Chapter 2.

Review of Current Conditions

Chapter 2 Review of Current Conditions

2.1 Existing Sewerage/Sanitation and Drainage Systems

2.1.1 Sewerage Systems and Sanitation Facilities

(1) Sewerage Systems

There are four sewerage systems in operation in the study area, all of which are separate collection systems under MWSS supervision. These are the Central System, the Ayala System, the Dagat-Dagatan System, and the Quezon City Separate System. The service area coverage by the system at present is shown below.

Table 3.2.1 Existing Sewerage Systems in the Study Area

System	City/Municipality	Area (ha)	Remarks
Central System	Manila City	2,620	No treatment
Ayala System	Makati	600	
Dagat-Dagatan System	Caloocan,Malabon, Navotas,Manila	333	Only STP is turned over to MWSS
Separate System	Quezon	1,000*	
Total		4,553	

Source ;MWSS

* This figure is based on measurement on the map by study team

Location of each system together with the NHA (National Housing Authority) system is shown in Figure 3.2.1. Outline of each system is summarized in Table 3.2.2. From the above table, only 7 % (46 km^2 / 636 km^2 = 7) of NCR is covered by sewerage system in areas.

As to the service coverage by respective sewerage systems, the number of household are 84,946 in Manila central collection system, 23,295 in Quezon city separate system and 3,009 in Ayala sewerage system. These systems serve for 111,250 households or about 900,000 persons in a total as of November 1994. Additional 100,000 persons projected for Dagat-Dagatan system increase overall served population up to 1,000,000 persons. However only 11 % of NCR population is accessible to the sewerage systems.

Table 3.2.2 Outline of the Existing Sewerage System

System Name		Manila Central System	Ayala System			Dagat-Dagatan System			Quezon City Separate System
Service Area (ha)		2,617 ha 68 % of Manila City	600 ha Makati			333 ha			approximately 1,000 ha
Service Population (person)		Actual 690,000 (based on the number of connection)	24,000 (based on the number of connection) + 85,000 (commercial/institute areas person equivalent)			Projected Population 104,000 Existing one is estimated 50,000			190,000 (based on the number of connection)
		Projection 1,200,000 (based on the service area)							
Sewerage System	Collection System	Seven Lift Station, and 305 km-long sanitary sewer pipe.	73km-long sanitary sewer pipe No lift station			18km-long sanitary sewer pipe and one pump station			Total 114 km of sanitary sewer pipe
	Treatment System	One Discharging Pump Station without treatment, One barrel of Outfall	wastewater traetment plant of the capacity of 40,000 m3/d with activated sludge treatment method.			WWTP with aerated lagoon treatment method of 12,600 m3/d capacity			41 communal treatment facilities, most of all are septic tanks.
Wastewater Volume Measured at Pumping Station/WWTP (m^3/d)		1994 yearly average 206,016	1994 yearly average 20,490			6,894			not measured
Unit Volume (l/cap/day)		299 (206,016/690,000x1000)	183			138			unknown
			influent	effluent	Removal rate(%)	influent	effluent	Removal Rate(%)	not measured
Wastewater Quality (mg/l)	BOD	100 (1994 Jan.~Nov.)	196	72	63	62	9	87	
	SS	48	75	44	41	78	19	76	
	COD	300	346	168	51	217	109	50	
Remarks									

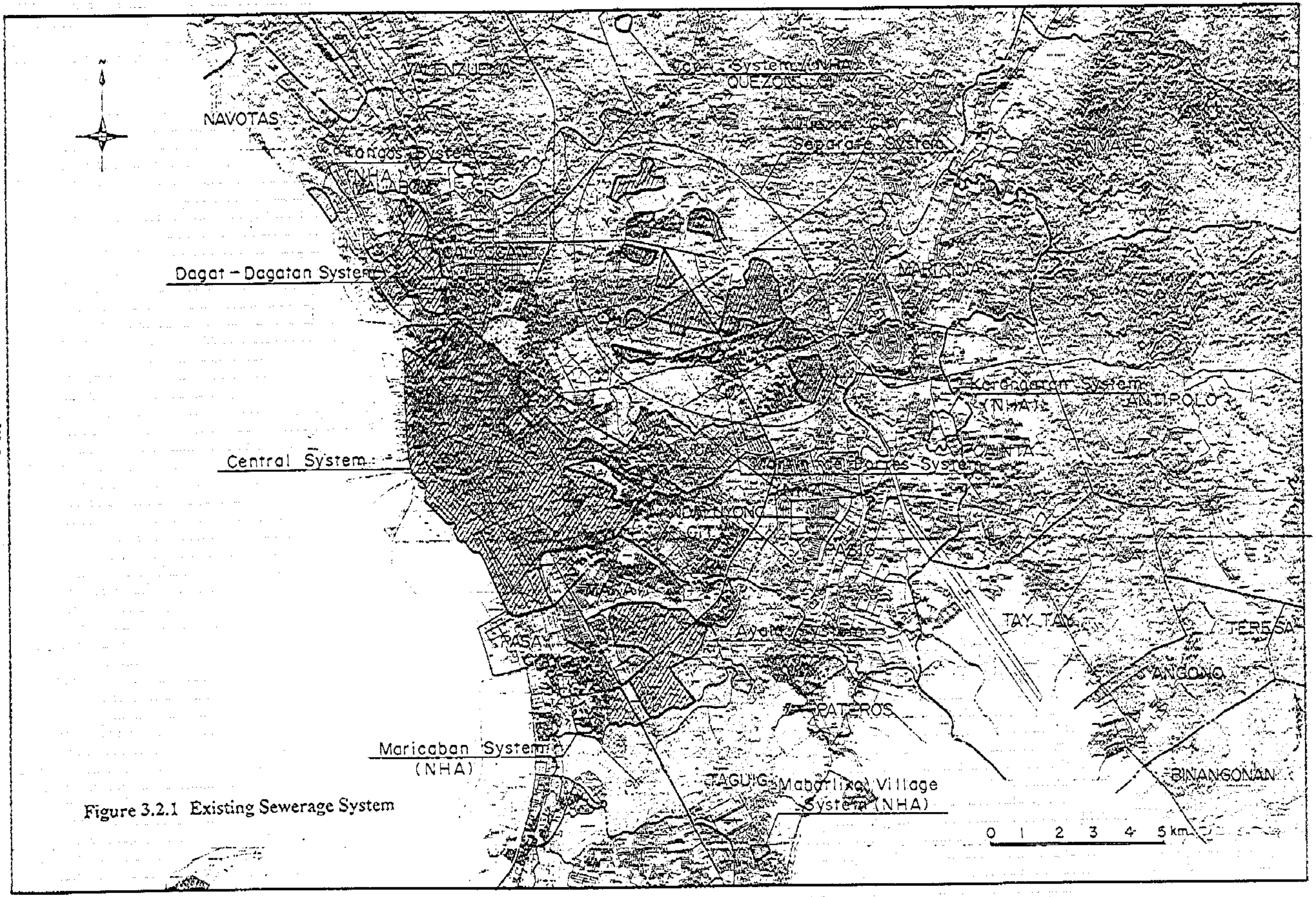


Figure 3.2.1 Existing Sewerage System

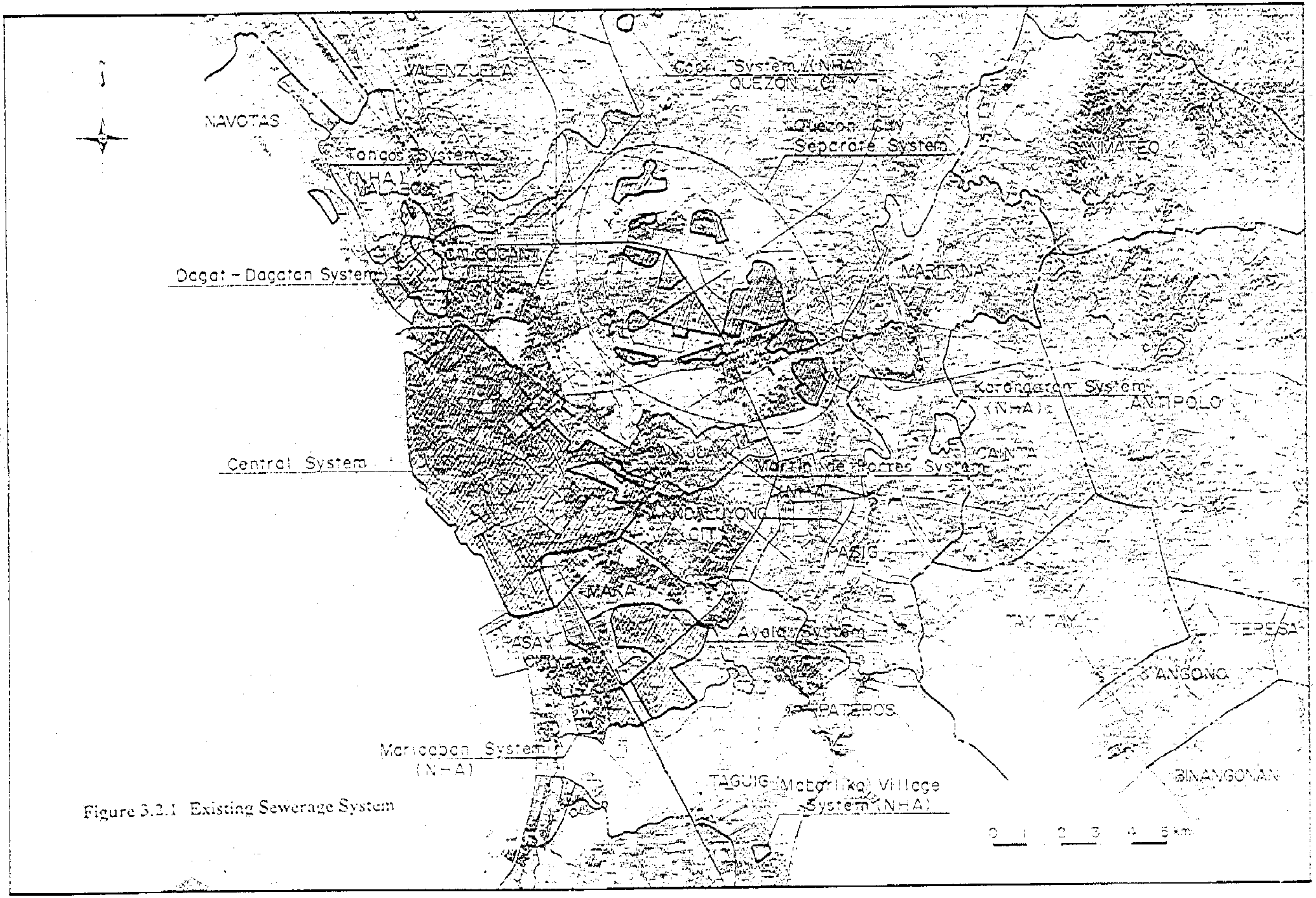


Figure 3.2.1 Existing Sewerage System

(2) Sanitation Facilities

Within the study area, over 90% of NCR households has sanitary toilets with private septic tank, while Rizal and Cavite provinces mark less percentage of sanitary toilet facilities. According to the NSO statistics which classify the households by its kind of toilet facilities , water-sealed sanitary toilet is prevailing with 91 % of total households in NCR, 79 % in Rizal province and 84 % in Cavite province.

There are two types of septic tanks in accordance with the in-house plumbing system. One is the separate treatment type which receive only the night soil, in which case sullage is discharged directly into drainage system. The other is the combined treatment type which treat all the sewage. According to the DOH official, many households, especially those built 20~30 years ago, adopted the latter type. Drainage system sometimes directly receives effluent of the septic tank due to the poor absorption field and also sullage. This is why present drainage system is said to be "practically combined sewer system".

The number of the septic tanks was estimated by the projects assisted by ADB in 1991 and WB in 1994. They showed different figures assuming different family number per household. WB assisted project proposed the need of accurate research on the number and dimension of the septic tank in the early stage of septage management plan. The gross septic tank volume (including leaching pit) is estimated 6 m^3, while effective septage storage capacity is 1.8m^3, according to the ADB feasibility study.

(3) Operation and Maintenance works by MWSS

At present, there is no On-going sewerage system construction. MWSS is only engaged in the operation and maintenance of the existing facilities. Of the three divisions of Sewerage System Department (SSD), Operation and Maintenance Division participates in the cleaning of sewer pipes and manholes, operation and maintenance of sewage pumping stations. Sewer maintenance works has been accomplished extensively in recent years. However, the division has only one jet-cleaning machine and cleaning efficiency is low.

Desludging is one of the major works of the SSD. The work is performed in two different manners. One is septage collection and disposal by MWSS personnel on a request basis, and the other is septage collection and disposal by Contractors on a regular work basis in a projected areas. These works are under the responsibilities of Septic Tank Maintenance Division, SSD. This division is also in charge of operation and maintenance of wastewater treatment plants, sewage quality analysis and monitoring.

They encountered the difficulties to ensure sludge disposal sites and in acquiring the ECC (Environmental Clearance Certificate). There is only one disposal site located in a stone quarry at Santa Rosa II near Marilao, Province of Bulacan, about 60 km far from the center of Metro Manila. The accomplishment of desludging in recent years is more than 4,000 households per year.

Third division of SSD, Sewer Connection Extension and Field Investigation Division, is responsible to 1) install and repair sewer mains and service connections, 2) conduct field investigations of existing systems and inspection of new collection system. This division is suffering from many unconnected service pipes, especially in Central System. The sewerage system developed by NHA is turned over to MWSS after the inspection and analysis by this division. Sewer maps and records are updated by this section.

2.1.2 Drainage System

In the study area, only Manila City had drainage plan, " Plan for the Drainage of Manila and Suburbs". The main drainage facilities in Manila and suburbs consist of open channels called "Esteros" and two types of box culvert, namely drainage main and outfalls. Outfalls are made of special culverts which connect to Manila Bay or Pasig River receiving wastewater from the Esteros. Other culverts function as drainage mains. In other areas creeks and laterals form main drainage systems. In 1990, DPWH in cooperation with JICA completed the master plan on flood control and drainage in Metro Manila to propose some effective projects .

Flood control, and operation and maintenance of main drainage in Metro Manila are managed by DPWH. LGUs (Local Government Units) are responsible for the small drainage facilities with the size less than 750 mm either in pipe diameter or width. The PMO(Project Management Office) for MMINUTE (Metro Manila Infrastructure, Utilities and Engineering) under DPWH and MMA are also undertaking small drainage projects in cooperation with Local Government. MWSS has not undertaken the drainage projects, except for the PROGRESS project in cooperation with MMINUTE.

2.2 Previous Studies Relevant to Sewerage/Sanitation Project

2.2.1 Sewerage and Sanitation Policy and Historical Circumstances

Philippine government issued "Water Supply, Sewerage and Sanitation Master Plan of the Philippines 1988-2000" and set up national target and investment plan. It was reviewed in the Medium-Term Philippine Development Plan (1993 ~ 1998).

On the Sewerage, the base figures in the Master Plan mainly come from "Sewerage and Sanitation Master Plan for Metro Manila " in 1979. This Sewerage and Sanitation Master plan has two major components ; one is a sewerage expansion program for collection, treatment, and disposal in MMR entailing rehabilitation of existing facilities and other is monitoring system. This plan proposed 5-stage implementation program called METROSS. Present status of each stage targets are as follows.

Table 3.2.3 Conditions and Status of 1979 Master Plan Sewerage Projects

Stage	Period	Main Content	Project Status
METROSS-I	1981-1985	- Rehabilitation and Expansion of the Central System - New construction of Tondo Pumping Station and its Outfall	This project is said to have been completed in 1990, but rehabilitation of Central System is still needed and is included in the on-going Manila Second Sewerage Project.
METROSS-II	1986-1993	-Construction of Southern Sewerage System covering separate sewer system in part of Manila , Makati , Pasay and Paranaque.	This project is not yet implemented in spite of some feasibility study and detailed design.
METROSS-III	1994-2000	-Construction of Northern Sewerage System covering separate sewer system in part of Manila, Navotas, Caloocan, Malabon and Quezon City.	This project is also not yet commenced .
METROSS-IV &V	2001~	coverage in San Juan basin ,Laguna and Marikina basin with combined sewer system.	This project is also not yet commenced .

The other component is sanitation program comprising 2 main items ; PROGRESS - minor drainage projects for the depressed area and STAMP - septic tank desludging program. The part of PROGRESS and STAMPS were implemented as a component of METROSS - I.

Of the the components in 1979 Master Plan Project, METROSS II has been reviewed. In 1990, the scope of work of the ADB project covered some more components like integrated septic tank desludging work and formulated the Project called "Second Manila Sewerage Project. Based on the study results by the project, MWSS formulated "Manila Second Sewerage Project" in 1994 with financial assistance from WB, which does not include sewerage expansion scheme and mainly focused on septage management plan.

2.2.2 On-going Project of MWSS

Manila Second Sewerage Project (MSSP)

According to the draft final report, main components are 1) Septage management, 2) Ayala and Manila Central sewerage system upgrading, 3) Street drainage improvement, 4) Laboratory and equipment support, 5) Environmental Impact assessment, and 6) Institutional framework and financing. Among the components, the project focused on the septage management, and environmental, financial, and institutional study/analysis. Proposed project is described in Table 3.2.4 and 3.2.5.

2.2.3 Other Related Environmental Studies

The improvement of sewerage system and sanitation facilities are the major components of environmental improvement projects as considered by many government agencies. The provision of sewerage systems is an effective countermeasures to improve water environment and human health. In the past, various government agencies focused on a review of on-going (at that time) and proposed environmental improvement programs to give the priority for solution of environmental problems. Conditions and status of these studies/projects are summarized in Table 3.2.6.

Table 3.2.4 MSSP Sanitation Project Summary

Items	Purpose	Main content	Benefit	Cost (in Million Pesos)
A. Septage Management Plan	improvement of collection, treatment and disposal system of septage in NCR.	(Phase 1) -Construction of Pilot Septage Treatment Plant (STP)in Dagat-Dagatan -Construction of 2 Barge Loading Station -Collection and Sea Dumping / Pilot Plant Treatment (Phase 2) -Construction and expansion of septage treatment plant	Cleaner environment resulting from the more effective function of septic tanks due to the removal of the accumulated sludge in the septic tank. In 2010, total 17.1 ton BOD and 46.5 ton SS is removed by treatment.	(Phase 1) Septage collection and Hauling 251.23 Barging of Septage for Sea Dumping 155.32 Construction of Pilot STP in Dagat-Dagatan 312.84 Construction of 2 Barge Loading Station 21.44 Supply of Vacuums Cars 171.43 (Phase 2) Construction and Expansion of 3 STP 6,628.62
B. Street Drainage	Mitigation of human contact with sewage by drainage construction	12 areas were selected		Only preliminary design was completed because this works was regarded as LGU-in-charge work

Table 3.2.5 MSSP Sewerage Project Summary

Items	Purpose	Main content	Benefit	Cost (in Million Pesos)
Ayala Sewage Treatment Plant	Upgrading/Rehabilitation of the function of treatment plant	(Phase 1) Manual coarse barscreen, Influent pit Pump, Fine Screen, Grit chamber air blower, Primary settling tank sludge collector, Sludge digester mixer, Odor suction fan from primary treatment and Gas burner unit for waste digester. (Phase 2) Aeration tank blower, Final settling tank sludge collector, Sludge thickener tank , Dewaterer and Odor suction fan for secondary treatment	With the implementation of the Phase 2, effluent of the plant is expected to improve to BOD 30 (now over 60) , which makes less pollution to the receiving body	Phase 1 94.10 "At present only the Phase 1 will be financed by World Bank
Ayala Sewerage System Rehabilitation	Rehabilitation of collection system of Ayala System	Construction of inverted siphon, replacement of trunk main ,new manhole Cleaning and TV inspection Repair/Grouting of pipes	It is expected that system overflows to the creek or drainage ways will be minimized by the completion of the rehabilitation.	Construction of inverted siphon, replacement of trunk main ,new manhole 139.64
Central System Rehabilitation	Rehabilitation of Manila Central System	Rehabilitation of Tondo Pumping Station Rehabilitation of 7 Lift Staiton Installation of flap gate at existing overflows	The sewage overflow to the Pasig river will be minimized by more reliable and efficient operation of the Pumpstation, Lift station and overflow structure.	198.08
Laboratory Strengthening	Proper control of treatment control by quality	Septage Treatment Plant laboratory(inc.Dagat-Dagatan WWTP labo.) Improvement of Ayala STP laboratory MWSS Central labo and sampling cars	Appropriate Water Quality control will help O&M plan	171.43 (including Vacuums car for Septage Management Plan)

Table 3.2.6 Condition and Status of Environment-related Study/Project

Study/Project Title	Objective of the Study/Project	Main Component of the Study/Project	Study/Project Status
1. Manila Metropoliyan Region Enviromental Impact Study (MMREIS)	- This Study concentrated on a review of on-going and proposed projects and on the prioritization of environmental problems.	-Environmental Management and Monitoring Program	-To date, only the public education program and others have been implemented.
		-Integrated Solid Waste Management Program	As of 1992 November, a project preparation study was being conducted under WB
		-Flood Control and Drainage Programs	This is made up of four sub-projects which are on -going under the DPWH
		-Water Quality Management Program	As to the desludging of septic tank, MWSS is undertaking the detailed design funded by WB.
		-Industrial Pollution Control Project	The project was formulated into WB-assisted IEPC program in 1992
2. Environmental Management Strategy (EMS)	EMS and IEPC (described later) are in pairs. Reviewed were the priority of the environmental problems; where recommendations were made on the specific environmental sectorial strategies.	-Water Quality Management Strategy -Land Use Strategy -Solid Waste Management -Flood Control -Toxic and Hazardous Waste Management -Other Strategies	
3. Laguna Lake Master Plan Environmental Management Program	In the Laguna Lake Master Plan, a total environmental management program was proposed.	-Water Quality Monitoring Program -Pollution Control Program -Watershed Management Program -Erosion ,Siltation ,Sedimentation Monitoring and Control Program -Environmental Data Base Management Program -Barging Operation and Monitoring Program	
4 Navotas-Malabon-Tullahan-Tenejeros Rehabilitation Program(NMTTRP)	For the purpose of restoring the function of the river, this program has bee implemented since 1987 headed by DENR and in cooperation with 16 organization and 2 NGOs	-Industrial Waste by DENR/LLDA -Flood Waste by DPWH -Domestic Sewage (Septic Tank Desludging) by MWSS -Squatter Relocation by NHA -Solid Waste by MMA	As of 1991, accomplishment is low
5.	This project was set up to	21 projects were proposed (detail in supporting report)	The Program started in June 1993 when

Pasig River Rehabilitation Project (PRRP)	improve the Pasig River water quality up to class-C criteria		River Rehabilitation Secretariat (RRS) is constituted to coordinate mechanism and to lay the groundwork for the PRRP's long-term objective.
6. Metro Manila Solid Waste Management Program (MMSWMP)	Improvement of enviromental conditions by proper solid waste management. With this program, collection rate is expected to rise to 90 %.	This program is composed of seven components, namely, 1) the construction of two sanitary landfills, 2) the construction of four transfer stations, 3) the procurement of transfer trucks trailers, 4) procurement of land fill equipment, 5) the provision of spare parts, 6) the upgrading of the solid waste improvement program workshop, and 7) the provision of technical assistance to support the implementation of the project and to prepare for the next phase of waste management investment.	
7. Industrial Efficiency and Pollution Control Program(IEPC)	This program was established in November 1992 to reduce the industrial pollution load which account for quite a large percentage of the organic water pollution.	The Program recommended the following 1) Institutional Strengthening, 2) Technical Assistance, 3) Waste Minimization plan for the existing firms, 4) THS management, 5) Wastewater Treatment facilities, 6) Waste Minimization plan for new firms and 7) Air Pollution Abatement. With IEPC, the industrial efficiency will improve and industrial	
8. Common and Individual Wastewater Treatment Facilities for Industrial Enterprises in Metro Manila Area	The aim of the Project are 1) establishment of common collection and treatment facilities, and 2) development of waste abatement and treatment facilities in individual Industrial Enterprises(IEs)		Now under F/S
9. Flood Control and Drainage Projects	DPWH	-Metro Manila Flood Control II -Malabon-Navotas-Valenzuela Drainage Improvement Project -Retrieval of Flood prone area in Metro Manila Project -Flood Control and Drainage Master Plan in Metro Manila It includes framework plan ,Master Plan whose target year is 2,020 and priority projects.	
10. MMINUTE project	A project management office for Metro Manila Infrastructure Utilities and Engineering (MMINUTE) under DPWH provide barangay-based infrastructure.	The on-going MMINUTE II-Fringe Program, which started in 1990, will see completion in 1995. It has set the improvement of city or municipal level streets including minor drainage facilities, bridge and river wall.	

2.3 Water Pollution Status and Future Problems in Metro Manila River System

2.3.1 Present Water Pollution Analysis

(1) Run-off Model of Pollution Load with Water Quality Checking Points

E isting sub-drainage basins are shown in Figure 3.2.2. This figure was prepared based on "The Study on Flood Control and Drainage Project in Metro Manila" conducted by JICA-study team in 1990. Sub-basin code names (PM-1,-2 etc.) are those used in the said Study. Figure 3.2.3 depicts the run-off model with checking points adopted in this study.

(2) Frame Values and Generated / Discharged Pollution Load by Sub-basin

a) Population

Population by sub-basin is calculated based on the 1990 population and population density by city/municipality, considering the locally concentrated population in some city/municipalities.

b) Domestic load

About 90% of the BOD load generated on-site is assumed to be discharged into public water body through the e isting sanitation facilities. Per capita BOD load is 40 g/day. Central System in Manila City discharges no BOD load into the river systems. Previous studies indicated that solid waste is also the cause of pollution with estimated BOD load of 6g/day/person equivalent to the 15% of the above-mentioned generated BOD load. In 2015, BOD generated on-site will increase to 50 g-BOD/day, but 6 g from waste will be reduced to zero.

c) Industrial load

Information on industrial BOD-load discharge is referred to "Industrial Efficiency and Pollution Control Program (IEPC)" conducted by World Bank assisted project in 1992. According to the report the total discharged BOD load is estimated at 304 ton/day. This industrial BOD load is used for distribution to each sub basin.

(3) Run-off ratio up to checkpoint

Total run-off ratio is defined as a combined factor of concentration ratio and a remaining ratio after river self-purification.

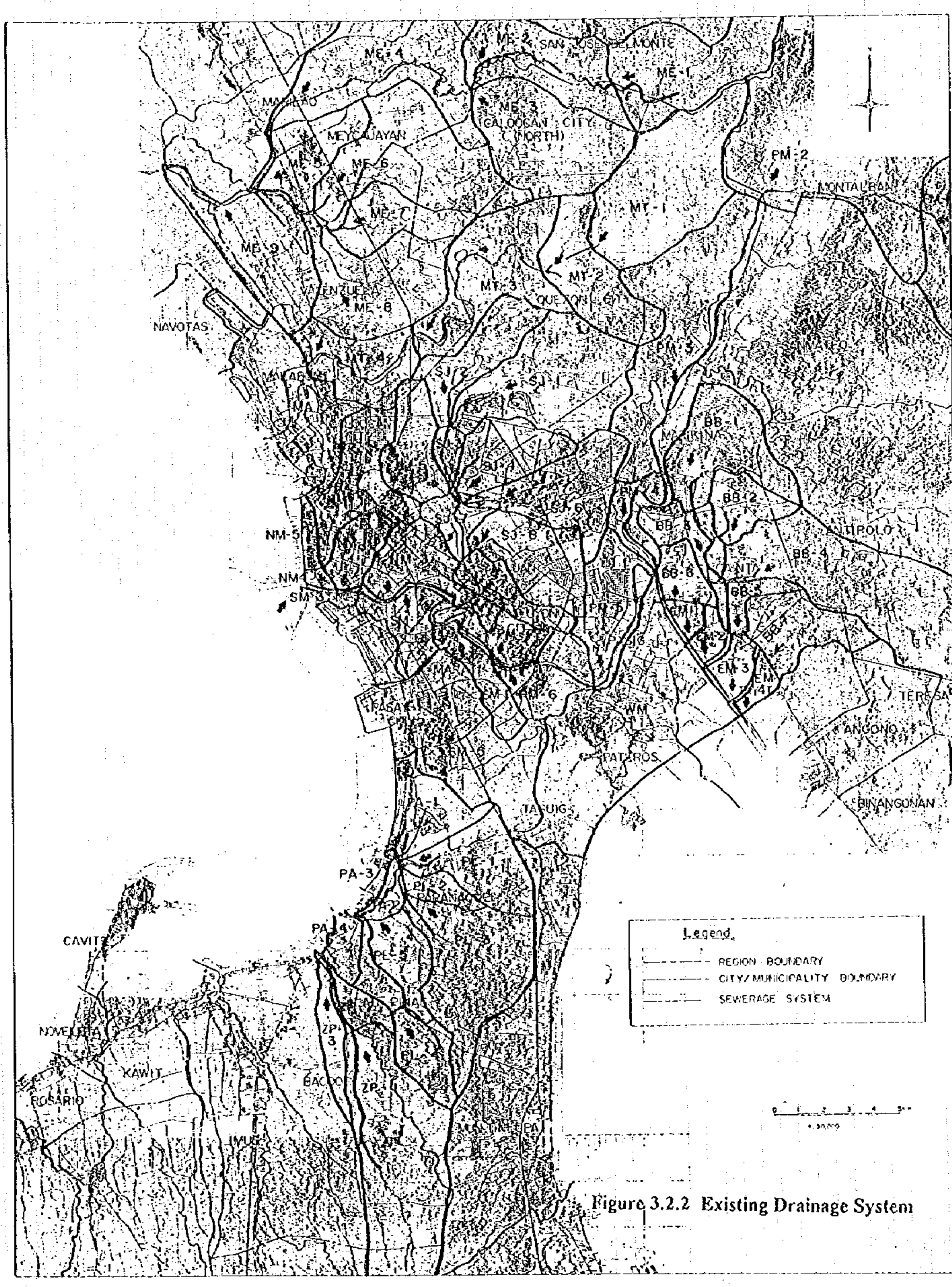
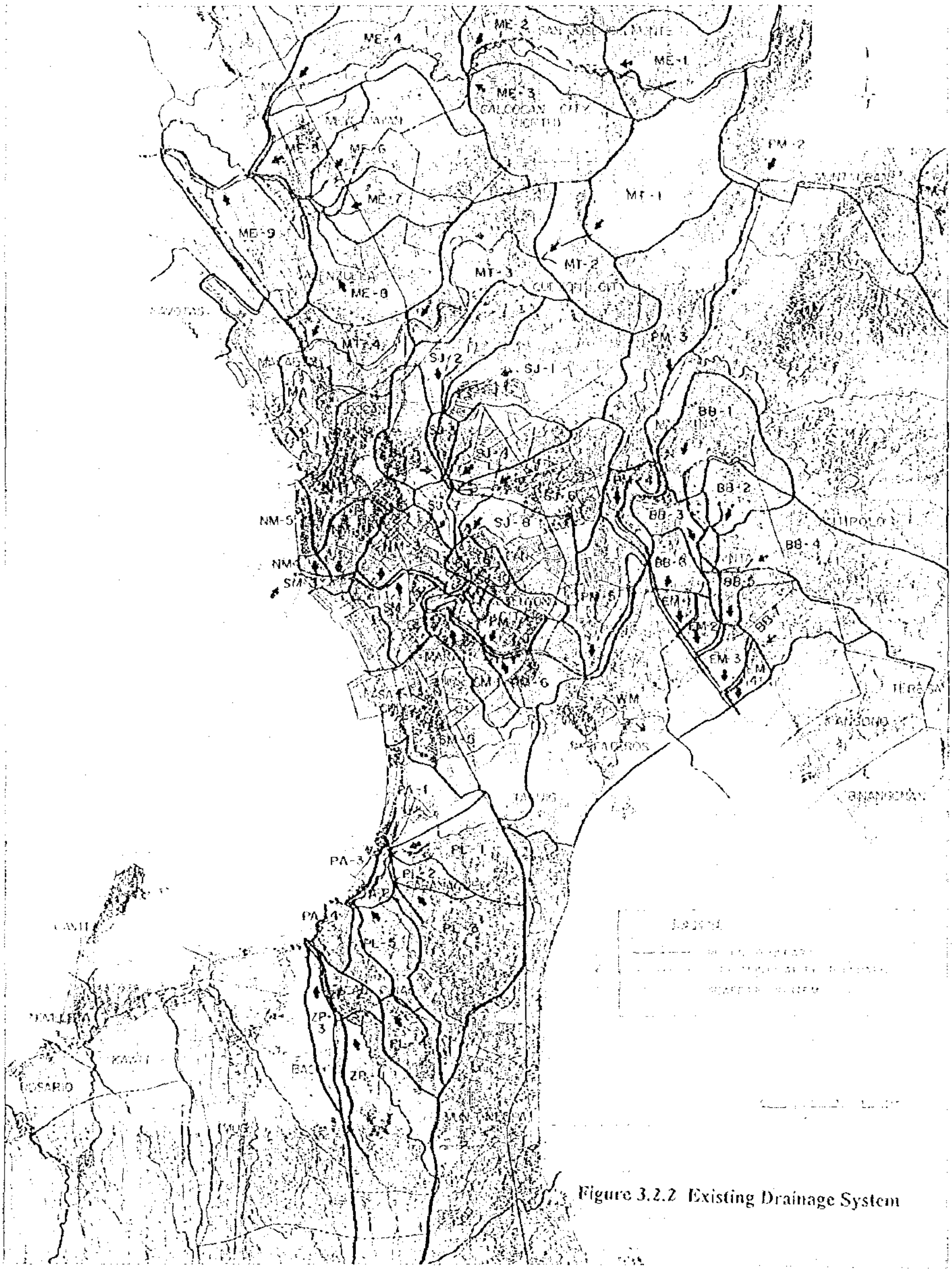


Figure 3.2.2 Existing Drainage System



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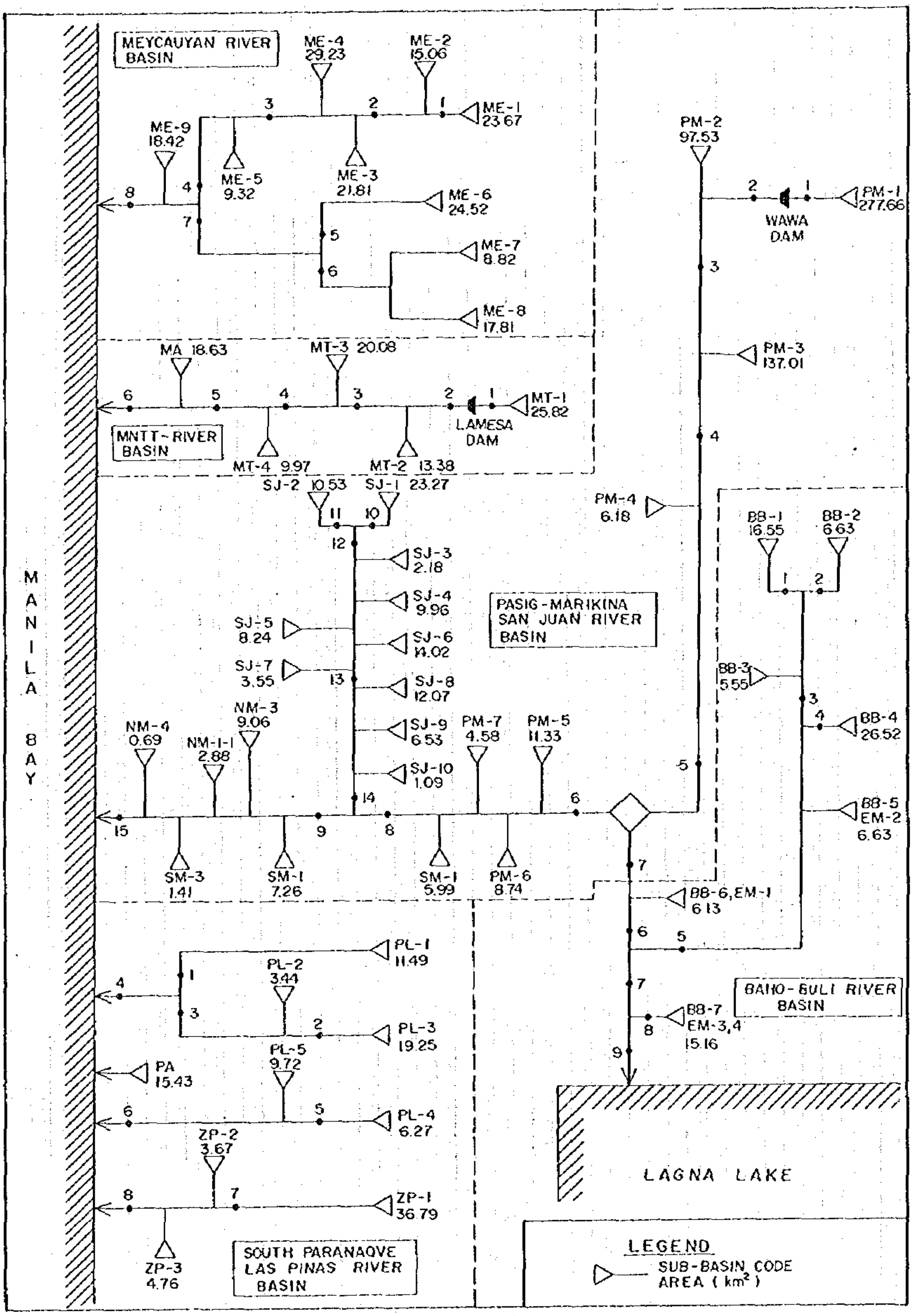


Figure 3.2.3 Metro Manila River System

Based on the experience in Japan, following concentration ratios are commonly adopted for the water pollution control study.

Land use type	Concentration ratio	Remarks
Rural area	0.0 - 0.20	The ratio is dependent on the arrangement status of drainage facilities
Urban area 1) med.-low pop.density 2) high pop.density	 0.1 - 0.60 0.6 - 1.00	
Sewerage system	1.00	

Self-purification ratio of the river is difficult to decide without field confirmation. In this study, the total run-off ratio is set up as follows. Industrial farms are usually situated in the vicinity of the rivers and their run-off rate is generally higher than residential area.

Domestic BOD run-off ratio	0.2
Industrial BOD run-off ratio	0.6

(4) River Flow

River flow data come from the "Philippine Water Resources Summary Data (Volume. 2 - Streamflow and Lake or River Stage Ending December 31, 1980)". Only the Marikina River is gauged in Metro Manila Region, of which two points data can be represented in the unit of cu.m/sec. Other data are shown in terms of gauge level. These two points are Sto. Nino, Marikina, Metro Manila and San. Rafael, Montalban,Rizal. From the Sto. Nino data, the specific flow factor (SFF) in $m^3/sec/km^2$ is calculated using the yearly average data. The drainage area is 499 km^2 and the flow is 19.5 cu.m/sec in year round, which calculates to be 0.039 $m^3/sec/km^2$ as a specific flow factor.

(5) Water quality estimation

Water quality in terms of BOD at each checking point is calculated from following formula;

$$C(mg/l) = \frac{\Sigma \text{ Domestic discharged BOD load (kg/d)} \times 0.2 + \Sigma \text{ Industrial discharged BOD (kg/d)} \times 0.6}{\Sigma \text{ River basin area } (km^2) \times 0.039 \ (m3/sec/km^2)} \times 10^3 * 86400$$

Water quality at each point is shown in Table 3.2.7.

2.3.2 Future Water Pollution Analysis

Without any countermeasures, the water quality will become worse in proportion to the economic development. Water quality in target year 2015 is estimated using the same method assuming that future industrial BOD load will be constant. Industrial expansion is likely to happen outside of MMR. As a reference, future condition with IEPC countermeasures is considered. IEPC strategy is industrial pollutive load abatement through waste minimization/clean technology and wastewater common/individual treatment. It reduces future 573 ton/day discharged loads to 130 ton/day. In this report calculation, IECP target is assumed to be accomplished in 2015 to 130 ton/day from e isting value. Future water quality is shown in Table 3.2.7

Table 3.2.7 River Water Quality

River System	Checking Point	Water Quality(mg/l) 1990	2015 without countermeasures	2015 with IEPC project	Existing Data
Pasig-Marikina-San Juan River	1	2	2	1	
	2	2	2	1	
	3	3	4	3	
	4	5	8	7	Rosario 16
	5	8	12	9	
	6	8	12	9	Vargas 21
	7				
	8	24	28	18	Lambingan 22
	9	30	37	25	Jones 30
	10	60	85	68	Congress 38
	11	60	85	68	
	12	60	85	68	Quezon Blu. 69
	13	61	85	68	Dalro Creek 70
	14	67	90	72	Sanchez 58
	15	29	36	25	
Meycauyan River	1	5	9	9	
	2	6	10	10	
	3	8	15	15	
	4	9	15	15	
	5	36	48	35	
	6	66	85	57	
	7	52	67	47	
	8	29	40	30	
Malabon-Tullaha River	1	0	0	0	
	2	0	0	0	
	3	11	19	19	Gulod 20
	4	19	34	34	North Exp. 60
	5	42	58	46	Mac. HighWay 78
	6	74	93	67	Gov.Pascual 45
Baho-Buli River	1	95	122	84	
	2	80	109	71	
	3	91	119	81	
	4	78	104	66	
	5	85	111	73	
	6	97	125	87	
	7	86	113	75	
	8	76	92	54	
	9	84	109	71	
South Paranaque-Las Pimas River	1	32	54	49	
	2	27	53	49	Parana. Bridg 14
	3	27	53	48	
	4	29	53	48	
	5	32	73	67	
	6	32	71	65	
	7	8	20	20	
	8	11	25	24	

Chapter 3.

Mater Plan

Chapter 3. Master Plan

3.1 Basic Policy and Conditions for Preparation of Sewerage/Sanitation Master Plan

3.1.1 Type of Plan, Definition and Basic Policy

(1) Type of plan and its definition in this study

a. Framework Plan

This plan establishes the development policy for the entire study area, such as the detailed demarcation of both the on-site treatment (without sewer system) area and the off-site areas (with sewer system). Although the target year for this plan is not fixed, the data projected for 2015 are utilized for the purpose of this plan. The Sewerage Framework Plan will cover the off-site treatment area, while the sanitation study will cover the entire study area because of the existing sanitation situation prevailing.

b. Master Plan

This Sewerage Master Plan embraces the long term sewerage development plan of the off-site treatment area up to the year 2015. Considering that the off-site treatment area, as defined in the Framework Plan, seems difficult to be fully covered in this study, the Sewerage Master Plan area will be selected based on social, economic and environmental priorities. Also, to be considered would be location, structure, capacity, staged construction, and the financial plan of the main facilities.

For the sanitation sector, a long-term septage management plan was completed last year. Since the target year and area of said plan was set at 2010 covering the NCR, an adjustment for target year and coverage area for this study should be made.

c. Staged Development Plan

This master plan, being a long term plan, entails a huge cost. It would be best to divide this development plan into several stages to be able to better manage the plan's physical and cost requirements. It is expected that by mid-stage, the on-site and off-site treatment will materialize.

(2) Common basic policy of each plan

a. Utilization of existing facility/system

The basic policy is to build a financially realistic plan based on a low cost sewerage/sanitation system. Thus, the existing sewerage and sanitation facilities and system, such as the "practical combined sewer system" should be more efficiently utilized. The use of the septic tank as an alternative to being connected to the sewerage system is most likely to continue, particularly in those areas not covered by said sewerage system.

b. Cooperation with related sectors

The development cost of a new sewerage and sanitation system can be further reduced by the utilization of private sector systems like the Ayala System or the adoption of a BOT scheme. The promotion of a communal treatment system or the installation of an upgraded on-site treatment facility can also be enforced by government through city planning, land use, and building construction regulations. Public consciousness on the importance of sewerage and sanitation facilities and practices should be enhanced by LGU community participation.

c. Balanced development of water supply and sewerage/sanitation

A well-balanced development between water supply level (level I, II and III) and sewerage/sanitation facilities has been emphasized recently. In case water supply precede without appropriate sewerage/sanitation facilities, increased sewage may cause degradation of the water environment. In Metro Manila, where septic tanks are commonly used and the majority of them are adopting the combined treatment of household sewage, increased volume of sewage is likely to flush-out untreated nigh soil into the drainage.

According to the Sanitation Code, however, capacity of septic tank is determined based on the unit volume of 50 gallons per capita per day (= 190 lpcd) and standard septic tank can be suited water supply of Level III as long as it is maintained in good condition. Regular desludging is indispensable from this point of view. As is described in the MSSP report, the priority of desludging is put on the households which receive water supply from the central distribution system and bear an environment tax.

It is recommended that MWSS will survey the sanitation facilities of the household when they apply for a water connection. If the facilities are not appropriate, MWSS should give guidance for the improvement of the facilities.

d Cooperated development of sewerage and sanitation facility

"Human health" and "environmental protection" are the two major target of sewerage/sanitation sector. In this Master Plan, improvement of human health is mainly shouldered by the development and appropriate management of sanitation facilities. Sewerage aims at water environment protection. The reason for this originates following facts;

- The latest Manila Second Sewerage Project focused on the management of sanitation facility to improve Metro Manila sanitary condition. This project contribute to the improvement of human health by reducing human contact with the sewage.
- The low cost combined system (interceptor system) proposed by the ADB consultant in 1991 and also approved in the MSSP report can improve the water environment but cannot directly contribute to the human health as far as the sewer network is not developed.

3.1.2 Target Level

There are two target levels that will be considered. The first is the target level that the MWSS can undertake by itself. These are sewer access rate (service coverage), effluent quality of the treatment plant, septage desludging and others. The second is the target level that the MWSS can accomplish with the cooperation of related agencies. An example of this is keeping the environmental standard for the public water body quality. The main items were discussed between the Study Team and the MWSS counterparts and target levels were limited to a few items described in Table 3.3.1. The details are as follows:

(1) Sewerage

a. Sewer access rate (service coverage)

This is critical considering the possible investment up to the target year. In the National Plan, it is said that completion of METROSS-II will increase the sewer access rate to 14%, METROSS-III to 24%. The maximum rate may be around 30% due to the adoption of an inexpensive interceptor system. In case the combined system is adopted, the sewer access rate may be changed to the service coverage or to the beneficial population rate.

b. Effluent quality from treatment plant

With appropriate O&M, the conventional sewage treatment plant can achieve a 30 mg/l of BOD_5, 40 mg/l of SS. The DENR-EMB effluent standard is 50 mg/l of BOD_5, so this target level seems appropriate. In the MSSP, this target level has also been adopted.

Table 3.3.1 Target Level

Category	Item	Existing	Target	Remark
Sanitation	Regular desludging of septic tank	once in more than 15 years in NCR	once in 5 to 10 years in target year 2015 in Level III supply area	projection from 2010 to 2015 is necessary. because MSSP covers up to 2010
Sewerage	Sewer access rate(service coverage)	less than 10% of NCR	nearly 30% of MWSS jurisdiction	depend on cost constraints
	Effluent quality from treatment plant	Ayala WWTP discharge over 65 mg/l BOD con.	Effluent ;less than 30 mg/l to all proposed treatment plant	Ayala WWTP is likely to clear effluent standard after the MSSP

(2) **Sanitation**

a. **Use of Sanitary toilets.**

Attaining a rate of 100 % on the use of sanitary toilet (water sealed toilet) is the final goal. However, this sanitation facility is installed at the owners expense, while the DOH is responsible for regulations regarding septic tank.

b. **Regular desludging and septic tank effluent quality.**

It is reported that a 32 liter/cap/yr of sludge is accumulated in each individual septic tank in Metro Manila (WHO report says it is 30 - 40 liter/cap/yr). If 1.8 m^3 is supposed to be the effective volume of storage capacity, maximum desludging interval is calculated as follows:

1800 liter / 5 persons x 32 liter/ per /yr = 11 year

The MSSP was developed targeting 0.7 million households now supplied water by MWSS at Level III to be desludged at a cycle of once in every 5 to 10 years. This level should be applied to all the Level III araes in 2015.

c. **Public toilets.**

Two public sanitary facilities were completed in the METROSS-I project. At present, however, MWSS has no intention of constructing public toilets.

d. **Others**

Upgrading of septic tank

Even if septic tanks are regularly desludged, any overflow of existing septic tank contains high BOD concentration and thus upgrading is recommended. The two options available are to standardize material and structure and to adopt a combined treatment of sullage and night soil. This can fall under the responsibility of the DOH.

(3) Environment

a. **Water quality standard attainment rate**

At present, all the rivers in the Metro Manila Region are classified into "Class C" except the upper stream of the Marikina River.

Class C demands a 10 mg/l of BOD concentration. The existing concentration is far above this standard and its rapid attainment would be very difficult. A simplified analysis of the BOD load distribution and its influence on the main river system in MMR are investigated and future degradation is forecasted. An interim standard may be adopted as the target aim of the related agencies, MWSS, DPWH, DOH, MMDA and LGUs.

For example, one proposal is the following table:

Table 3.3.2 Recommended Staged Target Level of Class "C"

Stage	1st stage	2nd stage	3rd stage	DENR-standard
Target year	2010	2015	2020	
BODcon. (mg/L)	30	25	20	10 mg /L

(4) Drainage

a. **Safety probability in return period**

DPWH is responsible for flood control and the main drainage system in the Philippines. But in case the MWSS constructs an interceptor pipe adopting the combined system into the sewer system, its design standard needs to meet the DPWH requirement. The probability of this happening is from five to ten years.

Since inland flooding is one of bigger problems in this country, a comprehensive run-off drainage plan that includes rivers, drainage, gutters and the sewerage system is required. This will clearly define the role and coverage of flood control and drainage, where flood control will flow through the river systems, and drainage control through the sewerage system.

b. Street drainage

In METROSS- I, a street drainage program was completed as PROGRESS. This was aimed at reducing human contact with stagnant sewage, especially at residential and depressed areas.

As for the MSSP, the original TOR includes street drainage as one of its components, but this was deferred for lack of budget sources and the uncertainty as to who the supervising agency would be for the project. The LGUs and DPWH (under the MMINUTE project) are both related agencies.

3.1.3 Basic Frame of the Plan

(1) Target Year

The target year for the total study, including that of water supply, is 2015, while MSSP aims for 2010 as its target year. Although this Master Plan conforms to 2015 as its target year, a periodic review is, however, mandatory to respond effectively to the social structural and other changes.

(2) Target Area

The entire study area is first divided into the Framework Plan area for both off-site and on-site treatment. Then the off-site treatment area (Sewerage Framework Plan area) is divided into the 2015 Master Plan area and the "future coverage area" in the latter section.

(3) Service Population

The total population within the study area for the target year of 2015 comes from project framework. This is further divided by each planning area in the latter section.

(4) Combined treatment of industrial wastewater and domestic/commercial wastewater

Before estimating the wastewater generated in the study area, an investigation should be conducted as to whether the combined treatment of industrial wastewater and domestic / commercial wastewater is allowed or not, as criteria on planning and designing varies according to its allowance or non-allowance.

1) Existing conditions.

The current policy of MWSS is not to accept any industrial wastewater into the sanitary sewers. Resolution 75 -71, Sewer use Regulations adopted by MWSS in 1971 is still valid.

Actually, the existing industrial firms located along the existing sewer line in the Central Sewerage System in Manila City are not allowed to discharge their wastewater into the sewer pipe and only the domestic wastewater of the industrial complexes are allowed into the sanitary sewers.

The reason is that industrial wastewater is usually highly pollutive in both BOD and toxic-hazardous load and these pollutants affect the function of sewerage facilities, especially biological treatment. There is also no system to check just exactly how pollutive the industrial wastewater is.

On the contrary, the 1979 Master Plan admitted allowance on condition that an industrial wastewater management program would be implemented, where new administrative organization and industrial waste regulations are proposed before allowing industrial wastewater into the sewerage system. The reasons for this recommendation are:

1. Industrial wastewater volume is only 12% of total wastewater volume discharged from MMR and has little effect on the sewer pipe size.
2. BOD loads amounts to 40% of total discharge load but it only affects secondary treatment (biological treatment) which will be adopted in some uncertain future.
3. Individual treatment cost may be a big burden to small firms.

2) <u>Recommendation</u>

Basically, industrial wastewater should be prohibited or not allowed into sewer system and individual or common treatment is to be promoted for the following reasons.

1. The MWSS and DENR policy on industrial wastewater prohibits it into the sewer system. The main purpose of the sewerage system should be focused on domestic wastewater.
2. The BOD loads of industrial wastewater in raw (not treated) BOD level, amounts to 53% of total BOD, while domestic wastewater accounts for 30%, and solid waste to 17% according to IEPC data. Sooner or later, secondary treatment of the sewage will be necessary for the protection of the environment and such a high percentage of industrial BOD loads require treatment high cost. The sewerage system should, therefore be constructed mainly for domestic wastewater.
3. The IEPC project is now being implemented by DENR and it does not consider allowing industrial wastewater because rapid sewerage expansion is not expected.

4. The existing effluent standard of the DENR/EMB should be respected and if this standard is strictly observed, treated wastewater can be discharged into the river system.
5. In NEDA Board Resolution No.5, treatment of industrial wastewater should comply with the effluent standard.

(5) Wastewater Volume and Quality

Wastewater volume is initially calculated by city/municipality and also by the type of wastewater - domestic, commercial, or industrial wastewater.

The major wastewater sources identified in the study area are domestic, commercial, business, institutional and industrial wastewater as point sources. Other pollution sources, such as agricultural and natural are not covered in this study.

Wastewater quantity was estimated, in principle, using the data on water consumption or discharged wastewater volume on a measurement basis and the type of wastewater in accordance with water supply study. Classifications are (1) domestic wastewater, (2) commercial wastewater (including business/institutional) and (3) industrial wastewater. Wastewater quality for the planning purposes is limited to BOD loading as a representative index of the organic substances. In addition to the above classification, the infiltration rate was considered.

The unit BOD loading from different pollution sourcse was estimated based on the investigation results conducted by the concerned agencies in the Philippines, with reference to experience in Japan and other countries.

a. Domestic wastewater

1) Unit Quantity

With regard to the per capita water consumption rate, the projection until the target year of 2015 was conducted from water supply side of this study by the city/municipality. The unit wastewater discharged rate (lpcd) is usually regarded as equal the water consumption rate in case infiltration of groundwater is included, and as 70 to 80% of water consumption rate when infiltration volume is taken into as another unit volume. There is no available data on the breakdown of water consumption, so 70% was adopted, as considered in the Second Manila Sewerage Project in 1990 by ADB, and also in the MSSP in 1994 by the WB consultant.

The unit volume of each city/municipality in 2015 is summarized in Table 3.3.6.

The unit consumption rate in some previous studies was estimated by population density or income level. In this study, however, this method is not adopted because population density projection by area is difficult due to the unavailability of local population data. This should be given consideration in the F/S or D/D stage. Water quantity from public faucet use is negligible.

2) Unit BOD load

In the 1979 Master Plan, the following figure was recommended after giving due consideration to the previous master plan, the LLDA report, and other data.

Table 3.3.3 1979 Master Plan Unit Load

BOD_5 (gram/cap/day)		S S (gram/cap/day)		N	P
Domestic	Total	Domestic	Total	gram/cap/day	gram/cap/day
50	75	50	75	12	2

Total includes commercial, institutional and industrial load.

In the Pasig River Rehabilitation Project, the reported per capita BOD load for the different income group was as follows, as of 1991:

High-income group	53 g / Day
Middle-income group	40 g / Day
Low-income group	25 g / Day

In the Environmental Management Strategy report, the World Bank consultant assumed that 35 g /cap/day of BOD is generated on the average. In Japan, an average figure on this subject is more or less 50 gpcd at present (night soil, 15-18 gpcd and sullage, 32-39).

For this study, a total of 40 gpcd (generated base) may be employed as the base year figure in 1995, broken down into night soil, 10 gpcd, and sullage, 30 gpcd. For future projections, an annual increase of 0.5 gpcd in sullage will be utilized, while the night soil load is assumed to be constant.

Table 3.3.4 BOD load of Domestic Wastewater

		1995	2000	2005	2010	2015
	Sullage	30	32.5	35	37.5	40
BOD	Night Soil	10	10	10	10	10
(gpcd)	Total	40	42.5	45	47.5	50

b. **Commercial Wastewater**

Commercial wastewater is also basically calculated from water supply projections. The discharge ratio is assumed to be 70% as same as that of domestic water.

Commercial water use is projected by city/municipality in supporting report. This figure is computed with the assumption that half the volume of the commercial areas where the groundwater source is saline will be connected to the central water distribution system. However, ground water volume assumed not to be converted to tap water is also included in total commercial volume. Table 3.1.6 shows total commercial wastewater volume in the target year of 2015.

Water quality of commercial wastewater is assumed to be the same as that of domestic wastewater.

c. **Industrial Wastewater**

Although industrial wastewater is not allowed into sewer system, its volume and water quality were investigated, the results of which are in supporting report.

d. **Infiltration rate**

The groundwater infiltration rate is taken into account by two ways:

(1) some percentage of wastewater discharged into sewer system

(2) constant infiltration rate per hectare per day

In case of adopting (1), 10% - 20% of daily maximum wastewater is employed considering the rain fall, ground water level, pipe joints and others.

MWSS has long adopted (2) method shown in following table

Table 3.3.5 infiltration rate in previous study

Type	1979 Master Plan	1991 Second Manila Sewerage Project F/S	1994 Manila Second Sewerage Project (Street Drainage)	MWSS Design Standard of Design Department
Existing System	37.5 m^3/ha/d	35 m^3/ha/d	40 m^3/ha/d	-
New System	15 m^3/ha/d	15 m^3/ha/d	15 m^3/ha/d	0.2 l/s/ha (17 m^3/ha/d)

Under the following assumption, the infiltration ratio against total wastewater is 27% , which seems a bit high.

(Assumption)
population density = 300 persons/ha, per capita water use = 200ml/d,
commercial/industrial ratio = 0.3 of domestic wastewater,
wastewater convert rate = 0.7, so
Q = 300 x 0.200 x 1.3 x 0.7 = 54.6 m3 / ha / d, ratio of Infiltration/sewage = 15 / 54.6 = 0.27

But considering the local construction skills, materials, climate conditions and O&M levels, the existing rate is adaptable in this plan. Quality control of the pipe material, fitting and pipe laying technic should be reviewed to prevent excessive infiltration.

e. **Peak factor**

Peak factor has two meanings. One is peak day flow factor which is the ratio of maximum daily flow against average daily flow and is usually used for treatment plant capacity design. The other is peak hour flow factor which is the ratio of maximum hourly flow against average daily flow, which will be used to decide sewer pipe capacity. In the past report, latter factor was decided by the Babbit Formula and this is the standard that MWSS also uses.

$M = 5 / P^{0.2}$; where P is population in thousand.

In this study, the peak daily flow factor is assumed to be 1.25 and peak hourly flow factor is 1.75 in accordance with the water supply design.

F. **Total Wastewater Volume**

1) wastewater volume

The calculation of the daily average wastewater volume by each city/municipality for the year 2015 is contained in Table 3.3.6 and Figure 3.3.1. In this table, domestic wastewater is assumed to come only from central distribution system as wastewater from public faucet is negligible. The catchment area-based wastewater volume and quality will be recalculated after the demarcation of the on-site and off-site treatment areas.

G. ***Influent wastewater quality***

Wastewater quality is the fundamental data for the calculation of the capacity of the wastewater treatment plant. It can be calculated from total discharged load and total wastewater, but for this master plan, it is decided as follows, with consideration of the existing plants' data and other data.

<u>**BOD(mg/l) ; 200, S S(mg/l) ; 200**</u>

Table 3.3.6 Wastewater Volume

unit ; m3 / d

City/Municipality	Served Pop.	Areas	Unit Volume	Wastewater	(m3/D)		Total-case(1)	Total-case(2)
	(persons)	(km2)	(lpcd)	(a)Domestic	(b)Commercial	(c)Industry	exclu.Industry	inclu.Industry
Manila	1,633,535	4,181	126	205,825	88,887	13,355	294,712	308,067
Pasay City	465,978	2,251	126	58,713	17,590	2,934	76,303	79,237
Quezon City	2,473,439	16,660	130	321,547	79,119	33,920	400,666	434,586
Calookan City	1,087,241	5,580	133	144,603	12,330	9,078	156,933	166,011
Mandaluyong	269,942	1,120	140	37,792	9,125	8,649	46,917	55,566
Las Pinas	693,735	3,270	133	92,267	4,656	14,746	96,923	111,669
Makati	532,141	1,840	140	74,500	39,025	5,290	113,525	118,815
Malabon	335,826	1,740	133	44,665	4,228	13,955	48,893	62,846
Marikina	490,213	2,280	140	68,630	4,530	5,668	73,160	78,828
Muntinlupa	539,007	3,970	126	67,915	7,126	24,000	75,041	99,041
Navotas	268,680	1,100	126	33,854	2,358	2,489	36,212	38,701
Paranaque	542,127	4,265	140	75,898	8,939	13,439	84,837	98,276
Pasig	622,218	3,160	126	78,399	11,997	47,137	90,396	137,533
Pateros	59,630	185	140	8,348	181	1,231	8,529	9,760
San Juan	146,095	620	140	20,453	5,510	796	25,963	26,759
Tagig	581,971	4,538	140	81,476	4,205	28,844	85,681	114,525
Valenzuela	597,902	4,480	126	75,336	5,278	19,351	80,614	99,965
NCR total	11,339,680	61,240	131	1,490,221	305,084	244,882	1,795,305	2,040,187
Angono	102,470	2,200	112	11,477	251	546	11,728	12,274
Antipolo	518,384	30,610	126	65,316	3,651	12,490	68,967	81,457
Baras	35,231	2,340	112	3,946	91	-	4,037	4,037
Binangonan	265,084	7,270	112	29,689	685	-	30,374	30,374
Cainta	306,106	2,190	126	38,569	3,293	30,287	41,862	72,149
Cardona	61,213	3,120	112	6,856	158	-	7,014	7,014
Jala-jala	30,302	4,930	112	3,394	78	-	3,472	3,472
Morong	58,361	3,760	112	6,536	151	-	6,687	6,687
Pililla	60,858	7,390	112	6,816	158	-	6,974	6,974
Rodorigues	124,681	31,280	126	15,710	939	2,456	16,649	19,105
San Mateo	156,924	6,490	126	19,772	795	2,437	20,567	23,004
Tanay	108,576	24,340	112	12,161	281	-	12,442	12,442
Taytay	221,233	3,364	126	27,875	1,585	14,463	29,460	43,923
Teresa	38,339	1,860	112	4,294	99	-	4,393	4,393
Rizal total	2,087,762	131,144	121	252,412	12,215	62,679	264,627	327,306
Cavite City	106,295	620	112	11,905	3,148	84	15,053	15,137
Bacoor	325,390	5,240	112	36,444	1,455	729	37,899	38,628
Imus	161,438	9,701	112	18,081	816	2,354	18,897	21,251
Kawit	74,764	1,750	112	8,374	258	67	8,632	8,699
Noveleta	31,796	390	112	3,561	81	46	3,642	3,688
Rosario	72,315	920	112	8,099	442	10,053	8,541	18,594
Cavite total	771,998	18,621	112	86,464	6,200	13,333	92,664	105,997
MWSS total	14,199,440	211,005	129	1,829,096	323,499	320,894	2,152,595	2,473,489

ServiceRate 0.9028

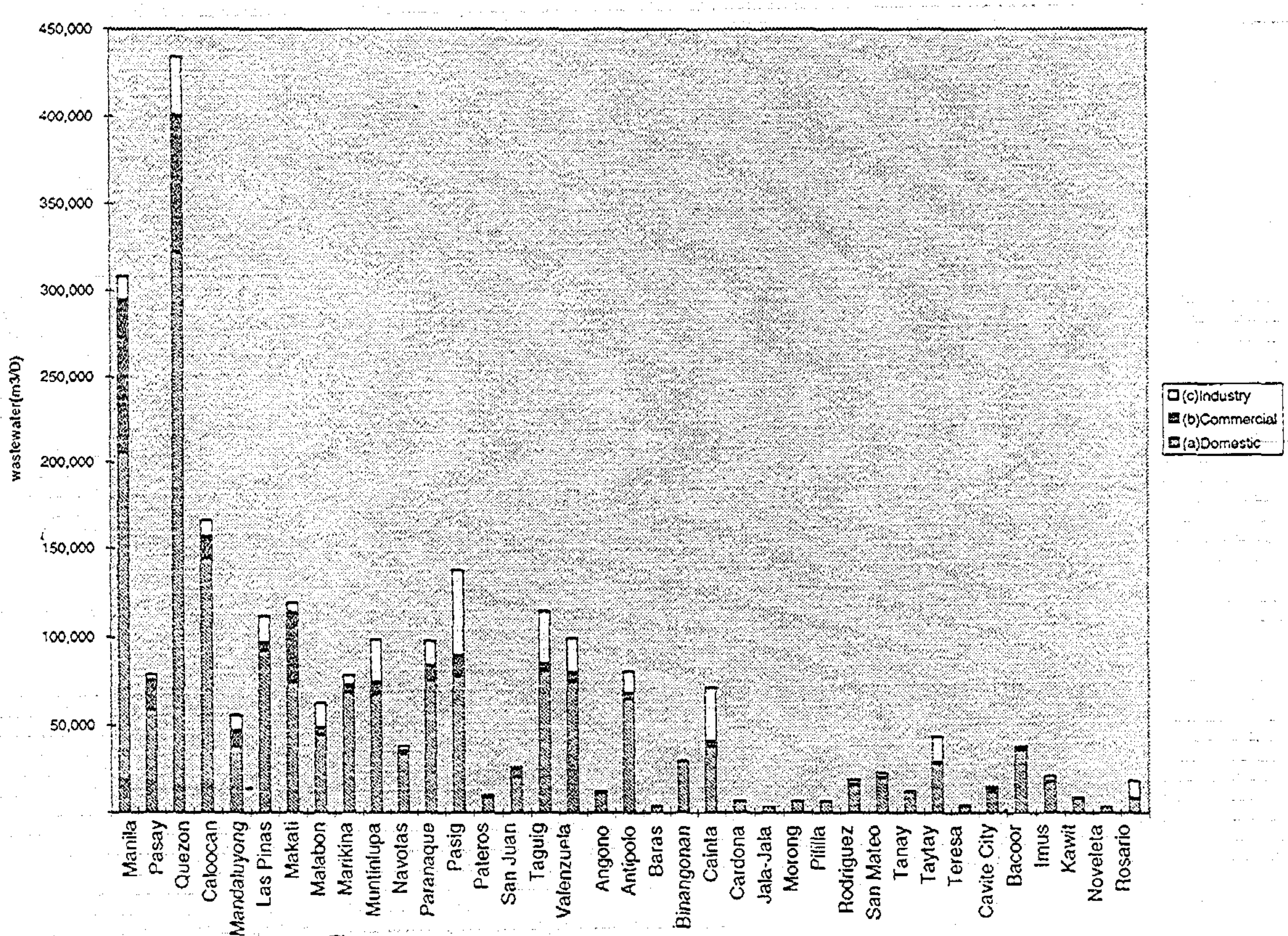


Figure 3.3.1 Wastewater Generation

3.1.4 Framework Plan Area

The objective of this section is to break up MWSS's jurisdiction into two areas:

(1) The area covered by Sewerage (Off-site treatment area)
(2) The area covered by Sanitation facility (On-site treatment area)

It should be noted, however, that these areas have not been clearly subdivided at the intermediate stage especially in the case that a combined system or a small-bore sewerage is adopted. The former starts with an interceptor system with the use of individual septic tanks as sanitation facilities in unserved areas; while the latter receives the effluent of septic tank into the sewerage system.

The sanitation coverage under the MSSP septage management plan covers all of the NCR up to the year 2010. This coverage may require review. The criteria for coming up with the demarcation are the development plan (land use), population trend, environmental impact factor, construction cost and water supply level.

Population density and construction cost

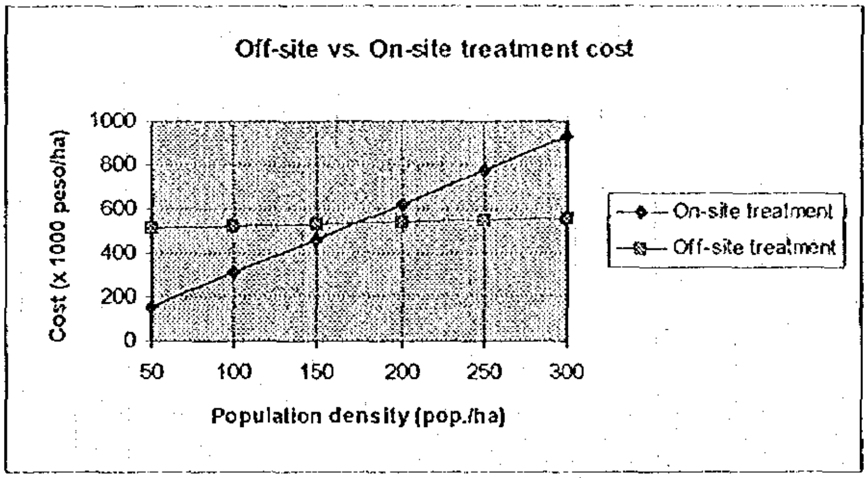
These are closely interrelated, thus this can be estimated using the following calculation:

(assumed condition)

- Population density (1) 100 persons / ha, (2) 180 ,(3) 300
- Number of persons per household 5 persons
- Household density (1) 20 hh/ ha, (2) 36, (3) 60
- Pipe-installation density 200 m / ha
- Pipe-installation cost 2000 pesos / meter
- Construction cost of Sanitary toilet with septic tank 15,500 pesos / households (DOH data)
- Lateral Pipe cost(house connection) 1,000 pesos/ household

	On-site treatment			Off-site treatment		
	(1) 100 pop/ha	(2) 180	(3)300	(1) 100 pop/ha	(2) 180	(3) 300
Pipe installation	-			Sewerpipe 200*2,500= 500,000 pesos Lateralpipe 20*1,000=20,000 pesos Total 520,000 pesos	pipe 200*2,500 = 500,000 Lateral 36*1,000= 36,000 Total 536,000	pipe 200*2,500 = 500,000 Lateral 60*1,000= 60,000 Total 560,000
Treatment facility	20* 15,500 = 310,000 pesos /ha	36* 15,500 = 558,000	60* 15,500 = 930,000	neglect	neglect	neglect
Total	310,000 pesos /ha	558,000	930,000	520,000 pesos /ha	536,000	560,000

If all other conditions other than population density are the same, the off-site system is more economical when population is over 180 persons/ha. Considering the cost of an off-site treatment facility, a threshold of 200 persons/ha can be used.



Development (land use)
Build-up areas, commercial areas in the future land use map projected in Part I are the priority areas of off-site treatment. Large-scale developments like Fort Bonifacio will be included in the area covered by the sewerage system. Basically, development trends are reflected into population and commercial water consumption increases in each city/municipality

Environment impact
From the estimates of future river water degradation, the San Juan and NMTT river basins, North and South of Manila, Las Pinas and the left bank of the Marikina areas have high degrees of influence on water pollution. The impact on Laguna Lake requires early sewerage coverage over lake basin areas in the NCR and Rizal where development areas are linked with the NCR.

Water Supply Level
The central Distribution System (Level III) is expected to expand to cover 90% of population in MWSS jurisdiction by 2015.

Sewerage areas decided from the above factors are shown in Figure 3.3.9 and Table 3.3.7. These cover almost the same areas as the 1979 master plan area except for Muntinlupa and the Manila Bay Reclamation Areas.

Table 3.3.7 On-site vs Off-site Treatment Area

City/Municipality	Area (ha)			Pop.2000			Pop.2005			Pop.2010			Pop.2015			Assumped
	Off-site	On-site	total	Off-site	On-site	total	Off-site	On-site	total	Off-site	On-site	total	Off-site	On-site	total	On-site rate
Manila	3,850	-	3,850	1,707,538		1,707,538	1,725,542		1,725,542	1,726,405		1,726,405	1,719,511		1,719,511	0%
Pasay	1,760	-	1,760	442,902		442,902	472,916		472,916	497,778		497,778	517,753		517,753	0%
Quezon	13,070	3,590	16,660	2,076,356	64,217	2,140,573	2,270,077	70,209	2,340,286	2,472,137	76,458	2,548,595	2,665,818	82,448	2,748,266	3%
Caloocan	1,214	4,366	5,580	749,847	249,949	999,796	762,151	326,636	1,088,787	752,692	405,295	1,157,987	724,827	483,218	1,208,045	25%-40%
Mandaluyong	1,120	-	1,120	277,905		277,905	287,911		287,911	294,888		294,888	299,935		299,935	0%
Las Pinas	2,950	320	3,270	470,244		470,244	565,280		565,280	664,913		664,913	770,817		770,817	0%
Makati	1,840	-	1,840	511,060		511,060	529,989		529,989	546,080		546,080	560,148		560,148	0%
Malabon	1,450	290	1,740	304,171	26,450	330,621	320,956	27,909	348,865	333,505	29,000	362,505	343,289	29,851	373,140	8%
Marikina	2,280	-	2,280	405,708		405,708	447,715		447,715	483,982		483,982	516,014		516,014	0%
Muntinlupa	3,050	920	3,970	391,807	43,534	435,341	447,636	49,737	497,373	495,438	55,049	550,487	539,007	59,890	598,897	10%
Navotas	540	560	1,100	240,447		240,447	262,494		262,494	282,502		282,502	298,533		298,533	0%
Paranaque	4,020	-	4,020	430,808		430,808	488,481		488,481	545,941		545,941	602,363		602,363	0%
Pasig	3,160	-	3,160	523,636		523,636	583,541		583,541	641,439		641,439	691,353		691,353	0%
Pateros	185	-	185	57,352		57,352	60,278		60,278	63,353		63,353	66,256		66,256	0%
San Juan	620	-	620	143,770		143,770	148,283		148,283	151,800		151,800	153,784		153,784	0%
Taguig	3,620	918	4,538	410,321		410,321	493,485		493,485	571,252		571,252	646,634		646,634	0%
Valenzuela	830	3,650	4,480	145,082	338,525	483,607	164,949	384,882	549,831	183,191	427,446	610,637	199,301	465,035	664,336	70%
Reclaimed area Manila side	331	-	331													
Reclaimed area Pasay side	491	-	491													
Reclaimed area Paranaque side	245	-	245													
NCR Total (Inc. Reclamation)	46,626	14,614	61,240	9,288,954	722,675	10,011,629	10,031,684	859,373	10,891,057	10,707,296	993,248	11,700,544	11,315,343	1,120,442	12,435,785	
NCR Total (Exc. Reclamation)	45,559	10,248	60,173													
Cavite	-	620	620		102,235	102,235		107,450	107,450		112,931	112,931		118,105	118,105	100%
Bacoor	-	5,240	5,240		238,872	238,872		279,798	279,798		320,860	320,860		361,544	361,544	100%
Imus	-	9,701	9,701		128,224	128,224		145,409	145,409		161,723	161,723		179,375	179,375	100%
Kawit	-	1,750	1,750		62,333	62,333		68,820	68,820		75,983	75,983		83,071	83,071	100%
Noveleta	-	390	390		26,509	26,509		29,412	29,412		32,473	32,473		35,329	35,329	100%
Rosario	-	920	920		59,409	59,409		65,915	65,915		72,775	72,775		80,350	80,350	100%
Cavite total	-	18,621	18,621	-	617,582	617,582	-	696,804	696,804	-	776,745	776,745	-	857,774	857,774	
Angono	-	2,200	2,200		70,641	70,641		83,294	83,294		98,212	98,212		113,855	113,855	100%
Antipolo	120	30,490	30,610	18,892	358,951	377,843	22,297	423,651	445,948	26,304	499,770	526,074	30,493	579,371	609,864	95%
Baras	-	2,340	2,340		25,704	25,704		30,322	30,322		35,753	35,753		41,448	41,448	100%
Binangonon	-	7,270	7,270		193,497	193,497		228,154	228,154		269,017	269,017		311,864	311,864	100%
Cainta	2,070	120	2,190	211,653	11,140	222,793	249,924	13,154	263,078	295,115	15,532	310,647	342,119	18,006	360,125	5%
Cardona	-	3,120	3,120		45,827	45,827		54,008	54,008		63,651	63,651		72,015	72,015	100%
Jala-Jala	-	4,930	4,930		22,688	22,688		26,738	26,738		31,510	31,510		35,649	35,649	100%
Morong	-	3,760	3,760		44,719	44,719		52,702	52,702		60,685	60,685		68,660	68,660	100%
Pililla	-	7,390	7,390		45,561	45,561		53,695	53,695		63,282	63,282		71,598	71,598	100%
Rodriguez	800	30,480	31,280	65,276	27,976	93,252	76,968	32,986	109,954	90,753	38,894	129,647	102,679	44,005	146,684	30%
San Mateo	1,250	5,240	6,490	114,545		114,545	135,061		135,061	159,251		159,251	184,616		184,616	0%
Tanay	-	24,340	24,340		81,207	81,207		95,751	95,751		112,901	112,901		127,737	127,737	100%
Taytay	893	2,471	3,364	109,391	46,882	156,273	128,983	55,279	184,262	152,085	65,179	217,264	172,070	73,744	245,814	30%
Teresa	-	1,860	1,860		28,702	28,702		33,827	33,827		39,866	39,866		45,105	45,105	100%
Rizal total	5,133	126,011	131,144	519,758	1,003,494	1,523,252	613,234	1,183,560	1,796,794	723,507	1,394,253	2,117,760	831,977	1,603,057	2,435,034	
MWSS Jurisdiction (inc.Recla.)	51,759	159,246	211,005	9,808,712	2,343,751	12,152,463	10,644,918	2,739,737	13,384,655	11,430,803	3,164,246	14,595,049	12,147,319	3,581,274	15,728,593	
MWSS Jurisdiction (exc.Recla.)	50,692	154,880	209,938													

3.2 Development Plan on Sewerage

3.2.1 Wastewater Collection System

(1) Alternative collection system

Two alternative collection systems, separate and combined, were comparatively studied. The characteristics of the two systems are summarized as follows:

Alternative 1. Separate system

A separate system has a parallel collection system for sanitary sewage and storm water run-off, respectively. This system is more advantageous as the surrounding sanitation environment is improved and water pollution is more controlled than in the combined system. This system is more suitable for areas where water pollution is strictly prohibited. It is also recommended in areas where conventional drainage facilities are well maintained and where enough space for the sanitary sewer facilities can be secured. Covering a new development area with separate system is also recommended because of the nuisance involved in the collection of night soil. Furthermore, land values go up wherever the living environment improves.

On the other hand, the collection of sanitary sewage requires construction of lateral sewer pipes and house connections which makes its cost very prohibitive.

Alternative 2. Combined system

A combined system is one that collects sanitary sewage and storm water run-off by means of one combined sewer. The Southeast Asian version of a combined system is the utilization of an existing waterway as a practical combined sewer for storm run-off, sullage, and for overflows from the septic tank. This combined sewage is initially converted in the interceptor sewer via an overflow structure. The advantage of this system is that the interceptor system is used only in the initial stage to save on cost while a sub-catchment area system is being flexibly developed. In adopting the interceptor system, the following conditions are required.

1) Existing drainage/channels presently collecting rainwater and sullage (miscellaneous waste water) can be used as combined sewers on a semi-permanent basis.
2) Discharge of diluted wastewater into a public water body is acceptable during rainy season.
3) Night soil is properly disposed of at the generated site.

This combined (interceptor) system contributes to water quality improvement and costs less than a separate system at the initial stage. But the surrounding environment will not improve unless a sub-catchment area is covered by the sewer network.

Other points to be observed are enumerated below:

1) Improvement and expansion of existing drainage systems

Existing waterways now functioning as drainage systems are not necessarily sufficient at the present time against storm water run-off. Such waterways may be used as receiving water bodies of overflow water from the diversion chamber in the areas served by the sewerage system. However, the improvement (dredging and widening of channels) and expansion of the existing drainage facilities shall be done in accordance with the arrangement by the LGUs as practiced in Metro Manila.

2) Proper operation and maintenance of septic tank by means of Septage Management Plan and solid waste disposal

The adopted sewerage system cannot be completed without proper treatment and disposal of night soil. Regular desludging of septic tanks and treatment of collected septage are the main components of the MSSP. Information dissemination and legislative measures on the design and construction of the facilities should be undertaken by the LGUs. Arrangements for desludging the facilities shall also be provided properly as well as sound disposal of the sludge. In addition, the present refuse collection and disposal shall be improved to cover sewerage service areas in order that sanitary landfill/composting can be performed.

3) Maintenance of overflow/diversion chamber to keep the function of adopted sewerage system

Aside from the design of the contrived chambers, periodic maintenance of the facilities, especially systematic solid waste removal, is essential. The function of the sewerage system depends on adequate arrangement by concerned agencies and cooperation of the beneficiaries.

4) Provision of house connections pipes to connect to overflow pipes of night soil treatment facilities

With reference to planned grade of the interceptor and overflow structure, it is difficult for the beneficiaries to realize an immediate improvement of living conditions. The collection and treatment of overflow water from septic tanks could contribute to the improvement of the water quality in the channels in the urban area/sewerage service area. Priority will be given to the selected locations within the sewerage service area with the installation of such connection pipes to interceptors where sewage fees will be charged.

(2) Adoption to this study area

The major factors to be taken into account in the selection of wastewater collection system are as follows:

1) Saving on construction cost for the sewer network is a major concern of the Government, as well as utilizing existing channels in the built-up areas. Drainage construction is under LGU/DPWH and coordination is required.
2) On-site sanitation facilities are widespread in the study area and recognized as a positive alternative for the sewerage system. thus, it would be best and practicable to continue using relevant existing facilities.
3) Although under the first stage of the combined collection system, water pollution in the channel caused by the discharge of sullage from house would not improve by using the current drainage system, water quality in the main river downstream of the built-up area will considerably improve.

With an emphasis on the low cost construction in order to realize sanitation/public water body quality improvement at a service level affordable at the present time in Metro Manila, the combined system is recommended as a structural frame.

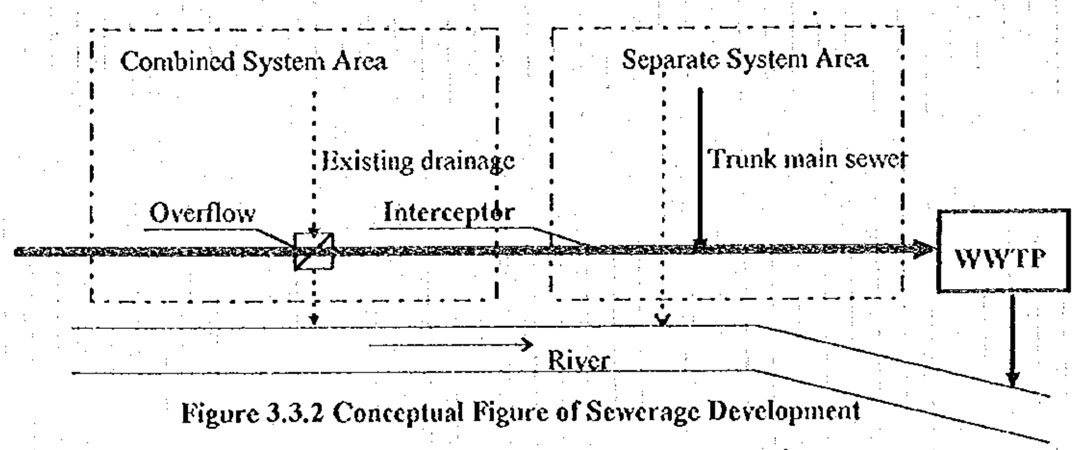


Figure 3.3.2 Conceptual Figure of Sewerage Development

This Master Plan does not cover sub-area sewer network system

Figure 3.3.4 is the conceptual drawing of staged improvement of combined wastewater collection system. This master plan aims to secure the STEP 2 level and the development and improvement of high priority areas.

As to the development of each sub-catchment area, one practical option is staged development from initially small-scale communal or sub-division sewerage system gradually up to the integrated sewerage system. Quezon City Separate System can adopt to this idea, where each communal sewer system will be integrated into overall system.

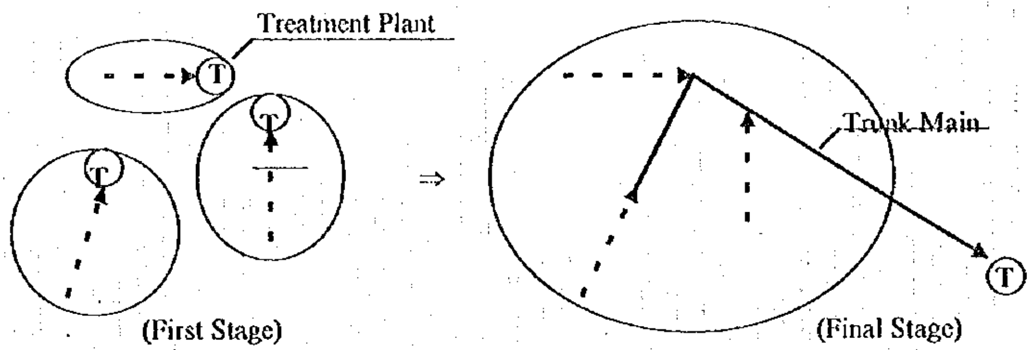


Figure 3.3.3 Staged Development of Sub-catchment Area

(3) Intercepting Capacity

One of the controversial points of a combined system is its intercepting capacity during rainy season.

The 1979 Master Plan and 1991 ADB Study proposed one x dry weather wastewater flow (DWWF) as the interceptor capacity. This is recognized as appropriate for following reasons:

1) There would be little advantage in increasing the interceptor capacity to reduce the extent of sanitary wastewater overflow. A study conducted by JICA in 1981 for Bangkok,Thailand showed only a 2% difference in the volume of sanitary wastewater discharged into water body between 1 x DWWF and 6 x DWWF.

2) Considering the weather characteristics of the Philippines, focus should be put on dry weather wastewater.

3) Interceptor will not be wasteful even if sub-areas will be developed by separate system.

4) It helps keep the construction both interceptor and treatment plant at a low cost where preliminary treatment and by-pass equipment is needed when 2 or 3 factors is adopted.

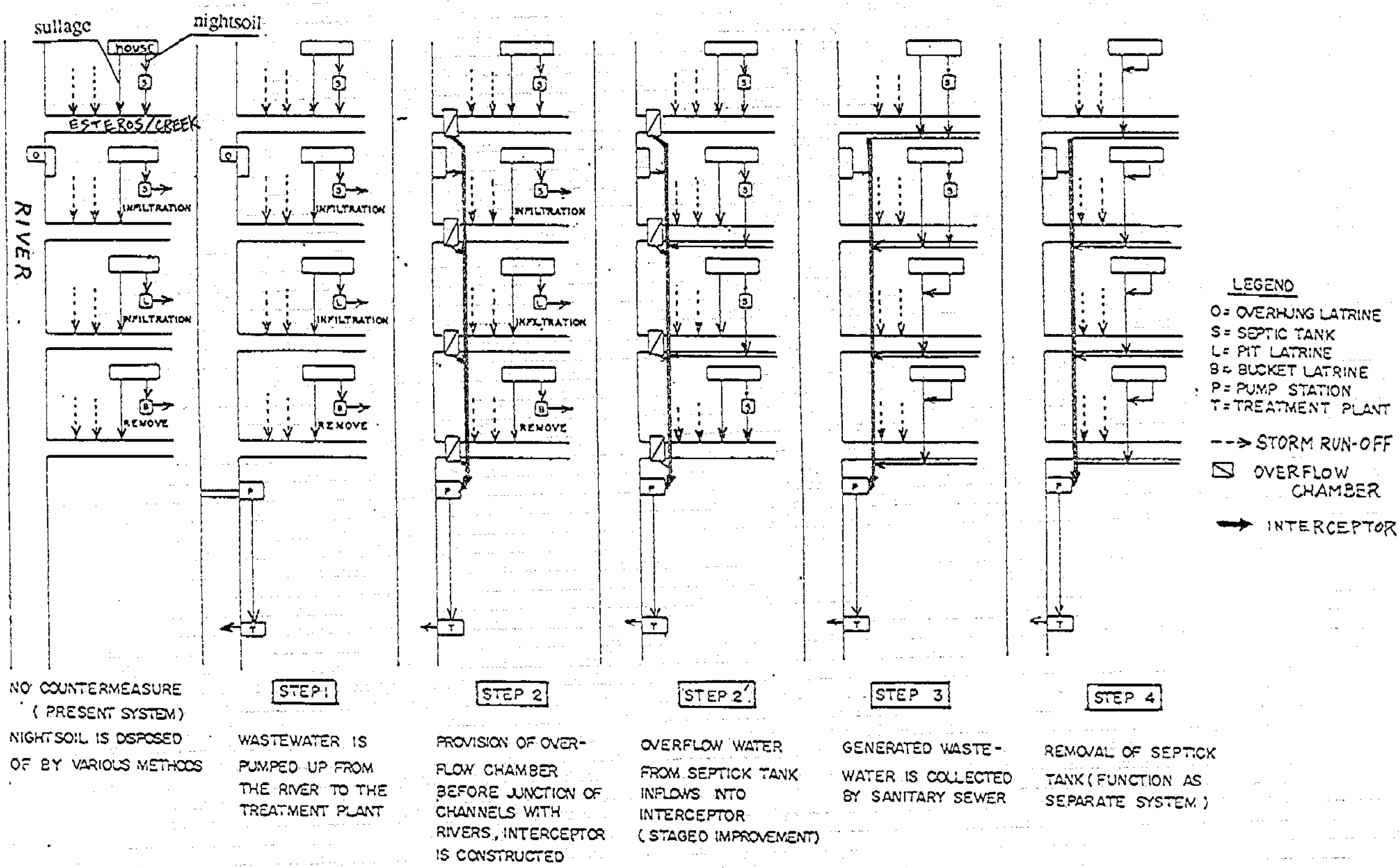


Figure 3.3.4 Staged Improvement Plan

3.2.2 Wastewater Treatment System

The existing Central Sewerage System discharges raw sewage through an outfall into Manila Bay. The proposed South Sewerage System also adopted this same method in 1991. Its theoretical background is the huge receiving capacity of Manila Bay as investigated in the 1979 Master Plan and the Bay's comparatively generous effluent standard. Manila Bay has not yet been officially classified and effluent is allowed up to 120mg of BOD (in case Manila Bay becomes a classified SC, a 100mg of BOD will be adopted).

But as reported in Manila Bay Monitoring Program in 1991, its ecological influence is not negligible. (See supporting report) Thus, the outfall system should be regarded as a temporary system.

Also from the point of recycling the water, treated water will become valuable asset.

Required conditions for the treatment method is enumerated below:

① To clear effluent target level and make effluent not hazardous
② To be able to cope with fluctuation both in influent volume and quality
③ Disposal of generated sludge is easy
④ Construction cost is low
⑤ Maintenance cost is low
⑥ Operation and Maintenance is easy

Of all the conditions mentioned, ① is most important. As to the inland water area, effluent of treatment plant is regulated at 50mg/l of BOD in response to its being Class "C" - NPI (new/proposed industry) by DENR-EMB, while coastal areas are as before.

To prevent the degradation of Manila Bay and other river systems, a target level of BOD 30 mg/l which corresponds to Class "B"- NPI is hereby recommended.

No categorization by discharging point is planned.

Another constraint is space. A location that can house a huge plant is difficult to acquire in Metro Manila, so the plant sites should be efficiently utilized.

The applicable treatment methods are selected and shown below: Their design criteria is shown in supporting report.

1. Stabilization Pond (SP)

2. Aerated Lagoon (AL)
3. Oxidation Ditch (OD)
4. Conventional Activated Sludge (AS)

Construction and O&M costs increased from 1 to 4 and the necessary site area is the reverse. SP area needs roughly 5 times of OD (necessary site area per capacity is 1~3m^2/m^3), AL needs 3 times and AS needs 0.5 times of OD.

A final decision should be made looking at the conditions in its totality. A wide plant site should be acquired to cope with the future plans of expanding and upgrading the treatment levels.

As to the sludge treatment, a drying bed after reducing the volume by thickening/digesting is economical as far as the site permits. Dry sludge can be disposed together with solid waste or recycled for agricultural use. Excess sludge is disposed of in a landfill site together with solid waste.

3.2.3 Alternative study of Sewerage System

In the 1979 master plan, a total of 21 alternative plans, each a combination of 27 areas (in Master Plan called "system") including the combined system, a separate system, different types of staged development, inland treatment, ocean outfall plan and others were evaluated and selected alternative plan became the 1979 Master Plan.

The first step was the review of unit sewerage zones (formerly called "system"). Basically, this zoning depends on the topographical condition considering the community boundaries, the development of the Dagat-Dagatan system, the implementation of the METROSS-I system, and also the construction of the Manggahan Floodway. Population, land use and wastewater were calculated for each zone.

The following stage was the determination of one catchment area size. Multiple small, medium and large scale collection system plans were developed and evaluated including ocean outfall with/without treatment. The evaluation was conducted under the assumption that all households in the off-site treatment area are equally served by the sewerage system.

(1) Sewerage zones

The total sewerage area of 50,692 ha (excluding the reclamation area of 1,067 ha) was divided into 27 sewerage zones mainly in compliance with the drainage basin concept, with consideration of the existing sewerage catchment areas and community boundaries. The city/municipality vs zone matrix is shown in Table 3.3.8 and Figure 3.3.5.

(2) Alternative study of the sewerage system

The major problems are (1) the choice between proposed ocean outfall system or inland treatment, and (2) what scale is appropriate for one catchment area. This judgment highly depends on the potential site for wastewater treatment plant (WWTP) in Metro Manila where land acquisition has become more and more difficult.

Potential site for WWTP

Before proposing plans, the potential areas for WWTP were investigated from the land use map and consultant's own site survey. The required area for WWTP is assumed to be 1.5 m^2 per daily maximum flow in m^3. After the survey, it was found that following sewerage zoning there can be a site for a WWTP only after wide re-development or if the present factories will relocate or vacate in favor of the WWTP.

North Quezon, Cubao, New Manila, Ortigas, Caloocan, Sampaloc, Guadalupe,

The potential areas are shown in supporting report.

Considering the potential WWTP site, the following plans were compared. (See Figure 3.3.6)

- Small Scale Inland Treatment System (SSITS)
- Medium Scale Inland treatment system(MSITS)
- Large Scale Inland treatment System (LSITS)
- Ocean Outfall System (OOS)
- Improved Ocean Outfall System(IOOS)

a. Small Scale Inland Treatment System

This system means one or a few adjacent zones have one wastewater treatment plant (WWTP) each.

The former master plan's South System was divided into 11 catchment areas, the Central System and North System were divided into five catchment areas that cross boundary lines. The North Quezon zone was transferred to the North System considering treatment site acquisition. Wastewater is treated in the inland areas.

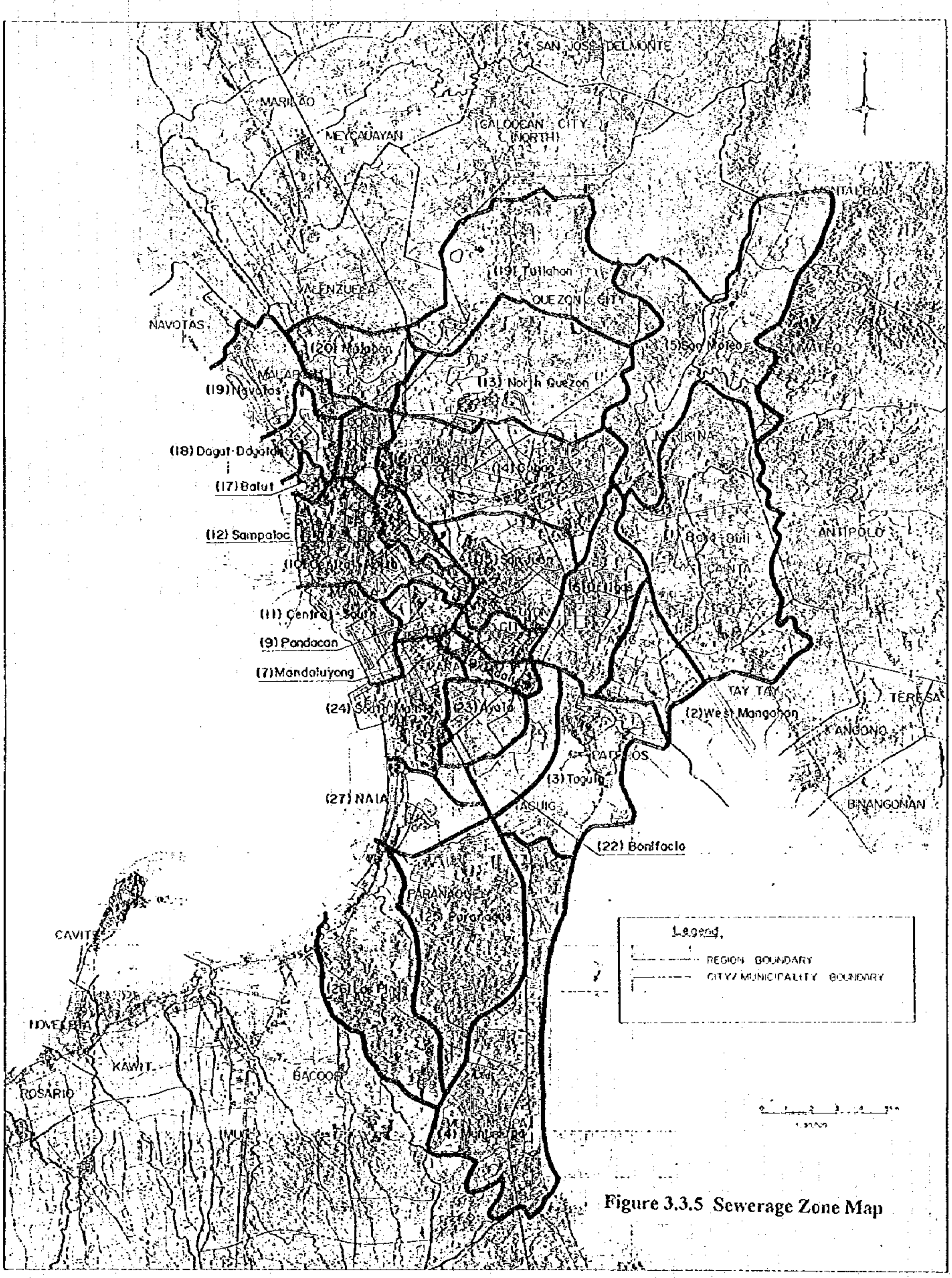


Figure 3.3.5 Sewerage Zone Map

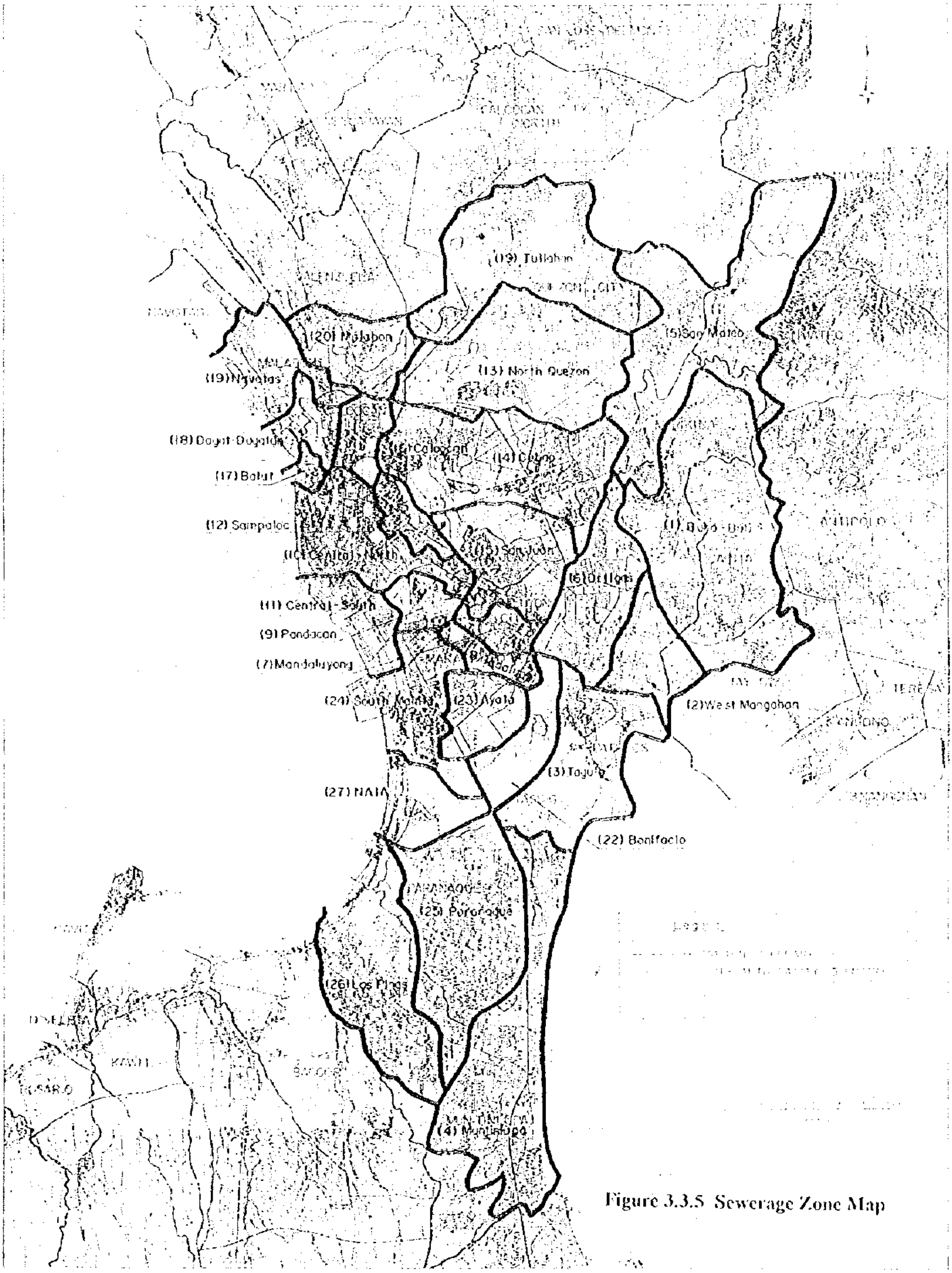


Figure 3.3.5 Sewerage Zone Map

Table 3.3.8 Zone-City/Municipality matrix

City/Municipality	zone	-1 Bali-Buho	-2 West Mangahan	-3 Taguig	-4 Muntinlupa	-5 San Mateo	-6 Ortigas	-7 Mandaluyong	-8 Gadalupe	-9 Pandacan	-10 North Central	-11 South Central	-12 Sampaloc	-13 North Quezon	-14 Cubao	-15 San Juan	-16 Caloocan	-17 Balut	-18 Dagat-Dagatan	-19 Tullahan	-20 Malabon	-21 Navotas	-22 Bonifacio	-23 Ayala	-24 South Manila	-25 Paranaque	-26 Las Pinas	-27 NAIA	Total
Manila	Area (ha)									540	1,739	818	285				145	98	10						215				3,850
	Pop. (person)									241,178	776,683	365,340	127,283				64,761	43,709	4,406						96,025				1,719,511
	Wastewater Daily Max. (cm/d)									59,652	192,101	90,361	31,483				16,018	10,826	1,105						23,750				425,295
	Wastewater Hourly Max (cm/d)									80,273	258,507	121,598	42,366				21,555	14,568	1,487						31,960				572,314
	Wastewater Daily Ave. (cm/d)									49,341	158,858	74,743	26,041				13,249	8,955	914						19,645				351,786
Pasay	Area (ha)																								1,074	83		603	1,760
	Pop. (person)																								315,917	24,417		177,389	517,753
	Wastewater Daily Max. (cm/d)																								74,165	5,732		41,640	121,537
	Wastewater Hourly Max (cm/d)																								97,387	7,526		54,678	159,592
	Wastewater Daily Ave. (cm/d)																								62,554	4,834		35,121	102,510
Quezon	Area (ha)					1,563	597						226	3,402	3,080	1,092				3,102									13,070
	Pop. (person)					318,797	121,767						46,096	693,888	629,043	222,729				632,608									2,665,818
	Wastewater Daily Max. (cm/d)					81,625	31,177						11,803	177,665	161,206	57,028				161,997									682,562
	Wastewater Hourly Max (cm/d)					104,838	40,066						15,168	228,318	207,245	73,287				208,184									877,166
	Wastewater Daily Ave. (cm/d)					69,909	26,733						10,120	152,338	138,277	48,898				138,904									585,250
Caloocan	Area (ha)													64	32		483		335	160	95	45							1,214
	Pop. (person)													30,212	19,106		288,378		200,014	95,529	56,720	26,808							724,827
	Wastewater Daily Max. (cm/d)													7,169	3,585		54,106		37,527	17,923	10,642	5,041							135,904
	Wastewater Hourly Max (cm/d)													9,653	4,827		72,851		50,528	24,133	14,329	6,787							183,108
	Wastewater Daily Ave. (cm/d)													5,928	2,964		44,734		31,027	14,819	8,799	4,108							112,430
Mandaluyong	Area (ha)						128	460								532													1,120
	Pop. (person)						34,278	120,188								142,469													299,935
	Wastewater Daily Max. (cm/d)						8,604	30,922								35,761													75,287
	Wastewater Hourly Max (cm/d)						11,278	40,530								46,874													98,682
	Wastewater Daily Ave. (cm/d)						7,267	26,117								30,205													63,590
Las Pinas	Area (ha)																									433	2,517		2,950
	Pop. (person)																									113,140	657,677		770,817
	Wastewater Daily Max. (cm/d)																									24,315	141,339		165,654
	Wastewater Hourly Max (cm/d)																									31,442	182,773		214,215
	Wastewater Daily Ave. (cm/d)																									20,751	120,622		141,373
Makati	Area (ha)								450															900	490				1,840
	Pop. (person)								136,993															273,985	149,170				560,148
	Wastewater Daily Max. (cm/d)								41,512															83,024	45,202				169,738
	Wastewater Hourly Max (cm/d)								55,417															110,833	60,343				226,593
	Wastewater Daily Ave. (cm/d)								34,560															69,119	37,631				141,310
Malabon	Area (ha)																		104		411	935							1,450
	Pop. (person)																		24,622		97,305	221,362							343,289
	Wastewater Daily Max. (cm/d)																		5,592		22,099	50,273							77,964
	Wastewater Hourly Max (cm/d)																		7,206		28,472	64,772							100,449
	Wastewater Daily Ave. (cm/d)																		4,785		18,912	43,023							66,721
Marikina	Area (ha)	1,306				895	79																						2,280
	Pop. (person)	295,576				202,558	17,879																						516,014
	Wastewater Daily Max. (cm/d)	72,065				49,379	4,359																						125,792
	Wastewater Hourly Max (cm/d)	93,041				63,761	5,628																						162,429
	Wastewater Daily Ave. (cm/d)	61,562				42,188	3,724																						107,474
Muntinlupa	Area (ha)				3,050																								3,050
	Pop. (person)				539,007																								539,007
	Wastewater Daily Max. (cm/d)				129,970																								129,970
	Wastewater Hourly Max (cm/d)				163,658																								163,658
	Wastewater Daily Ave. (cm/d)				113,126																								113,126
Navotas	Area (ha)																	40	227			273							540
	Pop. (person)																	22,114	125,494			150,925							298,533
	Wastewater Daily Max. (cm/d)																	3,945	22,386			26,922							53,253
	Wastewater Hourly Max (cm/d)																	5,283	29,978			36,063							71,314
	Wastewater Daily Ave. (cm/d)																	3,276	18,590			22,357							44,222
Paranaque	Area (ha)				158																					3,168	356	333	4,020
	Pop. (person)				23,675																					474,698	53,344	50,646	602,363
	Wastewater Daily Max. (cm/d)				6,543																					131,186	14,742	13,906	166,406
	Wastewater Hourly Max (cm/d)				8,212																					164,652	18,503	17,567	208,903
	Wastewater Daily Ave. (cm/d)				5,708																					114,452	12,861	12,211	145,233

Pasig	Area (ha)	1,100	1,023	247			790																						3,160
	Pop. (person)	240,661	223,815	54,039			172,838																						691,353
	Wastewater Daily Max. (cm/d)	55,900	51,995	12,554			40,152																						160,609
	Wastewater Hourly Max (cm/d)	71,672	66,654	16,094			51,473																						205,893
	Wastewater Daily Ave. (cm/d)	48,027	44,665	10,784			34,492																						137,907
Pateros	Area (ha)			185																									185
	Pop. (person)			66,256																									66,256
	Wastewater Daily Max. (cm/d)			13,459																									13,459
	Wastewater Hourly Max (cm/d)			17,732																									17,732
	Wastewater Daily Ave. (cm/d)			11,322																									11,322
San Juan	Area (ha)															620													620
	Pop. (person)															153,784													153,784
	Wastewater Daily Max. (cm/d)															41,787													41,787
	Wastewater Hourly Max (cm/d)															54,782													54,762
	Wastewater Daily Ave. (cm/d)															35,289													35,289
Taguig	Area (ha)			1,824	576				138														1,060						3,620
	Pop. (person)			325,818	103,247				24,651														192,918						646,634
	Wastewater Daily Max. (cm/d)			81,527	25,835				6,168														48,273						161,803
	Wastewater Hourly Max (cm/d)			103,194	32,701				7,807														61,102						204,804
	Wastewater Daily Ave. (cm/d)			70,694	22,402				5,349														41,858						140,302
Valenzuela	Area (ha)																			200	630								830
	Pop. (person)																			48,024	151,277								199,301
	Wastewater Daily Max. (cm/d)																			10,264	32,331								42,594
	Wastewater Hourly Max (cm/d)																			13,169	41,483								54,652
	Wastewater Daily Ave. (cm/d)																			8,811	27,754								36,565
Antipolo	Area (ha)	120																											120
	Pop. (person)	30,493																											30,493
	Wastewater Daily Max. (cm/d)	6,107																											6,107
	Wastewater Hourly Max (cm/d)	7,830																											7,830
	Wastewater Daily Ave. (cm/d)	5,246																											5,246
Cainta	Area (ha)	2,070																											2,070
	Pop. (person)	342,119																											342,119
	Wastewater Daily Max. (cm/d)	80,657																											80,657
	Wastewater Hourly Max (cm/d)	100,500																											100,500
	Wastewater Daily Ave. (cm/d)	70,736																											70,736
Rodriguez	Area (ha)					800																							800
	Pop. (person)					102,679																							102,679
	Wastewater Daily Max. (cm/d)					26,632																							26,632
	Wastewater Hourly Max (cm/d)					32,484																							32,484
	Wastewater Daily Ave. (cm/d)					23,706																							23,705
San Mateo	Area (ha)					1,250																							1,250
	Pop. (person)					184,616																							184,616
	Wastewater Daily Max. (cm/d)					44,365																							44,365
	Wastewater Hourly Max (cm/d)					54,612																							54,612
	Wastewater Daily Ave. (cm/d)					39,242																							39,242
Taytay	Area (ha)	655	238																										893
	Pop. (person)	126,210	45,860																										172,070
	Wastewater Daily Max. (cm/d)	28,757	10,449																										39,206
	Wastewater Hourly Max (cm/d)	36,329	13,201																										49,530
	Wastewater Daily Ave. (cm/d)	24,970	9,073																										34,043
Total	Area (ha)	5,251	1,261	2,256	3,786	4,508	1,594	460	588	540	1,739	818	511	3,466	3,120	2,244	620	138	676	3,462	1,136	1,253	1,060	900	1,779	3,604	2,873	941	50,692
	Pop. (person)	1,035,060	269,674	446,113	665,929	808,650	346,763	123,188	161,643	241,178	776,683	365,340	173,384	732,099	648,949	518,903	353,130	65,083	354,597	776,252	305,302	309,155	192,918	273,985	561,141	612,255	711,020	228,036	12,147,320
	Wastewater Daily Max. (cm/d)	243,484	62,444	107,540	162,347	202,002	84,293	30,922	47,680	59,652	192,161	90,361	43,285	184,834	164,851	134,576	70,124	14,770	66,610	190,185	65,071	82,236	48,273	83,024	143,117	161,232	156,081	55,637	2,946,732
	Wastewater Hourly Max (cm/d)	309,372	79,855	137,020	204,570	255,754	108,446	40,530	63,224	80,273	256,507	121,508	57,534	237,971	212,071	174,943	94,406	19,851	89,158	245,486	84,284	107,613	61,102	110,833	189,600	203,620	201,275	72,245	3,821,273
	Wastewater Daily Ave. (cm/d)	210,540	53,738	97,800	141,236	175,125	72,216	26,117	39,908	49,341	158,898	74,743	36,161	158,265	141,241	114,393	57,983	12,230	55,316	162,534	55,465	69,548	41,858	69,119	119,831	140,037	133,484	47,332	2,509,461

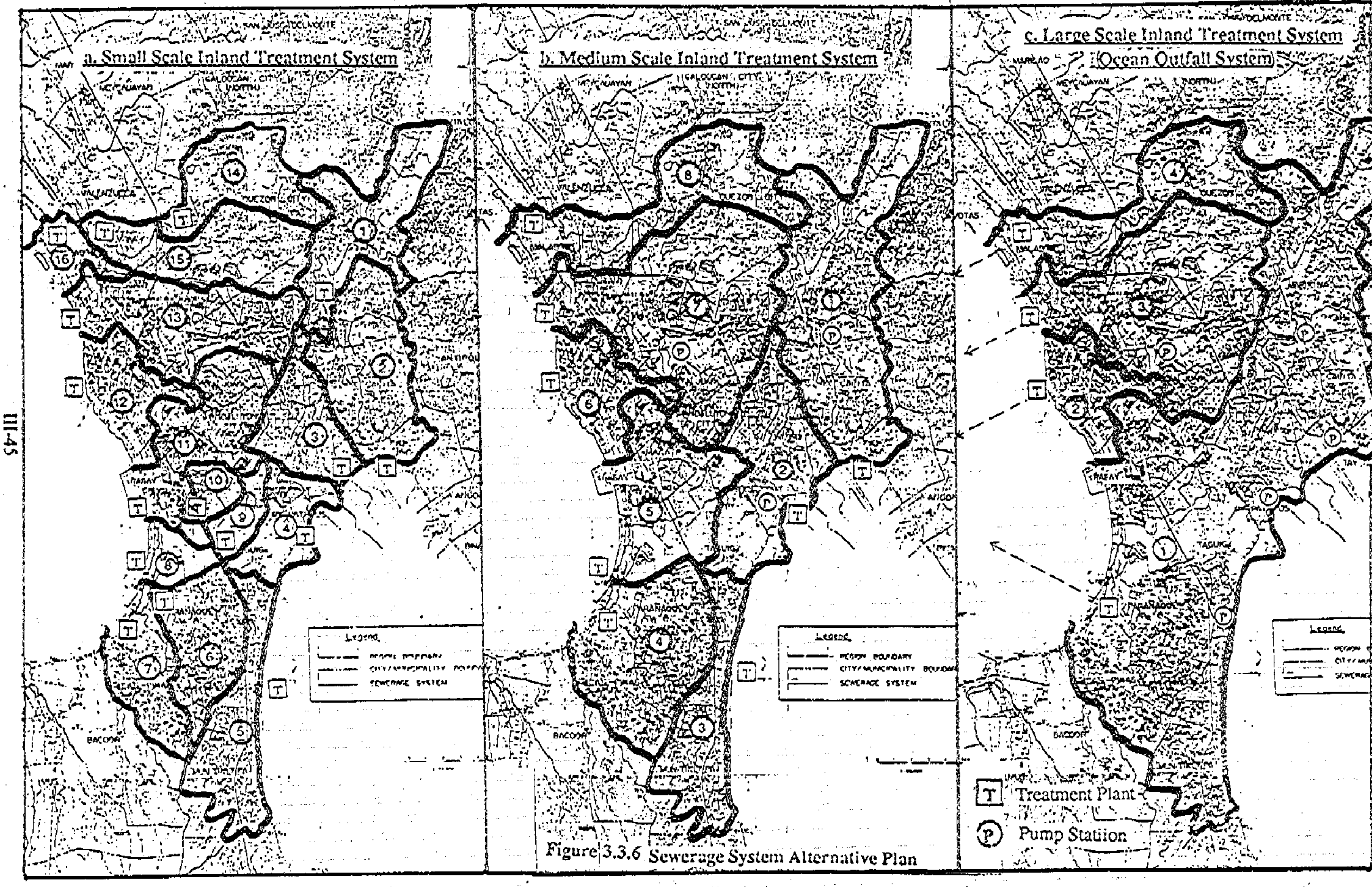


Figure 3.3.6 Sewerage System Alternative Plan

b. Medium Scale Inland Treatment System

Some of the small scale systems were integrated into the medium size system. The South System was divided into five areas, while the North and South System are same as in the former master plan.

c. Large Scale Inland Treatment System

Likewise, as in the former master plan, the collection method will be gathering the sewage toward Manila Bay from each river basin. Four large catchment areas (including the existing Central System) will have their own WWTP near the mouths of the NMTT, Pasig, and the Paranaque Rivers.

d. Ocean Outfall System

This system adopts same collection system of LSITS, but wastewater will be discharged through outfall into Manila Bay without treatment.

E. Improved Ocean Outfall System

Collection system will be the same as OOS and wastewater will undergo primary treatment (sedimentation) before being discharged into Manila Bay.

The ocean outfall length may be shortened due to the wastewater's improved quality but the mechanism and receiving capacity of Manila Bay has not been clarified enough to merit shortening the outfall's length.

(3) Comparison and evaluation of each plan

a.cost comparison

A cost comparison is shown in Table 3.3.9. Land acquisition price is disregarded. A breakdown of the cost is shown in supporting report in 1993 price base. The construction cost includes the interceptor/main trunk collection system, a huge pumping station, a treatment plant, and an outfall system. To simplify the comparison, the treatment method assumed is the aerated lagoon method.

Table 3.3.9 Cost Comparison of Each System

System	Construction Cost (million Pesos)	Operation & Maintenance Cost (million Pesos)		Total Cost (million Pesos)	Remarks
		Annually	30 years		
SITS	14,399	134	4,020	18,419	
MSITS	12,697	130	3,900	16,597	
LSITS	11,254	133	3,990	15,244	
OOS	15,247	151	4,500	19,747	
IOOS	18,773	185	5,550	24,323	

From the above table, MSITS and LSITS look advantageous.

b.Other factors

Other factors considered are shown below.

Table 3.3.10 Comparison Table of Sewerage System

	SSITS	MSITS	LSITS	OOS	IOOS
Environmental Impact	no bad influence to the water bodies	no bad influence to the water bodies	no bad influence to the water bodies	raw sewage discharged into Manila Bay have bad influence on not only ecology but also human health through pollution, food chain	influence is lower than OOS but still highly dangerous to ecology
Flexibility of Implementation	Priority area can be initially implemented	flexible implementation is rather possible compared to LSITS	local area implementation is affected by long trunk main and remote treatment plant site	same as LSITS	same as LSITS
Operational Effectiveness	Too many treatment plants make operation complicated	appropriate areawise operation and maintenance system is possible	Central control and operation is effective	same as LSITS. Operation includes check of bay water condition	Same as OOS
Investment Impact	One catchment area is small and initial investment works well	moderate invest-benefit effect can be accomplished	Due to its large catchment area, initial investment-effect is low	same as LSITS	same as LSITS

c. Recommendation

From the environmental and health points of view, the Ocean Outfall System is not recommended. Of the three inland treatment systems, the medium scale inland treatment system is the most advantageous from the other plans due to its flexibility and low initial investment cost.

(4) Optimization of the plan

Of the recommended MSITS catchment area, some additional optimization were considered taking into account the following items: the future development areas, the Dagat-Dagatan WWTP upgrading, and potential WWTP site.

① area (number is in accordance with the MSITS number in Figure 4.4): This has a narrow and long (20km) catchment area. At the early implementation of the upper Marikina river, it should be divided into two areas. It is better to draw the boundary line not according to drainage basin, but along the Marcos Highway or municipality boundary line, considering the densely populated Marikina area. A final decision should be made about the acquisition of the treatment plant area. The wastewater in the Marikina municipal area in the Bali-Buho sewerage zone will be converted into the San Mateo sewerage zone.

Area	1,306 ha
Pop.	295,576 persons
Wastewater(daily max)	72,055 m3/d

⑤ area: This can be divided into a catchment area with the existing Ayala System and the future development plan to initially save on cost. The Ayala System can stay for the time being until after the MSSP rehabilitation. Large scale developments like the Fort Bonifacio and Villamor Air Base areas should have an independent sewerage system with the cost to be shouldered by the developer. NAIA has its own treatment facility and its wastewater should be exempted from the lower area planning.

⑥ and ⑦ area

Three plans were considered and compared. Alternative figure is shown in Figure

(Case 1)

Treatment plant site will be secured in San Juan river basin by transfer/removal of built-up area. The Tondo pump station will deliver its sewage to Dagat-Dagatan WWTP, which will be upgraded to a secondary treatment plant for the Central System and its expansion area as proposed in MSSP.

(Case 2)

Treatment plant site for San Juan river basin will be secured in the Malabon-Navotas area together with the North System. The Tondo Pump Station will deliver its sewage to the Dagat-Dagatan WWTP, which will be upgraded to a secondary treatment plant for the Central System and its expansion area as proposed in the MSSP.

Two alternatives of Case 2 can be considered; (1) Case 2(a) ; A treatment plant site is acquired in the Laguna Lake shore area adjacent to the West Mangahan treatment plant site and (2) Case 2(b) ; A treatment plant site is secured in the Manila Bay Reclamation Area next to the South Manila System treatment plant. Case 2(a) is cheaper than case 2 because force main can be shortened but its plan transfer 6.0 m3/s of wastewater to the upper stream of Pasig River. Its hydrological effects hinders the adoption of this plan. Case 2(b) requires significant land reclamation and its probability is very small.

(case 3)

A new treatment plant for Central System will be constructed in a reclaimed area in Manila Bay near the Tondo pump station. The Dagat-Dagatan WWTP will be developed for the San Juan river basin area.

To make efficient use of the limited land, Dagat-Dagatan WWTP area should be utilized to the fullest. About 16 ha (including future Module 3 area now occupied by squatters) can provide about 500,000 m^3/d of treatment capacity using activated sludge method.

From the probability of land acquisition, case 2 is recommended.

Table 3.3.11 Comparison of Optimization Plan

	Case 1	Case 2	case 3
Construction cost	174million pesos	4626million pesos	5406 million pesos
Land Acquisition	Land acquisition near the confluence of San Juan and Pasig is difficult	Marine pond area is easier to secure than other place	Reclamation off the Tondo Pump Station is difficult

Breakdown is shown insupporting report.

Optimized plan is shown in Figure 3.3.8.

Outline of each catchment area is shown in Table 3.3.12. North Manila is divided into two sub-catchment areas.

Marikina system

The interceptor/Main trunk is installed along J P Rizal road and treatment plant is situated near the Marikina river. Due to site constraint, the oxidation ditch method is considered.

East Mangahan

The main trunk is along Imelda Avenue and treatment plant will be constructed in the rice field near the confluence of the Baho River and Manggahan flood way. The treatment method is an aerated lagoon method.

West Mangahan

The main trunk comes from the Ortigas area passing the Marikina River through Pasig to the boundary area of Pasig/Cainta/Taguig where an aerated lagoon plant will be built.

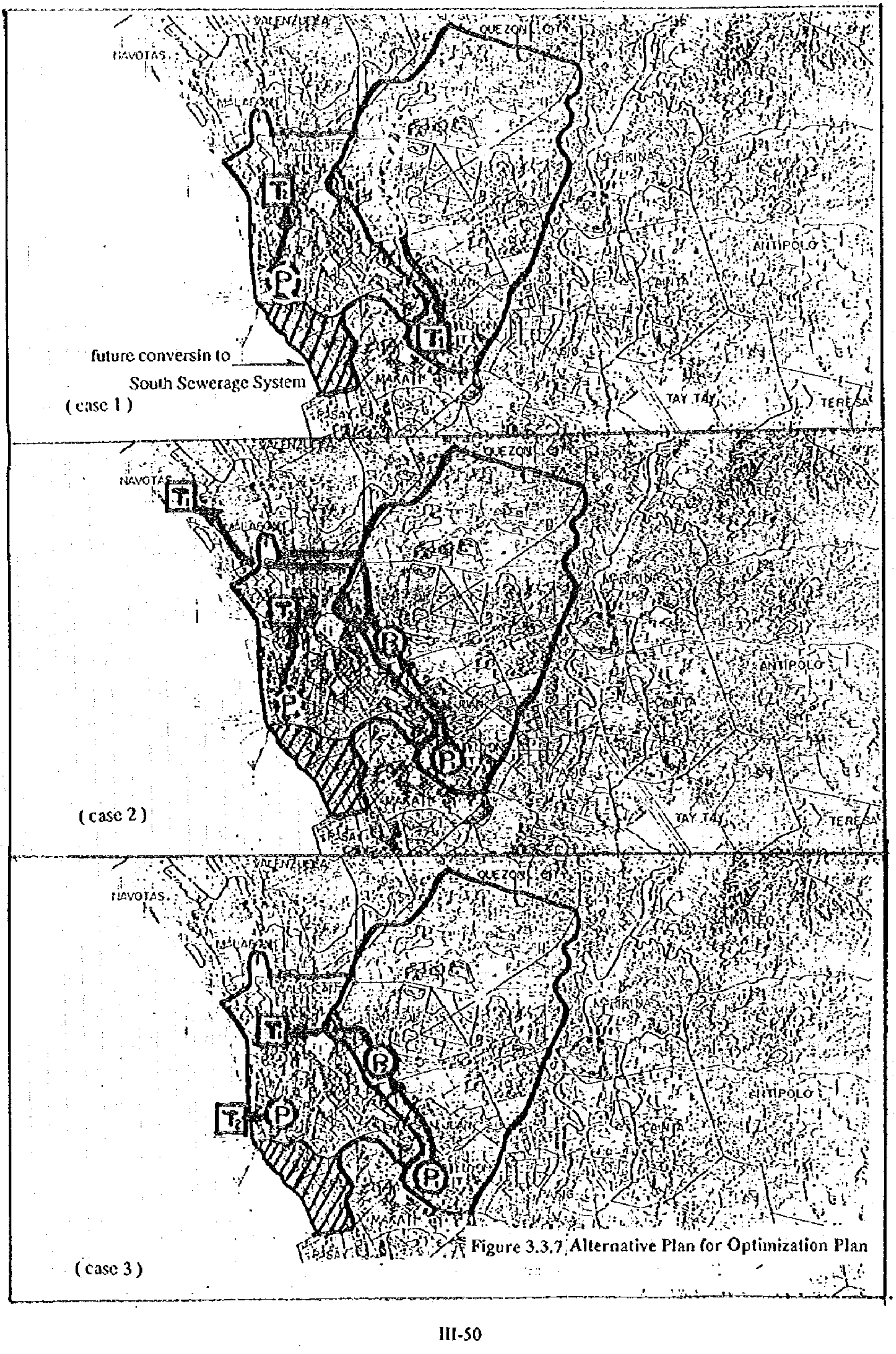


Figure 3.3.7 Alternative Plan for Optimization Plan

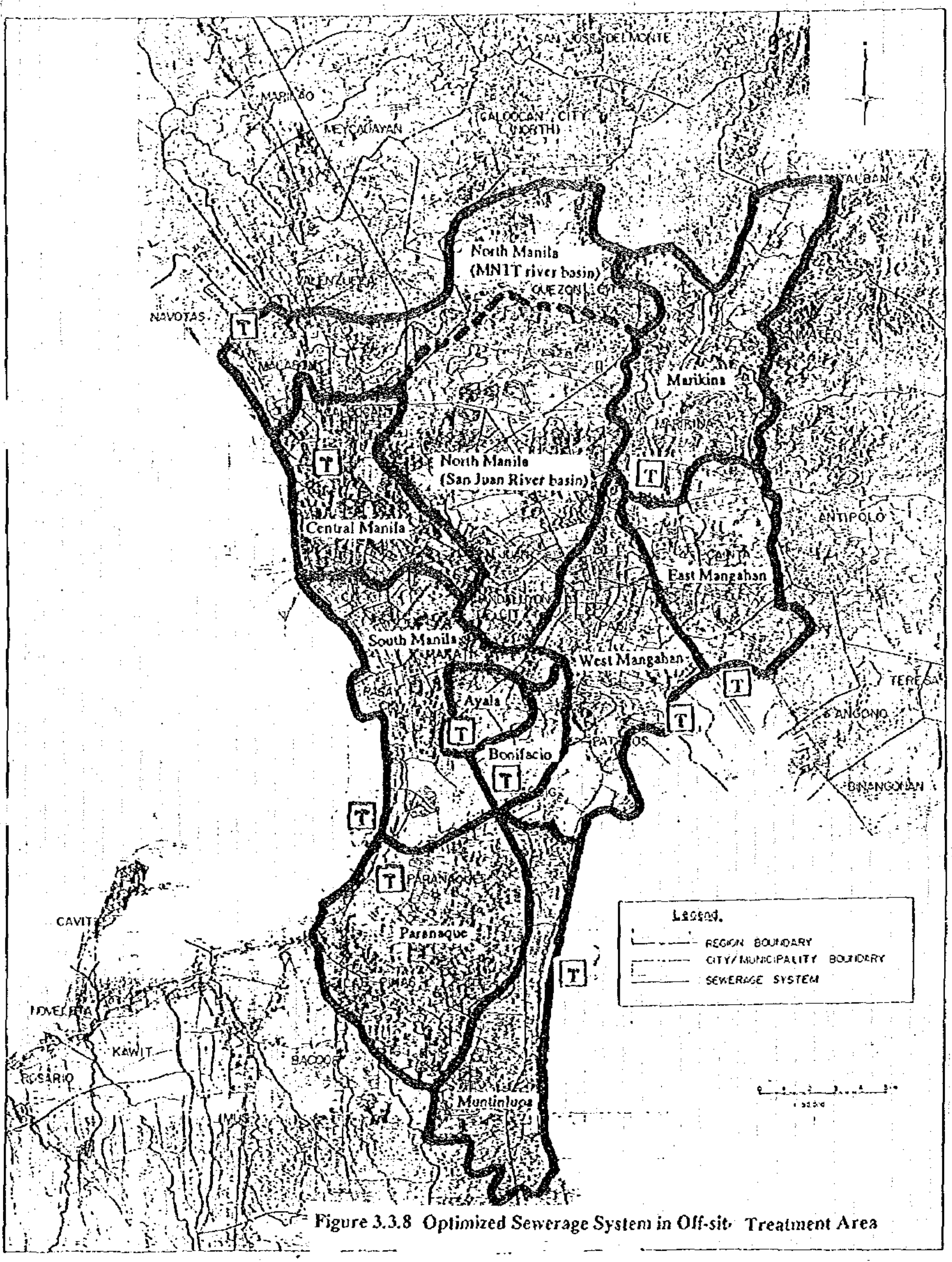


Figure 3.3.8 Optimized Sewerage System in Off-site Treatment Area

Table 3.3.12 Outline of Sewerage System

	System Name	Zone	Area (ha)	Population (persons)	Wastewater (dailymax) (m^3/D)
1	Marikina	San Mateo, Part of Baho-Buli	5,814	1,104,226	274,057
2	East Mangahan	Baho-Buli	3,945	739,484	171,429
3	West Mangahan	Ortigas,West Mangahan, Taguig	5,111	1,062,550	254,277
4	Muntinlupa	Muntinlupa	3,786	665,929	162,347
5	Paranaque	Paranaque, Las Pinas	6,557	1,323,275	317,313
6	South Manila	Central-south Pandacan, Gadalupe, South Manila NAIA	4,666	1,557,338	396,447
7	Ayala	Ayala	900	273,985	83,024
8	Bonifacio	Bonifacio	1,080	192,918	48,273
9	Central Manila	Central North Sampaloc, Balut, DagatDagatan Caloocan	3,692	1,723,686	386,890
10	North Manila (MNTT river basin)	Tuliahan, Malabon, Navotas,	5,851	1,480,709	337,492
	North Manila (San Juan River basin)	North Quezon, Cubao, San Juan, Mandaluyong	9,290	2,023,217	515,183
	sub-total		15,141	3,503,926	852,675
	Total		50,692	12,147,320	2,946,732

Muntinlupa

Reclamation area in Laguna Lake has to be efficiently used and activated sludge, which needs least area, is as the considered treatment method

Paranaque

The trunk main is installed to intercept wastewater running from the highland to Manila Bay. The treatment plant is located in the low land now being used for a marine pond. An aerated lagoon is considered.

South Manila

Tthe treatment plant will be constructed either in the reclamation areas or the marine pond area considering the land cost and possibility of acquisition. Staged development is studied in this area because this area includes future conversion area where is now temporarily connected to