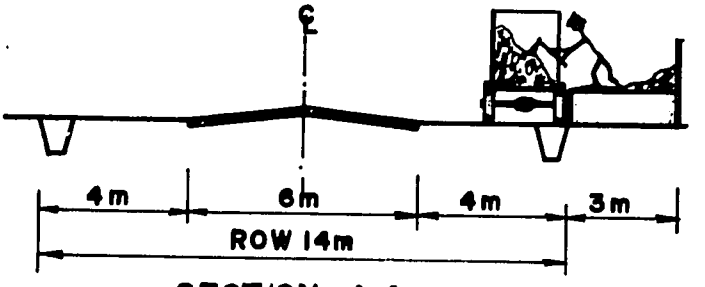
SECTION A A

LOADING STATION ALT I
WITH STORAGE

118

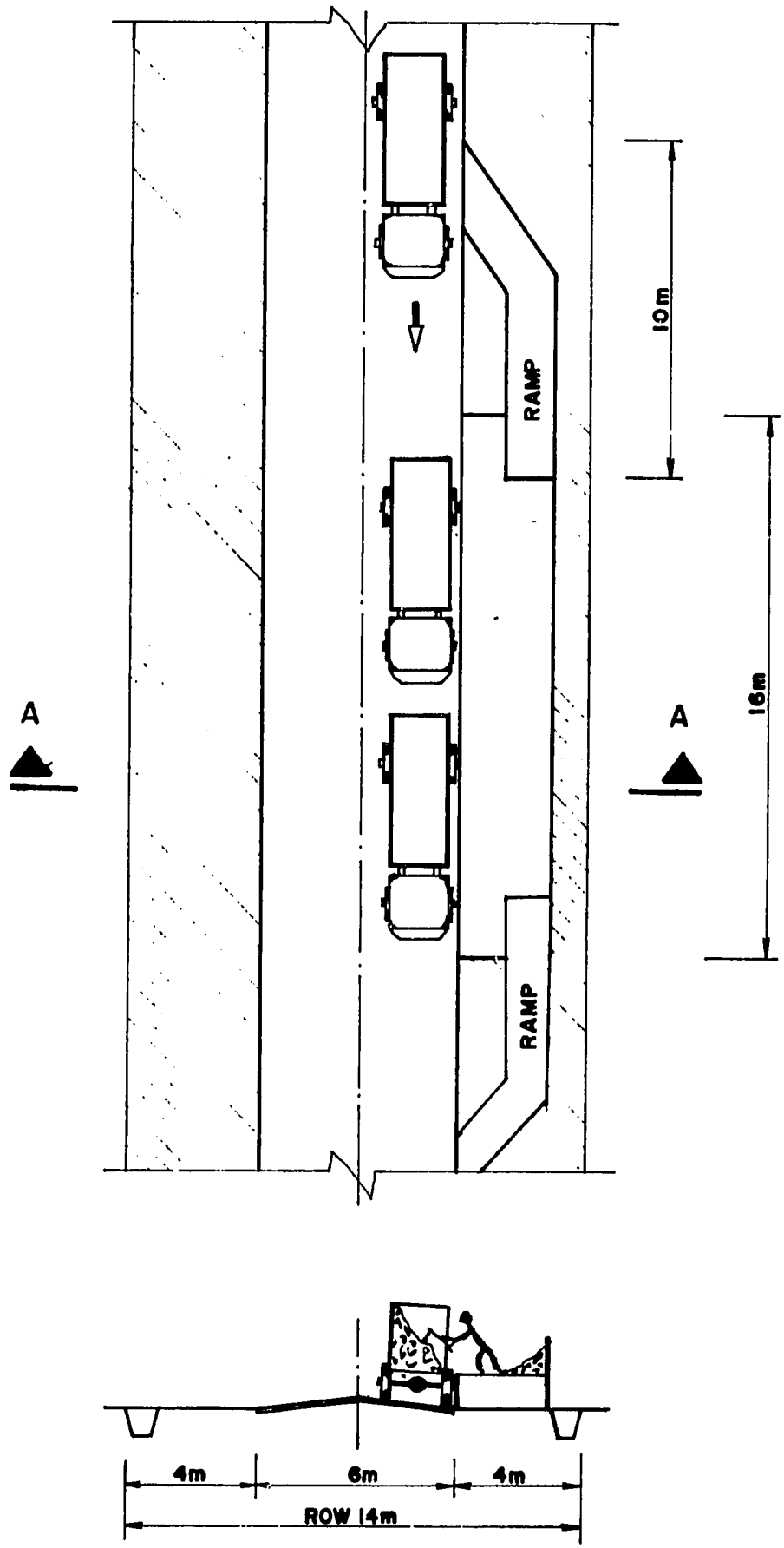
FIGURE 9.10





SECTION A A

LOADING STATION ALT. 2
WITHOUT STORAGE

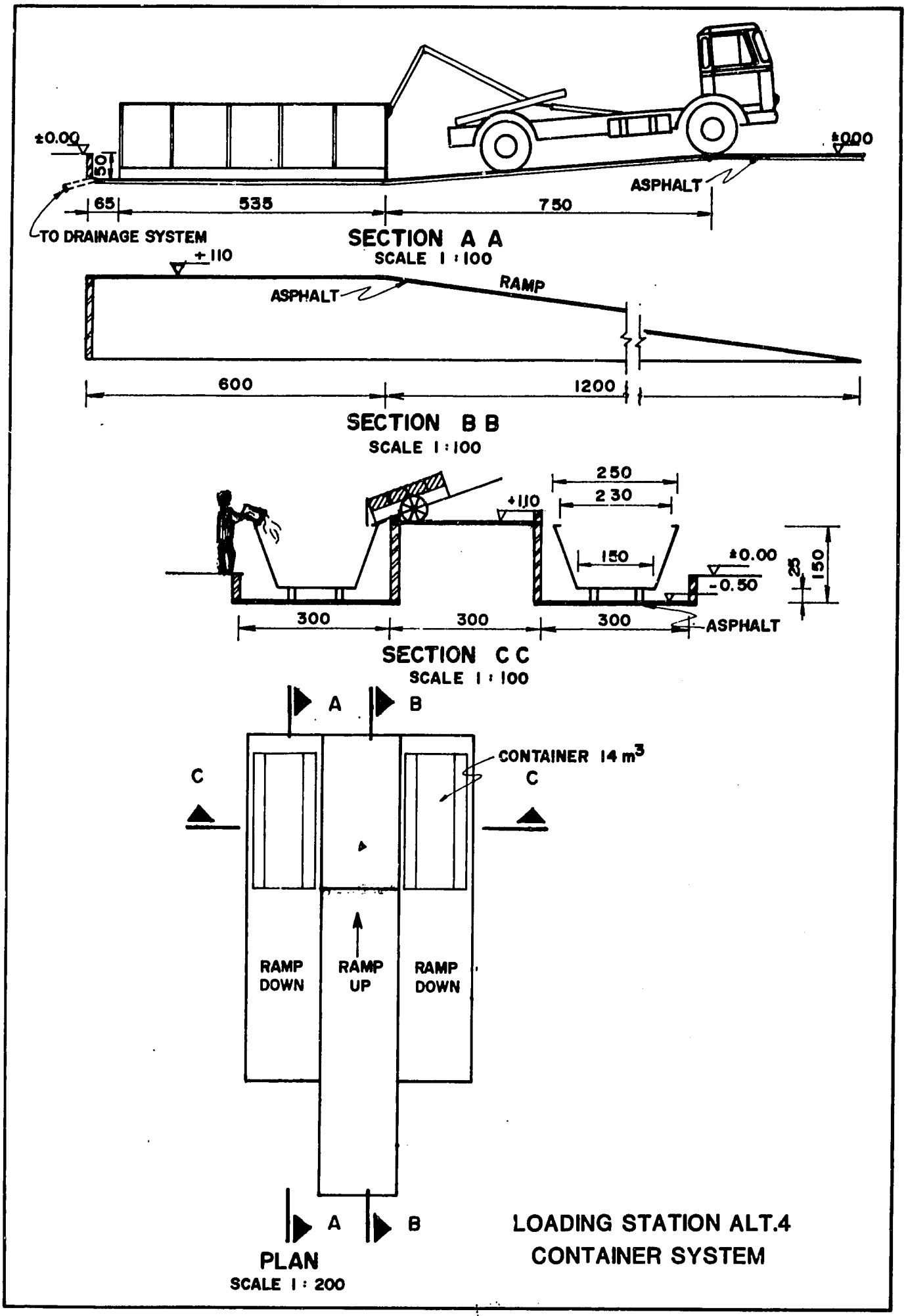


SECTION A A

LOADING STATION ALT.3

114

FIGURE 9.12


±0.00
±0.00
ASPHALT
65
535
750
TO DRAINAGE SYSTEM
SECTION A A
SCALE 1 : 100
+110
ASPHALT
RAMP
600
1200
SECTION B B
SCALE 1 : 100
250
230
+110
150
±0.00
-0.50
25
150
300
300
300
ASPHALT
SECTION C C
SCALE 1 : 100
A
B
C
C
CONTAINER 14 m3
RAMP DOWN
RAMP UP
RAMP DOWN
A
B
PLAN
SCALE 1 : 200
LOADING STATION ALT.4
CONTAINER SYSTEM

Under this alternative every day a solid wastes worker enters the yard of the household and carries the solid wastes container to the truck and returns the container to the yard. The use of plastic bags could eliminate a return trip with an empty container in many cases and the use of plastic bags together with household containers should be encouraged. The use of containerswith a properly fitting lid is considered necessary to prevent access by household animals and by insects even when plastic bags are used.

The use of trucks avoids the requirement for neighbourhood loading stations necessary when gerobaks are used for collection. In countries where labor cost are high, daily collection service is rarely provided. In many major cities the trend is to increase the collection interval to as much as one week. Although daily house to house collection is sometimes provided and is affordable by a small percentage of the upper income group regular service every second day should not result in significant detrimental effects to householders and it is recommended that more frequent service than once every two days not be offered in the early stages of the program.

Service Level 2 - Every second day house to house truck

This will be the highest level of residential collection service offered to the upper income group.

Householders, as a condition of service will be required to provide a household container meeting minimum standards and to replace it when necessary.

Service Level 3 - Daily house to house handcart

As for service level 1 it is recommended that this level of service not be considered at the present time.

Service Level 4 - Every second day house to house handcart

This level of service can be considered by all of the middle income group. The potential service area for service levels 1, 2, 3, and 4 are shown in Figure 9.13. The selection of the service area is based upon generalized income and land use data and the boundaries are approximate.

The use of secondary transfer stations is required when handcarts are used and it is recommended that in residential service areas the transfer stations to be of the continuously operated type with storage not provided.

Service Levels 5 and 6 - Curbside handcart service every second day or twice weekly

For curbside service could wastes are placed in container at the side of the road. As for service level 4 these service levels may be considered within the low income area as shown in Figure 9.13.

Service Level 7 - Communal

This is considered to be the minimum acceptable service level. Communal containers would be located at interval not exceeding about 125 metres. These containers would be removed daily to a loading station for transport to the disposal site. Figure 9.13 shows the general areas in which this level of service would be used.

9.2.1.4 Commercial Industrial Institutional Service

Service levels proposed for the commercial areas of the city, excluding markets, are shown in Figure 9.13. Daily service is proposed throughout the commercial areas because of the large volume of wastes generated and the general lack of external storage space either on private property or at potential loading station sites.

Containers used in this sector will be similar to household containers but sizes up to 60 litres can be considered. Normal collection service would consist of picking up a maximum of 2 containers from each customer.

The service levels include the following:

C-1 daily house to house truck
C-2 daily house to house handcart
C-3 daily curbside handcart

It is also proposed that special collection services be provided to meet the special disposal needs of certain industries. Examples are:

1. Removing earth carried into public streets by construction vehicles.

2. More frequent collection may be required by many operations such as large hotels and restaurants, and industries and institutions which produce large quantities of wastes. Such service can also be provided by the waste producer using his own equipment or by contract with private haulers.

9.2.1.5 Markets

The use of container systems has been considered for large markets and an analysis of transportation costs revealed that the use of conventional trucks capable of carrying three tonnes of market wastes is more cost effective than the use of the container system. At the central market unit costs were Rp.2,300 /ton and Rp.5,000 /ton respectively. Details of the analysis are presented in Tables 9.3 and 9.4.

Table 9.5 summarizes the type of solid wastes transportation facilities proposed for each of the markets in the city at the locations shown in Figure 9.14.

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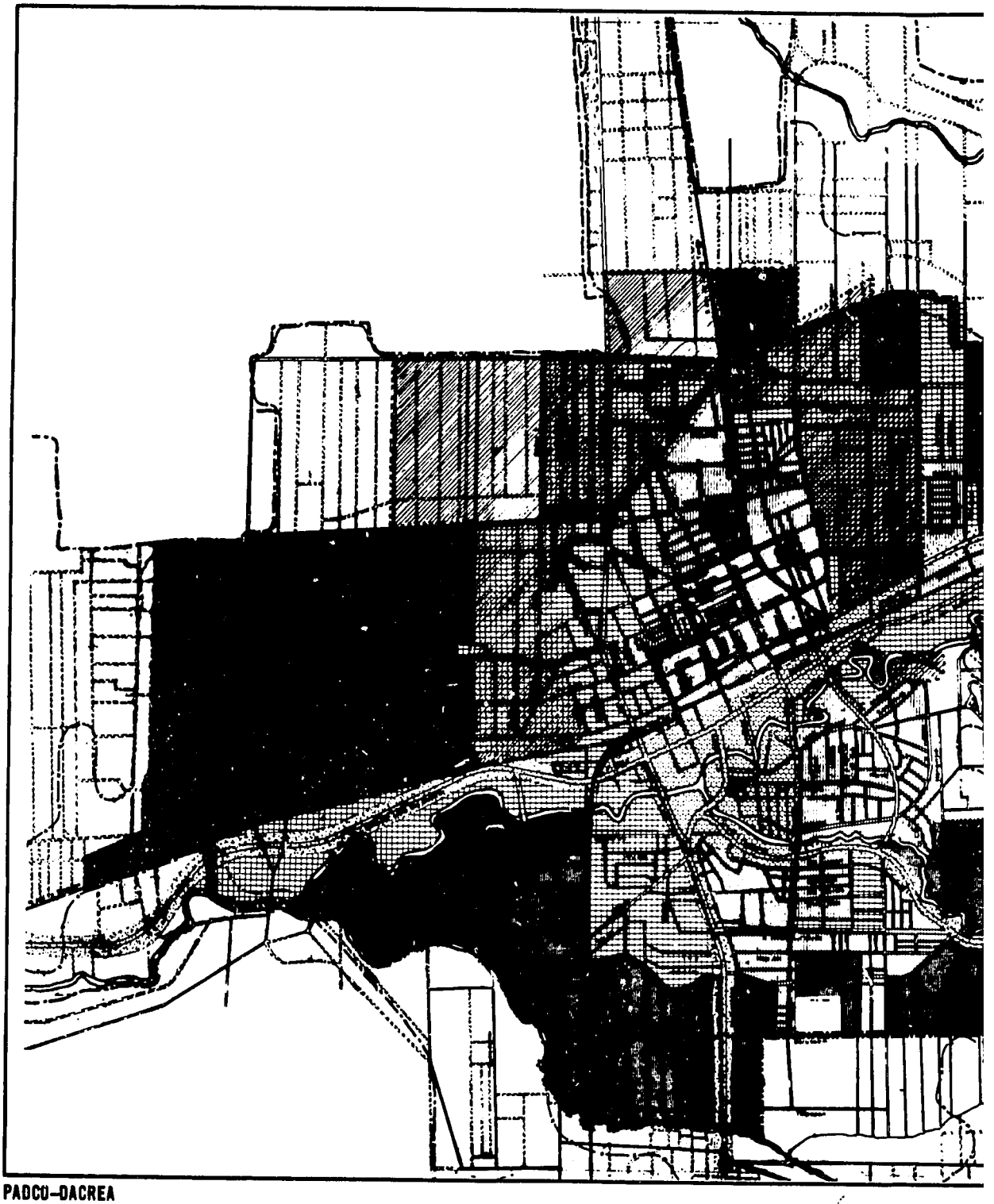

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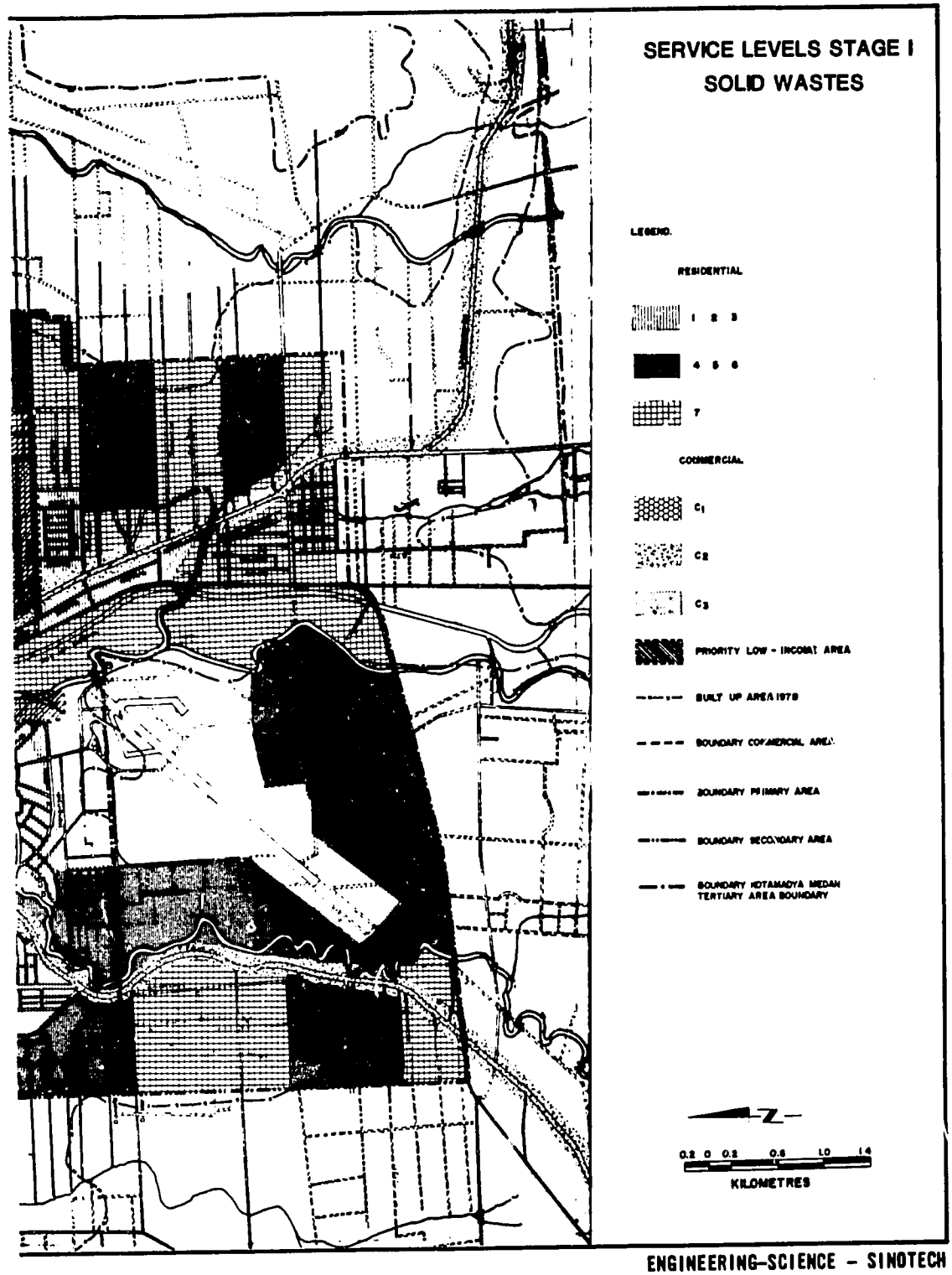
FIGURE 9.13



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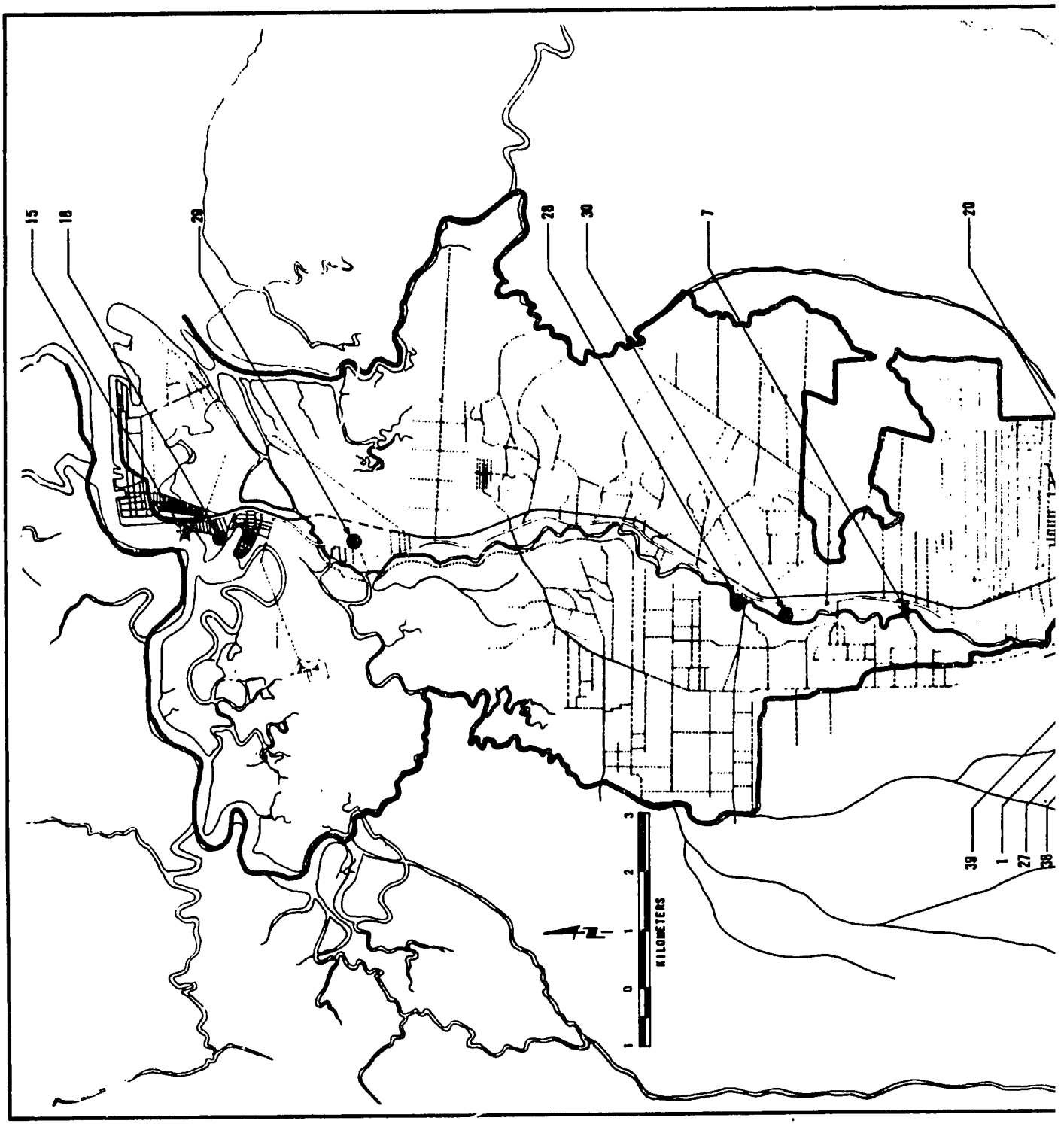

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FIGURE 9.1

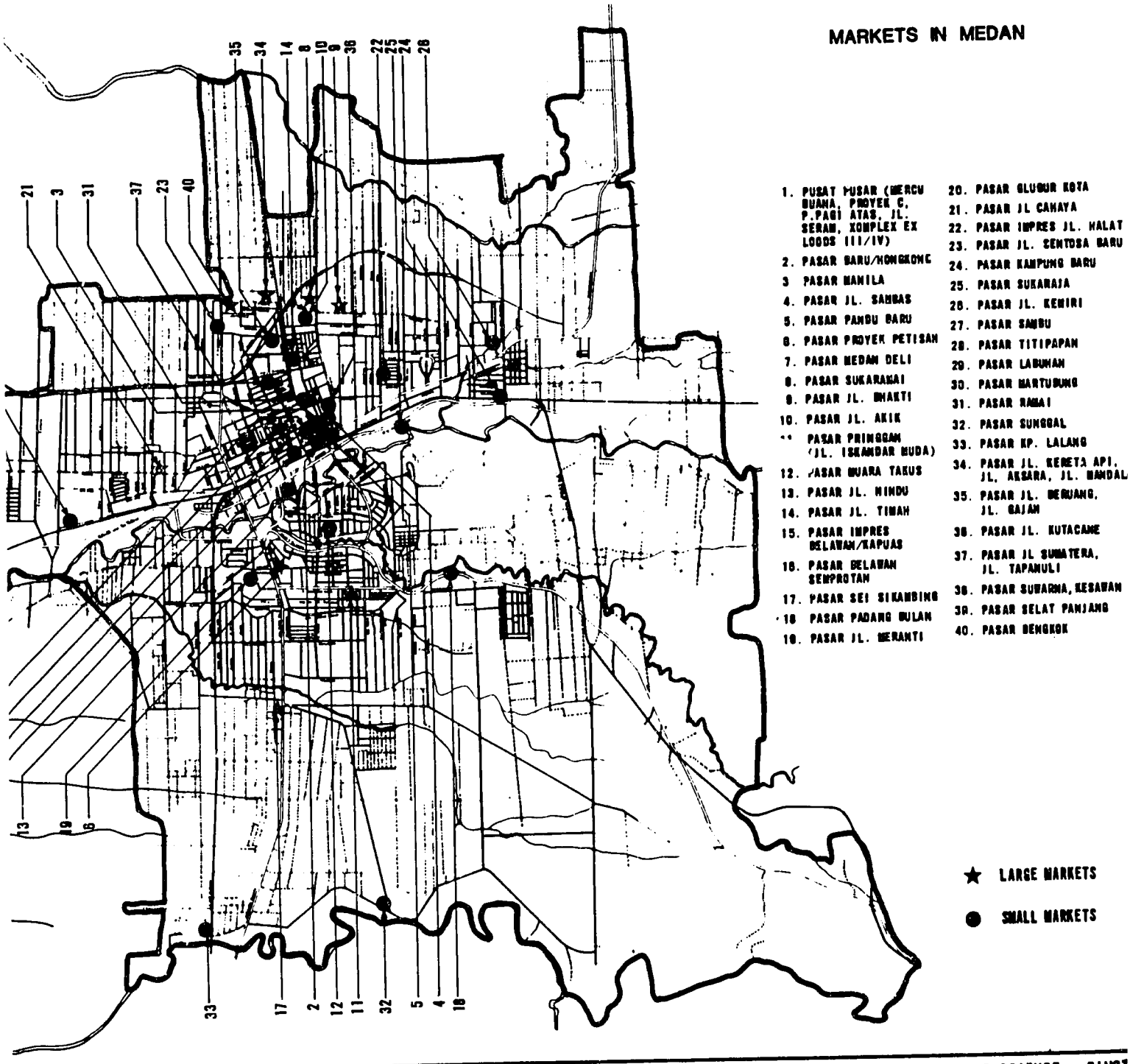

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TABLE 9.3

DESCRIPTION OF ALTERNATIVE
TRANSPORT SYSTEMS CENTRAL MARKET

	Container System	Conventional Truck System
1. Quantity of Waste tonnes per day	30	30
2. No. of Containers	6	0
3. Capacity of Containers/tonnes trucks	3.5	3
4. No. of Trucks	3	3
5. Trips/day total	9	10
6. Truck crew (per vehicle) driver laborers	1	3
7. Haul distance km	22	22
8. Overtime crew-hours	0	3
9. Loading Station type	4	1
10. Working days/year	300	300

TABLE 9.4

COMPARATIVE COSTS CONTAINER SYSTEM
AND CONVENTIONAL TRUCKS CENTRAL MARKET

(Millions of Rupiah)

	Container System		Conventional Truck System	
	Capital Cost	Annual Cost	Capital Cost	Annual Cost
Truck	91.8	24.2[a]	30.0	7.9[a]
Containers	12.4	3.2[a]	-	-
Salvage (trucks)	9.2[b]cr	1.5[b]cr	3.0[b]cr	0.5[c]cr
Transfer Stations	1.6	0.2[d]	0.7	0.1[a]
Insurance		4.4		1.5
Crew		3.0		5.4
Truck Maintenance and running costs		11.4		6.0
Container Maintenance		0.2		-
Total	115.0	48.1	33.7	21.4

Notes: a. 5 year life @ 10 percent, capital recovery.
b. 10 percent of purchase price.
c. 10 percent capital recovery factor.
d. 20 year life.

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TABLE 9.5

SOLID WASTES COLLECTION-MARKETS

Item	Reference No.	Name	Tonnes* per day	Loading Station type
1	1	Pusat Pasar	35	2 and 4
2	6	Petisah	3.5	1 or 2
3	7	Medan Deli	3.5	1 or 2
4	9	Jl. Bakti	3.5	3
5	11	Peringgan	3.5	1
6	15	Inpres Belawan/Kapuas	2.3	1 or 2
7	17	Sei Sikambing	2.3	2
8	21	Jl. Cahaya	2.3	3
9	34	Jl. Kereta Api	2.3	3
10	40	Bengkok	2.3	3
11	8	Sukaramai	1.7	3
12	27	Sambu	1.7	3
13	2	Pasar Baru/Hongkong	1.2	3
14	4	Sambas	1.2	3
15	12	Muara Takus	1.2	3
16	14	Jl. Timah	1.2	3
17	18	Padang Bulan	1.2	3
18	19	Jl. Meranti	1.2	3
19	20	Glugur Kota	1.2	3
20	22	Inpres Jl. Halat	1.2	3
21	33	Kampung Lalang	1.2	3
22	35	Jl. Beruang/Gajah	1.2	3
23	3	Manila	0.6	Handcart
24	5	Pandan Baru	0.6	"
25	10	Jl. Akik	0.6	"
26	13	Jl. Hindu	0.6	Handcart
27	16	Belawan Semprotan	0.6	"
28	23	Jl. Sentosa Baru	0.6	"
29	24	Kampung Baru	0.6	"
30	25	Sukaraja	0.6	"
31	26	Jl. Kemiri	0.6	"
32	28	Titi Papan	0.6	"
33	29	Labuhan	0.6	"
34	30	Martubung	0.6	"
35	31	Ramai	0.6	"
36	32	Sunggal	0.6	"
37	36	Jl. Kutacane	0.6	"
38	37	Jl. Sumatra/Tapanuli	0.6	"
39	38	Suwarna/Kesawan	0.6	"
40	39	Selat Panjang	0.6	"

* 1985 conditions

9.2.2 Street Sweeping

The present street sweeping program in Medan is shown in Figure 9.15. At present 224 km of streets are swept and by 1985 it has been estimated that this total will increase to 261.5 km with additional streets added as shown. One street sweeping machine is in use in the city but the most of the streets are swept by hand. In Jakarta the use of mechanized street sweepers imported from Japan is now being evaluated, however the high cost of the machines is a major factor affecting their application in Medan. A summary of the comparative costs of mechanized and hand street sweeping methods is summarized in Table 9.6. The cost per km of road swept is Rp.3 and Rp.2.2 for mechanized and hand methods respectively. The first stage street sweeping program has been based on the continued use of hand methods.

TABLE 9.6

COMPARATIVE COSTS STREET SWEEPING ALTERNATIVES
(Thousands of Rupiah)

A. Sweeping Machines	
Capital	
Street Sweeper	43,000
Equivalent annual cost	11,352
Salvage value (equivalent annual)	705
Equivalent annual net cost	10,647
Annual O & M	
Insurance 5%	2,150
Crew 2 men	1,008
Running cost	2,000
Total annual cost	15,805
Cost per km of street swept (2½ km/hour)	3
B. Hand Sweeping	
Capital	
Gerobak	85
Equivalent annual cost	22.4
O & M	
Crew 5 persons	1,440
Total annual cost	1,462.4
Cost per km of street swept (1 crew does one km each day)	1
Haul cost at 2,300 Rp./tonne and ½ tonnes/km	1.2
Total	2.2

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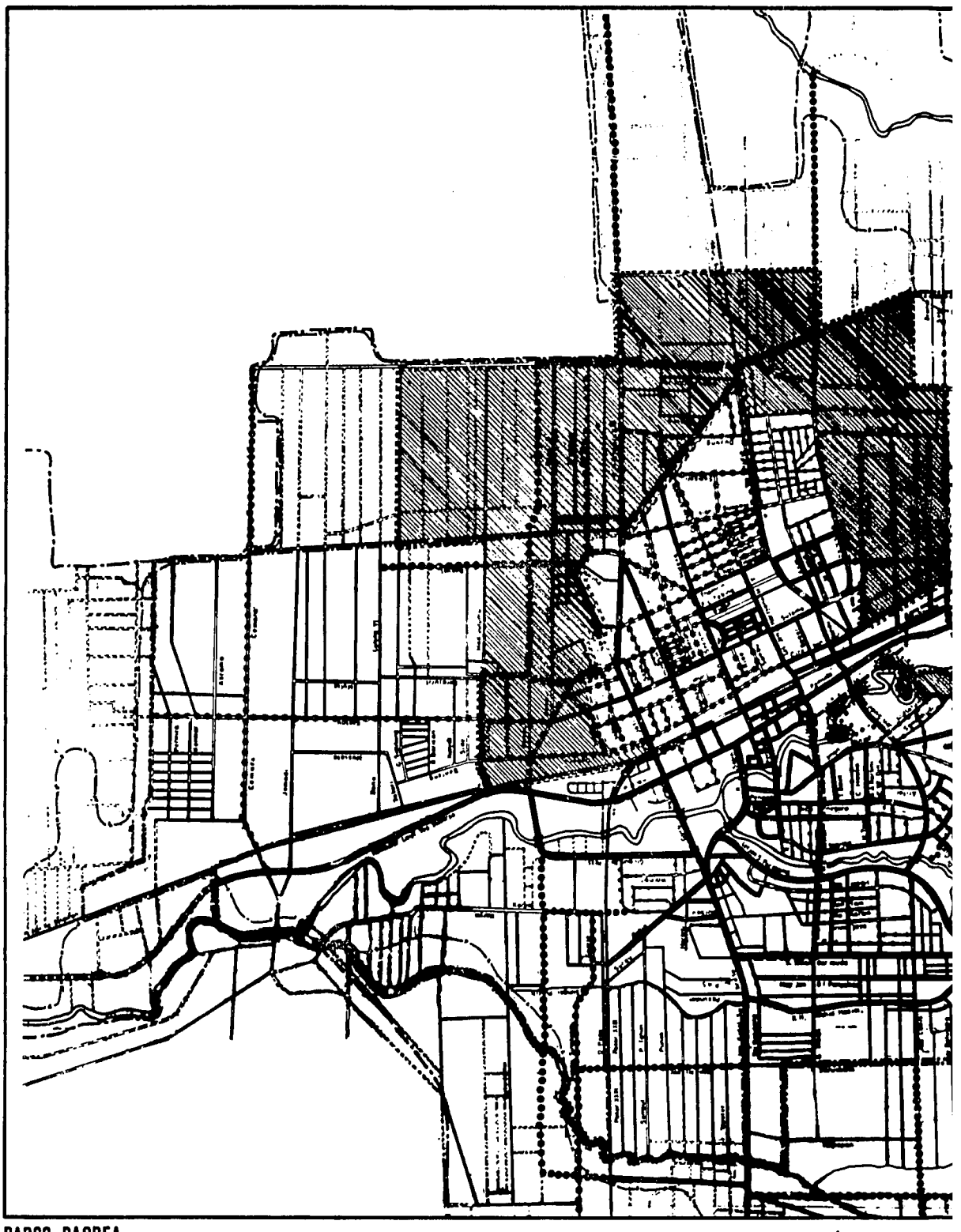

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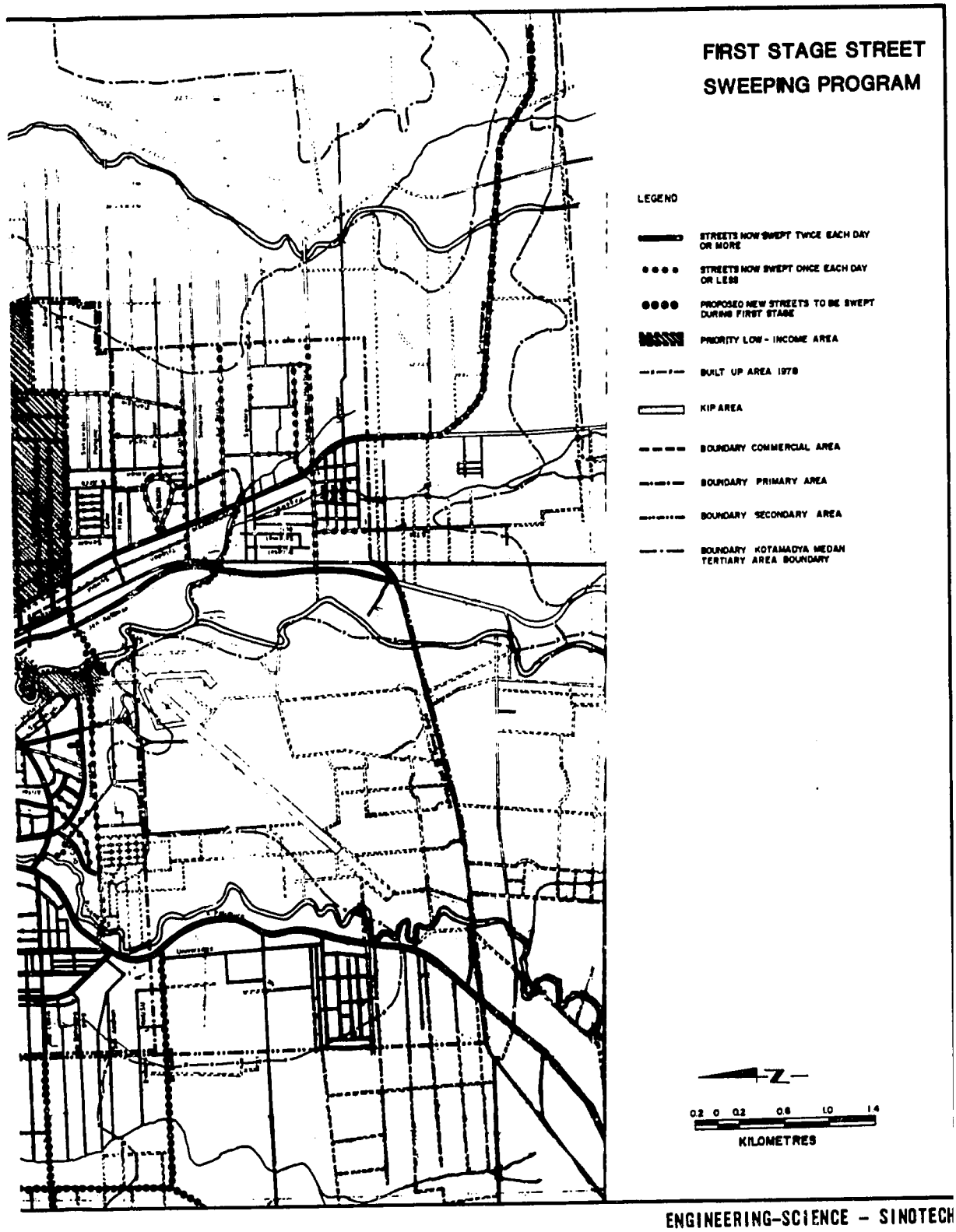
FIGURE 9.15



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9.2.3 Transfer

Conventional solid wastes transfer facilities are employed at central locations in or near the service area to transfer solid wastes from collection vehicles to larger truck/trailer combinations, for transportation to distant disposal sites. Typically such facilities may be more cost effective than direct haul by collection vehicles when one-way haul distances exceed approximately 10 km. Typical relationships are shown in Figure 9.16.

In Medan the maximum probable mean one way haul distance (to a potential disposal site near Belawan) is approximately 20 km. A number of other potential disposal sites are located within 10 km.

Accordingly the use of large transfer stations has not been considered for the first stage solid wastes program. The capacity of new vehicles should not be less than 3 tonnes payload to minimize transportation costs especially to distant disposal sites.

9.2.4 Disposal

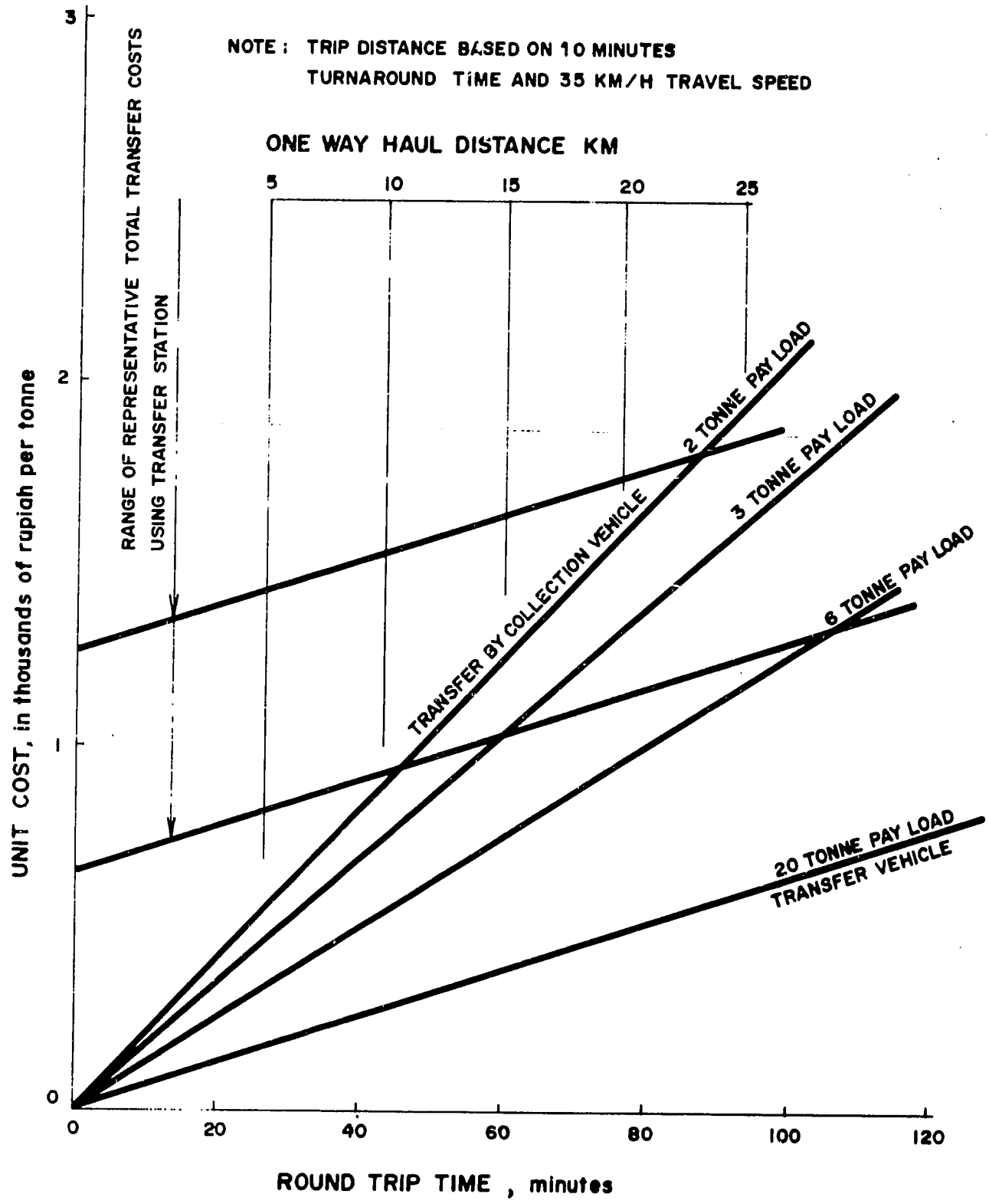
Sanitary landfill has been selected as the optimum disposal method for Medan for those wastes which are not processed at the existing commercially operated composting plant which processes about 75 tonnes per day of market wastes.

In the first stage program a 98 hectare site is required. At the present time the acquisition of a new disposal site has not been initiated by the city.

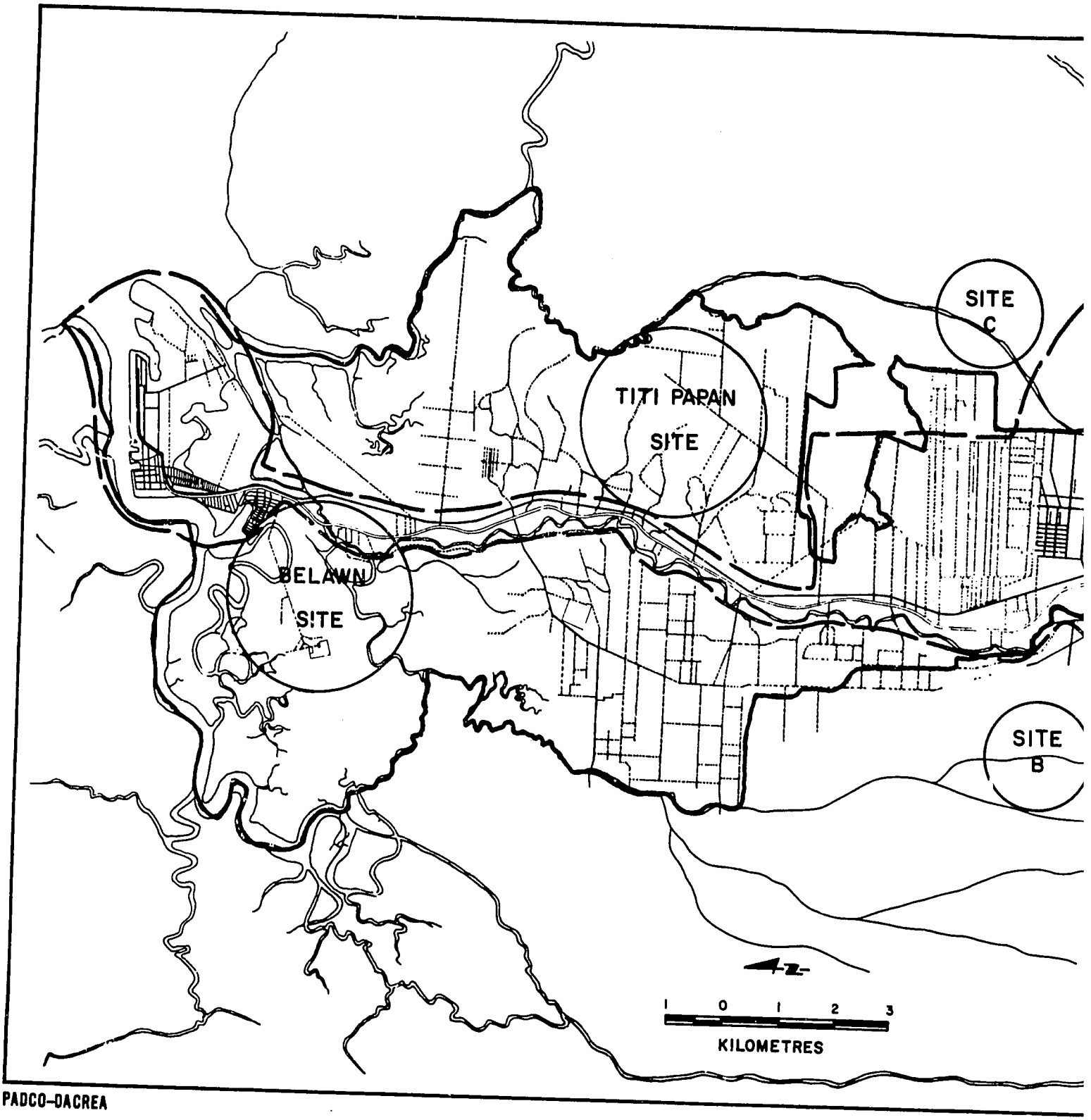
The topography of the study area provides three general types of sites that can be considered for landfill operations: ravines; plains; and coastal lowlands. These have been discussed in 6.3.3.

Typical sites which can be considered are shown in Figure 9.17. The cost of alternative transfer/disposal systems is a critical factor affecting disposal site selection. A comparative cost analysis has been carried out considering transportation, site acquisition and operating costs with the results shown in Table 9.7. In view the relatively small capacity of collection transfer vehicles the simultaneous use of more than one landfill site must be considered in the interest of overall system economy and such disposal system have been evaluated.

FIGURE 9.16



COMPARATIVE COSTS OF
TRANSFER ALTERNATIVES



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ALTERNATIVE SANITARY LANDFILL S
SOUTH
EAST
SITE
SITE A
BAYA BAB
CENTROID
OF
GENERATION
(NEAR 2000)
SITE
B

TABLE 9.7

SUMMARY OF ESTIMATED CAPITAL COSTS OF TRANSFER AND DISPOSAL ALTERNATIVES

	Unit Cost[d] Thousand of Rp./Tonne		
	Transfer	Disposal	Total
1. Single site Belawan[a]			
a. Direct	1,000	900	1,900
b. Transfer station	1500-2100	900	2400-3000
2. Single site			
- Titipapan[b]	800	1,600	2,400
- South East [b]			
3. Single site			
A Medan Barat[c]	400	2,000	2,400
B Paya Babi Area[c]			
4. Multiple site[c]			
Medan: a. site A & B	350	2,000	2,350
b. site A, B & C	300	2,000	2,300

Notes: a. Land costs based on 200 Rp./sq m
b. Land costs based on 500 Rp./sq m
c. Land costs based on 700 Rp./sq m
d. Land costs exclude compensation for improvements and crops

Disposal costs assume cover material is available on site and that sites are readily accessible.

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From the foregoing it is evident that the cost differential is not large among the transfer/disposal alternatives. The use of multiple sites does not result in significant cost reductions within the range of alternatives examined. The greater haul distances associated with the Belawan, Titipapan and South East sites are offset by lower land costs. The use of transfer stations for the Belawan site is significantly more costly.

The acquisition of landfill sites is at best a difficult process from the standpoint of public acceptance. Without significant benefits the selection of multiple sites is difficult to justify. Initially in Medan a single landfill site should be considered.

The selection of the optimum site will depend upon a number of factors including land cost, compensation for land improvements and crop losses, accessibility, and site development costs including the availability of cover material, all of which are dependent upon site specific investigations.

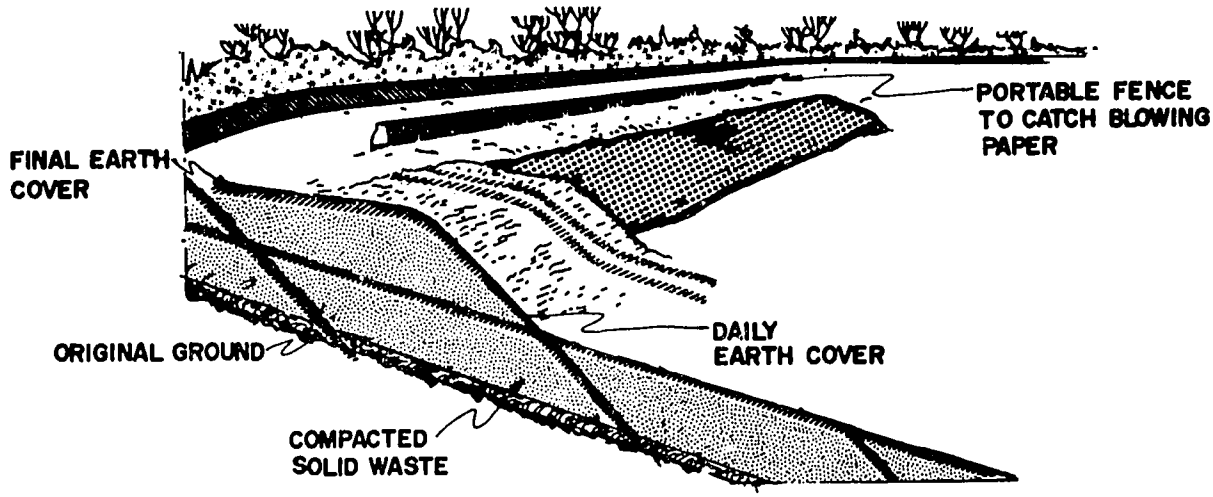
At this stage of the investigation sites in Belawan, Titipapan and to the south east of the city are all promising. Site development costs and the availability of cover material and the short term congestion along the road Belawan tend to make the cost and convenience of a Belawan site somewhat uncertain. Cover material from part and river dredging operations can be considered and with the construction of the Toll Road the traffic situation will be improved considerably. Other disadvantages must be weighed against the advantage of the isolation of the site from areas suitable for urban development. If similarly priced sites are available closer to Medan, they would result in significant reduction in overall haul and disposal costs. System requirements for the feasibility investigation have been based upon the Belawan site, filling to a finished depth of 2 metres. Landfill sites are frequently developed to elevations much higher than the surrounding terrain with corresponding reductions in the total site area required. Such practices can be considered in Medan, although it must be recognized that future potential beneficial uses of the completed site would be restricted. A typical area type sanitary landfill operation is illustrated in Figure 9.18.

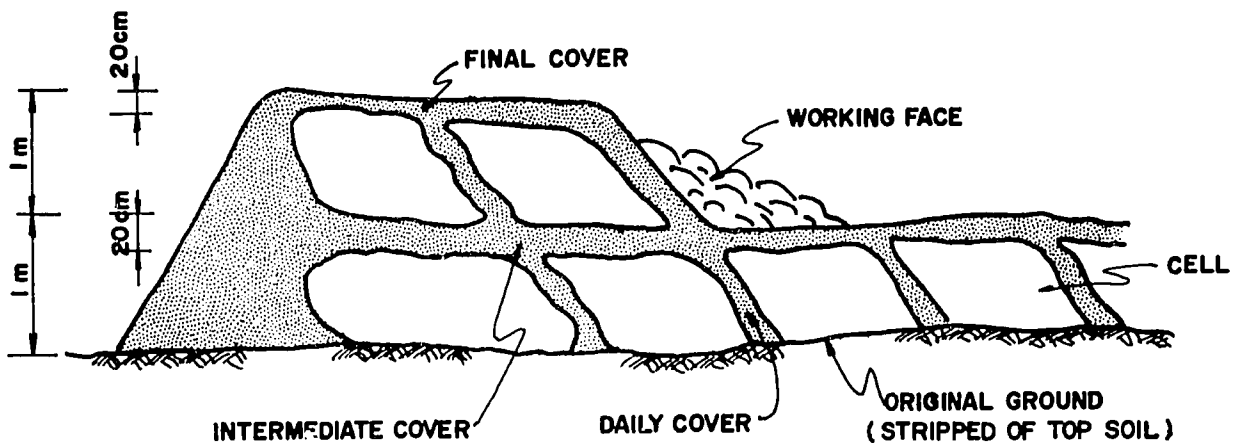
9.2.5 Collection and Disposal Outside the Municipal Service Area

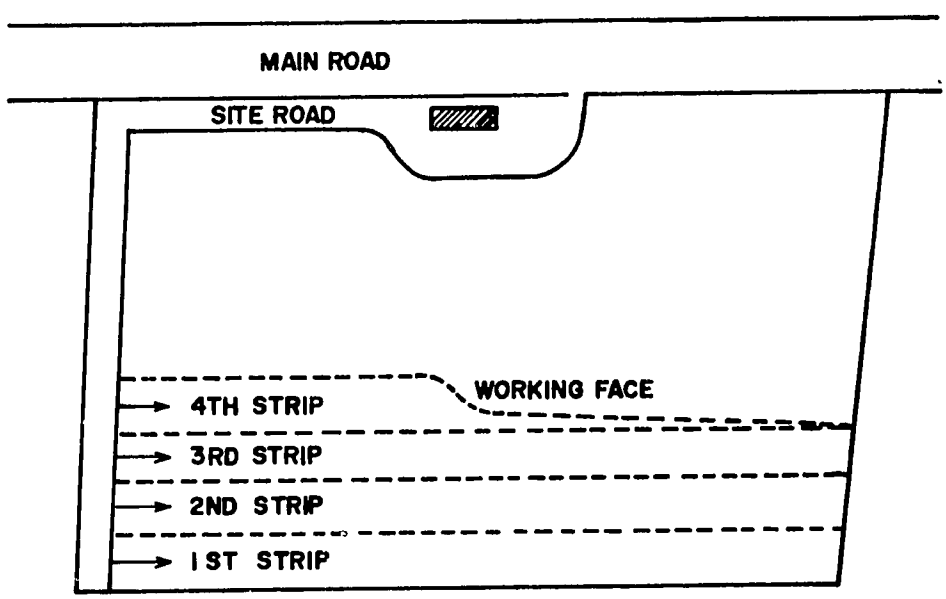
In areas outside of the boundaries of the municipal service area household disposal practices will continue. In rural areas with low population density solid wastes can be disposed of effectively by burial or by composting. Some types of wastes, such as paper and leaves, can also be burned without creating significant nuisance.

The following features are considered to be important elements of the solid wastes management program to mitigate current problems in densely populated areas which will not receive municipal service in the early stages of the program.

- Technical assistance by DKKP to kecamatan and kampung personnel for the mitigation of local disposal problems and the development of self help schemes.







PROPOSED TYPICAL SANITARY
LAND FILL OPERATIONS

- Logistic support by DKKP to help solve critical disposal problems.
- Public health education
- Public health inspection and regulation

9.3 SOCIAL AND ENVIRONMENTAL CONSIDERATIONS

9.3.1 Population Served

The population served by the proposed solid wastes management system at 1985 is summarized in Table 9.8.

TABLE 9.8

POPULATION SERVED - 1985

Area Status	Percent of Total Population			
	Low Income	Medium Income	High Income	Total
Primary	23.0	9.8	2.4	35.2
Secondary	23.5	0.1	0.2	23.8
Tertiary	1.6	1.3	0.4	3.3
Total	48.1	11.2	3.0	62.3

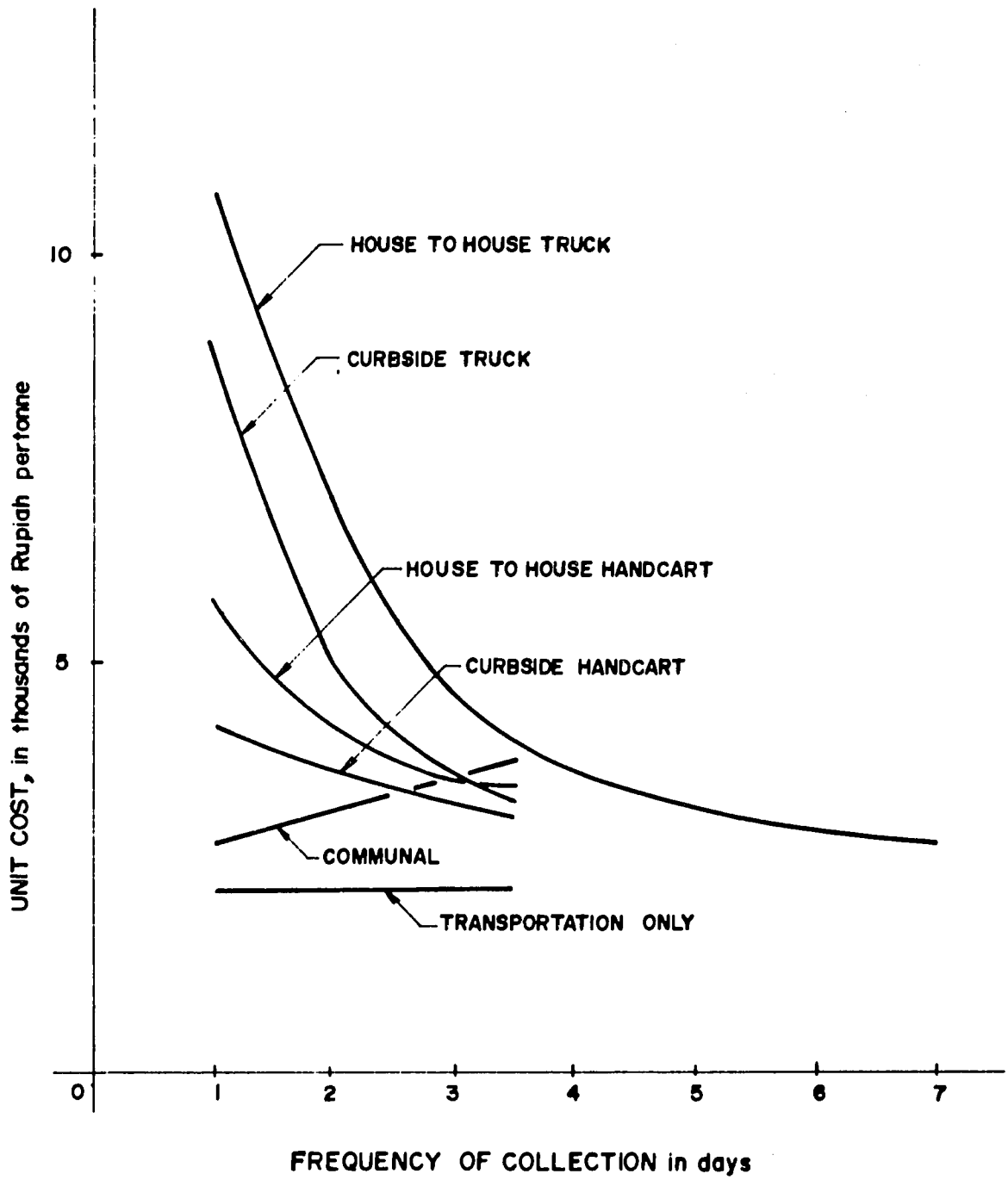
9.4 ECONOMIC CONSIDERATIONS

9.4.1 Importation of Engineering Materials

Materials and equipment used on the solid wastes system with large content of imported components are the trucks used for collection which are assembled in Indonesia from imported parts and the heavy equipment used at the landfill site which are imported as complete units sold and serviced by local suppliers.

9.4.2 Labor Intensive Methods

The evaluation of the use of labor intensive methods for solid wastes collection has been an inherent part of the evaluation of alternative collection methods. Typical unit costs for various types of collection service are shown in Figure 9.19 illustrating the cost effectiveness of labor intensive handcart methods in comparison with the more extensive use of trucks. Similar evaluations were carried out for alternatives



COMPARATIVE COST OF
COLLECTION ALTERNATIVES

methods of street sweeping and for the transport of wastes from market areas similarly confirming that the continued use of labor intensive methods in Medan provide least cost solutions for solid wastes management.

9.5 OPERATION AND MANAGEMENT

9.5.1 Organization

As discussed in Section 8, the organization structure of the Cleansing Department of the city was officially changed in July 2, 1979 from that of Figure 8.1 to that shown in Figure 8.2.

The transfer of all functions other than cleaning to other city departments will enable greater direction of effort in the cleaning tasks. However, lack of direct control of even routine vehicle servicing and repairs may interfere unduly with collection operations. Further, the initiation of the new service levels will require special organizational features which can be defined in an organization chart.

The increase in size of the service area of DKKP and the large increase in the number of vehicles and staff requires that the organizational structure of DKKP be expanded to ensure that adequate levels of supervision and control are provided.

This can be accomplished by defining a greater number of operational units on the basis of service type and geographical area.

Because of the limited capacity of the existing DKKP works yard to accommodate additional staff and equipment and because of the greater operational efficiency that can result from decentralization, it is recommended that two additional operational centers be formed and that the organizational structure be strengthed as shown in Figure 8.3.

Operational planning including such matters as vehicle and service schedules should be under the direct control of the area superintendents. The area superintendents will also have an inspection staff who will observe the operation of the collection system an report variations from established operational programmes so that corrective action can be taken.

It is also possible to consider the involvement of Kecamatan and Kampung administration in certain elements of the organization structure for example in the communal service element and in the handcart collection service types.

9.5.2 Staffing

The proposed staffing requirement at the 1985 operating condition is summarized in Table 9.9. The current staff level is approximately 1464 persons.

TABLE 9.9

SCHEDULE OF STAFF REQUIREMENTS 1985

Department Head	1
Administration	
Secretary	2
Clerks	2
Typists	5
Laborer Building Maintenance	2
Planning Monitoring Engineer	1
Technologists	3
Central District	
Superintendent	1
Clerk	1
Typist	2
Laborer Building Maintenance	2
Inspectors	3
Vehicle Service	
Maintenance Mechanic	1
Assistance Maintenance Mechanic	1
Laborer	2
Routed Service and Loading Stations	
Supervisor	1
Zone foremen	3
Drivers	7
Laborers	79
Commercial, Industrial, and Institutional service	
Market Parks	1
Foremen	3
Drivers	15
Laborer	45
Zone Foreman	3
Drivers	38
Laborers	279
Special Services	
Foreman	1
Drivers	3
Laborers	9

TABLE 9.9--(Continued)

Street Sweeping	
Foreman	3
Laborers	350
Eastern District	
Superintendent	1
Clerk	1
Typist	2
Laborer Building Maintenance	2
Vehicle Service	
As for central area	4
Domestic Routed	
Service and Loading	
Stations	
Zone foremen	3
Drivers	33
Laborers	130
Communal Collection Service	
Zone foremen	3
Laborers	87
Commercial, Industrial, and Institutional	
Zone Foremen	3
Drivers	13
Laborers	112
Street Sweeping	
Foremen	3
Sweeper	350
Western District	
Superintendent	1
Clerk	1
Typist	2
Laborer Building Maintenance	2
Inspector	3
Vehicle Service	
As for central district	4
Domestic Routed Service and Loading Stations	
Zone Foreman	3
Drivers	32
Laborers	130

TABLE 9.9--(Continued)

Communal Collection Service	
Zone foremen	3
Laborers	86
Commercial	
Industrial	
Institutional	
Zone foremen	3
Drivers	14
Laborers	113
Street Sweeping	
Foremen	3
Sweepers	350
Disposal	
Operators	2
Skilled Labor	3
Unskilled Labor	6
Total	2377

9.5.3 Training Program

Staff training will be necessary to prepare technical and supervisory personnel for their duties in implementing the solid wastes management program.

The following training program elements are proposed.

Refresher Courses - Part time attendance at the University of North Sumatra and the Medan Technical High School (STTM).

On the job training - Staff seminars by specialist advisors.

- Counterpart training with design consultants.

Subject material should cover:

- Solid wastes sampling and analytical methods
- Operational records and data analysis
- Cost effectiveness analysis procedures
- Fleet vehicle maintenance systems
- Vehicle maintenance

9.6 ESTIMATED COST AND RECOMMENDED IMPLEMENTATION SCHEDULE

9.6.1 Capital Costs

The capital costs of the First Stage program are presented in Table 9.10. It should be noted that the First Stage program now recommended differs to that proposed as part of the Master Plan projections. This is a result of Master Plan review meetings held with the GOL and the realization that it would be infeasible to proceed with the immediate action expenditures proposed for 1979/80 and 1980/81. As a result the program now recommended is more concentrated.

TABLE 9.10

SCHEDULE OF CAPITAL COSTS - MID 1979 PRICES

		No. Req'd	Unit Cost Millions of Rupiah	Total Costs Millions of Rupiah
1981/82	Trucks	57	10	570
	Handcarts	306	0.085	26
	Loading Stations	32	3.03	97
	Landfill Equipment			
	Bulldozer	1	82	82
	Front-end Loader	1	52	52
	Land			
	Loading Stations			70
	Landfill Sites			50
	Operating Centres			0
	Sub total 1981/82			947
1982/83	Trucks	54	10	540
	Handcarts	765	0.085	65
	Loading Stations	22	3	66

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TABLE 9.10--Continued

		No. Req'd	Unit Cost Millions of Rupiah	Total Costs Millions of Rupiah
	Operating Centers	2	L.S.	120
	Land			
	Loading Sites			48
	Landfill Sites			175
	Operating Centers			10
	Sub total 1982/83			1,103
1983/84	Trucks	28	10	280
	Handcarts	329	0.085	28
	Loading Stations	15	3	45
	Land-Loading Stations			33
	Sub total 1982/83			386
	GRAND TOTAL			2,436

Expenditure by year during Repelita III is given in Table 9.11. The costs here differ to those shown in Table 9.9 due to:

- the exclusion of land costs
- the exclusion of KIP costs
- the inclusion of taxes and duties
- updating to January 1980 prices

The costs do not include any allowance for engineering or contingencies.

9.6.2 Operating and Maintenance Costs

The annual operating and maintenance costs of the proposed solid waste management system at year 1985 conditions are summarized in Table 9.12.

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TABLE 9.11

SCHEDULE OF CAPITAL EXPENDITURE - SOLID WASTES
Millions of Rupiah - 1st Jan 1980 prices

Item	1981/82			1982/83			1983/84			Total		
	C	S	T	C	S	T	C	S	T	C	S	T
Trucks	-	729	729	-	673	673	-	340	340	-	1,742	1,742
Handcarts	-	21	21	-	66	66	-	27	27	-	114	114
Loading Stations	110	-	110	163	-	163	50	-	50	323	-	323
Landfill Equipment	-	179	179	-	-	-	-	-	-	-	179	179
New District Operating Centres	-	-	-	103	34	137	-	-	-	103	34	137
Total	110	929	1,039	266	773	1,039	50	367	417	426	2,069	2,495

TABLE 9.12

ANNUAL O&M COSTS 1985
(1980 prices)

	Amount in Thousand of Rp.
1. Salaries & Wages	503,000
2. Fringe Benefits	167,000
3. Honorarium	1,000
4. Vehicle O&M	458,000
5. Small Tools & Supplies	13,000
Total	1,142,000
Less existing	223,000
Incremental Costs	919,000

9.6.3 Recommended Implementation Schedule

The recommended implementation schedule for the first stage solid wastes program is shown in Figure 9.20.

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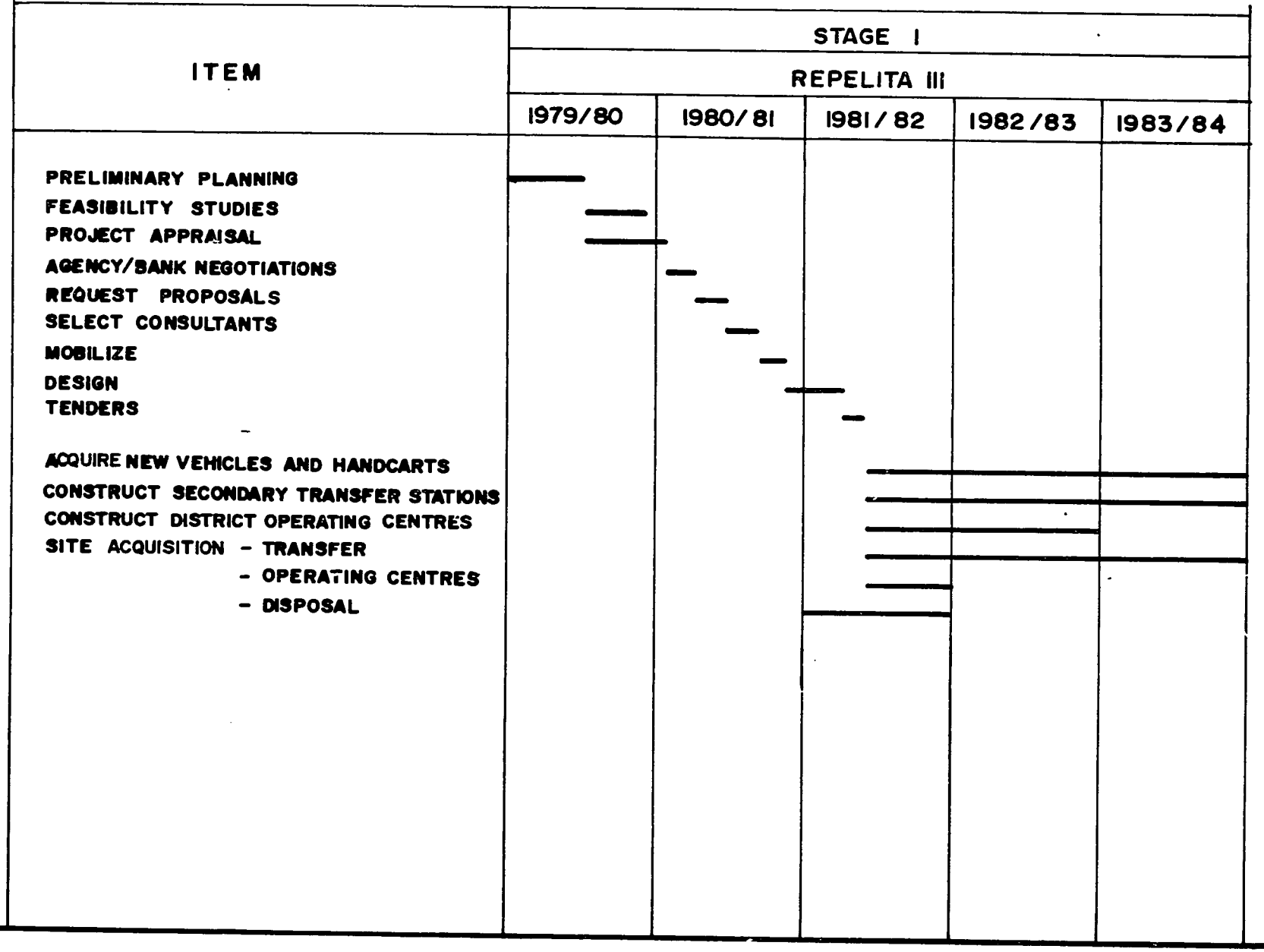
FIGURE 9.20

SOLID WASTES IMPLEMENTATION SCHEDULE



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 made during Repelita IV. As the timing of additional expenditures and the basis of their funding are so uncertain at present no attempt has been made to anticipate these in the projections.

The internal economic and financial rates of return have been calculated for the first stage investment program.

10.2 PROJECT COSTS

10.2.1 Capital Costs

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

TABLE 10.1

SOLID WASTE CAPITAL COSTS - FIRST STAGE PROGRAM
Rp. in Millions

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land	-	-	-	410	410
Civil Works	115	142	257	169	426
Equipment & Materials	169	898	1067	1002	2069
Engineering & Construction Supervision	125	-	125	125	250
Sub-total	409	1040	1449	1706	3155
Physical Contingencies	61	156	217	256	473
Sub-total	470	1196	1666	1962	3628
Price Contingencies	76	227	303	692	995
Total	546	1423	1969	2654	4623

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. These rates are:

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

10.2.2 Foreign Exchange Costs

Out of the total cost of Rp.4,623 million under half (42.6%) is in foreign exchange. This is considered a maximum estimate. There is always a considerable degree of uncertainty when estimating foreign exchange requirements as the allocation of supply and civil contracts between foreign and local companies cannot be predicted with certainty. The foreign exchange estimates assume that when construction and supply contracts are considered likely to attract international bids, the latter

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would be successful. Other assumptions used in estimating foreign exchange costs are:

- 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. If payment is made in local currency the cost is classified as indirect. For instance, 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. Similarly, the trucks required for the solid wastes program will be assembled in Indonesia from imported components and are therefore considered indirect costs.

- 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 a 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 Section 9 have been incorporated into the analyses.

10.3 PROJECT FUNDING

10.3.1 General Approach To Funding MUDS Programs

In discussion 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. Techinical 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 improvement's 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

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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 MUDS 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% 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% of development investment in Medan; external funds can similarly 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's and solid wastes loan/grant requirements would increase by the 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% of development expenditure. 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% in 1986/87. In making this calculation, debt service for solid wastes has been excluded as both operating costs and debt service payment for this service will be met directly from operating revenues

TABLE 10.2

PROTECTION OF KOTAMADYA MEDANS CONTRIBUTION TO MUDS PROGRAMS

Rp. in Millions

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
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. K I P [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 these will be required for vehicle replacement and expansion of solid waste service coverage.
d. Some operations costs will be necessary for KIP but they will come substantially from sectoral programs.

(user chargers). If the solid wastes debt service is included, total debt service increases by almost 50% and the percentage of debt service to development expenditure becomes 27% in 1986/87. However, this reduces to 22% in 1987/88 and 18% 1988/89. So even on this 'maximum' debt service assumption, only in two years is the quideline exceeded.

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

Notes: a. 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.

b. 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 generally improved financial housekeeping. The immediate implementation of a program such as that recommended in Section 21 and Appendix A of Volume III is an essential requirement if the Kotamadya is to meet the financial commitments proposed.

10.3.2 Solid Wastes Funding

The general requirement that Kotamadya Medan should contribute from its own resources to the MUDs sectoral investments was given particular emphasis by GOI officials in respect of the solid wastes program. As just discussed, the front-end contribution which can be afforded by the municipality is strictly limited, but the resources which will be available have been allocated to solid wastes and KIP. Thus the contribution by the Kotamadya to solid wastes capital investment during the first stage program is projected as Rp.800 million (17% of total cost). The balance of the finance is assumed to be a GOI loan, on terms discussed in 10.5.2.2.

The Kotamadya will be required to provide an additional Rp.500

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million as working capital over the same period. This reflects in part the need to make up the anticipated operating deficit in the first two years of the program. The investment and working capital requirements combined total Rp.1,300 million in Repelita III, by far the highest contribution by the municipality to any individual sector.

10.4 SOLID WASTE CHARGES

The different levels of service which have been proposed for the solid waste program were developed with reference to income levels in Medan. The criterion adopted was that around 1 percent of household expenditure is a reasonable amount to expend on these services. The different service levels and monthly rates which result from this approach are given in Table 10.3.

TABLE 10.3

PROPOSED SOLID WASTE CHARGES

Service Level	Rp per Month
1	1200
2	1000
3	900
4	800
5	700
6	600
7	200

The exception to the 1 percent criterion is service level 7, which is the community service. The charge proposed for this is below the cost of providing the service but it is not realistic to expect a willingness to pay more than Rp.200 per month by the poorest members of the community. It is not proposed that the full range of services be provided from the outset; service levels 1 & 3 would not be introduced until the end of Repelita III.

Cross-subsidization by industrial and commercial customers will therefore be required and the following rates are proposed:

Industry : Rp.3,000 per month

Commerce : Rp.2,500 per month

Market Stalls : Rp.1,500 per month

Existing rates are very low, ranging from Rp.650 to Rp.1,500 per month. The new proposed rates are by no means excessive and should not impose any undue burden.

In fixing the levels of charges, account has been taken of the need to provide sufficient revenue to cover operating costs and depreciation or debt service, whichever is the higher.

10.5 FINANCIAL EVALUATION

10.5.1 Introduction

Financial projections for the period 1980/81 - 1989/90 have been prepared. These are based on the capital expenditure and operating and maintenance costs associated with new and existing investments. The financial statements - income statement, flow of funds statement and balance sheet - are shown in Tables 10.4 through 10.6. All financial calculations are in current prices, based upon 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% from 1985 onwards.

10.5.2 Financial Assumptions

10.5.2.1 Income Statement

The solid waste revenue projections are based on the existing service level and the additional coverage planned in the period 1980/81 - 1983/84. They incorporate the proposed real rate increases discussed in 10.4 and assume that these will become effective in mid 1981/82. These rates have been increased annually in line with inflation.

Bad debts have been taken as 7 percent of revenue in 1981/82 - 1983/84 and at 5% thereafter. These high levels allow for the probable initial collection inefficiencies.

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 %
Trucks	15
Handcarts	15
Loading stations	5
Bulldozers	15
Front-end loaders	15
Operating centers	2.5

TABLE 10.4

SOLID WASTES - PROJECTED INCOME STATEMENT
Rp. Million in Current Prices

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Revenue									
Industrial/commercial	252	645	903	983	1057	1132	1212	1297	1387
Market stalls	112	281	376	409	440	471	504	540	577
Domestic	86	464	897	1087	1168	1251	1339	1433	1533
Total revenue	450	1390	2176	2479	2665	2854	3055	3270	3497
Operating expenses									
Maintenance/operating	337	660	847	955	1027	1100	1177	1259	1347
Personnel/administration	237	493	671	765	823	881	943	1009	1080
Bad debts	63	97	152	124	133	143	153	164	175
Total costs	637	1250	1670	1844	1983	2124	2273	2432	2602
Income before depreciation	(187)	140	506	635	682	730	782	838	895
Depreciation	-	243	496	652	698	747	799	855	915
Income before interest	(187)	(103)	10	(17)	(16)	(17)	(17)	(17)	(20)
Interest	-	-	-	-	-	344	337	330	322
Net surplus/(deficit)	(187)	(103)	10	(17)	(16)	(361)	(354)	(347)	342
Average net fixed assets	869	2752	4091	4270	3921	3476	2947	2327	1605
Rate of return before interest	-	-		-	-	-	-	-	-
Operating ratio	-	89.90	76.75	74.38	74.41	74.42	74.40	74.37	74.41

TABLE 10.5

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

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Source of Funds									
Income before depreciation	(187)	140	506	635	682	730	782	838	895
Long term debt	1438	1781	604	-	-	-	-	-	-
Local government equity	650	450	200	-	-	-	-	-	-
Total Sources	1901	2371	1310	635	682	730	782	838	895
Application of Funds									
Project investment	1738	2081	804	-	-	-	-	-	-
Increase/decrease in working capital*	116	270	213	-137	+34	+35	+37	+40	+41
Loan interest						344	337	330	322
Loan amortisation	-	-	-	-	-	75	82	89	97
Equity repaid	-	-	-	-	-	-	-	-	-
Total Applications	1854	2351	1017	-137	34	454	456	459	460
Net cash generated	47	20	293	772	648	276	326	379	435
Opening cash balance	-	47	67	360	1132	1780	2056	2382	2761
Closing cash balance	47	67	360	1132	1780	2056	2382	2761	3196

* excluding cash.

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TABLE 10.6

SOLID WASTES - PROJECTED BALANCE SHEET
Rp. Million in Current Prices

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Assets									
Fixed Assets	1738	4009	5176	5598	5993	6414	6863	7345	7858
Less Depreciation	-	243	761	1474	2275	3181	4203	5352	6641
Net Fixed Assets	1738	3766	4415	4124	3718	3233	2660	1993	1217
Inventories	222	302	199	134	144	154	165	176	188
Accounts Receivable	116	388	607	471	506	542	580	621	664
Cash	47	67	360	1132	1780	2056	2382	2761	3196
Total Current Assets	385	757	1166	1737	2430	2752	3127	3558	4048
Total Assets	2123	4523	5581	5861	6148	5985	5787	5551	5265
Equity and Liabilities									
Revaluation Surplus	-	190	531	892	1184	1446	1672	1860	1999
Local Government Equity	650	1100	1300	1300	1300	1300	1300	1300	1300
Operational Surplus	(187)	(290)	(280)	(297)	(313)	(674)	(1028)	(1375)	(1717)
Total Equity	463	1000	1551	1895	2171	2072	1944	1785	1582
Long Term Debt (net)	1438	3219	3823	3823	3748	3666	3577	3480	3374
Accounts Payable	222	304	207	143	154	165	177	189	203
Current Maturities	-	-	-	-	75	82	89	97	106
Total Current Liabilities	222	304	207	143	229	247	266	286	309
Total Liabilities	2123	4523	5581	5861	6148	5985	5787	5551	5265
Current Ratio	1.73	2.49	5.63	12.15					
% Debt/(Debt + Equity)	75.64	76.30	71.14	66.86					
Working Capital	163	453	959	1594					

10.5.2.2 Balance Sheet and Flow of Funds

Fixed Assets. Information on existing assets is not readily available and in view of their probable insignificance in relation to project investments, no allowance has been made for them. Their exclusion is not critical as by the end of 1982/83 the existing trucks will have been replaced by investments under the project and included in assets appropriately.

All assets have been revalued in line with the inflation assumptions discussed above. Depreciation includes an allowance for backlog depreciation; an equivalent amount has been added to the revaluation surplus.

Working Capital. Accounts payable are estimated at 10% of current year capital expenditure plus one months cash operating expenses.

Accounts receivable are estimated at 30 percent of gross revenue (less bad debts) in 1981/82 - 1982/84 and at 25 percent thereafter.

Inventories have been taken as 10% of current year capital expenditure and 25% of annual material costs.

Cash is calculated as a residual figure on the sources and application of funds statement. The cash surplus shown during Repelita IV would not materialize. The surplus results from depreciation provisions at a time when no allowance has been included for continuing or replacement expenditure. In practice, the surplus would be absorbed by such expenditure. No interest income has therefore been allowed for on this nominal cash surplus.

Loan Terms. The funding mix has been discussed in 10.3.2. The terms on which the 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 of 9 percent per annum - waived during construction
- repayment by way of a flat rate annuity of Rp. 419 million, commencing 1986/87

Financing Plan. The financing plan for 1981/82 - 1983/84 derived from the source and applications of funds statement is shown below:

SUMMARY OF FINANCING PLAN 1981/82 - 1983/84

	Rp Million	US $ Million	%
Application of Funds			
Project Cost	4623	7.40	82.9
Working Capital	959	1.53	17.1
Total	5582	8.93	100.0
Source of Funds			
GOI Loan	3823	6.12	68.5
Local Government Equity	1300	2.08	23.3
Internal Cash Generation	459	0.73	8.2
Total	5582	8.93	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. 2.0 million of investment costs and would be on-lent by GOI to the project as part of its loan funding.

10.5.3 Financial Evaluation

The critical consideration in reviewing the projected financial performance of solid waste operations is whether the required revenue can be generated. There are two important factors to be borne in mind when considering the revenue projections. First, there is no reliable source of information on the number of existing industrial and commercial establishments in Medan. The numbers used in the projections (as shown in Table 10.7) have been based on a number of sources, the main ones being the Repelita III Kotamadya Medan, the Chamber of Commerce and Industry for North Sumatra and the Census and Statistics office. However, there are considerable inconsistencies in these source and a best estimate has been made to arrive at current establishment numbers for projection purposes.

TABLE 10.7

NUMBER OF HOUSEHOLDS/ESTABLISHMENTS SERVED 1981/82 - 1983/84

Customer Category	1981/82	1982/83	1983/84
Industry	3127	3510	3550
Commerce	13601	15262	15422
Market Stalls	12901	13279	13656
Households	31000	70000	110000

The second vital assumption made is that the revenue collection efficiencies will improve dramatically. The poor performance of the existing collection mechanisms has been discussed in 8.2.1. This, of course, is connected with the very poor level of service provided at present which leads to an understandable reluctance to pay. With the improved service this reluctance should be overcome, but, even so, close cooperation between the solid waste and tax collection departments (DKKP and Dinas Pendapatan) in classifying customers by service level will be essential. Similarly, much stronger coordination between Dinas Pendapatan and the kampungs to ensure efficient collection of charges and their prompt and full remittance must be effected. If the revenue collection procedures are not improved, heavy subsidization will be required by the Kotamadya Medan. In such circumstances, serious consideration would have to be given to contracting out the collection service to private operators to avoid a strain on the very stretched resources of the city.

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If the new collection charges are introduced as recommended and if suitable customer classification and revenue collection procedures are introduced, then sufficient revenue to cover operating costs and depreciation (which significantly exceeds debt service) should be available as projected.

10.6 ECONOMIC EVALUATION

10.6.1 Introduction

As discussed elsewhere in this report, only approximately 25 percent of solid wastes generated in the city are collected. Under the first stage program proposals the quality of service will be greatly improved and coverage extended to around 50 percent of the population. The costs and benefits of these proposals are considered below.

10.6.2 Benefits of Proposed Investments

Health Benefits: Garbage dumps, official and unofficial, proliferate throughout the city. To the extent that these are breeding grounds for flies and rats, both transmitters of diseases, health benefits would result. Such benefits, however, are likely to be much less significant than in the case of the water and sewerage investments.

Environmental Benefits: The trash and garbage which litters all parts of the city is a chronic eyesore. The project would largely eliminate this problem and upgrade the urban environment. Also, the removal of the city dump will prevent the continued degradation of shallow groundwater which undoubtedly results from seepage from the dump. Both the rainwater which seeps through the rubbish and the periodic flood water absorb organic material and become polluted.

Reclaimed Land: The solid waste program includes the acquisition of a landfill site at Belawan. By the end of the first stage program 98 hectares of this site will be filled. Within five years, this will have packed and settled sufficiently for commercial and industrial use.

Savings on Drainage Maintenance: The open road side drains are choked with all types of organic and inorganic rubbish. The improved solid waste collection system will undoubtedly relieve this problem and could be expected to lead to savings in drainage maintenance costs. Such savings, however, are likely to be extremely limited, if any, because of the inadequate levels of existing expenditures.

Valuation of Benefits: It is appropriate to take the revenues which it is anticipated that the project will generate as a measure of the annual recurring benefit. The charges proposed are set at reasonable levels and the projected revenues are likely to accrue.

No attempt has been made at valuing possible health benefits, but allowance has been made for the reclaimed land at the landfill site. The current value of the land is Rp.200 per sq m. This compares with other usable land in the vicinity which has a market value of Rp.500 - 750 per sq m; this, in turn, is well below the cost price of serviced land (Rp.2500 per

sq m) at the Belawan industrial estate. It is reasonable to assume that the in-filled land will at least have a value equal to adjacent land. The 98 hectares is therefore valued at Rp.750 per sq m and is included in the benefit stream of the analysis in year 10.

Land worth Rp.410 million will be purchased for the project. It can be assumed that it will have at least an equivalent value at the end of the project's life and has been included in the benefit stream at that time.

10.6.3 Economic Costs

The project costs are summarized by year in Appendix B. In addition to initial capital costs in Repelita III, replacement of trucks is assumed to occur every seven years. As the market price of unskilled labor does not reflect its opportunity cost a factor of 0.5 has been used to convert this to its approximate economic cost. A further adjustment has been made by excluding taxes and duties from all costs.

Economic Internal Rate of Return

The cost and benefit streams are shown in Table 10.8 and give an economic internal rate of return of 22.18 percent when discounted over 25 years.

Financial Internal Rate of Return

The financial internal rate of return has been calculated on the same assumptions as used for the economic calculation, except all costs are taken at market prices. The revenue and cost streams are shown in Table 10.9 and give a financial rate of return of 10.34 percent.

TABLE 10.8

SOLID WASTES - ECONOMIC INTERNAL RATE OF RETURN

Year No.	Incremental Costs			Incremental	Net
	Capital [a]	O & M	Total	Revenue [b]	Flow
1	1347	222	1569	458	-1111
2	1445	579	2024	1085	- 939
3	522	745	1267	1339	72
4	-	777	777	1490	713
5	-	777	777	1490	713
6	-	777	777	1490	713
7	-	777	777	1490	713
8	641	777	1418	1490	72
9	606	777	1383	1490	107
10	306	777	1083	2240	1157
11	-	777	777	1490	713
12	-	777	777	1490	713
13	-	777	777	1490	713
14	-	777	777	1490	713
15	641	777	1418	1490	72
16	606	777	1383	1490	107
17	306	777	1083	1490	407
18	-	777	777	1490	713
19	-	777	777	1490	713
20	-	777	777	1490	713
21	-	777	777	1490	713
22	641	777	1418	1490	72
23	606	777	1383	1490	107
24	306	777	1083	1490	407
25	-	777	777	2941 [c]	2164

EIRR: 22.18%

NOTES:
a. 10% salvage value on retired trucks is assumed in the year of replacement. This has been deducted from the capital cost of new vehicles.
b. In year 10, 98 hectares of reclaimed land at the fill site will be available. The value of this land has been added to the revenue stream in that year.
c. In year 25 land purchased during the project period (excluding land fill site sold in year 10) is added to the revenue stream at original market cost.

TABLE 10.9

SOLID WASTES - FINANCIAL INTERNAL RATE OF RETURN

Year No.	Incremental Costs			Incremental	Net
	Capital	O & M	Total	Revenue	Flow
1	1474	285	1759	458	-1301
2	1583	731	2314	1085	-1229
3	571	933	1504	1339	- 165
4	-	974	974	1490	516
5	-	974	974	1490	516
6	-	974	974	1490	516
7	-	974	974	1490	516
8	674	974	1648	1490	- 158
9	637	974	1611	1490	- 121
10	322	974	1296	2240	944
11	-	974	974	1490	516
12	-	974	974	1490	516
13	-	974	974	1490	516
14	-	974	974	1490	516
15	674	974	1648	1490	- 158
16	637	974	1611	1490	- 121
17	322	974	1296	1490	194
18	-	974	974	1490	516
19	-	974	974	1490	516
20	-	974	974	1490	- 158
21	-	974	974	1490	- 121
22	674	974	1648	1490	- 158
23	637	974	1611	1490	- 121
24	322	974	1296	1490	194
25	-	974	974	2983	2009

FIRR: 10.34%

APPENDIX A

PROJECTED SOLID WASTE QUANTITIES

TABLE A.1

PROJECTED SOLID WASTE QUANTITIES

Kp. No.	Name of Kampung	Projected Population					Domestic Solid Waste Projections					
							Generation (Kilograms/Day)				Collections (Kilograms/Day)	
1	2	3	4	5	6	7	8	9	10	11	12	13
		1978	1980	1985	1990	2000	1980	1985	1990	2000	1980	1985
	KECAMATAN MEDAN KOTA	1.0000	1.0201	1.0511	1.0486	1.1069	0.51	0.56	0.62	0.75		
1.	Pasar Baru	7,667	7,821	8,221	8,620	9,143	3,989	4,604	5,344	6,857	3,989	4,604
2.	Pandau Hulu I	6,466	6,596	6,933	7,270	8,047	3,364	3,883	4,507	6,035	3,364	3,883
3.	Sudaramai I	9,089	9,272	9,956	10,440	11,556	4,729	5,575	6,473	8,667	4,729	5,575
4.	Sudirejo I	9,254	9,440	9,922	10,404	11,556	4,814	5,556	6,451	8,637	-	5,556
5.	Tegal Sari I	20,554	20,967	22,038	23,109	25,579	10,557	12,090	13,920	18,523	-	12,090
6.	Tegal Sari II	9,295	9,482	9,967	10,451	11,568	4,932	5,833	6,887	9,338	-	5,833
7.	Kotamatsum I	14,170	14,455	15,194	15,932	17,635	7,372	8,509	9,876	13,226	7,372	8,509
8.	Sudaramai II	12,957	13,217	13,893	14,568	16,125	6,741	7,780	9,032	12,094	6,741	7,780
9.	Mesjid	5,368	5,475	5,755	6,035	6,681	2,792	3,223	3,742	5,011	2,792	3,223
10.	Kotamatsum II	23,144	23,609	24,815	26,021	28,803	12,041	13,896	16,133	21,602	12,041	13,896
11.	Pusat Pasar	6,220	6,345	6,669	6,993	7,741	3,236	3,735	4,336	5,806	3,236	3,735
12.	Sei Rengas I	9,621	9,814	10,315	10,816	11,973	5,005	5,776	6,706	8,980	5,005	5,776
13.	Sei Rengas II	13,162	13,427	14,113	14,799	16,381	6,898	7,903	9,175	12,286	6,898	7,903
14.	Kotamatsum III	9,393	9,582	10,072	10,562	11,691	4,886	5,617	6,467	8,449	4,886	5,617
15.	Pandau Hulu II	9,423	9,612	10,103	10,594	11,727	4,902	5,658	6,568	8,795	4,902	5,658
16.	Teladan Timur	10,568	10,780	11,334	11,885	13,156	5,499	6,371	7,450	10,187	-	6,371
17.	Teladan Barat	10,994	11,215	11,788	12,361	13,682	5,720	6,601	7,664	10,262	5,720	6,601
18.	Pasar Merah Timur	10,810	11,027	11,591	12,154	13,453	5,624	6,491	7,536	10,090	5,624	6,491
19.	Pasar Merah Barat	5,358	5,466	5,746	6,025	6,669	2,788	3,218	3,736	5,002	2,788	3,218
20.	Sitirejo I	8,645	8,819	9,270	9,721	10,760	4,499	5,191	6,027	8,070	-	5,191
21.	Sitirejo II	13,422	13,692	14,392	15,091	16,704	6,985	8,060	9,356	12,528	-	3,060
22.	Sudirejo II	6,734	6,869	7,220	7,571	8,380	3,503	4,043	4,694	6,285	-	4,043
	KECAMATAN MEDAN TIMUR	1,0000	1.0289	1.0510	1.1069	1.1051						
23.	Sei Kera Hulu	19,969	20,546	21,594	23,902	26,414	10,358	11,942	14,279	20,905	-	11,942
24.	Sei Kera Hilir	19,113	19,665	20,668	22,877	25,281	10,029	11,574	14,184	18,861	-	11,574
25.	Sidorame Barat	21,259	21,873	22,589	25,004	27,632	11,155	12,650	15,503	20,724	-	12,650
26.	Durian	20,123	20,705	21,761	24,088	26,620	10,560	12,186	14,935	19,965	10,560	12,186
27.	Gelugur Darat	17,369	17,870	18,781	20,789	22,973	9,114	10,517	12,889	17,230	-	10,517
28.	Gang Buntu	9,739	10,020	10,531	11,657	12,882	5,110	5,897	7,227	9,662	5,110	5,897
29.	Pandau Hilir	10,729	11,039	11,602	12,842	14,191	5,630	6,497	7,962	10,643	5,630	6,497
30.	Sidodadi	12,560	12,924	13,583	15,035	16,614	6,591	7,607	9,322	12,461	6,591	7,607
31.	Pulo Brayan Darat	13,874	14,275	15,003	16,607	18,352	7,371	8,552	10,837	14,920	-	8,552
32.	Pulo Brayan Bengkel	11,176	11,498	12,085	13,377	14,783	5,864	6,768	8,294	11,087	-	6,768
33.	Sidorame Timur	10,105	10,397	10,927	12,005	13,366	5,303	6,119	7,499	10,025	-	6,119

TABLE A.1--CONTINUED

Kp. No.	Name of Kampung	Projected Population					Domestic Solid Waste Projections					
							Generation (Kilograms/Day)				Collection (Kiloframs/Day)	
1	2	3	4	5	6	7	8	9	10	11	12	13
		1978	1980	1985	1990	2000	1980	1985	1990	2000	1980	1985
34.	Tegal Rejo	12,730	13,102	13,770	15,242	16,844	6,682	7,711	9,450	12,633	-	7,711
	KECAMATAN MEDAN DENAI	1.0000	1.0404	1.1130	1.2873	1.3989						
35.	Bartan	23,748	24,707	27,101	34,901	48,823	12,601	15,177	21,639	36,617	-	-
36.	Bandar Selamat	16,386	10,806	12,028	15,490	21,669	5,511	6,736	9,634	16,252	-	-
37.	Indra Kasih	7,485	7,787	8,668	11,163	15,616	3,971	4,854	6,921	11,712	-	-
38.	Sidorejo	26,974	28,064	31,238	40,228	56,275	14,313	17,493	24,941	42,206	-	-
39.	Tegal Sari	47,606	32,453	36,453	46,944	65,670	16,702	20.414	29,105	49,253	-	-
	KECAMATAN MEDAN JOHOR	1.0000	1.0404	1.1043	1.2627	1.5158						
40.	Harjosari	20,945	21,792	24,065	30,387	46,061	11,114	13,476	18,840	34,546	-	-
	KECAMATAN MEDAN BARU	1.0000	1.0403	1.1161	1.1271	1.2996						
41.	Petisah Hulu	8,770	9,123	10,183	11,478	14,916	4,653	5,703	7,116	11,187	4,653	5,703
42.	Madras Hulu	5,320	5,534	6,177	6,962	9,047	2,822	3,459	4,316	6,785	2,822	3,459
43.	Jati	3,213	3,342	3,730	4,204	5,464	1,704	2,089	2,607	4,098	1,704	2,089
44.	Aur	10,681	11,112	12,403	13,980	18,169	5,557	6,711	8,173	11,073	5,557	6,711
45.	Sei Mati	7,941	8,261	9,220	10,392	13,505	4,213	5,163	6,443	10,129	4,213	5,163
46.	Hamdan	7,557	7,861	8,773	9,888	12,831	4,009	4,913	6,131	9,623	4,009	4,913
47.	Babura	10,675	11,106	12,396	13,971	18,156	5,664	6,942	8,662	13,617	5,664	6,942
48.	Anggrung	3,613	3,759	4,195	4,729	6,146	1,917	2,349	2,932	4,610	1,917	2,349
49.	Baru	8,801	9,156	10,219	11,518	14,969	4,670	5,723	7,141	11,227	-	5,723
50.	Merdeka	9,123	9,491	10,593	11,939	15,516	4,840	5,932	7,402	11,637	4,840	5,932
51.	Sukaraja	5,190	5,400	6,027	6,793	8,828	2,754	3,375	4,212	6,621	2,754	3,375
52.	Titi Rantai	9,837	10,233	11,421	12,872	16,728	5,228	6,518	8,170	12,546	-	6,518
53.	Darat	3,638	3,785	4,224	4,761	6,187	1,930	2,365	2,952	4,640	1,930	2,365
54.	Polonia	20,905	21,747	24,272	27,358	35,554	11,193	13,704	17,266	29,219	11,193	13,704
55.	Padang Bulan	6,244	6,495	7,249	8,170	10,618	3,313	4,059	5,065	7,964	-	4,059
	KECAMATAN MEDAN BARAT	[illegible]	1.0402	1.1039	1.1567	1.2242						
56.	Kesawan	[illegible]	10,120	11,171	12,921	15,818	5,161	6,256	8,011	11,864	5,161	6,256
57.	Petisah Tengah	[illegible]	14,297	15,782	18,255	22,348	7,292	8,838	11,318	16,761	7,292	8,838
58.	Silalas	[illegible]	10,191	11,471	13,269	16,244	5,299	6,424	8,227	12,183	5,299	6,424

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TABLE A.1--CONTINUED

KP. No.	Name of Kampung	Projected Population					Domestic Solid Waste Projections					
							Generation (Kilograms/Day)				Collection (Kilograms/Day)	
1	2	3	4	5	6	7	8	9	10	11	12	13
		1978	1980	1985	1990	2000	1980	1985	1990	2000	1980	1985
59.	Sekip	9,099	9,465	10,448	12,086	14,796	4,872	5,851	7,493	11,097	4,827	5,851
60.	Sei Putih Timur	16,077	16,723	18,461	21,354	26,142	8,529	10,338	13,240	19,607	-	10,338
61.	Sei Putih Barat	18,847	19,605	21,642	25,033	30,645	9,999	12,120	15,521	22,984	-	12,120
62.	Sei Sikambing	11,329	11,785	13,009	15,048	19,422	6,010	7,285	9,330	13,817	6,010	7,285
63.	Sei Agul	23,945	24,908	27,496	31,805	38,936	12,703	15,398	19,719	29,202	-	15,398
64.	Gelugur Kota	7,122	7,408	8,177	9,459	11,580	3,778	4,579	5,865	8,685	3,778	4,579
65.	Pulau Brayan Kota	12,124	12,612	13,924	16,105	19,717	6,432	7,797	9,985	14,788	6,432	7,797
	KECAMATAN MEDAN BELAWAN	1.0000	1.0200	1.0507	1.0513	1.1095						
66.	Belawan I	11,500	11,730	12,325	12,958	14,377	5,982	6,902	8,034	10,783	5,982	6,902
67.	Belawan II	27,533	28,083	29,508	31,022	34,419	14,322	16,525	19,234	25,814	14,322	16,525
68.	Belawan III	10,500	10,710	11,253	11,830	13,125	5,462	6,302	7,335	9,844	-	6,302
	KECAMATAN MEDAN SUNGGAL	1.0000	1.0510	1.1038	1.3142	1.4670						
69.	Padang Bulan Selayang	5,865	6,164	6,804	8,942	13,118	3,144	3,810	5,544	9,839	-	-
70.	Sei Sikambing C	7,700	8,093	8,933	11,739	17,222	4,127	5,003	7,278	12,917	-	-
71.	Sei Sikambing B	10,100	10,615	11,717	15,398	[illegible]	5,414	6,562	9,547	16,943	-	-
72.	Dwikora	4,625	4,861	5,365	7,051	[illegible]	2,479	3,004	4,372	7,758	-	-
73.	Tanjung Rejo	11,238	11,811	13,037	17,133	[illegible]	6,024	7,301	10,623	18,851	-	-
74.	Babura Sunggal	9,398	9,877	10,903	14,328	[illegible]	5,037	6,106	8,883	15,764	-	-
75.	Perladangan Helvetia	18,338	19,274	21,274	27,958	[illegible]	9,839	11,913	17,334	30,761	-	-
											218,337	441,253
A2	2000 Built Up Area	110,065	116,163	142,403	172,365	[illegible]	[illegible]	79,746	106,866	183,091	15,663	26,747
A3	Outside Built Up Area	103,748	109,496	134,232	162,474	[illegible]	[illegible]	75,170	100,734	172,583	-	-

APPENDIX B

SOLID WASTE CAPITAL COSTS : 1981/82 - 1983/84

SOLID WASTE CAPITAL COSTS: 1981/82 - 1983/84
Rp. IN MILLIONS

1981/82

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	139	139
Civil Works	27	46	73	37	110
Equipment & Materials	169	355	524	405	929
Engineering & Construction Supervision	52	-	52	52	104
Sub-total	248	401	649	633	1282
Physical Contigencies	37	60	97	95	192
Sub-total	285	461	746	728	1474
Price Contingencies	35	57	92	172	264
Total	320	518	838	900	1738

1982/83

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	233	233
Civil Works	75	77	152	114	266
Equipment & Materials	-	353	353	420	773
Engineering & Construction Supervision	52	-	52	52	104
Sub-total	127	430	557	819	1376
Physical Contingencies	19	65	84	123	207
Sub-total	146	495	641	942	1583
Price Contingencies	30	102	132	366	498
Total	176	597	773	1308	2081

1983/84

Item	Foreign			Local	Total
	Direct	Indirect	Total		
Land Acquisition	-	-	-	38	38
Civil Works	13	19	32	18	50
Equipment & Materials	-	190	190	177	367
Engineering & Construction Supervision	21	-	21	21	42
Sub-total	34	209	243	254	497
Physical Contingencies	5	31	36	38	74
Sub-total	39	240	279	292	571
Price Contingencies	11	68	79	154	233
Total	50	308	358	446	804